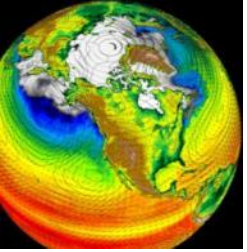
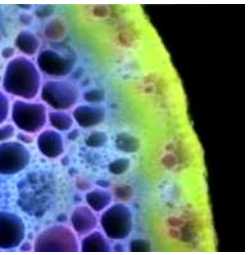
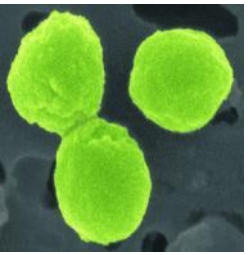


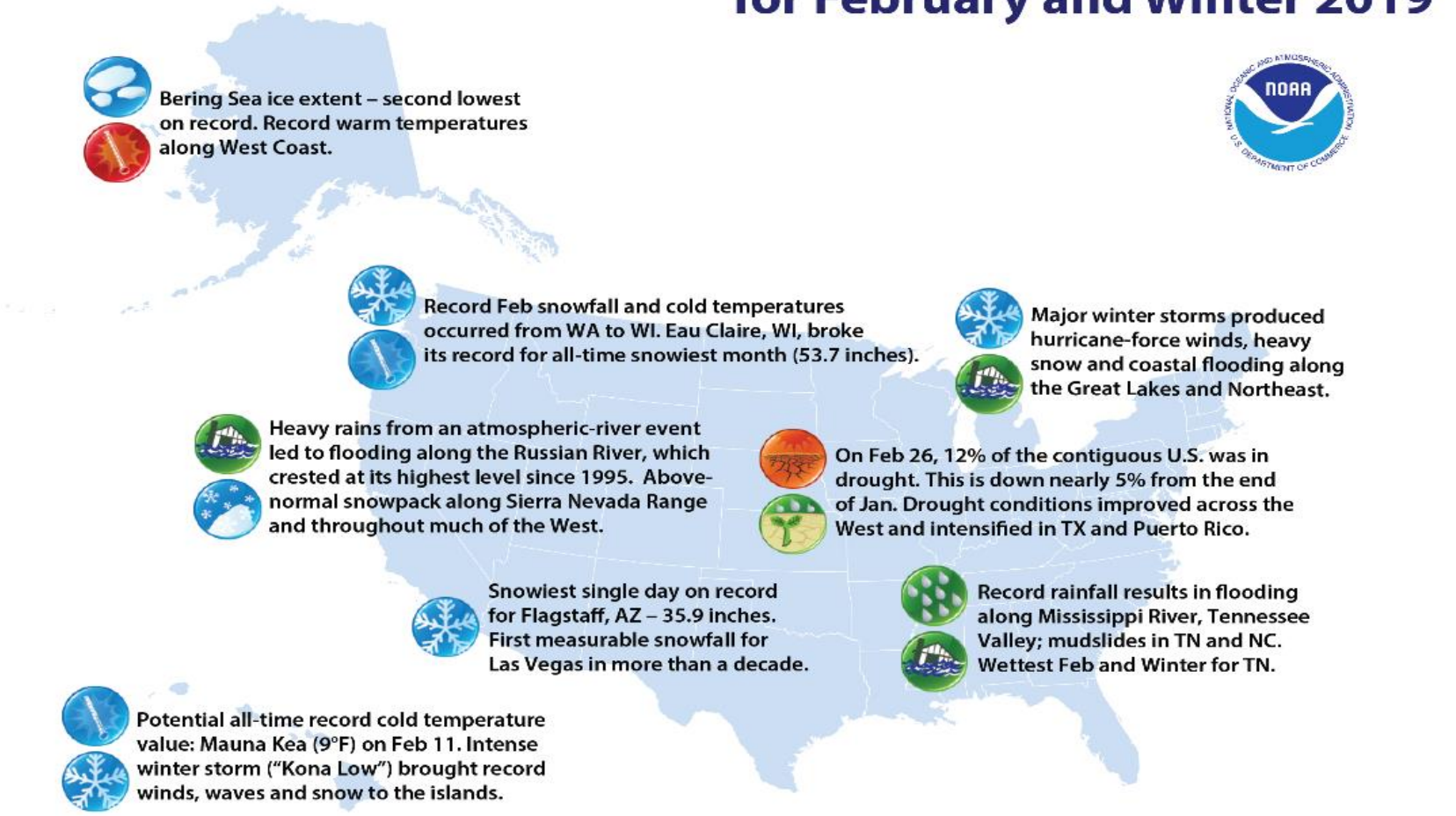
Climate and Environmental Sciences Division

BERAC update

April 25, 2019

G. Geernaert
BER/CESD

U.S. Selected Significant Climate Anomalies and Events for February and Winter 2019

