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Atmospheric Measurement Techniques Discussions

Interactive comment on "Ice hydrometeor profile retrieval algorithm for high frequency microwave radiometers: application to the CoSSIR instrument during TC4" *by* K. F. Evans et al.

Anonymous Referee #3

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Summary:

The article details a new Bayesian method for the retrieval of vertical profiles of ice water concentration, ice water equivalent mass sphere diameter and relative humidity from millimetre and sub-millimetre-wave radiometers. The a priori information of profiles of temperature, relative humidity and 5 microphysical parameters (3 for frozen and 2 for liquid particles) are derived from: CloudSat radar reflectivity profiles; ECMWF temperature and humidity profiles; cloud microphysical probability distributions obtained by in-situ cloud probes during the Tropical Composition, Cloud and Climate

Coupling (TC4) experiment.

The authors describe the generation and storage of a priori information using cumulative distribution function for the statistics of single variable at each layer and empirical orthogonal function for the two-point correlation between different variables and layers. The algorithm uses a hybrid approach to retrieve ice hydrometeor profiles. The fast Monte Carlo integration of the posterior distribution is first used, and if too few cases contribute to the integral, the optimal solution is found minimizing a cost function. The algorithm is applied using the CoSSIR radiometer data collected during the same measurement campaign to retrieve ice hydrometeor profiles. The authors show that the retrieval algorithm, applied to the 11 channels of the CoSSIR instrument, is able to retrieve frozen hydrometeor profiles at high altitude (>9 km). The algorithm is also validated by retrieving radar integrated backscatter at 94 GHz which shows a good agreement when compared against the CRS cloud radar measurements collected onboard of the same aircraft.

General comments:

The authors deal with the important issue of improving the quality of remote sensing measurements of ice clouds properties. They also stress the importance of a correct use of the measured mutual relationships between any free parameter of the problem and their value in different layers to reduce the ill-posedness of the inverse problem. The article describes with a wealth of details all the parts of the algorithm and the assumptions used to develop it. I found this very useful for comprehension and comparability with other retrieval algorithms.

A drawback of the manuscript is a far too long introduction. The idea to give an overview of the algorithm at the beginning of the paper to drive the reader in the two following sections and appendices is good, but I would suggest dedicating it a new section after the introduction. Tentatively, the insertion of general information regarding the source of the a priori information into section 1 would make possible to make a new

section with the algorithm outline from page 3124, line 21.

I appreciate the use of the appendices were details regarding specific aspects of the algorithm are given. I would suggest including in an appendix also the discussion on CloudSat reflectivity below -26 dBZ now included in section 2. Furthermore the reading of section 2 would be simplified if it were subdivided into subsections.

Technical corrections:

Page 3121, line 21: “distribution that IS much closer to log-normal”

3126, 5: put a reference to appendix B4 for the description of the melting model

3134, 9: “The relative humidities are converted TO water vapor mixing ratio q”

Fig. 10: colours used for hail and hexagonal aggregates are not distinguishable

Fig. 13: add the date in the caption or in the title

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 3117, 2012.