



# HiLAT

**Wilbert Weijer and the HiLAT team**

# HiLAT Overview

- High-Latitude Application and Testing of Global and Regional Climate Models
- New DOE project
  - June 1, 2015
- Focuses on evaluating climate feedbacks wrt **changes in the cryosphere**
- Joint between LANL and PNNL

# HiLAT Team

LANL	PNNL
Phil Jones	Phil Rasch
Wilbert Weijer	Susannah Burrows
Jeremy Fyke	Jin-Ho Yoon
Matthew Hecht	Hailong Wang
Elizabeth Hunke	Catrin Mills
Nicole Jeffery	
Joel Rowland	
Nathan Urban	
Jorge Urrego-Blanco	
Milena Veneziani	
Shanlin Wang	
Scott Elliott	
Alex Jonko	
Joseph Schoonover	

# HiLAT as RGCM project

- **HiLAT** is funded by the **RGCM** program
  - Regional & Global Climate Modeling
  - Program manager: Renu Joseph
  - Climate model application and testing
- **ACME** is funded by the **ESM** program
  - Earth System Modeling
  - Program manager: Dorothy Koch
  - Climate model development

# HiLAT Team: Overlap with ACME

LANL	PNNL
Phil Jones	Phil Rasch
Wilbert Weijer	Susannah Burrows
Jeremy Fyke	Jin-Ho Yoon
Matthew Hecht	Hailong Wang
Elizabeth Hunke	Catrin Mills
Nicole Jeffery	
Joel Rowland	
Nathan Urban	
Jorge Urrego-Blanco	<b>10 out of 19</b>
Milena Veneziani	
Shanlin Wang	
Scott Elliott	
Alex Jonko	
Joseph Schoonover	

# HiLAT Team: Diverse Capabilities

LANL	PNNL
Phil Jones	Phil Rasch
Wilbert Weijer	Susannah Burrows
Jeremy Fyke	Jin-Ho Yoon
Matthew Hecht	Hailong Wang
Elizabeth Hunke	Catrin Mills
Nicole Jeffery	
Joel Rowland	
Nathan Urban	
Jorge Urrego-Blanco	Sea Ice
Milena Veneziani	Land Ice
Shanlin Wang	Ocean
Scott Elliott	Atmosphere
Alex Jonko	Marine Biogeochemistry
Joseph Schoonover	Terrestrial Hydrology

