Wilbert Weijer and the HiLAT team

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U.S. DEPARTMENT OF ENERGY | Office of Science

Pacific Northwest NATIONAL LABORATORY

HiLAT: Overview

- High-Latitude Application and Testing of Global and Regional Climate Models
- New DOE Science Focus Area (SFA)
  - July 1, 2015
  - Partly continuation of COSIM SFA
- Funded by DOE's RGCM program
  - Program manager: Renu Joseph
- Joint between LANL and PNNL

HiLAT: Personnel & Capabilities

HiLAT SFA

LANL

Wilbert Weijer (PI)
Matthew Hecht
Milena Veneziani
Joseph Schoonover (PD)
Elizabeth Hunke
Jorge Urrego-Blanco (PD)
Scott Elliott
Nicole Jeffery
Shanlin Wang
Jeremy Fyke
Bill Lipscomb
Nathan Urban
Darin Comeau (PD)
Joel Rowland
Anastasia Piliouras (PD)

PNNL

Phil Rasch (co-PI)
Susannah Burrows
Hailong Wang
Ben Kravitz
Catrin Mills (PD)
Hansi Singh (PD)

Funded Collaborators

Gokhan Danabasoglu (NCAR)
Georgina Gibson (IARC)

Capabilities

Ocean
Sea Ice
Marine Biogeochemistry
Land Ice
UQ
Terrestrial Hydrology
Atmosphere

Collaborative Projects

ACME (Accelerated Climate Modeling for Energy)

66% of HiLAT staff shared with ACME

Benchmarking SFA (Biogeochemistry-Climate Feedbacks)

NGEE-Arctic (Next Generation Ecosystem Experiments)

RASM (Regional Arctic System Model)

CESM (Community Earth System Model)

SIPN (Sea Ice Prediction Network)

ISMIP6 (Ice Sheet Model Intercomparison Project)

FAMOS (Forum for Arctic Modeling & Observational Synthesis

HiLAT: Charge

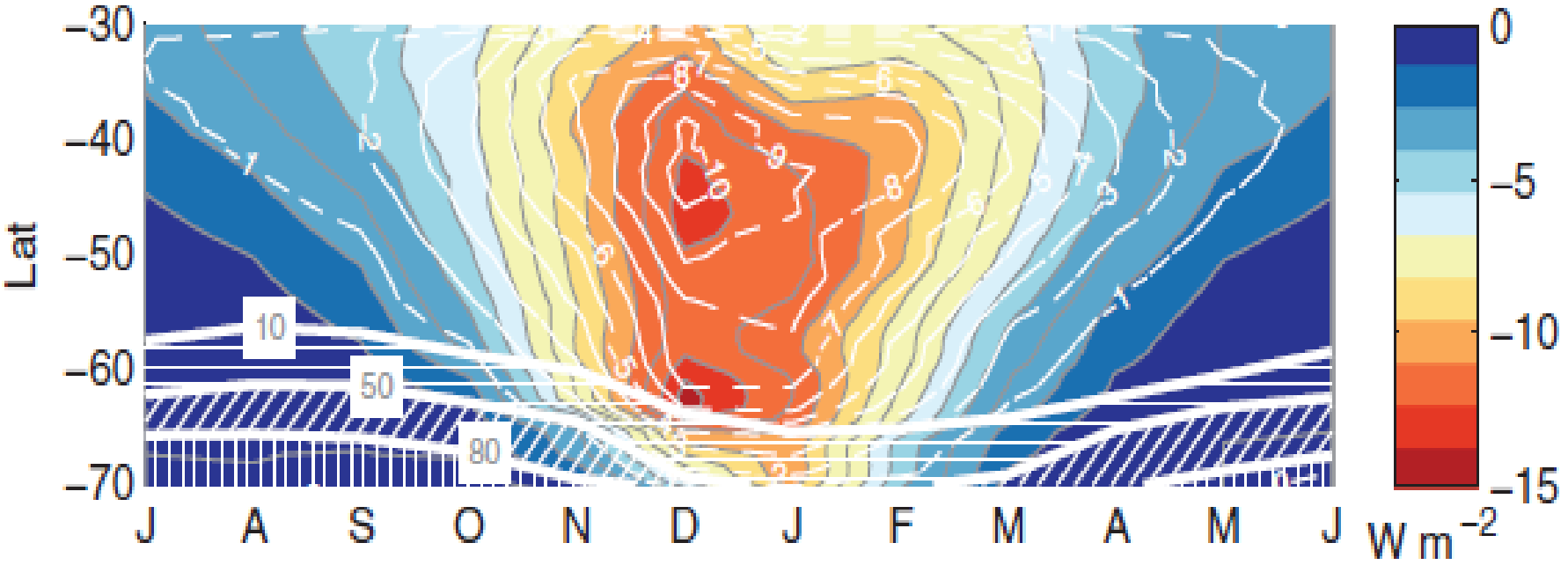
- Develop cross-cutting projects that involve a significant subset of these disciplines
- Quantify feedbacks between the cryospheric changes and the Earth's heat and water budgets
  - improve projections of high-latitude climate change…
  - …and the resulting regional and global impacts
- Theme 1: Regional feedbacks
  - Cryospheric changes affect high-latitude processes that modulate regional warming (polar amplification)
- Theme 2: Global feedbacks
  - Cryospheric changes affect polar/extrapolar interactions that modulate global warming

