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AGU-FM12

December 03 - 07, 2012

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Monday, December 03, 2012

Time	Session Info
8:00 AM-12:20 PM, Hall A-C (Moscone South), **B11B. Hyperspectral Remote Sensing of Vegetation: Knowledge Gain and Knowledge Gap Based on 40 Years of Research Posters**	
8:00-8:00 AM	**B11B-0419. Fusing Hyperspectral and LiDAR data from CAO-VSWIR for Increased Data Dimensionality** D.E. Knapp; G.P. Asner; J.W. Boardman; T. Kennedy-Bowdoin; M. Eastwood; C. Anderson; R.E. Martin; R.O. Green
8:00 AM-12:20 PM, Hall A-C (Moscone South), **IN11B. Informatics in Hydrological Modeling and Information Communication Posters**	
8:00-8:00 AM	**IN11B-1464. Future of Hydroinformatics: Towards Open, Integrated and Interactive Online Platforms** I. Demir; W.F. Krajewski
8:00 AM-10:00 AM, 2020 (Moscone West), **IN11F. Open Source Technologies and Architectures Facilitating Science Data Center Collaboration and Management II**	
8:30-8:45 AM	**IN11F-03. Combining data from multiple sources using the CUAHSI Hydrologic Information System *(Invited)*** D.G. Tarboton; D.P. Ames; J.S. Horsburgh; J.L. Goodall
8:00 AM-10:00 AM, 304 (Moscone South), **NH11D. Advances in Landslide Hazard Research: Assessment, Monitoring, and Forecasting I**	
9:00-9:15 AM	**NH11D-04. AUTOMATIC AND OBJECTIVE DETECTION OF SHALLOW LANDSLIDES FROM LIDAR-DERIVED, HIGH-RESOLUTION DIGITAL ELEVATION MODELS USING A WAVELET TRANSFORM** W.J. Reeder; J.A. McKean; D. Tonina
10:20 AM-12:20 PM, 2020 (Moscone West), **IN12A. Free and Open Source Software (FOSS) for Geoinformatics and Geosciences I**	
10:20-10:35 AM (Conflict)	**IN12A-01. Free and Open Source Software for Geospatial in the field of planetary science *(Invited)*** A. Frigeri
10:20 AM-12:20 PM, 304 (Moscone South), **NH12A. Advances in Landslide Hazard Research: Assessment, Monitoring, and Forecasting II**	
10:20-10:35 AM (Conflict)	**NH12A-01. Multi-Dimensional Shallow Landslide Stability Analysis Suitable for Application at the Watershed Scale** D. Milledge; D. Bellugi; J.A. McKean; W. Dietrich
10:20 AM-12:20 PM, 2020 (Moscone West), **IN12A. Free and Open Source Software (FOSS) for Geoinformatics and Geosciences I**	

10:35-10:50 AM (Conflict)	**IN12A-02. Earth-Base: testing the temporal congruency of paleontological collections and geologic maps of North America** N.A. Heim; P. Kishor; M. McClennen; S.E. Peters
10:20 AM-12:20 PM, 304 (Moscone South), **NH12A. Advances in Landslide Hazard Research: Assessment, Monitoring, and Forecasting II**	
10:35-10:50 AM (Conflict)	**NH12A-02. Hydrologic Controls on Shallow Landslide Location, Size, and Shape *(Invited)*** D. Bellugi; D. Milledge; T. Perron; J.A. McKean; W. Dietrich; M. Rulli
10:20 AM-12:20 PM, 2020 (Moscone West), **IN12A. Free and Open Source Software (FOSS) for Geoinformatics and Geosciences I**	
10:50-11:05 AM	**IN12A-03. The Future of ECHO: Evaluating Open Source Possibilities** D. Pilone; J. Gilman; K. Baynes; A.E. Mitchell
11:05-11:20 AM	**IN12A-04. From Particles and Point Clouds to Voxel Models: High Resolution Modeling of Dynamic Landscapes in Open Source GIS *(Invited)*** H. Mitasova; E.J. Hardin; A. Kratochvilova; M. Landa
10:20 AM-12:20 PM, 3001 (Moscone West), **GC12B. Sustainable Future: Climate, Resources, and Development I**	
11:20-11:35 AM (Conflict)	**GC12B-05. Sharing Water Data to Encourage Sustainable Choices in Areas of the Marcellus Shale *(Invited)*** S.L. Brantley; J.D. Abad; J. Vastine; D. Yoxtheimer; C. Wilderman; R. Vidic; R.P. Hooper; K. Brasier
10:20 AM-12:20 PM, 2020 (Moscone West), **IN12A. Free and Open Source Software (FOSS) for Geoinformatics and Geosciences I**	
11:20-11:35 AM (Conflict)	**IN12A-05. A Modular GIS-Based Software Architecture for Model Parameter Estimation using the Method of Anchored Distributions (MAD)** D.P. Ames; C. Osorio-Murillo; M.W. Over; Y. Rubin
11:35-11:50 AM	**Abstract Withdrawn**
11:50-12:05 PM	**IN12A-07. FOSS GIS on the GFZ HPC cluster: Towards a service-oriented Scientific Geocomputation Environment.** P. Loewe; J. Klump; J. Thaler
12:05-12:20 PM	**IN12A-08. An Open Source Tool to Test Interoperability** L.E. Bermudez
1:40 PM-6:00 PM, Hall A-C (Moscone South), **B13E. Warming waters: Role of Freshwaters in Regional and Global Carbon and Nutrient Cycling III Posters**	
1:40-1:40 PM	**B13E-0573. Whole watershed quantification of net carbon fluxes by erosion and deposition within the Christina River Basin Critical Zone Observatory** A.K. Aufdenkampe; D.L. Karwan; R.E. Aalto; J. Marquard; K. Yoo; B. Wenell; C. Chen

1:40 PM-6:00 PM, Hall A-C (Moscone South), **EP13B. Earth and Planetary Surface Processes General Contributions II: Tectonic, Hillslope, and Glacial Geomorphology Posters**	
1:40-1:40 PM	**EP13B-0843. Deformation of marine terraces in coastal Humboldt County, California: an evaluation using GIS-based analysis of LiDAR imagery** J.S. Padgett; H.M. Kelsey; D. Lamphear
1:40 PM-6:00 PM, Hall A-C (Moscone South), **EP13C. Earth and Planetary Surface Processes General Contributions III: Remote Sensing, Chronology, Aeolian, Planetary, Coastal, and Marine Posters**	
1:40-1:40 PM	**EP13C-0858. Lidar-enhanced geologic mapping, examples from the Medford and Hood River areas, Oregon** T.J. Wiley; J.D. McClaughry
1:40-1:40 PM	**EP13C-0859. Multi-resolution estimation of lidar-DTM surface flow metrics to identify characteristic topographic length scales** H. Sangireddy; P. Passalacqua; C.P. Stark
1:40 PM-6:00 PM, Hall A-C (Moscone South), **EP13E. Recent Progress in Understanding Physical and Ecological Effects of Large-Dam Removal I Posters**	
1:40-1:40 PM	**EP13E-0895. Using Repeat LiDAR Surveys to Determine the Geomorphic Changes Related the Removal of the Marmot Dam on the Sandy River, Oregon** C.D. Matzek; L.L. Ely; J.E. O'Connor
1:40 PM-6:00 PM, Hall A-C (Moscone South), **H13C. Deciphering Hydrological and Biogeochemical Processes in Catchment Studies With a Focus on New Measurement Technologies and Hysteresis Analysis II Posters**	
1:40-1:40 PM	**H13C-1355. Dynamic chemistry in the perched groundwater flowing through weathered bedrock underling a steep forested hillslope, north California** H. Kim; D.M. Rempe; J.K. Bishop; W. Dietrich; I. Fung; T.J. Wood
1:40 PM-6:00 PM, Hall A-C (Moscone South), **IN13A. Free and Open Source Software (FOSS) for Geoinformatics and Geosciences II Posters**	
1:40-1:40 PM	**IN13A-1494. An Accessible User Interface for Geoscience and Programming** E.O. Sevre; S. Lee
1:40-1:40 PM	**IN13A-1495. Web Viz 2.0: A versatile suite of tools for collaboration and visualization** C. Spencer; D.A. Yuen
1:40-1:40 PM	**IN13A-1496. JMARS - Planetary Remote Sensing Analysis Made Even Easier** S. Dickenshied; P.R. Christensen; D. Noss; S. Anwar; S. Carter; M.E. Smith
1:40-1:40 PM	**IN13A-1497. Interoperability of Multiple Datasets with JMARS** M.E. Smith; P.R. Christensen; D. Noss; S. Anwar; S. Dickenshied
1:40-1:40 PM	**IN13A-1498. Earth-Base: A Free And Open Source, RESTful Earth Sciences Platform** P. Kishor; N.A. Heim; S.E. Peters; M. McClennen

1:40-1:40 PM	**IN13A-1499. Collaboratory for the Study of Earthquake Predictability: Recent Developments and Extensions** M. Liukis; D. Schorlemmer; J. Yu; P.J. Maechling; J.D. Zechar; M.J. Werner; T.H. Jordan; T. Working Group
1:40-1:40 PM	**IN13A-1500. Open source software engineering for geoscientific modeling applications** L. Bilke; K. Rink; T. Fischer; O. Kolditz
1:40-1:40 PM	**IN13A-1501. Hardware and Software Interfacing at New Mexico Geochronology Research Laboratory: Distributed Control Using Pychron and RemoteControlServer.cs** W.C. McIntosh; J.I. Ross
1:40-1:40 PM	**IN13A-1502. Caching strategies for improving performance of web-based Geographic applications** M. Liu; M. Brodzik; J.A. Collins; S. Lewis; J. Oldenburg
1:40 PM-6:00 PM, Hall A-C (Moscone South), **IN13B. Open Data for Open Science in Geoinformatics Posters**	
1:40-1:40 PM	**IN13B-1503. OOI's Cyberinfrastructure: An Opening** J. Graybeal; T. Ampe; M. Arrott; A.D. Chave; R. Cressey; S. Jul; T. McPhail; M. Meisinger; J.A. Orcutt; C.L. Peach; O. Schofield; K. Stocks; J. Thomas; F. Vernon
1:40-1:40 PM	**IN13B-1504. Data Management for Flexible Access - Implementation and Lessons Learned from work with Multiple User Communities *(Invited)*** K.K. Benedict; S. Scott; W.B. Hudspeth
1:40-1:40 PM	**IN13B-1505. Opening Data in the Long Tail for Community Discovery, Curation and Action Using Active and Social Curation *(Invited)*** M.L. Hedstrom; P. Kumar; J. Myers; B.A. Plale
1:40-1:40 PM	**IN13B-1506. Active and Social Data Curation: Reinventing the Business of Community-scale Lifecycle Data Management** R.H. McDonald; P. Kumar; B.A. Plale; J. Myers; M.L. Hedstrom
1:40 PM-6:00 PM, Hall A-C (Moscone South), **NH13A. Advances in Landslide Hazard Research: Assessment, Monitoring, and Forecasting III Posters**	
1:40-1:40 PM	**NH13A-1598. LiDAR data and SAR imagery acquired by an unmanned helicopter for rapid landslide investigation** M. Kasai; Y. Tanaka; T. Yamazaki
4:00 PM-6:00 PM, 3007 (Moscone West), **C14B. Snow Cover–Vegetation Interactions I**	
5:00-5:15 PM	**C14B-05. Integration of airborne LiDAR data and voxel-based ray tracing to determine high-resolution solar radiation dynamics at the forest floor: implications for improving stand-scale distributed snowmelt models** K.N. Musselman; N.P. Molotch; S.A. Margulis

5:45-6:00 PM	**C14B-08. Under-canopy snow accumulation and ablation measured with airborne scanning LiDAR altimetry and in-situ instrumental measurements, southern Sierra Nevada, California** P.B. Kirchner; R.C. Bales; K.N. Musselman ; N.P. Molotch

Tuesday, December 04, 2012

Time	Session Info
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H21B. Advanced Watershed Characterization Using Remote Sensing Posters**	
8:00-8:00 AM	**H21B-1171. Understanding the interaction of climate, vegetation, channelization, and landsliding through lidar analysis** ***(Invited)*** P. Passalacqua; C.P. Stark
8:00-8:00 AM	**H21B-1180. Assessing riparian shade for the Lemhi River, Idaho using LiDAR: A point cloud analysis** L. Spaete; N.F. Glenn; R. Shrestha; M.L. Shumar; J. Mitchell
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H21H. Remote Sensing Applications in Hydrology V Posters**	
8:00-8:00 AM	**H21H-1274. Using LiDAR data to spatially scale and examine the accuracy of evapotranspiration estimates in the Western Boreal Plains, Canada** G. Sutherland; R.M. Petrone; L.E. Chasmer; K.J. Devito
8:00 AM-12:20 PM, Hall A-C (Moscone South), **IN21C. Large-Scale Data Analytics in Earth System Science I Posters**	
8:00-8:00 AM	**IN43B-1523. Development of teaching modules for geology and engineering coursework using terrestrial LiDAR scanning systems** L.D. Yarbrough; K. Katzenstein
10:20 AM-12:20 PM, 3008 (Moscone West), **GC22C. Geomorphology, Ecology, and Climate Coupling in Mountain Environments**	
10:50-11:05 AM	**GC22C-03. Coupled Modeling of Geomorphology and Ecohydrology: Topographic feedbacks driven by solar radiation** ***(Invited)*** E. Istanbulluoglu; J.H. Flores Cervantes; O. Yetemen
10:20 AM-12:20 PM, 3011 (Moscone West), **G22A. 4-D LiDAR Topography and Geodetic Imaging I**	
11:35-11:50 AM	**G22A-06. A Balloon-LIDAR (BLIDAR) for Earthquake Science** ***(Invited)*** B.A. Brooks; C.L. Glennie; K.W. Hudnut; T.L. Ericksen; J.H. Foster; D. Hauser; J. Avery

12:30 PM-1:30 PM, 2008 (Moscone West), **TH22G. Update on EarthCube: Past, Present, and Future**	
12:30-1:30 PM	**Update on EarthCube: Past, Present, and Future** C.A. Jacobs; E.E. Zanzerkia
1:40 PM-6:00 PM, Hall A-C (Moscone South), **A23B. Atmospheric Impacts of Oil and Gas Development III Posters**	
1:40-1:40 PM	**A23B-0196. LIDAR first results from the Oil Sands Region: A complex vertical atmosphere** K.B. Strawbridge
1:40 PM-6:00 PM, Hall A-C (Moscone South), **EP23C. Biophysical Interactions in Riverine Landscapes I Posters**	
1:40-1:40 PM	**EP23C-0825. Can erosion control structures in large dryland arroyo channels lead to resilient riparian and cienega restoration? Observations from LiDAR, monitoring and modeling at Rancho San Bernardino, Sonora, MX** S. DeLong; W.M. Henderson
1:40 PM-6:00 PM, Hall A-C (Moscone South), **G23A. 4-D LiDAR Topography and Geodetic Imaging II Posters**	
1:40-1:40 PM	**G23A-0897. Identifying Riverine Erosional Hotspots Using Airborne Lidar** M.J. Wick; K.B. Gran
1:40-1:40 PM	**G23A-0898. Interpolating Stage-Discharge Relationships using Serial LiDAR along the Sandy River, Oregon** I. Madin; J.T. English
1:40-1:40 PM	**G23A-0899. Determining Leaf-Angle Distribution of Vineyards in Delano, CA Using Terrestrial LiDAR** A. Hopkins; S. Grigsby; A. Harburger; S. Ustin
4:00 PM-5:00 PM, 104 (Moscone South), **IN24B. Leptoukh Lecture (Video On-Demand)**	
4:00-5:00 PM	**IN24B-01. Bridging Informatics and Earth Science: a Look at Gregory Leptoukh's Contributions** C. Lynnes
4:00 PM-6:00 PM, 3002 (Moscone West), **B24A. Disturbance Impacts and Responses II (Video On-Demand)**	
5:00-5:15 PM	**B24A-05. Summertime Climate Response to Mountain Pine Beetle Disturbance** H. Maness; P.J. Kushner; I. Fung

Wednesday, December 05, 2012

Time	Session Info
8:00 AM-12:20 PM, Hall A-C (Moscone South), **A31B. Geostationary Measurements of Global Atmospheric Composition II Posters**	

8:00-8:00 AM	**A31B-0028. Groundbreaking constraints on emissions from GEO-CAPE: case studies of CH4, NH3, SO2 and NO2.** G. Jeong; J.O. Bash; K.E. Cady-Pereira; D.K. Henze; R.C. Cohen; N.A. Krotkov; L. Lamsal; C. Li; K. Wecht; J. Worden; H.M. Worden; A. Perkins
8:00 AM-12:20 PM, Hall A-C (Moscone South), **A31F. Weather-Driven Renewable Energy II Posters**	
8:00-8:00 AM	**A31F-0109. Wind turbine wake properties from Doppler lidar measurements** Y. Pichugina; R.M. Banta; A. Brewer; J.K. Lundquist
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP31B. Ecogeomorphology: Footprints on a Landscape I Posters**	
8:00-8:00 AM	**EP31B-0809. Hydrographic network control of the spatial variation in tropical forest structure revealed by airborne LIDAR-derived mean canopy profile height** M. Detto; H. Muller-Landau; G.P. Asner; J. Mascaro
8:00-8:00 AM	**EP31B-0810. Linking morphology to ecosystem structure using air-borne lidar and Hyperspectral sensors for monitoring the Coastal Landscape** A. Taramelli; E. Valentini; C. Innocenti; F. Filipponi; R. Proietti; L. Nicoletti; M. Gabellini
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP31C. Quantifying Hillslope and Fluvial Processes Through Change Detection Using High-Resolution, Multitemporal Topographic Data I Posters**	
8:00-8:00 AM	**EP31C-0831. Evaluating dryland ecological and river restoration using repeat LiDAR and hydrological monitoring** W.M. Henderson; S. DeLong
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP31D. Tracers, Transport, and Topography: Theory and Technology for Tractive Tracking I Posters**	
8:00-8:00 AM	**EP31D-0838. Evaluating bedload transport with RFID and accelerometer tracers, airborne LiDAR, and HEC-GeoRAS modeling: field experiments in Reynolds Creek, Idaho** L. Olinde; J.P. Johnson; F.B. Pierson
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H31E. Remote Sensing of Riverscape Topography I Posters**	
8:00-8:00 AM	**H31E-1171. UTILITY OF CLOSE-RANGE REMOTE SENSING TECHNIQUES FOR MAPPING TOPOGRAPHY AND BATHYMETRY IN SMALL STREAMS** M.A. Fonstad; J. Dietrich
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H31G. Using Field Measurements and Experiments to Advance Science II Posters**	
8:00-8:00 AM	**H31G-1200. Identification of Hot Moments and Hot Spots for Real-Time Adaptive Control of Multi-scale Environmental Sensor Networks** T. Wietsma; B.S. Minsker

8:00-8:00 AM	**H31G-1218. Sensor-based actuation of water samplers in wireless sensor networks** P. Schneider; D. Burgener; J. Beutel; A. Wombacher; J. Seibert
8:00 AM-10:00 AM, 3022 (Moscone West), **H31N. Recent Advances in Modeling Water in the Coupled Earth System I**	
8:00-8:15 AM	**H31N-01. Progress and opportunities in Earth System model coupling with emphasis on hydrological model components** ***(Invited)*** D.J. Gochis; S.D. Peckham; J.S. Arrigo; J.S. Famiglietti; C.M. Ammann; J.T. Reager; J. Edman
8:00 AM-12:20 PM, Hall A-C (Moscone South), **IN31B. Environmental Sensor Networks and Informatics Posters**	
8:00-8:00 AM	**IN31B-1501. The Open Geospatial Consortium PUCK Standard: Building Sensor Networks with Self-Describing Instruments** ***(Invited)*** T.C. O'Reilly; A. Broering; J. del Rio; K.L. Headley; D. Toma; L.E. Bermudez; D. Edgington; J. Fredericks; A. Manuel
8:00 AM-10:00 AM, 3022 (Moscone West), **H31N. Recent Advances in Modeling Water in the Coupled Earth System I**	
9:45-10:00 AM	**H31N-08. The Essential Terrestrial Variables (ETV's) in Support of a National Framework for Numerical Watershed Prediction** ***(Invited)*** C. Duffy; L.N. Leonard; S. Ahalt; R. Idaszak; D. Tarboton; R.P. Hooper; L.E. Band
10:20 AM-12:20 PM, 2008 (Moscone West), **B32A. Chemical Indicators of Pathways in the Water Cycle I**	
10:20-10:35 AM (Conflict)	**B32A-01. Tracking raindrops: following water from its origin through a hillslope watershed** ***(Invited)*** T.E. Dawson
10:20 AM-12:20 PM, 2002 (Moscone West), **B32D. Remote Characterization of Vegetation Structure, Function, and Condition I**	
10:20-10:30 AM (Conflict)	**Introduction** Session opening remarks
10:30-10:50 AM (Conflict)	**B32D-03. Application of Single Photon Lidar for Retrieval of Ecosystem Structure** ***(Invited)*** R. Dubayah; M.A. Lefsky; D.J. Harding; P. Decola
10:50-11:05 AM	**B32D-04. Analysis of MABEL data (an ICESat-2 instrument simulator) for ecosystem studies** A.L. Neuenschwander; D. Pederson; L.A. Magruder
11:05-11:20 AM	**B32D-05. Estimating terrestrial aboveground biomass estimation using lidar remote sensing: a meta-analysis** S.G. Zolkos; S.J. Goetz; R. Dubayah

11:20-11:35 AM	**B32D-06. RADAR BACKSCATTER SATURATION WITH FOREST BIOMASS: FACTS AND MYTHS** S.S. Saatchi
11:35-11:50 AM	**B32D-07. Development of LiDAR aware allometrics for Abies grandis: A Case Study** G.A. Stone; W.T. Tinkham; A.M. Smith; A.T. Hudak; M.J. Falkowski; R. Keefe
11:50-12:05 PM	**B32D-08. Subcanopy Solar Radiation Model: an irradiation model for predicting light in heavily vegetated landscapes** C.A. Bode; M.P. Limm; J.C. Finlay; M. Power
12:05-12:20 PM	**B32D-09. Lidar based vegetation height models to quantify carbon stocks in Galveston saltmarshes** R.W. Kulawardhana; S.C. Popescu; R.A. Feagin
1:40 PM-6:00 PM, Hall A-C (Moscone South), **A33I.* Remote Sensing of CO2, CO, and CH4: Emerging Challenges I Posters**	
1:40-1:40 PM	**A33I-0257. Aerosol information content analysis of multi-angle high spectral resolution measurements and its benefit for high accuracy greenhouse gas retrievals** C.W. O'Dell; C. Frankenberg; O.P. Hasekamp; S. Sanghavi; A. Butz; J. Worden
1:40-1:40 PM	**A33I-0262. Satellite based estimates of reduced CO and CO2 emissions due to traffic restrictions during the 2008 Beijing Olympics** H.M. Worden; Y. Cheng; G. Pfister; G.R. Carmichael; Q. Zhang; D.G. Streets; M.N. Deeter; D.P. Edwards; J.C. Gille; J. Worden
1:40-1:40 PM	**A33I-0269. The investigation of CO2 and CH4 variability During Monsoon Season** J. Wang; J. Worden; S.S. Kulawik; V. Payne; X. Jiang
1:40-1:40 PM	**A33I-0274. CO profile retrieved from combined TES and MLS measurements on Aura satellite** M. Luo; W. Read; N.J. Livesey; S.S. Kulawik; J. Worden; R. Herman
1:40 PM-6:00 PM, Hall A-C (Moscone South), **B33A. Chemical Indicators of Pathways in the Water Cycle II Posters**	
1:40-1:40 PM	**B33A-0498. A look deep inside the a hillslope reveals a structured heterogeneity of isotopic reservoirs and distinct water use strategies for adjacent trees** J. Oshun; D.M. Rempe; P. Link; K.A. Simonin; W. Dietrich; T.E. Dawson; I. Fung
1:40-1:40 PM	**B33A-0502. Asian monsoon hydrometeorology from water isotopes: implications for speleothem climate record interpretation** J. Lee; C. Risi; I. Fung; J. Worden; R. Scheepmaker; B.R. Lintner; C. Frankenberg

<table>
<tr><td>1:40-1:40 PM</td><td>B33A-0507. The stable isotope composition of transpired water and the rate of change in leaf water enrichment in response to variable environments K.A. Simonin; A.B. Roddy; P. Link; R.L. Apodaca; K.P. Tu; J. Hu; T.E. Dawson; M. Barbour</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Hall A-C (Moscone South), C33D. Snow Cover–Vegetation Interactions II Posters</td></tr>
<tr><td>1:40-1:40 PM</td><td>C33D-0684. Effects of forest structure on snow accumulation and melt derived from ecohydrological instrument clusters across the Western US (Invited) N.P. Molotch; K.N. Musselman; P.B. Kirchner; R.C. Bales; P.D. Brooks</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Hall A-C (Moscone South), EP33B. Coastal Geomorphology and Morphodynamics I Posters</td></tr>
<tr><td>1:40-1:40 PM</td><td>EP33B-0874. A network-based analysis of delta morphology and ecology: An example from Wax Lake Delta M. Hiatt; P. Passalacqua; J.B. Shaw; D.C. Mohrig</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Hall A-C (Moscone South), H33A. A Vision for the Future: Exploring the Value of Geophysics in Hydrology I Posters</td></tr>
<tr><td>1:40-1:40 PM</td><td>H33A-1282. Hydrologic Prediction Through Earthcube Enabled Hydrogeophysical Cyberinfrastructure R.J. Versteeg; D. Johnson</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Hall A-C (Moscone South), H33B. Advances in the Theory, Modeling, Measurement, and Remote Sensing of Evapotranspiration From Terrestrial Surfaces III Posters</td></tr>
<tr><td>1:40-1:40 PM</td><td>H33B-1306. Species differences in evergreen tree transpiration at daily, seasonal, and interannual timescales P. Link; K.A. Simonin; J. Oshun; W. Dietrich; T.E. Dawson; I. Fung</td></tr>
<tr><td colspan="2">1:40 PM-6:00 PM, Hall A-C (Moscone South), H33H. Recent Advances in Modeling Water in the Coupled Earth System II Posters</td></tr>
<tr><td>1:40-1:40 PM</td><td>H33H-1423. Establishing a Framework for Community Modeling in Hydrologic Science: Recommendations from the CUAHSI CHyMP Initiative
J.S. Arrigo; J.S. Famiglietti; L.C. Murdoch; V. Lakshmi; R.P. Hooper</td></tr>
<tr><td colspan="2">1:40 PM-3:40 PM, 2002 (Moscone West), B33I. Remote Characterization of Vegetation Structure, Function, and Condition II</td></tr>
<tr><td>2:10-2:25 PM</td><td>B33I-03. Estimating animal biodiversity across taxa in tropical forests using shape-based waveform lidar metrics and Landsat image time series J.D. Muss; N. Aguilar-Amuchastegui; G.M. Henebry</td></tr>
<tr><td colspan="2">1:40 PM-3:40 PM, 3008 (Moscone West), A33O.* Airborne Observations of Greenhouse Gases and Black Carbon II</td></tr>
</table>

2:40-2:55 PM	**A33O-04. Constraints on tropospheric CO2 from TES and ACOS-GOSAT assessed with TCCON and HIPPO measurements** ***(Invited)*** S.S. Kulawik; K.W. Bowman; M. Lee; D.B. Jones; J. Worden; R. Nassar; C.W. O'Dell; S.C. Wofsy; D. Wunch; P.O. Wennberg; D.W. Griffith; V. Sherlock; N.M. Deutscher; J. Notholt; T. Warneke; I. Morino; R. Sussmann; R. Jimenez-Pizarro; S. Park; B. Daube; J.V. Pittman; B.B. Stephens; E.A. Kort; G.W. Santoni
1:40 PM-3:40 PM, 2002 (Moscone West), **B33I. Remote Characterization of Vegetation Structure, Function, and Condition II**	
2:55-3:10 PM	**B33I-06. Linkages of Biodiversity and Canopy Lidar Metrics in Central Africa** N.T. Laporte; N. Horning; D. Morgan
1:40 PM-3:40 PM, 2007 (Moscone West), **EP33C. Ecogeomorphology: Footprints on a Landscape II**	
3:10-3:25 PM	**EP33C-08. Ecogeomorphology: Impressions of organisms in critical zone evolution** ***(Invited)*** S.P. Anderson; N. Fierer; R.S. Gabor; H.R. Barnard; R.S. Anderson; B. Hoffman; D.M. McKnight
1:40 PM-3:40 PM, 2002 (Moscone West), **B33I. Remote Characterization of Vegetation Structure, Function, and Condition II**	
3:25-3:40 PM	**B33I-08. Linking Lidar, SAR and ED: How lidar and SAR fusion can influence the predictions and modeling of future forest states.** M. Brolly; M. Simard; G.C. Hurtt; R. Dubayah; J.P. Fisk
4:00 PM-6:00 PM, 2002 (Moscone West), **B34D. Remote Characterization of Vegetation Structure, Function, and Condition III**	
4:10-4:30 PM	**B34D-02. A Dual Wavelength Echidna® Lidar (DWEL) for Forest Structure Retrieval** ***(Invited)*** A.H. Strahler; E.S. Douglas; J. Martel; T. Cook; C. Mendillo; R.A. Marshall; S. Chakrabarti; C. Schaaf; C.E. Woodcock; Z. Li; X. Yang; D. Culvenor ; D. Jupp; G. Newnham; J. Lovell
4:30-4:45 PM (Conflict)	**B34D-03. Using Voxelized Point-Cloud Forest Reconstructions from Ground-Based Full-Waveform Lidar to Retrieve Leaf Area Index and Foliage Profiles** X. Yang; A.H. Strahler; C. Schaaf; Z. Li; T. Yao; F. Zhao; Z. Wang; C.E. Woodcock; D. Jupp; D. Culvenor ; G. Newnham; J. Lovell
4:00 PM-6:00 PM, 3020 (Moscone West), **H34E. Remote Sensing of Riverscape Topography II**	
4:40-5:00 PM (Conflict)	**H34E-03. A Decade Remote Sensing River Bathymetry with the Experimental Advanced Airborne Research LiDAR** ***(Invited)*** P.J. Kinzel; C.J. Legleiter; J.M. Nelson; K. Skinner

5:00-5:20 PM	**H34E-04. The Hydromorphic Character of Developing Anastomosed Systems Determined from Metre Scale Resolution Aerial LIDAR** N.S. Entwistle; G.L. Heritage; S. Bentley
4:00 PM-6:00 PM, 2003 (Moscone West), **EP34A. Advances in Numerical Modeling of River Fluxes Under Changing Environmental Conditions II**	
5:30-5:45 PM	**EP34A-07. Numerical model of the lowermost Mississippi River as an alluvial-bedrock reach: preliminary results** E. Viparelli; J.A. Nittrouer; D.C. Mohrig; G. Parker

Thursday, December 06, 2012

Time	Session Info
8:00 AM-12:20 PM, Hall A-C (Moscone South), **B41E. Remote Characterization of Vegetation Structure, Function, and Condition IV Posters**	
8:00-8:00 AM	**B41E-0345. Estimating tropical forest structure using discrete return lidar data and a locally trained synthetic forest algorithm** M.W. Palace; F.B. Sullivan; M. Ducey; C. Czarnecki; J. Zanin Shimbo; J. Mota e Silva
8:00-8:00 AM	**B41E-0346. Deriving Leaf Area Index (LAI) from multiple lidar remote sensing systems** H. Tang; R. Dubayah; F. Zhao
8:00-8:00 AM	**B41E-0347. Tree species identification in an African Savanna with airborne imaging spectroscopy and LiDAR from the Carnegie Airborne Observatory (CAO) using stacked support vector machines** C.A. Baldeck; M. Colgan; J. Féret; G.P. Asner
8:00-8:00 AM	**B41E-0350. Using small-footprint, discrete return LiDAR to obtain stand level age of loblolly pine in central Virginia, USA** V.F. Quirino; R.H. Wynne; H. Burkhart; V.A. Thomas
8:00-8:00 AM	**B41E-0360. Effect of vegetation structure on subcanopy solar radiation: a comparative study** A. Anand; R. Dubayah; M.A. Hofton
8:00 AM-12:20 PM, Hall A-C (Moscone South), **ED41A. Distributing Science Data for Reuse Posters**	
8:00-8:00 AM	**ED41A-0668. Landforms in Lidar: Building a Catalog of Digital Landforms for Education and Outreach** E. Kleber; C. Crosby; S.E. Olds; R. Arrowsmith
8:00-8:00 AM	**ED41A-0669. The CUAHSI Water Data Center: Empowering scientists to discover, use, store, and share water data** A.L. Couch; R.P. Hooper; J.S. Arrigo
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP41C. Natural and Controlled Experiments in Landscape Evolution I Posters**	

8:00-8:00 AM	**EP41C-0807. Using airborne lidar and multi-temporal InSAR to explore the role of landslide geometry in controlling their response to seasonal precipitation** A.L. Handwerger; J.J. Roering; D.A. Schmidt
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP41E. Roughness Controls on Landscape Process and Form I Posters**	
8:00-8:00 AM	**EP41E-0841. Utilizing Ground-based LiDAR (Terrestrial Laser Scanning) to estimate hydraulic roughness in gravel-bed rivers** J.T. Minear; S.A. Wright
8:00-8:00 AM	**EP41E-0846. Mapping Quaternary Alluvial Fans in the Southwestern United States based on Multi-Parameter Surface Roughness of LiDAR Topographic Data** N.R. Regmi; E. McDonald; S.N. Bacon
8:00 AM-10:00 AM, 2008 (Moscone West), **EP41I. The Deep Critical Zone and the Inception of Surface Processes I**	
8:45-9:00 AM	**EP41I-04. Fracture Patterns within the Shale Hills Critical Zone Observatory *(Invited)*** K. Singha; T. White; J. Perron; P.B. Chattopadhyay; C. Duffy
9:45-10:00 AM	**EP41I-08. The Influence of the Deep Critical Zone under Hillslopes on Hydrologic, Geomorphic, and Ecological Processes *(Invited)*** W. Dietrich; D.M. Rempe; J. Oshun
10:20 AM-12:20 PM, 3008 (Moscone West), **A42F.* Remote Sensing of CO2, CO, and CH4: Inverse Modeling and Data Assimilation III**	
11:35-11:50 AM	**A42F-06. Simultaneous data assimilation of CO2 and meteorological variables within LETKF coupled with NCAR CAM model** J. Kang; E. Kalnay; J. Liu; I. Fung; T. Miyoshi
11:50-12:05 PM (Conflict)	**A42F-07. Simultaneous assimilation of AIRS and GOSAT CO2 observations with Ensemble Kalman filter** J. Liu; E. Kalnay; I. Fung; J. Kang
10:20 AM-12:20 PM, 2018 (Moscone West), **H42D. Ecohydrology of Terrestrial and Aquatic Ecosystems in an Era of Rapid Change I**	
11:50-12:05 PM (Conflict)	**H42D-07. Dynamic Landscape Connectivity, Threshold Behavior, and Scaling Frameworks for Hydrologic and Bio-geochemical Fluxes *(Invited)*** E. Foufoula; S. Zanardo; M. Danesh-Yazdi; I. Zaliapin; M. Power; W. Dietrich
12:30 PM-1:30 PM, 2010 (Moscone West), **TH42I. New Lidar Technologies and Vision for the Future**	
12:30-1:30 PM	**New Lidar Technologies and Vision for the Future** P. Passalacqua; M.E. Oskin; C. Crosby; C.L. Glennie

1:40 PM-6:00 PM, Hall A-C (Moscone South), **B43D. Remote Sensing of Terrestrial Carbon Fluxes I Posters**	
1:40-1:40 PM	**B43D-0426. Carbon Emissions from Residue Burn Piles Estimated Using LiDAR or Ground Based Measurements of Pile Volumes in a Coastal Douglas-Fir Forest.** J.A. Trofymow; N. Coops; D. Hayhurst
1:40-1:40 PM	**B43D-0438. Detection of Biomass Change Using Lidar Modelled Canopy Heights** M.O. Hunter; D. Vitoria; D.C. Morton; M.M. Keller
1:40-1:40 PM	**B43D-0440. Lidar Estimation of Aboveground Biomass in a Tropical Coastal Forest of Gabon** V. Meyer; S.S. Saatchi; J. Poulsen; C. Clark; S. Lewis; L. White
1:40 PM-3:40 PM, 2008 (Moscone West), **EP43E. Rock to Sediment: Biotic, Lithologic, and Climatic Controls on Regolith Production, Mixing, and Transport II**	
2:10-2:25 PM	**EP43E-03. A bottom-up approach to determining the vertical extent of the weathered bedrock zone under ridge and valley topography** D.M. Rempe; W. Dietrich
1:40 PM-3:40 PM, 2003 (Moscone West), **EP43D. Linking Geomorphology and Morphodynamics to Sediment Budgets, Sediment Caliber, and the Stratigraphic Record III**	
3:10-3:25 PM	**EP43D-07. Building the coastline: Linking study of the modern and ancient depositional environments to predict the response of Mississippi River delta to environmental change** D.C. Mohrig; C. Armstrong
4:00 PM-6:00 PM, 3008 (Moscone West), **A44C.* Remote Sensing of CO2, CO, and CH4: Global distributions of CO2, CH4, and CO V**	
4:30-4:45 PM	**A44C-03. Space Based Observations of Amazon Carbon Cycle** N. Parazoo; K.W. Bowman; C. Frankenberg; J. Lee; J.B. Fisher; J. Worden; D.B. Jones; J.A. Berry; G.J. Collatz; I.T. Baker; M. Jung; J. Liu
5:00-5:15 PM	**A44C-05. Profiling Tropospheric CO2 using the Aura TES and TCCON instruments** L. Kuai; J. Worden; S.S. Kulawik; K.W. Bowman; S.C. Biraud; J.B. Abshire; S.C. Wofsy; V. Natraj; C. Frankenberg; D. Wunch; B.J. Connor; C.E. Miller; C.M. Roehl; R. Shia; Y.L. Yung
5:30-5:45 PM	**A44C-07. Decadal Record of Satellite Carbon Monoxide Observations** ***(Invited)*** H.M. Worden; M.N. Deeter; C. Frankenberg; M. George; F. Nichitiu; J. Worden; I. Aben; K.W. Bowman; C. Clerbaux; P. Coheur; J. de Laat; R. Detweiler; J.R. Drummond; D.P. Edwards; J.C. Gille; D. Hurtmans; M. Luo; S. Martinez-Alonso; S.T. Massie; G. Pfister; J.X. Warner