# HiLAT Charge

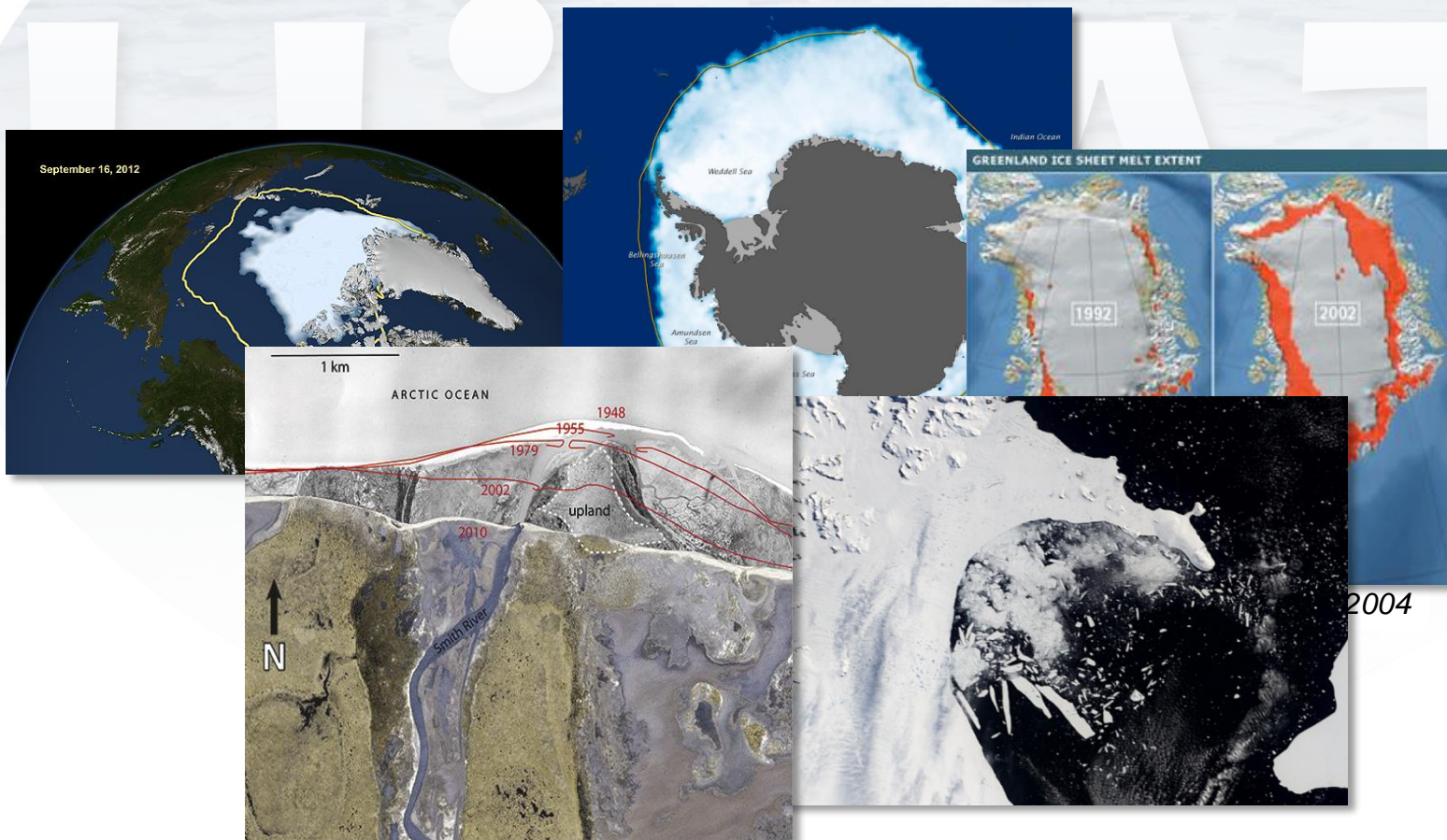
- Develop **cross-cutting projects** that involve a significant subset of these disciplines

HiLAT



# Central Theme

- Global warming strongly affects cryosphere
  - What are the regional and global consequences?





