

PROJECT SUMMARY

Longwave Radiation Processes and Surface Energy Budget on the Antarctic Plateau

Submitted to NSF Polar Programs (Polar Oceans and Climate), June 2005

Intellectual Merit:

A year-long field experiment, the South Pole Atmospheric Radiation and Cloud Lidar Experiment (SPARCLE) was carried out during 2001 at South Pole Station. Under the current grant, analyses of the SPARCLE data were completed on several projects: near-surface atmospheric temperature profiles, radiosonde performance at low temperatures, spectral longwave climatology, longwave cloud radiative forcing, cloud particle sizes from video images, and improvement of calibration procedures for interferometers. In the proposed work, analyses will continue on the topics of snow spectral emissivity and cloud processes. The project will be extended to analyze the complete surface energy budget and to make comparisons with a mesoscale model.

Snow emissivity. The spectrum of infrared radiation emitted by the snow surface, measured at South Pole and Dome C, will be analyzed to determine the variation of emissivity with wavelength, viewing angle, and snow grain size. The results will be compared to two conflicting theoretical models, and may also be able to constrain the temperature dependence of the absorption coefficient of pure ice in the 12- μm band.

Clouds. The seasonal cycle of cloud cover will be determined from downward infrared measurements, using a method developed under the current grant. Spectral infrared radiances measured at the South Pole will be used to infer the seasonal cycles of cloud optical depth and crystal sizes, and the frequency of occurrence of liquid droplets. Observations of longwave cloud radiative forcing at the surface will be compared to values computed from inferred cloud microphysical properties.

Surface energy budget. Monthly values of shortwave and longwave radiation fluxes, sensible heat, latent heat, and subsurface heat flux will all be determined directly from available measurements made by SPARCLE and other projects, quantifying uncertainties and determining the accuracy to which the energy budget can be closed.

Model evaluation. Predictions of the Polar Mesoscale Model (PMM5) will be compared to the observed surface energy budget components and clouds, and causes of the discrepancies will be diagnosed.

Broader Impacts:

The results of this research will find use in improving general circulation models and mesoscale models of the Antarctic atmosphere. Testing them in the coldest and driest environment on Earth, and in an area with little topography and no diurnal cycle, should help to identify model deficiencies that may be harder to detect in less-extreme climates.

This project provides support for a student at the University of Washington (UW) to complete his Ph.D., and for two students at the University of Idaho (UI) to complete Masters degrees.

As was done under the prior grant, the research results will continue to be used in curriculum development at UW and UI for undergraduate courses in climate, and graduate courses in glaciology and radiative transfer.