Impacts on Ecosystems and Clouds

Shanlin, Nicole, Susannah, Scott, and the rest of us

- Marine ecosystems impact clouds
  - DMS emission, precursor to sulfate aerosols
  - Marine Organics injected through sea spray

Change in reflected shortwave radiation due to sulfate and marine organic aerosols



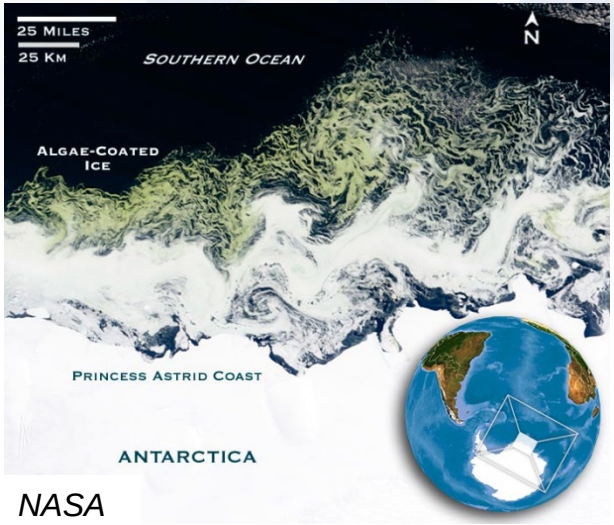
*McCoy, **Burrows, Elliott, Rasch** et al. (Sci. Adv. 2015)*

Impacts on Ecosystems and Clouds

Shanlin, Nicole, Susannah, Scott, and the rest of us

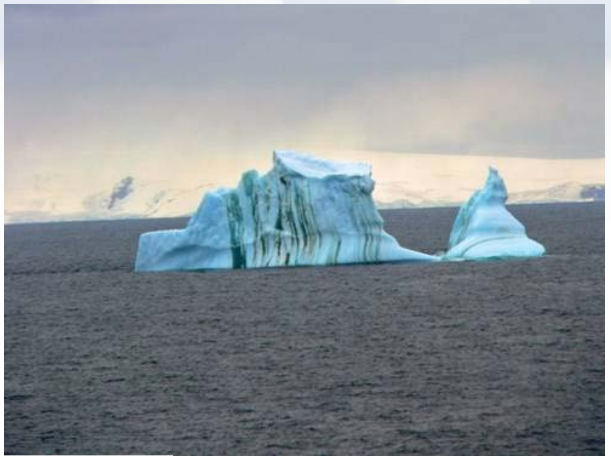
- Marine ecosystems sensitive to cryospheric changes
  - Changes in sea ice cover and seasonality
    - Light limitation, nutrients exchange
  - Ice sheet disintegration
    - Freshwater/nutrient inputs from ice sheets

