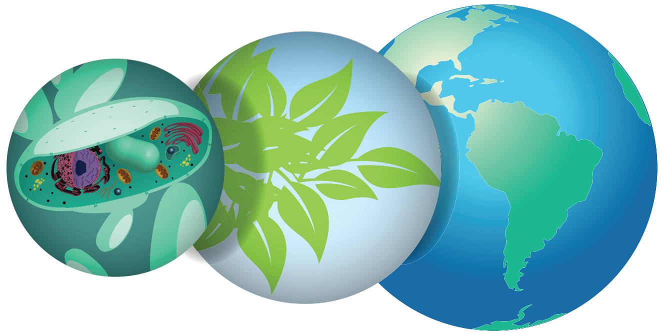
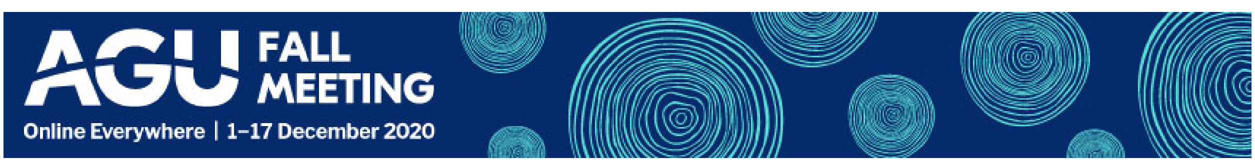


RUBISCO

REDUCING UNCERTAINTIES IN BIOGEOCHEMICAL INTERACTIONS THROUGH SYNTHESIS AND COMPUTATION

Laboratory Research Manager:
Forrest M. Hoffman (ORNL)
Senior Science Co-Lead:
William J. Riley (LBNL)
Chief Scientist:
James T. Randerson (University of California Irvine)
Technical Co-Managers, University Co-PIs, and Science Co-Leads:
Forrest M. Hoffman (ORNL), William J. Riley (LBNL), James T. Randerson (UCI), Scott M. Elliott (LANL), Gretchen Keppel-Aleks (UM), Charles D. Koven (LBNL), David M. Lawrence (NCAR), Yiqi Luo (NAU), Jiafu Mao (ORNL), Umakant Mishra (ANL), J. Keith Moore (UCI), and Shawn P. Serbin (BNL)

RUBISCO SFA Team Participation in the



American Geophysical Union (AGU) Fall Meeting
Online Everywhere
December 1–17, 2020

Argonne National Laboratory · Brookhaven National Laboratory · Berkeley Lab · Los Alamos National Laboratory · NAU · NCAR · Oak Ridge National Laboratory · UCI · Michigan

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2 Town Halls

Tuesday, December 1, 2020

TH004 - Collaborate with a DOE User Facility: Learn About Available Expertise and Resources, Open Call Opportunities, and Important Tips for Submitting Successful Proposals

Government-funded user facilities provide prestigious opportunities for academic, government, and industry researchers to enhance and accelerate their science at little to no cost. The U.S. Department of Energy, Office of Science, manages multiple user facilities dedicated to energy and environmental research. Through a competitive, peer-reviewed proposal process, scientists can collaborate with us to study biological and environmental functions, as well as matter and energy, at varying spatial and temporal scales.

In this session, participants will learn about:

- the role of user facilities in furthering national priorities such as energy security and predictive understanding of environmental processes,
- the expertise and instrumentation available at user facilities,
- examples of frontier-expanding energy and environmental research,
- numerous opportunities for collaborating with user facilities, and
- useful tips for submitting successful proposals.

Principal investigators, early career scientists, post-doctoral researchers, and graduate students from academic institutions, government laboratories, non-profits, and industry are invited to participate. Virtual and in-person speakers will include a mix of representatives from the Department of Energy and individual user facilities, as well as former and current researchers who regularly submit successful proposals. This is an exciting opportunity to start new collaborations, learn from experts how to navigate the proposal process, and help the science community push the boundaries of energy and environmental research.

Tuesday, December 1, 2020, 13:30–14:30
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/104182

Primary Contact:
Linda Isakson (Pacific Northwest National Laboratory)

Conveners:
Rolanda Jundt (Pacific Northwest National Laboratory)
David Gilbert (Lawrence Berkeley National Laboratory)

Moderator:
Linda Isakson (Pacific Northwest National Laboratory)

Presenters:
Paquita Zuidema (University of Miami)
Davinia Salvachua (National Renewable Energy Laboratory)
Mikayla Borton (Colorado State University)

Sharlene Weatherwax (U.S. Department of Energy)
Jeffrey Blanchard (University of Massachusetts Amherst)

Wednesday, December 2, 2020

TH011 - Science and Deployment Plan for the DOE Third Atmospheric Radiation Measurement Mobile Facility: Coupled Observational–Modeling Studies of Land–Aerosol–Cloud Interactions in the Southeastern United States

The DOE Atmospheric Radiation Measurement (ARM) user facility will be relocating the third ARM Mobility Facility (AMF3) to the Southeastern United States (SEUS) for a five year deployment starting in the fall of 2022. The AMF3 SEUS site science team is working with ARM and the larger scientific community to guide the siting of the new deployment to address critical science focal areas spanning five cross-cutting topics: convective cloud initiation, deep convective cloud processes, aerosol controls on cloud condensation nuclei, aerosol direct impacts on radiation, and land-atmosphere two-way interactions. This campaign will enable a wide range of observational, analysis, and modeling studies to characterize the relationships between local and regional weather patterns and surface processes across a patchwork of natural, managed, and anthropogenic landscapes in the SEUS region. The target audience for this town hall includes: the atmospheric and terrestrial ecosystem science communities, program managers across funding agencies (DOE BER/ESS, NASA, NSF, USDA), and SEUS partners and users of other related measurement networks (e.g. NEON). The goals of the proposed town hall are to present and solicit feedback on: scientific goals of the SEUS deployment, siting maps that meet operational and scientific requirements, and targeted field campaigns.

Wednesday, December 2, 2020, 10:00–11:00
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/104536

Primary Contact:
Chongai Kuang (Brookhaven National Laboratory)

Presenters:
Scott E. Giangrande (Brookhaven National Laboratory)
Shawn P. Serbin (Brookhaven National Laboratory)

Sections:
Hydrology
Global Environmental Change
Earth and Planetary Surface Processes
Biogeosciences
Atmospheric Sciences

Cross-Listed:
H - Hydrology
GC - Global Environmental Change
EP - Earth and Planetary Surface Processes
B - Biogeosciences
A - Atmospheric Sciences

Thursday, December 3, 2020

TH024 - DOE's Research in Multisector Dynamics: Emerging Field, Opportunities, and Connections Within Earth and Environmental Systems Science

DOE research in MultiSector Dynamics (MSD) is transforming the way scientists explore complex landscapes and the multi-scale interactions involving human and natural systems, sectors, and the influences and stressors that shape their evolution. Accompanying data, modeling, and analysis frameworks are reaching across traditional research domains in ways that have given rise to a new and emerging interdisciplinary field and community-of-practice. This Town Hall explores DOE's role in MSD research, the implications for insights into topics ranging from coastal science and integrated hydro-terrestrial modeling to global and regional Earth system predictability, and DOE's foundational role in the creation of this new field.

Thursday, December 3, 2020, 19:00–20:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/103809`

Primary Contact:
Robert Vallario (U.S. Department of Energy)

Presenters:
Gerald L. Geernaert (U.S. Department of Energy)
Xujing Davis (U.S. Department of Energy)
Patrick M. Reed (Cornell University)
Dave Judi (Pacific Northwest National Laboratory)
Jennie Rice (Pacific Northwest National Laboratory)
Jennifer F. Morris (Massachusetts Institute of Technology)

Sections:
Science and Society
Natural Hazards
Hydrology
Global Environmental Change
Biogeosciences

Cross-Listed:
SY - Science and Society
NH - Natural Hazards
H - Hydrology
GC - Global Environmental Change
B - Biogeosciences

Tuesday, December 8, 2020

TH044 - AmeriFlux: Bringing People, Ecosystems, and Data Together

As of this writing in April 2020, scientists in many countries are working under stay-at-home orders. Although the AmeriFlux network has strong virtual connectivity and ecosystem flux research continues apace, 2020 brings a field (and education) season like no other. Therefore, in addition to popular AmeriFlux town hall activities, this year we are adding new activities. For the former, come learn about opportunities for 2021 and news of the network. We will wrap up the first theme year, on Methane, and launch the next. Celebrate successes, like honors to colleagues, funding opportunities, and new data products. Join a conversation with other flux scientists and chart priorities for the AmeriFlux Management Project (AMP). New for this year, we'll launch activities for mentoring, connecting, and collaborating—which can take place locally or virtually, designed for people at different career levels, experience with fluxes, and locations across the Americas and world. These will include regional mini-workshops and facilitating peer-to-peer mentoring. The town hall will feature short, structured interactions to strengthen and celebrate our connections. This town hall is hosted by AMP and attracts a broad audience of ecologists and Earth scientists, early career and senior, from around the world. See you there!