Friday, December 07, 2012

Time	Session Info
8:00 AM-12:20 PM, Hall A-C (Moscone South), **EP51C. The Legacy of Extremes : Floods, Landslides, Earthquakes, and Long-Term Landscape Evolution I Posters**	
8:00-8:00 AM	**EP51C-1000. An enlarging landslide scar and evolution of the surrounding forested hillslope: Results from a dendrogeomorphic and multi-temporal LiDAR DTM survey** J.W. Keck; C. Hsiao; B. Lin; W.E. Wright; S. Chi
8:00-8:00 AM	**EP51C-1001. Tectonic controls on gravitational deformation in the Mino Mountains, central Japan: a regional sagging-feature mapping in forested mountains using high-resolution airborne LiDAR** H. Kaneda; T. Kono
8:00 AM-12:20 PM, Hall A-C (Moscone South), **GC51B. Spatiotemporal Change Detection and the Data Infrastructure of Environmental Observatories I Posters**	
8:00-8:00 AM	**GC51B-1179. Assessment of Recently Unchanged Forested Areas in the United States Using Landsat-WELD and LIDAR Data** A. Tyukavina; P. Potapov; M.C. Hansen
8:00-8:00 AM	**GC51B-1200. Simulated and Observed Trends in Daily Solar Radiation Coefficients of Variation** R. McNellis; D. Medvigy
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H51B. Ecohydrology of Terrestrial and Aquatic Ecosystems in an Era of Rapid Change II Posters**	
8:00-8:00 AM	**H51B-1344. Factors impacting manganese transport from soils into rivers using data from Shale Hills CZO** E. Herndon; S.L. Brantley
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H51C. Ecohydrology of Tropical Forests: Processes, Feedbacks, and Change I Posters**	
8:00-8:00 AM	**H51C-1362. Ecohydrological controls of watershed response to land use change in the montane cloud forest zone in Mexico** H. Asbjornsen; M.S. Alvarado-Barrientos; L.A. Bruijnzeel; T.E. Dawson; D.R. Geissert; G.R. Goldsmith; M. Gomez-Cardenas; A. Gomez-Tagle; S. Gotsch; F. Holwerda; J.J. McDonnell; L.E. Munoz Villers; C. Tobon
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H51H. Recent Advances in Theoretical, Numerical, and Experimental Methods in Flow and Transport in Porous Media III Posters**	
8:00-8:00 AM	**H51H-1453. Numerical modeling of coupled thermal chemical reactive transport: simulation of a heat storage system** H. Shao; N. Watanabe; A.K. Singh; T. Nagel; M. Linder; A. Woerner; O. Kolditz
8:00 AM-12:20 PM, Hall A-C (Moscone South), **H51J. Water Quality and Quantity in Urban Systems Posters**	

8:00-8:00 AM	**H51J-1489. Distributed Modeling with Parflow using High Resolution LIDAR Data** M. Barnes; C. Welty; A.J. Miller
8:00 AM-12:20 PM, Hall A-C (Moscone South), **IN51A. Advancing Partnerships, Collaborative Platforms, and Knowledge Networks in the Earth Sciences I Posters**	
8:00-8:00 AM	**IN51A-1689. Enabling the Integrated Assessment of Large Marine Ecosystems: Informatics to the Forefront of Science-Based Decision Support** M. Di Stefano; P.A. Fox; S.E. Beaulieu; A.R. Maffei; P. West; J.A. Hare
8:00 AM-10:00 AM, 2008 (Moscone West), **EP51D. Advances in Experimental Earth Surface Processes I**	
8:30-8:45 AM	**EP51D-03. Dynamics of sediment release from slope failure** Y. You; D.C. Mohrig; P.B. Flemings
9:15-9:30 AM	**EP51D-06. The dynamics of an experimental gravel bed meander with constant discharge and sediment supply** C.A. Braudrick; W. Dietrich; L.S. Sklar
10:20 AM-12:20 PM, 3003 (Moscone West), **H52E. Understanding Process Dynamics in the Critical Zone at Different Scales I**	
10:20-10:35 AM	**H52E-01. Modeling of Soil and Tree Water Status Dynamics in a Mixed-Conifer Forest of the Southern Sierra Critical Zone Observatory *(Invited)*** J.W. Hopmans; J. Rings; T. Kamai; M. Mollaei Kandelous; P.C. Hartsough; J.A. Vrugt
10:20 AM-12:20 PM, 2002 (Moscone West), **B52C. Quantifying Heterogeneity of Landscapes and Ecosystems in Earth System Models I**	
10:35-10:50 AM (Conflict)	**B52C-02. What is clumping? And the role of terrestrial LiDAR in its characterization** M. Beland; D.D. Baldocchi; H. Kobayashi
10:20 AM-12:20 PM, 3003 (Moscone West), **H52E. Understanding Process Dynamics in the Critical Zone at Different Scales I**	
10:35-10:50 AM (Conflict)	**H52E-02. Variability of Relative Humidity Reveals and Estimates Land Surface Controls on Evapotranspiration *(Invited)*** G. Salvucci; P. Gentine
10:50-11:05 AM	**H52E-03. Development of a Scaling Algorithm for Remotely Sensed and In-situ Soil Moisture Data across Complex Terrain** Y. Shin; B.P. Mohanty
10:20 AM-12:20 PM, 2005 (Moscone West), **EP52E. Process-Oriented Multiapproach Erosion Analysis in High Mountains: Decade to Millennia Timescales I**	
11:05-11:20 AM (Conflict)	**EP52E-04. Tracking landslides and landscape evolution using airborne lidar, InSAR, historical air photos, cosmogenic radionuclides, and numerical models *(Invited)*** J.J. Roering; B.H. Mackey; D.A. Schmidt; A.L. Handwerger; A.M. Booth; C. Cerovski-Darriau

10:20 AM-12:20 PM, 3003 (Moscone West), **H52E. Understanding Process Dynamics in the Critical Zone at Different Scales I**	
11:05-11:20 AM (Conflict)	**H52E-04. Connections between transport in events and transport at landscape-structuring timescales *(Invited)*** C.J. Harman; K.A. Lohse; P.A. Troch; M. Sivapalan
11:20-11:35 AM	**H52E-05. Geophysics applications in critical zone science: emerging topics. *(Invited)*** Y.A. Pachepsky; G. Martinez; A. Guber; C.L. Walthall; H. Vereecken
11:35-11:50 AM	**H52E-06. Can we use Electrical Resistivity Tomography to measure root zone moisture dynamics in fields with multiple crops? *(Invited)*** S. Garre; I. Coteur; C. Wongleecharoen; J. Diels; J. Vanderborght
11:50-12:05 PM	**H52E-07. Uniqueness, Scale, Resolution, Uncertainty, Stochastic Subsurface Hydrology, and Hydrological Tomographic Surveys. *(Invited)*** T.J. Yeh
12:05-12:20 PM	**H52E-08. Natural Constraints on Modeling Soil Temperature in Complex Terrain** M.S. Seyfried; T.E. Link; S. Bryden
1:40 PM-6:00 PM, Hall A-C (Moscone South), **A53I. Light Scattering and Radiative Transfer I Posters**	
1:40-1:40 PM	**A53I-0265. A short-standoff bistatic lidar system for aerosol cloud backscatter and fluorescence cross section, and depolarization ratio measurement** C. Glen; R.L. Schmitt; S. Sickafoose; M.S. Johnson; R. Shagam; T. Reichardt; A. Sanchez; B. Servantes
1:40 PM-6:00 PM, Hall A-C (Moscone South), **B53A. Biogeodynamics and Earth System Sciences II Posters**	
1:40-1:40 PM	**B53A-0658. Development of Airborne LiDAR based Sky View Factors to Estimate Micro-scale Energy Budget of Forest Areas: a Case Study of Taehwa Forest, Korea** S. An; J. Woo; B. Kim; J. Hong; S. Kim; S. Choi; Y. Kim; S. Quan
1:40 PM-6:00 PM, Hall A-C (Moscone South), **EP53C. Climate Change and Landscape Response III Posters**	
1:40-1:40 PM	**EP53C-1054. Climate driven landscape evolution of an impact crater** M.C. Palucis; W. Dietrich; K. Nishiizumi; A.D. Howard; D.A. Kring
1:40 PM-6:00 PM, Hall A-C (Moscone South), **H53A. Dryland Ecohydrology: Critical Issues and Technical Advances II Posters**	
1:40-1:40 PM	**H53A-1506. Hydrologic Activity of Deciduous Agroforestry Tree : Observed through Monitoring of Stable Isotopes in Stem Water, Solar Radiation Attenuation, and Sapflow** N.C. Ceperley; T. Mande; M.B. Parlange

1:40 PM-6:00 PM, Hall A-C (Moscone South), **H53I. Understanding Process Dynamics in the Critical Zone at Different Scales II Posters**	
1:40-1:40 PM	**H53I-1650. Toward an improved understanding of the role of transpiration in critical zone dynamics** B. Mitra; S.A. Papuga
1:40-1:40 PM	**Abstract Withdrawn**
1:40-1:40 PM	**H53I-1653. Rock-moisture dynamics in a hillsope underlain with weathered and fractured argillite** R. Salve; D.M. Rempe; W. Dietrich
1:40 PM-3:40 PM, 2020 (Moscone West), **IN53D. Semantics and Cyberinfrastructures for Next Generation Science II**	
1:40-1:55 PM	**IN53D-01. Providing Data Access for Interdisciplinary Research *(Invited)*** R.P. Hooper; A. Couch
4:00 PM-6:00 PM, 2008 (Moscone West), **EP54A. Coastal Geomorphology and Morphodynamics III**	
5:00-5:15 PM (Conflict)	**EP54A-05. Distributary Channel Evolution in Two Phases: Increased Asymmetry during Floods, Multiple Channel Extension during Low Flow** J.B. Shaw; D.C. Mohrig
4:00 PM-6:00 PM, 3003 (Moscone West), **GC54A. Spatiotemporal Change Detection and the Data Infrastructure of Environmental Observatories IV**	
5:00-5:15 PM (Conflict)	**GC54A-05. Critical Zone Observatories (CZOs): Integrating measurements and models of Earth surface processes to improve prediction of landscape structure, function and evolution *(Invited)*** J. Chorover; S.P. Anderson; R.C. Bales; C. Duffy; F.N. Scatena; D.L. Sparks; T. White

Final ID: B11B-0419

Fusing Hyperspectral and LiDAR data from CAO-VSWIR for Increased Data Dimensionality

D. E. Knapp; [1]; *G. P. Asner;* [1]; *J. W. Boardman;* [2]; *T. Kennedy-Bowdoin;* [1]; *M. Eastwood;* [3]; *C. Anderson;* [1]; *R. E. Martin;* [1]; *R. O. Green;* [3];

1. Dept. of Global Ecology, Carnegie Institution, Stanford, CA, United States.
2. Analytical Imaging and Geophysics LLC, Boulder, CO, United States.
3. Jet Propulsion Laboratory, Pasadena, CA, United States.

Body: The use of multi-sensor platforms for scientific data collection requires precise co-location in order to gain maximum data dimensionality for Earth system research. The different types of collection mechanisms of the sensors (e.g., scanning and pushbroom) can make it difficult to precisely match data from multiple sensors, even when the sensors are flown on the same aircraft at the same time. To overcome these problems, the Carnegie Airborne Observatory (CAO) AToMS sensor suite uses a method that maximizes the match between the Light Detection and Ranging (LiDAR), Visible-to-Near Infrared (VNIR), and Visible-to-Shortwave Infrared (VSWIR) sensors. This is done by generating an intensity image from the LiDAR data that serves as a base on which the spectrometers (VNIR and VSWIR) are matched using ground control points (GCPs). To do so, we employ the use of automated tie point matching in the overlap regions of the spectrometers to improve the co-location between flightlines. The combination of the GCPs and tie points produce data that is used to build camera models for the VNIR and VSWIR spectrometers such that they will match the LiDAR data. The result produces a matched hyper-dimensional data set with great scientific information content. We compare the data dimensionality of two contrasting scenes – a built environment at Stanford University and a lowland tropical forest in Amazonia. Principal components analysis revealed 336 dimensions (degrees of freedom) in the Stanford case, and 218 dimensions in the Amazon. The Amazon case presents what could be the highest level of remotely sensed data dimensionality ever reported for a forested ecosystem. Simulated misalignment of data streams reduced the effective information content by up to 48%, highlighting the critical role of achieving high precision when undertaking multi-sensor fusion. The instrumentation and methods described here are a pathfinder for future airborne applications undertaken by the National Ecological Observatory Network (NEON) and other organizations.

Final ID: IN11B-1464

Future of Hydroinformatics: Towards Open, Integrated and Interactive Online Platforms

I. Demir; [1]; *W. F. Krajewski;* [1];
1. IIHR Hydroscience & Eng., University of Iowa, Iowa City, IA, United States.

Body: Hydroinformatics is a domain of science and technology dealing with the management of information in the field of hydrology (IWA, 2011). There is the need for innovative solutions to the challenges towards open information, integration, and communication in the Internet. This presentation provides an overview of the trends and challenges in the future of hydroinformatics, and demonstrates an information system, Iowa Flood Information System (IFIS), developed within the light of these challenges. The IFIS is a web-based platform developed by the Iowa Flood Center (IFC) to provide access to flood inundation maps, real-time flood conditions, flood forecasts both short-term and seasonal, flood-related data, information and interactive visualizations for communities in Iowa. The key element of the system's architecture is the notion of community. Locations of the communities, those near streams and rivers, define basin boundaries. The IFIS provides community-centric watershed and river characteristics, weather (rainfall) conditions, and streamflow data and visualization tools. Interactive interfaces allow access to inundation maps for different stage and return period values, and flooding scenarios with contributions from multiple rivers. Real-time and historical data of water levels, gauge heights, and rainfall conditions are available in the IFIS by streaming data from automated IFC bridge sensors, USGS stream gauges, NEXRAD radars, and NWS forecasts. 2D and 3D interactive visualizations in the IFIS make the data more understandable to general public. Users are able to filter data sources for their communities and selected rivers. The data and information on IFIS is also accessible through web services and mobile applications. The IFIS is optimized for various browsers and screen sizes to provide access through multiple platforms including tablets and mobile devices. The IFIS includes a rainfall-runoff forecast model to provide a five-day flood risk estimate for more than 1000 communities in Iowa. Multiple view modes in the IFIS accommodate different user types from general public to researchers and decision makers by providing different level of tools and details. River view mode allows users to visualize data from multiple IFC bridge sensors and USGS stream gauges to follow flooding condition along a river. The IFIS will help communities make better-informed decisions on the occurrence of floods, and will alert communities in advance to help minimize damage of floods.

URL: http://ifis.iowafloodcenter.org

Final ID: IN11F-03

Combining data from multiple sources using the CUAHSI Hydrologic Information System *(Invited)*

D. G. Tarboton; [1]; *D. P. Ames;* [2]; *J. S. Horsburgh;* [1]; *J. L. Goodall;* [3];

1. Utah Water Research Laboratory, Utah State Univ, Logan, UT, United States.
2. Civil and Environmental Engineering, Brigham Young University, Provo, UT, United States.
3. Civil and Environmental Engineering, University of South Carolina, Columbia, SC, United States.

Body: The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) has developed a Hydrologic Information System (HIS) to provide better access to data by enabling the publication, cataloging, discovery, retrieval, and analysis of hydrologic data using web services. The CUAHSI HIS is an Internet based system comprised of hydrologic databases and servers connected through web services as well as software for data publication, discovery and access. The HIS metadata catalog lists close to 100 web services registered to provide data through this system, ranging from large federal agency data sets to experimental watersheds managed by University investigators. The system's flexibility in storing and enabling public access to similarly formatted data and metadata has created a community data resource from governmental and academic data that might otherwise remain private or analyzed only in isolation. Comprehensive understanding of hydrology requires integration of this information from multiple sources. HydroDesktop is the client application developed as part of HIS to support data discovery and access through this system. HydroDesktop is founded on an open source GIS client and has a plug-in architecture that has enabled the integration of modeling and analysis capability with the functionality for data discovery and access. Model integration is possible through a plug-in built on the OpenMI standard and data visualization and analysis is supported by an R plug-in. This presentation will demonstrate HydroDesktop, showing how it provides an analysis environment within which data from multiple sources can be discovered, accessed and integrated.

URL : http://his.cuahsi.org

Final ID: NH11D-04

AUTOMATIC AND OBJECTIVE DETECTION OF SHALLOW LANDSLIDES FROM LIDAR-DERIVED, HIGH-RESOLUTION DIGITAL ELEVATION MODELS USING A WAVELET TRANSFORM

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Body: An accurate and detailed inventory map of existing shallow landslides is a necessary component of shallow landslide risk assessment. Traditional methods for creating landslide inventory maps include visual interpretation of aerial photographs, visual analysis of topographic maps and field surveys. The visual methods tend to be subjective and can be greatly hampered by the presence of forests or other dense vegetation. Field surveying is time consuming and can be limited by access to steep or heavily vegetated terrain. Shallow slides are also often only reported as point locations with no recorded information about size or even two-dimensional footprint. The increasing availability of high resolution, LiDAR-derived digital elevation models (DEMs), showing bare earth topography even beneath forest canopies, has created new opportunities to improve and automate the shallow landslide mapping process.

Here we introduce the Automated Shallow Landslide Detection (ASLD) method, which is an integrated set of Matlab® utilities that, uses a two-dimensional continuous Morlet wavelet transform in an automated and largely unsupervised manner, to analyze high resolution terrain data and map the locations and footprints of shallow landslides. The terrain data are filtered to remove the finest scale of roughness and then the Morlet wavelet transform is applied to the terrain model. The Morlet wavelet is directionally selective and effectively steered to align with the aspect at each node in the DEM. This reduces confusion with other, likely non-landslide generated, topographic features that are not aligned with the local slope direction. Convex-upward features are then eliminated, as the polarity of their wavelet transform will be reversed. Finally, simple user-defined rules for the general shape of shallow landslides are applied to further eliminate false positives.

The capabilities of ASLD are demonstrated in two different drainages. Buckhorn Creek is tributary to the South Fork Salmon River in Central Idaho and the study area covers about 8.5 km^2. ASLD identified and mapped 540 shallow landslides in this drainage. The area covered by these slides was about 136,00 m^2 and we estimate that they contributed 360,000 metric tons of sediment to the Buckhorn Creek system over the period (unknown) of their formation. The second study area was approximately 37 km^2 of coastal hillslopes in Ventura County, California. ASLD identified and mapped 2,824 shallow landslides that covered an area of 660,000 m^2. We estimate that these slide contributed 1.75 million metric tons of sediment to the drainage network. Our results suggest that the ASLD method may substantially improve the objectivity, accuracy and completeness of shallow landslide inventories, particularly in forested landscapes.

Final ID: IN12A-01

Free and Open Source Software for Geospatial in the field of planetary science *(Invited)*

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Body: Information technology applied to geospatial analyses has spread quickly in the last ten years. The availability of OpenData and data from collaborative mapping projects increased the interest on tools, procedures and methods to handle spatially-related information. Free Open Source Software projects devoted to geospatial data handling are gaining a good success as the use of interoperable formats and protocols allow the user to choose what pipeline of tools and libraries is needed to solve a particular task, adapting the software scene to his specific problem.

In particular, the Free Open Source model of development mimics the scientific method very well, and researchers should be naturally encouraged to take part to the development process of these software projects, as this represent a very agile way to interact among several institutions.

When it comes to planetary sciences, geospatial Free Open Source Software is gaining a key role in projects that commonly involve different subjects in an international scenario.

Very popular software suites for processing scientific mission data (for example, ISIS) and for navigation/planning (SPICE) are being distributed along with the source code and the interaction between user and developer is often very strict, creating a continuum between these two figures.
A very widely spread library for handling geospatial data (GDAL) has started to support planetary data from the Planetary Data System, and recent contributions enabled the support to other popular data formats used in planetary science, as the Vicar one.

The use of Geographic Information System in planetary science is now diffused, and Free Open Source GIS, open GIS formats and network protocols allow to extend existing tools and methods developed to solve Earth based problems, also to the case of the study of solar system bodies.

A day in the working life of a researcher using Free Open Source Software for geospatial will be presented, as well as benefits and solutions to possible detriments coming from the effort required by using, supporting and contributing.

Final ID: NH12A-01

Multi-Dimensional Shallow Landslide Stability Analysis Suitable for Application at the Watershed Scale

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Body: The infinite slope model is the basis for almost all watershed scale slope stability models. However, it assumes that a potential landslide is infinitely long and wide. As a result, it cannot represent resistance at the margins of a potential landslide (e.g. from lateral roots), and is unable to predict the size of a potential landslide. Existing three-dimensional models generally require computationally expensive numerical solutions and have previously been applied only at the hillslope scale. Here we derive an alternative analytical treatment that accounts for lateral resistance by representing the forces acting on each margin of an unstable block. We apply 'at rest' earth pressure on the lateral sides, and 'active' and 'passive' pressure using a log-spiral method on the upslope and downslope margins. We represent root reinforcement on each margin assuming that root cohesion is an exponential function of soil depth. We benchmark this treatment against other more complete approaches (Finite Element (FE) and closed form solutions) and find that our model: 1) converges on the infinite slope predictions as length / depth and width / depth ratios become large; 2) agrees with the predictions from state-of-the-art FE models to within +/- 30% error, for the specific cases in which these can be applied. We then test our model's ability to predict failure of an actual (mapped) landslide where the relevant parameters are relatively well constrained. We find that our model predicts failure at the observed location with a nearly identical shape and predicts that larger or smaller shapes conformal to the observed shape are indeed more stable. Finally, we perform a sensitivity analysis using our model to show that lateral reinforcement sets a minimum landslide size, while the additional strength at the downslope boundary means that the optimum shape for a given size is longer in a downslope direction. However, reinforcement effects cannot fully explain the size or shape distributions of observed landslides, highlighting the importance of spatial patterns of key parameters (e.g. pore water pressure) and motivating the model's watershed scale application. This watershed scale application requires an efficient method to find the least stable shapes among an almost infinite set. However, when applied in this context, it allows a more complete examination of the controls on landslide size, shape and location.

Final ID: IN12A-02

Earth-Base: testing the temporal congruency of paleontological collections and geologic maps of North America

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Body: Free and open source software and data facilitate novel research by allowing geoscientists to quickly and easily bring together disparate data that have been independently collected for many different purposes. The Earth-Base project brings together several datasets using a common space-time framework that is managed and analyzed using open source software. Earth-Base currently draws on stratigraphic, paleontologic, tectonic, geodynamic, seismic, botanical, hydrologic and cartographic data. Furthermore, Earth-Base is powered by RESTful data services operating on top of PostgreSQL and MySQL databases and the R programming environment, making much of the functionality accessible to third-parties even though the detailed data schemas are unknown to them.

We demonstrate the scientific potential of Earth-Base and other FOSS by comparing the stated age of fossil collections to the age of the bedrock upon which they are geolocated. This analysis makes use of web services for the Paleobiology Database (PaleoDB), Macrostrat, the 2005 Geologic Map of North America (Garrity et al. 2009) and geologic maps of the conterminous United States. This analysis is a way to quickly assess the accuracy of temporal and spatial congruence of the paleontologic and geologic map datasets. We find that 56.1% of the 52,593 PaleoDB collections have temporally consistent ages with the bedrock upon which they are located based on the Geologic Map of North America. Surprisingly, fossil collections within the conterminous United States are more consistently located on bedrock with congruent geological ages, even though the USA maps are spatially and temporally more precise. Approximately 57% of the 37,344 PaleoDB collections in the USA are located on similarly aged geologic map units. Increased accuracy is attributed to the lumping of Pliocene and Quaternary geologic map units along the Atlantic and Gulf coastal plains in the Geologic Map of North America. The abundant Pliocene fossil collections are thus located on geologic map units that have an erroneous age designation of Quaternary. We also demonstrate the power of the R programming environment for performing analyses and making publication-quality maps for visualizing results.

URL: http://earth-base.org

Final ID: NH12A-02

Hydrologic Controls on Shallow Landslide Location, Size, and Shape *(Invited)*

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Body: Shallow landslides, typically involving just the soil mantle, are principally controlled by topography, soil and root strengths, and soil thickness, and are typically triggered by storm-induced increases in pore water pressure. The response of a landscape to landslide-triggering storms will thus depend on factors such as rainfall totals, storm intensity and duration, and antecedent moisture conditions. The two dominant mechanisms that generate high pore water pressures at a point are topographically-steered lateral subsurface flow (over timescales of days to weeks), and rapid vertical infiltration (over timescales of minutes to hours). We aim to understand the impact of different storm characteristics and hydrologic regimes on shallow landslide location, size, and shape. We have developed a regional-scale model, which applies a low-parameter grid-based multi-dimensional slope stability model within a novel search algorithm, to generate discrete landslide predictions. This model shows that the spatial organization of parameters such as root strength and pore water pressure has a strong control on shallow landslide location, size, and shape. We apply this model to a field site near Coos Bay, OR, where a ten-year landslide inventory has been mapped onto high-resolution topographic data. Our model predicts landslide size generally increases with increasing rainfall intensity, except when root strength is extremely high and pore pressures are topographically steered. The distribution of topographic index values (the ratios of contributing area to slope) of predicted landslides is a clear signature of the pore water pressure generation mechanism: as laterally dominated flow increases, landslides develop in locations with lower slopes and higher contributing areas; in contrast, in the case of vertically-dominated pore pressure rise, landslides are consistently found in locations with higher slopes and lower contributing areas. While in both cases landslides are found in the hollows, where the soils are sufficiently deep to overcome the effects of root strength, in the laterally-dominated case they are predicted to occur further down the hollows (which matches field observations). The size distribution of landslides is better predicted in our model when vertical infiltration dominates, but the observed distribution of topographic index values follows that predicted when lateral flow dominates. This suggests that both mechanisms must be taken into account in order to capture both location and size of shallow landslides (consistent with field observations). These results suggest that this modeling approach could allow us to use observed landslide locations and geometries to infer the dominant hydrologic triggering mechanisms. Furthermore, as the spatial and temporal resolution of precipitation forecasting improves, this model will enable us to more accurately predict both location and size of shallow landslides.

Final ID: IN12A-03

The Future of ECHO: Evaluating Open Source Possibilities

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2. NASA ECHO / GSFC, Greenbelt, MD, United States.
3. NASA ECHO / Raytheon, Riverdale, MD, United States.

Body: NASA's Earth Observing System ClearingHOuse (ECHO) is a format agnostic metadata repository supporting over 3000 collections and 100M science granules. ECHO exposes FTP and RESTful Data Ingest APIs in addition to both SOAP and RESTful search and order capabilities. Built on top of ECHO is a human facing search and order web application named Reverb. ECHO processes hundreds of orders, tens of thousands of searches, and 1-2M ingest actions each week.

As ECHO's holdings, metadata format support, and visibility have increased, the ECHO team has received requests by non-NASA entities for copies of ECHO that can be run locally against their data holdings. ESDIS and the ECHO Team have begun investigations into various deployment and Open Sourcing models that can balance the real constraints faced by the ECHO project with the benefits of providing ECHO capabilities to a broader set of users and providers.

This talk will discuss several release and Open Source models being investigated by the ECHO team along with the impacts those models are expected to have on the project. We discuss:

- Addressing complex deployment or setup issues for potential users
- Models of vetting code contributions
- Balancing external (public) user requests versus our primary partners
- Preparing project code for public release, including navigating licensing issues related to leveraged libraries
- Dealing with non-free project dependencies such as commercial databases
- Dealing with sensitive aspects of project code such as database passwords, authentication approaches, security through obscurity, etc.
- Ongoing support for the released code including increased testing demands, bug fixes, security fixes, and new features.

Final ID: IN12A-04

From Particles and Point Clouds to Voxel Models: High Resolution Modeling of Dynamic Landscapes in Open Source GIS *(Invited)*

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2. Civil Engineering, Czech Technical University, Prague, Czech Republic.

Body: Multitemporal data acquired by modern mapping technologies provide unique insights into processes driving land surface dynamics. These high resolution data also offer an opportunity to improve the theoretical foundations and accuracy of process-based simulations of evolving landforms. We discuss development of new generation of visualization and analytics tools for GRASS GIS designed for 3D multitemporal data from repeated lidar surveys and from landscape process simulations. We focus on data and simulation methods that are based on point sampling of continuous fields and lead to representation of evolving surfaces as series of raster map layers or voxel models. For multitemporal lidar data we present workflows that combine open source point cloud processing tools with GRASS GIS and custom python scripts to model and analyze dynamics of coastal topography (Figure 1) and we outline development of coastal analysis toolbox. The simulations focus on particle sampling method for solving continuity equations and its application for geospatial modeling of landscape processes. In addition to water and sediment transport models, already implemented in GIS, the new capabilities under development combine OpenFOAM for wind shear stress simulation with a new module for aeolian sand transport and dune evolution simulations. Comparison of observed dynamics with the results of simulations is supported by a new, integrated 2D and 3D visualization interface that provides highly interactive and intuitive access to the redesigned and enhanced visualization tools. Several case studies will be used to illustrate the presented methods
and tools and demonstrate the power of workflows built with FOSS and highlight their interoperability.

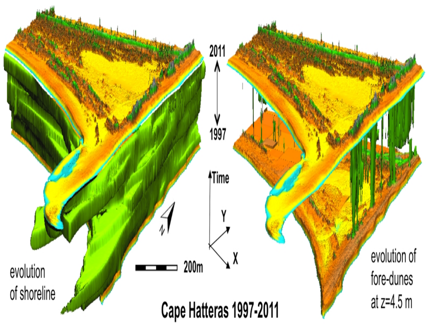

Figure 1. Isosurfaces representing evolution of shoreline and a z=4.5m contour between the years 1997-2011at Cape Hatteras, NC extracted from a voxel model derived from series of lidar-based DEMs.

Final ID: GC12B-05

Sharing Water Data to Encourage Sustainable Choices in Areas of the Marcellus Shale *(Invited)*

S. L. Brantley; [1]; *J. D. Abad;* [3]; *J. Vastine;* [2]; *D. Yoxtheimer;* [1]; *C. Wilderman;* [2]; *R. Vidic;* [3]; *R. P. Hooper;* [4]; *K. Brasier;* [1];

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4. CUAHSI, Washington D.C., DC, United States.

Body: Natural gas sourced from shales but stored in more permeable formations has long been exploited as an energy resource. Now, however, gas is exploited directly from the low-porosity and low-permeability shale reservoirs through the use of hydrofracturing. Hydrofracturing is not a new technique: it has long been utilized in the energy industry to promote flow of oil and gas from traditional reservoirs. To exploit gas in reservoirs such as the Marcellus shale in PA, hydrofracturing is paired with directional drilling. Such hydrofracturing utilizes large volumes of water to increase porosity in the shale formations at depth. Small concentrations of chemicals are added to the water to improve the formation and maintenance of the fractures. Significant public controversy has developed in response to the use of hydrofracturing especially in the northeastern states underlain by the Marcellus shale where some citizens and scientists question whether shale gas recovery will contaminate local surface and ground waters. Researchers, government agencies, and citizen scientists in Pennsylvania are teaming up to run the ShaleNetwork (www.shalenetwork.org), an NSF-funded research collaboration network that is currently finding, collating, sharing, publishing, and exploring data related to water quality and quantity in areas that are exploiting shale gas. The effort, focussed initially on Pennsylvania, is now developing the ShaleNetwork database that can be accessed through HydroDesktop in the CUAHSI Hydrologic Information System. In the first year since inception, the ShaleNetwork ran a workshop and reached eight conclusions, largely focussed on issues related to the sources, entry, and use of data. First, the group discovered that extensive water data is available in areas of shale gas. Second, participants agreed that the Shale Network team should partner with state agencies and industry to move datasets online. Third, participants discovered that the database allows participants to assess data gaps. Fourth, the team was encouraged to search for data that plug gaps. Fifth, the database should be easily sustained by others long-term if the Shale Network team simplifies the process of uploading data and finds ways to create community buy-in or incentives for data uploads. Sixth, the database itself and the workshops for the database should drive future agreement about analytical protocols. Seventh, the database is already encouraging other groups to publish data online. Finally, a user interface is needed that is easier and more accessible for citizens to use. Overall, it is clear that sharing data is one way to build bridges among decision makers, scientists, and citizens to understand issues related to sustainable development of energy resources in the face of issues related to water quality and quantity.

Final ID: IN12A-05

A Modular GIS-Based Software Architecture for Model Parameter Estimation using the Method of Anchored Distributions (MAD)

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Body: The Method of Anchored Distributions (MAD) is an inverse modeling technique that is well-suited for estimation of spatially varying parameter fields using limited observations and Bayesian methods. This presentation will discuss the design, development, and testing of a free software implementation of the MAD technique using the open source DotSpatial geographic information system (GIS) framework, R statistical software, and the MODFLOW groundwater model. This new tool, dubbed MAD-GIS, is built using a modular architecture that supports the integration of external analytical tools and models for key computational processes including a forward model (e.g. MODFLOW, HYDRUS) and geostatistical analysis (e.g. R, GSLIB). The GIS-based graphical user interface provides a relatively simple way for new users of the technique to prepare the spatial domain, to identify observation and anchor points, to perform the MAD analysis using a selected forward model, and to view results. MAD-GIS uses the Managed Extensibility Framework (MEF) provided by the Microsoft .NET programming platform to support integration of different modeling and analytical tools at run-time through a custom “driver.” Each driver establishes a connection with external programs through a programming interface, which provides the elements for communicating with core MAD software. This presentation gives an example of adapting the MODFLOW to serve as the external forward model in MAD-GIS for inferring the distribution functions of key MODFLOW parameters. Additional drivers for other models are being developed and it is expected that the open source nature of the project will engender the development of additional model drivers by 3rd party scientists.

URL: http://mad.codeplex.com

Final ID: IN12A-07

FOSS GIS on the GFZ HPC cluster: Towards a service-oriented Scientific Geocomputation Environment.

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Body: High performance compute clusters can be used as geocomputation workbenches. Their wealth of resources enables us to take on geocomputation tasks which exceed the limitations of smaller systems.

These general capabilities can be harnessed via tools such as Geographic Information System (GIS), provided they are able to utilize the available cluster configuration/architecture and provide a sufficient degree of user friendliness to allow for wide application.

While server-level computing is clearly not sufficient for the growing numbers of data- or computation-intense tasks undertaken, these tasks do not get even close to the requirements needed for access to “top shelf” national cluster facilities. So until recently such kind of geocomputation research was effectively barred due to lack access to of adequate resources.

In this paper we report on the experiences gained by providing GRASS GIS as a software service on a HPC compute cluster at the German Research Centre for Geosciences using Platform Computing’s Load Sharing Facility (LSF). GRASS GIS is the oldest and largest Free Open Source (FOSS) GIS project.

During ramp up in 2011, multiple versions of GRASS GIS (v 6.4.2, 6.5 and 7.0) were installed on the HPC compute cluster, which currently consists of 234 nodes with 480 CPUs providing 3084 cores. Nineteen different processing queues with varying hardware capabilities and priorities are provided, allowing for fine-grained scheduling and load balancing.

After successful initial testing, mechanisms were developed to deploy scripted geocomputation tasks onto dedicated processing queues. The mechanisms are based on earlier work by NETELER et al. (2008) and allow to use all 3084 cores for GRASS based geocomputation work. However, in practice applications are limited to fewer resources as assigned to their respective queue.

Applications of the new GIS functionality comprise so far of hydrological analysis, remote sensing and the generation of maps of simulated tsunamis in the Mediterranean Sea for the Tsunami Atlas of the FP-7 TRIDEC Project (www.tridec-online.eu). This included the processing of complex problems, requiring significant amounts of processing time up to full 20 CPU days.
This GRASS GIS-based service is provided as a research utility in the sense of “Software as a Service” (SaaS) and is a first step towards a GFZ corporate cloud service.

Final ID: IN12A-08

An Open Source Tool to Test Interoperability

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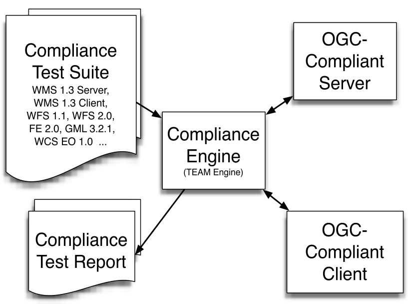
Body: Scientists interact with information at various levels from gathering of the raw observed data to accessing portrayed processed quality control data. Geoinformatics tools help scientist on the acquisition, storage, processing, dissemination and presentation of geospatial information. Most of the interactions occur in a distributed environment between software components that take the role of either client or server. The communication between components includes protocols, encodings of messages and managing of errors. Testing of these communication components is important to guarantee proper implementation of standards.

The communication between clients and servers can be adhoc or follow standards. By following standards interoperability between components increase while reducing the time of developing new software. The Open Geospatial Consortium (OGC), not only coordinates the development of standards but also, within the Compliance Testing Program (CITE), provides a testing infrastructure to test clients and servers.

The OGC Web-based Test Engine Facility, based on TEAM Engine, allows developers to test Web services and clients for correct implementation of OGC standards. TEAM Engine is a JAVA open source facility, available at Sourceforge that can be run via command line, deployed in a web servlet container or integrated in developer's environment via MAVEN. The TEAM Engine uses the Compliance Test Language (CTL) and TestNG to test HTTP requests, SOAP services and XML instances against Schemas and Schematron based assertions of any type of web service, not only OGC services. For example, the OGC Web Feature Service (WFS) 1.0.0 test has more than 400 test assertions. Some of these assertions includes conformance of HTTP responses, conformance of GML-encoded data; proper values for elements and attributes in the XML; and, correct error responses.

This presentation will provide an overview of TEAM Engine, introduction of how to test via the OGC Testing web site and description of performing local tests. It will also provide information about how to participate in the open source code development of TEAM Engine.

URL: http://cite.opengeospatial.org/



Final ID: B13E-0573

Whole watershed quantification of net carbon fluxes by erosion and deposition within the Christina River Basin Critical Zone Observatory

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3. Department of Soil, Water and Climate, University of Minnesota, Minneapolis, MN, United States.
4. Department of Plant and Soils Sciences, University of Delaware, Newark, DE, United States.

Body: We have proposed that the rate at which fresh, carbon-free minerals are delivered to and mix with fresh organic matter determines the rate of carbon preservation at a watershed scale (Aufdenkampe et al. 2011). Although many studies have examined the role of erosion in carbon balances, none consider that fresh carbon and fresh minerals interact. We believe that this mechanism may be a dominant sequestration process in watersheds with strong anthropogenic impacts. Our hypothesis – that the rate of mixing fresh carbon with fresh, carbon-free minerals is a primary control on watershed-scale carbon sequestration – is central to our Christina River Basin Critical Zone Observatory project (CRB-CZO, http://www.udel.edu/czo/). The Christina River Basin spans 1440 km2 from piedmont to Atlantic coastal plain physiographic provinces in the states of Pennsylvania and Delaware, and experienced intensive deforestation and land use beginning in the colonial period of the USA.