Plankton blooms along retreating ice edge



NASA

Sediment bearing iceberg

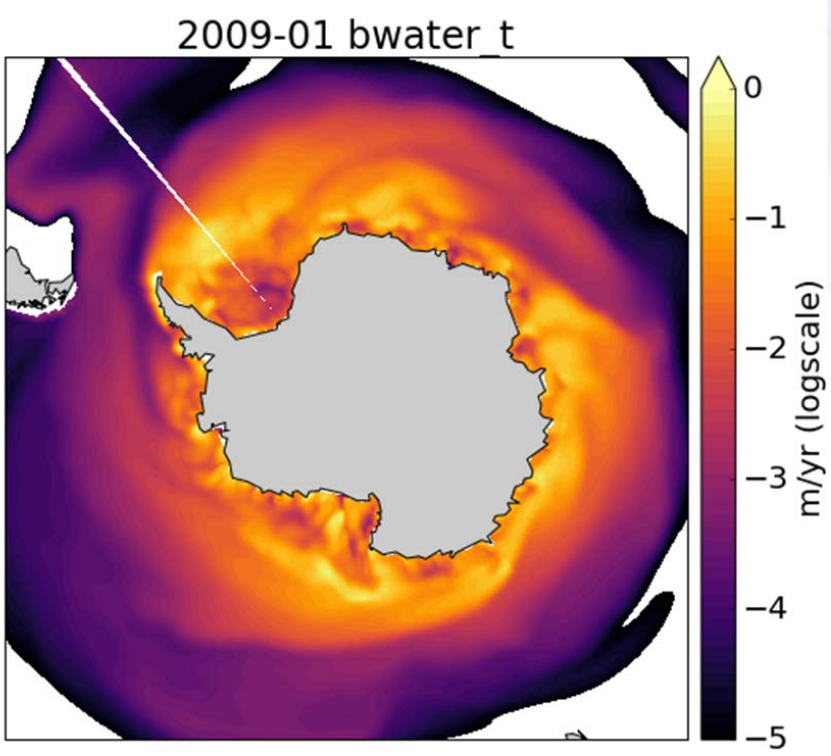


Raiswell

Impacts on Ecosystems and Clouds

Shanlin, Nicole, Susannah, Scott, and the rest of us

- How will changes in cryosphere affect marine (incl. sea ice) ecosystems?
- How will this affect radiative balance through aerosols?
- Approach
  - Ocean/sea ice experiments
  - Fully-coupled experiments
  - Apply perturbations
    - Freshwater
    - Nutrients