Tuesday, December 8, 2020, 10:00–11:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/105027`

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

Presenters:
Deb Agarwal (Lawrence Berkeley National Laboratory)
Margaret S. Torn (Lawrence Berkeley National Laboratory)
Sébastien Biraud (Lawrence Berkeley National Laboratory)
Trevor F. Keenan (Lawrence Berkeley National Laboratory)
Dario Papale (University of Tuscia)
Daniel B. Stover (U.S. Department of Energy)

Sections:
Hydrology
Global Environmental Change
General
Cryosphere
Biogeosciences
Atmospheric Sciences

Cross-Listed:
H - Hydrology
GC - Global Environmental Change
C - Cryosphere
B - Biogeosciences
A - Atmospheric Sciences

TH048 - DOE's Strategic Development in Coastal Research: Advancing a Coupled Model–Experiment Research Approach in U.S. Coastal Zones

Coastal systems are a highly dynamic component of the Earth system, developed from a near balance between land-aquatic interfaces and strongly influenced by natural, anthropogenic and variable weather and climatic drivers. While coastal systems play a critical role in biogeochemical cycling with the potential to provide major feedbacks to the Earth system, they are inadequately captured in process, ecosystem, regional, sectoral, and Earth system models. DOE has recently launched three new efforts that will examine coastal processes/activities in the mid-Atlantic, Alaskan and Great Lakes regions. The goal of this session is to highlight ongoing developments using a coupled model-experimental approach related to DOE's strategic research priorities. Additionally, this town hall will enable a community dialog to explore potential linkages to other community efforts and encourage coastal research collaborations.

Tuesday, December 8, 2020, 13:30–14:30
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/101772

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

Moderators:
Renu Joseph (U.S. Department of Energy)
Paul E. Bayer (U.S. Department of Energy)
Robert Vallario (U.S. Department of Energy)
Jennifer S. Arrigo (U.S. Department of Energy)

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

Sections:
Hydrology
Global Environmental Change
General
Biogeosciences

Cross-Listed:
OS - Ocean Sciences H - Hydrology
GC - Global Environmental Change
B - Biogeosciences

TH051 - The Surface Atmosphere Integrated Field Laboratory (SAIL) ARM Mobile Facility Campaign for Mountainous Hydrology Research

This Town Hall will introduce the Surface Atmosphere Integrated Field Laboratory (SAIL) campaign, wherein the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Program will deploy its second Mobile Facility (AMF2) to the Upper Gunnison Basin's East River Watershed, located in the Elk Mountain range of the Colorado Rocky Mountains between September 2021 and June 2023. The AMF2 atmospheric observatory will use a suite of 3-dozen instruments to measure precipitation, aerosols, radiation, clouds, winds, temperature, humidity, and surface fluxes throughout the campaign.

As an integrated field laboratory, SAIL will be collocated, and work in close concert with the DOE Subsurface Biogeochemistry Research (SBR) program's Watershed Function Scientific Focus Area (SFA), which is investigating surface and subsurface hydrology, biology, and chemistry in the same watershed. Together, these observations will quantify and characterize the major hydrological and atmospheric processes and their interactions that impact water and energy balances in the atmosphere-through-bedrock continuum within the East River Watershed.

The target audience includes the mountain research community including atmospheric scientists, hydrologists, snow scientists, and process and Earth System modelers, program managers (DOE BER, NASA, NSF, NOAA). The primary goal of this Town Hall is to engage and foster collaborations with the audience, so we will discuss the SAIL campaign observations, the process studies that the data can enable, and how the campaign can be used to confront and benchmark a wide range of models. We will also allocate significant time to discuss the potential science that SAIL data can enable, community data needs and interests, and opportunities for community participation and agency collaborations with the campaign.

Tuesday, December 8, 2020, 19:00–20:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/104755`

Primary Contact:
Daniel Feldman (Lawrence Berkeley National Laboratory)

Presenters:
V. Chandrasekar (Colorado State University)
Allison C. Aiken (Los Alamos National Laboratory)
Jiwen Fan (Pacific Northwest National Laboratory)
Kenneth H. Williams (Lawrence Berkeley National Laboratory)
Jeffrey S. Deems (National Snow and Ice Data Center)
David Gochis (National Center for Atmospheric Research)
L. Ruby Leung (Pacific Northwest National Laboratory)

Sections:
Hydrology
Global Environmental Change
Cryosphere
Atmospheric Sciences

Cross-Listed:
H - Hydrology
GC - Global Environmental Change
C - Cryosphere
A - Atmospheric Sciences

Friday, December 11, 2020

TH076 - U.S. Global Change Research Program (USGCRP) Interagency Working Group on Integrated Observations Celebrates 30 Years of Agency Observations

The US Global Change Research Program (USGCRP) is celebrating 30 years of advancing global change science and understanding. This town hall, hosted by the USGCRP Interagency Working Group on Integrated Observations (ObsIWG), will highlight advances in observational capabilities and agency research efforts over the past 30 years that are relevant to climate and global change, focusing on interagency coordinated observational activities. A discussion period will follow allowing for the community to engage with members of the ObsIWG about opportunities for enhanced coordination of future observational efforts.

Friday, December 11, 2020, 22:00–23:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/105510`

Primary Contact:
Diane Stanitski (NOAA ESRL Global Monitoring Laboratory)

Moderators:
Diane Stanitski (NOAA ESRL Global Monitoring Laboratory)

Sally A. McFarlane (U.S. Department of Energy)
Barry L. Lefer (NASA Headquarters)
Monika Kopacz (NOAA)

Presenters:
James H. Crawford (NASA Langley Research Center)
Olga V. Kalashnikova (NASA Jet Propulsion Laboratory)
Gregory J. Frost (Chemical Sciences Laboratory)
Ravan Ahmadov (NOAA ESRL/CSL)
Jessica L. McCarty (Miami University Oxford)
Carlos R. Mechoso (University of California Los Angeles)
Chris W. Fairall (NOAA Boulder)
Christopher S. Bretherton (Vulcan, Inc.)
Yangang Liu (Brookhaven National Laboratory)
Rene Garreaud (University of Chile)

Sections:
Ocean Sciences Global Environmental Change
General
Atmospheric Sciences

Cross-Listed:
OS - Ocean Sciences
GC - Global Environmental Change
A - Atmospheric Sciences

Tuesday, December 15, 2020

TH089 - Environmental System Science Priorities at the U.S. Department of Energy

The Environmental Systems Science (ESS) program, in the US Department of Energy's Office of Science, supports fundamental research needed to unravel the coupled physical, chemical, and biological processes that control the structure and functioning of terrestrial ecosystems and integrated watersheds across critical spatial and temporal scales. The goal is to advance robust, predictive understanding of these systems for use in Earth system, ecosystem and reactive transport models. Comprised of Terrestrial Ecosystem System Science (TES) and Subsurface Biogeochemical Research (SBR), the interdisciplinary research community supported by ESS addresses these complex questions using a systems approach, combining iterative model-driven experimentation and observation, new measurements, field studies, manipulative studies, and state of the art models. At this Town Hall, Program Managers will provide updates on the ESS portfolios and strategies, including linkages to other programs within Biological and Environmental Research (BER) at DOE and across other federal agencies. Finally, programmatic priorities for funding opportunities will be described, including both scientific and infrastructure needs. Significant time for discussion and questions will follow these brief presentations.

Tuesday, December 15, 2020, 13:00–14:00
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/102783

Primary Contact:
Jennifer S. Arrigo (U.S. Department of Energy)

Moderator:
Jennifer S. Arrigo (U.S. Department of Energy)

Presenters:
Gerald L. Geernaert (U.S. Department of Energy)
Daniel B. Stover (U.S. Department of Energy)
Paul E. Bayer (U.S. Department of Energy)

Sections:
Hydrology
Global Environmental Change
General
Biogeosciences

Cross-Listed:
H - Hydrology
GC - Global Environmental Change
B - Biogeosciences

3 Sessions Organized

Tuesday, December 8, 2020

B019 - Improving Earth System Predictability: New Mechanisms, Feedbacks, and Approaches for Predicting Global Biogeochemical Cycles in Earth System Models II Posters

Predictions of future atmospheric CO_2 levels are influenced by global carbon and nutrient cycles, climate interactions, and feedbacks to the Earth system. Relevant processes operate at different spatial and temporal scales and vary across terrestrial, coastal, and marine ecosystems. Uncertain biogeochemical feedbacks may be altered by anthropogenic disturbance agents, including tropospheric O_3, acceleration of nutrient and hydrological cycles, eutrophication, acidification, land cover/land use change, and potential climate intervention strategies. This session focuses on integrated understanding of feedback mechanisms that improve Earth system predictability, methods for evaluating and benchmarking process representations in Earth system models, approaches for constraining future climate projections (e.g., emergent constraints), and novel applications of artificial intelligence and machine learning for improving predictive understanding of global biogeochemical cycles.

