RUBISCO

REDUCING UNCERTAINTIES IN BIOGEOCHEMICAL INTERACTIONS THROUGH SYNTHESIS AND COMPUTATION

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Forrest M. Hoffman (ORNL)
Senior Science Co-Lead:
William J. Riley (LBNL)
Chief Scientist:
James T. Randerson (University of California Irvine)
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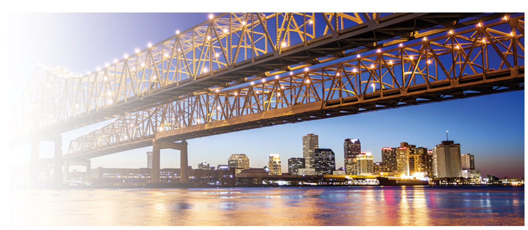
RUBISCO SFA Team Participation in the

AGU FALL MEETING
New Orleans
11-15 Dec. 2017
What will *you* discover?



American Geophysical Union (AGU) Fall Meeting
New Orleans Ernest N. Morial Convention Center
New Orleans, Louisiana, USA
December 11–15, 2017

Argonne National Laboratory · Brookhaven National Laboratory · Berkeley Lab · Los Alamos National Laboratory · NCAR National Center for Atmospheric Research · Oak Ridge National Laboratory · UCI · Michigan

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Thursday, December 14, 2017

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2 Awards

James T. Randerson Receives 2017 Piers J. Sellers Global Environmental Change Mid-Career Award

James T. Randerson, Chief Scientist for the RUBISCO SFA, is the inaugural honoree of the Piers J. Sellers Global Environmental Change Mid-Career Award of the American Geophysical Union's Global Environmental Change focus group. He will receive the award at 2017 AGU Fall Meeting. The award recognizes a scientist or team of midcareer scientists "for outstanding contributions in research, educational, or societal impacts in the area of global environmental change, especially through interdisciplinary approaches."

Citation

Jim Randerson is the perfect candidate for the Piers J. Sellers Global Environmental Change Mid-Career Award. Over the nearly 20 years between completing his Ph.D. at Stanford to his current position as Chancellor's Professor of Earth System Science at UC Irvine, Jim's professional ascent and scientific contributions have been nothing short of phenomenal, not unlike those of Piers in the period between completing his Ph.D. and entering the NASA astronaut program.

Jim's research focuses on the interactions between the terrestrial biosphere and Earth's climate system, investigating the effects of climate on ecosystems and also the feedbacks of terrestrial ecosystems on global and regional climate as mediated by processes such as disturbance, albedo, and carbon dioxide exchange. The breadth of his research ranges from fine-scale controls on wildfire in southern California, Alaska, and Brazil, to continental-scale patterns of wildfire emissions as radiative forcings on climate and energy budgets, to global models and syntheses of the Earth's terrestrial carbon exchange.

He is prolific, influential, and broadly engaged in a range of interdisciplinary Earth system science research endeavors around the world. He has accomplished this through the excellence of his own research as well as an extensive set of collaborations with the very best scientists working to understand and quantify the changing biosphere. This is very much like Piers's legacy in bringing together a broad team of top-notch scientists to rapidly advance interdisciplinary research of the Earth system in the 1980s and 1990s. Also like Piers, Jim has been a mentor to many students and early-career scientists who have gone on to excel in their own careers.

Having had the good fortune and pleasure to work with Piers, I am certain he would be pleased to have an award in his name being conferred upon Jim.

—Scott Goetz, Northern Arizona University, Flagstaff

Response

Thank you, Scott, for the generous citation! This award means a lot to me because I knew Piers—he served as a role model when I was starting out as a young scientist. I was fortunate to work first as a graduate student and then as a postdoc during the 1990s as a part of a NASA Interdisciplinary Science project that Piers co-led. The experience was amazing. Every 6 months, like clockwork, our team would assemble and review progress toward our goal of building a new generation of biosphere models. For the students and postdoctoral scholars participating in this project, these meetings were simultaneously intimidating and inspiring. Feedback on new ideas was swift, sometimes requiring soul searching, and often punctuated by Piers's sharp wit. Listening from the back of the room, we were witness to Piers and his friends defining a new field of global ecology. He pushed us to be our best through a singular combination of brilliance, humor, and passion. There are many of us who emerged from this ecosystem, now hoping to carry on in his footsteps and drawing inspiration from his editorial last year in the *New York Times*. When I look back at the transformative impact of Terra and other satellites in NASA's Earth Observing System, I view this achievement as a tribute to Piers and his colleagues inside and outside of NASA who changed the way we view the biosphere on Earth.

With every passing day, I feel more and more fortunate to have a career as a scientist. I am indebted to Chris Field for his careful mentorship as my Ph.D. advisor, and to my postdoc mentors Inez Fung and Terry Chapin for providing further guidance. I am lucky to work with wonderful colleagues at UC Irvine. I share this honor with them, and with the exceptional students and early-career scientists I have had the privilege of working with. My family makes all of this worthwhile, and I thank Kathleen, Kate, and John for their love and support!

—James Randerson, University of California, Irvine

Adapted from: AGU (2017), Randerson receives 2017 Piers J. Sellers Global Environmental Change Mid-Career Award, *Eos*, 98, `https://doi.org/10.1029/2017EO084955`. Published on 26 October 2017.

3 Town Halls

Monday, December 11, 2017

TH13B: DOE's Strategic Developments at the Terrestrial-Aquatic Interface

The terrestrial-aquatic interface is a highly dynamic component of the Earth system, developed from a near balance between terrestrial and aquatic conditions, and forming unique processes and community assemblages. These interfaces play a critical role in biogeochemical cycling with the potential to provide major feedbacks to the Earth system. A recent report highlighted the lack of data and multiscale models needed to describe how disturbances will influence key processes and feedbacks with the intent of model improvement. This session will highlight ongoing developments on a coupled model-experimental approach related to DOE's strategic research priorities and linkages to other community efforts.

Monday, December 11, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 208–209

Primary Contact:
Daniel B. Stover (U.S. Department of Energy)

Presenters:
Vanessa L. Bailey (Pacific Northwest National Laboratory)
Patrick Megonigal (Smithsonian Environmental Research Center)
Joel C. Rowland (Los Alamos National Laboratory)

TH13F: U.S. Global Change Research Program (USGCRP) Interagency Working Group on Integrated Observations

The role of the USGCRP Interagency Working Group on Integrated Observations (ObsIWG) is to facilitate the exchange of information and coordination of observational capabilities and observational technique-related research relevant to climate and global change within the participating agencies of USGCRP. This town hall will provide a brief introduction to USGCRP and the ObsIWG, present updates on several interagency coordinated observational activities, and provide a discussion period for the community to engage with members of the ObsIWG about how agencies can better coordinate observational efforts.

Monday, December 11, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 228–230

Primary Contact:
Sally A. McFarlane (U.S. Department of Energy)

Presenters:
Barry L. Lefer (NASA Headquarters)

Tuesday, December 12, 2017

TH23A: AmeriFlux: Research Initiatives for Network Action

The AmeriFlux Network continues to grow rapidly, with more than 250 registered sites and scientists measuring ecosystem carbon, water, and energy fluxes throughout the Americas (`http://ameriflux.lbl.gov/`). Hear about: the new data QA/QC pipeline, upcoming community workshops and other community activities, and technical resources from the AmeriFlux Management Projectand let us know your priorities. Discuss future ideas: a new plan for one-to-two year research initiatives for AmeriFlux. These will galvanize efforts to register new sites and expand publicly available data holdings, and provide a focus for site synthesis, modeling, and partnering with organizations and networks around the world. We want to hear your interests and ideas for these initiatives: Should AmeriFlux have a Year of the Wetland? A Year of the Arctic? A Campaign on the Ecosystem Water Budget, or a campaign to link Ecosystem to Earth Observations? We look forward to supporting novel science and a vibrant community as AmeriFlux enters its third decade.