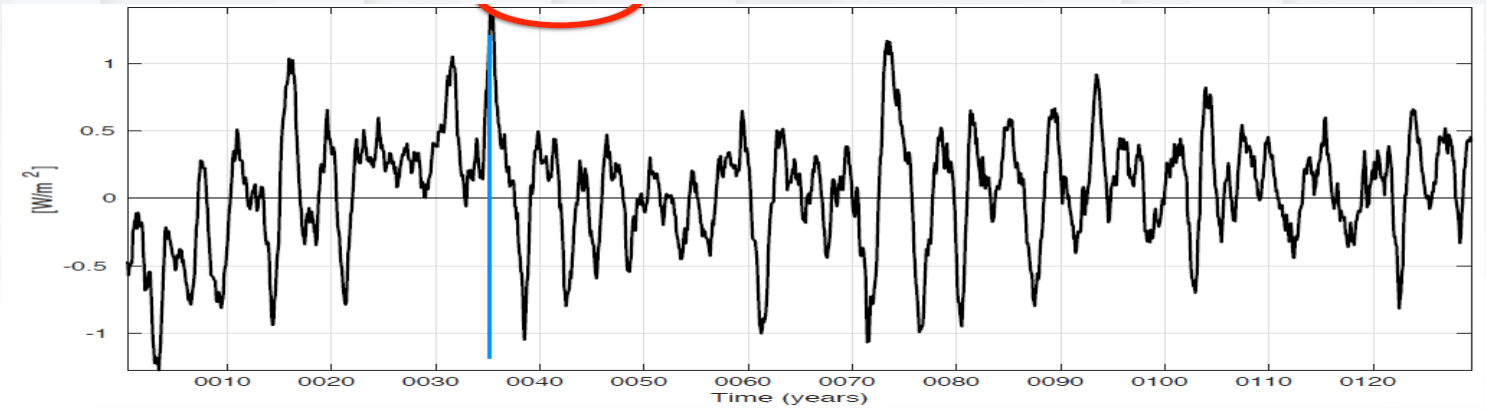


Code Base

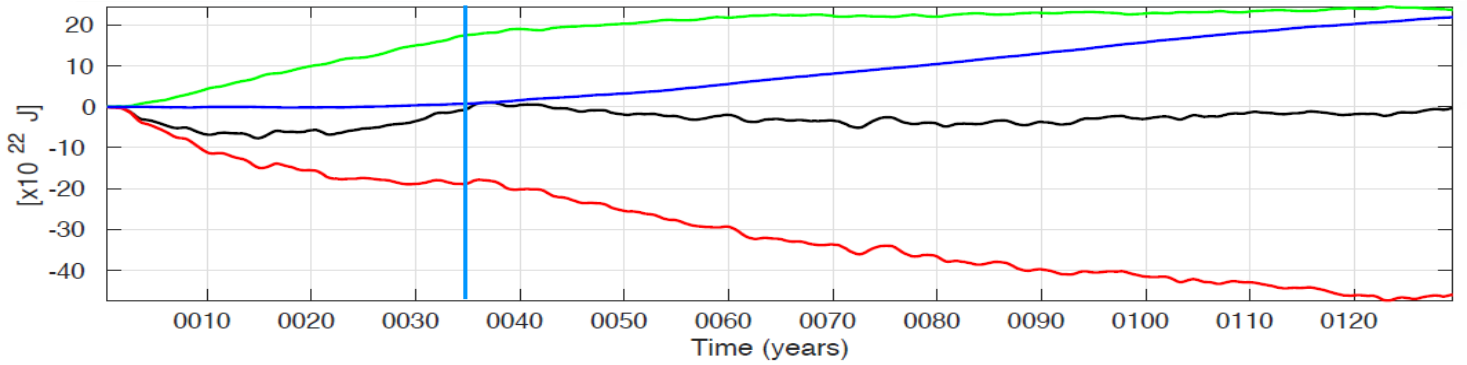
- ACME-HiLAT
  - Branched off of CESM1 (1.3 beta 10)
  - POP2 with BEC
    - Includes *Phaeocystis*
  - CICE5
    - Optimized parameter set (Urrego-Blanco et al.)
    - with zBGC
    - BGC coupling between ocean and sea ice
  - CAM5
    - With polar modifications, FreezeDry
- Still working on
  - Passing DMS through coupler
- Most experiments done at gx1v6/ne30

Control Integration

- Completed 150 yr PI control integration
  - Well-balanced TOA, OHC
  - But still significant sea ice biases