Tuesday, December 8, 2020, 07:00–23:59
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/104004`

Type: Poster

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

Conveners:
Cheryl S. Harrison (University of Texas Rio Grande Valley)
Cheng-En Yang (University of Tennessee)

Chairs:
Forrest M. Hoffman (Oak Ridge National Laboratory)
Cheryl S. Harrison (University of Texas Rio Grande Valley)
Cheng-En Yang (University of Tennessee)

OSPA Liaison:
Cheryl S. Harrison (University of Texas Rio Grande Valley)

Index Terms:
0428 Carbon cycling
0439 Ecosystems, structure and dynamics
1615 Biogeochemical cycles, processes, and modeling
1622 Earth system modeling

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Climate - SWIRL

Cross-Listed:
OS - Ocean Sciences
GC - Global Environmental Change

Co-Sponsored:
ESA: Ecological Society of America

B024 - Improving Earth System Predictability: New Mechanisms, Feedbacks, and Approaches for Predicting Global Biogeochemical Cycles in Earth System Models I

Predictions of future atmospheric CO_2 levels are influenced by global carbon and nutrient cycles, climate interactions, and feedbacks to the Earth system. Relevant processes operate at different spatial and temporal scales and vary across terrestrial, coastal, and marine ecosystems. Uncertain biogeochemical feedbacks may be altered by anthropogenic disturbance agents, including tropospheric O_3, acceleration of nutrient and hydrological cycles, eutrophication, acidification, land cover/land use change, and potential climate intervention strategies. This session focuses on integrated understanding of feedback mechanisms that improve Earth system predictability, methods for evaluating and benchmarking process representations in Earth system models, approaches for constraining future climate projections (e.g., emergent constraints), and novel applications of artificial intelligence and machine learning for improving predictive understanding of global biogeochemical cycles.

Tuesday, December 8, 2020, 13:30–14:30
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/110870`

Type: Oral

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

Conveners:
Cheryl S. Harrison (University of Texas Rio Grande Valley)
Cheng-En Yang (University of Tennessee)

Chairs:
Forrest M. Hoffman (Oak Ridge National Laboratory)
Cheryl S. Harrison (University of Texas Rio Grande Valley)
Cheng-En Yang (University of Tennessee)

OSPA Liaison:
Cheryl S. Harrison (University of Texas Rio Grande Valley)

Index Terms:
0428 Carbon cycling
0439 Ecosystems, structure and dynamics
1615 Biogeochemical cycles, processes, and modeling
1622 Earth system modeling

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Climate - SWIRL

Cross-Listed:
OS - Ocean Sciences
GC - Global Environmental Change

Co-Sponsored:
ESA: Ecological Society of America

Wednesday, December 9, 2020

H072 - Soil, Plant, and Climate Interactions in the Critical Zone Under Varying Land Use, Ecosystem Management, and Climatic Forcing I

Understanding of the physical-mechanisms underlying water, carbon, and nutrient cycling at the land-atmosphere interface rely on our perception of the climate-soil-vegetation interactions. For instance, land-use changes, ecosystem management, and climate variability alter the functionality of the Critical Zone, with potential implications for water resources, primary productivity, carbon sequestration, and land-atmosphere interaction. Despite the advances over the past decades, characterizing the effect of natural/human disturbances still necessitates a fundamental understanding of the interactions between hydrological, physical, and biogeochemical processes across spatiotemporal scales and biomes. Here, we solicit contributions aimed at building a mechanistic understanding of such interactions under different land-use changes, ecosystem management strategies, and climate forcings, through theoretical, modeling, experimental, and data analysis approaches. We welcome contributions that investigate fundamental and applied questions ranging from water and nutrient cycles to ecosystem productivity, water-carbon coupling to climate-soil-vegetation coevolution, plant water, and nutrient use efficiencies, ecological optimality, mineral-water interactions, and soil-carbon sequestration.

Wednesday, December 9, 2020, 19:00–20:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/109146`

Type: Oral

Primary Convener:
Salvatore Calabrese (Texas A&M University)

Conveners:
Guta Wakbulcho Abeshu (University of Houston)
Binayak Mohanty (Texas A&M University)
Hong-Yi Li (University of Houston)
William J. Riley (Lawrence Berkeley National Laboratory)

Chairs:
Salvatore Calabrese (Texas A&M University)
Binayak Mohanty (Texas A&M University)
Hong-Yi Li (University of Houston)
Guta Wakbulcho Abeshu (University of Houston)

OSPA Liaison:
Binayak Mohanty (Texas A&M University)

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Soils - SWIRL

Cross-Listed:
EP - Earth and Planetary Surface Processes B - Biogeosciences

Trans-Disciplinary:
B - Biogeosciences

Thursday, December 10, 2020

B051 - Understanding Phenological Responses and Feedbacks in Terrestrial Vegetation: Patterns, Mechanisms, and Consequences II Posters

Phenology is an integrative and sensitive indicator of ecosystem health and function that responds to climate, water and nutrient availability, disturbance, and environmental change. Understanding phenological responses to environmental change across spatial and temporal scales is critical for forecasting shifts in species activity and associated changes in biogeochemical cycling, landscape dynamics, and ecological processes. This session features recent advances in characterizing the spatio-temporal patterns in vegetation phenology using a variety of methods (e.g., satellite, drones, webcams, in situ measurements); determining underlying mechanistic processes; developing accurate model representations of vegetation phenology; and investigating phenological implications to key land surface processes and society.

Thursday, December 10, 2020, 07:00–23:59
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/103750`

Type: Poster

Primary Convener:
Jitendra Kumar (Oak Ridge National Laboratory)

Conveners:
William W. Hargrove (USDA Forest Service)
Min Chen (Pacific Northwest National Laboratory)
Jin Wu (Brookhaven National Laboratory)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0439 Ecosystems, structure and dynamics
0466 Modeling
0480 Remote sensing

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Climate - SWIRL

Cross-Listed:
IN - Earth and Space Science Informatics
GC - Global Environmental Change

B055 - Understanding Phenological Responses and Feedbacks in Terrestrial Vegetation: Patterns, Mechanisms, and Consequences I

Phenology is an integrative and sensitive indicator of ecosystem health and function that responds to climate, water and nutrient availability, disturbance, and environmental change. Understanding phenological responses to environmental change across spatial and temporal scales is critical for forecasting shifts in species activity and associated changes in biogeochemical cycling, landscape dynamics, and ecological processes. This session features recent advances in characterizing the spatio-temporal patterns in vegetation phenology using a variety of methods (e.g., satellite, drones, webcams, in situ measurements); determining underlying mechanistic processes; developing accurate model representations of vegetation phenology; and investigating phenological implications to key land surface processes and society.

Thursday, December 10, 2020, 19:00–20:00
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/110895

Type: Oral

Primary Convener:
Jitendra Kumar (Oak Ridge National Laboratory)

Conveners:
William W. Hargrove (USDA Forest Service)
Min Chen (Pacific Northwest National Laboratory)
Jin Wu (Brookhaven National Laboratory)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
0439 Ecosystems, structure and dynamics
0466 Modeling
0480 Remote sensing

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Climate - SWIRL

Cross-Listed:
IN - Earth and Space Science Informatics
GC - Global Environmental Change

H099 - Soil, Plant, and Climate Interactions in the Critical Zone Under Varying Land Use, Ecosystem Management, and Climatic Forcing II eLightning

Understanding of the physical-mechanisms underlying water, carbon, and nutrient cycling at the land-atmosphere interface rely on our perception of the climate-soil-vegetation interactions. For instance, land-use changes, ecosystem management, and climate variability alter the functionality of the Critical Zone, with potential implications for water resources, primary productivity, carbon sequestration, and land-atmosphere interaction. Despite the advances over the past decades, characterizing the effect of natural/human disturbances still necessitates a fundamental understanding of the interactions between hydrological, physical, and biogeochemical processes across spatiotemporal scales and biomes. Here, we solicit contributions aimed at building a mechanistic understanding of such interactions under different land-use changes, ecosystem management strategies, and climate forcings, through theoretical, modeling, experimental, and data analysis approaches. We welcome contributions that investigate fundamental and applied questions ranging from water and nutrient cycles to ecosystem productivity, water-carbon coupling to climate-soil-vegetation coevolution, plant water, and nutrient use efficiencies, ecological optimality, mineral-water interactions, and soil-carbon sequestration.