Here we present a synthesis of multi-disciplinary data from the CRB-CZO on materials as they are transported from sapprolite to topsoils to colluvium to suspended solids to floodplains, wetlands and eventually to the Delaware Bay estuary. At the heart of our analysis is a spatially-integrated, flux-weighted comparison of the organic carbon to mineral surface area ratio (OC/SA) of erosion source materials versus transported and deposited materials. Because source end-members – such as forest topsoils, farmed topsoils, gullied subsoils and stream banks – represent a wide distribution of initial, pre-erosion OC/SA, we quantify source contributions using geochemical sediment fingerprinting approaches (Walling 2005). Analytes used for sediment fingerprinting include: total mineral elemental composition (including rare earth elements), fallout radioisotope activity for common erosion tracers (beryllium-7, beryllium-10, lead-210, cesium-137), particle size distribution and mineral specific surface area, in addition to organic carbon and nitrogen content with stable isotope (13C, 15N) and radiocarbon (14C) abundance to quantify OC/SA and organic carbon sources and mean age. We then use multivariate mixing model analysis to quantify the fractional contribution of each source end-member to each sample of suspended or deposited sediments. Last, we calculate a predicted OC/SA based on source end-member mixing and compare to the measured OC/SA to quantify net change in mineral complexed carbon.

Final ID: EP13B-0843

Deformation of marine terraces in coastal Humboldt County, California: an evaluation using GIS-based analysis of LiDAR imagery

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Body: Forming at sea level, uplifted wave-cut platforms serve as long-term geodetic markers. The spatial distribution and elevation of marine terrace sequences offer insight to regional active tectonics. Using LiDAR imagery embedded within a geospatial information system (GIS), we employ a surface classification model (SCM) developed by Bowels and Cowgill (2012) that identifies uplifted marine terraces on the basis of their micro topographical characteristics, low slope and low roughness. The LiDAR data sets were compiled utilizing several public and private sources to cover a large portion of the Humboldt County (northern California) coastline extending from Big Lagoon south to Table Bluff. We supplement LiDAR-derived elevations with elevations derived from kinematic GPS. We test the applicability of the SCM approach to identifying deformed marine terraces, and we also use other geomorphic analyses, including longitudinal profiles and distribution of knickpoints, to assess tectonic evolution and rates of landscape change along the central Humboldt County coastal region. Uplifted marine terraces record the regional patterns of uplift; these patterns both record the development of several north-northwest trending thrust faults, anticlines and synclines and chronicle Quaternary tectonic deformation and erosional histories.

Final ID: EP13C-0858

Lidar-enhanced geologic mapping, examples from the Medford and Hood River areas, Oregon

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Body: Lidar-based 3-foot digital elevation models (DEMs) and derivatives (slopeshade, hillshade, contours) were used to help map geology across 1700 km2 (650 mi2) near Hood River and Medford, Oregon. Techniques classically applied to interpret coarse DEMs and small-scale topographic maps were adapted to take advantage of lidar's high resolution. Penetration and discrimination of plant cover by the laser system allowed recognition of fine patterns and textures related to underlying geologic units and associated soils. Surficial geologic maps were improved by the ability to examine tiny variations in elevation and slope. Recognition of low-relief features of all sizes was enhanced where pixel elevation ranges of centimeters to meters, established by knowledge of the site or by trial, were displayed using thousands of sequential colors. Features can also be depicted relative to stream level by preparing a DEM that compensates for gradient. Near Medford, lidar-derived contour maps with 1- to 3-foot intervals revealed incised bajada with young, distal lobes defined by concentric contour lines. Bedrock geologic maps were improved by recognizing geologic features associated with surface textures and patterns or topographic anomalies. In sedimentary and volcanic terrain, structure was revealed by outcrops or horizons lying at one stratigraphic level. Creating a triangulated irregular network (TIN) facet from positions of three or more such points gives strike and dip. Each map area benefited from hundreds of these measurements. A more extensive DEM in the plane of the TIN facet can be subtracted from surface elevation (lidar DEM) to make a DEM with elevation zero where the stratigraphic horizon lies at the surface. The distribution of higher and lower stratigraphic horizons can be shown by highlighting areas similarly higher or lower on the same DEM. Poor fit of contacts or faults projected between field traverses suggest the nature and amount of intervening geologic structure. Intrusive bodies were locally delimited by linear mounds where contact metamorphism hardened soft, fractured country rock. Bedrock faults were revealed where fault traces formed topographic anomalies or where topography associated with stratigraphic horizons or bedding-parallel textural fabrics was offset. This was important for identification of young faults and associated earthquake hazards. Previously unknown Holocene faults southwest of Hood River appear as subtle lineaments redirecting modern drainages or offsetting glacial moraines or glaciated bedrock. West of Medford, the presence young faulting was confirmed by elevation data that showed bedrock in the channel of the Rogue River at higher elevations below Gold Ray dam than in boreholes upstream. Such obscure structural features would have gone unrecognized using traditional topographic analysis or field reconnaissance. Fieldwork verified that lidar techniques improved our early geologic models, resolution of geologic features, and mapping of surficial and bedrock geology between traverses.

Final ID: EP13C-0859

Multi-resolution estimation of lidar-DTM surface flow metrics to identify characteristic topographic length scales

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Body: Characteristic length scales are present in topographic relief and provide insight into the scale ranges of processes governing catchment erosion. Despite the wide availability now of meter-resolution Digital Terrain Models (DTMs) that can in principle resolve such length scales, their objective measurement is still an unsolved problem. Here we explore how topographic length scales can be extracted from lidar DTMs by analyzing the resolution dependence of key surface drainage measures, and how such scales can be used to construct robust geomorphic feature extraction algorithms.

Inspired by the topographic index of TOPMODEL fame, we identify log(area/slope) and curvature as important metrics for the identification of length scales characteristic of landscape-forming processes. Further inspired by wavelet transform analysis, our key strategy is to smooth topography across a range of resolutions (smoothing kernel widths), then to map surface flow patterns at each resolution, and then to derive distributions of log(area/slope) and other metrics. This approach, first developed by Stark and Stark in 2001 and named Multi-Resolution Estimation (MRE), is based on the idea that the topographic effect of an erosion process dominant over a particular length scale range will vanish once smoothing (and thus resolution) exceeds that length scale range. Using the MRE approach we construct probability density functions and estimate modal values and inter-quartile ranges of topographic variables as a function of resolution and we are able to identify and extract characteristic scale breaks. We show that such scale breaks relate to characteristic topographic length scales in the landscape. We explore how such metrics can be used to aid algorithms designed for extraction of channel heads and other geomorphic features of interest from lidar DTMs, and we discuss the implications for assessing the processes that govern catchment evolution.

References:

Stark, C. P. and G. J. Stark. A channelization model of landscape evolution. Amer. Jour. Sci., 301:486-512, 2001

Final ID: EP13E-0895

Using Repeat LiDAR Surveys to Determine the Geomorphic Changes Related the Removal of the Marmot Dam on the Sandy River, Oregon

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Body: The removal of the Marmot Dam on the Sandy River, Oregon in October 2007 released an estimated 430,000 m3 of sand and gravel downstream. Field surveys by Major and others (Major and others, USGS Professional Paper 1792) following the dam removal documented deposition of nearly half of the eroded sediment (215,000 m3) in the first 2 km downstream of the dam within a year of breaching. However, the fate of more than 200,000 m3 of chiefly sand transported farther downstream is uncertain. In the current study, five sequential LiDAR data sets from 2006 to 2011 were used to quantify sediment storage and erosion in the 40 km from the former dam site to the confluence with the Columbia River to track the downstream movement of the sediment released from the reservoir. We hypothesized that a pulse of sediment from the dam removal would be distinguished by a successive downstream growth of sediment bars through time.

The LiDAR imagery includes two data sets acquired before the dam removal and three afterward. Geomorphic Change Detection software (GCD) (gcd.joewheaton.org) was used to quantify the locations and volume of sediment erosion and deposition through the successive years of LiDAR imagery. GCD allows for error assessment of each LiDAR-derived digital elevation map (DEM) and propagates the combined errors when differencing two repeat surveys. This process allows creation of DEM of Difference (DoD) maps with associated uncertainty estimates. Preliminary results of the LiDAR analysis agree with the previous field estimates of deposition within the first 2 km from the former dam. Following the initial phase of deposition immediately downstream of the dam breach, the subsequent surveys (2008-2011) show an erosional front beginning to migrate downstream through the newly deposited sediment. Many of the sediment bars still remained in 2011, but were reduced in size. After calibrating the model in the 2-km reach below the dam, we analyzed the additional 38 km of channel downstream using LiDAR and GCD to determine whether a sediment pulse related to dam removal could be distinguished downstream. A simple DoD with no error propagation was completed for the entire length of the river channel. Downstream from the former dam the river enters a 7 km bedrock gorge where no deposition was documented. In the ½-km reach immediately downstream from the gorge deposition appeared on river banks and in-channel bars 1-3 years after dam removal. Beyond this reach, the sediment pulse related to removal could not be readily distinguished from normal river processes. However, each segment of the 40-km study reach downstream of the dam shows net sediment deposition during the 5-year study period.

Final ID: H13C-1355

Dynamic chemistry in the perched groundwater flowing through weathered bedrock underling a steep forested hillslope, north California

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Body: The spatial and temporal pattern of groundwater chemistry in the seasonally perched groundwater systems that develop in the weathered bedrock zone under hillslopes have rarely been documented, yet chemical evolution of water here dictates the runoff chemistry to streams in many places. Here we exploit an intensively instrumented hillslope to document water well chemistry at three wells and adjacent stream. We have been sampling groundwater at daily frequency since October 2008 on a forested hillslope, "Rivendell", at the Angelo Coast Range Reserve located at the headwaters of the Eel River, California. The site is typical of California's coastal Mediterranean climate. The groundwater samples have been collected from a depth near the boundary between the weathered and fresh bedrock at three locations along the hillslope: Well 1 (bottom of hillslope), Well 3 (mid-slope), and Well 10 (near the ridge). Bulk rainwater and throughfall samples were collected at a meadow across the hillslope and at the middle of the slope, respectively, as well. Near the ridge (Well 10), during the first significant rainstorms of 2009 (133mm/42.5hours) and 2010 (220mm/42hours), when the water table changed only 0.32m and 0.66m, respectively, the concentration of Ca, Mg, and Na started to increase rapidly compared to the dry season (e.g. 2-6 μM vs 0.02-0.2μM [Mg]/day). However, during these same storms, K concentration sharply increased to 50-60 μM and decreased to 20-30μM, synchronizing with the water table responses. Throughfalls of these storms had at least 10 fold lower Ca, Mg, and Na concentrations than the well water while they had 10 fold higher K compared to the pre-event groundwater values. When the total seasonal cumulative rainfall exceeds 600 mm, the Well 10 solute concentration was diluted nearly 3 fold (e.g. [Mg] 0.3 mM vs. 0.1 mM) and the water table was raised significantly (2-6 meters). Throughout the rainy season, Well10 retained its diluted chemistry signature and on average the water table remained elevated as subsequent rainstorms repeatedly recharged the system. Well10 solute concentration slowly increased at the end of the rainy season when the water table fell. In contrast, at the foot of the hill slope, even though the water table was responsive to each rainfall event, its water chemistry developed a strong dilution signatures only during the intense rainstorms (total rainfall > 70mm); the solute concentration decreased (e.g. [Mg] = 0.1mM) during the rising limb of the well hydrograph and recovered back to its pre-event value (e.g. [Mg] = 0.3mM) during the falling limb of the well hydrograph. During small storms, the solute concentration of Well 1 either did not change or slightly increased. Mid-slope showed similar behavior to Well 1. The Well 3 solute concentration was diluted about 3 fold (e.g. [Mg] 0.3mM to 0.1mM) as the water table rose and increased as the water table receded. However unlike Well 1, the water chemistry of Well 3 did not recover to its pre-event composition at any point during the rainy season and the recovery rate was slower than that of Well 1. These water chemistry observations provide insight into the dynamics of water movement within the fractured, weathered bedrock zone, and point to both vertical and lateral mixing processes that influence the chemical evolution of waters.

Final ID: IN13A-1494

An Accessible User Interface for Geoscience and Programming

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Body: The goal of this research is to develop an interface that will simplify user interaction with software for scientists. The motivating factor of the research is to develop tools that assist scientists with limited motor skills with the efficient generation and use of software tools. Reliance on computers and programming is increasing in the world of geology, and it is increasingly important for geologists and geophysicists to have the computational resources to use advanced software and edit programs for their research.

I have developed a prototype of a program to help geophysicists write programs using a simple interface that requires only simple single-mouse-clicks to input code. It is my goal to minimize the amount of typing necessary to create simple programs and scripts to increase accessibility for people with disabilities limiting fine motor skills. This interface can be adapted for various programming and scripting languages. Using this interface will simplify development of code for C/C++, Java, and GMT, and can be expanded to support any other text based programming language.

The interface is designed around the concept of maximizing the amount of code that can be written using a minimum number of clicks and typing. The screen is split into two sections: a list of click-commands is on the left hand side, and a text area is on the right hand side. When the user clicks on a command on the left hand side the applicable code is automatically inserted at the insertion point in the text area. Currently in the C/C++ interface, there are commands for common code segments that are often used, such as for loops, comments, print statements, and structured code creation.

The primary goal is to provide an interface that will work across many devices for developing code. A simple prototype has been developed for the iPad. Due to the limited number of devices that an iOS application can be used with, the code has been re-written in Java to run on a wider range of devices.

Currently, the software works in a prototype mode, and it is our goal to further development to create software that can benefit a wide range of people working in geosciences, which will make code development practical and accessible for a wider audience of scientists. By using an interface like this, it reduces potential for errors by reusing known working code.

Final ID: IN13A-1495

Web Viz 2.0: A versatile suite of tools for collaboration and visualization

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Body: Most scientific applications on the web fail to realize the full collaborative potential of the internet by not utilizing web 2.0 technology. To relieve users from the struggle with software tools and allow them to focus on their research, new software developed for scientists and researchers must harness the full suite of web technology. For several years WebViz 1.0 enabled researchers with any web accessible device to interact with the peta-scale data generated by the Hierarchical Volume Renderer (HVR) system. We have developed a new iteration of WebViz that can be easily interfaced with many problem domains in addition to HVR by employing the best practices of software engineering and object-oriented programming. This is done by separating the core WebViz system from domain specific code at an interface, leveraging inheritance and polymorphism to allow newly developed modules access to the core services. We employed several design patterns (model-view-controller, singleton, observer, and application controller) to engineer this highly modular system implemented in Java.

Final ID: IN13A-1496

JMARS - Planetary Remote Sensing Analysis Made Even Easier

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Body: Planetary remote sensing data has been collected and made public over the years from a variety of missions, but accessing this data and performing analysis on it has often been a time consuming and problematic task.

JMARS (Java Mission-planning and Analysis for Remote Sensing) is a free geospatial application developed by the Mars Space Flight Facility at Arizona State University. Originally written as a misson planning tool for the THEMIS instrument on board the MARS Odyssey Spacecraft, it was released as an analysis tool to the general public in 2003. Since then it has expanded to be used for mission planning and scientific data analysis by additional NASA missions to Mars, the Moon, and Vesta and it has come to be used by scientists, researchers and students of all ages from more than 40 countries around the world.

JMARS tries to save a user from the nuances of working with planetary data by providing a quick and consistent method of accessing data from various missions which can then be analyzed and compared with each other. A user can easily access hundreds of maps and millions of individual images collected by the Viking, MOC, MOLA, TES, THEMIS, HiRISE, CTX, and CRISM instruments. Users can also import their own data and work with it in an identical fashion, then optionally share that data with other users.

Recent effort has been put into making JMARS easier and more consistent to use. A new toolbar makes panning and zooming easier and more intuitive, especially for systems without three button mice. Additionally, the toolbar also exposes measuring and data investigation tools that used to only be accessible in specific layers and obscure keyboard commands. The Layer Manager, which has long allowed users to reorder layers, adjust transparency, and access layer specific options, can now be optionally docked into the main view window, making it easier to work on laptops or overhead projectors. The Layer Manager can still be torn off into it's own independent window for users with multiple displays or ample screen real estate.

URL: http://jmars.mars.asu.edu

Final ID: IN13A-1497

Interoperability of Multiple Datasets with JMARS

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Body: Planetary Science includes all celestial bodies including Earth. However, when investigating Geographic Information System (GIS) applications, Earth and planetary bodies have the tendency to be separated. One reason is because we have been learning and investigating Earth's properties much longer than we have been studying the other planetary bodies, therefore, the archive of GCS and projections is much larger.

The first latitude and longitude system of Earth was invented between 276 BC and 194 BC by Eratosthenes who was also the first to calculate the circumference of the Earth. As time went on, scientists continued to re-measure the Earth on both local and global scales which has created a large collection of projections and geographic coordinate systems (GCS) to choose from. The variety of options can create a time consuming task to determine which GCS or projection gets applied to each dataset and how to convert to the correct GCS or projection. Another issue is presented when determining if the dataset should be applied to a geocentric sphere or a geodetic spheroid. Both of which are measured and determine latitude values differently. This can lead to inconsistent results and frustration for the user. This is not the case with other planetary bodies.

Although the existence of other planets have been known since the early Babylon times, the accuracy of the planets rotation, size and geologic properties weren't known for several hundreds of years later. Therefore, the options for projections or GCS's are much smaller than the options one has for Earth's data. Even then, the projection and GCS options for other celestial bodies are informal. So it can be hard for the user to determine which projection or GCS to apply to the other planets.

JMARS (Java Mission Analysis for Remote Sensing) is an open source suite that was developed by Arizona State University's Mars Space Flight Facility. The beauty of JMARS is that the tool transforms all datasets behind the scenes which gives the user the ability to use or access multiple datasets in one application without the worry of converting from one projection to another or GCS to another. The application creates an easy, efficient and stress free experience. With JMARS, the user can import their own data as well as access several other datasets such as HIRISE, MODIS, GOES, OSM (Open Street Map) and TIMS. Currently, the JMARS team has developed a method to access other datasets on the fly from the source servers. These include HIRISE (High Resolution Imaging Science Experiment) images, OSM datasets on a city scale, and we are currently working on ECHO datasets. There is no need for a third party website to download the datasets. Everything is done within JMARS.

Final ID: IN13A-1498

Earth-Base: A Free And Open Source, RESTful Earth Sciences Platform

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Body: This presentation describes the motivation, concept, and architecture behind Earth-Base, a web-based, RESTful data-management, analysis and visualization platform for earth sciences data. Traditionally web applications have been built directly accessing data from a database using a scripting language. While such applications are great at bring results to a wide audience, they are limited in scope to the imagination and capabilities of the application developer. Earth-Base decouples the data store from the web application by introducing an intermediate "data application" tier. The data application's job is to query the data store using self-documented, RESTful URIs, and send the results back formatted as JavaScript Object Notation (JSON).

Decoupling the data store from the application allows virtually limitless flexibility in developing applications, both web-based for human consumption or programmatic for machine consumption. It also allows outside developers to use the data in their own applications, potentially creating applications that the original data creator and app developer may not have even thought of. Standardized specifications for URI-based querying and JSON-formatted results make querying and developing applications easy. URI-based querying also allows utilizing distributed datasets easily. Companion mechanisms for querying data snapshots aka time-travel, usage tracking and license management, and verification of semantic equivalence of data are also described. The latter promotes the "What You Expect Is What You Get" (WYEIWYG) principle that can aid in data citation and verification.

Final ID: IN13A-1499

Collaboratory for the Study of Earthquake Predictability: Recent Developments and Extensions

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Body: The Southern California Earthquake Center (SCEC) has been working with international partners to develop a Collaboratory for the Study of Earthquake Predictability (CSEP). The collaboratory is designed to support a global program for conducting prospective forecasting experiments under rigorous, controlled conditions and evaluating the results using transparent, community-accepted criteria specified in advance. There are now four testing centers in California, New Zealand, Japan, and Europe, with a total of 229 models under evaluation, and a fifth is being developed in China. In this presentation, we describe how the testing centers have evolved to meet the CSEP design goals and share our experiences in operating the centers since their inception. In particular, we detail the cyberinfrastructure improvements to the W. M. Keck Foundation Testing Center at SCEC. This prototype center has been operational since September 1, 2007, and currently hosts intermediate-term and short-term forecasts, both alarm-based and rate-based, for California and the Western Pacific, as well as for the global testing region. Current efforts are focused on the reduction of testing latencies and procedures for the evaluation of externally hosted forecasting experiments, with the goal of supporting the new USGS program in operational earthquake forecasting. We describe the open-source CSEP software available for personal use by scientists to perform independent study and evaluation of their models prior submitting them to the Testing Center (http://northridge.usc.edu/trac/csep/wiki/MiniCSEP). We also discuss how the CSEP infrastructure is being applied to geodetic transient detection and the evaluation of ShakeAlert system for earthquake early warning, and how CSEP procedures will be adapted to ground motion prediction experiments.

URL: http://cseptesting.org

Final ID: IN13A-1500

Open source software engineering for geoscientific modeling applications

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Body: OpenGeoSys (OGS) is a scientific open source project for numerical simulation of thermo-hydro-mechanical-chemical (THMC) processes in porous and fractured media. The OGS software development community is distributed all over the world and people with different backgrounds are contributing code to a complex software system. The following points have to be addressed for successful software development:

-Platform independent code
-A unified build system
-A version control system
-A collaborative project web site
-Continuous builds and testing
-Providing binaries and documentation for end users

OGS should run on a PC as well as on a computing cluster regardless of the operating system. Therefore the code should not include any platform specific feature or library. Instead open source and platform independent libraries like Qt for the graphical user interface or VTK for visualization algorithms are used.

A source code management and version control system is a definite requirement for distributed software development. For this purpose Git is used, which enables developers to work on separate versions (branches) of the software and to merge those versions at some point to the official one.
The version control system is integrated into an information and collaboration website based on a wiki system. The wiki is used for collecting information such as tutorials, application examples and case studies. Discussions take place in the OGS mailing list.

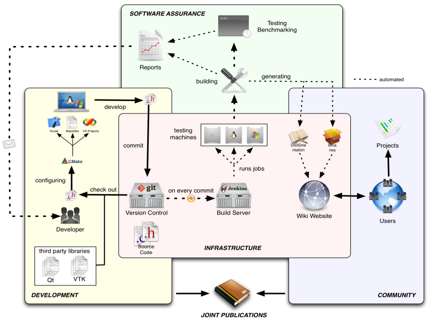
To improve code stability and to verify code correctness a continuous build and testing system, based on the Jenkins Continuous Integration Server, has been established. This server is connected to the version control system and does the following on every code change:

-Compiles (builds) the code on every supported platform (Linux, Windows, MacOS)
-Runs a comprehensive test suite of over 120 benchmarks and verifies the results
Runs software development related metrics on the code (like compiler warnings, code complexity, static analysis tools)
-Informs developers on errors (via email)
-Generates source code documentation
-Provides binaries for end users

These points enhance the software development process considerably. Firstly, platform independence is maintained. Additionally, errors in the source code can be tracked down easily. Lastly, developers gain access to code analysis

tools and up-to-date source code documentation.

URL: http://www.opengeosys.net



Overview of the OpenGeoSys software engineering workflow

Final ID: IN13A-1501

Hardware and Software Interfacing at New Mexico Geochronology Research Laboratory: Distributed Control Using Pychron and RemoteControlServer.cs

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Body: We developed a system for interfacing existing hardware and software to two new Thermo Scientific Argus VI mass spectrometers and three Photon Machines Fusions laser systems at New Mexico Geochronology Research Laboratory. NMGRL's upgrade to the new analytical equipment required the design and implementation of a software ecosystem that allows seamless communication between various software and hardware components. Based on past experience and initial testing we choose to pursue a "Fully Distributed Control" model. In this model, hardware is compartmentalized and controlled by customized software running on individual computers. Each computer is connected to a Local Area Network (LAN) facilitating inter-process communication using TCP or UDP Internet Protocols. Two other options for interfacing are 1) Single Control, in which all hardware is controlled by a single application on a single computer and 2), Partial Distributed Control, in which the mass spectrometer is controlled directly by Thermo Scientific's Qtegra and all other hardware is controlled by a separate application. The "Fully Distributed Control" model offers the most efficient use of software resources, leveraging our in-house laboratory software with proprietary third-party applications, such as Qtegra and Mass Spec. Two software products resulted from our efforts. 1) Pychron, a configurable and extensible package for hardware control, data acquisition and preprocessing, and 2) RemoteControlServer.cs, a C# script for Thermo's Qtegra software that implements a TCP/UDP command server. Pychron is written in python and uses standard well-established libraries such as, Numpy, Scipy, and Enthought ETS. Pychron is flexible and extensible, encouraging experimentation and rapid development of new features. A project page for Pychron is located at http://code.google.com/p/arlab, featuring an issue tracker and a Version Control System (Mercurial). RemoteControlServer.cs is a simple socket server that listens for incoming commands, processes them using Qtegra and returns the result. The standardized IPC and RPC protocols for intra and inter-computer communications consist of human-readable strings of ASCII characters making them easy to use and comprehend.

Final ID: IN13A-1502

Caching strategies for improving performance of web-based Geographic applications

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Body: The NASA Operation IceBridge mission collects airborne remote sensing measurements to bridge the gap between NASA's Ice, Cloud and Land Elevation Satellite (ICESat) mission and the upcoming ICESat-2 mission. The IceBridge Data Portal from the National Snow and Ice Data Center provides an intuitive web interface for accessing IceBridge mission observations and measurements. Scientists and users usually do not have knowledge about the individual campaigns but are interested in data collected in a specific place. We have developed a high-performance map interface to allow users to quickly zoom to an area of interest and see any Operation IceBridge overflights. The map interface consists of two layers: the user can pan and zoom on the base map layer; the flight line layer that overlays the base layer provides all the campaign missions that intersect with the current map view. The user can click on the flight campaigns and download the data as needed. The OpenGIS® Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. Web Feature Service (WFS) provides an interface allowing requests for geographical features across the web using platform-independent calls. OpenLayers provides vector support (points, polylines and polygons) to build a WMS/WFS client for displaying both layers on the screen. Map Server, an open source development environment for building spatially enabled internet applications, is serving the WMS and WFS spatial data to OpenLayers. Early releases of the portal displayed unacceptably poor load time performance for flight lines and the base map tiles. This issue was caused by long response times from the map server in generating all map tiles and flight line vectors. We resolved the issue by implementing various caching strategies on top of the WMS and WFS services, including the use of Squid (www.squid-cache.org) to cache frequently-used content. Our presentation includes the architectural design of the application, and how we use OpenLayers, WMS and WFS with Squid to build a responsive web application capable of efficiently displaying geospatial data to allow the user to quickly interact with the displayed information. We describe the design, implementation and performance improvement of our caching strategies, and the tools and techniques developed to assist our data caching strategies.

Final ID: IN13B-1503

OOI's Cyberinfrastructure: An Opening

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3. Woods Hole Oceanographic Institution, Woods Hole, MA, United States.
4. Amaryllis Consulting, LLC, Los Altos, CA, United States.

Body: The Ocean Observatories Initiative is a long-term, NSF-funded program to provide 25-30 years of sustained ocean measurements to study climate variability, ocean circulation and ecosystem dynamics, air-sea exchange, seafloor processes, and plate-scale geodynamics. The OOI will enable powerful new scientific approaches for exploring the complexities of Earth-ocean-atmosphere interactions, thereby accelerating progress toward the goal of understanding, predicting, and managing our ocean environment. The OOI can foster new discoveries that, in turn, move research in unforeseen directions.

The OOI Cyberinfrastructure will connect and coordinate the operations of OOI marine components and data processes, to meet the objectives of the oceanographic research and education communities. The CI will let all users easily interact with deployed resources, access collected data, and apply those data to their specific research and educational needs. The CI is a free and open product that adopts innovative and flexible strategies to bring the oceans to users, any time, any place, on any suitable device.

The OOI CI is dedicated to "using the latest computing technologies to solve the interoperability problem among vast amounts of heterogeneous geospatial data from various sources." OOI CI's charge is to be transformative, and its technologies and goals are just that (see URL). The Cyberinfrastructure integrates state-of-the-art and best-practice approaches to provide fully interoperable access to the widest possible collection of geospatial data. From the system-of-systems model of the planned observatories and the ingestion of data, models, and services; to the configurable, automated workflows producing real-time products, data curation and quality management strategies are supported to the fullest possible extent.

How do we build a system to efficiently support 750 core instruments across numerous platform types, add as-yet unknown instruments during the operations phase, and support any number of processes and external data in the system throughout its 25+ years of operation? What key strategies must be adopted, architectural approaches applied, and technologies integrated to provide complete discovery, access, and use of the system and its data? What defines the critical characteristics expected of the core system, the complete system, and the transformative system? And how can this system be leveraged by multiple science users, programs, and organizations beyond its initial target functionality?

We will present the CI team's best responses to these questions. The project is completing Release 2, two-thirds of the way to a fully public release, and halfway to the final system. The engagement of OOI marine operations and marine science teams prepares us to support marine operations, and the software will be applied to "real operations" very soon. Most of the fundamental marine and operational scenarios are in place at a basic level, and the capabilities have been laid out for a full suite of mature operations and science activities.

From these beginnings, we offer technical, social, and strategic perspectives on the challenges and solutions in geoinformatics data systems, and ask "Where to from here?"

Funding for OOI is provided by the National Science Foundation through a Cooperative Agreement with the Consortium for Ocean Leadership, which in turn funds the CI project.

URL: http://ci.oceanobservatories.org/agu2012

Final ID: IN13B-1504

Data Management for Flexible Access - Implementation and Lessons Learned from work with Multiple User Communities *(Invited)*

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2. University Libraries, University of New Mexico, Albuquerque, NM, United States.

Body: There is no shortage of community-specific and generic data discovery and download platforms and protocols (e.g. CUAHSI HIS, DataONE, GeoNetwork Open Source, GeoPortal, OGC CSW, OAI PMH), documentation standards (e.g. FGDC, ISO 19115, EML, Dublin Core), data access and visualization standards and models (e.g. OGC WxS, OpenDAP), and general-purpose web service models (i.e. REST & SOAP) upon which Geo-informatics cyberinfrastructure (CI) may be built. When attempting to develop a robust platform that may service a wide variety of users and use cases the challenge is one of identifying which existing platform (if any) may support those current needs while also allowing for future expansion for additional capabilities.

In the case of the implementation of a data storage, discovery and delivery platform to support the multiple projects at the Earth Data Analysis Center at UNM, no single platform or protocol met the joint requirements of two initial applications (the New Mexico Resource Geographic Information System [http://rgis.unm.edu] and the New Mexico EPSCoR Data Portal [http://nmepscor.org/dataportal]) and furthermore none met anticipated additional requirements as new applications of the platform emerged. As a result of this assessment three years ago EDAC embarked on the development of the Geographic Storage, Transformation, and Retrieval Engine (GSToRE) platform as a general purpose platform upon which n-tiered geospatially enabled data intensive applications could be built. When initially released in 2010 the focus was on the publication of dynamically generated Open Geospatial Consortium services based upon a PostgreSQL/PostGIS backend database. The identification of additional service interface requirements (implementation of the DataONE API and CUAHSI WaterML services), use cases provided by the NM EPSCoR education working group, and expanded metadata publication needs have led to a significant update to the underlying data management tier for GSToRE - the implementation of a hybrid relational (PostgreSQL/PostGIS) and document-based database (MongoDB) model in which core geospatial data (feature geometries) and related metadata are stored within the relational environment and attributes associated with those features are stored within the document-based database. This paper presents the current hybrid data management model and highlights the pros and cons of custom platform development as an alternative to building upon existing systems.

Final ID: IN13B-1505

Opening Data in the Long Tail for Community Discovery, Curation and Action Using Active and Social Curation *(Invited)*

M. L. Hedstrom; [1]; *P. Kumar;* [3]; *J. Myers;* [4]; *B. A. Plale;* [2];
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2. Indiana University, Bloomington, IN, United States.
3. University of Illinois, Urbana-Champaign, IL, United States.
4. Rensselaer Polytechnic Institut, Troy, NY, United States.

Body: In data science, the most common sequence of steps for data curation are to 1) curate data, 2) enable data discovery, and 3) provide for data reuse. The Sustainable Environments – Actionable Data (SEAD) project, funded through NSF's DataNet program, is creating an environment for sustainability scientists to discover data first, reuse data next, and curate data though an on-going process that we call Active and Social Curation. For active curation we are developing tools and services that support data discovery, data management, and data enhancement for the community while the data is still being used actively for research. We are creating an Active Content Repository, using drop box, semantic web technologies, and a Flickr-like interface for researchers to "drop" data into a repository where it will be replicated and minimally discoverable. For social curation, we are deploying a social networking tool, VIVO, which will allow researchers to discover data-publications-people (e.g. expertise) through a route that can start at any of those entry points. The other dimension of social curation is developing mechanisms to open data for community input, for example, using ranking and commenting mechanisms for data sets and a community-sourcing capability to add tags, clean up and validate data sets.

SEAD's strategies and services are aimed at the sustainability science community, which faces numerous challenges including discovery of useful data, cleaning noisy observational data, synthesizing data of different types, defining appropriate models, managing and preserving their research data, and conveying holistic results to colleagues, students, decision makers, and the public. Sustainability researchers make significant use of centrally managed data from satellites and national sensor networks, national scientific and statistical agencies, and data archives. At the same time, locally collected data and custom derived data products that combine observations and measurements from local, national, and global sources are critical resources that have disproportionately high value relative to their size.
Sustainability science includes a diverse and growing community of domain scientists, policy makers, private sector investors, green manufacturers, citizen scientists, and informed consumers. These communities need actionable data in order to assess the impacts of alternate scenarios, evaluate the cost-benefit tradeoffs of different solutions, and defend their recommendations and decisions.

SEAD's goal is to extend its services to other communities in the "long tail" that may benefit from new approaches to infrastructure development which take into account the social and economic characteristics of diverse and dispersed data producers and consumers. For example, one barrier to data reuse is the difficulty of discovering data that might be valuable for a particular study, model, or decision. Making data minimally discoverable saves the community time expended on futile searches and creates a market, of sorts, for the data. Creating very low barriers to entry to a network where data can be discovered and acted upon vastly reduces this disincentive to sharing data. SEAD's approach allows communities to make small incremental improvements in data curation based on their own priorities and needs.

Final ID: IN13B-1506

Active and Social Data Curation: Reinventing the Business of Community-scale Lifecycle Data Management

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3. Civil and Environmental Engineering, University of Illinois, Champagne, IL, United States.
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5. School of Information, University of Michigan, Ann Arbor, MI, United States.

Body: Effective long-term curation and preservation of data for community use has historically been limited to high-value and homogeneous collections produced by mission-oriented organizations. The technologies and practices that have been applied in these cases, e.g. relational data bases, development of comprehensive standardized vocabularies, and centralized support for reference data collections, are arguably applicable to the much broader range of data generated by the long tail of investigator-led research, with the logical conclusion of such an argument leading to the call for training, evangelism, and vastly increased funding as the best means of broadening community-scale data management. In this paper, we question this reasoning and explore how alternative approaches focused on the overall data lifecycle and the sociological and business realities of distributed multi-disciplinary research communities might dramatically lower costs, increase value, and consequently drive dramatic advances in our ability to use and re-use data, and ultimately enable more rapid scientific advance. Specifically, we introduce the concepts of active and social curation as a means to decrease coordination costs, align costs and values for individual data producers and data consumers, and improve the immediacy of returns for data curation investments. Further, we describe the specific architecture and services for active and social curation that are being prototyped within the Sustainable Environment – Actionable Data (SEAD) project within NSF's DataNet network and discuss how they are motivated by the long-tail dynamics in the cross-disciplinary sustainability research community.

URL: http://sead-data.net/

Final ID: NH13A-1598

LiDAR data and SAR imagery acquired by an unmanned helicopter for rapid landslide investigation

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2. Sapporo Development and Construction Department , Hokkaido Regional Development Bureau, Sapporo, Japan.

Body: When earthquakes or heavy rainfall hits a landslide prone area, initial actions require estimation of the size of damage to people and infrastructure. This includes identifying the number and size of newly collapsed or expanded landslides, and appraising subsequent risks from remobilization of landslides and debris materials. In inapproachable areas, the UAV (Unmanned Aerial Vehicles) is likely to be of greatest use. In addition, repeat monitoring of sites after the event is a way of utilizing UAVs, particularly in terms of cost and convenience. In this study, LiDAR (SkEyesBox MP-1) data and SAR (Nano SAR) imagery, acquired over 0.5 km2 landslide prone area, are presented to assess the practicability of using unmanned helicopters (in this case a 10 year old YAMAHA RMAX G1) in these situations. LiDAR data was taken in July 2012, when tree foliage covered the ground surface. However, imagery was of sufficient quality to identify and measure landslide features. Nevertheless, LiDAR data obtained by a manned helicopter in the same area in August 2008 was more detailed, reflecting the function of the LiDAR scanner. On the other hand, 2 m resolution Nano SAR imagery produced reasonable results to elucidate hillslope condition. A quick method for data processing without loss of image quality was also investigated. In conclusion, the LiDAR scanner and UAV employed here could be used to plan immediate remedial activity of the area, before LiDAR measurement with a manned helicopter can be organized. SAR imagery from UAV is also available for this initial activity, and can be further applied to long term monitoring.

Final ID: C14B-05

Integration of airborne LiDAR data and voxel-based ray tracing to determine high-resolution solar radiation dynamics at the forest floor: implications for improving stand-scale distributed snowmelt models

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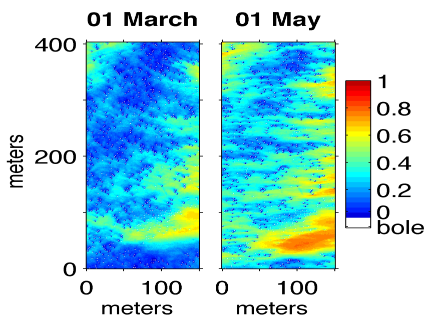
3. Geography and INSTAAR, University of Colorado Boulder, Boulder, CO, United States.
4. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States.

Body: Forest architecture dictates sub-canopy solar irradiance and the resulting patterns can vary seasonally and over short spatial distances. These radiation dynamics are thought to have significant implications on snowmelt processes, regional hydrology, and remote sensing signatures. The variability calls into question many assumptions inherent in traditional canopy models (e.g. Beer's Law) when applied at high resolution (i.e. 1 m). We present a method of estimating solar canopy transmissivity using airborne LiDAR data. The canopy structure is represented in 3-D voxel space (i.e. a cubic discretization of a 3-D domain analogous to a pixel representation of a 2-D space). The solar direct beam canopy transmissivity (DBT) is estimated with a ray-tracing algorithm and the diffuse component is estimated from LiDAR-derived effective LAI. Results from one year at five-minute temporal and 1 m spatial resolutions are presented from Sequoia National Park. Compared to estimates from 28 hemispherical photos, the ray-tracing model estimated daily mean DBT with a 10% average error, while the errors from a Beer's-type DBT estimate exceeded 20%. Compared to the ray-tracing estimates, the Beer's-type transmissivity method was unable to resolve complex spatial patterns resulting from canopy gaps, individual tree canopies and boles, and steep variable terrain. The snowmelt model SNOWPACK was applied at locations of ultrasonic snow depth sensors. Two scenarios were tested; 1) a nominal case where canopy model parameters were obtained from hemispherical photographs, and 2) an explicit scenario where the model was modified to accept LiDAR-derived time-variant DBT. The bulk canopy treatment was generally unable to simulate the sub-canopy snowmelt dynamics observed at the depth sensor locations. The explicit treatment reduced error in the snow disappearance date by one week and both positive and negative melt-season SWE biases were reduced. The results highlight the utility of LiDAR canopy measurements and physically based snowmelt models to simulate spatially distributed stand- and slope-scale snowmelt dynamics at resolutions necessary to capture the inherent underlying variability.



