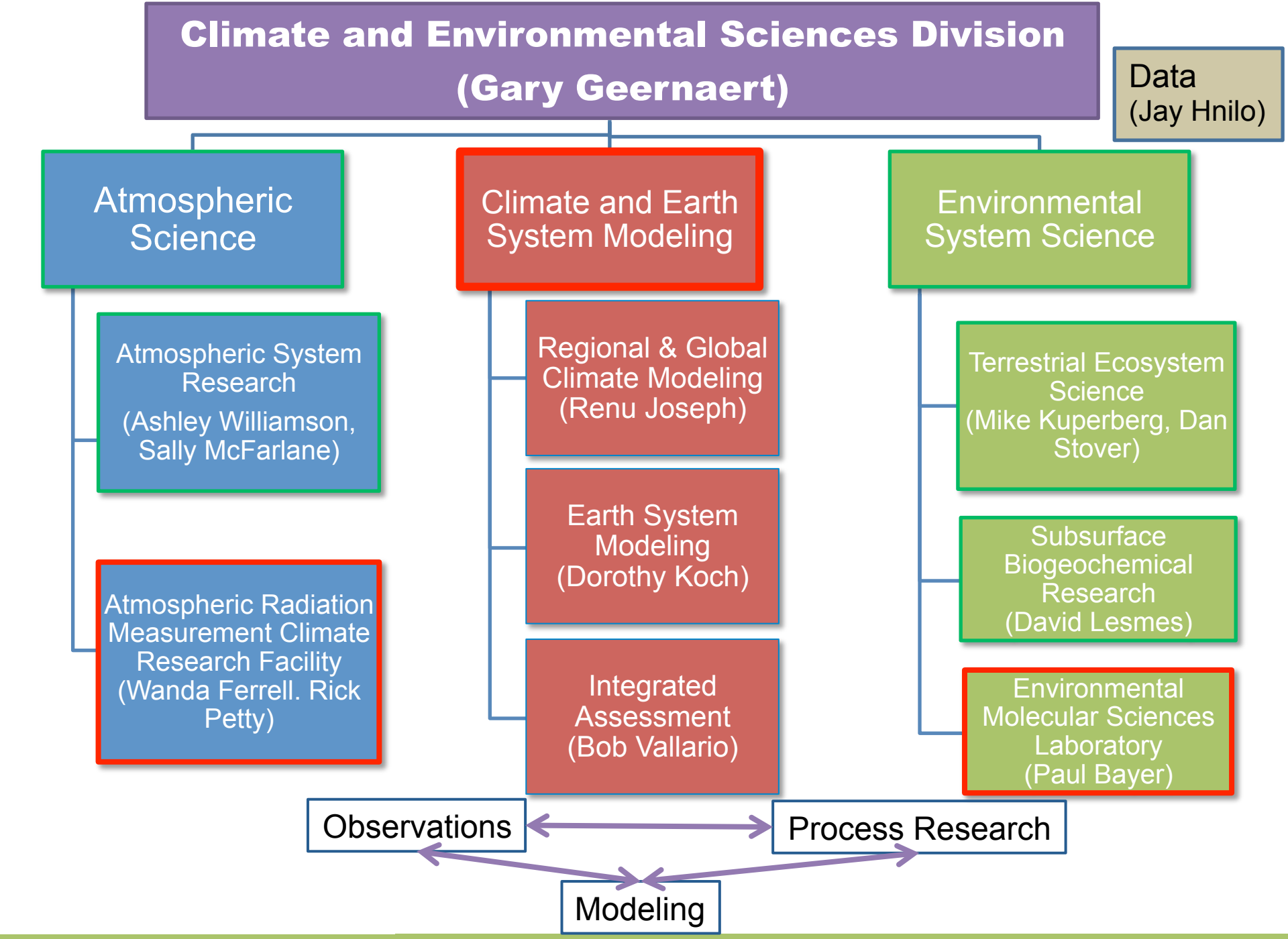
# DOE interests in the coupled Arctic/N. Atlantic