Thursday, December 10, 2020, 19:00–20:00
https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/107724

Type: eLightning

Primary Convener:
Salvatore Calabrese (Texas A&M University)

Conveners:
Binayak Mohanty (Texas A&M University)
Hong-Yi Li (University of Houston)
Guta Wakbulcho Abeshu (University of Houston)
William J. Riley (Lawrence Berkeley National Laboratory)

Chairs:
Binayak Mohanty (Texas A&M University)
Guta Wakbulcho Abeshu (University of Houston)
Salvatore Calabrese (Texas A&M University)

OSPA Liaison:
Hong-Yi Li (University of Houston)

Index Terms:
0414 Biogeochemical cycles, processes, and modeling
1807 Climate impacts
1813 Eco-hydrology
1834 Human impacts

Neighborhoods:
3. Earth Covering

SWIRLs and Tracks:
Soils - SWIRL

Cross-Listed:
EP - Earth and Planetary Surface Processes B - Biogeosciences

Trans-Disciplinary:
B - Biogeosciences

Co-Organized:
Biogeosciences

H104 - Soil, Plant, and Climate Interactions in the Critical Zone Under Varying Land Use, Ecosystem Management, and Climatic Forcing III eLightning

Understanding of the physical-mechanisms underlying water, carbon, and nutrient cycling at the land-atmosphere interface rely on our perception of the climate-soil-vegetation interactions. For instance, land-use changes, ecosystem management, and climate variability alter the functionality of the Critical Zone, with potential implications for water resources, primary productivity, carbon sequestration, and land-atmosphere interaction. Despite the advances over the past decades, characterizing the effect of natural/human disturbances still necessitates a fundamental understanding of the interactions between hydrological, physical, and biogeochemical processes across spatiotemporal scales and biomes. Here, we solicit contributions aimed at building a mechanistic understanding of such interactions under different land-use changes, ecosystem management strategies, and climate forcings, through theoretical, modeling, experimental, and data analysis approaches. We welcome contributions that investigate fundamental and applied questions ranging from water and nutrient cycles to ecosystem productivity, water-carbon coupling to climate-soil-vegetation coevolution, plant water, and nutrient use efficiencies, ecological optimality, mineral-water interactions, and soil-carbon sequestration.

Thursday, December 10, 2020, 22:00–23:00
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Session/111525`

Type: eLightning

Primary Convener:
Salvatore Calabrese (Texas A&M University)

Conveners:
Binayak Mohanty (Texas A&M University)
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3. Earth Covering

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Biogeosciences

4 Presentation Abstracts

Monday, December 7, 2020

H006-0003 - Developing a Gridded Upscaled Soil Moisture Dataset Using Sparse *in situ* Observations

Abstract
Soil moisture is an important variable for studying global hydrological processes. Existing gridded soil moisture datasets are from data assimilation products, remote sensing, and land surface models, which are subject to considerable bias due to satellite data retrieval and modeling errors. In recent years, there has been much interest in upscaling *in situ* observations of ecosystem variables (e.g. evapotranspiration, gross primary productivity) to generate gridded datasets using machine learning methods. Such procedure can be similarly applied to develop upscaled gridded soil moisture datasets, which will have different error sources than existing gridded soil moisture products, and can serve as a useful alternative for data cross-checking, model evaluation, and empirical analysis. In this research, global soil moisture observations are assembled from the International Soil Moisture Network, FLUXNET, and the Canadian Global Water Futures. Random forest models are fitted between soil moisture at different depths and a variety of predictors (meteorological conditions, vegetation, soil properties, land cover, and topography), for each ecosystem type and snow/non-snow/growing/non-growing seasons. In the next step, the models will be applied with global gridded meteorological, vegetation, soil, land cover, and topography datasets to obtain global gridded long-term soil moisture product.

Monday, December 7, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/776002

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GC018-03 - Deforestation Strengthens Dust Transport from North Africa to the Amazon

Abstract
Atmospheric mineral dust originating from Africa contains micronutrients that fertilize both surface marine ecosystem in Atlantic Ocean and tropical forest in Amazonia. However, the mechanism of land use and land cover change (LULCC) impacts on such nutrient transport pathway remain poorly understood. In this presentation, we use the Community Earth System Model (CESM) to investigate how large-scale deforestation affects the dust transport and deposition in the tropics. We find that surface biophysical changes (i.e., albedo increase, evapotranspiration and surface roughness decline) that accompany deforestation produce a warmer, drier and windier surface environment, which enhances the long-range dust transport from North Africa to the Amazon. Tropics-wide deforestation weakens Hadley circulation (HC) through reducing the surface latent heating that weakens the vertical velocity in deep tropics. The weakened upward branch of HC tends to force the tropical air poleward and this shift of more stable air tends to increase subtropical

static stability. Such atmospheric perturbation is related to the poleward expansion of HC that leads to the increase of local surface air pressure in North Africa. Local northeasterly winds increase accordingly and make the dust in North Africa more easily to be transported across the tropical North Atlantic Ocean. We estimate that the annual atmospheric phosphorus deposition from dust thereby increases by about 26±25% in the Amazon. Our results exemplify how LULCC can modify the tropical nutrient transport, the change of which may have important implications for the long-term changes in productivity and biodiversity of tropical ecosystems.

Monday, December 7, 2020, 20:38–20:42 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/689478

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GC018-05 - Disentangling Contributions of Climate Change and Land Use to Global Flood Change

Abstract
The mortality and economic losses caused by floods are increasing. In fact, the top 10 costliest floods since 1900 are all occurred over the past thirty years. On the one hand, this is the result of economy development, but on the other hand the hydrological cycle was largely intensified by climate change and human activities, particularly land use change. Disentangling these effects on flood risk change is very challenging due to the compound nature of the driving factors. Using the best available long-term historical climate forcing and a land surface model that is capable of representing the hydrological effects of land use, here we attempted to compare the effects on flood risk between climate change and land use. Results showed that over the past 110 years, climate change's effects were mixed, strong, and widespread, while land use's contributions were dominantly increase, modest, and restricted to the areas with large land use changes. However, when we aggregated their effects over large regions (e.g., major river basins), flood risk increase from land use may surpass that from climate change, as climate change's effects offset from locations to locations within regions. This suggests that we have to reduce large-scale deforestation to avoid the catastrophic consequence of floods from the compounding effects of climate change and large-scale deforestation.

Monday, December 7, 2020, 20:46–20:50 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/748781

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Tuesday, December 8, 2020

B019-0003 - Country-Level Carbon Sequestration Potential by the Middle of the 21st Century

Abstract
Countries have long been making efforts by reducing emissions of greenhouse gases to mitigate climate change. In the agreements of the United Nations Framework Convention on Climate Change, involved countries have committed to reduction targets. However, carbon (C) sink by natural ecosystems has been difficult to quantify. Using a transient traceability framework, we quantified country-level C sequestration potential by natural terrestrial ecosystems by the middle of the 21st century based on simulations of 12 CMIP5 Earth System Models under RCP8.5. The top 20 countries that have the highest C sequestration potential has the potential to sequester 62 Pg C by the middle of this century. Among the top 20 countries, Russia, Canada, United States, China, and Brazil sequester the most. The dominant forces to drive carbon sequestration are changes in net primary production and C residence time. Our results highlight that model-based estimates of land C sequestration may potentially offset a substantial proportion of greenhouse-gas emissions, especially for countries with a large change in NPP and long inherent residence time.

Tuesday, December 8, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/706677

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B019-0005 - Dissolved Organic Carbon in Arctic Rivers: Reduced Model with Functional Groups

Abstract
Boreal river systems play a crucial role in high latitude change as they carry the highest terrestrial input of all aquatic flow to the sea. This includes a massive dissolved organic flux, injected directly to the climatologically sensitive Arctic Ocean. The dissolved organics imply chemical functional groups that interact with coastal and open ocean biophysical properties such as light attenuation, surface tension, trace metal chelation and aerosol formation. We have performed reduced kinetic modeling for organic matter evolution along an idealized Siberian river. We studied reactivity, networking and fate for the major macromolecular groups based on their diverse structures: sugar, lipids, proteins, heteropolycondensate and humic substance are all considered. We found that along the stream course, chemical reactivity is slow relative to the coastal or open ocean, but mixing at tributary nodes plays a dominant role. Concentrations for the various carbon compounds stagger at connecting points based specifically on sourcing from the different Arctic sub-ecosystems: taiga, tundra, woodland, peat, bog and others. Even so, photochemical and microbial losses contribute to the final mix and along coastlines biophysical impacts are extreme. For example the chromophoric dissolved organic matter or CDOM attenuates at a one versus ten meter e-fold depending on

upstream ecology. Soil-runoff and deltaic (pre- versus post-) processing also exert discrimination on the functional distribution and aquatic chemical influence. Further investigation is necessary and ongoing, through an increase in the number of connection points dictating dilution and mixing. And we are hoping to investigate the interaction of humics as flocculants with mineral particles, since they are capable of removing turbidity as ionic strength rises in the plume.

Tuesday, December 8, 2020, 07:00–23:59 EST
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B019-0009 - Detection and Attribution of Climate-Driven Extremes in Net Biome Productivity from 1850 through 2100

Abstract
Terrestrial ecosystems take up about one-third of total anthropogenic carbon emissions, providing a check on rising atmospheric CO_2 concentration. While increases in CO_2 fertilization and water use efficiency increase vegetation productivity under rising atmospheric CO_2 levels, rising surface temperature often leads to a reduction in available soil moisture and an increase in plant respiration. This results in varying spatial and temporal responses of net biome production (NBP) and the strength of the land carbon sink. The latest generation of Earth system models and observations have shown that the increase in vegetation productivity could reach a tipping point beyond which the respiration losses could be higher than photosynthetic capacity, as the surface temperatures get higher than the optimum growing temperature of plants. However, the impacts of future climate on extremes in NBP is unknown. We investigated NBP extremes in the Community Earth System Model (CESM2) from 1850 through 2100 and attributed the NBP extremes to individual and compound effects of climate drivers. Preliminary results showed a net increase in the frequency of negative extremes in NBP, with anomalous reductions in soil moisture as the most dominant climate driver. We found increased variability in vegetation growth due to rising CO_2 emissions through the study of extremes in NBP. A larger increase in the frequency and intensity of negative extremes in NBP than positive extremes in NBP indicates persistent extremes-driven reductions in vegetation growth in the future, and this imbalance could lead to a net reduction in terrestrial carbon uptake capacity and carbon storage when ecosystem respiration exceeds photosynthesis. The consequences of declining NBP and increasing negative extremes in NBP may result in global reduction in plant productivity and crop yield, even as the demand for vegetation is increasing due to rising demand for food, fiber, fuel, and building material.