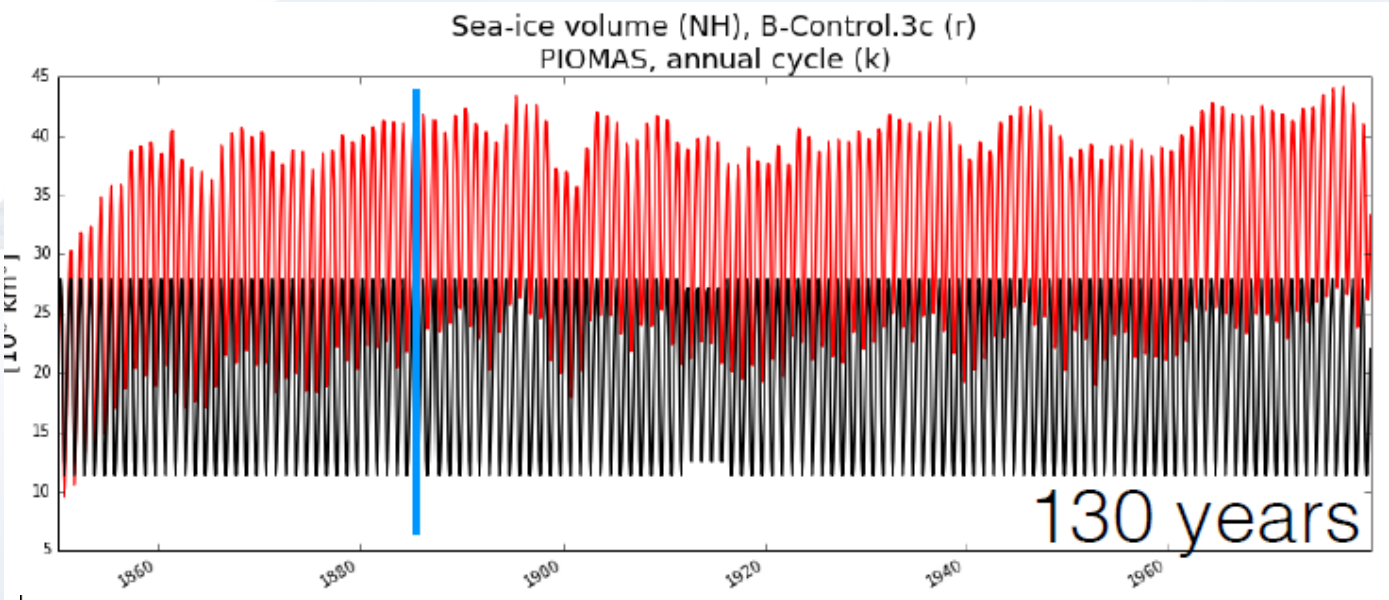


TOA balance

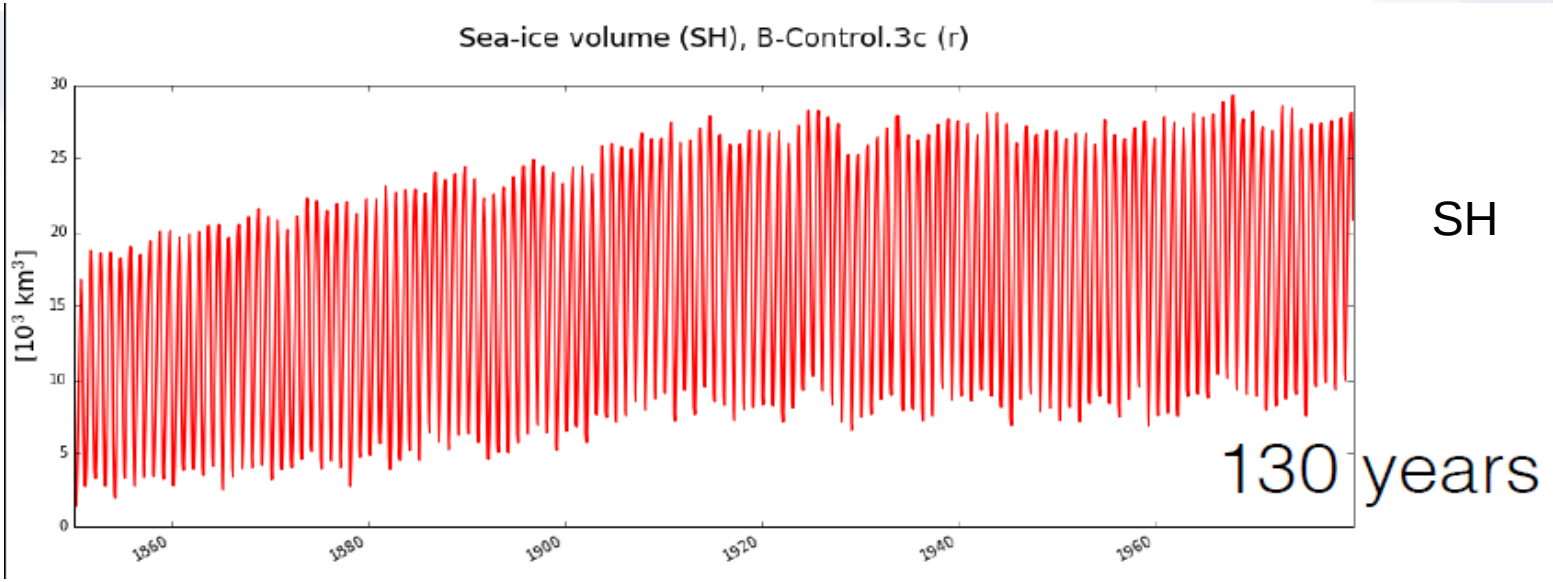


Ocean heat content

Control Integration



NH



SH

High- to Low-Latitude Connections