Tuesday, December 12, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 255–257

Primary Contact:
Margaret S. Torn (Lawrence Berkeley National Laboratory)

Presenters:
Deb Agarwal (Lawrence Berkeley National Laboratory)
Sébastien Biraud (Lawrence Berkeley National Laboratory)
Dennis D. Baldocchi (University of California Berkeley)
Dario Papale (ICOS Ecosystem Thematic Center)
Danielle S. Christianson (Lawrence Berkeley National Laboratory)
Housen Chu (Lawrence Berkeley National Laboratory)
Stephen Chan (Lawrence Berkeley National Laboratory)
Sigrid Dengel (Lawrence Berkeley National Laboratory)
Gilberto Pastorello (Lawrence Berkeley National Laboratory)
Daniel B. Stover (U.S. Department of Energy)

TH23C: Coordinated Model Evaluation Capabilities (CMEC) for CMIP DECK and Historical simulations

Three unique Earth system model evaluation capabilities have been developed in coordination with national laboratory support from DOE's Regional and Global Climate Modeling Program. These include the PMP (The Program for Climate Model Diagnosis and Intercomparison Metrics Package), the International Land Model Benchmarking Package (ILAMB) and the Toolkit for Extreme Climate Analysis (TECA). Collectively, these efforts are part of the Coordinated Model Evaluation Capabilities (CMEC) used to evaluate simulations from the Coupled Model Intercomparison Project (CMIP). These capabilities are strongly linked scientifically, and capture an extensive suite of model evaluation characteristics. The PMP provides objective simulation summaries with a diverse suite of relatively robust high-level summary statistics comparing simulations and observations across space and time scales. The ILAMB package provides modeldata comparison to facilitate improvements in the fidelity of terrestrial models and, in parallel, inform the design of new measurement campaigns to reduce uncertainties associated with biogeochemical and hydrological feedbacks. TECA contains analysis algorithms targeted at extreme event detection and analysis. This town hall will highlight the CMEC capabilities, and solicit feedback and discussion on the scientific opportunities to interrogate Earth system model simulations like they have never been tested before.

Tuesday, December 12, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 211–213

Primary Contact:
Renu Joseph (U.S. Department of Energy)

Presenters:
Renu Joseph (U.S. Department of Energy)
Peter J. Gleckler (Lawrence Livermore National Laboratory)
Forrest M. Hoffman (Oak Ridge National Laboratory)
William D. Collins (Lawrence Berkeley National Laboratory and University of California Berkeley)
Dean N. Williams (Lawrence Livermore National Laboratory)
Gerald L. Geernaert (U.S. Department of Energy)

TH23G: Observationally Driven Routine Large-Eddy Simulations: Enhancing Community Research through the DOE LASSO Project

During the last two years the Department of Energy Atmospheric Radiation Measurement (ARM) User Facility has supported a new project called the LES ARM Symbiotic Simulation and Observation (LASSO) project (`https://www.arm.gov/capabilities/modeling/lasso`). LASSO investigates the capability to generate routine, ensemble large-eddy simulations (LES), initially of shallow convection days at ARMs Southern Great Plains site in northern Oklahoma. The simulations and observational datasets are freely available to the community in "data bundles" that are discoverable by an interactive visualization tool. The LASSO pilot phase has ended and recommendations recently released regarding what ARM should implement for routine operations. This town hall is targeted at researchers, agency leadership, and other parties interested in learning about the new capability and giving feedback regarding its application. The town hall will begin with an overview of LASSO and the recommendations to ARM leadership from the pilot phase. This will be of particular interest to researchers who could benefit from routinely available LES and coincident observation datasets. The latter half of the town hall will focus on discussion and feedback about the project. We are interested in engaging with diverse researchers to identify novel applications for this unique model-observation framework.

Tuesday, December 12, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 265–266

Primary Contact:
William I. Gustafson (Pacific Northwest National Laboratory)

Presenters:
Andrew M. Vogelmann (Brookhaven National Laboratory)
James H. Mather (Pacific Northwest National Laboratory)

TH23I: SOCCR-2: The 2nd State of the Carbon Cycle Report, a Sustained National Climate Assessment report encompassing North America and Surrounding Waters

Responding to the Global Change Research Act (1990) and the U.S. Carbon Cycle Science Plan (2011), and as part of the Sustained National Climate Assessment, SOCCR-2 covers carbon cycle science in soils, water (including oceans), vegetation, aquatic-terrestrial interfaces (coastal/ estuaries/ wetlands), human settlements, agriculture, forestry and human social systems, integrating the scientific uncertainties and analyzing the effects of carbon stocks and flux changes and associated global change impacts, including trends and projections for both human-induced and natural changes. This town hall provides an overview of the report, its progress and next steps, as an opportunity to engage with the SOCCR-2 team of governmental and community scientists and program managers focused on carbon cycle research across North America.

Tuesday, December 12, 2017 12:30–13:30
New Orleans Ernest N. Morial Convention Center – 280–282

Primary Contact:
Gyami Shrestha (U.S. Carbon Cycle Science Program)

Presenters:
Gyami Shrestha (U.S. Carbon Cycle Science Program)
Nancy Cavallaro (U.S. Department of Agriculture)
Elisabeth K. Larson (NASA Headquarters)
Carolyn Olson (U.S. Department of Agriculture)
Zhiliang Zhu (U.S. Geological Survey)
Laura Lorenzoni (NASA Headquarters)
Daniel B. Stover (U.S. Department of Energy)

4 Sessions Organized

Tuesday, December 12, 2017

B21K: Vegetation Canopies: Physiology, Structure, Function I

Canopy structure along with leaf form and function determine global rates of photosynthesis and transpiration and, thus, heavily influence the global carbon, water, and energy cycles. Key unknowns remain regarding how leaf physiology and canopy structure respond to both temporal and spatial mesoclimatic changes, and the within-canopy microclimate.

In this session, we will explore the relative roles of leaf physiology, phenology, microclimate, and canopy structure in determining ecosystem states, traits, and rates. We are particularly interested in studies that use novel approaches to examine changes in canopy form and function, particularly those that bridge traditional boundaries with new theory, observations, and models. We encourage submissions of studies merging field and experimental observations, with both near-surface and remote sensing techniques. We also encourage empirical and modeling studies examining canopy processes across scales, from seconds to decades and from the leaf to the globe.

Tuesday, December 12, 2017 08:00–10:00
New Orleans Ernest N. Morial Convention Center – 383–385

Swirl: Earth Processes

Primary Convener:
Nicholas G. Smith (Texas Tech University)

Conveners:
Trevor F. Keenan (Lawrence Berkeley National Laboratory)
Han Wang (Northwest A&F University)
Ulo Niinemets (Estonian University of Life Sciences)

Chairs:
Han Wang (Northwest A&F University)
Ulo Niinemets (Estonian University of Life Sciences)
Nicholas G. Smith (Texas Tech University)
Trevor F. Keenan (Lawrence Berkeley National Laboratory)

OSPA Liaison:
Nicholas G. Smith (Texas Tech University)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0416 Biogeophysics
0426 Biosphere/atmosphere interactions
0476 Plant ecology

B23E: Vegetation Canopies: Physiology, Structure, Function II Posters

Canopy structure along with leaf form and function determine global rates of photosynthesis and transpiration and, thus, heavily influence the global carbon, water, and energy cycles. Key unknowns remain regarding how leaf physiology and canopy structure respond to both temporal and spatial mesoclimatic changes, and the within-canopy microclimate.

In this session, we will explore the relative roles of leaf physiology, phenology, microclimate, and canopy structure in determining ecosystem states, traits, and rates. We are particularly interested in studies that use novel approaches to examine changes in canopy form and function, particularly those that bridge traditional boundaries with new theory, observations, and models. We encourage submissions of studies merging field and experimental observations, with both near-surface and remote sensing techniques. We also encourage empirical and modeling studies examining canopy processes across scales, from seconds to decades and from the leaf to the globe.

Tuesday, December 12, 2017 13:40–18:00
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2109–2129

Swirl: Earth Processes

Primary Convener:
Nicholas G. Smith (Texas Tech University)

Conveners:
Trevor F. Keenan (Lawrence Berkeley National Laboratory)
Han Wang (Northwest A&F University)
Ulo Niinemets (Estonian University of Life Sciences)

Chairs:
Ulo Niinemets (Estonian University of Life Sciences)
Nicholas G. Smith (Texas Tech University)
Trevor F. Keenan (Lawrence Berkeley National Laboratory)
Han Wang (Northwest A&F University)

OSPA Liaison:
Nicholas G. Smith (Texas Tech University)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0416 Biogeophysics
0426 Biosphere/atmosphere interactions
0476 Plant ecology

Wednesday, December 13, 2017

B31A: Advances in Uncertainty Assessment and Reduction for Terrestrial Carbon Cycle Diagnosis and Prediction I Posters

Quantifying and reducing uncertainty in diagnosed and modeled carbon fluxes and stocks is a major challenge for the carbon cycle science community. Uncertainty in regional- to global-scale diagnoses limits our ability to test and develop accurate prognostic carbon cycle models, a major source of uncertainty in projections of future climate. However, recent advances in observations, ecosystem experiments, data assimilation techniques, and scientific computing have improved diagnostic and prognostic skill in carbon cycle science. We invite submissions that (1) investigate uncertainty in model forcings, parameters, or structure and the resulting uncertainty in diagnosis and/or predictions; (2) quantify and reduce uncertainty using benchmarking datasets and model–data integration; and (3) document new process understanding, observations, experiments or datasets that will advance this field. We welcome innovative work from all means of studying the terrestrial carbon cycle, including inventory assessments, ecosystem and earth system models, field experiments, remote sensing, and model–data syntheses.