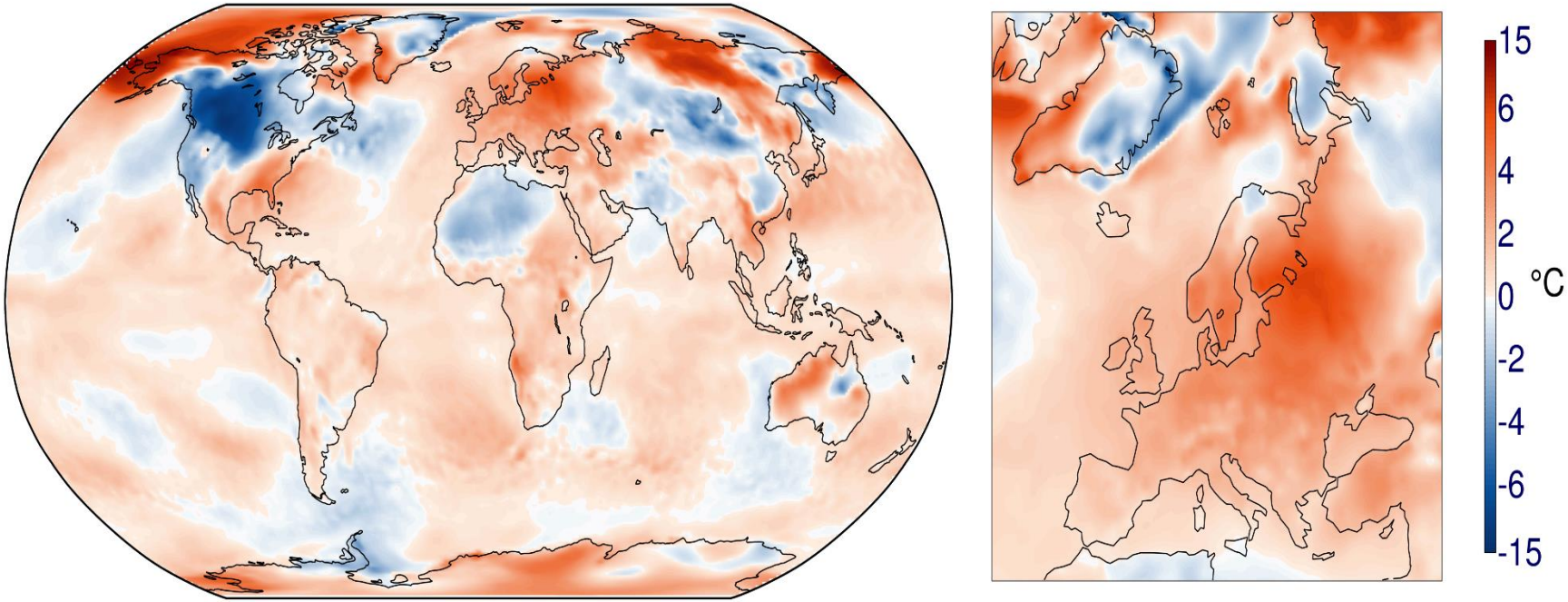


The average U.S. temperature for February was 32.0°F, 1.8°F below average, ranking in the coldest third of the 125-year record. The U.S. precipitation average for February was 3.22 inches, 1.09 inches above average, ranking second wettest on record. The winter average U.S. temperature was 33.4°F, 1.2°F above average. The winter precipitation total was 9.01 inches, 2.22 inch above average — wettest on record.

Moderate drought expands, covering nearly 33% of Puerto Rico.

Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc

Surface air temperature anomaly for February 2019 relative to 1981-2010



European Commission

opernicus
Europe's eyes on Earth

Climate Change Service
climate.copernicus.eu

IMPLEMENTED BY ECMWF

Executing our Strategic Plan 2018-2023

Vision: Improve a systems level understanding and predictability of the earth system in support of DOE's mission, through integrative theory, modeling, and experiment, over a variety of spatial and temporal scales.

High level Grand Challenges

- Integrated water cycle
- Biogeochemistry
- High latitudes
- Drivers and responses
- Data-model integration

Execution involving integrative coastal research involving terrestrial/aquatic regions

- Timing: models at sufficiently high resolution
- Collaborative opportunities: NOAA; USGS; NGA; NSF
- Topics: disturbance, initialization, data analytics (e.g., machine learning), software, advanced technologies

Workshops set the stage for future CESD priorities

Date: 2018	Topic	Venue
Jan 28-30, 2019	Leveraging distributed research to understand watershed syst	Bethesda
Apr 3, 2019	Modes of variability workshop (w/NOAA, NASA, NSF)	Greenbelt
Apr 4, 2019	Climate Modeling Summit	Greenbelt
April 2019	Assessing simulation of precipitation in Earth system models	Wash DC
April 29, 2019	Cyberinfrastructure	Bolger
July 1-2, 2019	Precipitation metrics workshop	Wash DC
Fall 2019	Integrated hydro-terrestrial models- development of a national prediction capability. (with NOAA, NSF, and USGS)	Wash DC
Fall 2019	Lessons learned from FACE, NGEE, and MODEX	Wash DC

Management Update: solicitations

Funds	Program lead	Issued	Proposals	Panel	Estimated Selections
FY19	ASR	Dec 26, 2018	94	May 7-10, 2019	10-15
FY19	TES	Dec 27, 2018	90	May 13-16, 2019	5-10
FY19	SBR	Jan 7, 2019	92	May 20-23, 2019	5-10

