A Multi-Year Data-Set of Arctic Mixed-Phase Stratus Properties as Derived by a Combination of High-Spectral Resolution Lidar and Millimeter Cloud Radar

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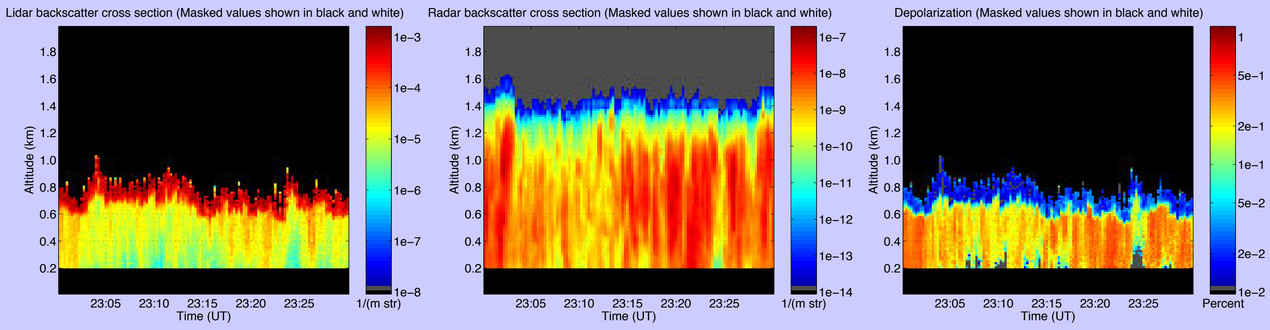
ARM Atmospheric Radiation Measurement

Introduction

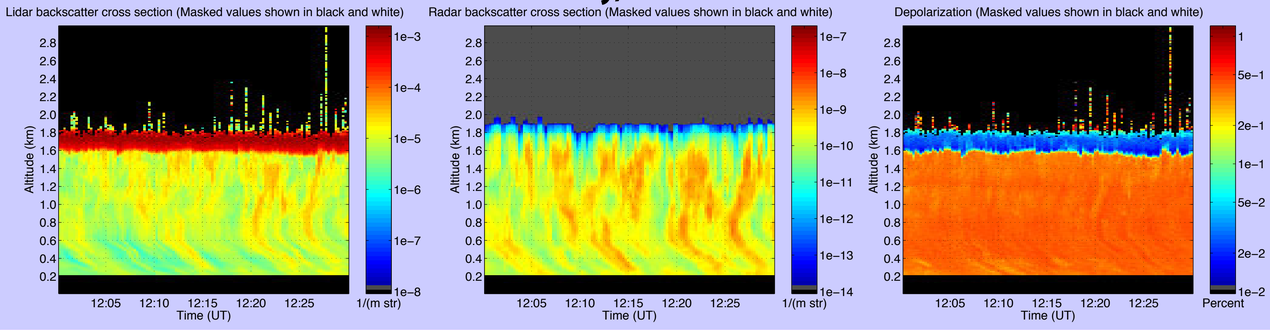
Mixed-phase clouds remain a difficult problem for both the observational and modeling communities. In particular, improved understanding of mixed-phase clouds in the Arctic is crucial because of radiative effects they impart on a region that is particularly sensitive to change. In order to better understand these cloud structures, the University of Wisconsin Arctic High Spectral Resolution Lidar (AHSRL) has been deployed to two different Arctic locations. The first deployment lasted two months and was to Barrow, AK in support of the ARM Mixed-Phase Arctic Clouds Experiment (M-PACE). The second deployment is ongoing, and to date almost three years of data have been collected at Eureka, Canada. In both locations, the lidar was co-located with a NOAA Millimeter Cloud Radar (MMCR). Mixed phase stratus has been readily detected at both locations, measurements from 2004-2007 contain nearly 1000 hours of single-layer mixed-phase stratus observations.

Single-Layer Mixed-Phase Arctic Stratus

09 October, 2004: Barrow



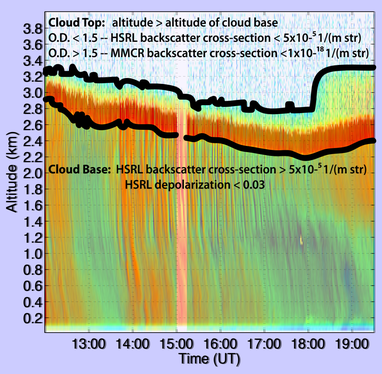
15 February, 2006: Eureka

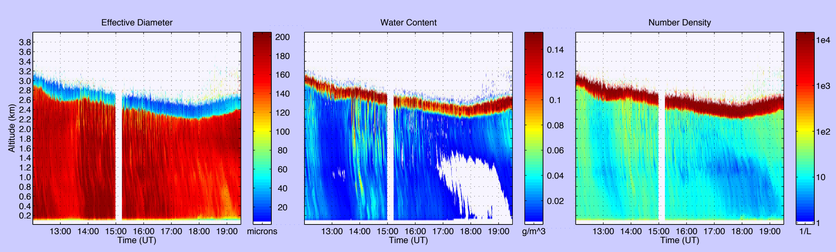


Motivation

Many microphysical retrievals obtained from satellite instruments require a priori information about the observed cloud. The same is true for parameterizations used for numerical simulations of cloud structures. Observations of this kind for Arctic clouds are very limited.