# Vision: High-Latitude Feedbacks

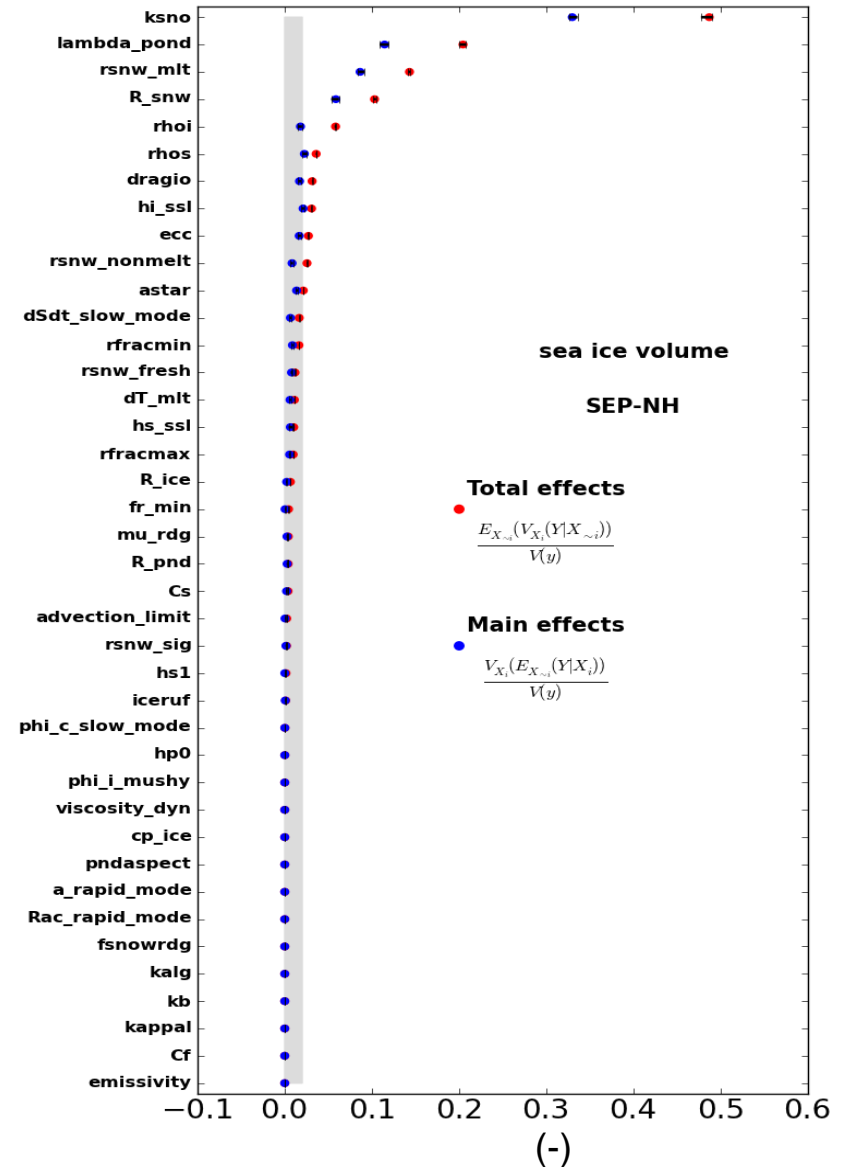
- Quantify **feedbacks** between the **cryospheric changes** and the Earth's **heat and water budgets**
  - improve projections of high-latitude climate change...
  - ...and the resulting regional and global impacts
- Theme 1: **Regional feedbacks**
  - Cryospheric changes affect high-latitude processes that modulate regional warming (polar amplification)
- Theme 2: **Global feedbacks**
  - Cryospheric changes affect polar/extrapolar interactions that modulate global warming

# Sea Ice Sensitivity & Predictability

Jorge, Nathan, Elizabeth

- Systematically explore the sensitivity of sea ice (CICE5) to different parameters

Most sensitive CICE5 parameters



*Urrego-Blanco, Urban and Hunke*  
(*J. Geophys. Res.*, *subm.*)

