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Potential Reduction of Uncertainty in Passive Microwave Precipitation Retrieval using the Cloud Dynamics and Radiation Database with the Inclusion of Dynamic and Thermodynamic Constraints: Results and Analysis

W.-Y. Leung (1,2), A. Mugnai (3), E.A. Smith (4), and G.J. Tripoli (1)

(1) University of Wisconsin, Madison, Wisconsin, USA, (2) Stockholm University, Stockholm, Sweden, (3) Istituto di Scienze dell'Atmosfera e del Clima, Consiglio Nazionale delle Ricerche, Roma, Italy, (4) Center for Research on the Changing Earth System, Tallahassee, Florida, USA

The type of physically based precipitation retrieval algorithm under study uses Bayesian approach to find microphysical profiles solution applied within a subset of Cloud Radiation Database (CRD), which consists of many realizations with sets of relationships between brightness temperatures (TBs) and rain rates. However, the relationship between the simulated microphysical profiles and the simulated multispectral TBs are not likely unique, as many configurations of liquid and ice hydrometeors can generate similar observed set of multispectral TBs. Therefore during precipitation retrieval, given a set of observed TB's, one can often match with sets of simulated microphysical profiles with strongly different precipitation outcomes. To improve precipitation estimation, additional constraints that could describe the dynamical and thermodynamical state of the atmosphere at the time of retrieval are needed. Fortunately, such constraints are virtually always available in the form of recent or short-term projections of the synoptic situation, which dramatically reduces the number of applicable profiles in the database, when the profiles include information of the synoptic situation in effect when they were simulated.
The Cloud Dynamics and Radiation Database (CDRD) is an attempt to include this additional information in the CRD to increase the available constraints in selecting applicable database entries used in the estimation procedure. This additional information includes the dynamical and thermodynamical structure of the atmosphere, which are stored as dynamical and theromodynamical tags in the CDRD. By using a Bayesian-based statistical estimation method, it is expected that more appropriate microphysical profiles can be chosen and thus precipitation retrieval uncertainties can be reduced.
In this study, the degree to which uncertainty in precipitation estimation can be reduced through the addition of these dynamic and thermodynamic constraints is estimated quantitatively. This is accomplished through a procedure whereby a CDRD of 120 cloud resolving model simulations is statistically analyzed to determine the impact which several of the strongest dynamic and thermodynamic constraints have on the variance in the predicted columnar liquid water paths, ice water paths, and surface rain rates associated with simulated multichannel brightness temperatures.

This work is being done at University of Wisconsin, Madison.