Program Manager

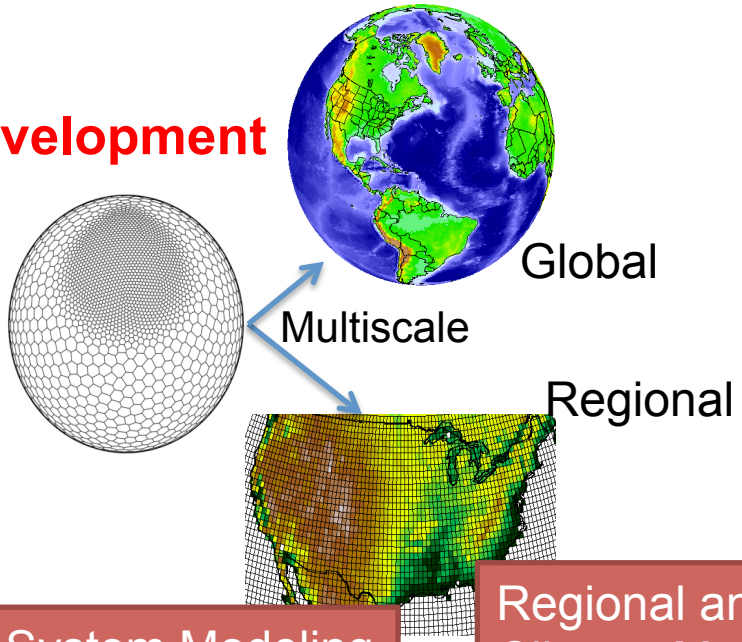
Renu Joseph
Regional and Global Climate Modeling Program


Climate and Environmental Sciences Division
(Gary Geernaert)
Data
(Jay Hnilo)
Atmospheric Science
Climate and Earth System Modeling
Environmental System Science
Atmospheric System Research
(Ashley Williamson, Sally McFarlane)
Atmospheric Radiation Measurement Climate Research Facility
(Wanda Ferrell. Rick Petty)
Regional & Global Climate Modeling
(Renu Joseph)
Earth System Modeling
(Dorothy Koch)
Integrated Assessment
(Bob Vallario)
Terrestrial Ecosystem Science
(Mike Kuperberg, Dan Stover)
Subsurface Biogeochemical Research
(David Lesmes)
Environmental Molecular Sciences Laboratory
(Paul Bayer)
Observations
Process Research
Modeling

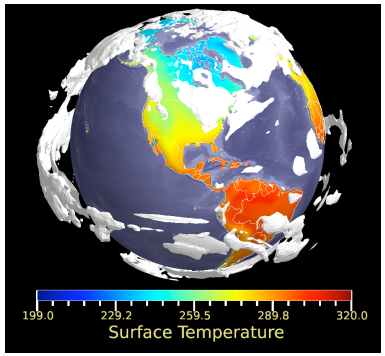
# DOE's Climate and Earth System Modeling

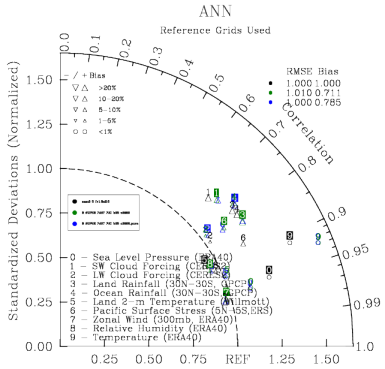
To advance fundamental understanding of climate variability and change by developing and analyzing Earth System Models and Integrated Assessment Models on temporal scales ranging from decadal to centuries and from global to regional.