Wednesday, December 13, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 1966–1979

Primary Convener:
Jingfeng Xiao (University of New Hampshire)

Conveners:
Kenneth J. Davis (Pennsylvania State University)
Forrest M. Hoffman (Oak Ridge National Laboratory)
Stephen M. Ogle (Colorado State University)

Chairs:
Kenneth J. Davis (Pennsylvania State University)
Forrest M. Hoffman (Oak Ridge National Laboratory)
Jingfeng Xiao (University of New Hampshire)
Stephen M. Ogle (Colorado State University)

OSPA Liaison:
Jingfeng Xiao (University of New Hampshire)

Index Terms:
0428 Carbon cycling
0434 Data sets
0466 Modeling
0480 Remote sensing

B31F: Vegetation Phenology as Forcing and Response Across Diverse Biomes: Detection, Attribution, Prediction, and Implications I Posters

Vegetation phenology is an integrated and sensitive indicator of ecosystem health and function that responds to growing conditions, disturbance, and climate change. Changes in phenology can also exert feedbacks on ecosystems and to the climate system by regulating vegetation dynamics and key land surface processes. This symposium draws upon recent advances in the detection of spatio-temporal variations in vegetation phenology with traditional and/or novel monitoring approaches (e.g., satellite, webcams, fluorescence, citizen scientist observations, crowdsourcing), and the attribution of these variations to underlying mechanistic processes. In addition, the session is looking forward to studies targeting accurate model representations of vegetation phenology at all scales, and/or investigating the phenological implications to key land surface processes and the societal sector. Abstracts reflecting the increasing research efforts across diverse biomes, including tropical forests, tundra and terrestrial-aquatic systems in addition to the temperate biome, are encouraged.

Wednesday, December 13, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2042–2062

Primary Convener:
Xiangtao Xu (Princeton University)

Conveners:
Forrest M. Hoffman (Oak Ridge National Laboratory)
Jin Wu (Brookhaven National Laboratory)
William W. Hargrove (USDA Forest Service)

Chairs:
Forrest M. Hoffman (Oak Ridge National Laboratory)
William W. Hargrove (USDA Forest Service)
Jitendra Kumar (Oak Ridge National Laboratory)
Kirsten de Beurs (University of Oklahoma)

OSPA Liaison:
Forrest M. Hoffman (Oak Ridge National Laboratory)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0426 Biosphere/atmosphere interactions
0480 Remote sensing
1630 Impacts of global change

B33H: Vegetation Phenology as Forcing and Response Across Diverse Biomes: Detection, Attribution, Prediction, and Implications II

Vegetation phenology is an integrated and sensitive indicator of ecosystem health and function that responds to growing conditions, disturbance, and climate change. Changes in phenology can also exert feedbacks on ecosystems and to the climate system by regulating vegetation dynamics and key land surface processes. This symposium draws upon recent advances in the detection of spatio-temporal variations in vegetation phenology with traditional and/or novel monitoring approaches (e.g., satellite, webcams, fluorescence, citizen scientist observations, crowdsourcing), and the attribution of these variations to underlying mechanistic processes. In addition, the session is looking forward to studies targeting accurate model representations of vegetation phenology at all scales, and/or investigating the phenological implications to key land surface processes and the societal sector. Abstracts reflecting the increasing research efforts across diverse biomes, including tropical forests, tundra and terrestrial-aquatic systems in addition to the temperate biome, are encouraged.

Wednesday, December 13, 2017 13:40–15:40
New Orleans Ernest N. Morial Convention Center – 383–385

Primary Convener:
Xiangtao Xu (Princeton University)

Conveners:
Forrest M. Hoffman (Oak Ridge National Laboratory)
Jin Wu (Brookhaven National Laboratory)
William W. Hargrove (USDA Forest Service)

Chairs:
William W. Hargrove (USDA Forest Service)
Xiangtao Xu (Princeton University)
Jitendra Kumar (Oak Ridge National Laboratory)

OSPA Liaison:
Xiangtao Xu (Princeton University)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0426 Biosphere/atmosphere interactions
0480 Remote sensing
1630 Impacts of global change

B34A: Advances in Uncertainty Assessment and Reduction for Terrestrial Carbon Cycle Diagnosis and Prediction II

Quantifying and reducing uncertainty in diagnosed and modeled carbon fluxes and stocks is a major challenge for the carbon cycle science community. Uncertainty in regional- to global-scale diagnoses limits our ability to test and develop accurate prognostic carbon cycle models, a major source of uncertainty in projections of future climate. However, recent advances in observations, ecosystem experiments, data assimilation techniques, and scientific computing have improved diagnostic and prognostic skill in carbon cycle science. We invite submissions that (1) investigate uncertainty in model forcings, parameters, or structure and the resulting uncertainty in diagnosis and/or predictions; (2) quantify and reduce uncertainty using benchmarking datasets and model–data integration; and (3) document new process understanding, observations, experiments or datasets that will advance this field. We welcome innovative work from all means of studying the terrestrial carbon cycle, including inventory assessments, ecosystem and earth system models, field experiments, remote sensing, and model–data syntheses.

Wednesday, December 13, 2017 16:00–18:00
New Orleans Ernest N. Morial Convention Center – 388–390

Primary Convener:
Jingfeng Xiao (University of New Hampshire)

Conveners:
Kenneth J. Davis (Pennsylvania State University)
Forrest M. Hoffman (Oak Ridge National Laboratory)
Stephen M. Ogle (Colorado State University)

Chairs:
Kenneth J. Davis (Pennsylvania State University)
Forrest M. Hoffman (Oak Ridge National Laboratory)
Jingfeng Xiao (University of New Hampshire)
Stephen M. Ogle (Colorado State University)

OSPA Liaison:
Jingfeng Xiao (University of New Hampshire)

Index Terms:
0428 Carbon cycling
0434 Data sets
0466 Modeling
0480 Remote sensing

B34C: Vegetation Phenology as Forcing and Response Across Diverse Biomes: Detection, Attribution, Prediction, and Implications III

Vegetation phenology is an integrated and sensitive indicator of ecosystem health and function that responds to growing conditions, disturbance, and climate change. Changes in phenology can also exert feedbacks on ecosystems and to the climate system by regulating vegetation dynamics and key land surface processes. This symposium draws upon recent advances in the detection of spatio-temporal variations in vegetation phenology with traditional and/or novel monitoring approaches (e.g., satellite, webcams, fluorescence, citizen scientist observations, crowdsourcing), and the attribution of these variations to underlying mechanistic processes. In addition, the session is looking forward to studies targeting accurate model representations of vegetation phenology at all scales, and/or investigating the phenological implications to key land surface processes and the societal sector. Abstracts reflecting the increasing research efforts across diverse biomes, including tropical forests, tundra and terrestrial-aquatic systems in addition to the temperate biome, are encouraged.

Wednesday, December 13, 2017 16:00–18:00
New Orleans Ernest N. Morial Convention Center – 383–385

Primary Convener:
Xiangtao Xu (Princeton University)

Conveners:
Forrest M. Hoffman (Oak Ridge National Laboratory)
Jin Wu (Brookhaven National Laboratory)
William W. Hargrove (USDA Forest Service)

Chairs:
Jin Wu (Brookhaven National Laboratory)
Min Chen (Carnegie Institution for Science, Stanford University)
Jitendra Kumar (Oak Ridge National Laboratory)
Kirsten de Beurs (University of Oklahoma)

OSPA Liaison:
Kirsten de Beurs (University of Oklahoma)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0426 Biosphere/atmosphere interactions
0480 Remote sensing
1630 Impacts of global change

Thursday, December 14, 2017

Friday, December 15, 2017

B51F: Integrated Understanding of Climate, Carbon, Nutrient Cycles, Human Activities, and Their Interactions in Terrestrial Ecosystems I Posters

Assessments of coupled climate–carbon cycle simulations indicate that terrestrial carbon cycle feedbacks are highly uncertain and could significantly alter the rate of atmospheric CO_2 increase and, therefore, climate change over the next one hundred years. The terrestrial carbon cycle is directly affected by increasing atmospheric CO_2 levels and by climate change, and, further, is altered indirectly by feedbacks from potentially limiting nutrients (e.g., nitrogen and phosphorus). Changes in CO_2 concentration and climate can affect the availability of these nutrients, and anthropogenic disturbances—such as tropospheric ozone, nitrogen deposition, and land cover and land use changes—also influence the carbon cycle, nutrient cycles, climate change, and the strength of their interactions. This session will focus on an integrated understanding of carbon, nutrient cycles, climate change, human activities, and their interactions and feedbacks to climate in terrestrial ecosystems.