LiDAR-derived solar direct beam canopy transmissivity computed as the daily average for March 1st and May 1st.

Final ID: C14B-08

Under-canopy snow accumulation and ablation measured with airborne scanning LiDAR altimetry and in-situ instrumental measurements, southern Sierra Nevada, California

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3. Department of Geography, Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO, United States.
4. Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States.

Body: We investigated the influence of canopy on snow accumulation and melt in a mountain forest using paired snow on and snow off scanning LiDAR altimetry, synoptic measurement campaigns and in-situ time series data of snow depth, SWE, and radiation collected from the Kaweah River watershed, Sierra Nevada, California. Our analysis of forest cover classified by dominant species and 1 m^2 grided mean under canopy snow accumulation calculated from airborne scanning LiDAR, demonstrate distinct relationships between forest class and under-canopy snow depth. The five forest types were selected from carefully prepared 1 m vegetation classifications and named for their dominant tree species, Giant Sequoia, Jeffrey Pine, White Fir, Red Fir, Sierra Lodgepole, Western White Pine, and Foxtail Pine. Sufficient LiDAR returns for calculating mean snow depth per m^2 were available for 31 - 44% of the canopy covered area and demonstrate a reduction in snow depth of 12 - 24% from adjacent open areas. The coefficient of variation in snow depth under canopies ranged from 0.2 – 0.42 and generally decreased as elevation increased. Our analysis of snow density snows no statistical significance between snow under canopies and in the open at higher elevations with a weak significance for snow under canopies at lower elevations. Incident radiation measurements made at 15 minute intervals under forest canopies show an input of up to 150 w/m^2 of thermal radiation from vegetation to the snow surface on forest plots.

Snow accumulated on the mid to high elevation forested slopes of the Sierra Nevada represents the majority of winter snow storage. However snow estimates in forested environments demonstrate a high level of uncertainty due to the limited number of in-situ observations and the inability of most remote sensing platforms to retrieve reflectance under dense vegetation. Snow under forest canopies is strongly mediated by forest cover and decoupled from the processes that dictate accumulation and ablation of snow in open locations, where almost all precipitation and meteorlogic measurements concerning snow are made. Snow accumulation is intercepted by vegetation until it accumulates to a depth equal to or greater than the height of the vegetation, is reduced by the amount of sublimation or evaporation occurring while on the canopy and is redistributed beneath the canopy at a different density or as liquid water. Ablation processes are dictated by the energy environment surrounding vegetation where sensible heat is mediated by shading of short wave radiation.

Final ID: H21B-1171

Understanding the interaction of climate, vegetation, channelization, and landsliding through lidar analysis *(Invited)*

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Body: The coevolution of landforms and ecosystems is evident in many landscapes around us. Humid uplands are an example, where soil development and vegetation growth are periodically disturbed by landsliding, enhancing denudation by runoff processes. Metrics such as drainage density have been proposed to capture the signature of climate since the classic work of Melton [1957], but limitations exist when these metrics are computed on coarse resolution topographic data. High resolution digital terrain models are sufficiently detailed to allow the identification of channel initiation and the assessment of drainage density, but require the development of objective feature extraction tools.
In this work we explore the climatological and vegetational controls on channelization and landsliding in humid uplands. A theoretical model is shown to capture the regolith-vegetation dynamics that characterize these landscapes, highlighting the interplay between runoff and landslide erosion as rainfall increases in severity. Results from the exploitation of lidar data with recently developed geomorphic feature extraction techniques show that metrics such as drainage density can be robustly measured and are able to capture the signature of climate, landsliding, and vegetation type.

Final ID: H21B-1180

Assessing riparian shade for the Lemhi River, Idaho using LiDAR: A point cloud analysis

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1. Geosciences, Idaho State University, Boise, ID, United States.

2. Idaho Department of Environmental Quality, Boise, ID, United States.

Body: Riparian vegetation plays a crucial role in shading streams by reducing the amount of incoming solar insolation that would otherwise reach the water surface, negatively affecting water temperature and photosynthetic organisms within the water column. Unlike incoming solar insolation, riparian shade can be manipulated by adding or removing riparian vegetation, making it attractive for restoration as well as thermal credit trading programs. Before riparian shade can be evaluated in such trading programs, the existing riparian vegetation needs to be quantified. Several studies have investigated the utility of LiDAR derived canopy height models for estimating riparian shade, however, few to no studies have used point cloud data as a direct model input in order to improve the riparian shade estimates. Using point cloud data increases spatial resolution and the ability to extract vegetation shape information without losses due to interpolation/rasterization. In this study, we assessed the ability of LiDAR point cloud data to estimate riparian shade for 32 km of the Lemhi River in north central Idaho. Riparian shade quantification of the point cloud and canopy height models are compared to shade values calculated using established models in practice.

Final ID: H21H-1274

Using LiDAR data to spatially scale and examine the accuracy of evapotranspiration estimates in the Western Boreal Plains, Canada

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2. Biological Sciences, University of Alberta, Edmonton, AB, Canada.

Body: In Canada a large portion of the boreal forest is comprised of the mosaic landscape of the Western Boreal Plains (WBP)—a region characterized by consistent water deficit conditions. Because potential evapotranspiration (PET) generally exceeds precipitation annually, evapotranspiration (ET) is the primary driver of the hydrologic balance in the WBP. Owing to this, the WBP is a hydrologically sensitive region, and future changes to the climate will significantly impact the region's water balance. This region is also an economic hub for the country's natural resource extraction (e.g. forestry, conventional oil and gas, and oilsands development) creating significant disturbance on the landscape. However, this sensitive landscape is characterized by sparse measurement stations, making it challenging to gain information and drive models outside of the tower-footprint scale. This scenario makes remote sensing an ideal method of acquiring spatial information pertaining to the hydro-meteorology of this region—though further investigation is needed to determine the most appropriate resolution at which remote sensing data is best collected. At a study site representative of the WBP, this research uses high-resolution (1m x 1m) Light Detection and Ranging (LiDAR) data of the vegetation structure as an input to the Penman-Monteith model to provide a spatially explicit estimate of ET. The accuracy of high-resolution spatially explicit and spatially static vegetation parameters are examined relative to eddy covariance (EC) validation data. Subsequently, high-resolution, spatially explicit vegetation parameters were resampled to lower resolutions, providing ET estimates from input data representative of the resolution of modern global satellite systems, i.e. SPOT (10m), Landsat (30m), and MODIS (250m, 500m, 1000m). The accuracy of these lower resolution estimates of ET are examined relative to high-resolution estimates and validation data. Understanding the relative accuracy of ET estimates with increasingly low-resolution input data will help determine the validity of using data acquired from low-resolution global satellite systems to drive regional-scale climate models.

Final ID: IN43B-1523

Development of teaching modules for geology and engineering coursework using terrestrial LiDAR scanning systems

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2. Department of Geology and Geological Engineering, South Dakota School of Mines & Technology, Rapid City, SD, United States.
3. The Black Hills Natural Sciences Field Station, South Dakota School of Mines & Technology, Rapid City, SD, United States.

Body: Exposing students to active and local examples of physical geologic processes is beneficial to the learning process. Students typically respond with interest to examples that use state-of-the-art technologies to investigate local or regional phenomena. For lower cognitive level of learning (e.g. knowledge, comprehension, and application), the use of “close-to-home” examples ensures that students better understand concepts. By providing these examples, the students may already have a familiarity or can easily visit the location. Furthermore, these local and regional examples help students to offer quickly other examples of similar phenomena.

Investigation of these examples using normal photographic techniques, as well as a more sophisticated 3-D Light Detection And Ranging (LiDAR) (AKA Terrestrial Laser Scanning or TLS) system, allows students to gain a better understanding of the scale and the mechanics of the geologic processes and hazards. The systems are used for research, teaching and outreach efforts and depending on departmental policies can be accessible to students are various learning levels. TLS systems can yield scans at sub-centimeter resolution and contain surface reflectance of targets.

These systems can serve a number of learning goals that are essential for training geoscientists and engineers. While querying the data to answer geotechnical or geomorphologic related questions, students will develop skills using large, spatial databases. The upper cognitive level of learning (e.g. analysis, synthesis, and evaluation) is also promoted by using a subset of the data and correlating the physical geologic process of stream bank erosion and rock slope failures with mathematical and computer models using the scanned data.

Students use the examples and laboratory exercises to help build their engineering judgment skills with Earth materials. The students learn not only applications of math and engineering science but also the economic and social implication of designed engineering solutions. These course learning modules were developed for traditional geological engineering courses delivered on campus, for more intensive field work courses and online-based asynchronous course delivery.

URL: www.geology.und.edu

Final ID: GC22C-03

Coupled Modeling of Geomorphology and Ecohydrology: Topographic feedbacks driven by solar radiation ***(Invited)***

E. Istanbulluoglu; [1]; *J. H. Flores Cervantes;* [1]; *O. Yetemen;* [1];
1. Civil and Environmental Eng., Univ of Washington, Seattle, WA, United States.

Body: There is a two-way coupling between geomorphic processes and vegetation dynamics. To examine the role of vegetation on landform development, landscape evolution models (LEMs) have used relatively simple theory of erosion-vegetation interactions and vegetation dynamics based on field evidence and conjecture. Such modeling studies have described “with broad strokes” the control of vegetation on landscape relief, drainage density, and sediment yields in a range of model sensitivity studies, often without any direct field confirmation. For improved predictions of climate-landscape relations in real-world cases, and identify the need for future model development, there is strong need for field confirmations of ecohydrologic LEMs. In this talk, we first discuss some of the key findings of recent LEM studies that incorporate vegetation. Second, we introduce the role of solar radiation on ecohydrologic processes in the CHILD LEM, and confirm model predictions against observations. Using the model we examine how solar radiation control the spatio-temporal dynamics of soil moisture, vegetation biomass, and their feedback on landform development in a semi-arid climate across a latitude gradient. We identify that at the catchment scale while the initial greening usually takes places relatively uniformly in space, the growing season takes longer on north facing slopes leading to higher overall biomass on north aspects. Through eco-geomorphic feedbacks, this leads to steeper north facing slopes, and increased valley asymmetry in the modeled landscapes. These findings are important to improve the predictions of climate change impacts on the landscape system.

Final ID: G22A-06

A Balloon-LIDAR (BLIDAR) for Earthquake Science *(Invited)*

B. A. Brooks; [1]; *C. L. Glennie;* [2]; *K. W. Hudnut;* [3]; *T. L. Ericksen;* [1]; *J. H. Foster;* [1]; *D. Hauser;* [3]; *J. Avery;* [1];

1. SOEST, University of Hawaii, Honolulu, HI, United States.
2. NCALM, University of Houston, Houston, TX, United States.
3. Earthquake Hazards Program, US Geological Survey, Pasadena, CA, United States.

Body: The past decade of Airborne (ALS) and Terrestrial (TLS) laser scanning work, while extremely beneficial for earthquake science, has also highlighted the need for an observational platform that is less expensive and easier to deploy than ALS and more mobile and less-susceptible to line-of-sight shadowing issues than TLS. For instance, in the short-term following a major surface-rupturing event, flight restrictions and equipment availability and rupture distances measured in the 10s of kilometers might significantly limit the ability of both ALS and TLS to most rapidly quantify surface rupture and afterslip phenomena. Recently, we have developed a relatively inexpensive balloon-mounted lidar system capable of acquiring data sets with absolute positioning on the order of 5 cm vertical and 10 cm horizontal with swath widths on the order of 150m and data density of 1000s per square meter. We can tow the system behind a vehicle at speeds of up to 20km/h or walk the balloon along user-defined trajectories at speeds of km/h. Additionally, the system can be deployed in a back-pack mode if airborne obstacles are unacceptable or higher resolution point clouds are desired. The user-controlled nature of the system allows us to employ adaptive sampling and near real-time processing techniques to best respond to changing or unanticipated field conditions. We tested the system along the Carrizo plain section of the southern San Andreas fault where recent anlaysis using the B4 ALS data set of meter-scale offset stream channels suggests characteristic 5m slip events. Time of mobilization to preliminary, geocoded results was on the order of 24 hours. Further analysis indicates that the higher resolution BLIDAR data documents geomorphic features at the scale of 10s of cms, notably significant differences in channel morphometry either side of the fault. These features could be indicative of afterslip or smaller than 5m slip events. We discuss how the system can further be used for paleoseismologic and tectonic geodetic applications.

Final ID:

Update on EarthCube: Past, Present, and Future

C. A. Jacobs; [1]; *E. E. Zanzerkia;* [1];
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Description: The EarthCube endeavor started in June 2011 and has increasing engaged a global community of geoscientists and cyber-technologists. A set of community-guide activities has resulted in roadmaps, workshops, numerous WebExs/conference calls, and two Charrettes. This town hall meeting will briefly review previous EarthCube activities, the current set of happenings, and plans for future actions.

Final ID: A23B-0196

LIDAR first results from the Oil Sands Region: A complex vertical atmosphere

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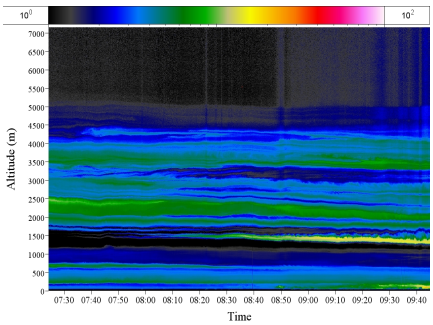
1. Environment Canada, Toronto, ON, Canada.

Body: Environment Canada is using LIDAR technology to probe the complex vertical structure of the atmosphere over the oil sands region.   This provided the critical vertical context for the interpretation of ground-based chemistry measurements and model verification and validation. In recent years, Environment Canada has designed an autonomous aerosol LIDAR system that can be deployed to remote areas such as the oil sands. The trailer that contains the LIDAR system includes a roof hatch assembly, basic meteorological tower, radar interlock system, climate control system and leveling stabilizers. A precipitation sensor is used to operate the roof hatch and three pan/tilt webcams capture sky conditions and monitor the Lidar system's health. A remote control interface is used to monitor all vital components of the system, including the ability to provide hard resets to the various electronic devices onboard. Every 10 seconds the system provides vertical aerosol profiles from near ground to 20 km. The LIDAR transmitter emits two wavelengths (1064nm and 532nm) and the detector assembly collects three channels (1064nm backscatter, 532nm backscatter and 532nm depolarization). The depolarization channel provided key information in identifying and discriminating the various aerosol layers aloft such as dust, forest fire plumes, industrial plume sources or ice crystals.   It operates 24 hours a day, seven days a week except during precipitation events and when aircraft fly over the site. The system is operated remotely and the data are updated every hour to a website to allow near real-time capability. First results from an intensive field campaign will be presented.



LIDAR false color plot showing the bottom 7 km of the atmosphere during a forest fire event. Note the forest fire plume is between 1.5 and 5 km.

Final ID: EP23C-0825

Can erosion control structures in large dryland arroyo channels lead to resilient riparian and cienega restoration? Observations from LiDAR, monitoring and modeling at Rancho San Bernardino, Sonora, MX

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Body: The use of erosion control structures to mitigate or even reverse erosion and to restore ecological function along dryland channels (arroyos and gullies) has led to a long list of both successful and failed restoration efforts. We propose that successful implementation of “engineering” approaches to fluvial restoration that include in-channel control structures require either a quantitative approach to design (by scientists and engineers), or intimate on-the-ground knowledge, local observation, and a commitment to adapt and maintain restoration efforts in response to landscape change (by local land managers), or both. We further propose that the biophysical interactions among engineering, sedimentation, flood hydrology and vegetation reestablishment are what determine resilience to destructive extreme events that commonly cause erosion control structure failure. Our insights come from comprehensive monitoring of a remarkable experiment underway at Ranch San Bernardino, Sonora, MX. At this site, private landowners are working to restore ecosystem function to riparian corridors and former cieñega wetlands using cessation of grazing; vegetation planting; upland grass restoration; large scale rock gabions (up to 100 m wide) to encourage local sediment deposition and water storage; and large earthen berms (up to 900 m wide) with cement spillways that form reservoirs that fill rapidly with water and sediment. Well-planned and managed erosion control structures have been used elsewhere successfully in smaller gully networks, but we are unaware of a comparable attempt to use gabions and berms for the sole purpose of ecological restoration along >10 km of arroyo channels draining watersheds on the order of ~400 km2 and larger. We present an approach to monitoring the efficacy of arroyo channel restoration using terrestrial and airborne LiDAR, remote sensing, streamflow monitoring, shallow groundwater monitoring, hydrological modeling and field observation. Our methods allow us to directly quantify the magnitude of sedimentation (and hence reversal of arroyo cutting) upstream of in-channel structures as a function of hydrology, and to quantify the dampening of flood energy caused by erosion control structures and by the restoration of riparian vegetation. We are also able to create a surface water budget that constrains water storage and infiltration by monitoring streamflow at several places above, within, and downstream of restoration efforts. We also speculate on the resilience of such efforts. Quantifying the effects of the restoration efforts at Rancho San Bernardino may prove useful in guiding similar large-scale ecological restoration efforts elsewhere in degraded dryland landscapes.

Final ID: G23A-0897

Identifying Riverine Erosional Hotspots Using Airborne Lidar

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Body: New high-resolution airborne lidar data may make it possible to develop a predictive model for stream erosion using only remote data. These data could be invaluable to help identify sediment sources in turbidity-impaired streams, simplifying the development of management plans to reduce sediment loading. The recent release of lidar-derived 3m DEMs (digital elevation models) for Northeastern Minnesota, USA, offers a unique opportunity to test this possibility. Here, we develop a GIS-based predictive model for erosion potential along Amity Creek in Duluth, Minnesota, and compare the results to two field datasets: Bank Erosion Hazard Index (BEHI) assessments, and field data collected after a large flood in June 2012.

Three major factors were used to predict erosion potential: a stream-power based erosion index, channel confinement, and soil erodibility. A stream-power based erosion index was calculated with slope and upstream area derived from Lidar data. Because erosion potential is elevated where the stream interacts with high valley walls cut into till, we also included a valley confinement factor that included proximity to high valley bluffs. Lastly, we use the Soil Survey Geographic (SSURGO) database to extract K values, the erodibility factor in the Revised Universal Soil Loss equation, along the channel corridor.

Two separate field surveys were conducted for comparison to one another and to GIS-based predictions: BEHI assessments at 27 points along the river and river walk surveys to assess erosion that occurred during an estimated >100-year flood on June 19th - 20th, 2012. This historic flood event offered us the opportunity to collect post-storm data that can be used to assess the validity of our predictive model. We mapped all observable erosion features including undercutting, slumps, and scouring, as well as when the bank and bed geology changed from sediments to bedrock.

Preliminary results show the GIS-based erosion predictions do have a positive correlation with BEHI surveys, but R-squared values are low (0.08 – 0.3). Our GIS-based predictions do not correlate well with post-storm observations. This may be due to the severity of the flooding which eroded areas that in a more typical storm may not have eroded.

One major challenge of this study is that bedrock exposure is not readily derived from Lidar or SSURGO data. Amity Creek has bedrock valley walls in many areas, especially close to the outlet. In these areas, our stream power index predicts high erosion potential due to large upstream areas and steep slopes, however, erosion potential is minimal in these areas. While lidar is a valuable tool for preliminary investigations of areas susceptible to erosion, it is unlikely that the remote data can completely replace field studies.

Final ID: G23A-0898

Interpolating Stage-Discharge Relationships using Serial LiDAR along the Sandy River, Oregon

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Body: Estimating discharge and flood stage along streams is a common and sometimes arduous process for emergency managers and researchers. In most cases this process includes hydrologic and hydraulic modeling to accurately depict inundation in order to examine the height of a particular flow. This study examines the use of multiple lidar data sets along the Sandy River, Oregon to establish relationships between water surface elevations, discharge, and stage height in order to accurately estimate flows without the use of complex models.
Airborne lidar elevation data were collected along the Sandy River in 2006, 2007, 2008, and 2011. All of these data sets contain water elevations at USGS gauge station 14142500 Sandy River below Bull Run River near Bull Run, Oregon. Real time data from this station provides accurate stage heights and discharge values. This data serves as calibration for water surface elevations extracted from lidar allowing for a linear relationship between the gauge and lidar elevations to be established for each year's lidar derived water surface. A linear regression analysis of this data allows for researchers to predict flow and stage by querying lidar elevations along the channel.
This analysis establishes estimated flows through simply input of elevations queried along the banks of the Sandy River. For geologists, this is an efficient method for estimating flows associated with known water marks of historic floods without going through complex modeling processes. In addition to geologic flows, this method allows emergency managers to quickly determine the discharge of potential flood scenarios based solely on lidar elevations. Results of such an analysis are most accurate at the site of the gauge station, but could be expanded upstream and downstream using known base flood elevations as the denominator in a ratio analysis.
This study examines the relationship between lidar elevation data and stage discharge relationship with the goal of predicting flows based solely on lidar elevations. While this study aims for accuracy of estimated flows it does not take into account changes in channel geometry. For this reason all results from such an analysis can only be described as estimations. The range of water surface elevations also plays into the accuracy of estimating flows. The Sandy River is a unique setting because of the four lidar flights providing a range of water surface elevations as data points to use in linear regression. For the purposes of repeating this study, one might use a ground based lidar system to conduct multiple scans over time to establish data points. .
In conclusion, this study creates a method for quickly estimating and forecasting flows based upon multiple water surface elevations derived from lidar. This method for estimating flows provides analysts with a quick method for estimating flood flows. While the current inventory of lidar throughout the United States is limited, lidar is fast becoming a standard for mapping the natural environment. As more areas are covered with multiple lidar collections this type of analysis will become stronger and more reliable for predictive flow modeling.

Final ID: G23A-0899

Determining Leaf-Angle Distribution of Vineyards in Delano, CA Using Terrestrial LiDAR

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Body: Plants can regulate the solar exposure they receive by adjusting their leaf-angles, and as a result, leaf-angle can serve as an indicator for plant health and photosynthetic activity. Leaf-angle also serves as an important input parameter for the calculation of reflectance and transmittance in vegetation canopies. This study presents an indirect and nondestructive method to retrieve leaf-angle by calculating surface normal vectors of grapevine leaves using terrestrial LiDAR scanning (TLS). Three scans were performed in June of 2012 at a table grape vineyard located in Delano, CA. Data points collected were classified based on scan number, elevation, red-green-blue (RGB) values, and hue-saturation-value (HSV) values. Individual leaf-angles were found by calculating the surface normal of a subset of leaf points. Subsets were made up of all points within a 5cm spherical radius of the central point of each individual leaf, with the origin calculated as the mean of all points in the subset. This process was repeated for all leaf centroid points in order to define the distribution of leaf-angles. Leaf-angles and their distribution in canopies can now serve as better inputs into corresponding research and models determining plant productivity and health. Utilizing more accurate import parameters allows agriculturalists to better monitor plant stress and practice more sustainable water management policies.

Final ID: IN24B-01

Bridging Informatics and Earth Science: a Look at Gregory Leptoukh's Contributions

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Body: With the tragic passing this year of Gregory Leptoukh, the Earth and Space Sciences community lost a tireless participant in--and advocate for--science informatics. Throughout his career at NASA, Dr. Leptoukh established a theme of bridging the gulf between the informatics and science communities. Nowhere is this more evident than his leadership in the development of Giovanni (GES DISC Interactive Online Visualization ANd aNalysis Infrastructure). Giovanni is an online tool that serves to hide the often-complex technical details of data format and structure, making science data easier to explore and use by Earth scientists. To date Giovanni has been acknowledged as a contributor in 500-odd scientific articles. In recent years, Leptoukh concentrated his efforts on multi-sensor data inter-comparison, merging and fusion. This work exposed several challenges at the intersection of data and science. One of these was the ease with which a naive user might generate spurious comparisons, a potential hazard that was the genesis of the Multi-sensor Data Synergy Advisor (MDSA). The MDSA uses semantic ontologies and inference rules to organize knowledge about dataset quality and other salient characteristics in order to advise users on potential caveats for comparing or merging two datasets. Recently, Leptoukh also led the development of AeroStat, an online Giovanni instance to investigate aerosols via statistics from station and satellite comparisons and merged maps of data from more than one instrument. Aerostat offers a neural net based bias adjustment to "harmonize" the data by removing systematic offsets between datasets before merging. These examples exhibit Leptoukh's talent for adopting advanced computer technologies in the service of making science data more accessible to researchers. In this, he set an example that is at once both vital and challenging for the ESSI community to emulate.

URL: http://giovanni.gsfc.nasa.gov

Final ID: B24A-05

Summertime Climate Response to Mountain Pine Beetle Disturbance

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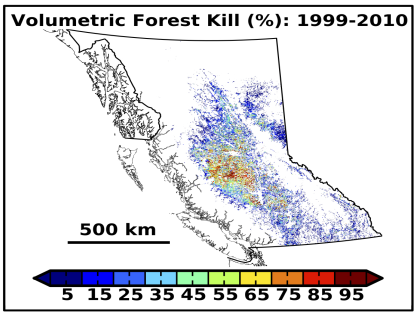
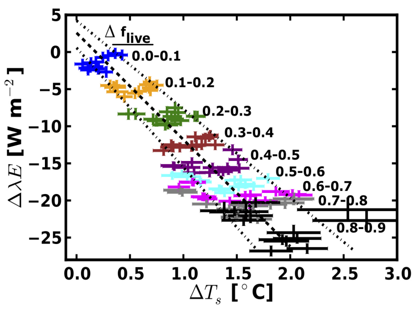
Body: The current mountain pine beetle infestation in British Columbian forests ranks among the largest ecological disturbances recorded to date and may foreshadow similar scale outbreaks in North American forests over the coming decades. Associated changes to the local surface energy balance may present substantial impacts on regional climate, but these effects have been poorly documented. Here we quantify the impact for summertime, by reporting changes to evapotranspiration, albedo, and surface temperature measured from a combination of in situ and remotely-sensed observations. Over 170,000 square-kilometers of affected forest, the typical decrease in summertime evapotranspiration is -19%; changes to the absorbed shortwave flux are comparatively negligible. The resulting increases in the outgoing sensible and radiative heat fluxes of 8% and 1%, respectively, correspond to a typical increase in surface temperature of 1 degree Celsius. These changes are comparable to those observed for other types of disturbance, such as wildfire, and may have secondary consequences for climate, including modifications to circulation, cloud cover, and precipitation.



Forest mortality (1999-2010) generated from data published by the BC Forest Ministry.



MODIS-observed changes in summertime surface temperature and latent heat flux. In-plot labels denote fractional volumetric forest mortality. The slope of the best-fit line allows indirect quantification of the post-disturbance changes to the outgoing radiative and convective fluxes.

Final ID: A31B-0028

Groundbreaking constraints on emissions from GEO-CAPE: case studies of CH4, NH3, SO2 and NO2.

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Body: While existing remote sensing measurements currently provide valuable sources of top-down constraints on a wide range of emissions of air pollutants and greenhouse gases, geostationary observations hold the potential to significantly advance our scientific understanding of constituent sources in several ways. Over North America, the proposed GEO-CAPE instrument will allow replacement of monthly mean and annual average estimates of emissions, ones that are tuned to current and/or historical observations, with detailed mechanistic models that are capable of projecting outside the envelope of current observations. GEO-CAPE observations are expected to be a major leap forward in observations that can test and constrain such models. In this manner, GEO-CAPE will also allow development of high space and time resolution emission fields that will enable detailed evaluation of other components of a chemical transport model (e.g. boundary layer fluid dynamics). Here we present case studies of the expected benefits of GEO-CAPE observations for constraining bi-directional fluxes of ammonia, the sources and chemical evolution of NOx, the lifetime of SO2, and the emissions of CH4 from anthropogenic vs natural sources. In each case, we illustrate the ways in which geostationary observations provide insight beyond current capabilities with low earth orbit satellites.

Final ID: A31F-0109

Wind turbine wake properties from Doppler lidar measurements

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Body: Wake properties were estimated from the High-Resolution Doppler Lidar (HRDL) measurements during the Turbine Wake and Inflow Characterization Study (TWICS) in the spring of 2011.

Velocity deficit, wake downwind extent, and wake meandering were obtained by detailed analysis of both lidar vertical-slice scans, performed straddling along the lidar-turbine centerline, and lidar conical scans, performed in narrow, nearly horizontal sectors that include the wind turbine inflow, and its wake at four levels. Simultaneous measurements of inflow and turbine outflow were corrected by terrain and wind direction to obtain mean wake properties.

It has been found out that an operating wind turbine generates a wake with the maximum velocity deficit varying from 20% to 70% extending up to 10 rotor diameters downstream of the turbine, depending on the wind strength and atmospheric turbulence.

Details including images and animations of the wake behavior will be presented.

Final ID: EP31B-0809

Hydrographic network control of the spatial variation in tropical forest structure revealed by airborne LIDAR-derived mean canopy profile height

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Body: Hydrologic flow and connectivity are important determinants of ecological pattern and process. The watershed structure acts as a template for the spatial distribution of vegetation which self-organizes through local stress optimization within the network flow paths of the basin.
These influences have long been recognized in riparian vegetation, deserts, savannas or other water-limited ecosystems. Here, we examine their importance in moist tropical forest. In dry ecosystems, water availability plays a crucial role in the spatial and temporal dynamics of vegetation, providing the most logical causal link with the drainage network, while in moist tropical forest this link is less apparent.
Remote sensing offers an invaluable tool to start investigating these variations systematically on larger spatial extent. Recent advances in LiDAR techniques have made it possible to monitor forest structure with unprecedented resolution. Unlike other passive remote sensors, the LiDAR has the advantage to penetrate the canopy and give information on the whole profile, hence it is suitable to study heterogeneous dense forests. For example, LiDAR-derived products such as mean canopy height (MCH) are well correlated with carbon stocks in tropical areas. Furthermore, it provides an accurate digital elevation model (DEM) that perfectly matches the vegetation above.
In this study we investigate the connection between the drainage network and LIDAR-derived MCH in a moist tropical forest in central Panama. The study area comprises thousands of hectares of mixed old-growth and old secondary forest in a relatively homogeneous geological formation with a very complex network of small streams that discharge into the Gatun Lake. These characteristics make the area ideal for studying the influence of the network on a relatively large area of land without confounding variation in lithological formation, forest type or climate.
Our analysis shows important isotropic scale invariant properties of vegetation variance, as revealed by wavelet decomposition. At scales of 100-1000 m, there is a strong correlation between MCH and topography. Upon extracting the complex hydrographic network from the digital terrain model, we found that vegetation tended to be taller along the drainage channels, and declined in a predictable manner with flow distance from the closest water link.
Based on previous knowledge of this forest, we hypothesize that this particular spatial arrangement of vegetation reflects a combination of water and nutrient availability, disturbance regimes, and past land use, which can all be ultimately linked to the drainage network. Studies conducted in tropical forests have shown that soil moisture and cation exchange capacity tend to be lower on steep slopes than on plateaus, and many chemical soil properties vary across the landscape in a predictable manner from ridge tops to riparian valleys. Windthrow, one of the most important mortality factors in these forests, is likely to be more common on ridgetops that are more exposed to winds. Finally, in this region, forests directly adjacent to streams are least likely to be cleared for agriculture or pasture, because these areas often have steep slopes, are less accessible for animals and machinery, receive less solar insolation and/or are poorly drained.

Final ID: EP31B-0810

Linking morphology to ecosystem structure using air-borne lidar and Hyperspectral sensors for monitoring the Coastal Landscape

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Body: Coastal landscape, and its evolution over time, provides the outline on which life must function and dictate the ecosystems and human activities that can exist or develop in a specific region. Basically emerged and submerged morphology, from terrestrial to aquatic environments, represents the structural feedback for sediment capping of coastal areas and influence in coastal erosion prevention and beach dunes system stabilization. This research addresses the feedbacks mechanism between morphology and linked ecosystem using multisource dataset (Hyperspectral - MIVIS and topographic/bathymetric LiDAR - Hakw-eye II). A physics based approach was applied to Hyperspectral and LiDAR airborne data, simultaneously acquired on 12 May 2009 in order to integrate geomorphological and ecological observations into a detailed morphoecological maps of the physiographic unit of the Sabaudia study area (Lazio Region - Central Italy). The basic strategy was to highlight the different components of the coastal system through:
1) maps of coastal morphology, where the topography and bathymetry DSM were used to produce a) the contour line of the +0.3 m on the mean sea level, to obtain a tide independent shore line, b) the depth's standard deviation, the slope and the convex/concavity to obtain an optimal description of the bedforms of the very shallow waters; 2) combined use of standard deviation maps and endmembers fraction maps, obtained by means of the Spectral Mixture Analysis (SMA) of hyperspectral data, to discriminate different types of bottom and surface cover. To extrapolate progressive evolution of the physiographic unit we have twisted a specific effort to quantify vegetation fractions pattern in emerged morphology highlighting the central role of the feedbacks between biological and physical processes that links the sand dune system stabilization to the shallow water seabed temporal evolution. The work did so far provide a good foundation for an intensive spatial analysis for the coastal sand-dunes system.

Final ID: EP31C-0831

Evaluating dryland ecological and river restoration using repeat LiDAR and hydrological monitoring

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Body: Recent improvements in the collection of multitemporal, high-resolution topographic data such as Light Detection and Ranging (LiDAR) have done a great deal to increase our ability to quantify the details of landscape change. Both Terrestrial Laser Scanning (TLS) and Airborne Laser Swath Mapping (ALSM) can be used to easily assess how Earth surface processes affect landscape form to a level of precision that was previously more difficult to attain. A comprehensive approach using ALSM, TLS-TLS comparison, and hydrological monitoring is being used to assess the effectiveness of a large scale ecological and river restoration effort by the Cuenca los Ojos Foundation at San Bernardino Ranch near Agua Prieta, Sonora, Mexico. In the study area, historical arroyo cutting and changes in land use led to the abandonment of a ciénega wetland and resulted in widespread ecological destruction. The current land managers have employed engineering methods in order to restore stream and ciénega ecology, including the installation of large rock gabions, earthen berms, and concrete spillways along channels. Our goal is to test the hypothesis that the use of dam and gabion structures leads to stream aggradation, flash flood dampening, and ultimately, increased available water and reestablishment of historic wetland plant and animal communities. We present results from LiDAR change detection that includes 2007-2011 ALSM to TLS change, and several 2011-2012 TLS-TLS comparisons. We also present results from streamflow monitoring, field observation, and monitoring of shallow groundwater and soil moisture conditions. Preliminary results show that channel aggradation occurs rapidly upstream of engineered structures. However, the apparent dampening of sediment transport by the structures leads to less aggradation and even incision immediately downstream of structures. Peak flood flows are decreased by the reservoirs formed behind large earthen berms. After several years of water retention, both in surface reservoirs and in the alluvium deposited upstream of gabions and berms, plant growth recovers.

Final ID: EP31D-0838

Evaluating bedload transport with RFID and accelerometer tracers, airborne LiDAR, and HEC-GeoRAS modeling: field experiments in Reynolds Creek, Idaho

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Body: Relationships between bedload transport, channel geometry, and bed topography in upland channels are not well understood due in part to a lack of quantitative field data. With this motivation, we are performing field experiments related to (i) bedload travel distances within and between transport events, (ii) style of bedload motion during transport events, and (iii) channel characteristics of depositional areas. To address these objectives, we deployed gravel and cobble Radio Frequency Identification (RFID) and accelerometer tracers, installed permanent RFID antennas, utilized airborne LiDAR, and conducted stream surveys in Reynolds Creek, Idaho. This gauged coarse alluvial stream is located at the USDA-Agricultural Research Service Reynolds Creek Experimental Watershed within the Owyhee Mountains. Flood discharges generally consist of occasional flashy winter rain-on-snow flows spanning less than a day, large spring snowmelt events lasting several weeks, and no high summer discharges during our experiments. Through repeat surveys of tracer clast positions, to date we have quantified travel distances of 800 RFID particles. Spring 2011 discharge transported RFID tracers nearly seven kilometers while the shorter Spring 2012 flow only displaced particles up to approximately three kilometers. During Winter 2011 rain-on-snow events, tracers moved a maximum of 200 meters. Statistical distributions of transport distances vary with deployment location and season- uniform distributions fit some datasets best while gamma distributions fit others better. Permanent cross-stream RFID antennas constrain periods of bedload motion and rest. In Spring 2012, antennas recorded significant RFID tracer motion initiating just when discharge began to rise due to snowmelt, travel times between antennas decreasing as flow increased, and RFID particles no longer passing almost immediately after the hydrograph peaked. Accelerometer tracers deployed in Spring 2012 expanded bedload motion records, confirming minimal motion after peak spring flow. Accelerometer clasts also revealed that cobbles deposited in relatively close vicinities can have similar and different modes of transport- some traveled consistently over weeks as discharge increased while others of similar sizes traveled in short bursts to arrive at the same stream location. At tracer deposition locations, we extracted local channel characteristics from airborne LiDAR and field surveys. Finally, we modeled shear stress with HEC-GeoRAS, airborne LiDAR, and discharge to identify locations with significant shear stress changes and compared these areas to where RFID particles preferentially deposited. The combination of field methods, statistical analysis, and flow modeling provide additional insight into bedload transport mechanisms.

Final ID: H31E-1171

UTILITY OF CLOSE-RANGE REMOTE SENSING TECHNIQUES FOR MAPPING TOPOGRAPHY AND BATHYMETRY IN SMALL STREAMS

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Body: River science is in the midst of a methodological revolution, where various remote sensing appraoches have been applied to the problem of mapping river forms and processes at high resolution and over large areas. Most of these advancements has been advanced by airborne and spaceborne remote sensing platforms, yielding ground resolutions at meter-scale or larger. Close-range remote-sensing approaches (helicopters, UAS platforms, helikites) have yielded much higher resolutions, but with increased costs, range limitations, and/or technical complexity. Many river researchers, however, still measure riverscapes in small study areas and with a desire for high precision measurements. As such, it is reasonable to infer that ground-based remote sensing techniques might yield highly-precise, low-cost, and easy to acquire information in small streams and be useful for a large user base.

Some of the small-stream features that are potentially mappable with close-range imaging include particle sizes, riparian vegetation, water depth, water surface elevations and superelevations, and riverbank and near-floodplain topography. Some of the important comparative metrics include (a) spatial resolution, (b) precision and accuracy, (c) cost, (d) ease of use, (e) speed and ability to map large areas, (f) the importance of specific observation platform, (g) software and hardware considerations, and (h) systematic vs. random errors.

In order to compare the utility of mapping approaches against these various metrics, we have mapped a 100m stream test reach in eastern Oregon with both a high-quality dSLR camera and a Kinect active near-IR distance sensor. The camera can map topography through the Structure from Motion (SfM) photogrammetric approach, and can map bathymetry using either SfM or through spectral depth approaches. The Kinect potentially can map above-water topography for land and water. We test the camera-based methods and the Kinect sensor on two platforms. First, by hand-holding the instruments, and second, by mounting the sensors on a 4m pole that is moved around as the researcher moves around the stream area. The precision and accuracy metrics for these approaches are validated against an RTK GPS.

