

Climate, Ocean and Sea Ice Modeling (COSIM)

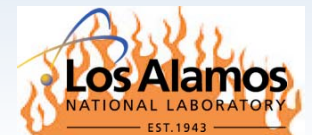
Phil Jones, COSIM project lead

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Mission

Develop and apply high-performance, multi-scale models of the Earth's climate for studying the role of ocean and ice systems in high-latitude climate change and the subsequent impacts on regions throughout the globe.



COSIM includes SFA and others

- BER Science Focus Area
- Related Projects
 - IMPACTS
 - High-res
 - Polar
 - Regional Frameworks
 - SciDAC
 - CSSEF
 - ISICLES
 - EaSM



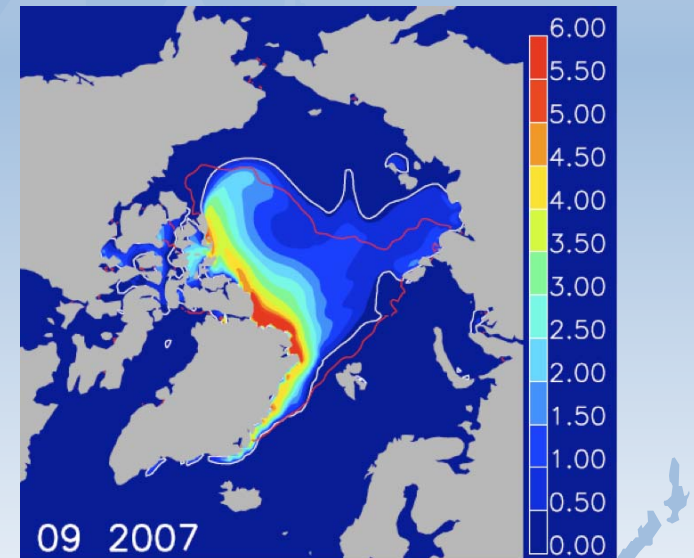
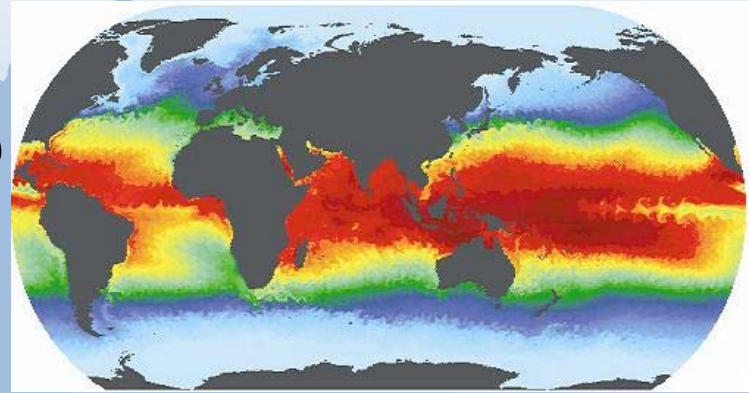
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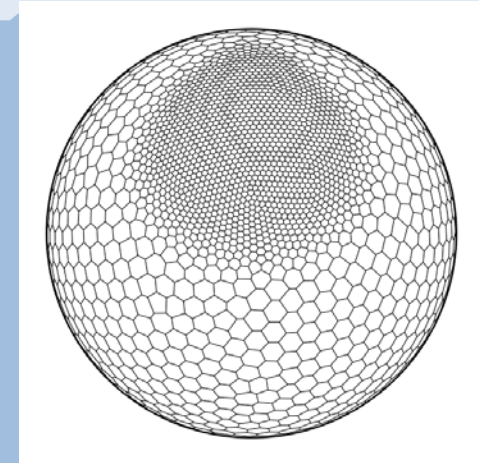
COSIM Develops Ocean/Ice Models