# Arctic Deltas and River Inputs

Joel

- Study response of Arctic deltas to climate change

- River discharge
- Permafrost thawing
- Sea level rise
- Sea ice changes

Lena River Delta



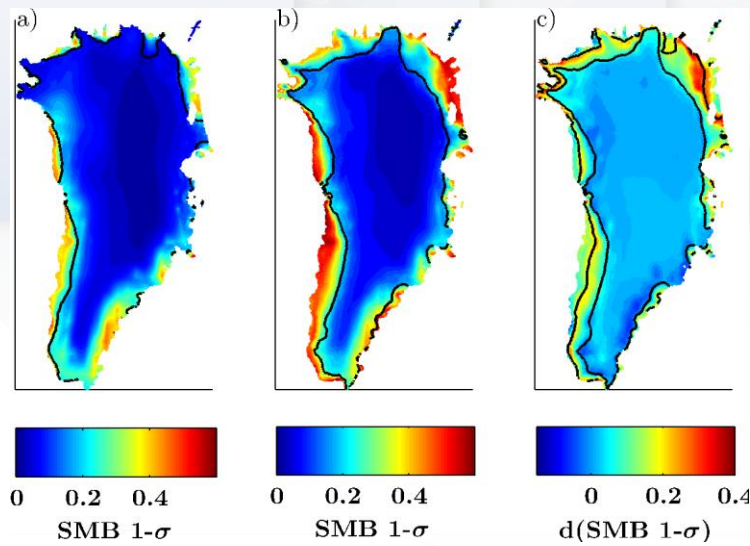
ESA



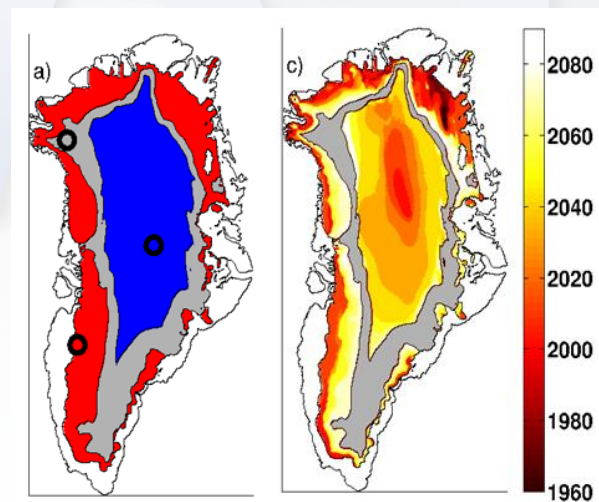
# Greenland Ice Sheet Evolution

Jeremy

- Quantify rates, variability of GrIS mass loss
- Detect and attribute anthropogenic signal in GrIS
- Assess feedbacks between ice sheet and climate



Surface Mass Balance variability in CESM

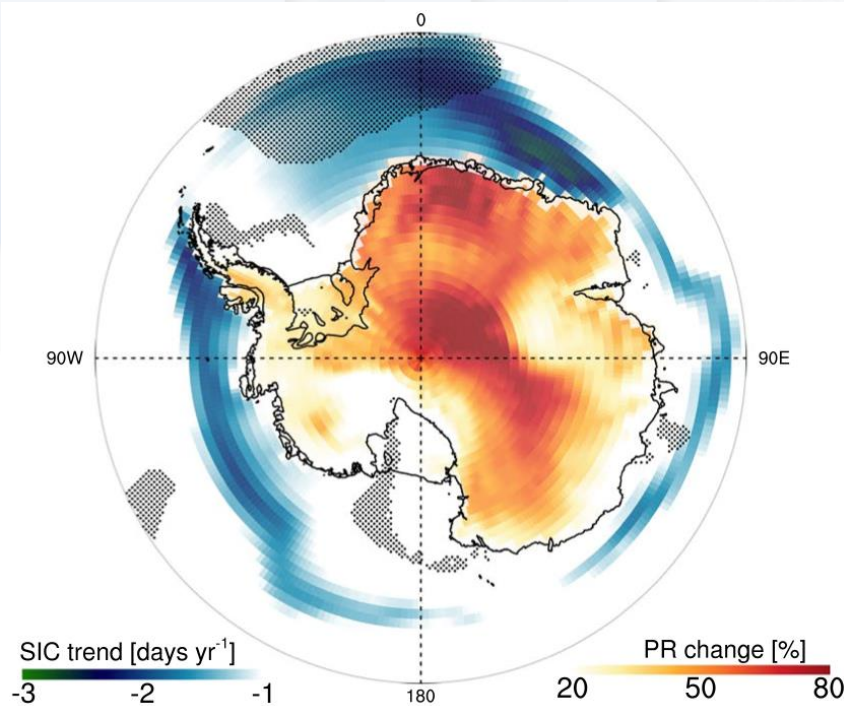


Emergence of anthropogenic signal

# Antarctic Ice Sheet Mass Balance

Jeremy, Hailong

- Surface water mass balance of Antarctica
  - Enhanced precipitation
  - Where does precipitation come from?
  - Water vapor tracking



Trend in sea ice covered days during 21<sup>st</sup> century  
Relative precipitation change