Friday, December 15, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 1852–1881

SWIRL Themes: Climate

Cross-Listed: GC - Global Environmental Change

Primary Convener:
Forrest M. Hoffman (Oak Ridge National Laboratory)

Conveners:
Xiaojuan Yang (Oak Ridge National Laboratory)
Atul K. Jain (University of Illinois Urbana Champaign)
Sasha Reed (U.S. Geological Survey)

Chairs:
Atul K. Jain (University of Illinois Urbana Champaign)
Xiaojuan Yang (Oak Ridge National Laboratory)
Forrest M. Hoffman (Oak Ridge National Laboratory)
Sasha Reed (U.S. Geological Survey)

OSPA Liaison:
Atul K. Jain (University of Illinois Urbana Champaign)

Index Terms:
0428 Carbon cycling
0439 Ecosystems, structure and dynamics
0470 Nutrients and nutrient cycling
1615 Biogeochemical cycles, processes, and modeling

B53J: Integrated Understanding of Climate, Carbon, Nutrient Cycles, Human Activities, and Their Interactions in Terrestrial Ecosystems II

Assessments of coupled climate–carbon cycle simulations indicate that terrestrial carbon cycle feedbacks are highly uncertain and could significantly alter the rate of atmospheric CO_2 increase and, therefore, climate change over the next one hundred years. The terrestrial carbon cycle is directly affected by increasing atmospheric CO_2 levels and by climate change, and, further, is altered indirectly by feedbacks from potentially limiting nutrients (e.g., nitrogen and phosphorus). Changes in CO_2 concentration and climate can affect the availability of these nutrients, and anthropogenic disturbances—such as tropospheric ozone, nitrogen deposition, and land cover and land use changes—also influence the carbon cycle, nutrient cycles, climate change, and the strength of their interactions. This session will focus on an integrated understanding of carbon, nutrient cycles, climate change, human activities, and their interactions and feedbacks to climate in terrestrial ecosystems.

Friday, December 15, 2017 13:40–15:40
New Orleans Ernest N. Morial Convention Center – 383–385

SWIRL Themes: Climate

Cross-Listed: GC - Global Environmental Change

Primary Convener:
Forrest M. Hoffman (Oak Ridge National Laboratory)

Conveners:
Xiaojuan Yang (Oak Ridge National Laboratory)
Atul K. Jain (University of Illinois Urbana Champaign)
Sasha Reed (U.S. Geological Survey)

Chairs:
Atul K. Jain (University of Illinois Urbana Champaign)
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Forrest M. Hoffman (Oak Ridge National Laboratory)
Sasha Reed (U.S. Geological Survey)

OSPA Liaison:
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Index Terms:
0428 Carbon cycling
0439 Ecosystems, structure and dynamics
0470 Nutrients and nutrient cycling
1615 Biogeochemical cycles, processes, and modeling

B54C: Integrated Understanding of Climate, Carbon, Nutrient Cycles, Human Activities, and Their Interactions in Terrestrial Ecosystems III

Assessments of coupled climate–carbon cycle simulations indicate that terrestrial carbon cycle feedbacks are highly uncertain and could significantly alter the rate of atmospheric CO_2 increase and, therefore, climate change over the next one hundred years. The terrestrial carbon cycle is directly affected by increasing atmospheric CO_2 levels and by climate change, and, further, is altered indirectly by feedbacks from potentially limiting nutrients (e.g., nitrogen and phosphorus). Changes in CO_2 concentration and climate can affect the availability of these nutrients, and anthropogenic disturbances—such as tropospheric ozone, nitrogen deposition, and land cover and land use changes—also influence the carbon cycle, nutrient cycles, climate change, and the strength of their interactions. This session will focus on an integrated understanding of carbon, nutrient cycles, climate change, human activities, and their interactions and feedbacks to climate in terrestrial ecosystems.

Friday, December 15, 2017 16:00–18:00
New Orleans Ernest N. Morial Convention Center – 383–385

SWIRL Themes: Climate

Cross-Listed: GC - Global Environmental Change

Primary Convener:
Forrest M. Hoffman (Oak Ridge National Laboratory)

Conveners:
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Atul K. Jain (University of Illinois Urbana Champaign)
Sasha Reed (U.S. Geological Survey)

Chairs:
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Index Terms:
0428 Carbon cycling
0439 Ecosystems, structure and dynamics
0470 Nutrients and nutrient cycling
1615 Biogeochemical cycles, processes, and modeling

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5 Presentation Abstracts

Monday, December 11, 2017

B13L-08: Exploring tropical forest vegetation dynamics using the FATES model

Tropical forest vegetation dynamics represent a critical climate feedback in the Earth system, which is poorly represented in current global modeling approaches. We discuss recent progress on exploring these dynamics using the Functionally Assembled Terrestrial Ecosystem Simulator (FATES), a demographic vegetation model for the CESM and ACME ESMs. We will discuss benchmarks of FATES predictions for forest structure against inventory sites, sensitivity of FATES predictions of size and age structure to model parameter uncertainty, and experiments using the FATES model to explore PFT competitive dynamics and the dynamics of size and age distributions in responses to changing climate and CO_2.

Monday, December 11, 2017 15:25–15:40
New Orleans Ernest N. Morial Convention Center – 383–385

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GC14A-07: Nonlinear Interactions between Climate and Atmospheric Carbon Dioxide Drivers of Terrestrial and Marine Carbon Cycle Changes

Quantifying interactions between global biogeochemical cycles and the Earth system is important for predicting future atmospheric composition and informing energy policy. We applied a feedback analysis framework to three sets of Historical (1850–2005), Representative Concentration Pathway 8.5 (2006–2100), and its extension (2101–2300) simulations from the Community Earth System Model version 1.0 (CESM1(BGC)) to quantify drivers of terrestrial and ocean responses of carbon uptake. In the biogeochemically coupled simulation (BGC), the effects of CO_2 fertilization and nitrogen deposition influenced marine and terrestrial carbon cycling. In the radiatively coupled simulation (RAD), the effects of rising temperature and circulation changes due to radiative forcing from CO_2, other greenhouse gases, and aerosols were the sole drivers of carbon cycle changes. In the third, fully coupled simulation (FC), both the biogeochemical and radiative coupling effects acted simultaneously. We found that climate–carbon sensitivities derived from RAD simulations produced a net ocean carbon storage climate sensitivity that was weaker and a net land carbon storage climate sensitivity that was stronger than those diagnosed from the FC and BGC simulations. For the ocean, this nonlinearity was associated with warming-induced weakening of ocean circulation and mixing that limited exchange of dissolved inorganic carbon between surface and deeper water masses. For the land, this nonlinearity was associated with strong gains in gross primary production in the FC simulation, driven by enhancements in the hydrological cycle and increased nutrient availability. We developed and applied a nonlinearity metric to rank model responses and driver variables. The climate–carbon cycle feedback gain at 2300 was 42% higher when estimated from climate–carbon sensitivities derived from the difference between FC and BGC than when derived from RAD. We re-analyzed other CMIP5 model results to quantify the effects of such nonlinearities on their projected climate–carbon cycle feedback gains.

Monday, December 11, 2017 17:30–17:45
New Orleans Ernest N. Morial Convention Center – 260–262

Authors:
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Michael Goulden (University of California Irvine)
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Charles D. Koven (Lawrence Berkeley National Laboratory)
Abigail L. S. Swann (University of Washington Seattle)
Natalie Mahowald (Cornell University)
Keith Lindsay (National Center for Atmospheric Research)
Ernesto Muñoz (National Center for Atmospheric Research)

Tuesday, December 12, 2017

GC21B-0949: The Role of Reforestation in Carbon Sequestration

In the United States (U.S.), the maintenance of forest cover is a legal mandate for federally managed forest lands. Reforestation is one option for maintaining forest cover on managed or disturbed lands, and as a land use change can increase forest cover on previously non-forested lands, enhancing carbon (C)-based ecosystem services and functions such as the production of woody biomass for forest products and the mitigation of atmospheric CO_2 pollution and climate change. Nonetheless, multiple assessments indicate that reforestation in the U.S. lags behind its potential, with continued ecosystem services and functions at risk if reforestation is not increased. In this context, there is need for multiple independent analyses that quantify the role of reforestation in C sequestration. Here, we report the findings of a large-scale data synthesis aimed at four objectives: 1) estimate C storage in major pools in forest and other land cover types; 2) quantify sources of variation in C pools; 3) compare the impacts of reforestation and afforestation on C pools; 4) assess whether results hold or diverge across ecoregions. Our data-driven analysis provides four key inferences regarding reforestation and other land use impacts on C sequestration. First, soils are the dominant C pool under all land cover types in the U.S., and spatial variation in soil C pool sizes has less to do with land cover than with other factors. Second, where historically cultivated lands are being reforested, topsoils are sequestering significant amounts of C, with the majority of reforested lands yet to reach sequestration capacity (relative to forested baseline). Third, the establishment of woody vegetation delivers immediate to multi-decadal C sequestration benefits in biomass and coarse woody debris pools, with two- to three-fold C sequestration benefits during the first several decades following planting. Fourth, opportunities to enhance C sequestration through reforestation vary among ecoregions, according to current levels of planting, typical forest growth rates, and past land uses (especially cultivation). Altogether, our results suggest that an immediate, but phased and spatially targeted approach to reforestation can enhance C sequestration in forest biomass and soils in the U.S. for decades to centuries to come.