Tuesday, December 8, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/756624

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B019-0010 - Have Land Surface and Carbon Cycle Processes in Earth System Models Improved Over Time?

Abstract
Better representation of biogeochemistry–climate feedbacks and ecosystem processes in Earth system models (ESMs) is essential for reducing uncertainties associated with projections of climate change during the remainder of the 21st century and beyond. Model–data comparison and integration activities are required to inform improvement of land carbon cycle models and the design of new measurement campaigns aimed at reducing uncertainties associated with key land surface processes. The International Land Model Benchmarking (ILAMB) Package was designed to facilitate systematic and comprehensive model–data comparison and improve understanding of factors influencing model fidelity. We used ILAMB to benchmark and intercompare terrestrial carbon cycle models coupled within ESMs used to conduct historical simulations for the Fifth and Sixth Phases of the Coupled Model Intercomparison Project (CMIP5 and CMIP6). Results indicate that the suite of CMIP6 land models exhibits better performance than the suite of CMIP5 land models in comparison with observations for a variety of biogeochemical, hydrological, and energy-related variables. These improvements are partially attributed to reductions of biases in temperature, precipitation, and incoming radiation, suggesting that free-running atmosphere models in these ESMs also improved; however, biases in some regions increased. An analysis of forcing variables, prognostic land variables, and relationships from variable-to-variable comparisons indicate an overall improvement in most CMIP6 models, with relationships for some models exhibiting the greatest improvement in ILAMB scores, suggesting that improved model process representation in some models, and likely increased model complexity, contributed to improved model performance. We further analyze the degree to which the range of model uncertainties may have been reduced for CMIP6 land models as compared with CMIP5 land models.

Tuesday, December 8, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/729408

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B019-0011 - The Community Land Model (CLM5) Parameter Perturbation Ensemble Project: Towards Comprehensive Understanding of Parametric Uncertainty on the Global Terrestrial Carbon Cycle

Abstract
The Community Land Model (CLM5) is widely used by the Earth System Modeling research community to study many aspects of the role of land in climate and weather. In particular, the omodel is frequently used to understand and predict global and regional land carbon stock trajectories, water state trends, and carbon-water interactions and water use efficiency trends. Recent work has demonstrated high uncertainty due to forcing, structural, and parametric uncertainties. Prior efforts to assess CLM parametric uncertainty have been hampered by computational constraints or code limitations, necessarily limited to selected parameters related to specific processes. Here, we present a new community effort to conduct a comprehensive tiered exploration of parameter sensitivity and uncertainty; the CLM5 Parameter Perturbation Ensemble project (CLM5PPE). We have identified 200+ model parameters across processes that control energy, water, carbon, and nitrogen interactions. Phase 1 of the CLM5PPE involves one-at-a-time high/low parameter perturbations for all 200+ parameters on a sparse grid (∼250 grid cells) that reasonably captures the main features of global higher-resolution simulations. Each simulation is checked for reasonableness (e.g., vegetation survivability rates). Each parameter perturbation is also run with environmental perturbations (CO_2, climate, N-deposition) that span historical and projected values. A set of 50 parameters are selected for further evaluation with the criteria for selection based on their importance in determining the mean, variability, and responses to environmental perturbations for a range of key land climate variables. Phase 2 uses these parameters to run a Latin hypercube sparse-grid 2500-member perturbed parameter ensemble, again repeated for each environmental perturbation. In Phase 3, ∼200 best performing parameter sets will be used to run an ensemble of historical and projection period 2° resolution simulations to provide a realistic and comprehensive assessment of parametric uncertainty. All data output from this project as well as the scripting infrastructure to automate parameter perturbations, generate large ensembles, and assess model performance will also be made available to facilitate further parameter exploration of this and future versions of CLM.

Tuesday, December 8, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/761603

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NH010-02 - Quantifying the Drivers and Predictability of Seasonal Changes in African Fire

Abstract
Africa contains some of the most vulnerable ecosystems to fires. Successful seasonal prediction of fire activity over these fire-prone regions remains a challenge and relies heavily on in-depth understanding of various driving mechanisms underlying fire evolution. Here, we assess the seasonal environmental drivers and predictability of African fire using the analytical framework of Stepwise Generalized Equilibrium Feedback Assessment (SGEFA) and machine learning techniques (MLTs). The impacts of sea-surface temperature, soil moisture, and leaf area index are quantified and found to dominate the fire seasonal variability by regulating regional burning condition and fuel supply. Compared with previously-identified atmospheric and socioeconomic predictors, these slowly evolving oceanic and terrestrial predictors are further identified to determine the seasonal predictability of fire activity in Africa. Our combined SGEFA-MLT approach achieves skillful prediction of African fire one month in advance and can be generalized to provide seasonal estimates of regional and global fire risk.

Tuesday, December 8, 2020, 08:40–08:45 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/678058

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B024-02 - Do Carbon Cycle Models of the Terrestrial Biosphere Need a Revelle Factor when Simulating Carbon Storage Rates from Increasing Levels of Gross Primary Production? (Invited)

Abstract
In the oceans, inflow of anthropogenic carbon dioxide through air sea gas exchange triggers a series adjustments in bicarbonate and carbonate ion concentrations that causes the pH to decline and net storage in dissolved inorganic carbon (DIC) to be more than a factor of 10 smaller than what would be expected if DIC adjusted directly in proportion to the overlying changes in atmospheric CO_2 mole fraction. This effect, known as the Revelle factor, is implicitly built into all state-of-the-art ocean biogeochemistry models through equations that represent the different forms of DIC as a function of temperature, alkalinity, pressure, salinity and the concentration of several other ions. On land, in contrast, carbon storage is often closely regulated by the initial response of gross primary production (GPP) to different forms of global change. The distribution of turnover

times in downstream pools (as well as their sensitivity to climate) can modify rates of carbon storage in important ways, yet the donor pool structure of many models means that downstream adjustments to inflows do not offer as much resistance to carbon storage as compared to what occurs in the oceans by means of changes in carbonate chemistry. Here we describe several processes that operate on individual plant, community, stand, and ecosystem levels that may limit carbon storage in terrestrial ecosystems, yet are not well represented in models. These include downregulation of CO_2 fertilization effects on net primary production relative to effects on gross primary production, adjustments in tree mortality as a function of tree biomass, changes in stand-level fire disturbance as a function biomass accumulation in live, coarse woody debris, and litter pools, and limits to carbon storage in soils posed by fixed number of binding sites to clay and mineral surfaces in soils. We highlight some of these limits using analysis of earth system models from the 6th Coupled Model Intercomparison Project (CMIP6) and through analysis of global fire and soil carbon age datasets.

Tuesday, December 8, 2020, 13:36–13:40 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/772940

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B024-05 - How Does Optimal Photosynthetic Acclimation Affect Future Carbon and Nutrient Cycling?

Abstract
Terrestrial photosynthesis is the largest flux of carbon between the atmosphere and the Earth's surface and is 10 times greater than carbon emissions from fossil fuel burning and land use change combined. Photosynthesis also connects the carbon cycle to water and nutrient cycles. As such, it is important to reliably simulate photosynthetic processes to accurately project future global change. Photosynthesis in land surface models (LSMs) is dependent on photosynthetic capacity, which is closely coupled to the enzymatic content of plant leaves. Most LSMs parameterize photosynthetic capacity using plant functional type-specific parameters, while others simulate it using soil nutrient-dependent values of leaf nutrient content. However, recent theoretical developments suggest that photosynthetic capacity acclimates to optimize photosynthesis primarily to aboveground climate. A key tenet of this optimization is that photosynthesis is maximized at the lowest possible nutrient use to build photosynthetic enzymes, such as Rubisco. Quantifications of this theory offer a simpler, yet more dynamic formulation for LSMs. Here, we integrated this optimization theory into the E3SM LSM (ELM) and simulated future photosynthesis under the RCP 8.5 climate scenario. In our simulation, we found that optimal acclimation resulted in an increase in global photosynthesis in 2100 as compared to present day, primarily as a result of CO_2 fertilization. Interestingly, we also simulated a decrease in Rubisco-based nitrogen, which occurred in response to both elevated CO_2 and elevated temperature. While the increase in photosynthesis is commonly observed in other LSM simulations, the reduction in leaf nitrogen is not. This effect is likely to alter simulated carbon-nitrogen interactions, possibly even reducing simulated nitrogen limitation of future productivity.