- Ocean Models
 - Parallel Ocean Program (POP)
 - New multi-scale ocean GCM (MPAS-O)
- Los Alamos Sea Ice Model (CICE)
 - Leading sea ice model
- Ice sheet model (Glimmer-CISM)
 - Greenland, W. Antarctic
- Ocean, ice components of Community Earth System Model (NSF/DOE)
- High performance computing
- Publicly available
 - International user base
 - <http://climate.lanl.gov>



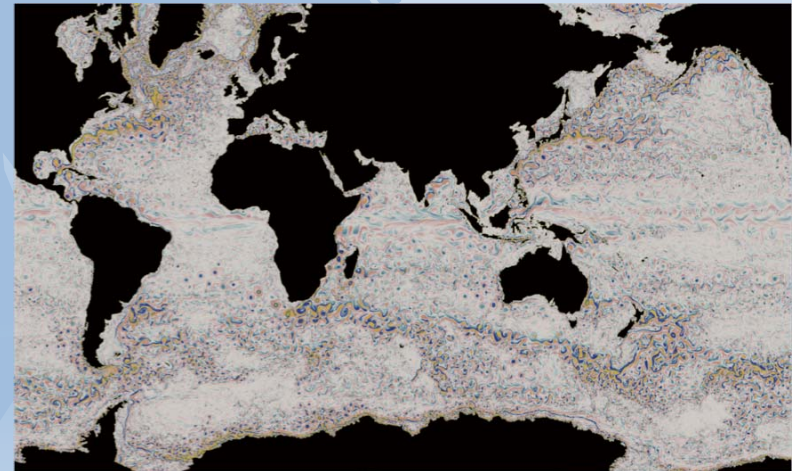
MPAS – Ocean

- Model for Prediction Across Scales (MPAS)
 - Variable resolution
 - New dynamics, advection
 - Two time level, implicit schemes
 - Split explicit barotropic mode
 - Hybrid vertical grid (ALE)
 - Joint LANL/NCAR
- Status (Petersen, Ringler)
 - Prototype working
 - Testing
 - Work toward production
 - Performance



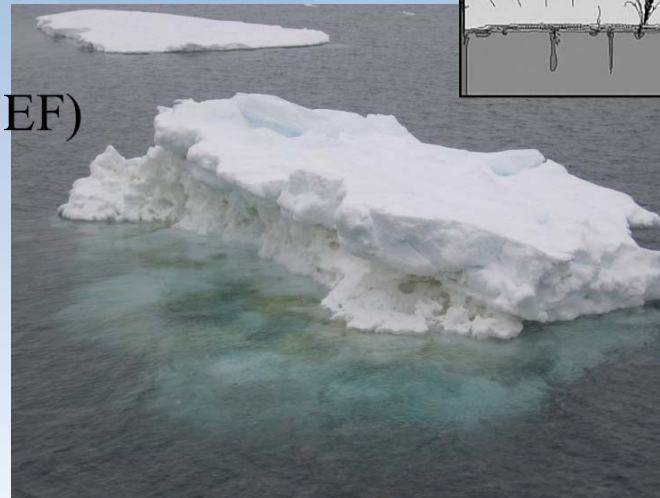
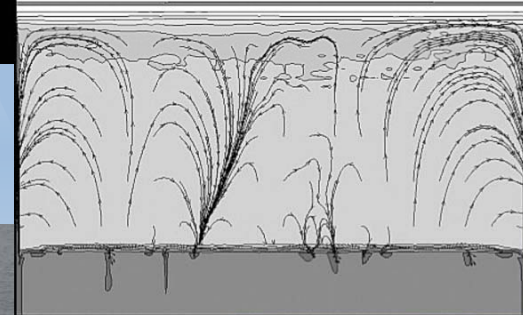
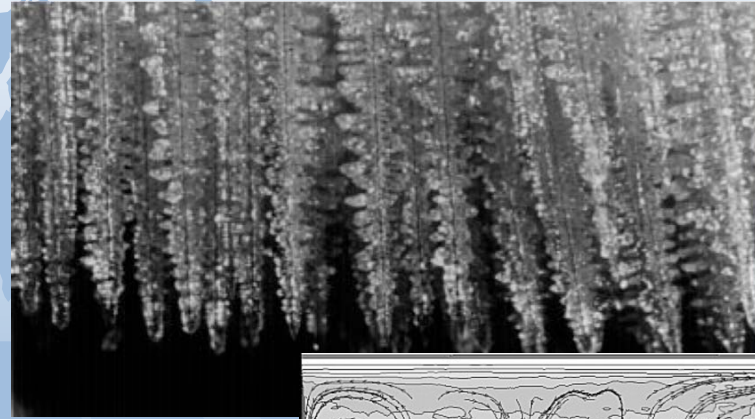
POP Status and Development