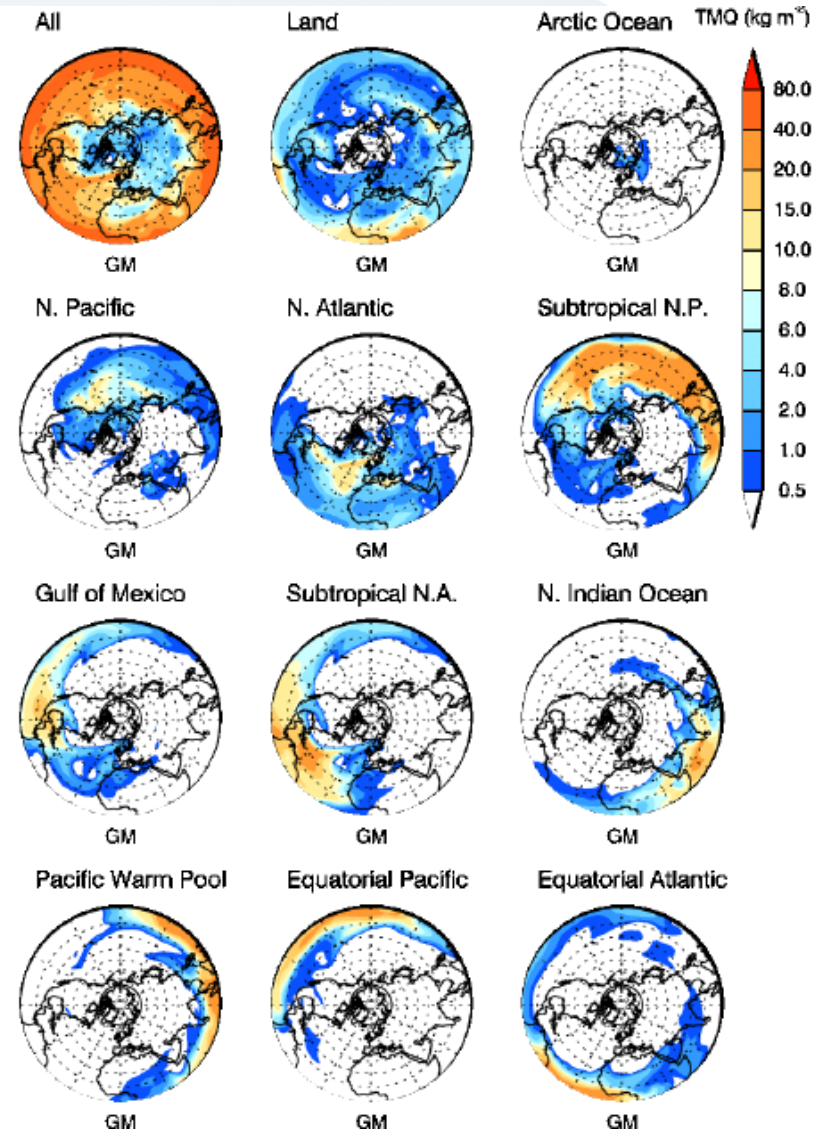
Lenaerts, Vizcaino, **Fyke**, et al.  
(*Clim. Dyn.*, 2016)



# Polar/Extrapolar Atmospheric Exchanges

Hailong, Jin-Ho, Phil R.

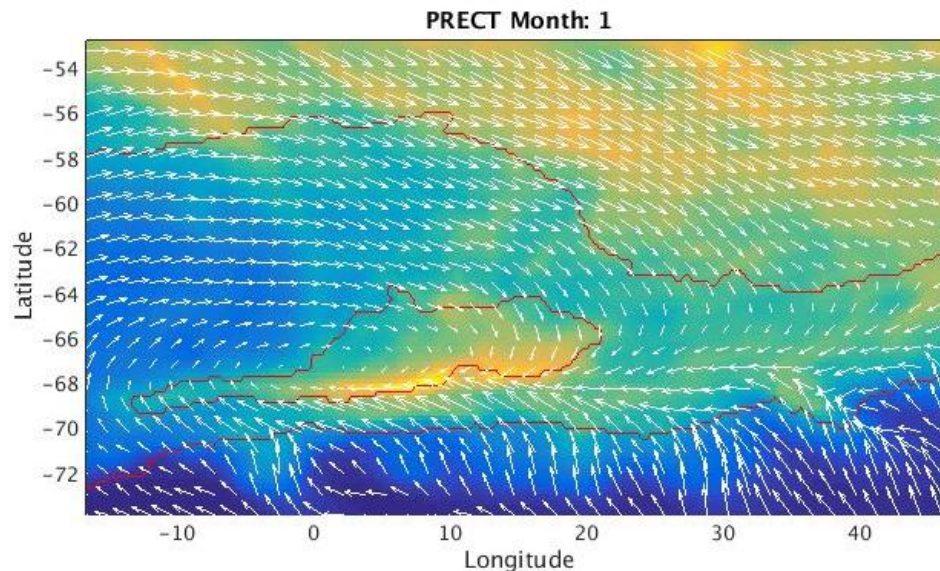
- Study response of polar/extrapolar atmospheric exchanges to Arctic sea ice decline
  - Water vapor tracking
  - Source/receptor analysis