Methodology

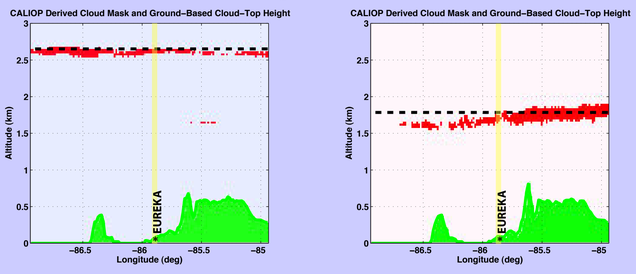




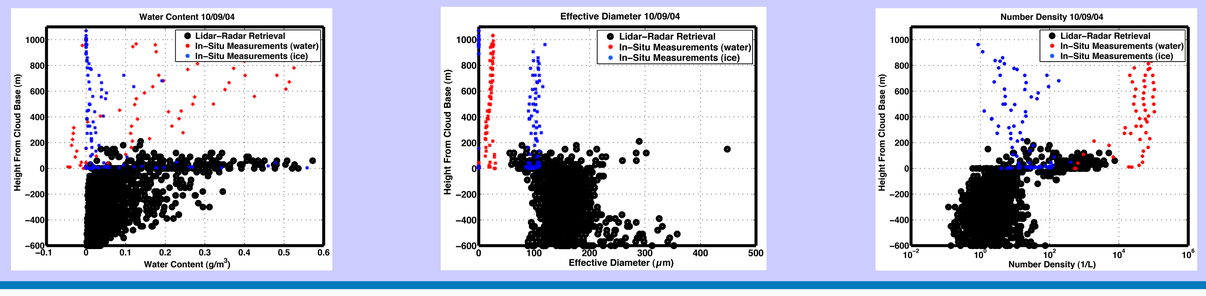
Assumptions for retrievals:
- **gamma distribution of particles**
- **spherical shape under presence of liquid, and variable shape elsewhere**

The HSRL and MMCR are utilized together to locate cloud boundaries. Above (left), plots of the two data products are overlaid, and criteria for cloud-base and cloud top are given. HSRL and MMCR measurements are then combined to retrieve cloud microphysical quantities (Donovan and Van Lammeren, 2001; Shupe, 2005). Temperature and wind data are retrieved from cloud structures observed within 20 minutes of radiosonde launches. All information is averaged over half hour periods and distributions of long-term statistics are created as shown at right.

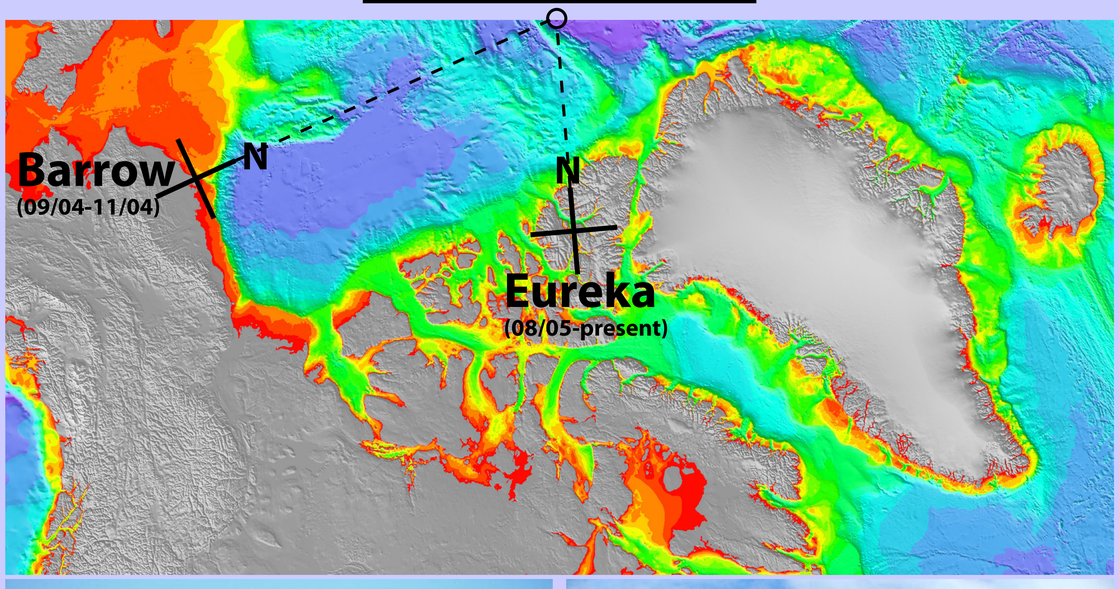
Comparison With other Measurements



Left: Comparisons of MMCR cloud-top height retrievals (black line) with a cloud-mask derived from CALIOP data (red). Below: Comparisons of the lidar-radar microphysical retrievals (black) with in-situ data from Barrow (blue and red).