Tuesday, December 8, 2020, 13:48–13:52 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/707218

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B024-07 - Global Evaluation of ELM v1 and the Role of the Phosphorus Cycle and Non-structural Carbon in the Historical Terrestrial Carbon Balance

Abstract
The importance of carbon (C)-nutrient interactions to the prediction of future C uptake has long been recognized. Many ESMs in CMIP6 (the Coupled Model Intercomparison Project phase 6) are now including nitrogen (N) cycle and C-N interactions. However, only a few models in CMIP6 have developed the capability to include phosphorus (P) cycle processes and C-N-P interactions. The Energy Exascale Earth System Model (E3SM) land model (ELM) version 1 is one of the few that has this capability. Here we provide a comprehensive global scale evaluation of ELM v1. Using the International Land Model Benchmarking (ILAMB) system we show that the implementation of P cycle dynamics is critical to improving model simulated biomass, leaf area index (LAI), and global net C balance. The evaluation of model sensitivity to a step increase of CO_2 with free-air CO_2 enrichment (FACE) observational data suggests that ELM v1 is able to capture the field observed responses for photosynthesis, growth, LAI and vegetation C stocks. The good agreement between model simulations and FACE observations is mainly due to the introduction of a non-structural carbon pool in ELM v1. Model simulations showed that global C sources and sinks are significantly affected by P limitation, as the historical CO_2 fertilization effect was reduced by 20% and C emission due to land use and land cover change was 11% lower when P limitation was considered. Our study suggests that introduction of C-N-P coupling and a non-structural carbon pool will likely have substantial consequences for projections of future C uptake.

Tuesday, December 8, 2020, 13:56–14:00 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/772905

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Wednesday, December 9, 2020

B038-0010 - Upscaling FLUXNET-CH_4: Data-driven Model Performance, Predictors, and Regional to Global Methane Emission Estimates for Freshwater Wetlands

Abstract
Wetlands are responsible for ∼30% of global methane (CH_4) emissions and introduce some of the largest uncertainties in the global CH_4 budget. Comparison of CH_4 emissions simulated by land

surface models show that uncertainties arise from differences in model parameterization and wetland extents. Data-driven upscaling may help constrain model uncertainties by providing independent emissions estimates. Although eddy covariance flux measurements of carbon dioxide have been upscaled to estimate global gross primary production, similar products for CH_4 fluxes are lacking. To address this gap, we use data from 47 FLUXNET-CH_4 freshwater wetland sites with machine learning to 1) evaluate data-driven model performance in predicting global CH_4 fluxes; 2) identify useful classes of predictors and important single predictors from a large suite of remote sensing, climatic, topographic, and biometeorological covariates; and 3) predict monthly CH_4 emissions from freshwater wetlands at regional to global scales.

Globally, the model performed well ($R^2 = 0.6$, MAE $= 26.2\,\mathrm{nmol\,m^{-2}\,s^{-1}}$, Bias $= 1.6\,\mathrm{nmol\,m^{-2}\,s^{-1}}$). Normalized errors were largest at swamps ($n = 6$), four of which are distinctive tropical sites, and smallest at marshes ($n = 10$). Mean seasonal cycles were reproduced well ($R^2 > 0.7$) at two-thirds of sites, although interannual anomalies were not accurately reproduced. Gridded climatology and tower-measured biometeorology were the most useful covariate classes for predicting CH_4 fluxes, land cover (including inundation and vegetation cover) was intermediate; and soil, relief, and vegetation greenness were least useful. The most important individual predictors included nighttime land surface temperature, potential radiation, enhanced vegetation index, air temperature, and latent heat flux. Several static predictors were also useful, including percent agricultural land use and slope. Preliminary estimates of average (2001–2012) annual CH_4 emissions scaled by wetland area were 151 Tg CH_4 globally, in close agreement with recent bottom-up model estimates (Saunois et al. 2020), with 96 Tg (∼64%) from the tropics, and 31 Tg (∼21%) from >45°N, in agreement with a recent northern upscaling effort (31–38 Tg; Peltola et al. 2019). We acknowledge the FLUXNET-CH_4 contributors for the data provided in these analyses.

Wednesday, December 9, 2020, 07:00–23:59 EST
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SY023-0020 - Collaboration to Better Understand Arctic Change

Abstract

Permafrost shifts, changing riverine flow, and alterations in snow, rain, and evapo-transpiration processes all impact the high latitude regions of the globe and are strongly affecting the stakeholder communities that reside in, and rely on, this land. Two projects focused on examining the coupled human-physical system, capturing changes, and producing collaborative science that will assist Arctic communities better adapt, and mitigate these changes, are described herein. The "Interdisciplinary Research for Arctic Coastal Environments" (InteRFACE) project, funded by the Department of Energy, focuses on how coupled, multi-scale feedbacks among land processes, such as permafrost, snow, and water, and human systems, such as transportation and resource availability, will impact the trajectory of change across the Arctic coastal interface. InteRFACE brings together multiple DOE funding streams, researchers at several US National Labs, and scientists from the University of Alaska Fairbanks. The NOAA "Experimental Framework for Testing the National Water Model: Operationalizing the Use of Snow Remote Sensing in Alaska" project seeks to evaluate the National Water Model for Alaska, and operationalize the use of the system for improved river prediction and forecasting. This project is a collaboration between the University of Alaska Fairbanks, the National Center for Atmospheric Research, and the New Mexico Consortium. Research results, with a focus on the collaborative partnerships, will be described and shared.

Wednesday, December 9, 2020, 07:00–23:59 EST

https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/763900

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Thursday, December 10, 2020

B053-07 - Short-term Water-Carbon Interactions Regulate Interannual Variability in Ecosystem Responses to Changing Climates

Abstract

The terrestrial carbon and water cycles are primarily driven by photosynthesis and transpiration that are both regulated by plant stomatal conductance. Such a physiological link not only determines ecosystem functioning, but also modulates flux exchanges between the biosphere and the atmosphere. The relationship between water losses via transpiration relative to carbon gains via photosynthesis can be estimated by plant water-use efficiency (WUE), a metric that involves multiple definitions across leaf to ecosystem scales. Despite its various functional forms, forest WUE trends inferred from different approaches ubiquitously increase in recent decades. Although several mechanisms have been proposed to explain rising forest WUE at seasonal time scales, none of them have examined the intra-seasonal variability of WUE and its impacts on long-term WUE trends. Here, we analyze the statistical distribution of sub-seasonal WUE at 33 eddy covariance sites with at least 10 years of measurements to investigate the effects of short-term WUE variability. Our random-forest variable importance analysis suggests that recent increases in site-specific WUE observations are strongly correlated with the corresponding trends inferred from its 95^{th} percentile. Further, our results demonstrate that seasonal mean WUE correlates well ($r = 0.75$ to 0.89) with the number of most active hours (i.e., cumulated hours when WUE exceeds a site-specific percentile), highlighting the importance of short-term favorable microclimatic conditions. Collectively, our findings suggest that a proper representation of seasonal cycles in WUE is needed to mechanistically explain recent increases in WUE observations and improve estimates in terrestrial carbon and water cycles.

Wednesday, December 9, 2020, 08:54–08:58 EST

`https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/752698`

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Monday, December 14, 2020

C047-0013 - Simulated and Observed Spatiotemporal Variations of Warming Caused Earlier Snow Melting in Northern High-Latitude Regions

Abstract

Land surface snow processes, which are challenging to simulate in Earth system models, are of critical importance in northern high-latitude regions, where they influence many other biogeophysical and biogeochemical processes. Capturing them in models is particularly difficult because of highly heterogeneous surface properties and lack of reliable data in remote and harsh regions. Here we present an offline land surface simulation using the Energy Exascale Earth System Model (E3SM) Land Model (ELM) over northern high-latitudes ($\geq$60°N) at a half-degree spatial resolution. Results are evaluated using the ILAMB package and the NCAR Land Diagnosis Tool (as shown on `https://elm-ngee-webserver.ornl.gov`). For assessing snow processes and their consequences on plant phenology, we derived DOYs (day of year) of snow melt and ground cover of 1998–2019

from northern hemisphere daily snow cover products by the US National Ice Center's Interactive Multi-sensor Snow and Ice Mapping System (USNIC-IMS).
USNIC-IMS data showed that earlier snow melt occurred in 2000–2010 (from DOY ∼160 to ∼150), but then began to reverse (DOY ∼155 in last 3 years), with large spatial-temporal variations. Combined with slightly earlier ground snow-cover since around 2010, yearly snow-free period increased from ∼115 to 130 days around 2010 and then dropped to ∼120 days in recent years. Remarkably, offline ELM simulations, with GSWP3v2 forcing, exhibited those trends, and simulated yearly-averaged 2.4±3.0 days earlier snow-cover and 6.4±3.4 days earlier melt, and thus 6.6±3.9 days longer snow-free season, compared to the observations.
Model-data discrepancies may be caused by model forcing or snow algorithms or both, which partially contributed to vegetation phenological shifts (and to spatiotemporal LAI mismatches) in some Arctic regions identified by two Diagnosis Tools. For example, severe under-estimation of LAI (and thus SOM) and phenological shifts apparently exist in Northeastern Siberian Russia and Northeastern Canada. Those biases could be a consequence of late snow melt and a short snow-free season due to heavy or extended winter snowfall. Our study demonstrates that data integration, model development and fidelity assessments are critical to further improve ELM performance in the pan-Arctic.