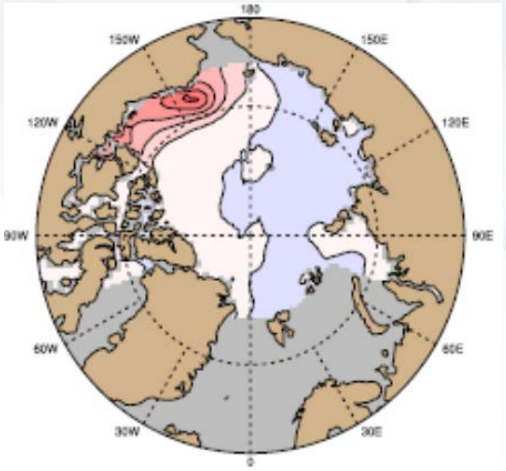
Mills, Kravitz, Rasch, H. Wang

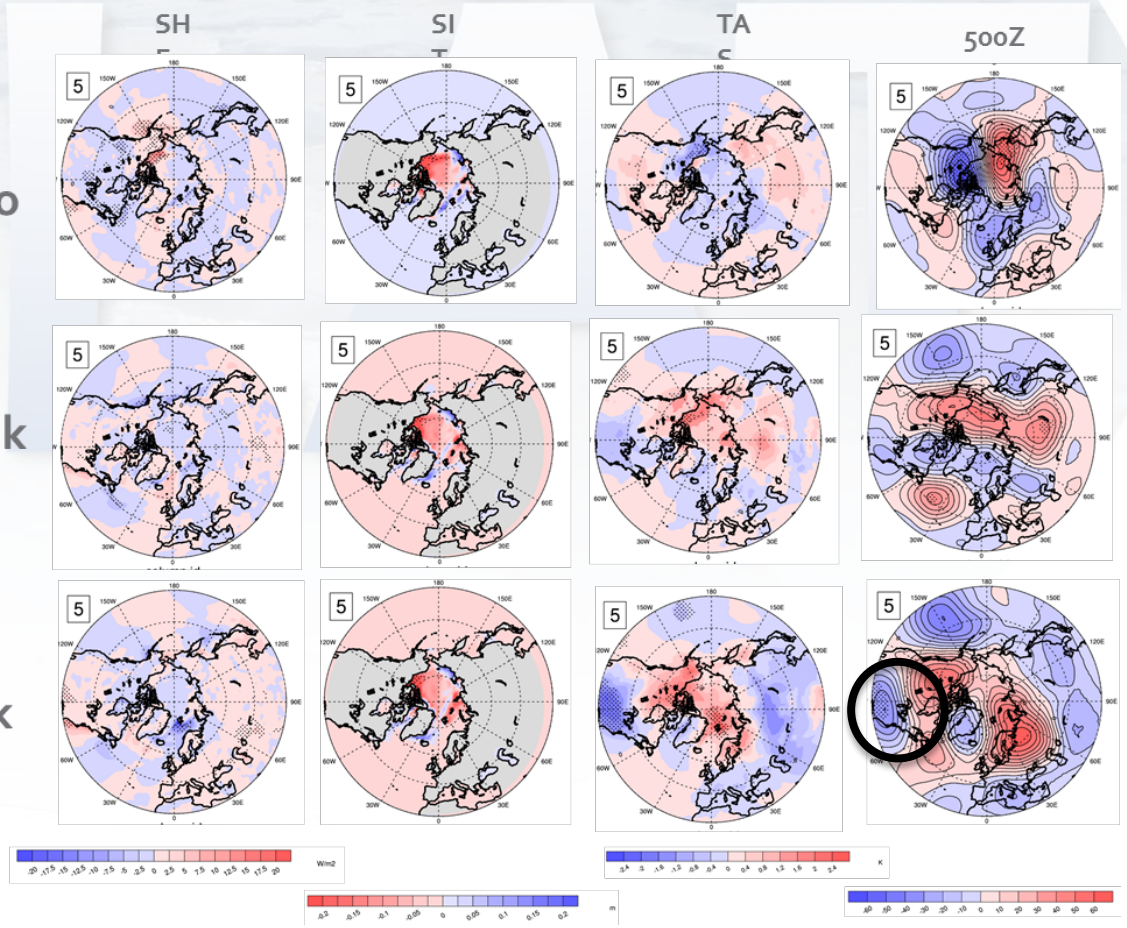
- What is the response of mid-latitude atmosphere to Arctic sea ice decline?