Management updates: Major reviews in 2019

Lab	Program	Type	Review date	Decision	Date
PNNL	Model	SFA	Sept 10-11, 2018	Accept	Feb 15, 2019
Multi-	SBR	IDEAS proj.	Feb 22, 2019	Accept	Apr 13, 2019
ORNL	TES	NGEE-Arctic	April 1-2, 2019		
Multi-	Data	Exashed	April 19, 2019		
ORNL	SBR	SFA	May 2-3, 2019		
LBNL	SBR	SFA	May 2-3, 2019		
ORNL	TES	SFA	June 3-5, 2019		
LBNL	TES	NGEE Tropics	July 24-26, 2019		
LANL,…	Model	Coastal Arctic	July 29, 2019		
PNNL,…	Model	Coastal Atlant	July 30, 2019		
LBNL	Model	CASCADE SFA	Sept 23-24, 2019		
LLNL	Model	PCMDI/Cl SFA	Sept 26-27, 2019		

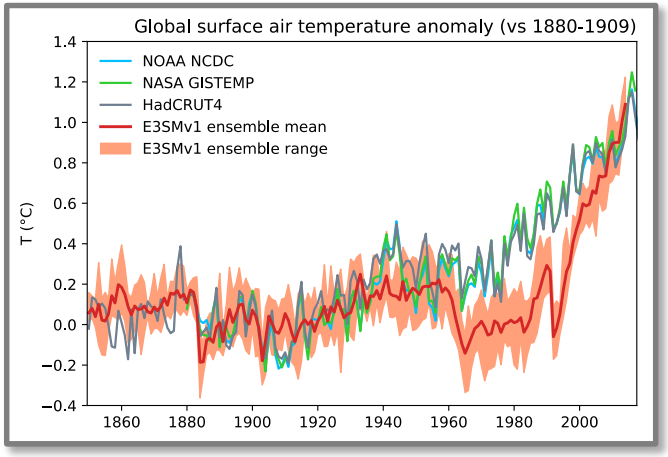
Management updates - PI meetings: 2018-2019

Title	Program(s)	Location	Date in 2019
Modeling PI meeting	EESM	Bolger	Nov 5-8, 2018
NGEE Tropics all hands	TES	Washington DC	Dec 7-8, 2018
NGEE Arctic all hands	TES	Washington DC	Dec 8-9, 2018
E3SM all hands mtg	Modeling	Denver, CO	Mar 19-21, 2019
ESS PI meeting	TES, SBR	Bolger	April 30-May 1, 2019
PCHES all hands	Modeling	Penn State	May 15-16, 2019
ARM/ASR PI meeting	ARM, ASR	Bethesda Marr.	June 10-13, 2019

Title		Location	Date in 2019
Committee of Visitors	CESD	Germantown	July 8-10

The DOE E3SM coupled model version 1: Overview and evaluation at standard resolution

Objective: Documentation and evaluation of **E3SMv1**, the first version of the **DOE Energy Exascale Earth System Model**:



Approach

Evaluation with CMIP6 DECK simulations (3000 simulated years)

- E3SMv1 compares favorably to CMIP5 models but also suffers from common biases affecting many models.
- MJO strength and propagation improved compared to E3SMv0
- ENSO events are well simulated
- Captures warming between 1850 and 2014, but diverges from observations in late 20th Century due to high sensitivity and strong aerosol forcing.

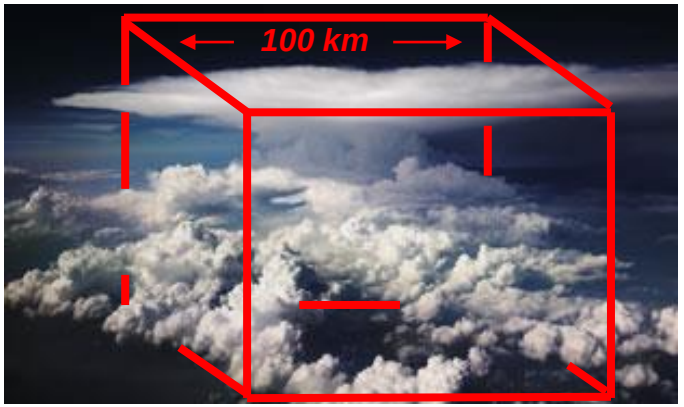
Impact

E3SMv1 provides DOE with capabilities to examine long-term environmental changes that will potentially impact the energy sector. Simulations will also serve as DOE's contribution to CMIP6.

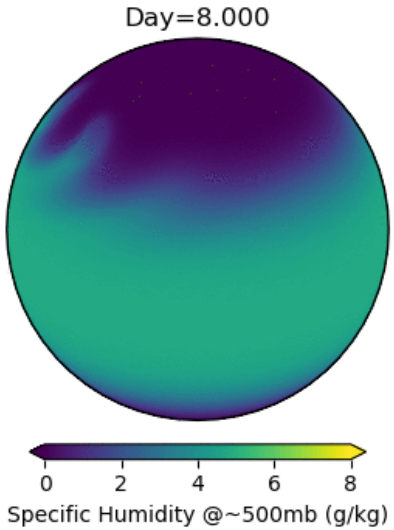
Golaz, J.-C., P. M. Caldwell, L. P. Van Roekel and co-authors (2019). The DOE E3SM coupled model version 1: Overview and evaluation at standard resolution. Journal of Advances in Modeling Earth Systems, accepted, https://doi.org/10.1029/2018MS001603

The Simple Cloud-Resolving E3SM Atmosphere Model - SCREAM

Motivation: Cloud-resolving simulations (with $\Delta x \approx 3$ km) avoid the need for convection parameterizations, which are a major source of climate change uncertainty.