Monday, December 14, 2020, 07:00–23:59 EST
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/702567`

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IN032-04 - Land Model Testbed: Accelerating Development, Benchmarking and Analysis of Land Surface Models

Abstract
A Land Model Testbed (LMT), designed to provide a computational framework for systematically assessing model fidelity and supporting rapid development of complex multiscale models, offers a general-purpose workflow for conducting large ensemble simulations of multiple land surface models, post-processing large volumes of model output, and evaluating model results.

It leverages existing tools for launching model simulations and the International Land Model Benchmarking (ILAMB) package for assessing model fidelity through comparison with best-available observational datasets.

Increased complexity and proliferation of uncertain parameters in process representations in land surface models has driven the need for frequent and intensive testing and evaluating of models to quantify uncertainties and optimize parameters such that results are consistent with observations.

The LMT described here meets these needs by providing tools to run thousands of ensemble simulations simultaneously on high performance computing resources, like the Summit supercomputer

at the Oak Ridge Leadership Computing Facility, as well as cloud environments like Amazon Web Services, post-processing outputs, automating execution of an enhanced version of ILAMB with site-specific benchmarks and multivariate functional relationships, and by offering ensemble diagnostics and a customizable dashboard for displaying model performance metrics and associated graphics.

We envision the LMT capabilities will serve as a foundational computational resource for a proposed modeling and synthesis center focused on terrestrial multiscale model-data integration.

Monday, December 14, 2020, 13:18–13:24 EST

https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/774042

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B089-03 - Exacerbated Drought Impacts on Global Ecosystems Due to Structural Overshoot

Abstract
Vegetation growth is affected not only by the concurrent climate, but also its status in the past and the associated lagged responses. Favorable climate in the past may stimulate vegetation growth to surpass the ecosystem carrying capacity, leave an ecosystem vulnerable to climate stresses. This phenomenon, known as structural overshoot, can greatly contribute to worldwide drought stress and forest mortality, but the magnitude of the impact is poorly known due to the dynamic nature of overshoot and complex influencing timescales. Here we use a dynamic statistical learning approach to identify and characterize ecosystem structural overshoot globally, and quantify the associated drought impacts. When applied to satellite observation of terrestrial vegetation during 1981–2015, we find that structural overshoot contributed to 33.9% of the drought. Overshoot droughts occur more frequently in mid-latitude semi-arid or dry sub-humid regions, with higher impacts in boreal ecosystems. The fraction of droughts related to overshoot is strongly associated with biodiversity, with mean annual temperature, vegetation coverage, and aridity as secondary factors. These overshoot droughts are not only more likely to happen in warmer months, leading to higher risks of compound extreme drought and heat, but also causing faster vegetation decline compared to normal droughts, contributing to the development of flash drought, and causing large impact on ecosystem stability. Although the overall overshoot numbers have decreased over the past 35 years, the hotspots regions still exist, especially in vulnerable ecosystems where drought has become more prevalent.

Monday, December 14, 2020, 22:08–22:12 EST

https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/760666

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Tuesday, December 15, 2020

GC095-09 - Soil Moisture-Atmosphere Feedbacks Mitigate Projected Surface Water Availability Declines in Drylands

Abstract
Global warming is expected to change surface water availability (precipitation minus evapotranspiration, $P-E$) and hence freshwater resources. However, the influence of land-atmosphere feedbacks on future $P-E$ changes and the underlying mechanisms remain unclear. Here we demonstrate that soil moisture (SM) strongly impacts future $P-E$ changes, especially in drylands, through regulating evapotranspiration and atmospheric moisture inflow. To do so, we use transient simulations from general circulation models, both with and without long-term SM changes, along with empirical statistical models of SM-atmosphere feedbacks. We find a consistent negative SM feedback on $P-E$, which may offset up to ~60% of the decline in dryland $P-E$ that is otherwise expected to occur. The negative feedback is not caused by atmospheric thermodynamic responses, i.e., temperature and humidity changes, to declining SM, but rather by SM-related regulation of atmospheric circulation and vertical ascent that enhance moisture transport towards drylands. This SM effect is a large source of uncertainty in projected dryland $P-E$ changes, underscoring the need to better constrain future SM changes and improve representation of SM-atmosphere processes in models.

Tuesday, December 15, 2020, 00:02–00:06 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/776439

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B102-07 - Understanding the Patterns and Drivers of Arctic Tundra Plant Communities

Abstract
The Arctic is undergoing rapid changes in climate, vegetation composition and productivity. To understand the impacts of climate change on the function of Arctic tundra ecosystems, it is crucial to understand vegetation distribution and heterogeneity across large spatial scales. Knowledge of the environmental drivers controlling current vegetation composition and distribution is necessary for modeling potential shifts under a warming climate.

Our study was focused on three watersheds in the Seward Peninsula of Alaska, where field surveys were conducted as part of the US DOE's NGEE-Arctic project. Using airborne hyperspectral imagery from NASA AVIRIS-NG, we developed a Deep Neural Network-based classifier to create a high resolution (5 m) map of Arctic tundra plant communities with an accuracy exceeding 80%.

Analysis of landscape patterns, using area and aggregation based metrics, show Alder-Willow Shrub and Tussock-Lichen Tundra communities occupy a greater proportion of the landscape and are more clumped together compared to Mesic Graminoid Herb Meadow and Sedge-Willow-Dryas Tundra communities.

We also developed an Environmental Niche Model to understand the relative importance of various environmental drivers in determining the presence/absence of plant communities. Preliminary results show that microtopography (e.g., elevation) and soil moisture are the primary drivers of vegetation distribution at the landscape scale. Keystone species, like nitrogen-fixing Alder shrubs, also influence the nutrient availability and vegetation communities in their hydrologically connected downslope neighborhood. High resolution maps of plant communities will provide a better representation of above-ground trait variability in Earth System Models, and will provide data for model parameterization, benchmarking and validation. Insights from niche modeling could improve our understanding of mechanisms and environmental drivers of vegetation distribution and succession.

Tuesday, December 15, 2020, 14:48–14:51 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/735528

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B106-07 - The CO_2 Effect on Evapotranspiration Trends as Inferred by Eddy Covariance Observations

Abstract
As a major pathway for ecosystems to lose water, evapotranspiration (ET) is an essential process that affects the water cycle and land-atmosphere feedback in the earth system. Elevated CO_2 significantly affects ecosystems, by increasing photosynthesis and/or reducing stomatal conductance, which affects both ET and carbon assimilation. These direct and indirect effects have been quantified by model simulations, however are rarely constrained with ecosystem level direct, and long-term observations. Here we analyzed the high-frequency eddy covariance (EC) based observations at 80 sites from Fluxnet and AmeriFlux that have more than 10 years of observations to quantify the effects of CO_2 on ET, and water use efficiency (WUE). We investigated the drivers of trends and interannual variation of WUE at all sites. Results indicate that among all sites, the majority of sites did not have a significant trend of ET over time; at the same time, 25 sites showed a significant increase in the ET over time and 11 sites have a significant ET decrease over time. As for the WUE, we found a significant increase trend in WUE at 26 sites. We also found that while net radiation, gross primary production, and soil water content contributed most for the interannual variation of ET for most sites, the elevated CO_2 also played a significant role in regulating the long-term trends of ET at most sites.

Tuesday, December 15, 2020, 23:54–23:58 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/719461

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Wednesday, December 16, 2020

B108-0027 - Quantifying the Carbon Budget of the U.S. Midwestern Agroecosystems through Model-Data Fusion

Abstract
Agroecosystems play a vital role in regional and global carbon cycles. Quantifying the carbon budget of agroecosystems remains a challenge mainly due to the complex impacts of human management on the carbon cycle of agroecosystems. Model-data fusion is a promising approach to accurately quantify the carbon budget of agroecosystems given more and more observations become available from satellite remote sensing. Here we present a model-data fusion system to quantify the carbon budget of the U.S. Midwestern agroecosystem. We first evaluated the performance of an advanced agroecosystem model, ecosys, in simulating carbon budget over the U.S. Midwestern. We conducted model simulations and evaluations at 7 cropland eddy-covariance sites in the U.S. Midwestern. The site-level simulations show that ecosys model captured both the magnitude and seasonal patterns of carbon fluxes (i.e. GPP, NEE, Reco), LAI, and dynamic of plant carbon allocation processes with high accuracy. We then scaled the simulations up to the 293 counties across three I-states (i.e. Illinois, Indiana, and Iowa). We constrained the model with a novel NIRv-based remotely sensed GPP product and crop yield data from USDA National Agricultural Statistics Service in the even years during 2001 and 2018, and evaluated the model performance in the odd years during the same period. The results show that the constrained ecosys model reproduced the spatial distribution and interannual variability of corn and soybean yield in the three I-states. The responses of the carbon cycle processes to the environmental variability obtained from the constrained model simulations were consistent with the observed ones, revealing the applicability of the constrained ecosys model in simulating the impacts of future climate change on the carbon cycle of the U.S. Midwestern agroecosystems. We finally quantified the carbon budget of the U.S. Midwestern agroecosystems at county scale using the constrained ecosys model under both historic and future climate conditions.