Final ID: H31G-1200

Identification of Hot Moments and Hot Spots for Real-Time Adaptive Control of Multi-scale Environmental Sensor Networks

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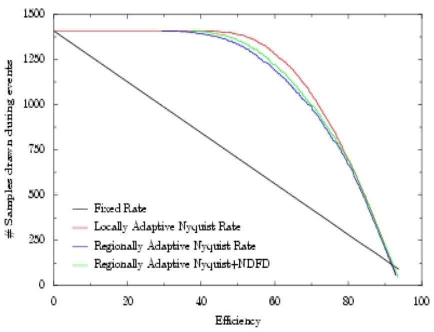
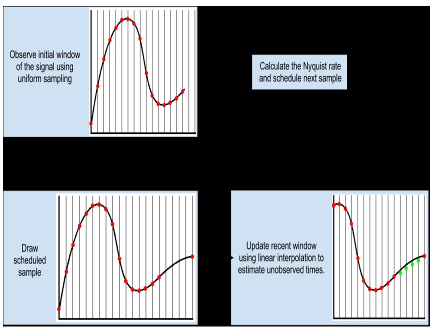
Body: Increased sensor throughput combined with decreasing hardware costs has led to a disruptive growth in data volume. This disruption, popularly termed "the data deluge," has placed new demands for cyberinfrastructure and information technology skills among researchers in many academic fields, including the environmental sciences. Adaptive sampling has been well established as an effective means of improving network resource efficiency (energy, bandwidth) without sacrificing sample set quality relative to traditional uniform sampling. However, using adaptive sampling for the explicit purpose of improving resolution over events -- situations displaying intermittent dynamics and unique hydrogeological signatures -- is relatively new. In this paper, we define hot spots and hot moments in terms of sensor signal activity as measured through discrete Fourier analysis. Following this frequency-based approach, we apply the Nyquist-Shannon sampling theorem, a fundamental contribution from signal processing that led to the field of information theory, for analysis of uni- and multivariate environmental signal data. In the scope of multi-scale environmental sensor networks, we present several sampling control algorithms, derived from the Nyquist-Shannon theorem, that operate at local (field sensor), regional (base station for aggregation of field sensor data), and global (Cloud-based, computationally intensive models) scales. Evaluated over soil moisture data, results indicate significantly greater sample density during precipitation events while reducing overall sample volume. Using these algorithms as indicators rather than control mechanisms, we also discuss opportunities for spatio-temporal modeling as a tool for planning/modifying sensor network deployments.



Pareto frontiers for local, regional, and global models relative to uniform sampling. Objectives are (1) overall sampling efficiency and (2) sampling efficiency during hot moments as identified using heuristic approach.



Locally adaptive model based on Nyquist-Shannon sampling theorem

Final ID: H31G-1218

Sensor-based actuation of water samplers in wireless sensor networks

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Body: Wireless sensor networks (WSN) have started to change environmental monitoring, and as such, real-time sensor data are available in high temporal and spatial resolution. However, sampling of water bodies and the analysis of these samples in the lab will continue to be an essential part of environmental monitoring, as many parameters can only be analyzed with accurate precision in the lab. In a joint project of computer sciences, network engineering and environmental research we integrated an automated water sampler (ISCO 6712) as an actuator into a WSN. Based on the online interpretation of sensor data an actuation schedule for the sampling of water is generated. This actuation schedule is transferred to the water sampling unit for remote execution. Electric conductivity (EC) was chosen as a proxy parameter for water origin (e.g. groundwater or river water in alluvial systems) and thus for changes in stable isotopes and water quality. The onset of river water infiltrating the observed section of the aquifer is detected by EC sampled at several locations and high temporal resolution (2min) using a stream based filtering technique rather than a simple signal threshold. The EC signal is continuously analyzed by the streaming filter defining a sampling event when the EC signal clearly leaves the boundaries of daily oscillation over given a time window. To cope with noise in the EC data, we implemented and evaluated different outlier detection algorithms and plausibility checks to actuate the automated water sampler at the onset of an event and then applying a static sampling scheme. As a next step, we are working on dynamic sampling schemes, which are based on stream processing algorithms predicting the peak and duration of EC events based on deconvolution and geostatistics (Cirpka 2007).

Final ID: H31N-01

Progress and opportunities in Earth System model coupling with emphasis on hydrological model components *(Invited)*

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Body: The need for improved assessments and predictions of many key environmental variables is driving a multitude of model development efforts in the geosciences. Increasingly, the aggregation of these various modeling components is referred to as 'Earth Systems Modeling' although, traditionally, 'Earth Systems Modeling' referred to a set of physics components that controlled the behavior of the Earth's climate and were used primarily in a global circulation modeling context. However, the proliferation of climate impacts research is driving a host of new Earth System Model development efforts as society seeks to understand how climate does and will impact key societal activities and resources and, in turn, how human activities influence climate and the environment. This surge in model development has highlighted the role of model coupling as a fundamental activity itself and, at times, a significant bottleneck in Earth Systems and climate impacts research. This talk explores some of the recent activities and progress that has been made in assessing the attributes of various approaches to the coupling of Earth Systems models. A roadmap on Earth System Model coupling, developed as part of the National Science Foundation's EarthCube effort will be discussed as will some initial results of a related pilot study that aims to provide a standardized framework for assessing model coupling activities. The goal of this effort is strategize optimal pathways forward in model coupling and to engage or enable a broader swath of geoscientists in Earth System model development. As such, the framework and roadmap presented stress the needs for open, standards-based approaches for code development, model interoperability and data and metadata structures as well as the need for multi-scale and multi-physics model structures.

Final ID: IN31B-1501

The Open Geospatial Consortium PUCK Standard: Building Sensor Networks with Self-Describing Instruments *(Invited)*

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Body: Sensor technology is rapidly advancing, enabling smaller and cheaper instruments to monitor Earth’s environment. It is expected that many more kinds and quantities of networked environmental sensors will be deployed in coming years. Knowledge of each instrument’s command protocol is required to operate and acquire data from the network. Making sense of these data streams to create an integrated picture of environmental conditions requires that each instrument’s data and metadata be accurately processed and that “suspect” data be flagged. Use of standards to operate an instrument and retrieve and describe its data generally simplifies instrument software development, integration, operation and data processing. The Open Geospatial Consortium (OGC) PUCK protocol enables instruments that describe themselves in a standard way. OGC PUCK defines a small “data sheet” that describes key instrument characteristics, and a standard protocol to retrieve the data sheet from the device itself. Data sheet fields include a universal serial number that is unique across all PUCK-compliant instruments. Other fields identify the instrument manufacturer and model. In addition to the data sheet, the instrument may also provide a “PUCK payload” which can contain additional descriptive information (e.g. a SensorML document or IEEE 1451 TEDS), as well as actual instrument "driver" code. Computers on the sensor network can use PUCK protocol to retrieve this information from installed instruments and utilize it appropriately, e.g. to automatically identify, configure and operate the instruments, and acquire and process their data. The protocol is defined for instruments with an RS232 or Ethernet interface. OGC members recently voted to adopt PUCK as a component of the OGC’s Sensor Web Enablement (SWE) standards. The protocol is also supported by a consortium of hydrographic instrument manufacturers and has been implemented by several of them (https://sites.google.com/site/soscsite/). Thus far PUCK has been deployed on oceanographic observatories in North America and Europe, and is generally applicable to environmental sensor networks. As an example we describe how PUCK can be used with other established and emerging OGC SWE standards to simplify configuration and operation of environmental sensor networks, and to automate assessment and processing of the sensor data.

The PUCK specification is free of charge and can be downloaded along with tools to implement and use the standard from http://www.opengeospatial.org/standards/puck.

URL: http://www.opengeospatial.org/standards/puck

Final ID: H31N-08

The Essential Terrestrial Variables (ETV's) in Support of a National Framework for Numerical Watershed Prediction *(Invited)*

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Body: There is a clear national need to provide geoscience researchers with seamless and fast access to essential geo-spatial/geo-temporal data to support physics-based numerical models necessary to understand, predict and manage the nations surface and groundwater resources. Fundamental advances in science such as the evaluation of ecosystem and watershed services, the detection and attribution of the impact of climatic change, represent examples that will require high resolution spatially explicit assessments. In this paper we propose the concept of Essential Terrestrial Variables (ETV's), which we define as those variables that are nominally required to support watershed/catchment numerical prediction anywhere in the continental US and ultimately at the global scale. ETV's would represent a fundamental community resource necessary to build the products/parameters/forcings commonly used in distributed, fully-coupled watershed and river basin models. We argue that there are at last 3 fundamental issues that must be resolved before implementation of ETV's in support of a national water model: 1) data access and accessibility, 2) data scale and scalability, 3) community provenance and data sustainability.

At the present time, there is no unified data infrastructure for supporting watershed models, and the data resource itself (weather/climate reanalysis products, stream flow, groundwater, soils, land cover, satellite data products, etc.) resides on many federal servers with limited or poorly organized access, with many data formats and without common geo-referencing. Beyond the problem of access to national data, the scale and scalability of computation for both data processing and model computational represents a major hurdle. This predicament is especially true since a full-scale national strategy for numerical watershed prediction will require data resources to reside very close to numerical model computation. Finally model/data provenance should be sufficient to allow reproducible results and scientific workflows that support continuous data and model tracking, geo-referencing, and general support for model/data reproducibility, data analytics and visualization. Furthermore, these workflows should be readily publishable and discoverable by the broader community with provisions for community comment on workflow utility, effectiveness, and improvement.

US policy on access to basic data is generally enlightened in that most national geospatial data can be acquired. However, it is clear that fast and efficient access to all the data and models is not yet available to the scientific community for systems that support integrated watershed modeling. Adoption of ETV's and the concomitant supporting cyber infrastructure would be an important step towards a national framework for numerical watershed prediction.

Final ID: B32A-01

Tracking raindrops: following water from its origin through a hillslope watershed ***(Invited)***

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Body: HydroWatch is an interdisciplinary research program aimed at expanding observations and then modeling the “life cycle” of water moving from its Oceanic origin through a hillslope watershed in Coastal Northern California. Intensive monitoring of inputs, fluxes, and pools of water as well as the climatic conditions and isotope composition of the geological, biological and atmospheric water reservoirs are used to quantify the dynamic water balance of small watershed at the Angelo Coast Reserve (http://angelo.berkeley.edu). Data on the stable isotope composition of atmospheric, plant, soil, fractured rock, and stream water has revealed that water inside of the hillslope may be one of the largest, yet poorly understood reservoirs. Moreover, subsurface flow paths of water are of two broad types: rapid and well connected and slow, buffered and seemingly poorly connected. The oxygen and hydrogen isotope composition as well as the d-excess of water reservoirs shows that some trees use the buffered hillslope reservoir throughout the long dry summer while others use a more variable and transient soil water pool to sustain their functioning. Observed diurnal fluctuations of the d-excess in the background atmospheric water vapor provided strong evidence that during the day as land surfaces warm and the boundary layer grows, plants alter the isotope composition of atmospheric humidity via non-isotopic steady-state transpiration effects. In contrast, at night equilibrium isotope effects dominated as the atmosphere subsides and stabilized. Taken together, our combined data has allowed us to more carefully track the raindrops through the hillslope watershed. These data can and will be used to model other watersheds in complex terrain.

Final ID: B32D-03

Application of Single Photon Lidar for Retrieval of Ecosystem Structure ***(Invited)***

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Body: One of the recent developments in remote sensing of ecosystem structure is the use of single photon lidar (SPL). An SPL instrument, ATLAS, is being developed for the measurement of ice sheet elevation for the ICESAT2 mission. Unlike waveform lidar, there is major uncertainty about SPL as deployed in space; among other considerations, low pulse energy and operation in visible wavelengths may make discrimination of canopy and ground signal from solar background difficult. In this talk we present an overview of our research using SPL for retrieval of ecosystem structure. We first provide background on SPL technology and highlight its differences with waveform lidar. We then review the characteristics of SPL data to be provided by ICESAT2. We present results of initial experiments with airborne SPL data used to simulate data from ICESAT2 and suggest directions for continued algorithm development. Lastly, we discuss the potential role of airborne and space-based SPL for characterizing important ecosystem structure in the future.

Final ID: B32D-04

Analysis of MABEL data (an ICESat-2 instrument simulator) for ecosystem studies

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Body: Plans are underway at NASA to launch the ICESat-2 (Ice, Cloud, and land Elevation Satellite) laser altimeter in 2016. While ICESat-2 is primarily designed to monitor changes in the cryosphere, it will also collect data over much of the Earth's vegetated surfaces. The Multiple Altimeter Beam Experimental Lidar (MABEL) has been developed by NASA to test the proposed instrument geometry planned for ICESat-2 as well as to validate the instrument performance models. MABEL data were collected over several sites in the eastern United States in September, 2012 as well as during its transit from California to Maryland. A data filtering and surface finding tool was developed by ARLUT specifically for MABEL data. The data filter developed for MABEL –Differential, Recursive, and Gaussian Adaptive Nearest Neighbor (DRAGANN)- uses an adaptive window size to efficiently filter noise photons from the signal photons. Once the data are filtered, a Kalman Filter (KF) designed for this application is implemented to extract both the ground and canopy surfaces. This paper addresses both the performance of the filtering and KF for extracting the canopy and ground surfaces from MABEL as well as the potential of photon counting lidar data for characterizing canopy height over vegetated surfaces.

Final ID: B32D-05

Estimating terrestrial aboveground biomass estimation using lidar remote sensing: a meta-analysis

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Body: Estimating biomass of terrestrial vegetation is a rapidly expanding research area, but also a subject of tremendous interest for reducing carbon emissions associated with deforestation and forest degradation (REDD). The accuracy of biomass estimates is important in the context carbon markets emerging under REDD, since areas with more accurate estimates command higher prices, but also for characterizing uncertainty in estimates of carbon cycling and the global carbon budget. There is particular interest in mapping biomass so that carbon stocks and stock changes can be monitored consistently across a range of scales – from relatively small projects (tens of hectares) to national or continental scales – but also so that other benefits of forest conservation can be factored into decision making (e.g. biodiversity and habitat corridors). We conducted an analysis of reported biomass accuracy estimates from more than 60 refereed articles using different remote sensing platforms (aircraft and satellite) and sensor types (optical, radar, lidar), with a particular focus on lidar since those papers reported the greatest efficacy (lowest errors) when used in the a synergistic manner with other coincident multi-sensor measurements. We show systematic differences in accuracy between different types of lidar systems flown on different platforms but, perhaps more importantly, differences between forest types (biomes) and plot sizes used for field calibration and assessment. We discuss these findings in relation to monitoring, reporting and verification under REDD, and also in the context of more systematic assessment of factors that influence accuracy and error estimation.

Final ID: B32D-06

RADAR BACKSCATTER SATURATION WITH FOREST BIOMASS: FACTS AND MYTHS

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Body: In recent years, climate change policies and scientific research created a widespread interest in quantify the carbon stock and changes of global forests extending from forest patches to national and regional scales. However, because of the large spatial extent of forests, their heterogeneity from structural and species diversity causing meters to kilometer scales variations, their complex dynamics causing landscape scale differences in changes of biomass, and their continues degradation from human activities, the quantification of forest biomass from conventional inventory data alone has become a major challenge.

Remote sensing techniques with Lidar and Radar are considered to be the most efficient way of estimating forest biomass at large scales and with uncertainty comparable to estimation from inventory plots. Radar backscatter and interferometric based estimation of forest biomass has been studied extensively and considered as dedicated spaceborne options of monitoring and quantifying forest biomass. However, the literature on the radar-based estimation techniques of biomass has been misleading in defining the sensitivity and lack of sensitivity, so called saturation effect of radar measurements.

In this paper, I provide results from a combination of observations and model simulations to demonstrate the physical nature of the loss of sensitivity of radar backscatter to biomass, examine the biophysical that impact the sensitivity, extend the results to other radar measurements including polarimetric and interferometric modes.

URL: http://carbon.jpl.nasa.gov

Final ID: B32D-07

Development of LiDAR aware allometrics for Abies grandis: A Case Study

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Body: Forest managers rely increasingly on accurate allometric relationships to inform decisions regarding stand rotations, silvilcultural treatments, timber harvesting, and biometric modeling. At the same time, advances in remote sensing techniques like LiDAR (light detection and ranging) have brought about opportunities to advance how we assess forest growth, and thus are contributing to the need for more accurate allometries. Past studies have attempted to relate LiDAR data to both plot and individual tree measures of forest biomass. However, many of these studies have been limited by the accuracy of their coincident observations. In this study, 24 Abies grandis were measured, felled, and dissected for the explicit objective of developing LiDAR aware allometrics. The analysis predicts spatial variables of competition, growth potential (e.g, trees per acre, aspect, elevation, etc.) and common statistical distributional metrics (e.g., mean, mode, percentiles, variance, skewness, kurtosis, etc.) derived from LiDAR point cloud returns to coincident in situ measures of Abies grandis stem biomass. The resulting allometries exemplify a new approach for predicting structural attributes of interest (biomass, basal area, volume, etc.) directly from LiDAR point cloud data, precluding the measurement errors that are propogated by indirectly predicting these structure attributes of interest from LiDAR data using traditional plot-based measurements.

Final ID: B32D-08

Subcanopy Solar Radiation Model: an irradiation model for predicting light in heavily vegetated landscapes

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Body: Solar radiation flux, irradiance, affects many biological (e.g. photosynthesis, germination, metabolism) and hydrological (e.g. snow melt, water cycling) processes. Models of these processes often require data at the watershed scale. GIS based solar models that predict irradiation at the watershed scale take topographic shading into account, but do not account for vegetative shading. Methods that quantify subcanopy irradiation do so only at a single point. Further, calibrating the subcanopy models require significant field effort and knowledge of individual species characteristics (leaf area index, mean leaf angle, clumping factor, etc.). Upscaling from point values to watersheds is a significant source of uncertainty.

We propose an approach to modeling irradiation that uses airborne LiDAR to estimate canopy openness as a Light Penetration Index (LPI). We coupled LPI with the GRASS GIS r.sun solar model to produce the Subcanopy Solar Radiation model (SSR). SSR accounts for both topographic shading and vegetative shading at the watershed scale. Output is 52 raster maps (one per week) of 24 hours of irradiation (watt-hours/m2).

We calibrated the r.sun model to a weather station at our field site and to field measurements of direct and diffuse solar radiation taken for 24 hours at the weather station site. We validate predictions of the SSR by comparing modeled output to field measurements and to a standard method for point estimation of subcanopy radiation, hemispherical photographs processed with Gap Light Analyzer 2.0 (GLA). Based on ANCOVA analysis, SSR and GLA models exhibit a similar linear relationship with field data, and the models predict similar total solar radiation flux across the range of canopy openness. With similar quality to a standard point method, but with greatly expanded spatial coverage, SSR should become a useful tool in watershed analysis.

Final ID: B32D-09

Lidar based vegetation height models to quantify carbon stocks in Galveston saltmarshes

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Body: Concern over global climate change has stimulated much interest in identifying existing and potential carbon sinks. Wetland ecosystems are highly recognized for their high productivity and thus as major terrestrial carbon (C) sinks. The rapid decline in the extent and health of these wetland ecosystems has created a need for non-destructive methods for the study of their C dynamics. However, these biomass estimates are mostly based on vegetation structural properties, particularly based on vegetation height models. Hence, for better quantification of vegetation biomass and C estimates, the accuracy of vegetation height models derived using lidar data is of paramount importance. Yet, unlike in woody vegetation dominated ecosystems, the use of lidar in saltmarshes is limited due to several reasons: 1) relatively dense vegetation cover limits laser penetration affecting the accuracy of terrain and thus vegetation height estimates; and 2) relatively shorter vegetation demands high point density data with high vertical accuracy to capture relatively smaller differences between terrain and vegetation canopy surfaces. Thus, the use of lidar data to characterize saltmarsh vegetation community demands appropriate methodologies. Our overall objective in this study was to develop a methodology for deriving salt marsh vegetation height models using airborne lidar data. More specific objectives involved: (1) understanding the interaction between discrete-return airborne lidar data and marsh vegetation; (2) finding appropriate grid sizes for deriving terrain and vegetation height models; and (3) analyze lidar-derived surface accuracies by comparing estimates to field measurements.

In this study, we used 1m point spacing airborne lidar data from Federal Emergency Management Agency (FEMA) program to derive vegetation height models (VHM) for Spartina alterniflora saltmarshes in Galveston, Texas. We first derived digital terrain models (DEMs) and verified their vertical accuracy using field elevation data obtained using survey grade GPS. These DEMs served as input for deriving VHMs at different grid sizes (i.e. 1m, 3m, 5m and 10m). These VHMs were evaluated against field-collected vegetation height measurements collected using different approaches. Field measurements of vegetation heights include visual estimates for different grid sizes and also individual plant and culm heights. With this work, we seek to develop a remote sensing (RS) based approach to predict vegetation biomass (and thus C) in these salt marsh ecosystems using lidar data available for much of the coastal United States. Our study brings a contribution to the methods of estimating biomass and thus C estimates based on light detection and ranging (lidar) data as a nondestructive method.

Final ID: A33I-0257

Aerosol information content analysis of multi-angle high spectral resolution measurements and its benefit for high accuracy greenhouse gas retrievals

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Body: New generations of space-borne spectrometers for the retrieval of atmospheric abundances of greenhouse gases require unprecedented accuracies as atmospheric variability of long-lived gases is very low. These instruments, such as GOSAT and OCO-2, typically use a high spectral resolution oxygen channel (O_2 A-band) in addition to CO_2 and CH_4 channels to discriminate changes in the photon path-length distribution from actual trace gas amount changes. Inaccurate knowledge of the photon path-length distribution, determined by scatterers in the atmosphere, is the prime source of systematic biases in the retrieval. In this work, we investigate the combined aerosol and greenhouse gas retrieval using multiple satellite viewing angles simultaneously. We find that this method, hitherto only applied in multi-angle imagery such as from POLDER or MISR, greatly enhances the ability to retrieve aerosol properties by 2-3 degrees of freedom. We find that the improved capability to retrieve aerosol parameters significantly reduces interference errors introduced into retrieved CO_2 and CH_4 total column averages. Instead of focusing solely on improvements in spectral and spatial resolution, signal-to-noise ratios or sampling frequency, multiple angles reduce uncertainty in space-based greenhouse gas retrievals more effectively and provide a new potential for dedicated aerosols retrievals.

Final ID: A33I-0262

Satellite based estimates of reduced CO and CO2 emissions due to traffic restrictions during the 2008 Beijing Olympics

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Body: We present estimates of the reductions in CO and CO2 emissions resulting from the control measures on the Beijing transportation sector taken during the 2008 Beijing Olympics. This study used MOPITT (Measurements Of Pollution In The Troposphere) multispectral satellite measurements of near surface CO along with WRF Chem (Weather Research and Forecasting model with Chemistry) simulations for Beijing during August, 2007 and 2008 to estimate changes in CO due to meteorology and emissions. Using fractional changes in the emissions inventory transportation sector along with a reported CO/CO2 emission ratio for Beijing vehicles, we find the corresponding reduction in CO2 emissions. We then compare this reduction to target CO2 emissions in the RCP (representative concentration pathway) scenarios being considered for the IPCC AR5 (Intergovernmental Panel on Climate Change, 5th Assessment Report). Our result suggests that urban traffic reductions could play a significant role in meeting target cuts for global CO2 emissions, even for the most aggressive control scenario (RCP2.6).

Final ID: A33I-0269

The investigation of CO2 and CH4 variability During Monsoon Season

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Body: A significant uncertainty with quantifying tropical fluxes of CO2, methane, or other atmospheric trace gas using atmospheric observations of these trace gasses is related to uncertainties in vertical transport during monsoon time periods. CO2 and CH4 are very important atmospheric greenhouse gases, which have significant impacts on the globe climate change. And they are useful trace gasses for interrogating model transport fields because of their long life times and because they can be measured using satellites with sufficient precision to capture variations in transport and fluxes. Here we use measurements of CH4 and CO2 from TES to diagnose transport associated with the monsoon by comparing how variations in the monsoon strength affect variations in CO2 and methane. Comparisons to model fields of CO2 and methane during this same time period allow us to relate errors in transport to uncertainties in the underlying fluxes.

Final ID: A33I-0274

CO profile retrieved from combined TES and MLS measurements on Aura satellite

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Body: Carbon monoxide (CO) is an important tracer in studies of pollution sources, air quality, and atmospheric transport and chemistry. CO is one of the major precursors for tropospheric ozone production. Its distribution in the upper-troposphere / lower-stratosphere (UTLS) provides very useful information in studies of UTLS exchange mechanisms. However, satellite remote sensing observations of CO by an individual instrument are limited in sensitivity either in the troposphere or above tropopause. For example, the nadir radiance measurements by the Tropospheric Emission Spectrometer instrument (TES) on NASA's Aura satellite launched July 2004 are used to derive CO profiles with maximum retrieval sensitivity in the mid-troposphere; the limb radiance measurements by the Microwave Limb Sounder (MLS) instruments, also aboard Aura, are used to derive CO profiles at and above the upper-troposphere. Here we present a new Aura CO data product, which is derived from combining TES and MLS measurements. The new CO profiles cover the entire atmosphere with much improved vertical sensitivity over the two stand-alone products in the UTLS region. For example, compared to the TES CO profile with a degree of freedom for signal (DOFS) of less than 2, the Aura CO profile has a DOFS of 2-4 in altitude below 50 hPa. We present the retrieval algorithm and results. Preliminary data validation comparing the new Aura product to the in-situ aircraft and balloon CO measurements will be presented.

Final ID: B33A-0498

A look deep inside the a hillslope reveals a structured heterogeneity of isotopic reservoirs and distinct water use strategies for adjacent trees

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Body: Whereas recent studies have begun to note the importance of weathered rock as a source of moisture for vegetation and, through transpiration, as a moderator of local and regional climate, no study has looked deeply into a hillslope in three-dimensions to explore dynamics in the hydrologic cycle and tree water use. Here, we use natural abundance stable isotope techniques to reveal distinct isotopic reservoirs within the hillslope, as well as quantify the movement of water from weathered rock and soil into vegetation. Our study site, at the Angelo Coast Range Reserve in Northern California, is a 4000 m2 unchanneled catchment that drains into Elder Creek, in the South Fork of the Eel River basin. Although average annual rainfall is 1900mm, 90% falls between October and May, forcing vegetation to find deep sources of moisture to survive the dry summer. An old-growth mixed conifer forest with trees as tall as 65 m grows on a 38° slope, with soils 10-60 cm thick underlain by vertically dipping, weathered turbidite sequences of the Coastal Franciscan Belt. A perched seasonally drains to unweathered bedrock. The water table fluctuates between 3 and 5 m below the surface near Elder Creek, and between 18 and 24 m below the surface at the hillslope divide. The site contains over 850 sensors monitoring the climatic variables and the movement of water through the subsurface, vegetation and into the atmosphere. Daily rainwater sampling during storm events from 2007-2012 shows a Local Meteoric Water Line, setting the context for our comparison of isotopic reservoirs. From Summer 2011 to Fall 2012, bi-weekly to tri-weekly samples were collected of tree xylem of over 30 individuals of Pseudotsuga menziesii, quercus agrifolia, arbutus menziesii, Umbellularia californica, Notholithocarpus densiflorus, acer macrophyllum, as well as from soil and rock to a depth of 1-1.3 m, and from the water table at 12 wells across the hillslope. Analysis reveals a structured heterogeneity of distinct isotopic reservoirs in the soil, weathered bedrock, and groundwater that is most strongly developed in the late summer. Whereas well water reflects rainwater input and soil water fluctuates between the chemistry of rainwater and a strongly developed evaporative front, rock moisture is consistently far more negative than the volume weighted rainfall. Extracted water from tree xylem indicates trees use exclusively unsaturated zone moisture, but that hardwoods use shallow sources of rock and soil moisture in late summer and opportunistically use new rainwater, whereas Douglas-fir place a greater reliance on deeper rock moisture and never exclusively use new rainwater. Finally, findings suggest the presence of a large reservoir of plant available water in unsaturated weathered rock that is essential in sustaining vegetation in a Mediterranean climate.

Final ID: B33A-0502

Asian monsoon hydrometeorology from water isotopes: implications for speleothem climate record interpretation

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Body: Previous studies have documented high correlations between speleothem δ18Op and millennial timescale climate forcings. From LMDZ model analysis, we show that δ18Op at cave sites over southern China is weakly correlated with upstream precipitation in the core of the Indian monsoon region rather than local precipitation, but it is well-correlated with the δ18Op over large areas of southern and central China, consistent with coherent speleothem δ18Op variations over different parts of China. We suggest that the high correlation between insolation and speleothem δ18Op in southern China reflect the variations of hydrologic processes over Indian monsoon region on millennial and orbital timescales. The δ18Op in the drier part (north of ~30N) of China, on the other hand, has consistently negative correlations with local precipitation and may capture local hydrologic processes related to changes in the extent of the Hadley circulation.

Final ID: B33A-0507

The stable isotope composition of transpired water and the rate of change in leaf water enrichment in response to variable environments

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Body: Previous research has shown that during daylight hours the isotope composition of leaf water is generally well approximated by steady-state leaf water isotope enrichment models. However, there is little direct confirmation of isotopic steady state (ISS) transpiration. Here we use a novel method to evaluate the frequency (or infrequency) of ISS transpiration and the rate of change in leaf water enrichment when leaves are exposed to a variable environment. Specifically, our study had three goals. First, we wanted to develop a new method to measure the isotope fluxes of transpiration that relies on isotope ratio infrared spectroscopy (IRIS) and highlight how an IRIS instrument can be coupled to plant gas exchange systems. In doing so, we also developed a method for controlling the absolute humidity entering the gas exchange cuvettes across a wide range of concentrations (approximately 4000 ppmv to 22000 ppmv) without changing the isotope composition of water vapour entering the cuvette. Second, we quantified variation in the isotope composition of transpired water vapor and the rate of change in leaf water enrichment that can occur as a result of changes in relative humidity, leaf surface conductance to water vapour, leaf temperature and the isotope composition of atmospheric water vapor. Third, we examine the differences between steady state and non-steady state model predictions of leaf water enrichment at the site of evaporation. In our measurements the isotopic compositions of transpired water were neither stable nor equal to source water until leaves had been maintained at physiological steady state for at least 40 minutes. Additionally when transpiration was not at ISS, the steady state model predictions of leaf water enrichment at the site of evaporation exceeded non steady-state model predictions by up to 8 per mil. Further, the rate of change in leaf water enrichment was highly sensitive to variation in leaf water content. Our results suggest that a variable environment is likely to preclude isotopic steady-state transpiration and that this effect would be exacerbated by lengthy leaf water turnover times.

Final ID: C33D-0684

Effects of forest structure on snow accumulation and melt derived from ecohydrological instrument clusters across the Western US *(Invited)*

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5. Hydrology and Water Resources, University of Arizona, Tucson, AZ, United States.

Body: In the higher elevations of the western U.S., seasonal snow accumulation provides the primary source of water input to the terrestrial ecosystem. Recent changes in climate and vegetation cover (e.g. fire suppression, beetle infestation, fire) have potentially large, yet unrealized implications for water availability and ecosystem health. In this regard, we have developed a series of ecohydrological instrument clusters to measure snow depth, soil moisture and temperature, sap flow, and fluxes of carbon, water vapor, and energy. Clusters deployed across elevational transects in the Sierra Nevada and Rocky Mountains provide the measurements needed to understand the impacts of forest structure on snowmelt dynamics and broader ecohydrological feedbacks. These observations indicate that snow accumulation is greater in open versus under canopy locations (29% greater on average) but snow ablation rates (sublimation and melt) are also greater in open areas (39% greater on average). Therefore snow water equivalent differences between open versus under canopy locations were generally lower than snowfall differences. As a result of these competing factors, snow disappearance timing is more similar in open versus sub-canopy areas then would be expected based on snow accumulation differences alone. The time-space evolution of differences in snow water equivalent between under canopy and open areas, therefore, is a function of the magnitude of the differences between open and sub-canopy snow accumulation (i.e. input terms) versus differences between open and sub-canopy snowmelt and sublimation (i.e. loss terms). The magnitude of the differences in these two terms in open versus under canopy positions is dictated by several physiographic and climatic factors which vary across a variety of scales. This presentation will synthesize observations from diverse climatic and physiographic regimes to develop the conceptual models of snow-vegetation interactions needed for testing a variety of climate and land cover change hypotheses.

URL : http://instaar.colorado.edu/mtnhydro/Mountain_Hydrology/Home.html

Final ID: EP33B-0874

A network-based analysis of delta morphology and ecology: An example from Wax Lake Delta

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Body: Land loss and increased nitrogen loading are altering the eco-geomorphic equilibrium of coastal Louisiana. As a result, in recent years sustainable practices in the management of river, coastal, and wetland areas have emerged. River diversions, for example, have been implemented or planned in hopes of mitigating land loss throughout the coast of Louisiana. Denitrification in coastal wetlands has the potential of limiting the risks of hypoxia and related ecological issues by reducing the nutrient export to receiving waters. Understanding of the physical and biogeochemical processes acting on deltaic systems may better inform more sustainable conservation practices.

In this study we perform a network scale analysis of the delta morphology and ecology of Wax Lake Delta (WLD) in coastal Louisiana. We apply network theory concepts such as network connectivity to characterize the topology of the channel network, its spatial variations, and the impact on the transport of environmental fluxes. Based on field data, we deduce that channel discharge is not conserved through the system, resulting in the loss of ~50% of the incoming flow, and thus suggesting the importance of the hydraulic connectivity of the distributary channels to the islands. We estimate the hydraulic residence time of the island interiors and couple with the hydraulic travel time of the distributary channels to obtain the denitrification potential for the entire WLD system. We also explore seasonal variations in flow conditions, along with tides, and how they affect the connectivity of the network, as well as the effects on the export of nitrogen. The results give insight into the denitrification potential of WLD and the interactions between delta morphology and biogeochemical processes at the delta network scale.

Final ID: H33A-1282

Hydrologic Prediction Through Earthcube Enabled Hydrogeophysical Cyberinfrastructure

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Body: Accurate prediction of hydrologic processes is contingent on the successful interaction of multiple components, including (1) accurate conceptual and numerical models describing physical, chemical and biological processes (2) a numerical framework for integration of such processes and (3) multidisciplinary temporal data streams which feeds such models. Over the past ten years the main focus in the hydrogeophysical community has been the advancement and developments of conceptual and numerical models. While this advancement still poses numerous challenges (e.g. the in silico modeling of microbiological processes and the coupling of models across different interfaces) there is now a fairly good high level understanding of the types, scales of and interplay between processes.
In parallel with this advancement there have been rapid developments in data acquisition capabilities (ranging from satellite based remote sensing to low cost sensor networks) and the associated cyberinfrastructure which allows for mash ups of data from heterogeneous and independent sensor networks. The tools for this in generally have come from outside the hydrogeophysical community - partly these are specific scientific tools developed through NSF, DOE and NASA funding, and partly these are general web2.0 tools or tools developed under commercial initiatives (e.g. the IBM Smarter Planet initiative). One challenge facing the hydrogeophysical community is how to effectively harness all these tools to develop hydrologic prediction tools. One of the primary opportunities for this is the NSF funded EarthCube effort (http://earthcube.ning.com/). The goal of EarthCube is to transform the conduct of research by supporting the development of community-guided cyberinfrastructure to integrate data and information for knowledge management across the Geosciences. Note that Earthcube is part of a larger NSF effort (Cyberinfrastructure for the 21st Century (CIF21), and that Earthcube is driven by the vision to "develop a framework to understand and predict responses of the Earth as a system— from the space-atmosphere boundary to the core, including the influences of humans and ecosystems.”
Effective development of hydrologic prediction tools will require the hydrogeophysical community to engage in and become conversant with the cyberinfrastructure community. In my presentation I will provide several examples of how such tools could look like, and what some of the opportunities are for getting this engagement going and develop cyberinfrastructure enabled hydrologic prediction tools.

Final ID: H33B-1306

Species differences in evergreen tree transpiration at daily, seasonal, and interannual timescales

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Body: Mediterranean climates have rainy winter and dry summer seasons, so the season of water availability (winter) is out of phase with the season of light availability and atmospheric demand (summer). In this study, we investigate the seasonality of tree transpiration in a Mediterranean climate, using observations from a small (8000 m2), forested, steep (~35 degree) hillslope at the UC Angelo Reserve, in the northern California Coast Range. The site is instrumented with over 850 sensors transmitting hydrologic and meteorological data at less than 30-minute intervals. Here, we analyze four years of high-frequency measurements from 45 sap flow sensors in 30 trees, six depth profiles of soil moisture measured by TDR, and spatially distributed measurements of air temperature, relative humidity, solar radiation, and other meteorological variables.

The sap flow measurements show a difference in transpiration seasonality between common California Coast Range evergreen tree species. Douglas firs (Pseudotsuga menziesii) maintain significant transpiration through the winter rainy season and transpire maximally in the spring, but Douglas fir transpiration declines sharply in the summer dry season. Madrones (Arbutus menziesii), in contrast, transpire maximally in the summer dry season. The seasonal patterns are quantified using principal component analysis. Nonlinear regressions against environmental variables show that the difference in transpiration seasonality arises from different sensitivities to atmospheric demand (VPD) and root-zone moisture. The different sensitivities to VPD and root-zone moisture cause species differences not just in seasonal patterns, but also in high temporal frequency (daily to weekly) variability of transpiration. We also contrast the interannual variability of dry season transpiration among the different species, and show that precipitation above a threshold triggers a Douglas fir response. Finally, we use a simple 1-D model of the atmospheric boundary layer to estimate the effects of species differences in transpiration on atmospheric boundary layer temperature and humidity.

Final ID: H33H-1423

Establishing a Framework for Community Modeling in

Hydrologic Science: Recommendations from the CUAHSI CHyMP Initiative

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Body: The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) continues a major effort towards supporting Community Hydrologic Modeling. From 2009 – 2011, the Community Hydrologic Modeling Platform (CHyMP) initiative held three workshops, the ultimate goal of which was to produce recommendations and an implementation plan to establish a community modeling program that enables comprehensive simulation of water anywhere on the North American continent. Such an effort would include connections to and advances in global climate models, biogeochemistry, and efforts of other disciplines that require an understanding of water patterns and processes in the environment.

To achieve such a vision will require substantial investment in human and cyber-infrastructure and significant advances in the science of hydrologic modeling and spatial scaling. CHyMP concluded with a final workshop, held March 2011, and produced several recommendations. CUAHSI and the university community continue to advance community modeling and implement these recommendations through several related and follow on efforts.

Key results from the final 2011 workshop included agreement among participants that the community is ready to move forward with implementation. It is recognized that initial implementation of this larger effort can begin with simulation capabilities that currently exist, or that can be easily developed. CHyMP identified four key activities in support of community modeling: benchmarking, dataset evaluation and development, platform evaluation, and developing a national water model framework. Key findings included:

1)The community supported the idea of a National Water Model framework; a community effort is needed to explore what the ultimate implementation of a National Water Model is. A true community modeling effort would support the modeling of “water anywhere” and would include all relevant scales and processes.

