PROJECT SUMMARY

Cloud properties across the Arctic Basin from surface and satellite measurements – An existing Arctic Observing Network

Submitted to NSF Office of Polar Programs, Arctic Natural Sciences Section, May 2006

Intellectual Merit:

The research proposed here will increase the fundamental understanding of both temporal and spatial variability of Arctic clouds. Knowledge of Arctic cloud properties is important for understanding the overall energy balance of the Arctic, and how Arctic climate interacts with the global climate system. There have been many short-term field experiments to study Arctic clouds at specific locations, but there is a lack of knowledge regarding the temporal and spatial variability of cloud properties across the Arctic. The longest record of data exists at the North Slope of Alaska ARM site, but this is only at a single location. New data are now available from other ground-based sites that complement the measurements in Alaska and broaden our understanding of Arctic clouds. We proposed to combine these ground-based measurements at various sites with satellite observations to make a network of cloud observations across the Arctic.

This proposed work directly addresses many stated objectives and goals for both SEARCH and the IPY. SEARCH has identified the need for long-term observations of important Arctic climate parameters, such as clouds, and has recognized the value of coordinated surface-satellite activities, both of which are fundamental components of our proposal. Additionally, by making the link between disparate observations at multiple sites to a comprehensive, long-term cloud data set, this study is a combination of "Observing Activities" and "Understanding Activities," two components of the SEARCH objectives. Arctic clouds will be one of the important indicators signifying if, and when, the Arctic system is moving to a new climatic state; the identification of such change is one of the main goals of SEARCH. The proposed work of data integration and analysis of Arctic cloud observations will yield a significant contribution to the legacy of infrastructure and data that will result from the IPY.

The proposed work specifically addresses the following four questions:

What are the macrophysical and microphysical properties of clouds at various locations in the Arctic? A comprehensive suite of macro- and micro-physical cloud property retrieval algorithms will be applied to Arctic cloud measurements from various surface sites. The derived products will provide a baseline of Arctic cloud properties upon which to identify and understand future change, and to validate models.

How do Arctic cloud properties vary both temporally and spatially? Multi-year records of cloud observations from Barrow, Alaska and Eureka, Canada will be used to investigate inter-annual cloud variability. Additionally, time periods of overlapping measurements at the different stations are expected to provide important insight into the spatial dependence of cloud properties.

How do the spatial and temporal variability of Arctic cloud properties depend upon regional "forcing" parameters? Using ancillary data at each surface site, differences or similarities in cloud properties, and their variability, will be associated with regional meteorological properties that contribute to the forcing of cloud formation to explain the observed variability.

Do satellite retrievals yield similar cloud properties and variability to the coincident surface-based measurements? Cloud properties derived from the surface measurements will be related to retrievals from satellite instruments. Based on this information, the satellite measurements will then be used to expand our analysis to other regions of the Arctic, in particular the locations of possible future or newly coordinated surface sites, such as Tiksi, Russia and Ny'Alesund, Norway.

Broader Impacts:

The results of this research will find use in improving models of weather and climate in the Arctic. This project will integrate and synthesize data from existing Arctic research stations that have been developed and operated by various agencies. This research will benefit society, because Arctic clouds affect systems that are of considerable importance to Arctic inhabitants, as well as global climate. The IPY is an opportunity to establish high-quality records of data that can be used decades from now to explore how Arctic climate responds to anthropogenic change.

This project provides support for a graduate student at the University of Idaho, and for the continued development of a promising young scientist interested in polar research. As was done under prior NSF support, the research results will continue to be used in curriculum development for undergraduate and graduate courses in atmospheric science and climate studies.

This project will continue our international collaboration with the Canadian Network for the Detection of Atmospheric Change (CANDAC).