Determining Large-Scale 3D Cloud Ice Water Content by Combining Satellite and Surface Measurements in both Mid-Latitudes and the Tropics

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Objectives

Large-scale distribution of cloud ice water amount (1) is required for deriving cloud water advective tendency as forcing term for single-column models, (2) can be used to validate cloud resolving and global climate models, and (3) is extremely useful for understanding cloud microphysical and precipitation processes. While excellent in quality, surface cloud radar observations provide only single-point measurements; thus unable to be used to derive areal cloud ice distributions. Satellite observations, however, can cover a large area in a very short time period while having limited ability in resolving vertical cloud distributions. In this study, we take the advantages of both satellite and surface cloud radar observations. By combining the two, we derive large-scale 3-D ice water contents in a 10°×10° area surrounding ARM sites. In this poster, we show one-year 3-D ice water retrieval and analysis results (7/1/05 - 6/30/06) in a 10°×10° area centered at SGP and TWP-Darwin sites.

Methods

Point Measurements

- MMCR
- MWR
- ECMWF
- RT model simulations
- a-priori database
- non-spherical scattering

Areal Measurements

- IR cloud top height
- satellite AMSU-B MW data
- Bayesian retrieval

Ice water retrieval algorithm, schematically described in the above diagram, is based on the MMCR radar reflectivity time-height cross section observed at Darwin site during the 40 days of TWP-ICE. Cloud ice water content retrievals are performed using data observed by 4 satellites (NOAA-15/16/17/18), resulting in ice water retrievals available up to 8 times a day. Two examples (Jan. 19 & Jan. 24) of the ice water retrievals are shown, both in horizontal distribution of ice water path and in distance-height cross-section of ice water contents.

Seasonal Variation of IWP Distributions around SGP and TWP-Darwin (10°×10°)

Seasonal IWP distribution centered at ARM sites and time series of 10°×10° areal averaged IWP. Dots are daily averaged values while lines are 10-day running means.

Conclusions

- Combining satellite and surface radar observations enables us to retrieve 3-D cloud ice water contents over large-scale surrounding ARM sites (10°×10°). Retrieved data are available for 7/1/2005 – 6/30/2006 for 10°×10° areas covering SGP and TWP-Darwin.

- Retrievals are validated by MMCR data for TWP-ICE and SGP March 2000 IOP. Characteristics of cloud ice water as c-regimes are studied.

- Data available: PI products at ARM Website, as well as at http://cirrus.met.fsu.edu

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