- POP Maintenance
 - Changes for CCSM/CESM
 - Hi-res simulations
 - Still a production and test platform
 - Implicit time stepping (JFNK), alpha model, imbedded bndy for ocean/ice shelf
- Limited additional development
 - Forward in time
 - Surface layer issues (fresh water flux)



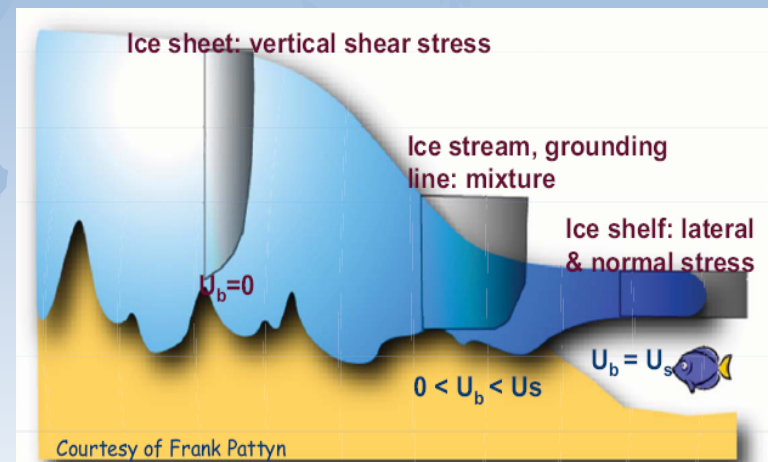
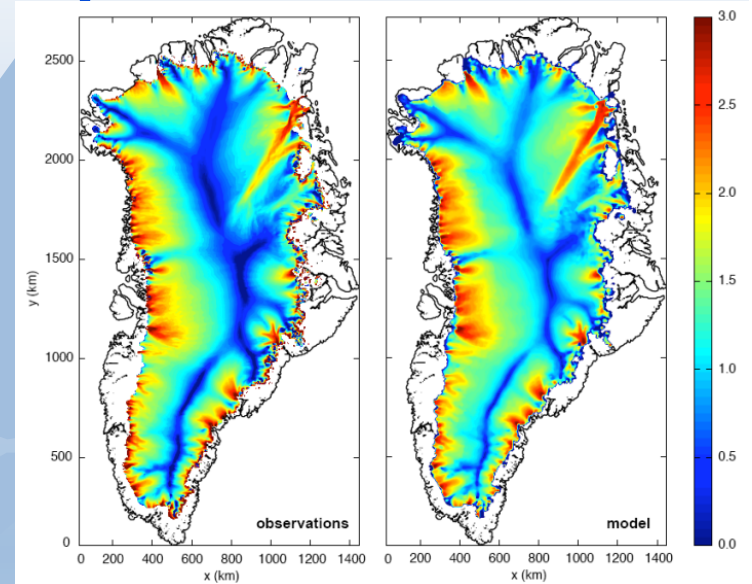
Sea Ice Developments

- CCSM/CESM
- Multi-phase ice
 - Percolation, brine channels
 - Melt ponds, flooding
 - Ice ecosystems and BGC
 - See posters (Turner, Jeffery)
- Snow ice
- Future dynamics
 - Alternative rheologies (CSSEF)
- Ice-ocean coupling
 - Embedded, momentum
 - Water, salt flux
 - Mushy layer



