

**CCSM Polar Climate and Climate Variability Working Groups  
Joint Meeting  
February 6–7, 2006  
NCAR Mesa Lab, Boulder, Colorado**

**DAY 1: CLIMATE VARIABILITY**

The first day of this joint meeting featured a number of presentations about climate variability, particularly as it affects and is affected by polar processes. These included terrestrial, oceanic, and atmospheric studies, as well as interactions among them.

Alex Hall's (UCLA) work, "Constraining snow–albedo feedback with the present–day seasonal cycle," investigates Northern Hemisphere snow albedo feedback in 17 different models of the IPCC 4th Assessment Report and proposes a method for constraining it in future climate simulations by validating analogous simulated snow albedo feedbacks occurring in the seasonal cycle against available observations. Steve Vavrus (University of Wisconsin) spoke on "The role of terrestrial snow cover in the climate system," for which he compared fully coupled CCSM simulations with and without terrestrial snow cover. He finds that permafrost extent is larger in the no–snow simulation, soil surface moisture decreases, and the troposphere warms. Dave Lawrence (NCAR) also discussed permafrost in his talk, "CCSM projections of severe permafrost degradation during the 21st century," noting that permafrost degradation is associated with northward expansion of shrubs and forests, release of soil carbon, increased discharge of fresh water to the Arctic Ocean, and decreased sea ice extent in September. Slawek Tulaczyk (UC Santa Cruz) presented recent observations of increased discharge from the Greenland ice sheet, showing examples of glaciers that are thinning and speeding up. The additional fresh water input to the East Greenland Current from these glaciers is comparable to the variability in freshwater flux through Fram Strait. Whether the increased melting is due to atmospheric or oceanic changes is unknown.

Ocean studies included "Heat and fresh water exchange from Arctic to the northern North Atlantic," by Bruno Tremblay (Lamont–Doherty), who compared CCSM3 with the GFDL and GISS GCMs. The goal of this study is to quantify the relative importance between the density and wind driven exchange of heat and fresh water between the Arctic and the northern North Atlantic. Preliminary results show that GFDL has thinner ice and a larger seasonal cycle of ice extent, GISS has thicker ice and a smaller seasonal cycle; CCSM has greater variability in water and heat fluxes than either of them, while GFDL has greater variability in the inflow of heat on the Barents Sea shelf. Aixue Hu (NCAR) discussed

"Thermohaline circulation response to the fresh water hosing in the North Atlantic in CCSM2 and CCSM3 under present-day and LGM conditions," finding that the maximum meridional overturning decreases in hosing experiments but rebounds if the additional fresh water fluxes are turned off. Fresh water transport in or out of the Arctic balances sea ice transport in the non-hosing configurations, but in the hosing experiments, fresh water is imported in both present-day and LGM cases; Bering Strait plays a role in the present-day thermohaline circulation but it is closed in LGM experiments. Ilana Wainer (University of Sao Paolo) looked at "Weddell Sea warming trends in CCSM3," examining the evolution of water masses in 3 simulations: 40 years of interannual Large-Yeager (LY) forcing, 40 years using the repeat LY annual cycle, and 40 years using the repeat cycle with interactive sea ice. She found that the observed dense water masses of the Weddell Sea could be detected in the simulations; however, when the interactive sea-ice model is included, these water masses are much better represented.

On the atmospheric side, Camille Li (University of Washington) discussed "Storms and jets in the LGM," wondering whether shifts in jets could alter atmospheric eddy activity and be related to Dansgaard-Oeschger events. Justin Wettstein (University of Washington) also discussed the LGM in "Glacial and modern patterns of climate variability in the CCSM," finding that bulk LGM climatology was structurally similar to modern climatology, except very near the ice sheets and in the case of the Northern Hemisphere jet stream. LGM sea level pressure variance was very similar to the modern run in the Southern Hemisphere and strongly suppressed in the Northern Hemisphere, resulting in similar Southern Hemisphere modes of variability and altered Northern Hemisphere ones. Nat Johnson (Penn State) presented a new method for analyzing such fields in his talk, "Classification of sea level pressure patterns: A comparison between self-organizing maps and principal component analysis;" self-organizing maps identify the distribution of data, can capture nonlinear features, and are easier to interpret than principal components. Marilyn Raphael (UCLA) presented "Impact of Antarctic sea ice variability upon the coupled ocean-atmosphere system in CCSM3," replacing CSIM with satellite observations and running simulations using monthly climatological minima and maxima. She found an organized dynamic response related to the Southern Hemisphere annular mode. John Chiang (UC Berkeley) discussed "Global climate impacts of a permanent El Niño: Preliminary results of CAM3 simulations," in which he imposed oceanic heat fluxes in the slab ocean that effectively decrease the equatorial Pacific zonal SST gradient. This increases equatorial rainfall, weakens the Walker circulation, strengthens the Hadley circulation, and increases the atmospheric heat transport to high latitudes. The high latitudes warm, reducing sea ice and the amplitude of the seasonal cycle of temperatures over land. Such changes could be related to past ice ages.

