A Comprehensive 4D-Var Vortex Initialization Using a Nonhydrostatic Axisymmetric TC Model with Convection Accounted for

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A four-dimensional variational (4D-Var) vortex initialization (VI) system is developed for a nonhydrostatic axisymmetric numerical model with convection accounted for (the RE87 model). Derivations of the tangent linear and adjoint models of the RE87 model and the correctness checks are presented. As an initial evaluation of the 4D-Var VI system, a cost function that measures the model fit to satellite microwave retrievals of tropical cyclone (TC) warm-core temperatures and total precipitable water (TPW) from the following four polar-orbiting satellites within a slightly longer than 1-h assimilation window is minimized using the limited-memory quasi-Newton minimization algorithm: the Suomi National Polar-orbiting Partnership, NOAA-20, Fengyun-3D, and Global Change Observation Mission – Water Satellite 1. An azimuthal spectral analysis in cylindrical coordinates centered on the TC centers shows that the warm core and TPW fields within TCs are dominated by the axisymmetric component. The 4D-Var VI results assimilating the axisymmetric component of the above satellite retrievals produced a significant reduction in the cost function and the norm of the gradient as the minimization process is completed. The gradient of the cost function is accurately computed by a single integration of the RE87 adjoint model. In the cases of Hurricane Florence and Typhoon Mangkhut, improved forecast of intensifications and more realistic vertical structures of all model state variables (e.g., temperature, water vapor mixing ratio, liquid water content mixing ratio, tangential and radial wind components, and vertical velocity) are obtained when compared with a parallel run initialized simply by the European Centre for Medium-Range Weather Forecasts ERA5 reanalysis.

***Thursday, 30 January 2020, 3:30pm**
***Please note special location-FL2/1001-Small Auditorium**
Refreshments 3:15pm
NCAR-Foothills Laboratory, 3450 Mitchell Lane

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