Approach: By leveraging DOE's world-leading investments in hardware and software, we are building the world's fastest global cloud-resolving model with a non-hydrostatic dynamical core with increasing resolution from 25km (E3SMv1) to 3km.



Movie: 500 mb water vapor concentration at 500 mb from idealized baroclinic instability at 3 km resolution.

Impact

- This research is pushing the boundaries of both science and computing.
- The goal is to have a fully tested model in 3 years which will become the default E3SM atmosphere model in 5-10 years.

Environmental Molecular Sciences Lab

Accelerating scientific discovery and pioneering new capabilities to understand biological and environmental processes across temporal and spatial scales

Proposal Opportunities

- 2020 Large-Scale EMSL Research – 96 proposals
- 2020 FICUS call - 53 Letters of Intent

Scientific Leadership

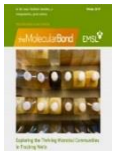
- New EMSL Director (Douglas Mans) – April 2019
- New Strategic Plan - April 2019
- New organizational structure – Nov 2018
- EMSL's FTICR-MS is key for the WHONDRS Hydro-biogeochemical network.
- 3 patents – TEM imaging, Mass Spec, Microbial Consortia

WHONDRS
Worldwide Hydrobiogeochemistry Observation Network for Dynamic River Systems

Outreach and User Activities

- Workshop at 2018 AGU Meeting – Modeling Microbial Processes
- 2019 Integration Meeting (Oct 8-10, 2019) – Plant, Soil, Aerosol Interactions.
- Webinar on Capabilities and New Technologies
- *Molecular Bond* online
- EMSL/ARM/ASR Summer School – July 15-19, 2019

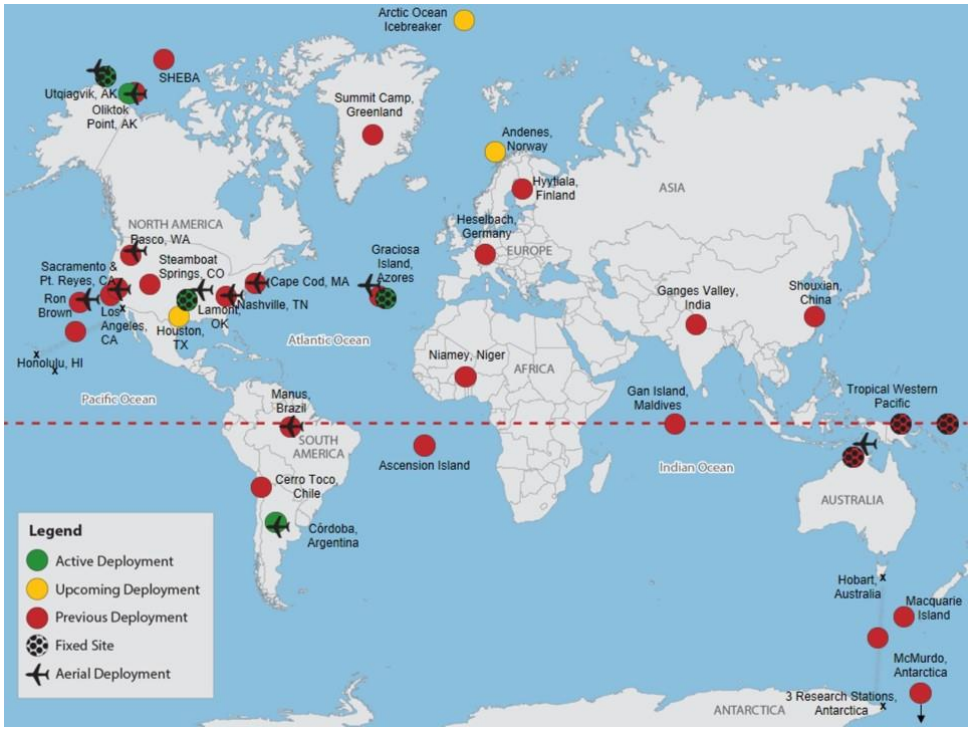
AGU100 ADVANCING EARTH AND SPACE SCIENCE
FALL MEETING
Washington, D.C. | 10–14 Dec 2018



Microbes in Fracing Wells

Circadian Rhythms

ARM Update



CAMPAIGNS

- **CACTI (deep convection in Argentina) – ends April 2019**
- **ArcticShark UAS and tethered balloon flights this summer at SGP**
- **Multiple guest instrument campaigns at fixed sites**
- **MOSAIC (ice breaker in central Arctic Ocean) – Sep 2019 – Oct 2020**
- **COMBLE (cold air outbreaks in Norway) – Jan - May 2020**

Replacement aircraft project:

- G-1 aircraft was retired December, 2018 after CACTI campaign
- ARM received full funding for a replacement aircraft in FY2019
- CRJ200 or Challenger850 aircraft identified as best alternative
- PNNL released RFP for available aircraft; award for aircraft purchase expected by end of May 2019
- Aircraft to be modified for research; expected mission ready for research campaigns in 2022