Wednesday, December 16, 2020, 07:00–23:59 EST
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/754342`

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B110-0012 - The Carbon Cost of Maintaining Ecosystem Carbon Sinks and Its Climate and Soil Dependence

Abstract
Terrestrial ecosystems take up about 1/3 of anthropogenic emissions and serve as a critical carbon sink to mitigate climate change. The size of ecosystem carbon sink is dependent on the availability of exogenous (e.g. light, water and nutrient) and endogenous (e.g. carbohydrate, mycorrhizal) resources to ecosystems and how ecosystems use these resources. Ecosystems loose carbohydrate via respiration to provide metabolic energy to maintain the function and growth of living organisms in plants and soil. The carbon accumulated per unit carbon cost for an ecosystem (denoted as carbon cost efficiency, which is an extension of the commonly used carbon use efficiency by considering heterotrophic respiration) thus places a critical constraint on the potential carbon sink strength. In this study, we used a global network of eddy covariance measurements (∼212 sites) to quantify the carbon cost efficiency of various ecosystems. We found strong relationships between carbon cost efficiency and environmental factors, soil and remotely-sensed vegetation status across flux sites, which allows for global inference of the potential of terrestrial ecosystems to offset future emissions.

Wednesday, December 16, 2020, 07:00–23:59 EST
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/713363`

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B116-0026 - Understanding Phenology of Diverse Tropical Vegetation Using High Spatio-Temporal Resolution Remote Sensing

Abstract
Vegetation phenology is an integrated and sensitive indicator of ecosystem function that responds to disturbance, seasonality, variability and extremes in weather and climate. Phenology modulates surface energy balance and hydrological processes at the landscape scale. Knowledge of tropical forest phenology, however, is limited because highly diverse communities of tree species exhibit a variety of often-subtle phenological patterns. Heterogeneous tropical forests also exhibit highly variable and heterogeneous responses to biotic and abiotic stressors. While satellite remote sensing is commonly used to study vegetation phenology, frequent cloud cover, smoke from fires, and sensor artifacts complicate the study of tropical phenology. Widely used satellite platforms like MODIS and Landsat suffer from limitations of coarse spatial resolution or low temporal repeat frequency. We used satellite remote sensing data from two platforms: a) Sentinel-2 MultiSpectral Instrument operated by European Space Agency; and b) VENµS, a cooperative Earth observation program of Israel and France using a minisatellite that combines high spatial resolution and frequent repeats for selected study areas.

We focused our analysis at a series of sites across a gradient of wet and dry tropical forests and varying land use, from evergreen tropical forests, to savannas, to grasslands and croplands, and where both Sentinel-2 and VENµS imagery were available. We developed Normalized Difference Red Edge Index (NDRE) time series from both platforms, which showed greater dynamic range than the frequently used Normalized Difference vegetation Index (NDVI) from MODIS. Analyses of high spatio-temporal resolution data help reveal the dominant phenological patterns in heterogeneous tropical vegetation, despite frequent occultation from clouds and smoke. Preliminary analysis shows varying phenological responses during wet vs dry seasons across broadleaf evergreen forest, savannas and grasslands.

Wednesday, December 16, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/740161

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GC119-0011 - Towards a Multiscale Crop Modelling Framework for Climate Change Adaptation Assessment

Abstract
Predicting the consequences of manipulating genotype (G) and agronomic management (M) on agricultural ecosystem performances under future environmental (E) conditions remains a challenge. Crop modelling has the potential to enable society to assess the efficacy of G $\times$ M technologies to mitigate and adapt crop production systems to climate change. Despite recent achievements, dedicated research to develop and improve modelling capabilities from gene to global scales is needed to provide guidance on designing G $\times$ M adaptation strategies with full consideration of their impacts on both crop productivity and ecosystem sustainability under varying climatic conditions. Opportunities to advance the multiscale crop modelling framework include representing crop genetic traits, interfacing crop models with large-scale models, improving the representation of physiological responses to climate change and management practices, closing data gaps and harnessing multisource data to improve model predictability and enable identification of emergent relationships. A fundamental challenge in multiscale prediction is the balance between process details required to assess the intervention and predictability of the system at the scales feasible to measure the impact. An advanced multiscale crop modelling framework will enable a gene-to-farm design of resilient and sustainable crop production systems under a changing climate at regional-to-global scales.

Wednesday, December 16, 2020, 07:00–23:59 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/765143

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B117-04 - Midwest US Croplands Determine Model Divergence in North American Carbon Fluxes

Abstract
Terrestrial biosphere models (TBMs) are integral tools to study ecosystem–atmosphere carbon exchange. However, TBMs diverge markedly in their carbon flux estimates, limiting our ability to forecast climate change impacts on the terrestrial carbon cycle. Model evaluation has routinely focused on locally optimized processes and functional relationships, yet the space–time variability in carbon flux estimates at regional to continental scales has remained divergent as ever. Here, we leverage atmospheric CO_2 observations to explore emergent patterns in the divergence among TBM estimates of gross primary productivity (GPP) and net ecosystem exchange (NEE) over North America. To do so, we evaluate a suite of diagnostic, prognostic, and machine-learning TBMs and solar-induced fluorescence (SIF) data products based on how well their regional patterns explain the variability in biospheric CO_2 drawdown.

Models with GPP and NEE estimates that effectively reproduce atmospheric CO_2 variability (as is indicated by R^2 values) share a strong growing-season sink in the Midwest US croplands, whereas the remaining models tend to place most growing-season uptake in forests. The difference in model explanatory power depends mainly on how well models represent the seasonal cycle of the growing-season cropland sink, rather than the partition of fluxes across biomes. Our results suggest that improving model representation of cropland processes that govern the seasonality of fluxes, such as phenology and carbon allocation, is a priority for robust quantification of North American carbon exchange.

Wednesday, December 16, 2020, 08:42–08:46 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/702348

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B117-05 - The Historic Effect of CO_2 on Global Photosynthesis

Abstract
Global photosynthesis results in the single largest flux of carbon dioxide between the atmosphere and the biosphere. Long-term changes in photosynthesis could therefore provide a strong feedback to climate change through changing the growth rate of atmospheric CO_2. Global photosynthesis cannot be observed, however, and must therefore be inferred through emergent dynamics in multiple proxies. But the historic sensitivity of global photosynthesis derived from such proxies spans an order of magnitude, leading to large uncertainty in estimates of both the historic and expected future changes in photosynthesis. Here, we examine the various proxies of long-term photosynthetic change, and show that they can be reconciled by combining known plant physiology with emergent dynamics of the global carbon cycle. The results suggest that global photosynthesis has increased due to elevated CO_2, but with a much lower sensitivity that that implied by some proxies, and a higher sensitivity than that inferred from remote-sensing based estimates.

Wednesday, December 16, 2020, 08:46–08:50 EST
https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/773642

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Thursday, December 17, 2020

B128-07 - Tropical Forest Vulnerability to ENSO Induced Extremes in a Changing Climate

Abstract
Tropical forests are a crucial carbon sink to rising atmospheric CO_2; however, they could be experiencing a tipping point. Their ability to remove carbon from the atmosphere is decreasing due to continuous deforestation from human practices and tree mortality from frequent climatic extremes. Therefore, it is very important to study the vulnerability of tropical forests to climate change. Compared with changes in mean climates, the ecosystem resilience is more sensitive to changes in

climate variability. El Niño-Southern Oscillation (ENSO) is the most important mode of climate variability on interannual to decadal time scales and exerts extensive impacts on Earth's climate and ecosystems through prominent teleconnections. It significantly affects the intensity and occurrence of extreme events worldwide. Despite the inter-model discrepancies in the projected changes of ENSO properties itself, the frequency and intensity of strong/extreme ENSO events tend to increase in the future as well as the strength of ENSO impacts and teleconnections over continental regions. It leads to increased interannual variability (IAV) in temperature, precipitation and radiation and wildfire frequency. Thus, an ENSO event of a given strength could produce more extreme impacts and induce more stress on global ecosystems. In this study, we will investigate the vulnerability of tropical forests to the projected increases of ENSO-induced extremes and their responses to global climate by analyzing multi-model results from the CMIP6 archive. We will delineate the ENSO induced effects from the trends of mean climates by comparing the model results on the ENSO years with those on the normal years. Initial results showed that the ENSO-induced extremes have great impacts on tropical forests and the enhanced IAV induced by ENSO will increase vulnerability of tropical forests, especially for those forests in locations that do not currently experience strong IAV.

Thursday, December 17, 2020, 08:54–08:58 EST
`https://agu.confex.com/agu/fm20/meetingapp.cgi/Paper/768641`

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