On the Use of Data Assimilation Methodologies for Examining Cloud System - Environment Interactions

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While data assimilation (DA) has many applications, its fundamental purpose is the combination of information from disparate sources [1,2]. In most modern DA algorithms, each piece of information is associated with a probability distribution. These are then related through a model that maps from one probability space into another. The outcome is an estimate of the probability structure of one or more variables of interest conditioned on each piece of information; typically prior knowledge, a set of observations, and the formulation of the model itself. Information derived from this probability distribution may include an optimal estimate and/or measures of variability and relationship between variables (e.g., (co)variance).

This presentation demonstrates how this very general perspective on data assimilation can be used to explore the fundamental relationships in a physical system. Specifically, a Markov chain Monte Carlo inverse algorithm [3,4] is used to compute the probability distribution of cloud variables in a deep convective cloud system, joint with the system dynamics, radiative fluxes and heating rates, and thermodynamic environment. The results clearly depict the multivariate functional relationships between cloud microphysics and the system state. It is also clear that, when cloud microphysical characteristics are constrained with observations, many aspects of the deep convective structure are also uniquely determined. Where this is not the case, the results provide guidance as to which observations are required to produce robust estimates of convective dynamics and environment, as well as their uncertainty characteristics.

References


