

Collaborative Research: Integrated Characterization of Energy, Clouds, Atmospheric state, and Precipitation at Summit (ICECAPS)

INTELLECTUAL MERIT

Cryospheric changes have been at the forefront of recent Arctic climate research, embodied by diminishing sea-ice concentrations and accelerating melt of ice sheets and glaciers. However, current model projections of these changes, and their future course, are highly variable and uncertain due in large part to a lack of process-level understanding of the coupled climate system and specifically those components that impact the surface energy and ice mass budgets. The atmosphere, including aerosols, clouds, and precipitation, imparts significant influences on the changing Arctic climate system, and specifically on the future fate of the Greenland Ice Sheet (GrIS). To understand the GrIS mass budget requires knowledge of multiple sources and sinks. Atmospheric processes are strong drivers for important contributions on both sides of the mass budget, where precipitation is the primary source and surface energy budgets are a critical factor in the sink. Enhanced atmospheric measurements are needed to develop the necessary process-level understanding of these source and sink processes and to ultimately improve models' ability to represent their interactions with the broader climate system.

In 2010, the observatory at Summit, Greenland, in the center of the GrIS, was expanded to include a comprehensive suite of cloud-atmosphere observing instruments including microwave and infrared spectrometers, cloud radar, depolarization lidar, ceilometer, precipitation sensor, sodar, and a twice-daily radiosonde program. A continuation of this project is proposed here, with moderate enhancements to include atmospheric aerosol observations. Measurements from this expanded instrument suite will be used to derive critical baseline atmospheric data products including:

- ***Atmospheric State*** – tropospheric temperature, moisture, and wind profiles
- ***Aerosols*** – concentration of total particles and cloud condensation nuclei
- ***Cloud Macrophysics*** – occurrence, vertical boundaries, temperature
- ***Cloud Microphysics*** – phase, water content, and characteristic particle size
- ***Precipitation*** – type and rate

Together these products, when combined with similar ongoing measurements at Summit, can be used to study processes that impact the surface energy budget and precipitation at the site, as well as addressing questions related to atmospheric stability, cloud phase composition, the persistence of stratiform clouds, and aerosol-cloud interactions. It is further anticipated that these observations will continue to be used by a broad cross-section of the scientific community to promote understanding of GrIS and Arctic climate, validate satellite observations, and evaluate model simulations.

BROADER IMPACTS

Continued atmosphere-cloud-aerosol-precipitation observations over the central GrIS will address explicit goals identified by SEARCH and fulfill directives put forth by IARPC in the U.S. Arctic Research Plan for 2013-2017. These ongoing observations are the first of their kind and will continue to provide the foundation for unprecedented advances in the understanding of how atmospheric processes impact the GrIS. Importantly, these continued observations will also build towards the statistically-representative datasets that are necessary to evaluate, and ultimately improve, the performance of regional and global climate models. Improved model performance is needed to understand, predict, and plan for future changes to the GrIS and Arctic climate system.

Graduate students play significant roles in most aspects of this project, gaining valuable experience with polar field work, operating instruments, and processing data. In addition, this research team has developed a unique education and outreach plan to work with students from local schools using simple, proxy instrumentation to help develop their understanding of atmospheric principles and observations, and to enhance the scientific curriculum in their schools.