Application of Immersed Boundary Method to Variational Doppler Radar Analysis System (VDRAS)

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The Variational Doppler Radar Analysis System (VDRAS), which further developed by National Center for Atmospheric Research (NCAR), has been widely used for nowcasting and also quantitative precipitation forecast (QPF). Although many successful applications by VDRAS were shown in the recent years, the lack of ability to resolve terrain effect limits its performance when encounter areas with complex topography.

For the purpose of improving the analysis system, Ghost Cell Immersed Boundary Method (GCIBM) is applied to this 4D-VAR radar data assimilation system includes both cloud model and its adjoint model. The GCIBM-implemented model can simulate reasonable terrain effects by enforcing terrain boundary conditions implicitly through ghost cell grids and is suitable for any Cartesian grid code. The GCIBM is chosen for our needs since VDRAS cloud model is just constructed in Cartesian coordinate.

In this study, the validation experiment is accomplished by a two-dimensional linear mountain wave simulation. The numerical simulation shows compatible result with proposed analytical solution. Furthermore, a three-dimensional leeside vortex simulation also conducted. A pair of symmetric vortices forms at leeside becomes elongated as time evolves, represents good agreement with previous studies. More, a preliminary real case experiment is performed by modified VDRAS based on GCIBM. The dataset for the assimilation is observed from three radars served during IOP 8 of 2008 South-West Monsoon Experiment (SoWMEX) in Taiwan. The terrain effects are obviously shown from dynamic and thermodynamic variables in both analysis and forecast. Verifications proved the new system can provide more realistic results and bring positive impacts on wind forecast and even QPF at the same time.