2)Implementation of a community modeling program could initially focus on continental scale modeling of water quantity (rather than quality). The goal of this initial model is the comprehensive description of water stores and fluxes in such a way to permit linkage to GCM’s, biogeochemical, ecological, and geomorphic models. This continental scale focus allows systematic evaluation of our current state of knowledge and data, leverages existing efforts done by large scale modelers, contributes to scientific discovery that informs globally and societal relevant questions, and provides an initial framework to evaluate hydrologic information relevant to other disciplines and a structure into which to incorporate other classes of hydrologic models.

3)Dataset development will be a key aspect of any successful national water model implementation. Our current knowledge of the subsurface is limiting our ability to truly integrate soil and groundwater into large scale models, and to answering critical science questions with societal relevance (i.e. groundwater’s influence on climate).

4)The CHyMP workshops and efforts to date have achieved collaboration between university scientists, government agencies and the private sector that must be maintained. Follow on efforts in community modeling should aim at leveraging and maintaining this collaboration for maximum scientific and societal benefit.

Final ID: B33I-03

Estimating animal biodiversity across taxa in tropical forests using shape-based waveform lidar metrics and Landsat image time series

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Body: Studies have shown that forest structural heterogeneity is a key variable for estimating the diversity, richness, and community structure of forest species such as birds, butterflies, and dung beetles. These relationships are especially relevant in tropical forests when assessing the impacts of forest management plans on indicator groups and species. Typically, forest structure and biodiversity are evaluated using field surveys, which are expensive and spatially limited. An alternative is to use the growing archive of imagery to assess the impacts that disturbances (such as those caused by selective logging) have on habitats and biodiversity. But it can be difficult to capture subtle differences in the three-dimensional (3D) forest structure at the landscape scale that are important for modeling these relationships.

We use a unique confluence of active and passive optical sensor data, field surveys of biodiversity, and stand management data to link metrics of spatial and spatio-temporal heterogeneity with key indicators of sustainable forest management. Field sites were selected from tropical forest stands along the Atlantic Slope of Costa Rica for which the management history was known and in which biodiversity surveys were conducted. The vertical dimension of forest structure was assessed by applying two shape-based metrics, the centroid (C) and radius of gyration (RG), to full waveform lidar data collected by the LVIS platform over central Costa Rica in 2005. We developed a map of the vertical structure of the forest by implementing a recursive function that used C and RG to identify major segments of each waveform. Differences in 3D structure were related to estimates of animal biodiversity, size and type of disturbance, and time since disturbance—critical measurements for achieving verifiable sustainable management and conservation of biodiversity in tropical forests. Moreover, the relationships found between 3D structure and biodiversity suggests that it may be possible to implement a rapid and robust assessment of forest dynamics and biodiversity at the landscape scale by complementing field surveys with data acquired from active (such as lidar) and passive optical sensors.

Final ID: A33O-04

Constraints on tropospheric CO2 from TES and ACOS-GOSAT assessed with TCCON and HIPPO measurements *(Invited)*

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4. Environment Canada, Toronto, ON, Canada.
5. Colorado State University, Fort Collins, CO, United States.
6. Harvard University, Cambridge, MA, United States.
7. California Institute of Technology, Pasadena, CA, United States.
8. University of Wollongong, Wollongong, NSW, Australia.
9. The National Institute of Water and Atmospheric Research, Wellington, New Zealand.
10. Institute of Environmental Physics, University of Bremen, Bremen, Germany.
11. Karlsruhe Institute of Technology, Karlsruhe, Germany.
12. Center for Global Environmental Research, National Institute for Environmental Studies (NIES), Tsukuba, Ibaraki, Japan.
13. National University, Bogota, Colombia.
14. Seoul National University, Seoul, Korea, Republic of.
15. National Center for Atmospheric Research, Boulder, CO, United States.

Body: Obtaining accurate estimates of surface fluxes of atmospheric CO2 requires an improved understanding of the processes controlling the global distribution of CO2. We investigate the global distribution of CO2 through the assimilation of Aura-TES and ACOS-GOSAT into the GEOS-Chem model. The assimilated fields are compared against HIPPO aircraft profiles and TCCON column observations, which are non-coincident with the satellite sampling. We find that column observations from GOSAT and free tropospheric CO2 from TES provide complementary information with TES assimilation improving the model values in the summertime when uptake is a maximum. In contrast we find that GOSAT XCO2 most significantly improves the overall model bias.

Final ID: B33I-06

Linkages of Biodiversity and Canopy Lidar Metrics in Central Africa

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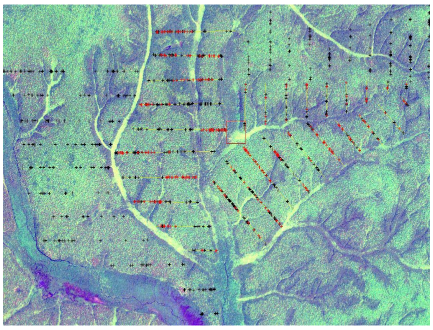
Body: Central Africa contains the second largest dense humid forest in the world, and one of the largest carbon and biodiversity reservoirs on Earth. With 60% of the forest currently under logging concessions, the Congo basin is poised to undergo extensive land use change. Increases in bushmeat trade, resulting from extensification of logging roads, have already been well documented. From a quantitative standpoint, little is known of the structure of these forests, how logging affects forest biomass or functioning, and how canopy habitat heterogeneity relates to animal species richness or diversity. Here we document, using random forest and MaxEnt, how information from GLAS lidar metrics, ALOS-PalSAR and Landsat imagery, combined with field observations of great ape nest locations (figure 1) and vegetation types, can be merged to create a map of gorilla and chimpanzee habitat in a region spanning Cameroon, the Republic of Congo, and the Central African Republic. From an initial selection of 48 variables we found the most important for mapping habitat suitability were a combination of PalSAR backscatter, NDVI image texture. Landsat ETM+ top of the atmosphere reflectance and principle component images. While NDVI from ETM+bands was an important predictor of gorilla and chimpanzee nest presence, species-specific differences in habitat use were also identified. Tree canopy height from GLAS was the most important variable predicting chimpanzee nesting habitat, while Landsat ETM+ bands were most important for gorilla nesting habitat. These preliminary results indicate merging field observations with satellite imagery promises to significantly improve our understanding of ape habitat-use at the landscape scale.



Combining GLAS lidar metrics, ALOS-PalSAR and Landsat imager with field observations of great ape nest locations for habitat mapping in C. Africa

Final ID: EP33C-08

Ecogeomorphology: Impressions of organisms in critical zone evolution *(Invited)*

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3. INSTAAR & Environ. Studies, Univ of Colorado, Boulder, CO, United States.
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5. Lewis and Clark College, Portland, OR, United States.

Body: Organisms pervade Earth's critical zone, and shape it through their impact on geochemical, hydrological and geomorphological processes. Examples from Gordon Gulch in the Boulder Creek Critical Zone Observatory illustrate the involvement of organisms in weathering, mobile regolith transport, and hydrologic function of the critical zone, all processes that are at the core of critical zone evolution and function. We examine *i)* evidence of involvement of microorganisms in chemical weathering of rock, *ii)* the role of trees in physical weathering and downslope transport of mobile regolith, and *iii)* the effect of vegetation on runoff, which can influence both weathering and erosion.

Microorganisms are present throughout soil profiles. Although microbial biomass declines roughly exponentially and diversity diminishes with depth, populations do not vanish even in saprolite at depths > 1m in a critical zone developed within Proterozoic gneiss. Fluorescence of leached organic matter from the same profiles shows that organic matter at the top of saprolite is derived from microbial biomass to a much greater extent than in upper layers of the soil. Deep organic matter is more oxidized, consistent with humic substances being used by microbes as electron shuttles, a process likely coupled to incipient bedrock weathering.

While it is well known that trees transport soil when they are blown down, generating pit and mound microtopography, only a small fraction of trees die in this fashion. As a large proportion of a tree's biomass is underground, it is inevitable that the growth of roots displace soil. Those roots that penetrate the saprolite can also damage rock, and can play a role in releasing blocks of rock into the mobile regolith column. We find that growth of roots of ponderosa pines displaces mobile regolith in a characteristic pattern surrounding a trunk. Fresh rock emerges in an annulus around tree trunks. Mobile regolith is demonstrably inflated by up to 0.1 m adjacent to trunks, and declines with characteristic length scales of order 1 m. Inflation patterns are asymmetric, likely reflecting the locations of large roots. We therefore argue that the growth and decay of roots serve as displacement events that promote downslope creep of mobile regolith. Translating this into transport rate requires knowledge of tree spacing and demographics. Root growth below soil can open fractures in the saprolite, generating damage that is similarly paced by tree spacing, growth and decay rates.

Vegetation modulates water movement on its path between precipitation and runoff. In most years, maximum water table rise and runoff occurs during sustained snowmelt, when evapotranspiration demands are low and water inputs are high. In summer 2012, however, heavy mid-summer rains produced water table and discharge responses more commonly seen during snowmelt, demonstrating that it is not the precipitation phase that controls runoff. Instead, water inputs must exceed vegetation demands or must incite preferential flow through the vadose zone.

These examples point to the fundamental roles of organisms in controlling the delivery of water to rock, mediating

incipient mineral weathering, and opening rock fractures and moving mobile regolith.

Final ID: B33I-08

Linking Lidar, SAR and ED: How lidar and SAR fusion can influence the predictions and modeling of future forest states.

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Body: Among remote sensing tools available for forest structure research, the active methods of LiDAR and RaDAR possess the potential to provide faster and more valuable information than many other methods available. One of their major downfalls is the survey cost incurred, particularly in scientific research where many instances require dual coverage. Identifying synergies between these methods could potentially reduce the need for forest coverage by both sensors. Here we present a study that addresses these limitations primarily through comparison of interferometric coherence between direct measurements provided by radar interferometry and through those predicted from extinction estimates obtained from LiDAR waveforms. The theories presented here for establishing extinction estimates from radar and LiDAR synergy have the potential to improve forest biomass estimation where interferometric radar data has been acquired. This is because both height and extinction values can potentially be obtained from radar data alone through the establishment of this relationship with the lidar derived extinction and therefore coherence. In addition, the relevance of obtaining large-scale extinction estimates using radar coverage is emphasised within a modelling environment using the Ecological Demography (ED) model. We examine, for multiple sites, how the availability of radar coherence and therefore extinction estimates provided by the theory can be used within the forest modelling process to provide canopy extinction variations which drive photosynthetic processes. In particular, the influence of functional type and location variations are analysed and ultimately the theory’s ability to predict the current and future status of forests.

Final ID: B34D-02

A Dual Wavelength Echidna® Lidar (DWEL) for Forest Structure Retrieval ***(Invited)***

A. H. Strahler; [1]; *E. S. Douglas;* [2]; *J. Martel;* [4]; *T. Cook;* [4]; *C. Mendillo;* [2]; *R. A. Marshall;* [3]; *S. Chakrabarti;* [4]; *C. Schaaf;* [5]; *C. E. Woodcock;* [1]; *Z. Li;* [1]; *X. Yang;* [5]; *D. Culvenor ;* [7]; *D. Jupp;* [6]; *G. Newnham;* [7]; *J. Lovell;* [8];

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Body: A newly-constructed, ground-based lidar scanner designed for automated retrieval of forest structure, the Dual Wavelength Echidna Lidar (DWEL), separates laser “hits” of leaves from hits of trunks and branches using simultaneous laser pulses at 1548 nm, where leaf water content produces strong absorption, and at 1064 nm, where leaves and branches have similar reflectances. The DWEL uses a rotating mirror scan mechanism on a revolving mount, coupled with full digitization of return waveforms, to identify, locate, and parameterize scattering events in the three-dimensional space around the scanner.

In the DWEL instrument, the two measurement lasers are triggered simultaneously. Laser pulses are sharply peaked; full-width half-max pulse length of the lasers is 5.1 ns, corresponding to 1.53 m in distance. The laser pulses are expanded and collimated to a 6-mm beam diameter (1/e2), then shaped into a top-hat cross section using a diffraction apparatus. Interchangeable optics provide a beam divergence of 1.25-, 2.5-, or 5-mrad. A mirror and two dichroic filters combine the beams and join them with a visible green continuous-wave marker laser. The combined beam is guided along an optical path to the 10-cm rotating scan mirror. Scan encoders in zenith and azimuth directions resolve the pointing of the instrument to 215 units per 2π radians. Scan resolution has three settings: 1-, 2-, and 4-mrad. Scan time varies with resolution: 11 min at 4 mrad; 41 min at 2 mrad; and 2.7 hr at 1 mrad. The return beam enters the 10-cm diameter Newtonian-Nasmyth telescope and is directed to the receiver assembly, which splits the return beam using a dichroic filter and narrowband pass filters. Two 0.5 mm InGaAs photodiodes measure the return signal, which is sampled by two digitizers at 2 gigasamples per second with 10-bit precision. This provides a 7.5-cm sampling of the 1.53 m pulse, allowing very good reconstruction of the return waveform. The designed signal-to-noise ratio is 10:1 (8:1) at 100 m with 0.1 reflectance at 1064 nm (1548 nm). A compact PCI single board computer collects the digital and housekeeping data, which is offloaded in real time via gigabit ethernet to a separate field PC. Instrument weight is 20.4 kg (45 lbs), including high-density lithium ion batteries to meet the power requirement of 115 W. The laser system attains a 3R safety classification, and is eye-safe unless viewed directly within 30 m using optical magnification. First images from the Harvard Forest, Petersham, MA, demonstrate the quality and new information content of DWEL scans.

The DWEL was built by the Center for Space Physics and Center for Remote Sensing, Boston University, with the support of the US National Science Foundation under grant MRI-0923389. It is based on the design of the Echidna Validation Instrument (EVI), constructed by Australia’s Commonwealth Scientific and Industrial Research Organization

(CSIRO), and is a realization of a concept for a scanning lidar with full-waveform digitizing, trademarked Echidna®, developed and patented by CSIRO (US patent 7,187,452, Australian Patent 2002227768, New Zealand Patent 527547, Japanese Patent 4108478 and others).

Final ID: B34D-03

Using Voxelized Point-Cloud Forest Reconstructions from Ground-Based Full-Waveform Lidar to Retrieve Leaf Area Index and Foliage Profiles

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Body: This study presents a new methodology to directly retrieve two important biophysical parameters, Leaf Area Index (LAI; m^2) and Foliage Area Volume Density (FAVD; m^2 LAI/m^3 volume) profiles through the voxelization of point-cloud forest reconstructions from multiple ground-based full-waveform Echidna® lidar scans.

Previous studies have verified that estimates of LAI and FAVD made from single EVI scans, using azimuth-averaged gap probability with zenith angle (Jupp et al. 2009; Zhao et al. 2011), agree well with those of traditional hemispherical photos and LAI-2000 measurements. Strahler et al. (2008) and Yang et al. (2012) established a paradigm for the 3-D reconstruction of forest stands using a full-waveform, ground-based, scanning lidar by merging point clouds constructed from overlapping EVI scans, thereby allowing virtual direct representation of forest biomass. Classification procedures (Yang et al. 2012), based on the shape of the laser pulse returned to the instrument, can separate trunk from foliage scattering events. Volumetric datasets are produced by properly assigning attributes, such as gap probability, apparent reflectance, and volume associated with the laser pulse footprint at the observed range, to the foliage scattering events in the reconstructed point cloud. Leaf angle distribution is accommodated with a simple model based on gap probability with zenith angle as observed in individual scans of the stand. Clumping occurring at scales coarser than elemental volumes associated with scattering events is observed directly and therefore does not require parametric correction. For validation, comparisons are made between LAI and FAVD profiles retrieved directly from the voxelized 3-D forest reconstructions and those observed from airborne and field measurements.

The voxelized 3-D forest reconstructions derived from EVI point clouds provide a pathway to estimate “ground truth” FAVD, LAI, and above-ground biomass without destructive sampling. These virtual measurements will be very helpful in validating retrieval algorithms for LAI and above-ground biomass using large-footprint spaceborne or airborne lidar systems, thus facilitating large-area inventories. Due to nature of the ground-based instrument, the measurements are highly repeatable and easy to obtain. The enhanced characterization of leaf area spatial distribution within the forest stand possible from EVI is of interest to both land biogeoscientists who require bulk vegetation biomass measures and to atmospheric biogeoscientists, who require information on surface roughness, photosynthesis, and respiration processes. Moreover, the EVI can be deployed to monitor disturbance and deforestation detected by optical sensors, such as MODIS or Landsat, to provide better calibration of the type and nature of change.

This research was supported by the National Science Foundation under grant DBI-0923389.

Final ID: H34E-03

A Decade Remote Sensing River Bathymetry with the Experimental Advanced Airborne Research LiDAR ***(Invited)***

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Body: Since 2002, the first generation of the Experimental Advanced Airborne Research LiDAR (EAARL-A) sensor has been deployed for mapping rivers and streams. We present and summarize the results of comparisons between ground truth surveys and bathymetry collected by the EAARL-A sensor in a suite of rivers across the United States. These comparisons include reaches on the Platte River (NE), Boise and Deadwood Rivers (ID), Blue and Colorado Rivers (CO), Klamath and Trinity Rivers (CA), and the Shenandoah River (VA). In addition to diverse channel morphologies (braided, single thread, and meandering) these rivers possess a variety of substrates (sand, gravel, and bedrock) and a wide range of optical characteristics which influence the attenuation and scattering of laser energy through the water column. Root mean square errors between ground truth elevations and those measured by the EAARL-A ranged from 0.15-m in rivers with relatively low turbidity and highly reflective sandy bottoms to over 0.5-m in turbid rivers with less reflective substrates. Mapping accuracy with the EAARL-A has proved challenging in pools where bottom returns are either absent in waveforms or are of such low intensity that they are treated as noise by waveform processing algorithms. Resolving bathymetry in shallow depths where near surface and bottom returns are typically convolved also presents difficulties for waveform processing routines. The results of these evaluations provide an empirical framework to discuss the capabilities and limitations of the EAARL-A sensor as well as previous generations of post-processing software for extracting bathymetry from complex waveforms. These experiences and field studies not only provide benchmarks for the evaluation of the next generation of bathymetric LiDARs for use in river mapping, but also highlight the importance of developing and standardizing more rigorous methods to characterize substrate reflectance and in-situ optical properties at study sites. They also point out the continued necessity of ground truth data for algorithm refinement and survey verification.

Final ID: H34E-04

The Hydromorphic Character of Developing Anastomosed Systems Determined from Metre Scale Resolution Aerial LIDAR

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Body: Anastomosing channels are rare in the UK primarily due to inappropriate channel and floodplain engineering and management. This study examines the character of developing anastomosed channels on the River Wear and the River Irthing in northern England using metre scale resolution aerial LIDAR data. The LIDAR data are used to create a detailed digital surface and terrain models (DSM & DTM) of the study reaches. The data accurately records vegetation character and sub-channel planform and morphology. Topographic metrics reveal a well-developed vegetation community and a diverse terrain, dominated by an interlinked channel network split by variable length, generally low elevation interfluves. Utilisation of the LIDAR DEM in the JFLOW+ 2D hydrodynamic model has generated local hydraulic variable estimates through the anastomosed reaches across a range of flows. These data demonstrate clearly how elevated flows are transferred out of the primary channel and distributed along the interconnected secondary channel network, creating a diverse set of hydraulic environments. Interfluve areas become quickly inundated further dissipating flow energy. Shear stress estimates across the study sites reveal a generally reduced ability to mobilise sediments and erode channel margins. It would appear that the topographic character of these developing anastomosing sites efficiently manages flood flow energy, activating secondary channels and low elevation interfluves to distribute flood flows, creating a dynamically stable river environment. These findings are contrasted against data from wandering channel systems, characterised by a poorly developed riparian vegetation community, where bar deposition and bank erosion dominate. A model of channel evolution linking wandering and anastomosed channel types is proposed, demonstrating from the topographic data how wandering systems may develop into anastomosed systems with appropriate riparian vegetation management.

Final ID: EP34A-07

Numerical model of the lowermost Mississippi River as an alluvial-bedrock reach: preliminary results

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Body: Recent field studies reveal that the river bed of the Lower Mississippi River is characterized by a transition from alluvium (upstream) to bedrock (downstream). In particular, in the downstream 250 km of the river, fields of actively migrating bedforms alternate with deep zones where a consolidated substratum is exposed. Here we present a first version of a one-dimensional numerical model able to capture the alluvial-bedrock transition in the lowermost Mississippi River, defined herein as the 500-km reach between the Old River Control Structure and the Gulf of Mexico. The flow is assumed to be steady, and the cross-section is divided in two regions, the river channel and the floodplain. The streamwise variation of channel and floodplain geometry is described with synthetic relations derived from field observations. Flow resistance in the river channel is computed with the formulation for low-slope, large sand bed rivers due to Wright and Parker, while a Chezy-type formulation is implemented on the floodplain. Sediment is modeled in terms of bed material and wash load. Suspended load is computed with the Wright-Parker formulation. This treatment allows either uniform sediment or a mixture of different grain sizes, and accounts for stratification effects. Bedload transport rates are estimated with the relation for sediment mixtures of Ashida and Michiue. Previous work documents reasonable agreement between these load relations and field measurements. Washload is routed through the system solving the equation of mass conservation of sediment in suspension in the water column. The gradual transition from the alluvial reach to the bedrock reach is modeled in terms of a “mushy” layer of specified thickness overlying the non-erodible substrate. In the case of a fully alluvial reach, the channel bed elevation is above this mushy layer, while in the case of partial alluvial cover of the substratum, the channel bed elevation is within the mushy layer. Variations in base level are accounted for in terms of a specified rate of sea level rise. In addition, the model allows a subsidence rate that varies in space and time. The time rate of change of channel bed elevation is computed solving the equation of mass conservation of the bed material. Validation of the model against field data is currently in progress in a relatively simplified setting, in which the bed material is characterized in terms of a single grain size. In addition, due to the lack of information on the geometry and the grain size characteristics of the floodplain, the modeling effort is restricted to the channel bed, and the procedure to route the washload through the system is not implemented. Having clearly in mind that the present Lowermost Mississippi River is not in equilibrium, validation runs are performed in two steps. The model is first run under pre-1930 conditions, under the assumption that the natural Mississippi River was not too far from long-term steady-state. The model is then run from the 1930s to the 2010s with the prevailing inputs of water and sediment and the model results are compared against field data. In the near future we plan to test the model with non-uniform bed material, and extend it to include inundation of the floodplain, and deposition of washload on it.

Final ID: B41E-0345

Estimating tropical forest structure using discrete return lidar data and a locally trained synthetic forest algorithm

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Body: Forests are complex ecosystems with diverse species assemblages, crown structures, size class distributions, and historical disturbances. This complexity makes monitoring, understanding and forecasting carbon dynamics difficult. Still, this complexity is also central in carbon cycling of terrestrial vegetation. Lidar data often is used solely to associate plot level biomass measurements with canopy height models. There is much more that may be gleaned from examining the full profile from lidar data. Using discrete return airborne light detection and ranging (lidar) data collected in 2009 by the Tropical Ecology Assessment and Monitoring Network (TEAM), we compared synthetic vegetation profiles to lidar-derived relative vegetation profiles (RVPs) in La Selva, Costa Rica. To accomplish this, we developed RVPs to describe the vertical distribution of plant material on 20 plots at La Selva by transforming cumulative lidar observations to account for obscured plant material. Hundreds of synthetic profiles were developed for forests containing approximately 200,000 trees with random diameter at breast height (DBH), assuming a Weibull distribution with a shape of 1.0, and mean DBH ranging from 0cm to 500cm. For each tree in the synthetic forests, crown shape (width, depth) and total height were estimated using previously developed allometric equations for tropical forests. Profiles for each synthetic forest were generated and compared to TEAM lidar data to determine the best fitting synthetic profile to lidar profiles for each of 20 field plots at La Selva. After determining the best fit synthetic profile using the minimum sum of squared differences, we are able to estimate forest structure (diameter distribution, height, and biomass) and to compare our estimates to field data for each of the twenty field plots. Our preliminary results show promise for estimating forest structure and biomass using lidar data and computer modeling.

Final ID: B41E-0346

Deriving Leaf Area Index (LAI) from multiple lidar remote sensing systems

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Body: LAI is an important biophysical variable linking biogeochemical cycles of earth systems. Observations with passive optical remote sensing are plagued by saturation and results from different passive and active sensors are often inconsistent. Recently lidar remote sensing has been applied to derive vertical canopy structure including LAI and its vertical profile. In this research we compare LAI retrievals from three different types of lidar sensors. The study areas include the La Selva Biological Station in Costa Rica and Sierra Nevada Forest in California. We first obtain independent LAI estimates from different lidar systems including airborne lidar (LVIS), spaceborne lidar (GLAS) and ground lidar (Echidna). LAI retrievals are then evaluated between sensors as a function of scale, land cover type and sensor characteristics. We also assess the accuracy of these LAI products against ground measurements. By providing a link between ground observations, ground lidar, aircraft and space-based lidar we hope to demonstrate a path for deriving more accurate estimates of LAI on a global basis, and to provide a more robust means of validating passive optical estimates of this important variable.

Final ID: B41E-0347

Tree species identification in an African Savanna with airborne imaging spectroscopy and LiDAR from the Carnegie Airborne Observatory (CAO) using stacked support vector machines

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Body: Airborne remote sensing data provide promising opportunities for species identification of individual tree and shrub crowns across large areas which cannot be mapped from the ground. Previous investigations of the potential for species identification of crowns from airborne data have focused on pixel-level information (0.5-1m2), and thus have been unable to take advantage of the structural information that exist at the crown level. Hyperspectral data consisting of 58 bands from 517 to 1054nm and LiDAR (light detection and ranging) data providing vegetation height information were acquired over several landscapes within Kruger National Park, South Africa, by the CAO in 2008 at 1.1m spatial resolution. Over 1,000 individual trees and shrubs were mapped and identified in the field to construct species spectral and structural libraries. We used stacked support vector machines (SVM) that incorporate pixel-level spectral information and crown-level structural information to predict species identity for individual tree crowns. The addition of a crown-level classification step that incorporates crown structural information significantly improved model accuracy by ~6% and our prediction accuracy of the final model was ~75% for 16 species classes. This model was then used to predict the species identity of individual crowns across multiple airborne-mapped landscapes, made possible by an automated crown segmentation algorithm. The resultant species maps will make it possible to examine the environmental controls over individual species distributions and tree community composition, and provide important landscape-scale species distribution information relevant to park management and conservation.

Final ID: B41E-0350

Using small-footprint, discrete return LiDAR to obtain stand level age of loblolly pine in central Virginia, USA

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Body: The objective of this study was to evaluate the utility of small-footprint discrete return LiDAR for determining loblolly pine stand age. The study area was in the Appomattox-Buckingham State Forest, Virginia, USA. LiDAR data were acquired in 2008 using an Optech ALTM 3100. A stratified random sampling approach was used to select over 200 circular plots (15 m radius) with ages (the dependent variable) varying from 5 to 71 years old. LiDAR-derived independent variables were obtained using metrics computed from normalized point densities, heights (above ground) and intensities. The three best models have only one to two variables, as follows: 100th percentile of height alone (adjusted R2 = 88.3%, RMSE = 1.2 years), 100th percentile of height along with the variance of intensity (adjusted R2 = 90.8%, RMSE = 1.17 years), and the 99.5th percentile along with the density of points between the 20th and 40th percentiles (adjusted R2 = 90.6%, RMSE = 1.17 years). These results show that small-footprint, discrete return LiDAR can be used to estimate plot level age of loblolly pine stands - and may, by inference, be used to establish indices of site quality if age is known.

Final ID: B41E-0360

Effect of vegetation structure on subcanopy solar radiation: a comparative study

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Body: Vertical structure of vegetation canopy influences spatial variability of radiation regime under forest canopies. A comparison of transmittance profiles and subcanopy radiation regime for two structurally different forest sites is done based on ray tracing and principles of radiative transfer using Lidar data. Medium footprint waveform Lidar data from Laser Vegetation Imaging Sensor (LVIS) was collected from the sites in Sierra National Forest (SNF), California and Smithsonian Environmental Research Center (SERC), Maryland in 2008 and 2003 respectively. Sites in both forest areas have varying vegetation structure with SNF sites representing mixed conifers whereas the sites in SERC represent eastern broadleaf trees. The Lidar waveform is processed to derive canopy gap probability as a function of height which is used to derive transmittance profiles and solar radiation as a function of canopy height using a 3-D light transmittance model. Geostatistics is applied to compare how the vertical and horizontal distribution of solar radiation under sub-canopy surface varies with varying vertical canopy structures such as foliage density, canopy cover and canopy height. This comparison is expected to increase knowledge on vegetation structure effects forest canopies.

Final ID: ED41A-0668

Landforms in Lidar: Building a Catalog of Digital Landforms for Education and Outreach

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Body: Lidar (Light Detection and Ranging) has emerged as a fundamental tool in the earth sciences. The collection of high-resolution lidar topography from an airborne or terrestrial platform allows landscapes and landforms to be spatially represented in at sub-meter resolution and in three dimensions. While the growing availability of lidar has led to numerous new scientific findings, these data also have tremendous value for earth science education. The study of landforms is an essential and basic element of earth science education that helps students to grasp fundamental earth system processes and how they manifest themselves in the world around us. Historically students are introduced to landforms and related processes through diagrams and images seen in earth science textbooks. Lidar data, coupled with free tools such as Google Earth, provide a means to allow students and the interested public to visualize, explore, and interrogate these same landforms in an interactive manner not possible in two-dimensional remotely sensed imagery. The NSF-funded OpenTopography facility hosts data collected for geologic, hydrologic, and biological research, covering a diverse range of landscapes, and thus provides a wealth of data that could be incorporated into educational materials.

OpenTopography, in collaboration with UNAVCO, are developing a catalog of classic geologic landforms depicted in lidar. Beginning with textbook-examples of features such as faults and tectonic landforms, dunes, fluvial and glacial geomorphology, and natural hazards such as landslides and volcanoes, the catalog will be an online resource for educators and the interested public. Initially, the landforms will be sourced from pre-existing datasets hosted by OpenTopography. Users will see an image representative of the landform then have the option to download the data in Google Earth KMZ format, as a digital elevation model, or the original lidar point cloud file. By providing the landform in a range of data types, educators can choose to load the image into a presentation, work with the data in a GIS, or do more advanced data analysis on the original point cloud data. In addition, for each landform, links to additional online resources and a bibliography of select publications will be provided.

OpenTopography will initially seed the lidar landform catalog, but ultimately the goal is to solicit community contributions as well. We envision the catalog development as the first phase of this activity, and hope that later activities will focus on building curriculum that leverages the catalog and lidar data to teach earth system processes.

URL: http://opentopography.org/

Final ID: ED41A-0669

The CUAHSI Water Data Center: Empowering scientists to discover, use, store, and share water data

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Body: The proposed CUAHSI Water Data Center (WDC) will provide production-quality water data resources based upon the successful large-scale data services prototype developed by the CUAHSI Hydrologic Information System (HIS) project. The WDC, using the HIS technology, concentrates on providing time series data collected at fixed points or on moving platforms from sensors primarily (but not exclusively) in the medium of water. The WDC's missions include providing simple and effective data discovery tools useful to researchers in a variety of water-related disciplines, and providing simple and cost-effective data publication mechanisms for projects that do not desire to run their own data servers. The WDC's activities will include:

1. Rigorous curation of the water data catalog already assembled during the CUAHSI HIS project, to ensure accuracy of records and existence of declared sources.

2. Data backup and failover services for "at risk" data sources.

3. Creation and support for ubiquitously accessible data discovery and access, web-based search and smartphone applications.

4. Partnerships with researchers to extend the state of the art in water data use.

5. Partnerships with industry to create plug-and-play data publishing from sensors, and to create domain-specific tools.

The WDC will serve as a knowledge resource for researchers of water-related issues, and will interface with other data centers to make their data more accessible to water researchers. The WDC will serve as a vehicle for addressing some of the grand challenges of accessing and using water data, including:

a. Cross-domain data discovery: different scientific domains refer to the same kind of water data using different terminologies, making discovery of data difficult for researchers outside the data provider's domain.

b. Cross-validation of data sources: much water data comes from sources lacking rigorous quality control procedures; such sources can be compared against others with rigorous quality control. The WDC enables this by making both kinds of sources available in the same search interface.

c. Data provenance: the appropriateness of data for use in a specific model or analysis often depends upon the exact details of how data was gathered and processed. The WDC will aid this by curating standards for metadata that are as descriptive as practical of the collection procedures. "Plug and play" sensor interfaces will fill in metadata appropriate to each sensor without human intervention.

d. Contextual search: discovering data based upon geological (e.g. aquifer) or geographic (e.g., location in a stream network) features external to metadata.

e. Data-driven search: discovering data that exhibit quality factors that are not described by the metadata. The WDC will partner with researchers desiring contextual and data driven search, and make results available to all.

Many major data providers (e.g. federal agencies) are not mandated to provide access to data other than those they collect. The HIS project assembled data from over 90 different sources, thus demonstrating the promise of this approach. Meeting the grand challenges listed above will greatly enhance scientists' ability to discover, interpret, access, and analyze water data from across domains and sources to test Earth system hypotheses.

Final ID: EP41C-0807

Using airborne lidar and multi-temporal InSAR to explore the role of landslide geometry in controlling their response to seasonal precipitation

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Body: Tectonically active areas with weak, clay-rich lithology and high seasonal precipitation are prone to large, deep-seated, slow-moving landslides. These slope failures often exhibit seasonal velocity fluctuations driven by precipitation, which acts to increase pore-water pressure and decrease effective stress along basal shear zones. Pore-water pressure changes in landslides are often represented as a diffusive process that occurs over the time scale $T_D = Z^2 / D_0$, where Z is landslide depth and D_0 is characteristic hydraulic diffusivity. This time scale serves as a first-order approximation of time between the onset of precipitation and landslide acceleration (i.e. landslide response time). Using this framework for modeling hydrologically driven changes in pore-water pressure suggests that the length of time required for landslides to respond to rainfall should strongly depend on landslide size, and specifically depth, where shallow landslides will respond before deep landslides. However, no studies have systematically assessed the link between landslide depth and response times because the observations required to test this have been limited to individual slides in isolated geographic regions.

Here we use satellite radar interferometry (InSAR) time series, precipitation data, and high-resolution topographic data from airborne lidar to quantify the seasonal dynamics and geometry of 10 slow-moving landslides of varying size in the Eel River catchment, northern California. We processed 23 ALOS SAR scenes using the Repeat Orbit Interferometry Package (ROI PAC), and inverted 53 small-baseline (< 1200 m) interferograms to calculate a smooth line-of-sight time series at each pixel. Landslides were identified by stacking interferograms, and using high resolution DEMs and with previously published landslide inventories. These slides share the same lithologic, tectonic, and climatic conditions, thereby allowing us to isolate and explore the relationship between landslide depth and response time. The landslides have areas ranging from 0.16 to 3.1 km^2 and minimum depths that range from 8 to 40 m. Between February 2007 and January 2011 each slide exhibits well-defined seasonal velocity changes with a periodicity of ~1 year and average downslope velocities ranging from 0.2 to 1.2 m/yr. However, despite significant variations in landslide size and depth our data show no clear relationship between seasonal precipitation and response time (80 +/- 35 days). The infiltration of precipitation through preferential flow paths, such as deformation cracks common on active landslides, is a likely mechanism that can explain our results. Our findings challenge and potentially contradict assumptions made in many landslide models and motivate a reevaluation of mechanical-hydrologic mechanisms that control landslide dynamics.

Final ID: EP41E-0841

Utilizing Ground-based LiDAR (Terrestrial Laser Scanning) to estimate hydraulic roughness in gravel-bed rivers

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Body: Roughness is one of the more difficult parameters to quantify in the field for hydraulic studies, partially because it occurs at a variety of scales (i.e. grain, unit and reach), and because individual roughness elements, such as trees, grass and sediment grains, are difficult to measure. Ground-based LiDAR (also known as Terrestrial Laser Scanning) is changing the collection of high-quality topographic datasets for a variety of scientific endeavors, including forestry, geomorphology and hydrology and can be used to quantify hydraulic roughness in the field. Using datasets collected from several rivers in California, we evaluate the use of ground-based LiDAR (also known as Terrestrial Laser Scanning) for estimating hydraulic roughness in gravel-bed rivers. From our initial measurements, in addition to topography, there are a number of useful parameters that can be collected quickly and efficiently with ground-based LiDAR, including some that are not explicitly considered by existing hydraulic equations.

Final ID: EP41E-0846

Mapping Quaternary Alluvial Fans in the Southwestern United States based on Multi-Parameter Surface Roughness of LiDAR Topographic Data

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Body: Quaternary alluvial fans, common landforms in hyper- to semi-arid regions, have diverse surface morphology, desert varnish accumulation, clasts rubification, desert pavement formation, soil development, and soil stratigraphy. Their age and surface topographic expression vary greatly within a single fan between adjacent fans. Numerous studies have demonstrated that the surface expression and morphometry of alluvial fans can be used as an indicator of their relative age of deposition, but only recently has there been an effort to utilize high resolution topographic data to differentiate alluvial fans with automated and quantifiable routines

We developed a quantitative model for mapping the relative age of alluvial fan surfaces based on a multi-parameter surface roughness computed from 1-meter resolution LiDAR topographic data. Roughness is defined as a function of scale of observation and the integration of slope, curvature (tangential), and aspect topographic parameters. Alluvial fan roughness values were computed across multiple observation scales (3m×3m to 150m×150m moving observation windows) based on the standard deviation (STD) of slope, curvature, and aspect. Plots of roughness value versus size of observation scale suggest that the STD of each of the three topographic parameters at 7m×7m observation window best identified the signature of surface roughness elements. Roughness maps derived from the slope, curvature, and aspect at this scale were integrated using fuzzy logic operators (fuzzy OR and fuzzy gamma). The integrated roughness map was then classified into five relative morpho-stratigraphic surface age categories (active wash to ~400 ka) and statistically compared with a similar five–fold surface age map of alluvial fans developed using traditional field surveys and aerial photo interpretation. The model correctly predicted the distribution and relative surface age of ~61% of the observed alluvial fan map. The results of the multi-parameter model imply that the first order roughness elements of alluvial fan surfaces have the average wavelength of 7m, and the roughness contributed by these elements decreases with the age of alluvial fans.