Tuesday, December 12, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 0949

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GC21E-0985: Uncertainty in Earth System Models: Benchmarks for Ocean Model Performance and Validation

The mean ocean CO_2 sink is a major component of the global carbon budget, with marine reservoirs holding about fifty times more carbon than the atmosphere. Phytoplankton play a significant role in the net carbon sink through photosynthesis and drawdown, such that about a quarter of anthropogenic CO_2 emissions end up in the ocean. Biology greatly increases the efficiency of marine environments in CO_2 uptake and ultimately reduces the impact of the persistent rise in atmospheric concentrations. However, a number of challenges remain in appropriate representation of marine biogeochemical processes in Earth System Models (ESM). These threaten to undermine the community effort to quantify seasonal to multidecadal variability in ocean uptake of atmospheric CO_2.

In a bid to improve analyses of marine contributions to climate–carbon cycle feedbacks, we have developed new analysis methods and biogeochemistry metrics as part of the International Ocean Model Benchmarking (IOMB) effort. Our intent is to meet the growing diagnostic and benchmarking needs of ocean biogeochemistry models. The resulting software package has been employed to validate DOE ocean biogeochemistry results by comparison with observational datasets. Several other international ocean models contributing results to the fifth phase of the Coupled Model Intercomparison Project (CMIP5) were analyzed simultaneously.

Our comparisons suggest that the biogeochemical processes determining CO_2 entry into the global ocean are not well represented in most ESMs. Polar regions continue to show notable biases in many critical biogeochemical and physical oceanographic variables. Some of these disparities could have first order impacts on the conversion of atmospheric CO_2 to organic carbon. In addition, single forcing simulations show that the current ocean state can be partly explained by the uptake of anthropogenic emissions. Combined effects of two or more of these forcings on ocean biogeochemical cycles and ecosystems are challenging to predict since additive or antagonistic effects may occur. A benchmarking tool for accurate assessment and validation of marine biogeochemical outputs will be indispensable as the model community continues to improve ESM developments. It will provide a first order tool in understanding climate–carbon cycle feedbacks.

Tuesday, December 12, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 0985

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Forrest M. Hoffman (Oak Ridge National Laboratory)

GC23E-06: The Influence of Current and Future Climate on the Spatial Distribution of Coccidioidomycosis in the Southwestern United States

Coccidioidomycosis, otherwise known as valley fever, is an infectious fungal disease currently endemic to the southwestern U.S. The magnitude, spatial distribution, and seasonality of valley fever incidence is shaped by variations in regional climate. As such, climate change may cause new communities to become at risk for contracting this disease. Humans contract valley fever by inhaling fungal spores of the genus *Coccidioides*. *Coccidioidesa* grow in the soil as a mycelium, and when stressed, autolyze into spores 2–5 µm in length. Spores can become airborne from any natural or anthropogenic soil disturbance, which can be exacerbated by dry soil conditions. Understanding the relationship between climate and valley fever incidence is critical for future disease risk management. We explored several multivariate techniques to create a predictive model of county-level valley fever incidence throughout the southwestern U.S., including Arizona, California, New Mexico, Nevada, and Utah. We incorporated surface air temperature, precipitation, soil moisture, surface dust concentrations, leaf area index, and the amount of agricultural land, all of which influence valley fever incidence. A log-linear regression model that incorporated surface air temperature, soil moisture, surface dust concentration, and the amount of agricultural land explained 34% of the county-level variance in annual average valley fever incidence. We used this model to predict valley fever incidence for the Representative Concentration Pathway 8.5 using simulation output from the Community Earth System Model. In our analysis, we describe how regional hotspots of valley fever incidence may shift with sustained warming and drying in the southwestern U.S. Our predictive model of valley fever incidence may help mitigate future health impacts of valley fever by informing health officials and policy makers of the climate conditions suitable for disease outbreak.

Tuesday, December 12, 2017 14:55–15:10
New Orleans Ernest N. Morial Convention Center – 267–268

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B24D-05: Widespread Inhibition of Day-time Ecosystem Respiration and Implications for Eddy-covariance Flux Partitioning

Global terrestrial ecosystems absorb about a third of anthropogenic emissions each year, due to the difference between two key processes: photosynthesis and respiration. Despite the importance of these two processes at the global scale, no direct measurement exists of either. Eddy-covariance (EC) measurements have been widely used as the closest 'quasi-direct' observation, and the resulting estimates have been used to produce global budgets of photosynthesis and respiration. Recent research, however, suggests that current estimates may be biased by up to 25%, as the methods used to partition observed net carbon fluxes to photosynthesis and respiration do not take into account any inhibition of leaf respiration in light. Yet the prevalence of light-inhibition of leaf respiration remains debated, and impacts on global estimates of photosynthesis and respiration unquantified. Here, we use novel approaches to estimate the extent of light-inhibition across the global FLUXNET EC network, and find strong evidence for an inhibition effect on ecosystem respiration, which varies by season and plant functional type. We develop partitioning methods that allow for inhibition, and find that that diurnal patterns of ecosystem respiration might be markedly different than previously thought. The results call for the reevaluation of global terrestrial carbon cycle models, and also suggest that current global budgets of photosynthesis and respiration may be biased on the order of magnitude of anthropogenic fossil fuel emissions.

Tuesday, December 12, 2017 17:00–17:15
New Orleans Ernest N. Morial Convention Center – 356–357

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Wednesday, December 13, 2017

B31A-1978: Scoring Methods in the International Land Benchmarking (ILAMB) Package

The International Land Model Benchmarking (ILAMB) project is a model-data intercomparison and integration project designed to improve the performance of the land component of Earth system models. This effort is disseminated in the form of a python package which is openly developed (`https://bitbucket.org/ncollier/ilamb`). ILAMB is more than a workflow system that automates the generation of common scalars and plot comparisons to observational data. We aim to provide scientists and model developers with a tool to gain insight into model behavior. Thus, a salient feature of the ILAMB package is our synthesis methodology, which provides users with a high-level understanding of model performance.

Within ILAMB, we calculate a non-dimensional score of a model's performance in a given dimension of the physics, chemistry, or biology with respect to an observational dataset. For example, we compare the Fluxnet-MTE Gross Primary Productivity (GPP) product against model output in the corresponding historical period. We compute common statistics such as the bias, root mean squared error, phase shift, and spatial distribution. We take these measures and find relative errors by normalizing the values, and then use the exponential to map this relative error to the unit interval. This allows for the scores to be combined into an overall score representing multiple aspects of model performance. In this presentation we give details of this process as well as a proposal for tuning the exponential mapping to make scores more cross comparable.

However, as many models are calibrated using these scalar measures with respect to observational datasets, we also score the relationships among relevant variables in the model. For example, in the case of GPP, we also consider its relationship to precipitation, evapotranspiration, and temperature. We do this by creating a mean response curve and a two-dimensional distribution based on the observational data and model results. The response curves are then scored using a relative measure of the root mean squared error and the exponential as before. The distributions are scored using the so-called Hellinger distance, a statistical measure for how well one distribution is represented by another, and included in the model's overall score.

Wednesday, December 13, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 1978

Authors:
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David M. Lawrence (National Center for Atmospheric Research)
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William J. Riley (Lawrence Berkeley National Laboratory)
James T. Randerson (University of California Irvine)

GC31C-1016: The Effects of Ecoregion Dynamics on Agroregions for Permanent Crops in the Continental US Under Future Climate Change Scenarios

Fruit and Tree Nut production in the US averaged 14% of total annual production, or roughly $28 billion in total revenue for the most recent 5 year period (2011–2015). The success of these crops is highly dependent on environmental conditions. Cold snaps before winter dormancy, early frosts in spring, and lack of sufficient chilling hours can reduce productivity, inflict wood damage, and lead to economic loss. Climate change can increase the likelihood of these threats and may have long-term implications for the areas where these crops are grown due to the migration of ecoregions as climate patters shift. We delineate ecoregions using multi-attribute spatio-temporal clustering and calculate chilling unit accumulation under past, present, and future climate scenarios using measured and modeled data. These results are then compared to current agroregions in the US to calculate risk dynamics, potential economic loss, and to map future agroregion scenarios. Our results offer considerations for food system sustainability under a shifting climate.