Workshop report 2018

- ARM Mobile Facility Workshop Report available

Using ARM site retrievals to better understand the low cloud optical depth feedback

Objective

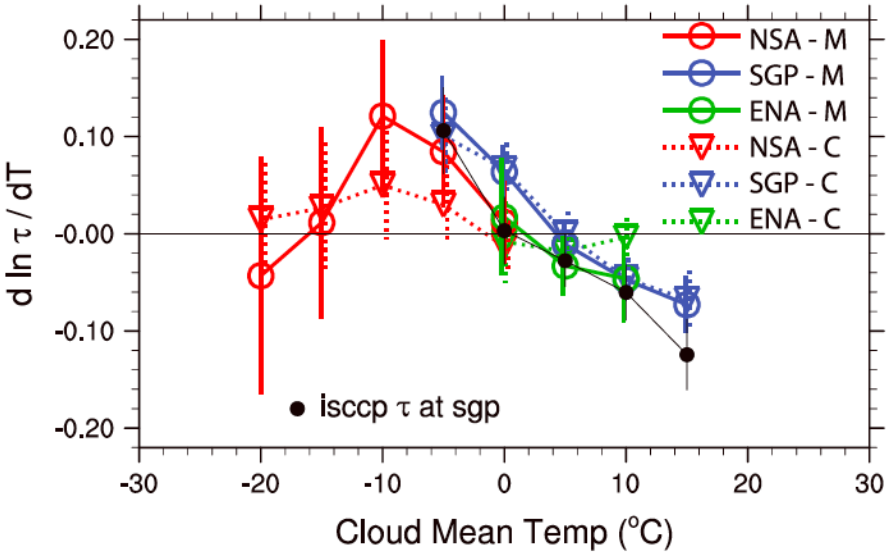
- Use ground-based ARM observations to study the low-cloud reflectivity response to warming in middle and high latitudes

Approach

- Quantify the sensitivity of the optical depth to warming at ARM's NSA, SGP, and ENA site
- Use detailed cloud retrievals from each site to test for mechanisms hypothesized to drive cloud changes

Impact

- Provided insight into processes behind the optical depth response to warming in observations that can be used to assess models



Independent optical depth retrievals from three ARM sites ("SGP", "NSA", "ENA") from two retrieval methods ("C" or "M") show an increase in optical depth with warming at colder temperatures and an decrease with warming at warmer temperatures. This behavior is consistent with what can be found from satellites ("isccp t at sgp").

Terai, C. R., Zhang, Y., Klein, S. A., Zelinka, M. D., Chiu, J. C. & Min, Q. Mechanisms behind the extratropical stratiform low-cloud optical depth response to temperature in ARM site observations, *J. Geophys. Res. Atmos.*, 124, doi:10.1029/2018JD029359 (2019).

Fungal Spores are a Primary Source of Sodium Salt Particles in Amazon Air

Challenge

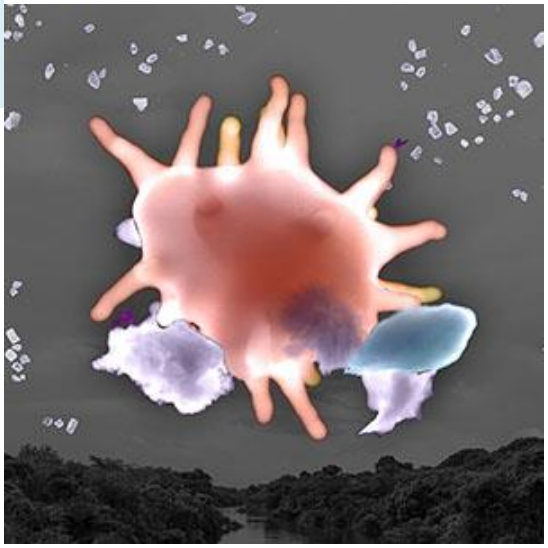
- Sodium salt particles have been measured in Amazon air, but the only explanation to-date was long range transport.

Approach and Results

- An international team of scientists used advanced chemical imaging and atmospheric modeling to determine the composition of sodium salt particles.
- They discovered that fungal spores make up as much as 69 percent of airborne sodium salt particles in the central Amazon basin.

Significance and Impact

- Never have fungal spores been considered a significant source of sodium salt particles over the Amazon.
- Understanding where these particles will be present and in what quantities can help scientists better predict climate patterns and ecosystem impacts.



Contrary to previous theories, fungal spores, rather than sea salt, contribute the most to atmospheric sodium salt particles over the pristine Amazon basin.