High- to Low-Latitude Connections

Mills, Kravitz, Rasch, H. Wang

- Approach 1:Use *Self-Organizing Maps* on free-running model



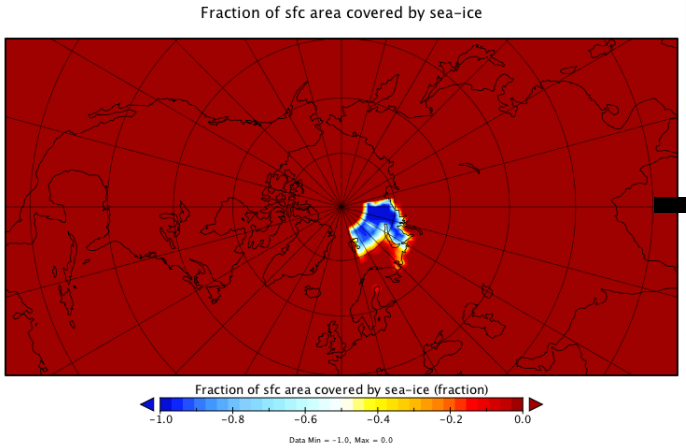


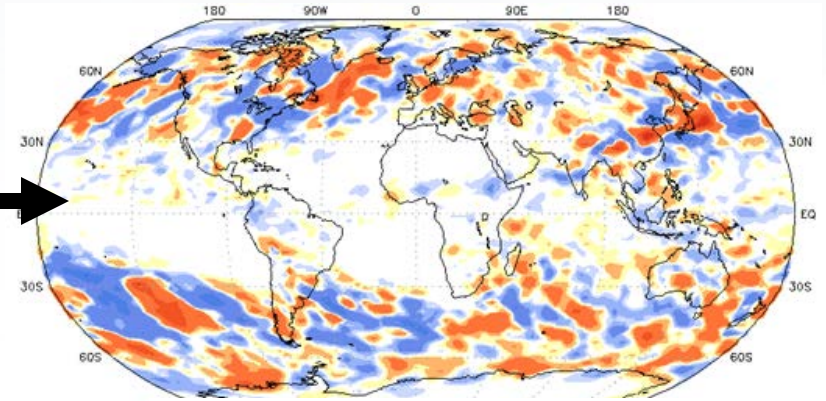
***Mills** et al. (GRL, 2016)*

High- to Low-Latitude Connections

Mills, Kravitz, Rasch, H. Wang

- Approach 2: Use *System Identification* approach to determine climate sensitivities to Arctic sea ice perturbations
  - Divide Arctic in several sectors
  - Perturb each sector daily by removing sea ice
  - Run with random sequence of 1s and 0s
  - Project response back on input sequence





