Investigating Reflectivity-Liquid Water Content Relationships in Mixed-Phase Clouds

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1. Separating Liquid Water Contributions within Radar Spectra

The retrieval algorithm is based on the continuous wavelet transform and fuzzy logic.

2. Results for One Hour

3. Evaluation of Retrievals based on Microwave Radiometer Data

No direct measurements of retrieved quantities make the evaluation of this retrieval algorithm very challenging. Here, we first convert liquid reflectivity to LWC using Frisch et al. (1995) and compare the resulting LWP to that measured by the MWR.

4. Comparisons for 267 One-Hour Periods

The retrieval algorithm is applied to two months of data (185 hours in October 2011 and 82 hours in April 2012). Low LWP are more difficult to retrieve. Uncertainties originate from two sources:

1. The retrieval itself.
2. Variations in the Z-LWC relationships.

5. Investigating Z-LWC Relationships at Low LWP Using a Cloud Resolving Model

Model data are from a simulation of a mixed-phase cloud observed during April 8th, 2008, using the Distributed Hydrodynamic Aerosol and Radiative Modeling Application (DHARMa, Arramov et al. 2011).

6. Ice influence on the Z-LWC Relationship

In downdrafts, the Z-LWC relationship is fairly constrained. The impact of ice is small because ice amount is small in downdrafts. In updrafts, the Z-LWC relationships have large variations, which appear to be driven by large quantities (i.e., large reflectivities) of ice.

7. Variations of Drop Size Distributions in Updrafts and Downdrafts

Further investigation of Z-LWC relationships in mixed-phase clouds will be performed using a parcel model (Lebo et al. 2008). These relationships will be studied in different environments with various liquid and ice quantities. This study is also going to use in-situ data, although the existence of small ice will increase the difficulty in obtaining liquid droplets size distributions.

8. Future Work

Summary

In mixed-phase clouds, ice particles grow at the expense of liquid droplets. The interactions between liquid and ice phases increase the uncertainties if a single Z-LWC relationship is used to calculate LWC profiles. The Z-LWC relationships depend on cloud processes, including dynamical and microphysical properties. Understanding of the microphysical mechanisms leading to the formation of Z-LWC relationships will allow for the improvement of the LWC based on the retrieval algorithm.

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