Observation Sites

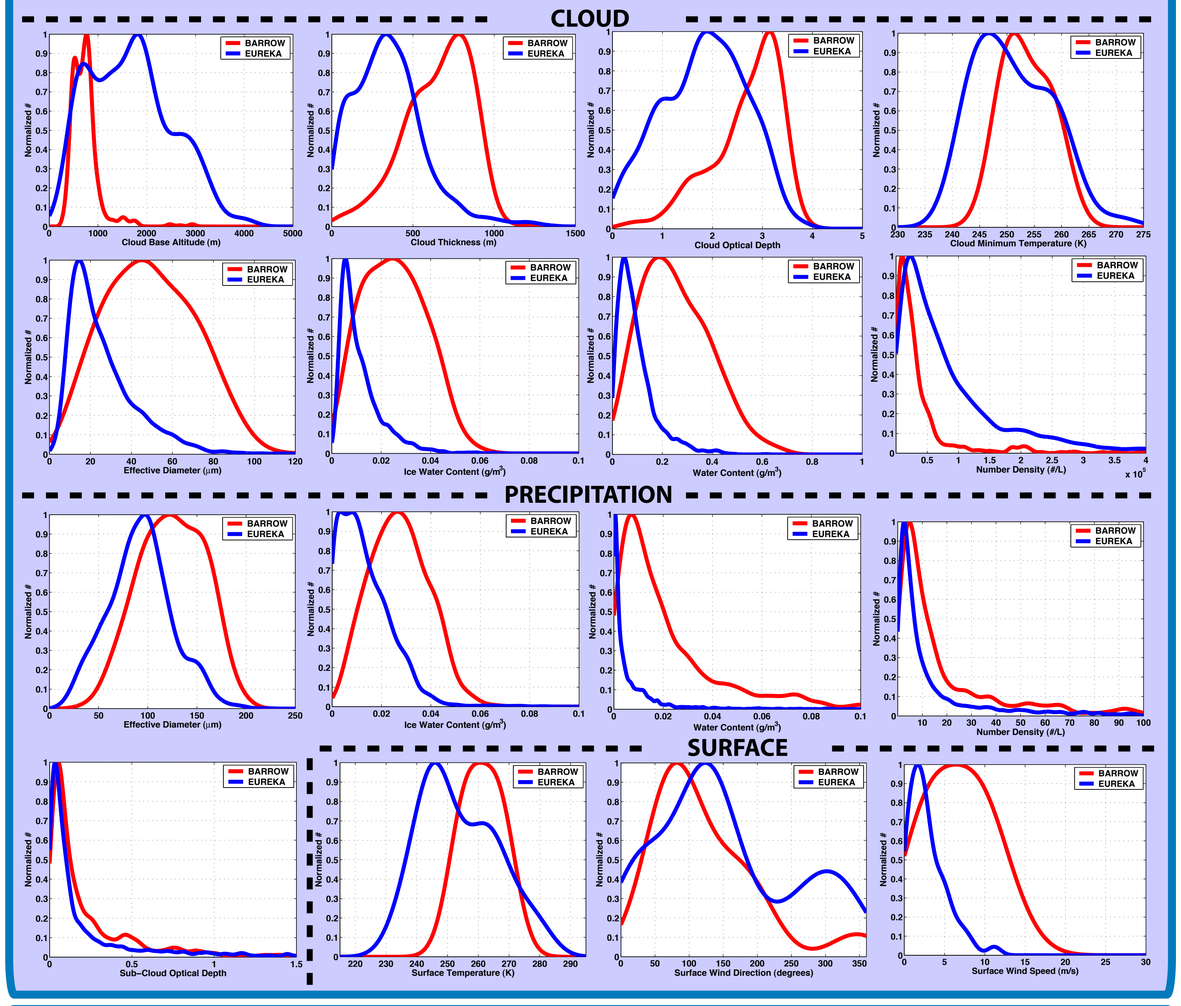


The seatainer housing for the AHSRL in Barrow (left) and Eureka (right). The map of the western Arctic (top) shows the differences in location between Barrow and Eureka. (Bathymetric chart courtesy of the NOAA IBCAO program. Also visible in the Eureka picture is the antenna for the NOAA millimeter cloud radar (MMCR).

Instrument Descriptions

AHSRL		MMCR	
Wavelength:	**532 nm**	**Wavelength:**	**8.6 mm**
Laser Pulse Width:	**40 ns**	**Doppler Velocity:**	**yes**
Receiver Field of View:	**45 μrad**	**Sensitivity:**	**~ -40 dBZ**
Receiver Aperture:	**40 cm**	**Antenna:**	**1.8 m**
Altitude Resolution:	**7.5 m**	**Altitude Resolution:**	**45 m**
Temporal Resolution:	**2.5 s**	**Transmit Power:**	**100 W peak**

Long-Term Stratus Properties



Acknowledgements

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