**Development**




**Analysis**



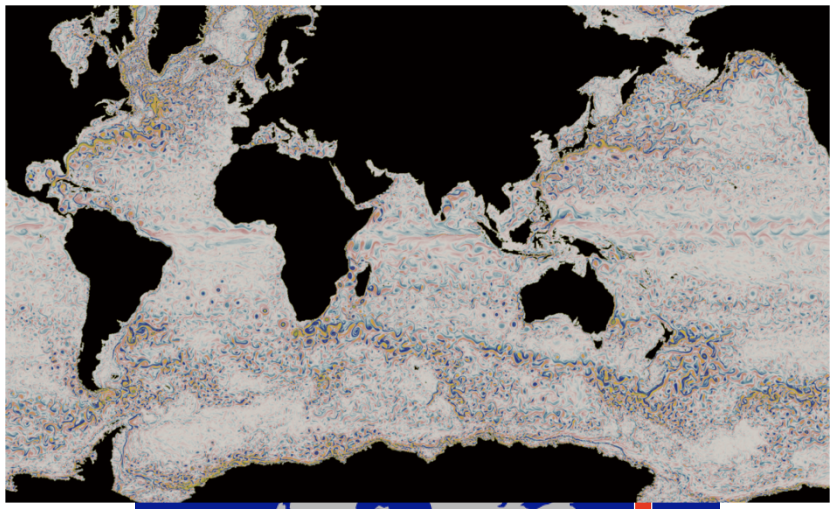

Earth System Modeling

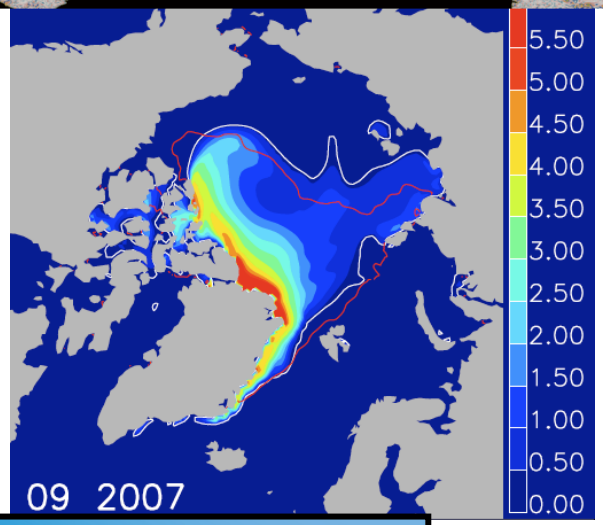
Regional and Global Climate Modeling

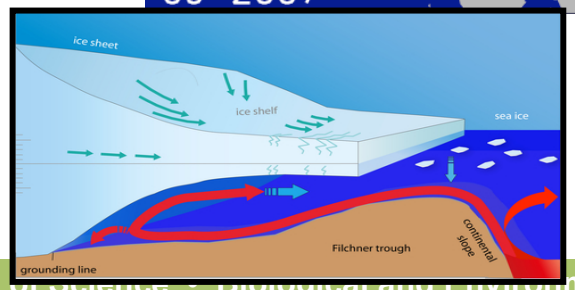
Integrated Assessment Research Program

# COSIM Develops Ocean/Sea-Ice/Ice Sheet Models

- Parallel Ocean Program (POP)
  - State-of-the-art ocean GCM
  - New multi-scale ocean (MPAS-Ocean)
- Los Alamos Sea Ice Model (CICE)
  - Leading model for climate, forecasts
- Ice sheet model (Glimmer-CISM)
  - Greenland, W. Antarctic
- Ocean, ice components of Community Earth System Model (NSF/DOE) and new ACME model
- High performance computing
- Publicly available
  - Large international user base
  - http://climate.lanl.gov