Participants:
EMSL
PNNL
LBNL
UC Berkeley
Purdue University
Xiamen University
Max Planck Institute for Chemistry
Federal University of São Paulo
University of São Paulo
Federal University of Para

Reference: S. China, S.M. Burrows, B. Wang, T.H. Harder, J. Weis, M. Tanarhte, L.V. Rizzo, J. Brito, G.G. Cirino, P.-L. Ma, J. Cliff, P. Artaxo, M.K. Gilles, and A. Laskin, “Fungal spores as a source of sodium salt particles in the Amazon basin.” *Nature Communications* (2018). DOI: 10.1038/s41467-018-07066-4

Climatic Responses to Future Trans-Arctic Shipping

Motivation

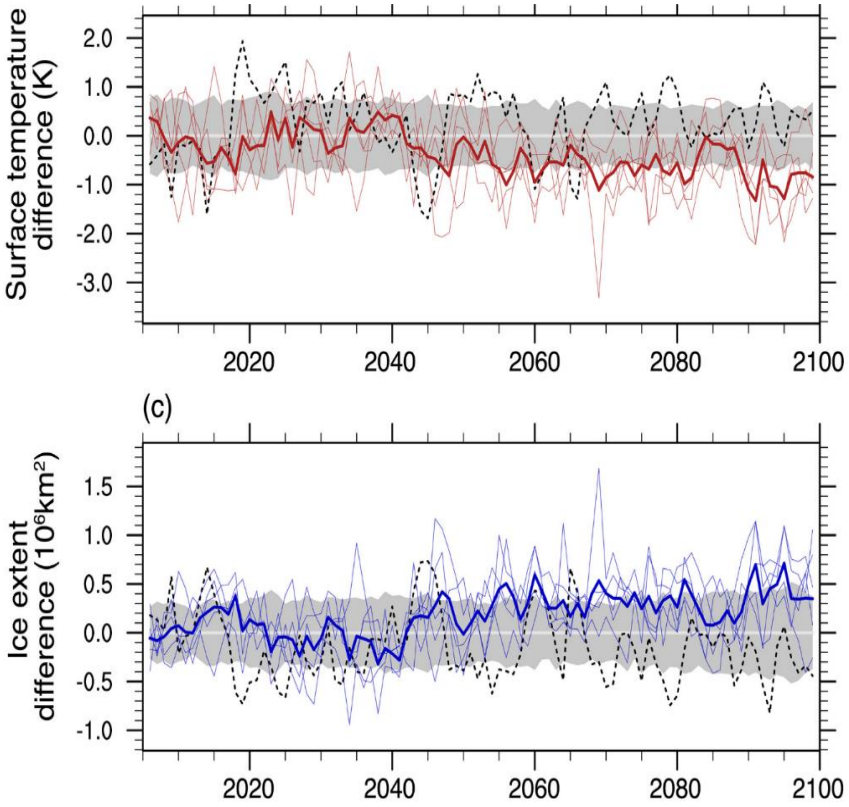
- As sea-ice loss enables greater commercial shipping traffic across the Arctic, how will increased shipping emissions effect the regional climate?

Approach

- Used an Earth System Model (CESM 1.2.2) and a new suite of 21st Century projections of Arctic shipping trends.
- This study simulates the physical interactions of albedo, clouds, oceans, sea-ice, and allows for specific shipping routes to vary with seasonal and decadal sea-ice changes.

Impact

- Trans-Arctic shipping will reduce Arctic warming by nearly 1°C by 2099 due to sulfate-driven liquid water cloud formation.
- Albedo induced sea-ice growth and decreased downwelling longwave radiation from reduced atmospheric water vapor content amplify the cooling.
- However, these results should not be interpreted as a potential method to counter the effects of warming. Any cooling might disappear if limits on sulfur emissions go into effect.



Sea-surface temperature (solid red line) and sea-ice extent (solid blue line) differences north of 65°N. Dashed lines represent a control run with no shipping emissions. Note the decrease in sea-surface temperature and an increase in sea-ice extent at the end of the century.

S.R. Stephenson, W. Wang, C.S. Zender, H. Wang, S.J. Davis, and P.J. Rasch, "Climatic Responses to Future Trans-Arctic Shipping." *Geophysical Research Letters* **45**(18), 9898–9908 (2018). [DOI: 10.1029/2018GL078969].

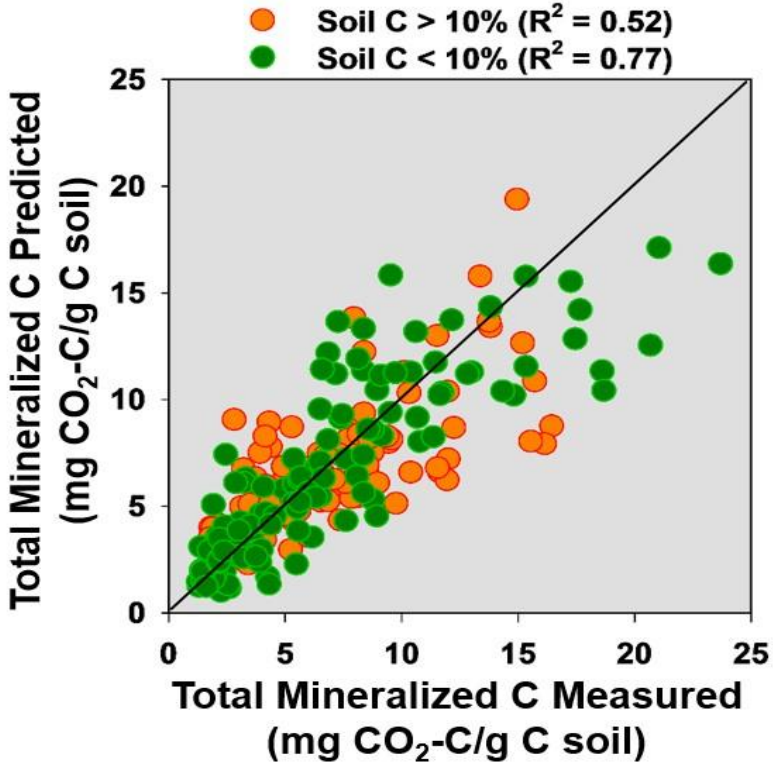
Predicting the Decomposability of Organic Matter in Warming Tundra Soils

Challenge

The potential decomposability of permafrost organic matter is a key uncertainty for predicting the release of C from thawing permafrost and assessing the impacts/feedbacks of this release to future climate.