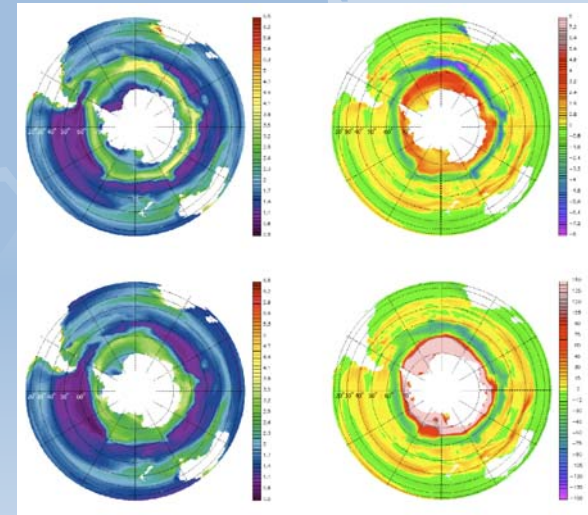
Ice Sheet Development

- Community Ice Sheet Model
 - Glimmer-CISM
- Glimmer in CESM1 (SciDAC)
 - CCSM Ice Sheet WG
- Higher-order terms
- New variational formulation (COSIM)
- Ice sheet/shelf interactions (IMPACTS)
 - Immersed boundary for moving interface
 - Ocean vertical coordinate
- Basal hydrology, melting (Polar)
- Parallelization, solvers (ASCR)
- Sea level rise
- See posters/presentations (Lipscomb, Price, Asay-Davis)



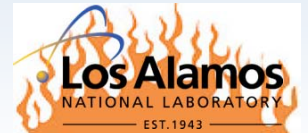
Ocean Biogeochemistry

- Ocean ecosystem model
 - Biochemical, Elemental Cycling (BEC)
- Trace gases
 - Dimethyl sulfide, CO, N₂O, ammonia/ammonium
- Coupled sulfur cycle (SciDAC)
- High latitude ecosystems
 - Ice algae, related food webs
 - With IARC (Deal)
- Methane clathrate/hydrates (IMPACTS, DOE FE)



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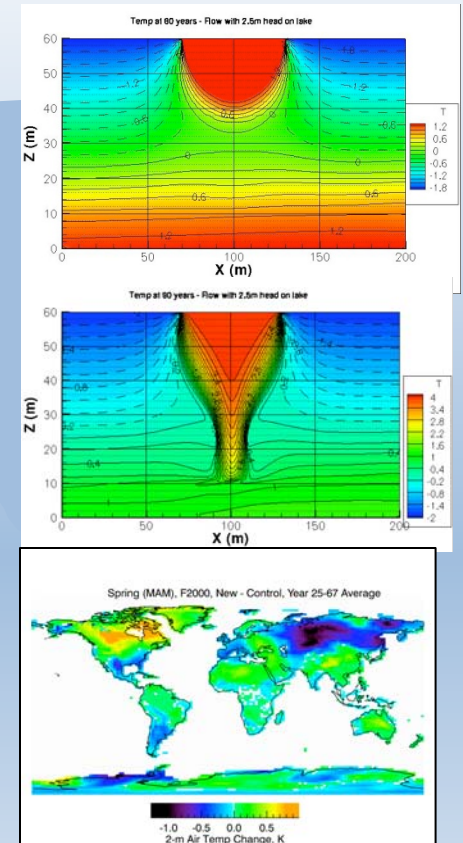
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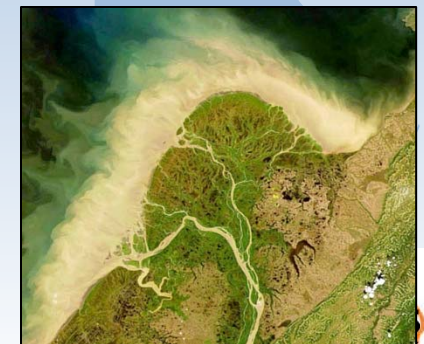
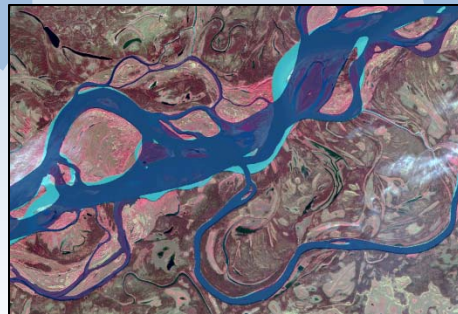
Arctic Hydro-geomorphic Response