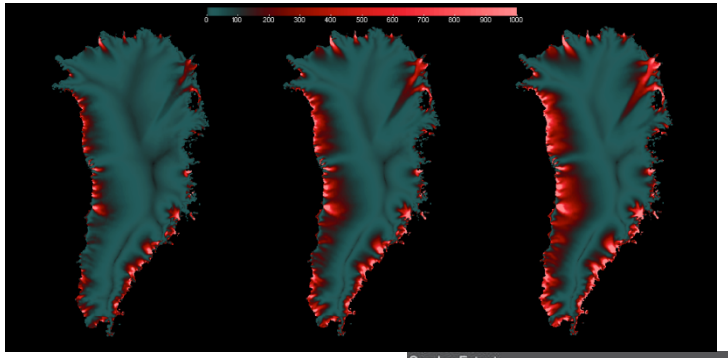



# COSIM Applications

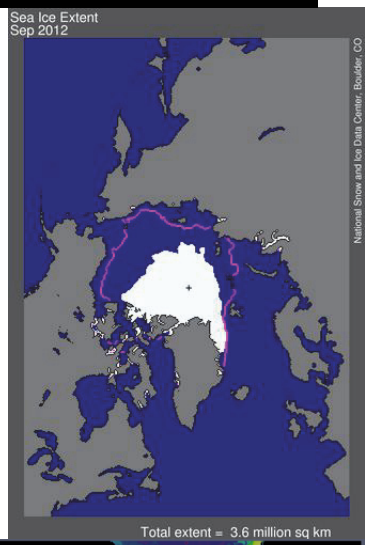
- Ice sheets and sea-level rise
  - Coupled ice sheet, ocean and sea ice
- Arctic sea ice retreat
  - Sea Ice Prediction Network (SIPN)
  - Earth System Prediction Capability
- Eddy-resolving ocean modeling
  - Now fully coupled with 25km atmosphere model
  - Relevant pub

    den Toom et al. (incl. Weijer, Hecht, Maltrud of COSIM),2014, J. Phys. Oceangr. Response of Strongly Eddying Global Ocean to N. Atlantic Freshwater Perturb.
    - Realistic Greenland runoff in an eddying ocean model in impact on AMOC
- High-latitude biogeochemistry
  - New capability for BGC within sea ice, coupling with ocean BGC
  - Relevant pub:

    Elliott, S. et al. 2012. Pan-Arctic simulation of coupled nutrient-sulfur cycling due to sea ice biology. Journal of Geophysical Research –Biogeosciences, 2011JG001649.

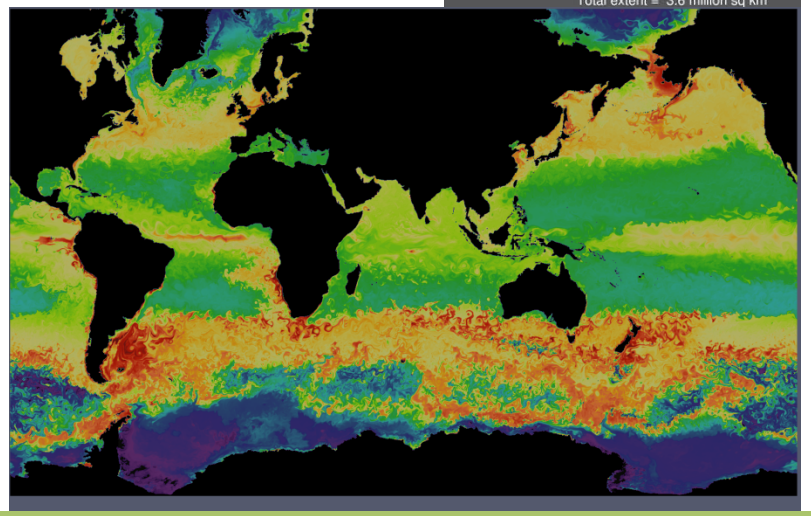


CISM simulations of Greenland exploring different rates of basal lubrication (SEARISE)



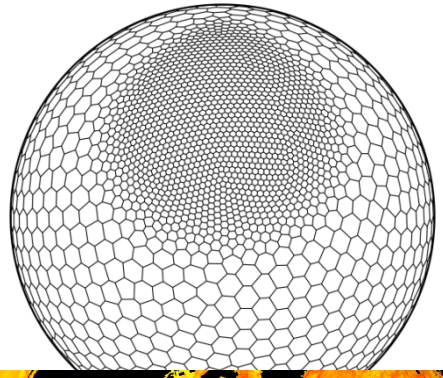

Observed 2012 sea ice minimum (courtesy NSIDC)