# Freshwater Impacts on NADW/AABW

Wilbert, Milena, Matthew, Nicole, Alex

- Changes in high-latitude freshwater discharge
  - AMOC/polar/subpolar exchanges
  - AABW formation
  - Polynyas



Precipitation and winds  
over Weddell Sea polynya;  
NCAR ASD simulation with  
0.1° POP

**Weijer et al.**  
(*J. Clim.*, *subm*)

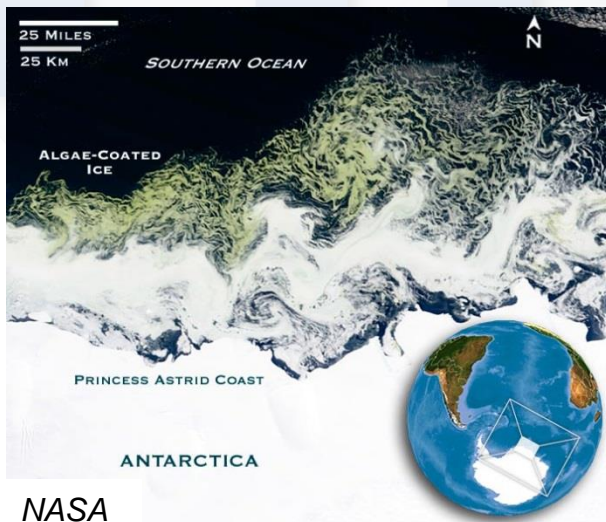


# Impacts on Ecosystems and Clouds

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

- Sensitivity of marine ecosystems to
  - Changes in sea ice cover and seasonality
  - Freshwater/nutrient inputs from ice sheets
  - Changes in riverine inputs in the Arctic