(see Rowland poster)

- Lake, river changes important to Arctic transport into ocean
 - Rapid and widespread
 - Accelerate beyond surface heating
- Modeling and remote sensing
 - ARCHY
 - CLM and CESM sensitivity studies
- Links to NGEE, LANL capabilities



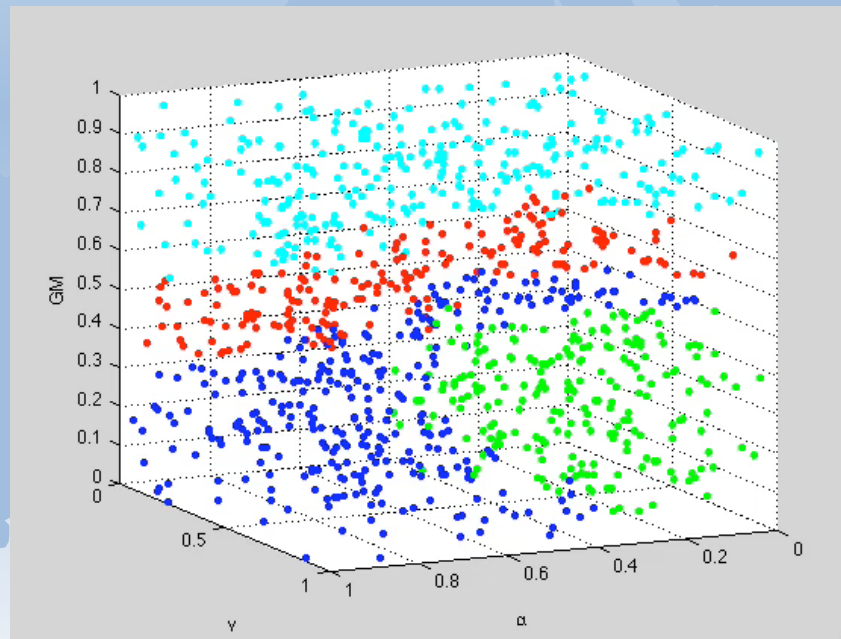
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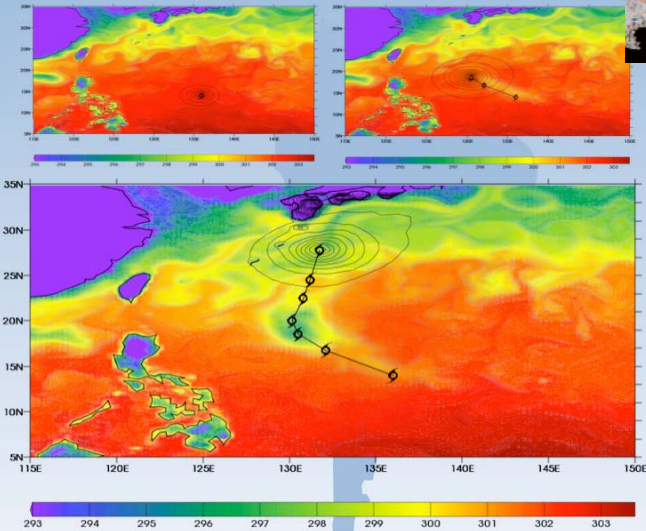
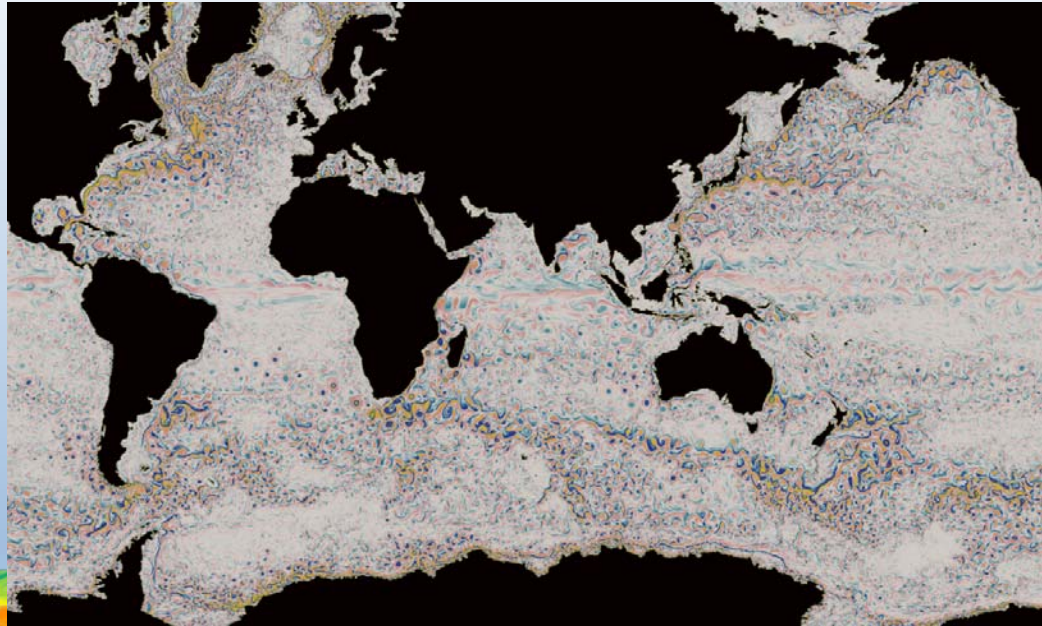
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Other Developments