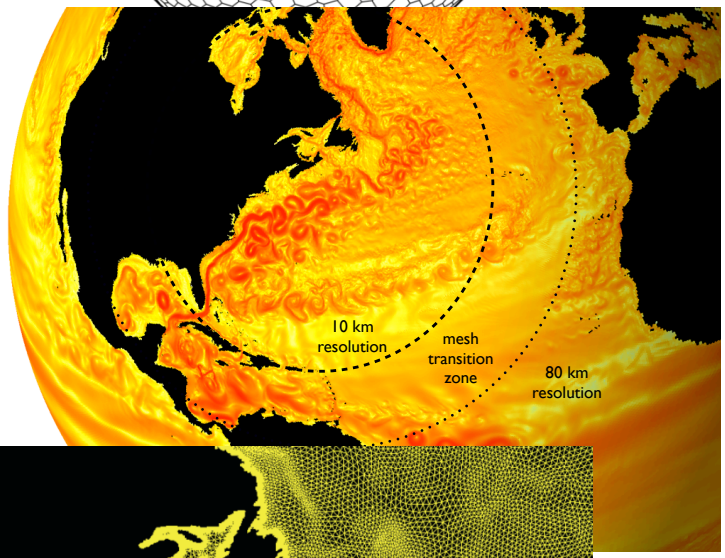
Chlorophyll concentration from global eddying ocean simulation with marine BGC model

