A Long-term Cloud Microphysical Properties Dataset for Arctic Cloud Study Based on ARCF NSA Site Observations

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1. Introduction

Arctic clouds are important, but are not well simulated in climate models (Figure 1).

Accurate cloud properties are needed to better understand arctic cloud processes, especially related to arctic mixed-phase clouds.

A new suite of multiple-sensor retrieval algorithms are developed to provide the following cloud properties to better study arctic clouds, especially mixed-phase clouds, which has been applied to observations at NSA site.

- *Cloud boundaries and phase*
- *Liquid water path (LWP) and effective radius (r_{eff})*
- *Ice water content (IWC) and general effective radius (D_{ge}) profiles*

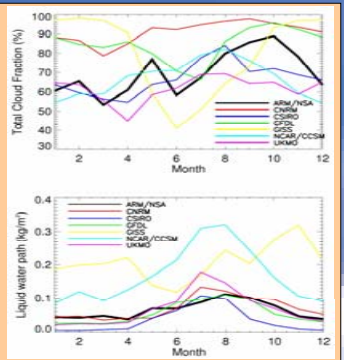

Figure 1: GCM simulations and observations around the NSA site. The model data are all from the Climate of the 20th century experiments (**http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php).**

2. Adiabatic characteristics of arctic mixed-phase clouds

In situ data indicate that LWC and r_{eff} profiles follow the adiabatic profiles very well in the mixed-phase clouds observed during the MPACE (Figure 2) . This provides an important constraint on mixed-phase cloud retrieval.

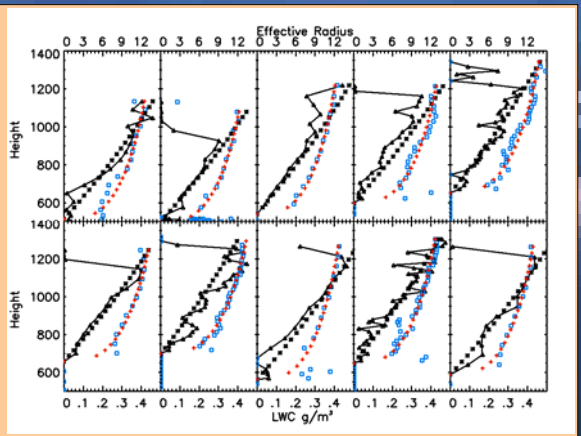

Figure 2: In situ LWC (Δ) and r_{eff} (□) profiles and adiabatic LWC (*) and r_{eff} (+) profiles based on data on 10 October 2004 during the MPACE experiment. In situ data are processed and provided by Dr. McFarquhar

3. A new suite of arctic mixed-phase cloud retrieval algorithm:

Water Phase	**LWP**	Derived from combining MWR, ceilometer, and cloud temperature (Wang 2007)
	r_{eff}	***All LWP range:*** derived from cloud boundaries, cloud temperature, MPL derived cloud extinction coefficient and the adiabatic feature of the water clouds. ***LWP < 40 g/m²***: AERI+ MPL (Wang et al. 2004)
Ice phase	**IWC and D_{ge}**	***Below water dominated mixed-phase layer*:** Combining MMCR and MPL measurements (Wang and Sassen 2002)
		***Within water dominated mixed-phase layer*:** Using MMCR and retrieved IWC and D_{ge} information below.

4. Comparison between retrievals and in situ measurements

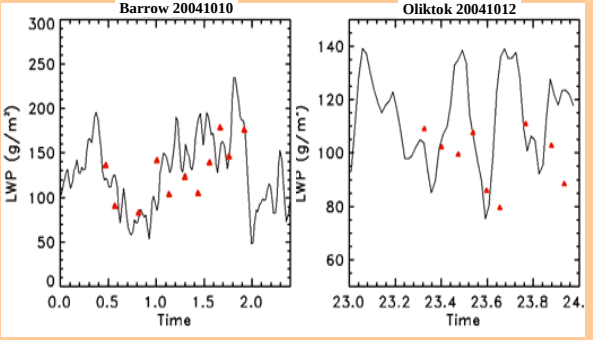

Figure 3: LWP comparison: New MWR retrievals (solid lines) and In situ measurements (triangles).

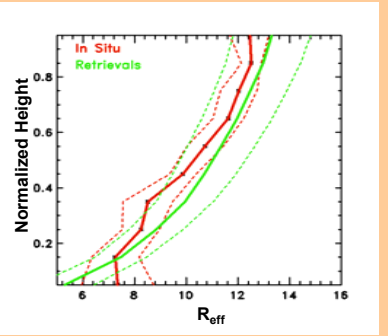

Figure 4: R_{eff} comparison for in situ and retrieval for observations during 1-2 UTC around the Barrow site.

5. A mixed-phase cloud retrieval example during the M-PACE

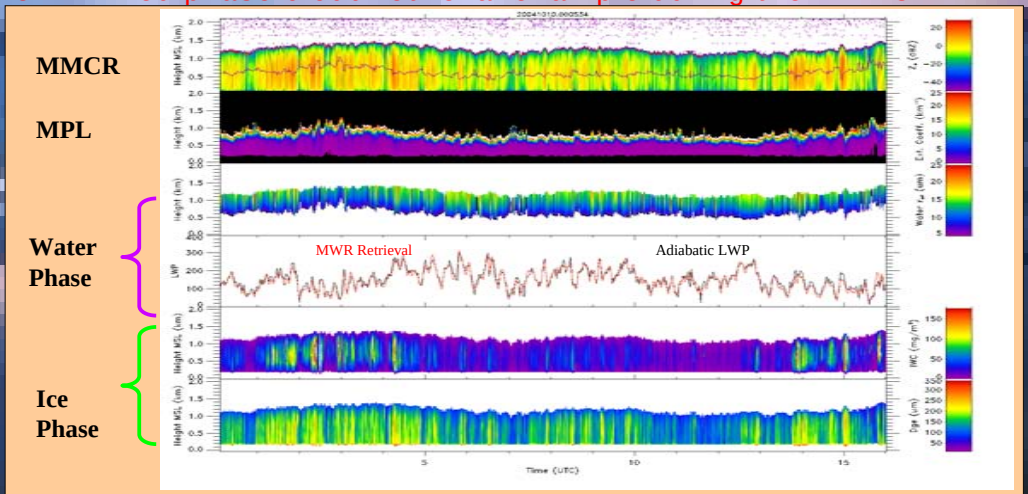

Figure 5: A retrieval example of mixed-phase clouds observed at the Barrow site on 10 October 2004 by combining MMCR, MPL, MWR, and radiosonde data.

6. Summary

- A new suite of algorithms are developed and validated to provide a reliable characterization of arctic clouds, including mixed-phase clouds.
- Results for the M-PACE period will be available to the CPM group shortly after this meeting.
- The algorithms are applying to multiple-year observations at the ARCF NSA site. Data will be available this fall.

References

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Wang, Z., 2007: Refined Two-channel Microwave Radiometer Liquid Water Path Retrieval at Cold Regions by Using Multiple-sensor Measurements. *IEEE Geoscience and Remote Sensing Letters (Accepted).*