Final ID: EP41I-04

Fracture Patterns within the Shale Hills Critical Zone Observatory ***(Invited)***

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Body: Rock fractures are known to exist within the deep Critical Zone and are expected to influence groundwater flow, but there are limited data on their orientation and spatial arrangement and no general framework for systematically predicting their effects. Here, we explore fracture patterns within the Susquehanna-Shale Hills Critical Zone Observatory, and consider how they may be influenced by weathering, rock structure, and stress via field observations of variable fracture orientation within the site, with implications for the spatial variability of structural control on hydrologic processes. Based on field observations from 16-m deep boreholes and surface outcrop, we suggest that the appropriate structural model for the watershed is steeply dipping strata with meter- to decimeter-scale folds superimposed, including a superimposed fold at the mouth of the watershed that creates a short fold limb with gently dipping strata. These settings would produce an anisotropy in the hydraulic conductivity and perhaps also flow, especially within the context of the imposed stress field. Recently conducted 2-D numerical stress modeling indicates that the proxy for shear fracture declines more rapidly with depth beneath valleys than beneath ridgelines, which may produce or enhance the spatial variability in permeability. Even if topographic stresses do not cause new fractures, they could activate and cause displacement on old fractures, making the rocks easier to erode and increasing the permeability, and potentially driving a positive feedback that enhances the growth of valley relief. Calculated stress fields are consistent with field observations, which show a rapid decline in fracture abundance with increasing depth below the valley floor, and predict a more gradual trend beneath ridgetops, leading to a more consistent (and lower) hydraulic conductivity with depth on the ridgetops when compared to the valley, where values are higher but more variable with depth. Hydraulic conductivity is a fundamental property controlling the zone of active flow within the watershed.

Final ID: EP41I-08

The Influence of the Deep Critical Zone under Hillslopes on Hydrologic, Geomorphic, and Ecological Processes *(Invited)*

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Body: In actively uplifting terrain, channels cut through bedrock, hillslopes emerge and steepen, and a soil mantle drapes across the bedrock if erosion rates are not too high. Beneath the soil down to fresh bedrock extends the invisible part of the critical zone where stresses associated with emergence towards the surface and drainage of the bedrock leads to joint opening, fracture development and the generation of a hydrologically dynamic zone that stores and transmits water. Chemical erosion may further increase the saturated conductivity of this zone. Studies from many regions increasingly point to a prominent role of flow in this deeper part of the critical zone in surface processes. Here we describe observations from three intensive field campaigns (two past and one current) conducted over a 25 year period that explore how this deep part of the critical zone works hydrologically and connects to surface processes. All three sites are developed in turbidite sequences with varying mixtures of sandstone and mudstone, and consist of hillslopes draining to unchanneled valleys. Rates of uplift and erosion are sufficient that chemical weathering plays a secondary role to the breakdown of the rock. In the lowest gradient site in the grasslands just north of San Francisco, saturated conductivity decreased with depth in the critical zone, but was locally highly variable. Areas of lower saturated conductivity caused local exfiltration of water back to the surface and pore pressures well above hydrostatic. Saturation overland flow, channel initiation and possibly landslide initiation are associated with these exfiltration gradients. At our steepest site in the Oregon Coast Range, an upslope thickening critical zone lies underneath the 43 degree slope. All of the rainfall enters the fractured, weathered bedrock, but local exfiltration during intense rain can lead to shallow landsliding, especially after forest clear-cut removal (as happened at our site). In response to storm events, local pore pressures in the fractured bedrock differ greatly across the landscape. Our current research site in Northern California is developed primarily on argillite under a mixed canopy of mature evergreen forest. The critical zone systematically thickens toward the divide, and despite erosion rates of 0.2 to 0.4 mm/yr, the depth to fresh bedrock at the hilltop exceeds 20 m. No overland flow or lateral flow through the soil occurs; instead all runoff is from groundwater perched on the very low permeability fresh bedrock at the base on the critical zone. Twelve wells record the spatial pattern of this perched water table, and reveal widely varying response to storm inputs. The groundwater runoff sustains ecologically significant low flow during the nearly 6 months of no precipitation in adjacent creeks. The forest, despite being within meters of the perched groundwater, does not rely as the primary source of water, even at the end of summer. Instead, rock moisture in the unsaturated part of the critical zone is exploited by trees. Rare storms may cause the perched water table to reach the soil and destabilize it, while the transition from weathered to fresh bedrock at the base of the critical zone may eventually define the plane of failure for deep-seated earthflows which are common in the area.

Final ID: A42F-06

Simultaneous data assimilation of CO_2 and meteorological variables within LETKF coupled with NCAR CAM model

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Body: We have succeeded in estimating surface CO_2 fluxes at the model grid-scale resolution by assimilating meteorological variables and CO_2 simultaneously every 6 hours with the Local Ensemble Transform Kalman Filter (LETKF). This was done as an observing system simulation experiment (OSSE) using a simplified AGCM (Kang et al. 2011, 2012). Based on our very encouraging results, we implemented our advanced data assimilation system on the NCAR CAM model coupled with the LETKF . We analyze not only the assimilated meteorological variables and atmospheric CO_2 but also surface CO_2 fluxes estimated by the state vector augmentation method. The simultaneous ensemble Kalman filter data assimilation allows us to consider the transport error on atmospheric CO_2 forecast because it provides time-evolving error covariance between wind and atmospheric CO_2 fields at every analysis step. Other advanced methods developed by Kang et al., 2011, 2012 in the simpler OSSE system are now implemented and tested in the CAM-LETKF system with simulated observations. The results will be presented and will guide our forthcoming assimilation of real observations.

Final ID: A42F-07

Simultaneous assimilation of AIRS and GOSAT CO2 observations with Ensemble Kalman filter

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Body: Lack of CO_2 vertical information could lead to bias in the surface CO_2 flux estimation (Stephens et al., 2007). Liu et al. (2012) showed that assimilating AIRS CO_2 observations, which are sensitive to middle to upper troposphere CO_2, improves CO_2 concentration, especially in the middle to upper troposphere. GOSAT is sensitive to CO_2 over the whole column, but the spatial coverage is sparser than AIRS. In this study, we assimilate AIRS and GOSAT CO_2 observations simultaneously along with surface flask CO_2 observations and meteorology observations with Ensemble Kalman filter (EnKF) to constrain CO_2 vertical profiles simulated by NCAR carbon-climate model. We will show the impact of assimilating AIRS and GOSAT CO_2 on the CO_2 vertical gradient, seasonal cycle and spatial gradient by assimilating only GOSAT or AIRS and comparing to the control experiment. The quality of CO_2 analysis will be examined by validating against independent CO_2 aircraft observations, and analyzing the relationship between CO_2 analysis fields and major circulation, such as Madden Julian Oscillation. We will also discuss the deficiencies of the observation network in understanding the carbon cycle.

Final ID: H42D-07

Dynamic Landscape Connectivity, Threshold Behavior, and Scaling Frameworks for Hydrologic and Bio-geochemical Fluxes *(Invited)*

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Body: The hydrologic connectivity of landscapes (the surface fluvial and non-fluvial flowpaths and the flowpaths in the sub-surface) is temporally and spatially changing as dictated by landscape features and precipitation. Developing simple conceptual frameworks for quantifying the response of a basin (hydrologic, sedimentologic, and bio-geochemical) based on theories of network dynamics is still an open problem with slow progress. In this talk two issues will be addressed: (1) scaling of peak flows in response to space-time variable rainfall of duration smaller than the time of concentration of the basin, and (2) predictive modeling and scaling of bio-geochemical fluxes using a spatially explicit model of light and nutrient availability, streamflow, and temperature on the connected network. Data from the Walnut Gulch watershed and the Eel river at Angelo Coast Range Reserve are used for model development and testing.

Final ID:

New Lidar Technologies and Vision for the Future

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Description: NCALM, OpenTopography, and UNAVCO, have advanced technology and community access to high-resolution Earth-surface observations with lidar. Goals of this town hall:

1) To present new technologies and data search tools

2) To gather the community's opinion on where future efforts should be directed

3) To disseminate information about how to obtain lidar.

Community feedback will be communicated to NSF through participating program officers.

Final ID: B43D-0426

Carbon Emissions from Residue Burn Piles Estimated Using LiDAR or Ground Based Measurements of Pile Volumes in a Coastal Douglas-Fir Forest.

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Body: Following forest harvest, residues left on site and roadsides are often disposed of to reduce fire risk and free planting space. In coastal British Columbia burn piles are the main method of disposal, particularly for accumulations from log processing. Quantification of residue wood in piles is required for: smoke emission estimates, C budget calculations, billable waste assessment, harvest efficiency monitoring, and determination of bioenergy potentials. A second-growth Douglas-fir dominated (DF1949) site on eastern Vancouver Island and subject of C flux and budget studies since 1998, was clearcut in winter 2011, residues piled in spring and burned in fall. Prior to harvest, the site was divided into 4 blocks to account for harvest plans and ecosite conditions. Total harvested wood volume was scaled for each block. Residue pile wood volume was determined by a standard Waste and Residue Survey (WRS) using field estimates of pile base area and plot density (wood volume / 0.005 ha plot) on 2 piles per block, by a smoke emissions geometric method with pile volumes estimated as ellipsoidal paraboloids and packing ratios (wood volume / pile volume) for 2 piles per block, as well as by five other GIS methods using pile volumes and areas from LiDAR and orthophotography flown August 2011, a LiDAR derived digital elevation model (DEM) from 2008, and total scaled wood volumes of 8 sample piles disassembled November 2011. A weak but significant negative relationship was found between pile packing ratio and pile volume. Block level avoidable+unavoidable residue pile wood volumes from the WRS method (20.0 m^3 ha^{-1} SE 2.8) were 30%-50% of the geometric (69.0 m^3 ha^{-1} SE 18.0) or five GIS/LiDAR (48.0 to 65.7 m^3 ha^{-1}) methods. Block volumes using the 2008 LiDAR DEM (unshifted 48.0 m^3 ha^{-1} SE 3.9, shifted 53.6 m^3 ha^{-1} SE 4.2) to account for pre-existing humps or hollows beneath piles were not different from those using the 2011 LiDAR DEM (50.3 m^3 ha^{-1} SE 4.0). The block volume ratio (total residue pile / harvest scale, wood volumes x 100) for the WRS method (3.3% SE 0.45) was lower than for LiDAR 2011 method (8.1% SE 0.31). Using wood densities from *in situ* samples and LiDAR 2011 method wood volumes, total residue pile wood biomass in the blocks was 21.5 t dry mass ha^{-1} (SE 1.9). Post-burn charred residues were ~1.5 t dry mass ha^{-1} resulting in C emission estimates of 10 t C ha^{-1} (SE 0.91), assuming 50% C, and equivalent to 2 - 3 years of pre-harvest stand C uptake (NEP 4.8 t C ha^{-1} y^{-1} SE 0.58). Results suggest the WRS method may underestimate residue pile wood volumes, while the geometric method may overestimate depending on packing ratio used. While remote sensing methods reduce uncertainty in estimating volumes or areas of all piles in a block, quantification of packing ratios remains a significant source of uncertainty in determining block level residue pile wood volumes. Additional studies are needed for other forest and harvest types to determine the wider applicability of these findings.

Final ID: B43D-0438

Detection of Biomass Change Using Lidar Modelled Canopy Heights

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Body: Recent studies demonstrate that airborne lidar remote sensing is a powerful technology for quantification of tropical forest biomass. We employed small footprint airborne lidar data from two sampling periods (2008 and 2012) to study forest structure in the Ducke Reserve north of Manaus, Brazil and in the Tapajos National Forest south of Santarem, Brazil. As a first step toward measurement of biomass change, we compared ground-based measurements of biomass change using forest inventory based entirely on ground measurements and forest inventory supplemented by lidar heights. Height is a significant factor for forest biomass calculations at both the local and regional scales (Araujo, et al. 1999, Chave, et al. 2004); But the error of field measured heights leads to variability in biomass that is larger than expected changes in biomass over short time scales. The use of lidar canopy model height in biomass calculations should reduce error considerably as compared to field measured heights because estimates of error for field measured heights in the humid tropics are as large as 5 m for trees greater than 30 cm diameter, whereas lidar has sub-meter accuracy. Application of lidar height estimates for dominant and emergent canopies significantly improves expected canopy height error, and therefore biomass estimates. Comparisons of surveys from two periods suggests that errors in tree height measurement can overwhelm attempts to measure biomass change using ground data alone. We explore the implications of these forest inventories for the detection of biomass change based primarily on lidar height measurements.

Final ID: B43D-0440

Lidar Estimation of Aboveground Biomass in a Tropical Coastal Forest of Gabon

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Body: Estimation of tropical forest carbon stocks is a critical yet challenging problem from both ground surveys and remote sensing measurements. However, with its increasing importance in global climate mitigation and carbon cycle assessment, there is a need to develop new techniques to measure forest carbon stocks at landscape scales. Progresses have been made in terms of above ground biomass (AGB) monitoring techniques using ground measurements, with the development of tree allometry techniques. Besides, studies have shown that new remote sensing technologies such as Lidar can give accurate information on tree height and forest structure at a landscape level and can be very useful to estimate AGB. This study examines the ability of small footprint Lidar to estimate above ground biomass in Mondah forest, Gabon.
Mondah forest is a coastal tropical forest that is partially flooded and includes areas of mangrove. Its mean annual temperature is 18.8C and mean annual precipitation is 2631mm/yr. Its proximity to the capital of Gabon, Libreville, makes it particularly subject to environmental pressure.
The analysis is based on small footprint Lidar waveform information and relative height (RH) metrics that correspond to the percentiles of energy of the signal (25%, 50%, 75% and 100%). AGB estimation is calibrated with ground measurements. Ground-estimated AGB is calculated using allometric equations based on tree diameter, wood density and tree height. Lidar-derived AGB is calculated using a linear regression model between the four Lidar RH metrics and ground-estimated AGB and using available models developed in other tropical regions that use one height metric, average wood density, and tree stocking number. We present uncertainty of different approaches and discuss the universality of lidar biomass estimation models in tropical forests.

Final ID: EP43E-03

A bottom-up approach to determining the vertical extent of the weathered bedrock zone under ridge and valley topography

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Body: Underlying landscapes composed of ridge and valley topography lies a three dimensional surface below which the bedrock is unweathered. This zone between the ground surface and the fresh bedrock boundary is unmapped and poorly known yet strongly influences geomorphic, hydrologic, geochemical, ecological and atmospheric processes. Current models for development of this zone emphasize top-down processes associated with infiltrating waters and gases. We propose, as a means to estimate the thickness of this zone across a landscape, a bottom-up model that assumes weathering essentially ceases below the groundwater table. In this model, hillslope erosion and drainage of fresh bedrock (inducing weathering) are both driven by channel incision. The difference between the surface topography and the sloping groundwater table thus defines the weathered zone. We present a one-dimensional, steady state analytical model that couples a surface erosion model and groundwater flow model. The model predicts an increasing depth to the weathering front and an increasing residence time of particles in the weathered zone from channel to hillslope divide. The maximum depth to fresh bedrock (which occurs under the hilltop) decreases with decreasing saturated conductivity of the bedrock, slower channel incision rates, slower soil transport diffusivities, and shorter hillslopes. Lithology of the fresh bedrock therefore influences the thickness of the weathered zone through the saturated hydraulic conductivity of the bedrock. Measurements of rate processes and topography, as well as depth to fresh bedrock at the divide can be used to estimate the saturated hydraulic conductivity and porosity of the fresh bedrock. Despite its simplicity, the model makes testable predictions. The model also forms a conceptual framework in which top-down and bottom up processes could be coupled. Drilling and geophysical observations from ongoing work at an experimental hillslope named Rivendell in Northern California will be presented and reveal a deep (up to 20 m) weathered zone that is consistent with model predictions.

Final ID: EP43D-07

Building the coastline: Linking study of the modern and ancient depositional environments to predict the response of Mississippi River delta to environmental change

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Body: We combine data from the modern Mississippi River delta with industry-grade subsurface data from Breton Sound and Barataria Bay to define the Late Miocene to Recent behavior of this constructional coastline. Data from a seismic volume covering over 1000 square km of the delta and multiple subsurface wells are joined with measurements from the modern Mississippi system to highlight three properties of the coastal system that are particularly relevant to predicting maintenance of the delta surface: (1) the long-term composition of Mississippi River delta (i.e., the fraction of deposited sand versus mud); (2) variation in measured subsidence rate as a function of the time window; and (3) sedimentation patterns connected to channels and overbank surfaces. Examination of 10 km of well logs in latest Pliocene to latest Miocene deposits reveals that roughly 50 percent of the delta is composed of sand, a value similar to the reported composition of modern sub-deltas within the system. This sand fraction building the delta is roughly double the fraction of sand versus mud transported down the Mississippi River on an annual basis, indicating that sand not total sediment load controls aggradation of the dynamic delta top. We will discuss the shortcoming in using measured reductions in total suspended-sediment load for the Mississippi River system to estimate change in delta surface area under the condition of relative sea-level rise. The primary component of this relative sea-level rise is land-surface subsidence. Using the seismic data and well control we have quantified the dependence of measured subsidence rate on duration of the observation interval. In our study area the measured rates of local subsidence range from roughly 0.01 mm/yr to 100 mm/yr as the measurement window varies from 100,000 to 1 year. This wide range in rates highlights the challenge associated with tying land loss to overall subsidence. The highest rates of measured subsidence in the field area are connected to recent slip on growth faults that have been active for greater than 20 million years. Using geophysical data we identify the degree to which spatial variations in basin subsidence by growth faulting has affected the positioning of river channels and their deposits on the delta since the Late Miocene.

Final ID: A44C-03

Space Based Observations of Amazon Carbon Cycle

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Body: Recent evidence indicates a decrease in photosynthetic activity in Amazon forests during large-scale drought. However, changes in basin-wide carbon balance, and hence net biological exchange of carbon with the atmosphere, is still highly uncertain as measurements of carbon cycle species beyond local or ecosystem scale are sparse. Here we use new satellite measurements of solar-induced chlorophyll fluorescence and XCO2 from GOSAT to examine relationships between terrestrial GPP and XCO2 during the 2010 Amazon drought. We compare XCO2 from multiple retrieval products, including ACOS b2.9 and b2.10, NIES, and RemoTeC. Despite some sensitivity to retrieval algorithm and post processing filters, we observe a net increase in XCO2 from July 2009 to December 2010 across all products, most notably a spike exceeding 4 ppm in the central Amazon following drought onset. We furthermore observe a basin-wide decrease in GPP of 1.1 +/- 0.36 PgC based on concomitant measurement of fluorescence, consistent with ecosystem models. This inverse relationship of rising XCO2 and decreasing GPP in seasonally wet forests of the central Amazon suggests that local imbalance of terrestrial carbon exchange during periods of extreme drought causes detectable increases in CO2. Despite these findings, further work is needed to understand the impact of retrieval algorithms and screening criteria on variations of XCO2 in tropical forests.

Final ID: A44C-05

Profiling Tropospheric CO2 using the Aura TES and TCCON instruments

L. Kuai; [1]; *J. Worden;* [1]; *S. S. Kulawik;* [1]; *K. W. Bowman;* [1]; *S. C. Biraud;* [2]; *J. B. Abshire;* [3]; *S. C. Wofsy;* [4]; *V. Natraj;* [1]; *C. Frankenberg;* [1]; *D. Wunch;* [5]; *B. J. Connor;* [6]; *C. E. Miller;* [1]; *C. M. Roehl;* [5]; *R. Shia;* [5]; *Y. L. Yung;* [5]
;

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Body: Characterizing the global carbon budget requires mapping the global distribution and variability of CO2 sources and sinks. Measurements of the total column of CO2 by ground or by satellite have the potential to estimate global sources and sinks (Rayner and O'Brien, GRL, 2001, Olsen and Randerson, JGR, 2004) but are less sensitive to regional scale and local sources and sinks because CO2 is a long-lived gas which makes it challenging to disentangle local sources from CO2 transported into the observed air parcel (Keppel-Aleks et al., BGD, 2011). We explore the use of total column measurements with estimates of the free tropospheric CO2 by TES to distinguish boundary layer CO2 and free tropospheric CO2 because quantify the vertical gradient between the free troposphere and boundary layer is critical for estimating CO2 fluxes (Stephens, Science, 2007) and near surface CO2 should be more sensitive to local fluxes than the total column CO2. In this study, CO2 profiles are estimated from the Total Carbon Column Observing Network (TCCON) measurements and integrated into a column-averaged concentration. These column averages agree with aircraft data within 0.67 ppm, consistent with the uncertainties due to measurement noise and temperature. There is a bias of about -5 ppm, consistent with Wunch et al. (Atmos. Meas. Tech. 2010). Free troposphere estimates of CO2 are obtained from the GEOS-Chem model that has assimilated CO2 measurements from Aura Tropospheric Emission Spectrometer. The boundary layer CO2 estimates are calculated by subtracting TES free tropospheric CO2 from TCCON column CO2. This estimate of boundary layer CO2 agrees well with aircraft data with RMS of 1.44 ppm for about the fifty PBL CO2 estimates. This work shows that total column from NIR measurements (GOSAT, TCCON and OCO-2) and free troposphere measurement from TIR (e.g. TES and AIRS) can be used to profile CO2 and obtain PBL CO2 with precision necessary to capture the atmospheric CO2 variability. It also shows potential of joint retrieval of NIR and TIR. With a long-term boundary layer CO2 record, the CO2 surface flux can be better quantified.

Final ID: A44C-07

Decadal Record of Satellite Carbon Monoxide Observations *(Invited)*

H. M. Worden; [1]; *M. N. Deeter;* [1]; *C. Frankenberg;* [2]; *M. George;* [3]; *F. Nichitiu;* [4]; *J. Worden;* [2]; *I. Aben;* [5]; *K. W. Bowman;* [2]; *C. Clerbaux;* [3]; *P. Coheur;* [6]; *J. de Laat;* [9, 5]; *R. Detweiler;* [1]; *J. R. Drummond;* [7]; *D. P. Edwards;* [1]; *J. C. Gille;* [1]; *D. Hurtmans;* [6]; *M. Luo;* [2]; *S. Martinez-Alonso;* [1]; *S. T. Massie;* [1]; *G. Pfister;* [1]; *J. X. Warner;* [8];

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Body: Atmospheric carbon monoxide (CO) distributions are controlled by anthropogenic emissions, biomass burning, transport and oxidation by reaction with the hydroxyl radical (OH). Quantifying trends in CO is therefore important for understanding changes related to all of these contributions. Here we present a comprehensive record of satellite observations from 2000 through 2011 of total column CO using the available measurements from nadir-viewing thermal infrared instruments: MOPITT, AIRS, TES and IASI. We examine trends for CO in the Northern and Southern hemispheres along with regional trends for E. China, E. USA, Europe and India. Measurement and sampling methods for each of the instruments are discussed. We find that all the satellite observations are consistent with a modest decreasing trend ~ -1%/year in total column CO over the Northern hemisphere for this time period. Although decreasing trends in the United States and Europe have been observed from surface CO measurements, we also find a decrease in CO over E. China. Some of the interannual variability in the observations can be explained by global fire emissions, but the overall decrease needs further study to understand the implications for changes in anthropogenic emissions.

Final ID: EP51C-1000

An enlarging landslide scar and evolution of the surrounding forested hillslope: Results from a dendrogeomorphic and multi-temporal LiDAR DTM survey

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Body: Landslide sediment hazard assessments performed in Taiwan commonly rely on the area of landslide scars clearly visible in aerial photos or satellite images to gauge sediment hazard. Although studies in Taiwan have shown that erosion rates associated with an exposed landslide scar can be more than two times as high as pre-landslide levels, it has also been shown that a significant amount of sediment is derived from further retrogressive enlargement of the scar. Hillslope surface features such as tension cracks and secondary scarps located outside of the scar may be indicative of future landslide activity, however, because temporal relationships between those features and the landslide scar are unknown, confidence in future scar enlargement area estimates can be limited. The goal of this study is to investigate how a hillslope both spatially and temporally evolves around an enlarging landslide scar and how that evolution may have been related to the final area of the scar.

The hillslope is the north face of a low elevation(800m to 1200m) spur located in the northern Xueshan mountains of Taiwan. Prior to formation of the landslide scar, the hillslope was defined by a forested, nearly planar surface incised by several shallow, parallel draining hollows. During a period of strong typhoons between 1997 and 2008, the landslide scar initiated at the foot of the slope and intermittently enlarged along one of the hollows until reaching the ridgeline. Presently, numerous tension cracks, debris flow channels and smaller landslide scarps cut across the hillslope on all sides of the scar.

Evolution of the scar is reconstructed using aerial photo and satellite images. The location of landslide features hidden by the forest outside of the scar are surveyed in the field and an attempt is made to identify the timing of sub-canopy movement using a dendrogeomorphic survey on primarily alder and all available conifer trees. Multiple AirLIDAR DTM data sets, recorded throughout the later half of landslide scar development, are used to analyze changes in hillslope topography. Inferences regarding rainfall characteristics and hillslope scale landslide processes that include both the visible scar and landslide features obscured by the forest are presented and implications for landslide sediment hazard assessments discussed.

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Tectonic controls on gravitational deformation in the Mino Mountains, central Japan: a regional sagging-feature mapping in forested mountains using high-resolution airborne LiDAR

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Body: Many linear geomorphic features of gravitational origin, known as sagging or sackung, are recognized on and around high mountain ridges worldwide. A complete scanning and mapping of those sagging features in a given region, however, has ever been difficult because classic aerial-photograph examination does not allow detection of small geomorphic features under forest canopies. We here present the first complete distribution map of sagging features in a wide area using high-resolution airborne LiDAR and the elaborate DEM visualization that facilitates mapping and interpretation of small geomorphic features of various morphology and orientations. The target area is the western Mino Mountains, central Japan, where the ~40-km-wide and ~50-km-long area is characterized by relatively monotonous, moderate- to high-relief mountains of 1000-1600 m high and uneven active-fault distribution. The recently acquired 1-m-resolution LiDAR data of the Etsumi Sankei Sabo (Erosion Control) Office cover the entire western Mino Mountains, providing the rare opportunity to examine various controls on large-scale gravitational deformation and mass-wasting in a humid temperate tectonically active region. We produced stereo-paired Red Relief Image Maps to visualize DEMs and carefully mapped sagging features as well as tectonic-geomorphic features. Based on the tentative distribution map, sagging features are generally associated with higher-altitude terrains, indicating that high potential energy is one important factor for the formation of sagging features. The sagging features also appear to be concentrated around active faults, in particular around fault tips and in fault step-over areas, which may suggest strong tectonic controls on gravitational deformation. In contrast, lithology does not seem to be a major factor to control gravitational deformation in the studied area.

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Assessment of Recently Unchanged Forested Areas in the United States Using Landsat-WELD and LIDAR Data

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Body: According to the USDA Forest Service Forest Inventory Analysis Program (2006) the amount of forestland in the United States has remained relatively constant in the past century and is estimated at an average of 755 million acres. However, forested areas are the subject of various land use activities, leading to disturbances altering forest ecology and biodiversity. Therefore the objective of the current research is to assess the extent of recently unchanged and relatively unfragmented (forest patch area >100 km2) forest areas in different WWF-defined terrestrial ecoregions of the contiguous US. Landsat-based WELD tree cover product for the year 2006 and tree cover loss product for 2006-2010 were used as input data for GIS-analysis aimed to identify recently unchanged core forest areas. More than 1.2 million ICESat-GLAS shots facilitated distinguishing between core and recently disturbed forests' vertical structure. Analysis of core forest areas distribution by ecoregion showed that in several ecoregions, such as Piney Woods, Southeastern Mixed forests and Southeastern Conifer forests, due to the high forest use intensity unfragmented recently unchanged forests occupy less than 30% of ecoregion forest area, though total forested area in these regions remains high. We've also analyzed the protection status of core forest areas in terms of potential forest disturbances in the years to come.

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Simulated and Observed Trends in Daily Solar Radiation Coefficients of Variation

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Body: This study investigates the possibility of historical and future changes in daily scale surface solar radiation variability. Coefficients of variation (CVs) were computed for the daily downward surface solar radiation from (i) the International Satellite Cloud Climatology Project (ISCCP), and (ii) 15 GCMs that have contributed to the Coupled Model Intercomparison Project 5 (CMIP5). Regression analysis was used to identify trends in CVs. Analysis of the ISCCP observations indicated that there have been statistically significant changes in solar radiation variability for 35% of the globe since 1984. Particularly large increases were found for tropical Africa, the Maritime Continent, and parts of Eurasia. Similar trends were detected in multi-model ensembles of "AMIP" and "historical" CMIP5 simulations. Preliminary analysis indicates that these trends are enhanced in CMIP5 simulations of future climate. Such changes in daily climate variability will have consequences for any process depending nonlinearly on climate, including solar energy production, agriculture, and natural terrestrial ecosystems.

Final ID: H51B-1344

Factors impacting manganese transport from soils into rivers using data from Shale Hills CZO

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Body: Many soils are enriched in trace elements due to atmospheric inputs from industrial sources but little is known about how long these contaminants persist in soils or the rates at which they are transferred into rivers. Modeling the movement of contaminants through the environment is complicated by the heterogeneity of soils and the variability of contaminant mobility across spatial scales. In this study, we use soil, water, and vegetation chemistry to compare rates of Mn contaminant mobilization and removal from soils at ridge, hillslope, and catchment-scales in the Susquehanna Shale Hills Critical Zone Observatory (SSHCZO). The SSHCZO is a first-order, forested watershed located within the Susquehanna River Basin (SRB) in Pennsylvania, U.S.A. Studies from the SSHCZO are compared to trends in long-term water quality measurements for the Susquehanna River to evaluate terrestrial inputs to the river system.

At SSHCZO, we find that Mn is being removed ~7x more quickly from soils in swales than soils on convex-upward hillslopes; thus, swales are a large source of dissolved Mn to the stream. Release rates of Mn from all soils are dwarfed by rates of uptake into vegetation, consistent with the hypothesis that trees temporarily slow the removal of atmospherically-deposited Mn from the soil by accumulating Mn in plant biomass. However, elevated levels of dissolved organic carbon in soil pore waters may enhance Mn release in the swales; therefore, vegetation may first decrease then increase rates of Mn removal from soils over the long-term. Unlike the major rock-derived elements which exhibit chemostatic behavior, Mn concentrations in the stream vary widely over a large range of stream discharge rates. High Mn fluxes in the stream occur in short pulses that only weakly respond to precipitation events, suggesting that dissolved Mn loads in rivers are not solely driven by the hydrology but are rather strongly impacted by processes in the soil and stream sediments. Current area-normalized release rates of Mn from soils in the Shale Hills watershed are consistent with rates estimated for the SRB; however, the Susquehanna River experienced a decline in dissolved Mn concentrations from the 1950s to the present. We propose that higher inputs of Mn to the Susquehanna River in the past reflect rapid leaching of Mn contaminants that declined as atmospheric inputs of Mn decreased.

Final ID: H51C-1362

Ecohydrological controls of watershed response to land use change in the montane cloud forest zone in Mexico

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Body: Land use conversion and climate change threaten the hydrological services from tropical montane cloud forest (TMCFs) regions, but knowledge about the ecohydrological mechanisms controlling catchment response is limited. This project traced the hydrologic sources, fluxes and flowpaths across the atmosphere-plant-soil-stream continuum under different land cover types (degraded pasture, regenerating forest, mature forest, pine reforestation) in a seasonally dry TMCF in Veracruz, Mexico. We used hydrological (cloud water interception, CWI; streamflow) and ecophysiological measurements (transpiration, E; foliar uptake, FU) in combination with stable isotope techniques to identify the key ecohydrological processes of each land cover and quantify the hydrological effects of TMCF conversion.

Results revealed that CWI was only ≤2% of total annual rainfall due to low fog occurrence and wind speeds. Fog without rainfall reduced E by a factor of 4-5 relative to sunny conditions and by a factor of 2 relative to overcast conditions, whereas the water 'gained' from the fog suppression effect was ~80-100mm year-1 relative to sunny conditions. At the canopy scale, FU resulted in the recovery of 9% of total E, suggesting a crucial role in alleviating plant water deficit; nevertheless, it was not sufficient to compensate for the 17% water loss from nighttime E.

Trees primarily utilized water from 30-50cm soil depth, while water reaching the stream was derived from deep, 'old' water that was distinct from both 'new' rainwater and water accessed by plants. These findings suggest that plants mainly access a more tightly bound soil water pool that does not actively mix with the more mobile water recharging deep soil and groundwater pools. Soils had high porosity, saturated conductivity, infiltration rates, and water storage capacity, which contributed to the relatively low rainfall-runoff responses, mainly generated from deep subsurface flowpaths.

Results showed that conversion of mature forest to pasture or forest regeneration on former TMCF increased annual water yield by 600mm and 300mm, respectively, while planting pine on degraded pastures reduced water yield by 365mm. Differences in water yield mainly reflect differences in rainfall interception loss. Runoff behavior was similar among land cover types, except for very high intensity storms when pasture showed higher surface runoff.

Our results suggest that the ecophysiological effects of fog via suppressed E and FU has a greater impact on water

yield than direct inputs from CWI in this TMCF. Rapid vertical rainfall percolation and recharge result in a largely groundwater driven system whereby streamflow dynamics is uncoupled from plant water uptake, and water storage capacity and buffering potential are exceptionally high. These factors, combined with the soil properties, resulted in reduced dry season flows due to land use conversion to pasture only being detected towards the end of the dry season. Projected lifting of the cloud base associated with regional climate change combined with declining rainfall may significantly alter ecohydrological functions of these TMCFs.

Final ID: H51H-1453

Numerical modeling of coupled thermal chemical reactive transport: simulation of a heat storage system

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Body: As a carbon-free energy supply technology, the operation time and final energy output of thermal solar power plants can be greatly extended if efficient thermal storage systems are applied. One of the proposed design of such system is to utilize reversible thermochemical reactions and its embedded reaction enthalpy, e.g. the Ca(OH)2/CaO hydration circle, in a fixed-bed gas-solid reactor (Schaube et al. 2011) The modeling of such a storage system involves multiple strongly-coupled physical and chemical processes. Seepage velocity is calculated by the nonlinear Forchheimer law. Gas phase density and viscosity are temperature, pressure and composition dependent. Also, heat transfer between gas and solid phases is largely influenced by the exothermal heat produced by the hydration of calcium oxide. Numerical solution of four governing PDEs include the mass balance, reactive transport, heat balance equations for gas and solid phases, which are implemented into the open source scientific software OpenGeoSys in a monolithic way. Based on it, a 2D numerical model, considering the boundary heat loss of the system, was set up to simulate the energy-storage and release circle. The high performance computing techniques were employed in two stages. First, the dynamic behavior of the heat storage system is simulated on a parallel platform. Second, a large number of processors are employed to perform sensitivity analysis, whereas the reaction rates and efficiency factor of heat transfer are parameterized so that the measured and simulated temperature profile fit with each other. The model showed that heat transfer coefficient between solid and gas phase, grain size of the filling material will influence the final performance greatly. By varying these factors, the calibrated model will be further applied to optimize the design of such energy storage system.

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Distributed Modeling with Parflow using High Resolution LIDAR Data

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Body: Urban landscapes provide a challenging domain for the application of distributed surface-subsurface hydrologic models. Engineered water infrastructure and altered topography influence surface and subsurface flow paths, yet these effects are difficult to quantify. In this work, a parallel, distributed watershed model (ParFlow) is used to simulate urban watersheds using spatial data at the meter and sub-meter scale. An approach using GRASS GIS (Geographic Resources Analysis Support System) is presented that incorporates these data to construct inputs for the ParFlow simulation. LIDAR topography provides the basis for the fully coupled overland flow simulation. Methods to address real discontinuities in the urban land-surface for use with the grid-based kinematic wave approximation used in ParFlow are presented. The spatial distribution of impervious surface is delineated accurately from high-resolution land cover data; hydrogeological properties are specified from literature values. An application is presented for part of the Dead Run subwatershed of the Gwynns Falls in Baltimore County, MD. The domain is approximately 3 square kilometers, and includes a highly impacted urban stream, a major freeway, and heterogeneous urban development represented at a 10-m horizontal resolution and 1-m vertical resolution. This resolution captures urban features such as building footprints and highways at an appropriate scale. The Dead Run domain provides an effective test case for ParFlow application at the fine scale in an urban environment. Preliminary model runs employ a homogeneous subsurface domain with no-flow boundaries. Initial results reflect the highly articulated topography of the road network and the combined influence of surface runoff from impervious surfaces and subsurface flux toward the channel network. Subsequent model runs will include comparisons of the coupled surface-subsurface response of alternative versions of the Dead Run domain with and without impervious surfaces. Following this we will compare the homogeneous domain with a version incorporating the spatial pattern of surficial soil properties and three-dimensional heterogeneity in the subsurface.

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Enabling the Integrated Assessment of Large Marine Ecosystems: Informatics to the Forefront of Science-Based Decision Support

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Body: Integrated assessments of large marine ecosystems require the understanding of interactions between environmental, ecological, and socio-economic factors that affect production and utilization of marine natural resources. Assessing the functioning of complex coupled natural-human systems calls for collaboration between natural and social scientists across disciplinary and national boundaries. We are developing a platform to implement and sustain informatics solutions for these applications, providing interoperability among very diverse and heterogeneous data and information sources, as well as multi-disciplinary organizations and people. We have partnered with NOAA NMFS scientists to facilitate the deployment of an integrated ecosystem approach to management in the Northeast U.S. (NES) and California Current Large Marine Ecosystems (LMEs). Our platform will facilitate the collaboration and knowledge sharing among NMFS natural and social scientists, promoting community participation in integrating data, models, and knowledge. Here, we present collaborative software tools developed to aid the production of the Ecosystem Status Report (ESR) for the NES LME. The ESR addresses the D-P-S portion of the DPSIR (Driver-Pressure-State-Impact-Response) management framework: reporting data, indicators, and information products for climate drivers, physical and human (fisheries) pressures, and ecosystem state (primary and secondary production and higher trophic levels). We are developing our tools in open-source software, with the main tool based on a web application capable of providing the ability to work on multiple data types from a variety of sources, providing an effective way to share the source code used to generate data products and associated metadata as well as track workflow provenance to allow in the reproducibility of a data product. Our platform retrieves data, conducts standard analyses, reports data quality and other standardized metadata, provides iterative and interactive visualization, and enables the download of data plotted in the ESR. Data, indicators, and information products include time series, geographic maps, and uni-variate and multi-variate analyses. Also central to the success of this initiative is the commitment to accommodate and train scientists of multiple disciplines who will learn to interact effectively with this new integrated and interoperable ecosystem assessment capability. Traceability, repeatability, explanation, verification, and validation of data, indicators, and information products are important for cross-disciplinary understanding and sharing with managers, policymakers, and the public. We are also developing an ontology to support the implementation of the DPSIR framework. These new capabilities will serve as the essential foundation for the formal synthesis and quantitative analysis of information on relevant natural and socio-economic factors in relation to specified ecosystem management goals which can be applied in other LMEs.