Approach and Results

- Conducted 60-day laboratory incubations to assess the potential decomposability of active layer and permafrost organic matter in Arctic tundra soils.
- Evaluated whether mid infrared (MIR) spectra of bulk soils can predict the amount of C mineralized during short-term incubations.
- MIR calibration models reasonably estimated the decomposability of tundra soils. The best calibrations were obtained for soils with C concentrations of 10% or lower.



Significance and Impact

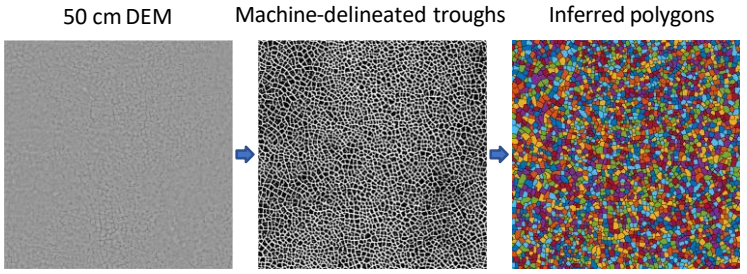
Application of MIR calibration models to already collected and archived soils will enable rapid and widespread regional assessments of potential decomposability of Arctic soil organic matter.

Matamala, R., Jastrow, J.D., Calderón, F.J., Liang, C., Fan, Z., Michaelson, G.J. and Ping, C.L. 2019. Predicting the decomposability of arctic tundra soil organic matter with mid infrared spectroscopy. *Soil Biology and Biochemistry* 129:1-12. https://doi.org/10.1016/j.soilbio.2018.10.014

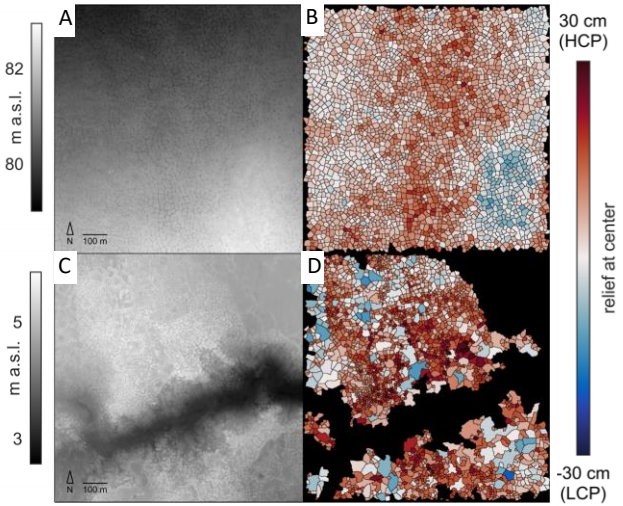
Machine-Learning-Based Measurement of Ice Wedge Polygon Properties

NGEE Arctic

Objective	• We created a machine-learning based, rapid assessment technology, to quantify ice wedge polygon tundra characteristics from digital elevation models.
New science	• Our technique can quickly delineate polygon boundaries, types, numbers and topographic properties over large regions.
Impact	• We now have a reliable, automated method to quantify rates and amount of change in arctic topography in response to climate driven permafrost degradation. • Analysis products can directly inform both high-resolution model grids, and provide sub-grid landscape parameterization data for Earth System Models to better predict ecosystem evolution.



Neural Network Application (1 km^2 site)



DEMs and estimates of polygonal relieve at Prudhoe (A, B) and Utqiaġvik (C, D).

Abolt, CJ, Young, MH, Atchley, AL, and Wilson, CJ, 2019. Brief communication: Rapid machine-learning based extraction and measurement of ice wedge polygons in high-resolution digital elevation models. The Cryosphere,13(1), DOI:105194/tc-13-237-2019

New Model for U Transport in Wet-Dry Cycled Floodplains

Scientific Achievement

Wet-dry cycling promotes accumulation of *hexavalent* and tetravalent U

Significance and Impact

Multiple accumulation mechanisms explain why U is so strongly retained in sediments

