ICECAPS: New Observations of Clouds, Atmosphere, and Precipitation at Summit, Greenland

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Instrument Suite Operating at Summit

As part of the NSF Arctic Observation Network, the Integrated Characterization of Energy, Clouds, Atmospheric state, and Precipitation at Summit (ICECAPS) project is providing a fresh look at detailed atmosphere and cloud properties over the central Greenland Ice Sheet. These observations are an important contribution towards the ISOMOS network of Arctic atmospheric observatories, and offer exciting new perspectives on this unique environment.

Cloud Properties

ICECAPS measurements offer the first continuous, detailed characterization of cloud properties and structures over the central Greenland Ice Sheet.

- Clouds (here defined as hydrometers in the atmosphere that are identified by at least one of the ICECAPS instruments) occur at least 65% of the time in each month with a late winter minimum.
- Cloud fraction decreases with increasing height.
- Supercooled liquid water is present year round, occurring >10% of the time in late winter but as much as 60% of the time in summer.
- Snowfall rate in the month of July is >10 mm/day

Atmospheric Structure

The ICECAPS twice-daily radionuclide program provides an unprecedented perspective on atmospheric structure above the central Greenland Ice Sheet.

- Periodic, warm, moist, and cloudy air masses advect onto the ice sheet. There is a clear distinction between air masses containing clouds and those that do not.
- A temperature inversion has occurred in every ICECAPS sounding except one.
- Strong, surface based inversions predominate through the winter season (98% of the time). Moving towards summer, the low-level inversions are increasingly weaker and more often elevated off the surface.
- Moisture inversions are typically associated with temperature inversions.
- Based on the annual cycle of temperature and atmospheric structure, "seasons" at Summit can be characterized as:
  - Summer: July and August
  - Autumn: September and part of October
  - Winter: Most of October through mid-May
  - Spring: mid-May through June.

Complementary Perspectives

21 September 2010: Classic Arctic mixed-phase stratocumulus, glaciated intermittently by deeper layers of falling ice. This case illustrates the complementary abilities of the ICECAPS instruments:

- Cloud Ice: Falls from mixed-phase and deeper ice cloud layers.
- Identified by high radar reflectivity and velocity, low lidar backscatter, high lidar depolar ration, < -40 C temperatures near top.
- Precipitation: Intermittent, light snowfall. Identified by high radar reflectivity and low depolar ratio, high lidar depolar ratios, < -40 C temperatures near top.
- Cloud Liquid: Multiple, stratiform layers with intermittent gaps.
- Identified by high lidar backscatter and low depolar ratio, MWR-derived LWP > 8 g/m^2, high IR moisture, radiosonde-measured saturated layers.

Dynamics / Atmos. Structure: Mixed-layers associated with cloud liquid identified by wide radar spectrum width and constant radiosonde equivalent potential temperature. Sodar shows increased near-surface static stability when liquid cloud is gone (i.e., low IR moisture), the surface cools, and T inversions strengthen.

ECMWF operational model output provided by K. Forbes