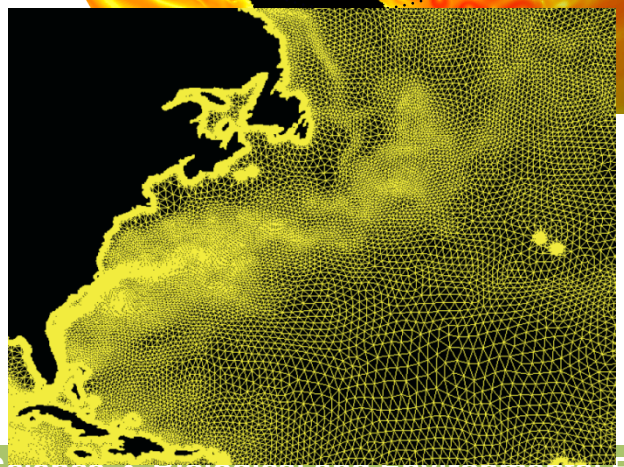


# Model for Prediction Across Scales (MPAS)

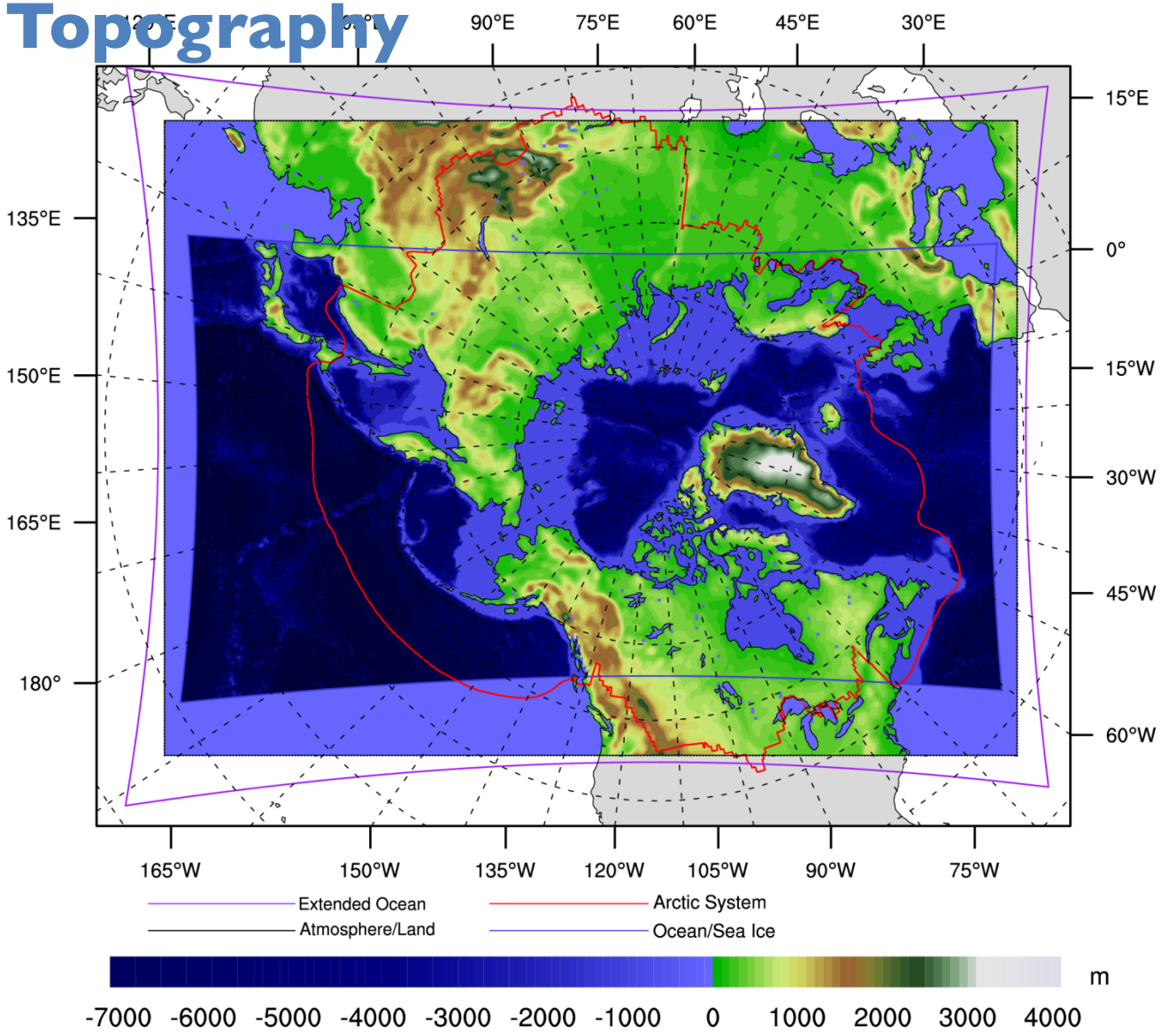
- New variable resolution ocean, sea ice,
  - Allows resolution where important
  - Cost-effective for eddying simulations
  - Ocean v2.0 just released
  - Sea ice, land ice soon
- Target application: Arctic-N.Atlantic
  - Arctic sea ice, Greenland melt, AMOC and ocean circulation changes, ice and ice-edge ecosystems
- Target application: Southern Ocean/Antarctic
  - Eddy-active Southern Ocean, interaction with marine ice shelves, Antarctic sea ice, Southern Ocean biogeochemical exchange





# RASM Domains for Coupling and Topography




The Arctic System domain (red line) after Roberts et al. (2010).

