Comparison of Liquid Cloud Microphysical Retrievals During the Black Forest, Germany AMF Deployment

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ABSTRACT

We will present preliminary comparisons of single-layer liquid cloud microphysical retrieval products for several cases during the deployment of the ARM Mobile Facility (AMF-1) at the Black Forest Germany in 2007. The retrievals that are compared include a new version of the MICROBASE algorithm which accounts for attenuation at W-band radar frequencies, the mixed-phase cloud property retrieval algorithm (MIXCRA; Turner 2005) which retrieves cloud optical depth and cloud particle effective radius from Atmospheric Emitted Radiance Interferometer (AERI) high-resolution infrared radiance measurements and lidar cloud boundaries, and a combined cloud radar and microwave radiometer retrieval (Ebel 2011). Future plans involve the evaluation of these (and other) retrievals through a radiative closure study.

MOTIVATION

The quantification of cloud microphysical properties (e.g. LWC(z), reflectivity) is an important step towards improving our understanding of cloud processes and the subsequent testing, evaluation and improvement of numerical models of the atmosphere and climate. The accurate retrieval of these properties from remote sensing observations remains an area of active research with a variety of algorithmic approaches of varying complexity. In May 2013 the DOE Climate and Environmental Sciences Division hosted a joint workshop bringing together participants from various European Union programs and the DOE ARM/ASR programs. The primary objective of the workshop was to advance algorithm development and uncertainty quantification for retrieving cloud and precipitation from ground-based remote sensors through international scientific collaboration and data sharing. One of the action items from this workshop was to build a set of real-atmosphere cases that can be used for retrieval algorithm evaluation using data from the ARM/EU Convective and Orographic Precipitation Study (COPS) dataset.

ALGORITHMS

New version of MICROBASE retrieval with W-band attenuation correction

- Merged Soundings
  - Brightness temperature
- AERI
  - Ground-based passive infrared radiometer
- SHEBA
  - A polarization-sensitive lidar
- MWRRET
  - WRF for LWC scaling
- ARCI
- NPL CONSORTIUM
  - HIRS, reflectivity, brightness, emissivity
- ASSIM
  - Cloud liquid water content
- Liquid water content
  - Liquid cloud water content: Adjustability - no entrainment
  - Non-precipitation
  - Refractive index
  - Liquid and solid: 1 (Lobert 2004)
- Liquid effective radius
  - Mix and Johnson (2003)
  - LWC = (4/3π/2)1/3 a
- Microwave
  - Attenuation correction for W-band reflectivity
  - LWC = 2×[log(8.0×10^(-1))/log(IWC)]
- Cloud emissivity
  - a(0) = (0.07, 0.05)
  - n = 1.5 (Cotton, 1971)
- Reflectivity
  - Cloud reflectivity
  - Li et al. (2005)
- Liquid effective radius
  - Mixed and Johnson (2003)
  - LWC = (4/3π/2)1/3 a
- Cloud effective radius
  - Microwave
  - LWC vs. LWC
  - Microwave
  - LWC vs. LWC
- Liquid effective radius
  - Parameterization from SHEBA
  - Collis et al., 1995
  - Li et al., 2006

What do we do next?

Next steps are to include additional retrievals of varying complexity. Sometimes significant differences for multi-layer cloud cases (with ice) and drizzling cloud cases will be observed. Good agreement among techniques for single layer, non-drizzling clouds (consistent with Zhao et al. (2012) and Huang et al. (2012)).

COMPARISONS: Daily plots at Black Forest Germany in 2007

95GHz Reflectivity

WWP: MWRRET vs. MIXCRA

LWC MICROBASE – LWC EBEL

LWC MICROBASE – LWC MICROBASE

LWC MICROBASE vs. LWC EBEL

95GHz Reflectivity

LWP: MWRRET vs. MIXCRA

LWC MICROBASE – LWC EBEL

LWC MICROBASE – LWC MICROBASE

LWC MICROBASE vs. LWC EBEL

REFERENCES


PRELIMINARY DISCUSSION

- Good agreement among techniques for single layer, non-drizzling clouds (consistent with Zhao et al. (2012) and Huang et al. (2012)).
- Sometimes significant differences for multi-layer cloud cases (with ice) and drizzling cloud cases.
- Next steps are to include additional retrievals of varying complexity.

WHAT DO WE DO NEXT?

- Include Loehnert et al. (2004) integrated Profile Technique, which employs an optimal estimation approach.
- Expand comparison and evaluation to mixed-phase and ice clouds.
- Use radiative closure via the Broadband Heating Rate Profile (BBHRP) framework to evaluate retrieval products.

HOW CAN YOU GET INVOLED?

If you have cloud property retrievals for the AMF Black Forest, Germany deployment or a retrieval algorithm that you would like to apply to this dataset and include in the comparison and evaluation exercise, please contact Meng Wang (mwang@bnl.gov) or Michael Jensen (mjensen@bnl.gov).

references (cont’d)