Plankton blooms along retreating ice edge



Sediment bearing iceberg



Raiswell

McKenzie River plume

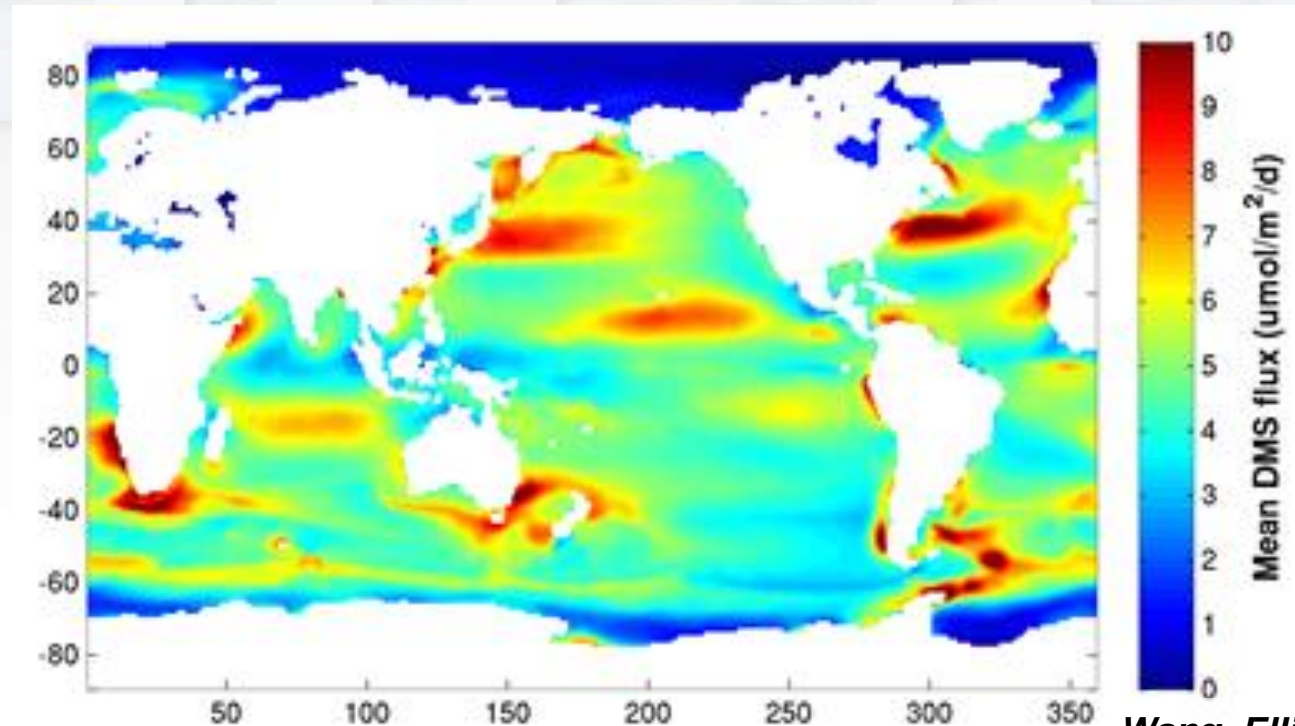


eosnap.com

# Impacts on Ecosystems and Clouds

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

- → Biogenic aerosol emissions
  - Dimethyl Sulfide (DMS)
  - Marine Organics



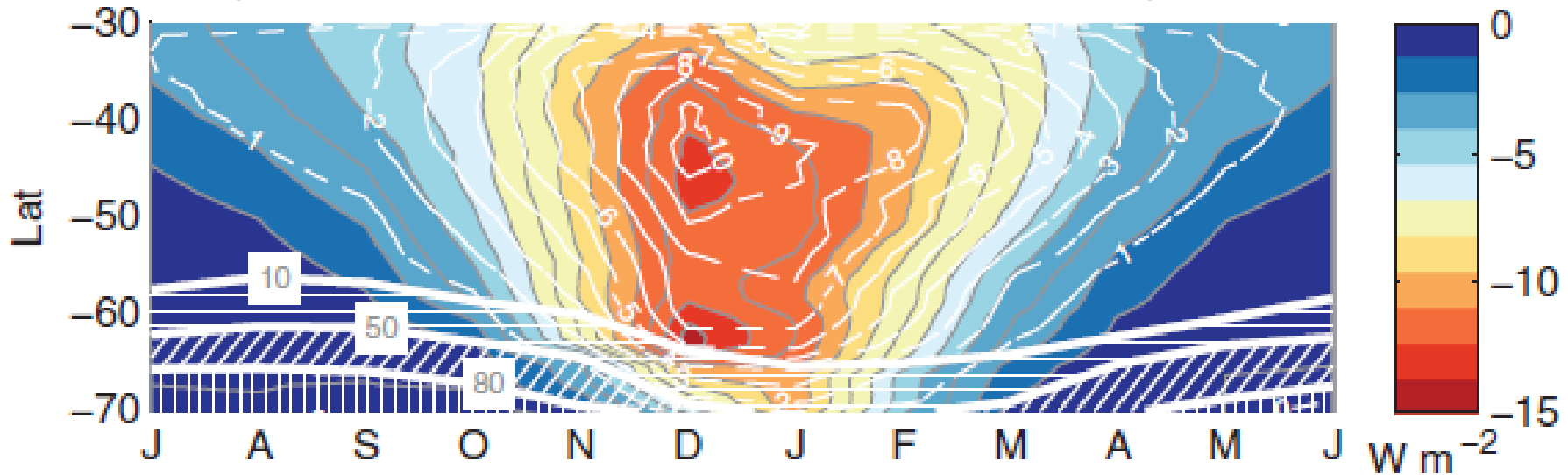
*Wang, Elliott et al.*  
(*J. Geophys. Res.* 2015)