Final ID: EP51D-03

Dynamics of sediment release from slope failure

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Body: Slope failure generated turbidity currents are an important source-to-sink pathway for the transport of sand and silt into the deep ocean. Accurate interpretation of sedimentary deposits associated with those turbidity currents requires a complete understanding of how sediments are released during slope failure. Sediment release from different slope failure events can be drastically different and we can identify two end members. One is where large amounts of sediments are released rapidly in a short period of time and the other is where sediments are released slowly but steadily over a long period of time. We create slope failure in sand and silt in the lab and present measurements on the pore pressure, velocity of falling sediment, and a numerical model that couples the release of sediments to the pore pressure field in the deposit. We show the release of sediment is closely related to the evolution of pore pressure. We observe both rapid and slow releasing events in the flume experiments. Slow releasing is associated with a larger magnitude of underpressure than rapid releasing. Rapid releasing causes pore pressure to drop, thereby returning the sediment releasing back to the slow mode. In general the velocity of the falling sediment is constant throughout an experiment and the rate of sediment release from the slope failure is proportional to the rate of pore pressure dissipation. The experimental results combined with the numerical model suggests that we can use coefficient of consolidation, shear dilation rate, bulk modulus, and the Skempton's pore pressure parameter for a deposit to estimate the rate of sediment release from a slope failure event.

Final ID: EP51D-06

The dynamics of an experimental gravel bed meander with constant discharge and sediment supply

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Body: As rivers meander, channel migration and cutoffs introduce continuous and episodic changes, respectively, in local boundary shear stress and bedload flux. These changes must affect the local and reach scale channel dynamics, but assessing their influence is limited by complications associated with varying discharge as well as challenging spatial and time scales. Here we explore the dynamics of a scaled-down gravel bed meandering river with constant discharge and sediment supply in a 6.1 m by 17 m long experimental flume at UC Berkeley's Richmond Field Station. The experiments are similar to Braudrick et al. (2009), but with constant rather than varying sediment supply. The flume was filled with a sorted sand with D50 of 0.85 mm, and had an initial 40 cm wide channel with a sinuosity of 1.1. Alfalfa sprouts provided bank and floodplain strength. The alfalfa was seeded by hand throughout the floodplain while a low flow provided irrigation during the 7-day alfalfa growth period. Sand (model gravel) and a lightweight plastic sediment (model sand) were fed independently from the upstream end of the flume at constant rates of 1.8 and 5 kg/hr, respectively. Despite the steady input conditions the experimental channel was quite dynamic as channel migration and bend morphology varied spatially and temporally. The sinuosity in the downstream 10 m of the flume (away from the inlet condition) increased from 1.1 to about 1.6 over the first 75 hours of the experiment, when 3 cutoffs in 29 hours decreased the sinuosity back to just over the initial value. Bank erosion was fastest when curvature was low at the beginning of the experiment and following cutoffs, and slowed once sinuosity increased. Once curvature increased the bends became asymmetric as bank erosion occurred almost exclusively at the bend apex. As the channel migrated, the local sinuosity increased, which decreasing the water surface slope and hence shear stress. The lower shear stress caused subsequent channel migration and also sediment transport to decrease. Consequently, the channel aggraded, forcing water onto the floodplain and further reducing the shear stress in the channel. While the channel was aggrading, most of the sediment flux out the bottom of the flume was the suspended model sand. Cutoffs occurred when the overbank flow was sufficient to alter floodplain strength either by eroding a path around alfalfa, or by limiting alfalfa growth in floodplain areas inundated during the low flow used to irrigate the alfalfa between the runs. Comparing the duration of these experiments to time in the field strongly depends on whether the timescale of interest is set by the flow or by sediment transport. Assuming a scaling factor between 0.01 and 0.02 and that flood flows occur approximately 8 days/year, this 120 hour experiments represent 4-6 years of field time using Froude similarity to scale time from the laboratory to the field, or 220-622 years assuming sediment transport similarity. This experiment showed decreased shear stress due to channel migration limited sediment transport, and that cutoffs were a function of both in-channel and floodplain processes.

Final ID: H52E-01

Modeling of Soil and Tree Water Status Dynamics in a Mixed-Conifer Forest of the Southern Sierra Critical Zone Observatory *(Invited)*

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Body: Trees play a key role in controlling the water and energy balance at the land-air surface. By changing water content of soil and atmosphere, trees influence meteorological, climatological and hydrological cycles. Numerical models allow simulating the relevant hydrological processes; most importantly the movement of water as it is transported through the soil, taken up by roots into the tree and ultimately transpired into the atmosphere along water potential gradients across the soil-root-tree-atmosphere continuum (SPAC). The results of a multi-year deployment of soil moisture sensors to study the hydrologic/biotic interactions in a mixed-conifer forest in the Southern Sierra Critical Zone Observatory (CZO) will be presented. To better understand root-soil water interactions, a mature white fir (Abies concolor) and the surrounding root zone was continuously monitored (sap flow, canopy stem water potential, soil moisture, soil water potential and temperature), to characterize the hydraulics SPAC. In addition, we present a hydrodynamic model, simulating unsaturated flow in the soil and tree with stress functions controlling spatially distributed root uptake and canopy transpiration. To parameterize the in-situ tree water relationships, we combine the numerical model with observational data in an optimization framework, minimizing residuals between modeled and measured observational data.

Final ID: B52C-02

What is clumping? And the role of terrestrial LiDAR in its characterization

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Body: In the current context of climatic changes, there is a pressing need for improved understanding and prediction capabilities of ecosystems response to modified environmental conditions. In efforts to meet this need, biophysical models simulating mass and energy exchange between the surface and the atmosphere have a critical role. These models help us understand the individual components driving the complex land processes, and how, in turn, these processes may be affected under future scenarios for different plant functional types and climatic regions. A significant component of land processes over forested surfaces relates to tree leaf area – the photosynthetic surface area as a community, and the spatial arrangement of individual leaf elements – because the abundance of tree leaves determines the area available to collect the solar energy and atmospheric carbon required for photosynthesis, and their arrangement determines how much of this solar energy the different individual leaves will have access to. The latter is partly a function of leaf aggregation, or clumping; as leaf clumping increases, more leaves will cast shadow on each other and reduce the amount of light available to the leaf community. This sunlit-shaded leaf stratification has been shown to improve the agreement between model outputs and measurements of carbon assimilation from the eddy covariance technique at FLUXNET sites, especially for structurally heterogeneous sites. However, leaf area and clumping are problematic to estimate in the field, mainly because most indirect methods use the Beer-Lambert law to concurrently derive both of them, resulting in a two unknowns and one equation situation. This can be solved by (1) having access to direct measurements of leaf area –which is rare - or (2) using information on gap size – which involves a number of challenges and uncertainty in the results. In this research we propose a third avenue: the use of Terrestrial LiDAR Scanner (TLS) measurements to first infer leaf area at a scale for which clumping can be measured directly (the scale of voxels having 30 cm in side length), followed by radiative transfer simulations providing estimates of clumping for any given ground area or sun angle, thus allowing daily, monthly, and yearly integrals of sunlit fractions of leaf area. Two models are involved in the process: the VoxLAD model computes leaf area density at the voxel scale, and the FLiESvox model is a ray tracing model simulating the light environment from a voxel-based representation of trees. Both models are run on the NERSC High-Performance Computing facilities. We will show results from the approach using measurements taken at the Tonzi savanna FLUXNET site located near Ione, CA, USA. This site's instrumentation includes a 10 meter long tram collecting light transmission data from a PAR sensor running daily between sunrise and sunset at 30 minutes intervals. Radiative transfer simulations of light transmission based on TLS measurements of a 40 x 40 m2 area around the tram will be validated against the PAR sensor observations. Our ability to reproduce the PAR sensor measurements suggests TLS measurements hold great potential for accurately characterizing plot level tree leaf area index and clumping factors in forest environments.

Final ID: H52E-02

Variability of Relative Humidity Reveals and Estimates Land Surface Controls on Evapotranspiration ***(Invited)***

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Body: The ability to predict terrestrial evapotranspiration (ET) is limited by the complexity of rate-limiting pathways as water moves through the soil, vegetation (roots, xylem, stomata), canopy air space, and the atmospheric boundary layer. The practical impossibility of specifying the numerous parameters required to model this process in detail (e.g. soil pores and stomatal response to water and environmental stress) has lead to simplified, physically based models that depend on only a few so-called effective parameters. This effective parameter approach, however, requires site-specific calibration using measured ET, which is only feasible at a few well-instrumented sites. Here we show that the key, rate-limiting, parameter of most ET models, the land-surface resistance to water vapor transport, can be estimated from an emergent relationship between the diurnal cycle of the relative humidity profile and ET. The observed relation is that the vertical variance of the relative humidity profile is less than what would occur for increased or decreased evaporation rates, suggesting that land-atmosphere feedback processes minimize this variance. The relation is found to hold over a wide range of climate conditions (arid to humid) and limiting factors (soil moisture, leaf area, energy). Using this relation, daily estimates of ET can be obtained globally from widely available meteorological measurements, many of which are available as far back as the early 1900s. In conjunction with measured long-term trends in precipitation, stream flow, and pan evaporation, such long-term ET estimates could provide important insights, and empirical constraints, on projected accelerations of the hydrologic cycle by global climate models.

Final ID: H52E-03

Development of a Scaling Algorithm for Remotely Sensed and In-situ Soil Moisture Data across Complex Terrain

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Body: Spatial scaling algorithms have been developed/improved for increasing the availability of remotely sensed (RS) and in-situ soil moisture data for hydrologic applications. Existing approaches have their own drawbacks such as application in complex terrains, complexity of coupling downscaling and upscaling approaches, etc. In this study, we developed joint downscaling and upscaling algorithm for remotely sensed and in-situ soil moisture data. Our newly developed algorithm can downscale RS soil moisture footprints as well as upscale in-situ data simultaneously in complex terrains. This scheme is based on inverse modeling with a genetic algorithm. Normalized digital elevation model (NDEM) and normalized difference vegetation index (NDVI) that represent the heterogeneity of topography and vegetation covers, were used to characterize the variability of land surface. Our approach determined soil hydraulic parameters from RS and in-situ soil moisture at the airborne-/satellite footprint scales. Predicted soil moisture estimates were driven by derived soil hydraulic properties using a hydrological model (Soil-Water-Atmosphere-Plant, SWAP). As model simulated soil moisture predictions were generated for different elevations and NDVI values across complex terrains at a finer-scale (30 m 30 m), downscaled and upscaled soil moisture estimates were obtained. We selected the Little Washita watershed in Oklahoma for validating our proposed methodology at multiple scales. This newly developed joint downscaling and upscaling algorithm performed well across topographically complex regions and improved the availability of RS and in-situ soil moisture at appropriate scales for agriculture and water resources management efficiently.

Final ID: EP52E-04

Tracking landslides and landscape evolution using airborne lidar, InSAR, historical air photos, cosmogenic radionuclides, and numerical models *(Invited)*

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Body: In mountainous landscapes, landslides often dominate sediment budgets and impose a distinct morphologic signature. Although landsliding can be highly variable in space and time, the availability of remote sensing imagery, erosion rates via cosmogenic radionuclides, and airborne lidar has greatly improved our ability to decipher patterns of landslide activity related to tectonics, lithology, and climate. Here, we summarize a suite of studies for landslide-dominated catchments in Northern California that collectively reveal how landslides drive landscape evolution. Using historical air photos and airborne lidar, we mapped active, slow-moving landslides and their transport rates in the mélange- and mudstone-dominated Eel River by tracking the displacement of markers such as trees and shrubs. The landslides exhibit branching forms in upslope areas and tend to coalesce downslope, delivering sediment directly into channel networks. Although active landslides account for only 7% of the landscape surface, their sediment flux amounts to more than 50% of the suspended sediment recorded at downstream sediment gauging stations. These landslides also exhibit multi-year variations that appear to reflect climate trends, such as the Pacific Decadal Oscillation. Using satellite-based interferometry, we show that these landslides vary seasonally, accelerating approximately two months after the onset of rainfall events in the fall. Surprisingly, this seasonal response does not depend on landslide size, challenging existing hydrologic models for landslide triggering.
Catchment-averaged erosion rates derived from cosmogenic radionuclides reveal strong local variations in erosion that appear to correspond with stream channel knickpoints along tributaries to the Eel River. These knickpoints are frequently observed using airborne lidar data while field studies demonstrate that they are comprised of massive collections of interlocking resistant coarse boulders (>10m) that will likely persist in the landscape for long time periods. Active landslides are less frequent upstream of these knickpoints and average slope angles are lower than downstream areas. These observations are consistent with results from a numerical model that incorporates landslide flux driven by a nonlinear rheology. Taken together, our results demonstrate that landslides do not occur randomly, but instead exhibit spatial and temporal patterns related to baselevel lowering, climate patterns with diverse timescales, and lithology. Combined with modeling, these results begin to provide predictive capability for erosion in catchments driven by slow-moving landslides.

Final ID: H52E-04

Connections between transport in events and transport at landscape-structuring timescales ***(Invited)***

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Body: Complex spatial and temporal variability can arise in the critical zone when feedbacks occur at multiple time scales between transported materials and the landscape and soils through which it is transported. This is clearly illustrated where geomorphic transport processes, soil development, and vegetation interact in semi-arid shrublands. Here we use soil and terrain data and a numerical model of overland flow on semi-arid hillslopes to show that microtopography can generate spatial variations in the dominance of transport processes operating at different timescales, with consequences for the direction of resource redistribution between functional units within these ecosystems.

Conceptual and numerical models of the redistribution of mineral, organic and water have mostly been developed on low-gradient alluvial fans and pediments. These have focused on the fluvial transport of resources from the inter-spaces between shrub canopies to the areas below the canopy in those few storm events that generate significant run-off. These processes are believed to produce a mosaic of resource islands in which biota are concentrated.

We investigated the spatial distribution of soil properties (including organic matter and soil hydraulic properties), vegetation, and microtopography on two steeper hillslopes of contrasting lithology (one granite, one schist) in the Sonoran desert foothills of the Catalina Mountains. Three hypotheses were developed through iteration between fieldwork and data analysis. These tested whether there were significant differences in soil composition and hydraulic properties below- and between-canopy, whether the surface soil organic matter was directly associated with above-ground biomass, and whether soil organic matter distributions measured along transects below shrubs showed downslope asymmetries indicative of the processes that create them. Data from these sites were used in a numerical model to investigate how these structures could be related to the population of runoff events and processes that generate them.

The results suggest that over the long term, slope-dependent transport processes (such as rainsplash, bioturbation and trampling) seem to play an important role in these steeper hillslopes in inverting the flow of resources. Over many storm and inter-storm periods, soil organic matter is transported downslope in plumes extending at least two canopy radii downslope from below woody-shrub canopies into the inter-space. This pattern was particularly evident where microtopography and soil properties create micro-sites protected from fluvial transport.

While many of the patterns observed are similar to those from more stable geomorphic surfaces, the results suggest that long-term downslope transport processes in sloping terrain can disrupt the autogenic processes that reinforce the redistribution of resources under shrubs. This result has important implications for our understanding of the relationship between ecosystem function and landscape-scale transport in these environments.

Final ID: H52E-05

Geophysics applications in critical zone science: emerging topics. ***(Invited)***

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Body: Geophysical studies have resulted in remarkable advances in characterization of critical zone. The geophysics applications uncover the relationships between structure and function in subsurface as they seek to define subsurface structural units with individual properties of retention and transmission of water, energy, solutes, electrical charge, etc. Several focal points of the research have emerged as the knowledge base of the critical zone geophysics grows.

Time-lapse or multiple geophysical surveys admittedly improve the subsurface characterization. One of intriguing possibilities here is to use the temporal variation in geophysical parameters among time-lapse surveys directly to model spatial variation in soil properties affecting soil-water contents. Because critical phenomena causing erratic routing have been recently discovered in hillslope subsurface flow networks, it remains to be seen whether the time-lapse imagery depicts the same flow network if weather conditions are seemingly similar.

High-frequency network observations usually reveal the temporal stability patterns in soil variables, including water contents, CO2 fluxes, etc. It becomes clear that these patterns can be described with spatiotemporal geostatistics models, and the opportunity arises to infer the spatial correlation structure of soil parameters from temporal variations of soil dynamic variables.

There are indications that the spatial correlation structures of the geophysical parameters and soil/plant variables can be similar even though the correlations between these parameters are low. This may open additional avenues for mapping sparsely measured soil and plant variables.

Fallacies of scale in geophysical depicting subsurface structural units and patterns are far from being understood. Soil state variables affect geophysical retrieval in nonlinear ways, and therefore scale effects in retrievals are warranted. For this reason, the strength and type of dependencies between geophysical and ecological variables are bound to vary with support and spacing. The mismatch between supports of soil measurement and geophysical footprints has been acknowledged but not resolved.

Search is under way for metrics to compress dense geophysical data to be analyzed jointly with the sparser ecological information in space and time. Segmentation methods are needed that are specific to the data generated in critical zone geophysics. The geophysical data presentation will remain an art to some extent, and therefore interaction between form and content in this presentation is of interest.

Currently modeling abandons the role of consumer of the structural information about the flow and transport domain, and becomes an organic part of the retrieval process. Much more is done in aquifer modeling than in modeling of variably saturated domains. Model abstraction and multimodeling can provide the functional evaluation of the retrieval components, such as segmentation, and results. The gap remains between the rich information content of the geophysical data and complexity of models in which the retrieval results are used.

Field critical zone research is hardly possible without the input from geophysics. It is critical to achieve a tighter coupling of geophysical tools with other tools used in diagnostics, monitoring, and prediction of critical zone processes.

Final ID: H52E-06

Can we use Electrical Resistivity Tomography to measure root zone moisture dynamics in fields with multiple crops? ***(Invited)***

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Body: Agriculture on shallow or steep soils in the humid tropics often leads to low resource use efficiency. Contour hedgerow intercropping systems have been proposed to reduce run-off and control soil erosion. However, competition for water and nutrients between crops and associated hedgerows may reduce the overall performance of contour hedgerow systems.

Electrical resistivity tomography (ERT) is a valuable technique to assess the distribution and dynamics of soil moisture non-invasively. Root water uptake is a spatially variable and small-scale process, which requires at least decimeter resolution and a high sensitivity in order to be able to monitor changes in time and space. Careful experimental design is of uttermost importance in order to maximize the information content of the ERT survey and to gain insights in the possibilities and limitations of the survey. Virtual experiments in combination with absolute and spatial performance measures provide a way to optimize the information that can be retrieved from an ERT experiment.

We used this approach to identify a suitable measurement methodology to monitor water fluxes in a contour hedgerow intercropping system in Ratchaburi province, Thailand. The virtual experiment showed that there are important differences between the tested measurement configurations. We saw that the optimal ERT array was capable of recognizing distinct water depletion zones under the different crops. However, sharp contrasts in the 1-D water depletion profile are smoothened. ERT measurements conducted in Thailand showed that the soils of our experimental plots were very heterogeneous both along the slope as with depth. This observation highlighted some constraints of the ERT method for soil moisture monitoring in the field, such as the difficulty to define a relationship between electrical conductivity and soil moisture in very heterogeneous soils. Nevertheless, the data indeed revealed contrasting water depletion patterns under monocropping and intercropping systems. ERT allowed us to access information about the vadose zone moisture dynamics that would be unavailable with classical soil moisture measurements.

Final ID: H52E-07

Uniqueness, Scale, Resolution, Uncertainty, Stochastic Subsurface Hydrology, and Hydrological Tomographic Surveys. ***(Invited)***

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Body: Non-unique solutions to mathematical forward or inverse problems of flow through geological media arise from the lack of information that satisfies necessary conditions for the problems to be well defined. Non-unique solutions to forward or inverse modeling of field problems stem from uncertainty of the governing equations, the necessary conditions, multi-scale heterogeneity, scale discrepancies between observation and model, noise and others. Stochastic approach is a probabilistic approach which derives the unbiased solution and quantifies the solution uncertainty. Unconditional and conditional stochastic approaches are therefore most appropriate for forward and inverse modeling of hydrological processes. Based on spatial statistics of measured parameters at local scales and governing equations, unconditional approach derives up-scaled effective parameters for the entire field and uncertainty associated with their predictions. This approach is practically useful but it yields predictions with large uncertainty because diffusive length of the flow and transport process is smaller than the correlation length of the dominant heterogeneity. Conditional approach reduces the uncertainty by preserving hard and soft data at sampling locations. Amount of reduction in uncertainty however rests upon the quantity of spatial data. Joint conditioning using geophysical survey and hydrological data is useful but may spoil joint interpretation due to their ambiguous cross-correlation. Hydrological tomographic survey, which jointly interprets non-redundant hydrological data, is the key to the future hydrological characterization. In conjunction with geophysical monitoring of responses of the subsurface, hydrological tomographic surveys could be the ultimate characterization approach.

URL : www.hwr.arizona.edu/yeh

Final ID: H52E-08

Natural Constraints on Modeling Soil Temperature in Complex Terrain

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Body: Soil is a critical interface between physical and biological processes for much of the terrestrial world. The biological impacts of climate change will be partially moderated in the soil. It has been understood for many years that soil temperature (Ts) influences a host of soil processes, as evidenced by the prominent role it plays in Soil Taxonomy. These processes regulate soil carbon dynamics, soil formation, soil fertility and plant growth. A changing climate potentially impacts all of these processes, but predicting the soil response to climate change based on climate information alone is not straightforward due to variability of field conditions and nonlinearity of critical processes. Soil temperature, for example, is often estimated from air temperature (Ta), which is often the basis for model discretization. Field observatories are ideal locations to learn how Ts varies temporally and spatially in field conditions. We present a combination of spatially and temporally extensive Ts and Ta data, along with intensive fiber optic distributed temperature data (DTS). We show that topographic features and snow cover exert controls on Ts similar to those of Ta. For example, Ts variations within 300 m on contrasting slopes at identical elevations have about the same range of temperatures as those seen in a 1000 m elevation (and corresponding Ta) gradient and snow effects may result in Ts gradients that are the reverse of Ta. We use DTS data to show that slope and aspect strongly control Ts but also that, within slope/aspect class, variability is quite low most of the year, suggesting that, with appropriate discretization, Ts can be simulated with good accuracy and precision. The accuracy and precision of Ts estimates in the region are strongly seasonal, with very low variability during the winter and very high variability during snow melt. These natural spatial and temporal constraints to model accuracy and precision can be mitigated to some extent, but should be recognized regardless, especially when upscaling processes such as carbon mineralization, that are strongly affected by Ts.

Final ID: A53I-0265

A short-standoff bistatic lidar system for aerosol cloud backscatter and fluorescence cross section, and depolarization ratio measurement

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Body: We have designed a short-standoff bistatic lidar system, used for the direct measurement of the optical backscatter at 355-nm and 1064-nm and laser induced fluorescence (LIF) cross sections as well as depolarization ratio of aerosols inside a vacuum sealed, aerosol flow chamber. The 355- and 1064-nm beams are sent through the aerosol chamber at an angle of ~2° with respect to the field of view of the receiver optics to ensure that measurements reflect true backscatter. This bistatic lidar configuration naturally defines a limited region in space where the laser beams and the receiver field of view overlap, a region that can be easily quantified using a standard calibration procedure. Our technique also takes advantage of a specially designed vacuum sealed, aerosol flow chamber that provides a well-mixed, uniform aerosol distribution over the region of sensitivity. Both modeling results and experimental measurements confirm that little particle loss is observed inside the aerosol flow chamber. A TSI aerodynamic particle sizer (APS) is used to measure the aerosol concentration in the chamber, and the N2 concentration can be calculated using the measured temperature and pressure of the air inside the chamber. Optical backscatter and LIF cross sections are determined by comparing the measured elastic and LIF signals with the N2 Raman scattering signal from the same sample volume, a technique which eliminates the need for absolute radiometric calibration of the system. Instead, all detectors in the system are calibrated relative to the N2 Raman channel and the unknown aerosol cross sections are determined by taking the ratio of the backscatter (or LIF) signals to the Raman signal and multiplying by the well-known Raman cross section of N2. Particulate population depolarization parameters are determined by measuring the rejected polarized light from a Glan Laser prism polarizer and comparing those intensity measurements with that of the direct backscatter intensity. This work will focus on particle specific optical backscatter cross-sections and depolarization ratios for atmospherically relevant particle populations including Arizona road dust, black carbon, ammonium sulfate, and sodium chloride. Preliminary results of the absolute scattering cross-section and polarization parameters will be presented. Sandia National Laboratories is a multi-program laboratory operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Final ID: B53A-0658

Development of Airborne LiDAR based Sky View Factors to Estimate Micro-scale Energy Budget of Forest Areas: a Case Study of Taehwa Forest, Korea

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Body: About 6% of earth incoming solar radiation energy (nearly 173 petawatts) is absorbed by the ground surface, which fuels earth surface energy budget and physical/biological/ecological cycles including biogenic emission processes. Many key factors and indices have been proposed to understand the phenomenon initiated from solar energy. In this study, we proposed a new solar energy estimation parameter, the Sky View Factor (SVF), to understand energy budget of vegetated surface. The SVF is a ratio between an open sky area and covered surroundings, such as building and colonnade, which represents an estimation of the visible area of the sky from an earth view point. The high resolution airborne Light Detection And Ranging (LiDAR) dataset instead of low resolution satellite information was used to develop SVFs, because the more reliable ground surface information are very important to correctly estimate the factors. The airborne LiDAR-based SVF calculator tool was also developed to estimate SVFs efficiently then applied to estimate SVFs at Taehwa forest area in support of surface landcover composition analysis. The validation results using shortwave and longwave radiation flux data monitored from Taehwa flux tower and the satellite remote sensing data (LANDSAT ETM+) will be discussed.

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Final ID: EP53C-1054

Climate driven landscape evolution of an impact crater

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Body: Both fluvial sediment transport and periodic debris flows account for sediment routing and landscape evolution on steep slopes, and in many environments, both of these processes will occur over time depending on the duration or intensity of the storm or snowmelt event, the timing between these events, the availability of entrainable sediment, and surface material properties. Understanding these processes is necessary if we want to use fluvial and debris flow deposits in the field to predict the runoff, and more importantly, the amount and intensity of precipitation or snowmelt needed to create these deposits. This type of analysis can inform us about the paleo-climate and paleo-hydrology for a region, especially when pollen records are sparse, and is extremely important for understanding the hydrology and climate of other planets, like Mars. Meteor Crater, an impact crater that formed ~50,000 years ago in northern Arizona, shows exceptional development of gully features in its steep walls, with depositional evidence that both fluvial and debris flow processes played a role in gully and fan formation. At the crater bottom, there are over 30-m of lake sediments from a lake that disappeared ~10,000 -11,000 years ago, indicating the transition from the Pleistocene to the current, drier climate. Initial dating of apparently youngest debris flow levees suggests that debris flow activity also shut down in the transition to the drier Holocene climate. The lower slopes of the crater are laced with debris flow levees and here we explore how we can use these deposits to infer the frequency of debris flows over the finite existence of this landform and the possible intensity and duration of rainstorms in the late Pleistocene responsible for these events. We rely in part on our ongoing experimental studies of debris flow mechanics to estimate volume of water needed to mobilize granular mixtures of sediment. We are using high-resolution topographic (LiDAR) data, contoured to 25-cm, to allow us to resolve individual debris flow events and deposit. The LiDAR data were used to delineate contributing drainage areas to each gully and to the corresponding debris flow lobes and levee tracks. For each of the 74 mapped gully systems, we determined the total volume of material eroded from the entrainment zone by projecting adjacent un-gullied surfaces across the gullies. The volume of lobate deposits associated with each gully system was also mapped, giving us an estimate of the volume of sediment, and frome that the minimum about of water per flow event. Dividing the volume of sediment per event into the eroded gully volume, gives us an estimate of the number of events that must have occurred in each gully. Division of the number of events by the time during which these flows were active (~40,000 years), gives an indication of the frequency of debris flow activity. The next step is to model rainfall-runoff responses through selected gully systems to explore possible intensity-duration conditions that could lead to debris flow activity.

Final ID: H53A-1506

Hydrologic Activity of Deciduous Agroforestry Tree : Observed through Monitoring of Stable Isotopes in Stem Water, Solar Radiation Attenuation, and Sapflow

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Body: The net benefit of agroforestry trees for small scale farmers in dryland agricultural systems is debatable because while they provide significant direct and indirect services, they also consume considerable amounts of scare water resources. In this study we monitor the stable isotopes of water to improve a water budget of a Sclerocarya birrea tree in a millet field in South Eastern Burkina Faso. Data obtained from air temperature and humidity, surface temperature, solar radiation, and soil moisture sensors attached to a wireless sensor network uniquely configured around the agroforestry tree provided the initial calculation of the local water balance. Isotopic ratios were determined from water extracted from stems and sub canopy soil, and from nearby ground water, precipitation, and surface water that was sampled weekly. A linear mixing model is used to predict when the tree switched between water sources. The results from the linear mixing model coupled with a tree water balance demonstrate the extreme seasonality of the annual cycle of water use by this deciduous species.

Final ID: H53I-1650

Toward an improved understanding of the role of transpiration in critical zone dynamics

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Body: Evapotranspiration (ET) is an important component of the total water balance across any ecosystem. In subalpine mixed-conifer ecosystems, transpiration (T) often dominates the total water flux and therefore improved understanding of T is critical for accurate assessment of catchment water balance and for understanding of the processes that governs the complex dynamics across critical zone (CZ). The interaction between T and plant vegetation not only modulates soil water balance but also influences water transit time and hydrochemical flux – key factors in our understanding of how the CZ evolves and responds. Unlike an eddy covariance system which provides only an integrated ET flux from an ecosystem, a sap flow system can provide an estimate of the T flux from the ecosystem. By isolating T, the ecohydrological drivers of this major water loss from the CZ can be identified. Still, the species composition of mixed-conifer ecosystems vary and the drivers of T associated with each species are expected to be different. Therefore, accurate quantification of T from a mixed-conifer requires knowledge of the unique transpiration dynamics of each of the tree species. Here, we installed a sap flow system within two mixed-conifer study sites of the Jemez River Basin – Santa Catalina Mountains Critical Zone Observatory (JRB – SCM CZO). At both sites, we identified the dominant tree species and installed sap flow sensors on healthy representatives for each of those species. At the JRB CZO site, sap sensors were installed in fir (4) and spruce (4) trees; at the SCM CZO site, sap sensors were installed at white fir (4) and maple (4) and one dead tree. Meteorological data as well as soil temperature (Ts) and soil moisture (θ) at multiple depths were also collected from each of the two sites. Preliminary analysis of two years of sap flux rate at JRB – SCM CZO shows that the environmental drivers of fir, spruce, and maple are different and also vary throughout the year. For JRB fir, during the snowmelt period, Ts across multiple depths was the primary control on the sap flux rate (R2 ≈ 0.7). During the dry and monsoon periods only net radiation (Rn) was found to be a driver of the flux rate (R2 ≈ 0.4). For JRB spruce, a combination of Ts across multiple depths as well as air temperature (R2 ≈ 0.5) were the dominant drivers of sap flux rate during the snowmelt period. During the monsoon period, Rn (R2 ≈ 0.4) was the dominant driver. For SCM maple, during the dry period, θ across multiple depths was the primary driver of the sap flux rate (R2 ≈ 0.8); the strength of the correlation with the control of θ on sap flux rate drastically dropping (R2 ≈ 0.2) during the monsoon period. For SCM white fir, θ across multiple depths was a weak driver of sap flux rate during the dry (R2 ≈ 0.1) and monsoon periods (R2 ≈ 0.2). This study highlights the importance of species-specific information for understanding the role of transpiration in critical zone processes. Specifically, unique environmental drivers that vary throughout the year for different vegetation types complicate the assessment of both catchment-scale water and carbon balances and for understanding of the processes that govern the complex dynamics across the CZ.

Final ID: H53I-1653

Rock-moisture dynamics in a hillsope underlain with weathered and fractured argillite

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Body: In order to explore the recharge process through a deep, weathered bedrock zone in a strongly seasonal rainfall environment, we document the early rainy season and annual rock-moisture dynamics along a steep Northern California hillslope underlain by a thick zone of unsaturated weathered and fractured argillite. All runoff to the channel at the base of the hillslope occurs via groundwater flow that is perched on underlying low-permeability fresh bedrock. We report the timing and depth of the first rise in moisture content in response to early winter rains and storm, seasonal, and annual moisture dynamics throughout the zone.

Our measurements show that after a long summer dry season, the first rains rapidly penetrate through the soil mantle and into the underlying weathered bedrock. Large rains generate a response as deep as 6 m into the weathered bedrock within a few weeks. But within hours to days of the start of rain, the perched groundwater, at depths from 4 to 18 m below the surface, responds. The wetting advanced into the bedrock, with the groundwater response magnitude and timing differing greatly across the hillslope. We distinguish soil moisture from rock moisture (which includes both exchangeable matrix water and fracture water) and find that while the soil moisture dynamically rises and falls with each successive storm event, the rock moisture in the shallow, weathered bedrock tends to vary less after initial wet up. Surprisingly, despite the more than 1400 mm of annual water flux through the unsaturated zone, the lower portions near the water table show no moisture variation, even as the water table rises and falls with each storm pulse. These observations suggest that fracture flow plays a predominant role in transmitting water to the water table, and hence, the runoff characteristics, water chemistry, rock-moisture availability to vegetation, the hillslope stability itself is tied to this process.

We present a conceptual model to explain these dynamics, suggesting that the rapid-delivery mechanism of unsaturated flow, and thus recharge, to the water table is through a vertically varying fracture network bounded by low-conductivity matrix bedrock. The near-surface saprolite may play an important role in creating elevated moisture conditions sufficient to cause rapid drainage to the fracture system with incoming rains.

Final ID: IN53D-01

Providing Data Access for Interdisciplinary Research ***(Invited)***

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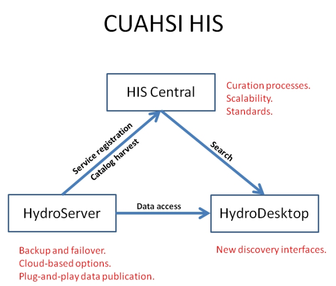
Body: Developing an interdisciplinary understanding of human and environmental interactions with water requires access to a variety of data kinds collected by various organizations. The CUAHSI Hydrologic Information System (HIS) is a standards-based, services-oriented architecture designed for time-series data. Such data represents an important type of data in water studies. Through the efforts of HIS, a standard transmission language, WaterML2, has been adopted by the Open Geospatial Consortium and is under consideration by the World Meteorologic Organization as an international standards. Web services have also been developed to retrieve data and metadata. HIS is completed with a metadata catalog, hosted by San Diego Supercomputing Center, which indexes more than 20 million time series provided from over 90 different services. This catalog is supported through a hierarchically organized controlled vocabulary that is open for community input and mediation. Data publishers include federal agencies, universities, state agencies, and non-profit organizations such as watershed associations. Accessing data from such a broad spectrum of sources through a uniform service standard promises to truly transform the way in which hydrologic research is done. CUAHSI HIS is a large-scale prototype at this time, but a proposal is under consideration by the National Science Foundation to operationalize HIS through a data facility, tentatively called the CUAHSI Water Data Center.
Establishing HIS is an important step to enable research into human-environment interactions with water, but it is only one step. Other data structures will need to be made accessible and interoperable to support this research. Some data—such as two-dimensional GIS coverages—already have widely used standards for transmission and sharing. The US Federal government has long operated a clearinghouse for federal geographic data that is now being augmented with other services such as ArcGIS OnLine. Other data, such as gridded data, have standard storage formats (e.g., netCDF) but its native format is not convenient for water research. Some progress has been made to “transpose” these data sets from gridded data to a grid of virtual gages with time series. Such a format is more convenient for research of a limited spatial extent through time. Advances in relational data base structure now make it possible to serve very large data sets, such as radar-based precipitation grids, through HIS. Expanding the use of a standards-based services-oriented architecture will enable interdisciplinary research to proceed far more rapidly by putting data onto scientists’ computers with a fraction of the effort previously required.

URL : http://his.cuahsi.org



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Distributary Channel Evolution in Two Phases: Increased Asymmetry during Floods, Multiple Channel Extension during Low Flow

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Body: River mouth bifurcations are an important feature on many river deltas. However, the processes that control their evolution remain unclear due to a lack of repeat surveys defining the evolution of these channels. We have collected such a data set on the Wax Lake Delta (WLD) in southern Louisiana. The survey site at the downstream end of a major distributary channel documents its transition into four terminal channels over a distance of roughly 500 m. Repeat surveys at the site reveal two important and distinct channel behaviors; a phase where channels volume is conserved during river flood and a phase of channel extension during a period of low river flow. The flood of 2011 produced no systematic channel extension and the total volume for the channels in the survey area decreased by 1.2 x 10^3 m^3 as channel volume increased in two channels and reduced in the remaining two. Channel bifurcation asymmetry (measured as the width of the wider channel divided by the width of the narrower one) increased from a mean value of 1.29 before to 2.80 after the flood. During the 8 month period of low flow preceding the 2011 flood, each of the four surveyed channels extended basinward distances between 150 and 500 m and channel beds incised up to 0.80 m or 160% of their previous depths. Increased channel length and incision produced a gain in total channel volume of 2.3 x 10^5 m^3, with individual channel contributions ranging from 15-35%. The channel bifurcation asymmetry was small and showed little change (1.27-1.29). We conclude that channel dynamics on the front of the Wax Lake Delta are unsteady and depend on both the river hydrograph and open bay conditions. During flood flow some channels grow at the expense of others, increasing bifurcation asymmetry and providing a potential explanation for the many asymmetrical bifurcations observed on the sub-aerially exposed WLD. During low flow, multiple channels can simultaneously extend and deepen. We posit that bifurcations are most likely to occur during times of low discharge when bay-driven processes combine with river flow to rework flood-deposited sand allowing multiple distributary channels to extend and incise on the delta front.

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Critical Zone Observatories (CZOs): Integrating measurements and models of Earth surface processes to improve prediction of landscape structure, function and evolution *(Invited)*

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Body: The "Critical Zone" - that portion of Earth's land surface that extends from the outer periphery of the vegetation canopy to the lower limit of circulating groundwater - has evolved in response to climatic and tectonic forcing throughout Earth's history, but human activities have recently emerged as a major agent of change as well. With funding from NSF, a network of currently six CZOs is being developed in the U.S. to provide infrastructure, data and models that facilitate understanding the evolution, structure, and function of this zone at watershed to grain scales. Each CZO is motivated by a unique set of hypotheses proposed by a specific investigator team, but coordination of cross-site activities is also leading to integration of a common set of multi-disciplinary tools and approaches for cross-site syntheses. The resulting harmonized four-dimensional datasets are intended to facilitate community-wide exploration of process couplings among hydrology, ecology, soil science, geochemistry and geomorphology across the larger (network-scale) parameter space. Such an approach enables testing of the generalizability of findings at a given site, and also of emergent hypotheses conceived independently of an original CZO investigator team. This two-pronged method for developing a network of individual CZOs across a range of watershed systems is now yielding novel observations and models that resolve mechanisms for Critical Zone change occurring on geological to hydrologic time-scales. For example, recent advances include improved understanding of (i) how mass and energy flux as modulated by ecosystem exchange transforms bedrock to structured, soil-mantled and/or erosive landscapes; (ii) how long-term evolution of landscape structure affects event-based hydrologic and biogeochemical response at pore to catchment scales; (iii) how complementary isotopic measurements can be used to resolve pathways and time scales of water and solute transport from canopy to stream, and (iv) how feedbacks between the Critical Zone, changing climate and changing land use are occurring on timescales relevant to human decisions and policy making.

URL : www.criticalzone.org