Special Seminar

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Visiting from the University of Utah

Effects of Midwinter Arctic Leads on Boundary Layer Clouds

Hosted by Dave Randall

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Leads are quasi-linear openings within the interior of the polar ice pack, where the ocean is exposed directly to the atmosphere. Due to the extreme air-water temperature contrast (20 to 40 K), turbulent and radiative heat fluxes over leads can be two orders of magnitude larger than those over the ice surface in winter and thus dominate the wintertime heat budget of the Arctic boundary layer. Cold-season leads may also produce boundary layer clouds that extend tens of kilometers downwind. These clouds can spatially and temporally extend the impacts of leads on the Arctic surface heat budget. We are using multi-source observations and a 3D cloud-resolving model to understand the impact of leads on the boundary layer clouds. We have used measurements from the ARM cloud radar at Barrow and the Advanced Microwave Scanning Radiometer for EOS (AMSR-E) on board Aqua to establish statistical associations between large-scale lead fraction and low cloud occurrence. We expected low cloud occurrence frequency to increase with the large-scale lead flux (lead fraction x calculated sensible heat flux per unit area over open leads). However, we found just the opposite. Low cloud occurrence frequency from CloudSat-CALIPSO over a large-scale region also increased with the large-scale lead flux. Motivated by these results, a 3D cloud-resolving model, System for Atmospheric Modeling (SAM), was used to explore the underlying physics. We found that a wide recently frozen lead produces large sensible heat fluxes, but reduced latent heat fluxes, and consequently produces thinner and less extensive low-level clouds. This result provides a plausible explanation for the counterintuitive observational results: The observed high lead fraction must largely consist of newly refrozen leads which produce less low-level cloudiness. Our results emphasize the need to differentiate, in observations and in models, recently refrozen leads from open-water leads and from thicker ice.

Link to colloquia page: https://www.atmos.colostate.edu/colloquia/