# Impacts on Ecosystems and Clouds

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

- Clouds, radiation budget

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



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

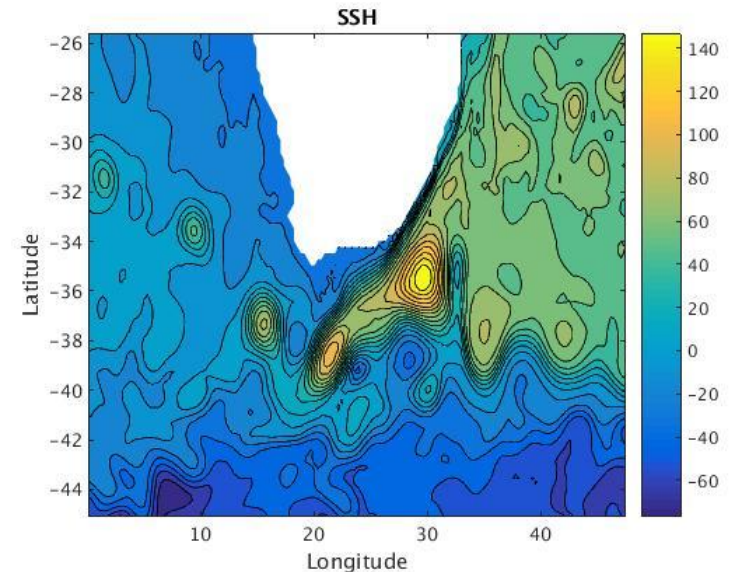
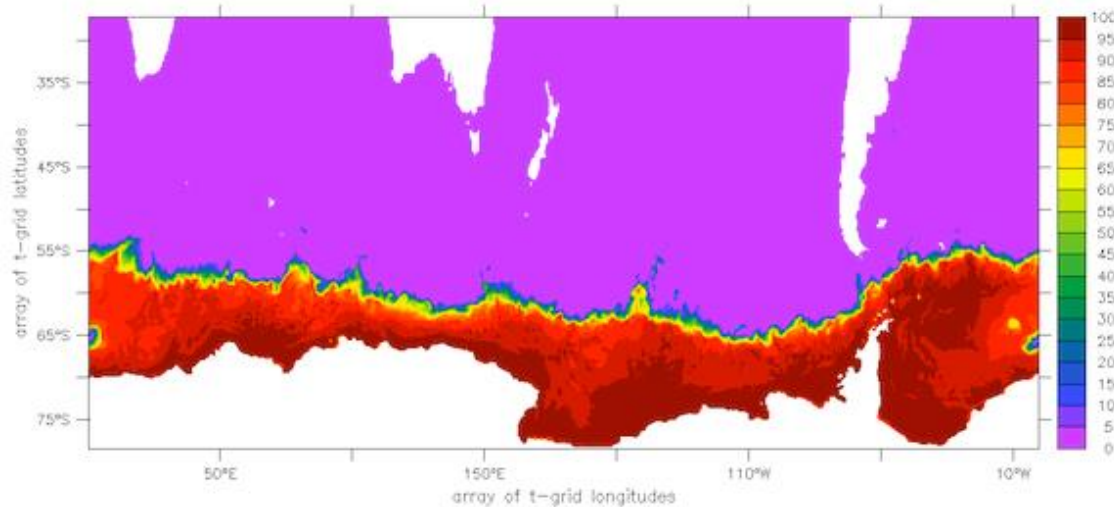


# Code Base

- ACME v0.1
  - Branched off of CESM1 (1.3 beta 10)
  - POP2
  - CAM5, with polar modifications
    - Still deciding on FV or SE core
- Additional developments
  - CICE5 physics
  - Marine biogenic aerosols
    - DMS and Marine Organics
- Most experiments done at gx1v6
  - But also new eddy-permitting version at 0.3°/ne30

# Eddy-permitting version of CESM

- Motivation: Better resolve critical transport features
  - Transient *and* standing eddies important for SO heat transport
  - Boundary currents carry freshwater/nutrients from ice sheets
    - e.g., Labrador Current, Antarctic Slope Current
  - Also interest in Agulhas Leakage, Zapiola Anticyclone
- Early tests are promising



# Conclusion

- HiLAT new project focused on high-latitude climate change
  - Wide range of topics
  - Strongly interdisciplinary
  - Great challenge for a group with limited experience in coupled simulations
- Excited to collaborate with PCWG community