Small droplets at cloud top, possible ice, no precipitation

Large droplets at cloud top, ice, precipitation

M-PACE found

ISDAC expected

Rangno & Hobbs (2000)

Indirect Semi-Direct Aerosol Campaign

April 2008, Barrow Alaska

PIs: Steve Ghan, Greg McFarquhar, Hans Verlinde

ARM AVP: Beat Schmid, Greg McFarquhar, John Hubbe, Debbie Ronfeld

In situ measurements: Sarah Brooks, Don Collins, Dan Cziczo, Manvendra Dubey, Greg Kok, Alexei Korolev, Alex Laskin, Paul Lawson, Peter Liu, Claudio Mazzoleni, Ann-Marie McDonald, Greg McFarquhar, Walter Strapp, Alla Zelenyuk

Retrievals: Connor Flynn, Dan Lubin, Mengistu Wolde, David Mitchell, Matthew Shupe, David Turner

Modeling: Ann Fridlind, Xiaohong Liu, Shaocheng Xie

Motivation

• Most studies of cloud-aerosol interactions have focused on warm clouds.
• Cloud-aerosol interactions are much more complex for ice or mixed-phase clouds than for warm clouds.
• The Mixed-Phase Arctic Cloud Experiment at the ARM site in Barrow has provided new insight into these interactions.
• The arctic air during April is expected to be much more polluted than the air during M-PACE.
• Little is known about the composition of arctic ice nuclei.

Key Issues

1. How do properties of the Arctic aerosol during April differ from those measured by the Mixed Phase Arctic Cloud Experiment (M-PACE) during October?
2. To what extent do the different properties of the Arctic aerosol during April produce differences in the microphysical and macrophysical properties of clouds and the surface energy balance?
3. How well can cloud models and the cloud parameterizations used in climate models simulate the sensitivity of Arctic clouds and the surface energy budget to the differences in aerosol between April and October?
4. How well can long-term surface-based measurements at the ACRF Barrow site provide retrievals of aerosol, cloud, precipitation and radiative heating in the Arctic?

Applications

• CCN closure
• Droplet number closure
• Cloud extinction closure
• Cloud water closure
• Cloud modeling
• Semi-direct effect
• Crystal nucleation
• Aerosol extinction retrieval
• CCN retrieval
• MMCR retrievals
• MWR retrievals
• AERI retrievals
• ASD retrievals
• Small ice crystal issue
• Long-lived mixed-phase clouds
• CloudSAT/CALIPSO validation

Measurements

Aircraft
• temperature
• humidity
• total particle concentration
• aerosol size distribution (0.1-3 µm)
• single particle composition
• Cloud Condensation Nuclei concentration
• Ice Nuclei concentration
• optical scattering by aerosol
• optical absorption by aerosol
• vertical velocity
• cloud liquid water content
• total cloud water content
• cloud particle size distribution (0.5-2500 µm)
• cloud particle image (10-2500 µm)
• cloud extinction

Surface
• size-resolved aerosol hygroscopicity (0.02-0.6 µm)
• cloud optical depth, effective radius

Quinn et al., Tellus (2007)