***Kravitz** et al. (Atmos. Chem. Phys, 2017)*

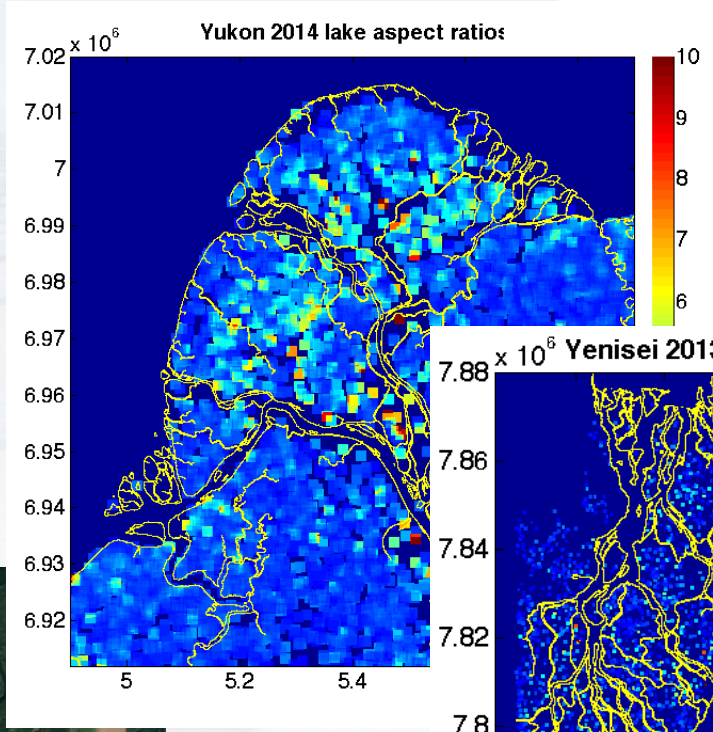
Deltas

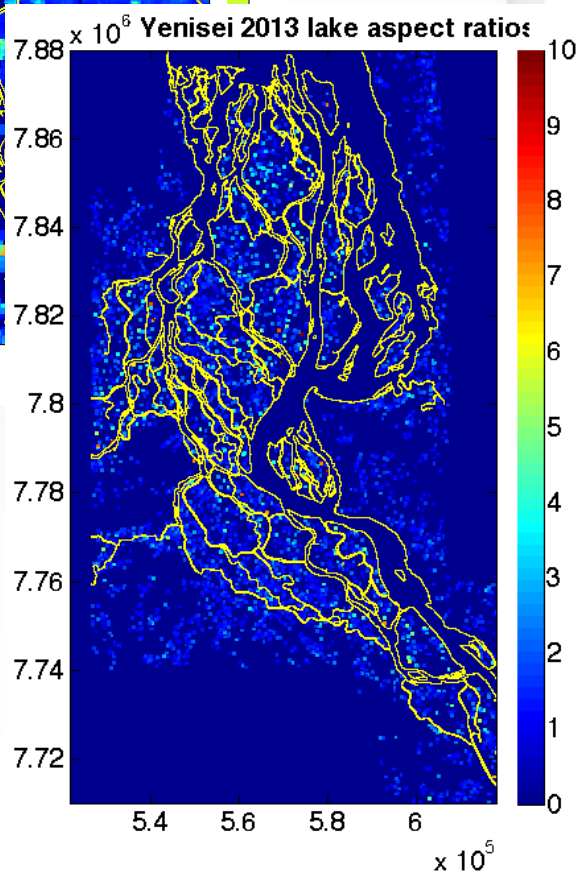
Rowland, Piliouras

- How much morphologic variability is there between Arctic deltas?
  - How does morphology influence storage and delivery of water, sediment and nutrients?
  - What do spatial patterns of lakes and channels tell us about delta behavior and lateral distribution of fluxes at the shoreline?
  - How do river/delta dynamics and outputs influence entrainment of sediment by sea ice?

Deltas

Rowland, Piliouras





Ways for Collaboration

- DOE Office of Science Graduate Student Research (SCGSR) Program
  - “Supplemental awards to outstanding U.S. graduate students to pursue part of their graduate thesis research at a DOE laboratory”
  - Bi-annual
  - Next deadline: May 16, 2017
  - US citizens or permanent residents
- Science Undergraduate Laboratory Internships (SULI)
  - “…encourages undergraduate students to pursue science, technology, engineering, and mathematics (STEM) careers by providing research experiences at the Department of Energy (DOE) laboratories.”
  - Summer internships, or fall/spring semester
  - Next deadline: May 31, 2016 (Fall 2016)

Ways for Collaboration

- Possible new DOE RGCM call
  - Due any moment
  - But high-latitudes?