Wednesday, December 13, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 1016

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B31J-06: Ice-Wedge Polygon Formation Impacts Permafrost Carbon Storage and Vulnerability to Top-Down Thaw in Arctic Coastal Plain Soils

Ice-wedge polygons are ubiquitous, patterned ground features throughout Arctic coastal plains and river deltas. The progressive expansion of ice wedges influences polygon development and strongly

affects cryoturbation and soil formation. Thus, we hypothesized that polygon type impacts the distribution and composition of soil organic carbon (C) stocks across the landscape and that such information can improve estimates of permafrost C stocks vulnerable to active layer thickening and increased decomposition due to climatic change. We quantified the distribution of soil C across entire polygon profiles (2-m depth) for three developmental types — flat-centered (FCP), low-centered (LCP), and high-centered (HCP) polygons (3 replicates of each) — formed on glaciomarine sediments within and near the Barrow Environmental Observatory at the northern tip of Alaska. Active layer thickness averaged 45 cm and did not vary among polygon types. Similarly, active layer C stocks were unaffected by polygon type, but permafrost C stocks increased from FCPs to LCPs to HCPs despite greater ice volumes in HCPs. These differences were due to a greater presence of organic horizons in the upper permafrost of LCPs and, especially, HCPs. On average, C stocks in polygon interiors were double those of troughs, on a square meter basis. However, HCPs were physically smaller than LCPs and FCPs, which affected estimates of C stocks at the landscape scale. Accounting for the number of polygons per unit area and the proportional distribution of troughs versus interiors, we estimated permafrost C stocks (2-m depth) increased from 259 $\mathrm{Mg\,C\,ha^{-1}}$ in FCPs to 366 $\mathrm{Mg\,C\,ha^{-1}}$ in HCPs. Active layer C stocks did not differ among polygon types and averaged 328 $\mathrm{Mg\,C\,ha^{-1}}$. We used our detailed polygon profiles to investigate the impact of active layer deepening as projected by Earth system models under future climate scenarios. Because HCPs have a greater proportion of upper permafrost C stocks in organic horizons, permafrost C in areas dominated by this polygon type may be at greater risk for destabilization. Thus, accounting for geospatial distributions of ice-wedge polygon types and associated variations in C stocks and composition could improve observational estimates of regional C stocks and their vulnerability to changing climatic conditions.

Wednesday, December 13, 2017 09:15–09:30
New Orleans Ernest N. Morial Convention Center – 386–387

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B33C-2098: Effects of ENSO-induced Extremes on Terrestrial Ecosystems

The El Niño Southern Oscillation (ENSO) with its warm (El Niño) and cold phase (La Niña) has well-known global impacts on the Earth system through the mechanism of teleconnections. Not only the global mean temperature and precipitation distributions will be changed but also the climate extremes will be enhanced during ENSO events. In this study, the advanced Earth System Model ACME version 0.3 was used to simulate terrestrial biogeochemistry and global climate from 1982 to 2020 with prescribed Sea Surface Temperature (SST) from data fusions of the NOAA high resolution daily Optimum Interpolation SST (OISST), CFS v2 9-month seasonal forecast and data reconstructions. We investigated how ENSO-induced climate extremes affect land carbon dynamics both regionally and globally and the implications for the functioning of different vegetated ecosystems under the influence of climate extremes. The results show that the ENSO-induced climate extremes, especially drought and heat waves, have significant impacts on the terrestrial carbon cycle. The responses to ENSO-induced climate extremes are divergent among different vegetation types.

Wednesday, December 13, 2017 13:40–18:00
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2098

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B34C-07: Spatiotemporal Analysis of Corn Phenoregions in the Continental United States

The delineation of regions exhibiting similar crop performance has potential benefits for agricultural planning and management, policymaking and natural resource conservation. Studies of natural ecosystems have used multivariate clustering algorithms based on environmental characteristics to identify ecoregions for species range prediction and habitat conservation. However, few studies have used clustering to delineate regions based on crop phenology. The aim of this study was to perform a spatiotemporal analysis of phenologically self-similar clusters, or phenoregions, for the major corn growing areas in the Continental United States (CONUS) for the period 2008–2016. Annual trajectories of remotely sensed normalized difference vegetation index (NDVI), a useful proxy for land surface phenology, derived from Moderate Resolution Spectroradiometer (MODIS) instruments at 8-day intervals and 250 m resolution was used as the phenological metric. Because of the large data volumes involved, the phenoregion delineation was performed using a highly scalable, unsupervised clustering technique with the help of high performance computing. These phenoregions capture the spatial variability in the timing of important crop phenological stages (like emergence and maturity dates) and thus could be used to develop more accurate parameterizations for crop models applied at regional to global scales. Moreover, historical crop performance from phenoregions, in combination with climate and soils data, could be used to improve production forecasts. The temporal variability in NDVI at each location could also be used to develop an early warning system to identify locations where the crop deviates from its expected phenological behavior. Such deviations may indicate a need for irrigation or fertilization or suggest where pest outbreaks or other disturbances have occurred.

Wednesday, December 13, 2017 17:30–17:45
New Orleans Ernest N. Morial Convention Center – 383–385

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B34A-08: Applying ILAMB to Data from Several Generations of the Community Land Model to Assess the Relative Contribution of Model Improvements and Forcing Uncertainty to Model-data Agreement

The International Land Model Benchmarking (ILAMB) project is a model-data intercomparison and integration project designed to assess and help improve land models. The current package includes assessment of more than 25 land variables across more than 60 global, regional, and site-level (e.g., FLUXNET) datasets. ILAMB employs a broad range of metrics including RMSE, mean error, spatial distributions, interannual variability, and functional relationships. Here, we apply ILAMB for the purpose of assessment of several generations of the Community Land Model (CLM4, CLM4.5, and CLM5). Encouragingly, CLM5, which is the result of model development over the last several years by more than 50 researchers from 15 different institutions, shows broad improvements across many ILAMB metrics including LAI, GPP, vegetation carbon stocks, and the historical net ecosystem carbon balance among others. We will also show that considerable uncertainty arises from the historical climate forcing data used (GSWP3v1 and CRUNCEPv7). ILAMB score variations due to forcing data can be as large for many variables as that due to model structural differences. Strengths and weaknesses and persistent biases across model generations will also be presented.

Wednesday, December 13, 2017 17:45–18:00
New Orleans Ernest N. Morial Convention Center – 388–390

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Thursday, December 14, 2017

B41E-2010: Soil Bulk Density by Soil Type, Land Use and Data Source: Putting the Error in SOC Estimates

An important part of SOC stock and pool assessment is the assessment, estimation, and application of bulk density estimates. The concept of bulk density is relatively simple (the mass of soil in a given volume), the specifics Bulk density can be difficult to measure in soils due to logistical and methodological constraints. While many estimates of SOC pools use legacy data in their estimates, few concerted efforts have been made to assess the process used to convert laboratory carbon concentration measurements and bulk density collection into volumetrically based SOC estimates. The methodologies used are particularly sensitive in wetlands and organic soils with high amounts of carbon and very low bulk densities. We will present an analysis across four database measurements: NCSS – the National Cooperative Soil Survey Characterization dataset, RaCA – the Rapid Carbon Assessment sample dataset, NWCA – the National Wetland Condition

Assessment, and ISCN – the International soil Carbon Network. The relationship between bulk density and soil organic carbon will be evaluated by dataset and land use/land cover information. Prediction methods (both regression and machine learning) will be compared and contrasted across datasets and available input information. The assessment and application of bulk density, including modeling, aggregation and error propagation will be evaluated. Finally, recommendations will be made about both the use of new data in soil survey products (such as SSURGO) and the use of that information as legacy data in SOC pool estimates.

Thursday, December 14, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2010

Authors:
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Dylan Beaudette (U.S. Department of Agriculture)
Zamir Libohova (U.S. Department of Agriculture)
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B41I-2078: Towards a Global Harmonized Permafrost Soil Organic Carbon Stock Estimates

Permafrost affected soils store disproportionately large amount of organic carbon stocks due to multiple cryopedogenic processes. Previous permafrost soil organic carbon (SOC) stock estimates used a variety of approaches and reported substantial uncertainty in SOC stocks of permafrost soils. Here, we used spatially referenced data of soil-forming factors (topographic attributes, land cover types, climate, and bedrock geology) and SOC pedon description data ($n = 2552$) in a regression kriging approach to predict the spatial and vertical heterogeneity of SOC stocks across the Northern Circumpolar and Tibetan permafrost regions. Our approach allowed us to take into account both environmental correlation and spatial autocorrelation to separately estimate SOC stocks and their spatial uncertainties (95% CI) for three depth intervals at 250 m spatial resolution. In Northern Circumpolar region, our results show 1278.1 (1009.33 – 1550.45) Pg C in 0–3 m depth interval, with 542.09 (451.83 – 610.15), 422.46 (306.48 – 550.82), and 313.55 (251.02 – 389.48) Pg C in 0–1, 1–2, and 2–3 m depth intervals, respectively. In Tibetan region, our results show 26.68 (9.82 – 79.92) Pg C in 0–3 m depth interval, with 13.98 (6.2 – 32.96), 6.49 (1.73 – 25.86), and 6.21 (1.889 – 20.90) Pg C in 0–1, 1–2, and 2–3 m depth intervals, respectively. Our estimates show large spatial variability (50 – 100% coefficient of variation, depending upon the study region and depth interval) and higher uncertainty range in comparison to existing estimates. We will present the observed controls of different environmental factors on SOC at the AGU meeting.