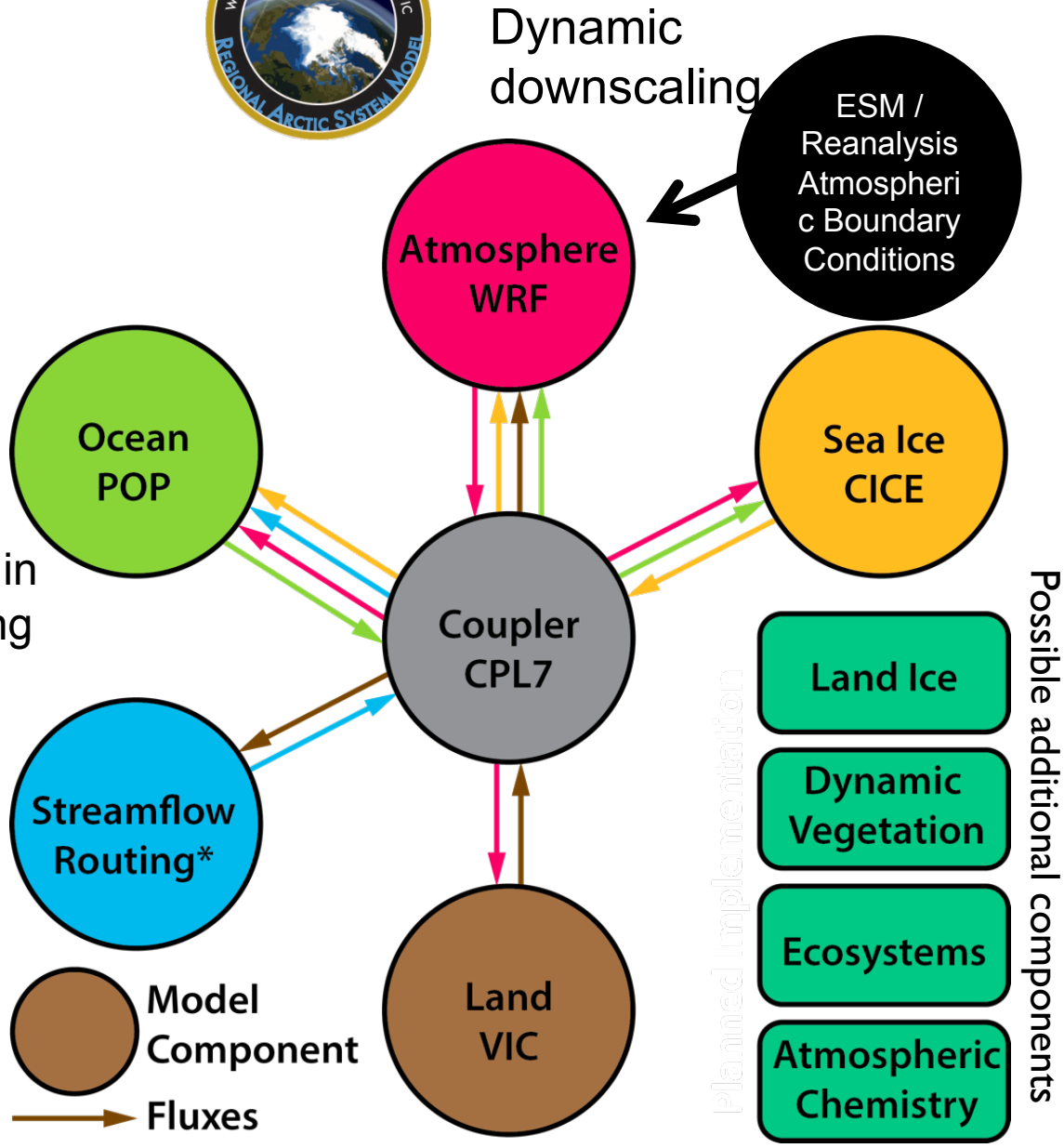
Pan-Arctic region to include:

- all sea ice covered ocean in the NH
- Arctic river drainage
- critical inter-ocean exchange and transport
- large-scale atmospheric weather patterns (AO, NAO, PDO)
- WRF and VIC model domains cover the entire colored region
- POP and CICE domains cover the inner colored region

# RASM wiring diagram

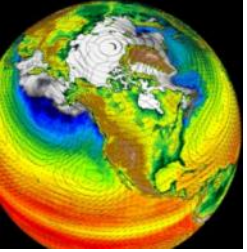
## Motivation:

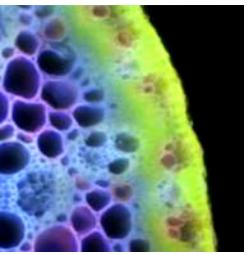
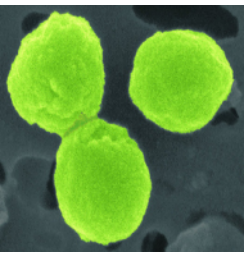
1. Evaluate ice-ocean simulations with realistic atmospheric forcing
2. Understand parameter sensitivity to changing spatial resolution
3. Optimize parameter space in sea ice / ocean and coupling between components
4. Provide guidance for fully coupled high-resolution regional and global climate model simulations



# Interests

- Looking forward to the workshop
  - Summary/report
- Looking  to enhance our current capabilities in Global and Regional Modeling
  - interested in collaborating on ocean process and OCB research
  - for model evaluation needs
- We have new modeling capabilities to offer
  - MPAS Ocean
  - MPAS Sea-ice into the future
  - Sea-Ice BGC modeling



# Thank You