Helps explain why uranium plumes so long-lived

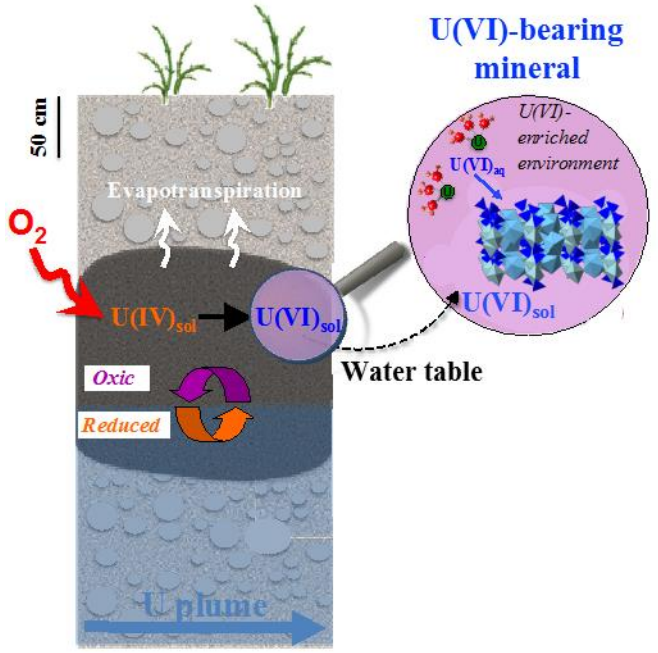
Research Details

* Shiprock DOE legacy site contaminated with largest uranium groundwater plume in Western U.S.

* Synchrotron and Mössbauer spectroscopy, chemical extractions, and hydrological measurements show that sediment-hosted U^{IV} is oxidized to U^{VI} faster than dissolved U^{VI} can be transported away.

* U^{VI} accumulates seasonally and is stable against reduction

* Overturns widely held assumption that U accumulates only as U(IV) in reduced sediments because U(VI) is unstable



Anoxic organic-enriched sediments strongly accumulate U^{IV}, and sulfide. Seasonal oxidation reactions of theses sediments triggered by changing water tables promote conversion U^{IV} to relatively immobile U^{VI}

SLAC Groundwater Quality SFA

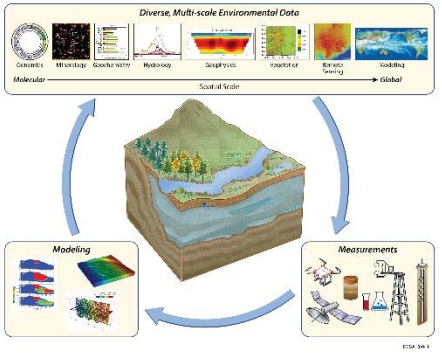
V. Noël, *et al*. *Water Research* **152**, 251-263 (2019)

EOS Article: Launching an Accessible Archive of Environmental Data

A new digital archive enables community use of terrestrial and subsurface ecosystem data sets

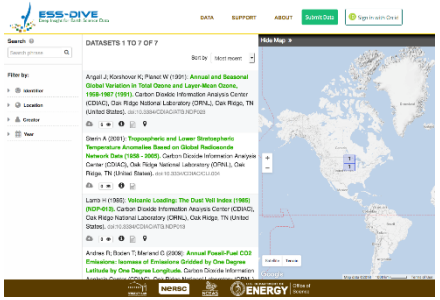
Challenge

Earth scientists need access to long-term, spatially dense, high-quality observational data sets coupled with simulations to understand and predict ecosystem behavior over timescales spanning decades to centuries



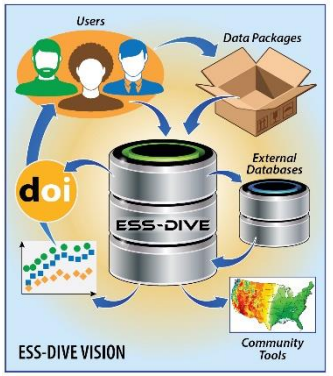
Approach and Results

- Data services launched on 1 April 2018
- Established to provide long-term stewardship and enable broad usage of data from research in the DOE's Environmental System Science (ESS) domain
- Proactively engaging with the ESS scientific research community to understand their needs and to adopt or develop standards
- Designed using Findable, Accessible, Interoperable, and Reusable (FAIR) principles



Significance and Impact

- The ESS-DIVE data portal allows members of the public to search published data and download files (249 datasets available)
- Engaging with the ESS Community to define and develop features needed
- Includes all relevant data from previous ESS archive



Reference: Varadharajan, C., S. Cholia, C. Snavely, V. Hendrix, C. Procopiou, D. Swantek, W. J. Riley, and D. A. Agarwal (2019), Launching an accessible archive of environmental data, *Eos, 100,* https://doi.org/10.1029/2019EO111263. Published on 08 January 2019.

2019 EMSL/ARM/ASR Aerosol Summer School

- Summer program for graduate students and early career scientists
- Co-sponsored by the EMSL and ARM user facilities and the ASR research program
- Agenda focus on aerosol chemical & physical properties, including tutorials on field and lab experiments, as well as aerosol modeling approaches
- Will expose students to a wide array of sensors and instruments available at EMSL and ARM facilities

- Daily topics:
  - Methods of aerosol characterization; aerosol sources
  - Secondary organic aerosol, formation and ageing
  - Climate radiative forcing by aerosols.
  - Field studies of aerosols: opps provided by ARM and ASR
  - Modeling of aerosol atmospheric and climate effects
- Instructors include EMSL and ARM staff from PNNL and BNL, and invited university speakers

THANK YOU!