Thursday, December 14, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2078

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B41I-2083: The Influence of Soil Organic Matter Chemistry and Site/soil Properties in Predicting the Decomposability of Tundra Soils

With the increase in high latitude warming, there is a need to better understand the potential vulnerability of soil organic matter (SOM) stored in Arctic regions. In this study, we used mid infrared spectroscopy (MidIR) to determine the influence of soil chemistry and site properties in the short-term mineralization potential of SOM stored in tundra soils. Soils from the active and permafrost layers were collected from four tundra sites on the Coastal Plain, and Arctic Foothills of the North Slope of Alaska and were incubated for 60 days at a range of temperatures. Site and soil properties including acidic versus non-acidic tundra, lowland versus upland areas, total soil organic carbon (TOC) and total nitrogen (TN) concentrations, 60-day carbon mineralization potential (CMP), MidIR spectra and the chemical composition of the SOM stored in these soils were determined. Partial least squares (PLS) models for CMP versus MidIR spectra were produced upon splitting the dataset into site and soil properties categories. We found that SOM composition determined by MidIR spectroscopy was most effective in predicting CMP for tundra soils and it was most relevant for the active-layer mineral and upper permafrost soil horizons and/or soils with C concentrations of 10% or lower. Analysis of the factor loadings and standardized beta coefficients from the CMP PLS models indicated that spectral bands associated with clay contents, phenolic OH, aliphatic, silicates, carboxylic acids, and polysaccharides were influential for lower TOC soils, but these bands were less important for higher TOC soils. High TOC soils were influenced by a combination of other factors. Our results suggest that different factors affect the short-term CMP of SOM in tundra soils depending on the amount of TOC present. We show MidIR as a powerful tool for quickly and reasonably estimating the short-term CMP of tundra soils. Widespread application of MidIR measurements to already collected and archived tundra region soils could provide a quick and reliable assessment of the CMP of these soils, reduce the need for incubation studies, and contribute to upscaling and model benchmarking of SOM mineralization of tundra soils.

Thursday, December 14, 2017 08:00–12:20
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 2083

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H42B-08: Remote SST Forcing and Local Land-Atmosphere Moisture Coupling as Drivers of Amazon Temperature and Carbon Cycle Variability

Interannual variability of climatic conditions in the Amazon rainforest is associated with El Niño-Southern Oscillation (ENSO) and ocean-atmosphere interactions in the North Atlantic. Sea surface temperature (SST) anomalies in these remote ocean regions drive teleconnections with Amazonian surface air temperature (T), precipitation (P), and net ecosystem production (NEP). While SST-driven NEP anomalies have been primarily linked to T anomalies, it is unclear how much the T anomalies result directly from SST forcing of atmospheric circulation, and how much result indirectly from decreases in precipitation that, in turn, influence surface energy fluxes. Interannual variability of P associated with SST anomalies lead to variability in soil moisture (SM), which would indirectly affect T via partitioning of turbulent heat fluxes between the land surface and the atmosphere. To separate the direct and indirect influence of the SST signal on T and NEP, we performed a mechanism-denial experiment to decouple SST and SM anomalies. We used the Accelerated Climate Modeling for Energy (ACMEv0.3), with version 5 of the Community Atmosphere Model and version 4.5 of the Community Land Model. We forced the model with observed SSTs from 1982–2016.

We found that SST and SM variability both contribute to T and NEP anomalies in the Amazon, with relative contributions depending on lag time and location within the Amazon basin. SST anomalies associated with ENSO drive most of the T variability at shorter lag times, while the ENSO-driven SM anomalies contribute more to T variability at longer lag times. SM variability and the resulting influence on T anomalies are much stronger in the eastern Amazon than in the west. Comparing modeled T with observations demonstrate that SST alone is sufficient for simulating the correct timing of T variability, but SM anomalies are necessary for simulating the correct magnitude of the T variability. Modeled NEP indicated that variability in carbon fluxes results from both SST and SM anomalies. As with T, SM anomalies affect NEP at a much longer lag time than SST anomalies. These results highlight the role of land-atmosphere coupling in driving climate variability within the Amazon, and suggest that land atmospheric coupling may amplify and delay carbon cycle responses to ocean-atmosphere teleconnections.

Thursday, December 14, 2017 12:05–12:20
New Orleans Ernest N. Morial Convention Center – 293–294

Authors:
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Yang Chen (University of California Irvine)
James T. Randerson (University of California Irvine)
Forrest M. Hoffman (Oak Ridge National Laboratory)

GC43C-1086: Representation of Deforestation Impacts on Climate, Water, and Nutrient Cycles in the ACME Earth System Model

Deforestation causes a series of changes to the climate, water, and nutrient cycles. Employing a state-of-the-art earth system modelACME (Accelerated Climate Modeling for Energy), we comprehensively investigate the impacts of deforestation on these processes. We first assess the performance of the ACME Land Model (ALM) in simulating runoff, evapotranspiration, albedo, and

plant productivity at 42 FLUXNET sites. The single column mode of ACME is then used to examine climate effects (temperature cooling/warming) and responses of runoff, evapotranspiration, and nutrient fluxes to deforestation. This approach separates local effects of deforestation from global circulation effects. To better understand the deforestation effects in a global context, we use the coupled (atmosphere, land, and slab ocean) mode of ACME to demonstrate the impacts of deforestation on global climate, water, and nutrient fluxes. Preliminary results showed that the land component of ACME has advantages in simulating these processes and that local deforestation has potentially large impacts on runoff and atmospheric processes.

Thursday, December 14, 2017 13:40–18:00
New Orleans Ernest N. Morial Convention Center – Poster Hall D–F, 1086

Authors:
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Friday, December 15, 2017

GC51G-08: Changes in Land Cover and Terrestrial Biogeochemistry in the US: Key Findings from the Climate Science Special Report (CSSR)

The continual increase in annual average temperatures (1.0°C for the period 1901–2016 for the contiguous US), growing number of high temperature records, increasing intensity and frequency of heavy precipitation events in most parts of the US, and rising global mean sea level are among the key findings from the forthcoming Climate Science Special Report (CSSR) produced by the US Global Change Research Program (USGCRP). A chapter new to the climate science assessments directly addresses the feedbacks between climate change, land use and land cover change, and the carbon cycle. While the terrestrial biosphere is presently a net carbon sink, which has steadily increased since 1980, the future sign and magnitude of biosphere uptake cannot be determined because of uncertainties in the future trajectory of land cover and land use. Citing recent research, the chapter highlights that the combined effects of land use and land cover changes due to human activities account for $40\% \pm 16\%$ of the human-caused global radiative forcing from 1850 to present. Moverover, plant community structure has already been altered by climate change and changes in the frequency and intensity of extreme events. Changes in temperature also have direct effects on the land surface as well as feedbacks to the atmosphere. For example, the number of consecutive frost-free days and the length of the growing season have increased across all regions in the contiguous US; however, overall plant productivity has been limited by biotic factors and seasonal limitations in water and nutrient availability. Within cities, the urban heat island (UHI) effect results in daytime temperatures 0.5°C–4.0°C higher and nighttime temperatures 1.0°C–2.5°C higher in urban areas than surrounding rural areas. We discuss terrestrial and biogeochemical forcings and feedbacks that can serve as critical evaluation and paramaterization datasets for Earth system modeling approaches with implications for management of agriculture, forestry, and urban environments.

Friday, December 15, 2017 09:45–10:00
New Orleans Ernest N. Morial Convention Center – 267–268

Authors:
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Forrest M. Hoffman (Oak Ridge National Laboratory)
Deborah N. Huntzinger (Northern Arizona University)
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B53J-02: Carbon Cycle Extremes in the 22nd and 23rd Century and Attribution to Climate Drivers

Terrestrial ecosystems are affected by climate extremes such as droughts and heatwaves which have a potential to modify carbon budgets. Previous studies have found the impact of negative extremes in gross primary production (GPP) and net ecosystem production (NEP) to be diminishing towards the end of the 21^{st} century relative to the overall increase in global carbon uptake. A few studies have estimated that the land use changes (e.g. from forest to croplands) would cause more cumulative carbon loss between 1850 and 2300 than due to climate change caused by anthropogenic forcing over the same interval. However, not many studies have looked at the impact of carbon cycle extremes beyond 21^{st} century especially under with and without LULCC scenarios.

This study aims to analyze spatiotemporal extreme events in GPP and NEP using the model CESM1-BGC and understand the climate drivers they can be attributed to. Using the Community Earth System Model (CESM1-BGC), we investigated the impact of climate extremes on the terrestrial ecosystem using simulations forced by Representative Concentration Pathway 8.5 with and without land-use and land-cover change (LULCC). To capture non-linear feedbacks in the global carbon cycle, both these simulations were extended to the year 2300. It is important to understand the impacts of climate extremes on the carbon cycle for quantifying carbon-cycle climate feedback and estimating future atmospheric CO_2 levels and temperature increases. The results of this study would help improve our understanding of carbon cycle extremes and inform future mitigation policy.