## DAY 2: MODEL DEVELOPMENT

The second day's presentations and discussions were focused on modeling issues. John Weatherly's (CRREL) study, "CSIM albedo parameterization from melt season data" utilized SHEBA data to develop an albedo parameterization including melt ponds. Bonnie Light (University of Washington) and Bruce Briegleb (NCAR) presented "A new parameterization for shortwave radiative transfer in sea ice," which employs inherent optical properties (such as absorption and scattering coefficients) in a delta-Eddington scheme to model shortwave radiative transfer for sea ice and snow. This parameterization propagates solar radiation deeper into the ice, and significantly more radiation reaches the ocean, but melt ponds remain difficult to model.

Ed Andreas (CRREL) discussed his observations and theoretical studies of the turbulent surface transfer coefficients, "Parameterizing the turbulent surface fluxes over summer sea ice," and identified two aerodynamics seasons: winter with its drifting snow, and the snow-free summer. He reported a parameterization for summer sea ice that depends only on ice concentration and also fits observations in marginal ice zones. Ed lastly emphasized the need to appropriately model melt ponds because of their contribution to air-ice momentum transfer through form drag. Elizabeth Hunke (LANL), in "Evaluating the Large and Yeager forcing data for Arctic simulations," presented results comparing the LY data with original NCEP and the AOMIP protocol. She recommends that AOMIP modelers adopt a modified version of the LY data.

Bill Lipscomb (LANL) discussed his work, "Improving dynamical stability in sea ice models," exploring an instability permitted by the viscous-plastic dynamics model in high-resolution (~10 km) simulations. The current ridging scheme in CSIM potentially amplifies such instability. Changing the ridging participation function to give smoother ice strengths makes the model much more stable; building thinner ridges (in agreement with ice draft observations) also improves stability. Helga Schaffrin (University of Washington) discussed a new method for modeling the ice dynamics, "An optimization approach to modeling sea ice dynamics: A 1D Lagrangian model and beyond," which appears promising in 1D results; work on a 2D model is in progress.

Leah Necas (UC Irvine) presented progress on her project, "Evaluating the new CCSM SOM configuration," which couples active atmosphere, land, and sea ice components with a slab ocean model. She is currently validating the new configuration in ice-only mode against the original ice-only configuration that used a mixed-layer ocean parameterization embedded in the ice model. Mariana Vertenstein presented progress and plans for CCSM software developments, including single executable concurrent and sequential versions,

increased code reuse across CCSM, and the creation of new CCSM data models.

Dimitris Menemenlis (JPL) showed results from the Alfred Wegener Institute illustrating a chaotic response to a small point perturbation in surface temperature that only appears in coupled (ice-ocean) simulations, not in stand-alone ice or ocean experiments. He questions whether this behavior is physical or a numerical artifact.

## DISCUSSION

Marika Holland (NCAR) discussed the upcoming CSL allocation (unofficially 89% of the proposed amount) and upcoming CCSM releases. There could be a release of CSIM in 2007 for testing new parameterizations prior to the full CCSM release proposed for 2009. Improvements desired for the ice model include the following. Some of these projects are already well under way; others have yet to be started.

- improved radiation scheme (Light and Briegleb)
- improved boundary layer exchange (Andreas)
- snow metamorphosis (Hunke and Lipscomb)
- blowing snow parameterization (Tremblay)
- dynamic stability improvements (Lipscomb and Hunke)
- inclusion of biogeochemistry
- sea ice "hydrology" including melt ponds (Holland, Weatherly), brine pockets and drainage, percolation and snow-ice formation

## Participants:

Marika Holland, NCAR  
Elizabeth Hunke, LANL  
Steve Vavrus, U Wisconsin  
Bruno Tremblay, LDEO/McGill  
Kevin Trenberth, NCAR  
Alex Hall, UCLA  
Cecilia Bitz, U of Washington  
Ed Andreas, US Army, CRREL  
David Lawrence, NCAR  
Liz Cassano, CIRES  
Joel Finnis, CIRES  
John Chiang, UC Berkeley  
Mike Alexander, NOAA Earth System Research Lab  
Young-Oh Kwon, NCAR  
Nat Johnson, Penn State U

Paquita Zuidema, U of Miami  
Mingrui Dai, NSIDC  
Bob Tomas, NCAR  
Dimitris Menemenlis, JPL/Caltech  
Bruce Briegleb, NCAR  
Natalie Mahowald, NCAR  
Jerry Meehl, NCAR  
Leah Necas, UC Irvine  
Bill Large, NCAR  
Camille Li, U Washington  
Justin Wettstein, U Washington  
Bonnie Light, APL/U Washington  
Bill Lipscomb, LANL  
Helga Schaffrin, U Washington  
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