Estimation of Background Error Covariance Matrix for Precipitation Locking from Passive Microwave Satellites

Jieying He [1,2], A.J. Gasiewski[1], Kun Zhang[1]
(1) Center for Environmental Technology (CET), University of Colorado at Boulder, CO, USA
(2) Key Laboratory of Microwave Remote Sensing, National Space Science Center, Chinese Academy of Sciences, Beijing, China

Abstract—The background error covariance matrix B plays an important role in meteorological variational data assimilation systems based on passive microwave satellite data and iterative extended Kalman filtering. The atmospheric state variable statistics embodied in this matrix impact the Kalman gain significantly, and incorrect statistics can result in instabilities that amplify noise in unobservable prognostic modes. The potential for precipitation locking of Numerical Weather Prediction (NWP) models to large discernible precipitation cells and heavy cloud features under conditions of rapidly evolving mesoscale convection such as hurricane rain bands requires that this matrix consider all hydrometric and thermodynamic variables and be both flow dependent and rapidly calculable.

In this study we report on progress to demonstrate generation of B using time differencing of forecast prognostic state variables suitable for precipitation locking of a real-time all-weather microwave radiance assimilation system based on iterative extended Kalman filtering and fast forward radiative transfer models. This study is based on the "NMC method" under which the prognostic variable state increments are small enough that both hydrometric and thermodynamic state variables can be assumed to be Brownian processes whose error covariances grow linearly with time. Under the Brownian assumption the covariance matrix is developed from the increments in the forecast state variables, which are themselves Gaussian for short enough time periods. We focus in this study on the appropriate time differences to be used to justify the Brownian assumption for both hydrometric (e.g., rain, cloud liquid water, cloud ice, snow, and graupel density) and thermodynamic variables(e.g. temperature, water vapor, winds) within the framework of the Weather Research and Forecasting (WRF) model, and in particular the determination of the proper scaling factor between the time difference increments and B. The representation of B with multivariate rendering and its applications in a 3D-Var precipitation locking analysis system will be discussed, along with an ab initio demonstration of precipitation locking.