Friday, December 15, 2017 13:55–14:10
New Orleans Ernest N. Morial Convention Center – 383–385

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B53J-05: Evaluating the Terrestrial Biogeochemical Responses and Feedbacks of Stratospheric Geoengineering Strategies

Stratospheric aerosol geoengineering options, involving injection of sulfur dioxide (SO_2) aerosols into the stratosphere, are being proposed to reduce the heating effects of increasing anthropogenic atmospheric carbon dioxide (CO_2). While the impacts of stratospheric aerosol geoengineering on climate changes, such as stratospheric ozone depletion and weakened monsoons, have been extensively investigated in the past few decades, few studies have considered the biogeochemical (BGC) responses and feedbacks on land. Previous Earth system model (ESM) simulations incorporating stratospheric aerosol geoengineering scenarios primarily focused on the atmospheric radiative forcing and temperature response in the absence of ocean and land responses. The land model setup in these simulations did not incorporate the carbon-nitrogen cycles and effects on the hydrological cycle considering vegetation responses. Since ESMs simulated very different aerosol distributions for the G3 and G4 scenarios in the Geoengineering Model Intercomparison Project (GeoMIP), we instead adopted the G4SSA scenario to simulate the BGC responses and feedbacks on land due to stratospheric aerosol geoengineering using the Community Earth System Model with active biogeochemical dynamic variations enabled. Implications for the terrestrial carbon cycle and hydrological responses will be presented.

Friday, December 15, 2017 14:40–14:55
New Orleans Ernest N. Morial Convention Center – 383–385

Authors:
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Joshua S. Fu (University of Tennessee)

GC54B-03: Future Flood Risk in the Tropics as Measured by Changes in Extreme Runoff Intensity is Strongly Influenced by Plant-physiological Responses to Rising CO_2

Climate change is expected to increase the frequency of intense flooding events, and thus the risk of flood-related mortality, infrastructure damage, and economic loss. Assessments of future flooding from global climate models based only on precipitation intensity and temperature neglect important processes that occur within the land-surface, particularly the impacts of plant-physiological responses to rising CO_2. Higher CO_2 reduces stomatal conductance, leading to less water loss through transpiration and higher soil moisture. For a given precipitation rate, higher soil moisture decreases the amount of rainwater that infiltrates the surface and increases runoff. Here we assess the relative impacts of plant-physiological and radiative-greenhouse effects on changes in extreme runoff intensity over tropical continents using the Community Earth System Model. We find that extreme percentile rates increase significantly more than mean runoff in response to higher CO_2. Plant-physiological effects contribute to only a small increase in precipitation intensity, but are a dominant driver of runoff intensification, contributing to one-half of the 99th percentile runoff intensity change and one-third of the 99.9th percentile change. Comprehensive assessments of future flooding risk need to account for the physiological as well as radiative impacts of CO_2 in order to better inform flood prediction and mitigation practices.

Friday, December 15, 2017 16:30–16:45
New Orleans Ernest N. Morial Convention Center – 265–266

Authors:
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James T. Randerson (University of California Irvine)

B54C-03: Atmospheric redistribution of reactive nitrogen and phosphorus by wildfires and implications for global carbon cycling (Invited)

Fires are an important process regulating the redistribution of nutrients within terrestrial ecosystems. Frequently burning ecosystems such as savannas are a net source of N and P to the atmosphere each year, with atmospheric transport and dry and wet deposition increasing nutrient availability in downwind ecosystems and over the open ocean. Transport of N and P aerosols from savanna fires within the Hadley circulation contributes to nutrient deposition over tropical forests, yielding an important cross-biome nutrient transfer. Pyrodenitrification of reactive N increases with fire temperature and modified combustion efficiency, generating a global net biospheric loss of approximately 14 Tg N per year. Here we analyze atmospheric N and P redistribution using the Global Fire Emissions Database version 4s and the Accelerated Climate Modeling for Energy earth system model. We synthesize literature estimates of N and P concentrations in fire-emitted aerosols and ecosystem mass balance measurements to help constrain model estimates of these biosphere-atmosphere fluxes. In our analysis, we estimate the fraction of terrestrial net primary production (NPP) that is sustained by fire-emitted P and reactive N from upwind ecosystems. We then evaluate how recent global declines in burned area in savanna and grassland ecosystems may be changing nutrient availability in downwind ecosystems.

Friday, December 15, 2017 16:30–16:45
New Orleans Ernest N. Morial Convention Center – 383–385

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Natalie Mahowald (Cornell University)

B54C-04: Improving Simulated Spatial Distribution of Productivity and Biomass in Amazon Forests using the ACME Land Model

Tropical forests play a crucial role in the global carbon cycle, accounting for one third of the global NPP and containing about 25% of global vegetation biomass and soil carbon. This is particularly true for tropical forests in the Amazon region, as it comprises approximately 50% of the worlds tropical forests. It is therefore important for us to understand and represent the processes that determine the fluxes and storage of carbon in these forests. In this study, we show that the implementation of phosphorus (P) cycle and P limitation in the ACME Land Model (ALM) improves simulated spatial pattern of NPP. The P-enabled ALM is able to capture the west-to-east gradient of productivity, consistent with field observations. We also show that by improving the representation of mortality processes, ALM is able to reproduce the observed spatial pattern of above ground biomass across the Amazon region.

Friday, December 15, 2017 16:45–17:00
New Orleans Ernest N. Morial Convention Center – 383–385

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Richard J. Norby (Oak Ridge National Laboratory)

B54C-06: Nitrogen and Phosphorus Plant Uptake During Periods with no Photosynthesis Accounts for About Half of Global Annual Uptake

Uncertainties in current Earth System Model (ESM) predictions of terrestrial carbon-climate feedbacks over the 21st century are as large as, or larger than, any other reported natural system uncertainties. Soil Organic Matter (SOM) decomposition and photosynthesis, the dominant fluxes in this regard, are tightly linked through nutrient availability, and the recent Coupled Model Intercomparison Project 5 (CMIP5) used for climate change assessment had no credible representations of these constraints. In response, many ESM land models (ESMLMs) have developed dynamic and coupled soil and plant nutrient cycles. Here we quantify terrestrial carbon cycle impacts from well-known observed plant nutrient uptake mechanisms ignored in most current ESMLMs. In particular, we estimate the global role of plant root nutrient competition with microbes and abiotic process at night and during the non-growing season using the ACME land model (ALMv1-ECA-CNP) that explicitly represents these dynamics. We first demonstrate that short-term nutrient uptake dynamics and competition between plants and microbes are accurately predicted by the model compared to ^{15}N and ^{33}P isotopic tracer measurements from more than 20 sites. We then show that global nighttime and non-growing season nitrogen and phosphorus uptake accounts for ∼46 and 45%, respectively, of annual uptake, with large latitudinal variation. Model experiments show that ignoring these plant uptake periods leads to large positive biases in annual N leaching (globally ∼58%) and N_2O emissions (globally ∼68%). Biases these large will affect modeled carbon cycle dynamics over time, and lead to predictions of ecosystems that have overly open nutrient cycles and therefore lower capacity to sequester carbon.

Friday, December 15, 2017 17:15–17:30
New Orleans Ernest N. Morial Convention Center – 383–385

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Jinyun Tang (Lawrence Berkeley National Laboratory)

B54C-07: Nutrient Cycle Benchmarks for Earth System Land Model

Projecting future biosphere-climate feedbacks using Earth system models (ESMs) relies heavily on robust modeling of land surface carbon dynamics. More importantly, soil nutrient (particularly, nitrogen (N) and phosphorus (P)) dynamics strongly modulate carbon dynamics, such as plant sequestration of atmospheric CO_2. Prevailing ESM land models all consider nitrogen as a potentially limiting nutrient, and several consider phosphorus. However, including nutrient cycle processes in

ESM land models potentially introduces large uncertainties that could be identified and addressed by improved observational constraints.

We describe the development of two nutrient cycle benchmarks for ESM land models: (1) nutrient partitioning between plants and soil microbes inferred from ^{15}N and ^{33}P tracers studies and (2) nutrient limitation effects on carbon cycle informed by long-term fertilization experiments. We used these benchmarks to evaluate critical hypotheses regarding nutrient cycling and their representation in ESMs. We found that a mechanistic representation of plant-microbe nutrient competition based on relevant functional traits best reproduced observed plant-microbe nutrient partitioning. We also found that for multiple-nutrient models (i.e., N and P), application of Liebigs law of the minimum is often inaccurate. Rather, the Multiple Nutrient Limitation (MNL) concept better reproduces observed carbon-nutrient interactions.

Friday, December 15, 2017 17:30–17:45
New Orleans Ernest N. Morial Convention Center – 383–385

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RUBISCO | REDUCING UNCERTAINTIES IN BIOGEOCHEMICAL INTERACTIONS THROUGH SYNTHESIS AND COMPUTATION

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