- Solvers and implicit formulations (CSSEF)
- Slow, fast modes (Wingate, see poster)
- Initial state sensitivity and data assimilation (High-res)



Eddy-resolving simulations

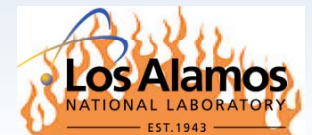


High-res (McClean)



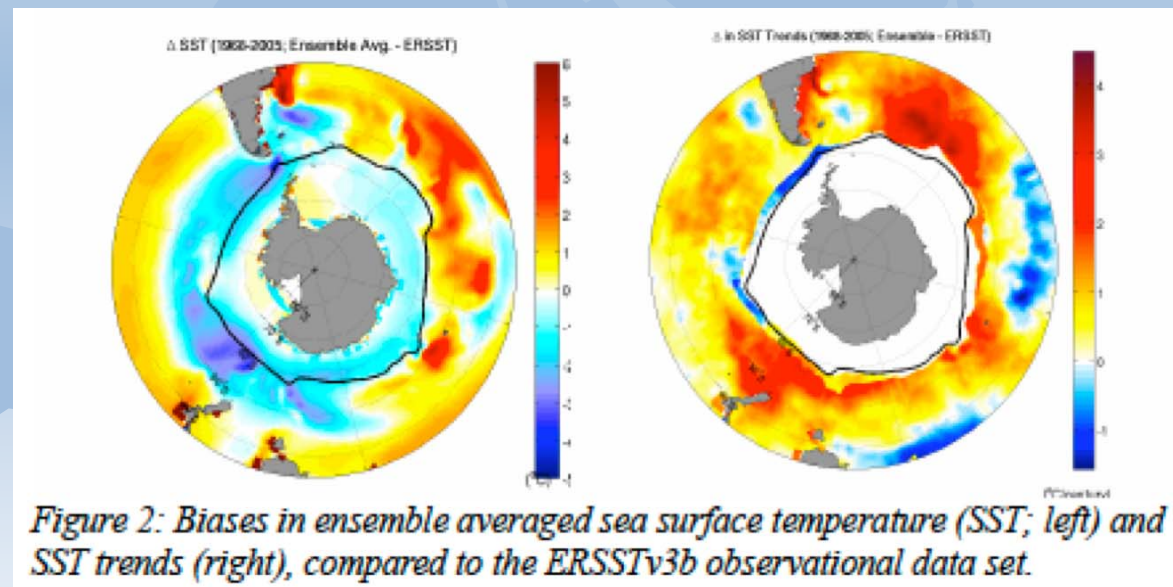
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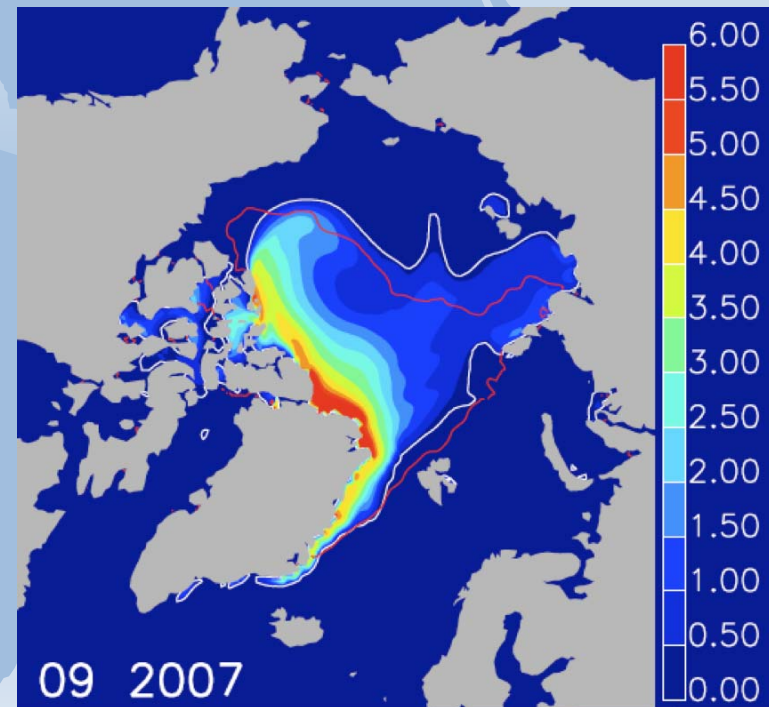
Other Ocean Studies

- Analysis of CCSM4 results
 - Southern ocean
 - Some tropical aspects
 - See Weijer poster



Arctic Change

- Understand recent changes in sea ice
 - Poles warming faster
 - Sea ice changes rapid, episodic
- Standalone CICE forced by CORE atm, CCSM3/POP ocn data
- Good representation of 2007 rapid ice loss
- Validation and improvement in sea ice response in climate simulations



Sea ice thickness (m) with simulated (white) and satellite-derived (red) 15% concentration ice edge. 2007 minimum.

Greenland Ice Sheet

- Ice sheet hydrology
- Melt/mass loss
- Field work
- Mernild presentation



Summary

- COSIM is DOE center for ocean/ice models
- Continued release/delivery of new models
 - Ocean: POP maintenance, new MPAS model
 - Sea ice: continued releases, multi-phase, alternative rheologies
 - Ice sheets: Higher-order CISM dynamics, basal hydrology, ocean/ice shelf interactions
 - High latitude BGC
 - New formulations, algorithms, co-design
- Use models to advance science
 - Ultra high resolution for eddies, regional climate change, extremes
 - Variable resolution
 - High latitudes: ice sheets and sea level rise, sea ice retreat, ocean circulation changes, BGC feedbacks