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Application of Spectral Filtering scheme for Spherical Limited-Area domain to Regional forecast model

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The spectral filter for spherical limited-area domain was applied to time integration procedure of regional model as a numerical scheme to remove small scale noises, which cannot be properly resolved in numerical models. This filter is designed to provide the sharp filter response, selective scale decomposition, and the isotropy on the limited-area domain by using the filter equation with high-order spherical Laplacian operator. The high-order filter equation is solved by low-order elliptic equations with the first or the second spherical Laplacian operator. It is controlled by the order of the spherical Laplacian operator and wave cutoff scale parameter. For the application to the regional weather forecast model, the filter is reconstructed into the regional map projection, e.g., Mercator map projection. The weather research and forecasting (WRF) model is used and the spectral filter works on the vertical velocity field in which the unresolved kinematic features appear prominently. The filter parameters are set to damp the amplitude of wave component with wavelength of two times the grid interval by half in every time step. The effect of the filter on the removal of small-scale waves was evaluated through the tropical cyclone (TC) track and intensity prediction. For the accurate prediction of typhoon, the TC initialization scheme, named the structure adjustable balanced vortex (SABV) scheme, is used for all test cases. In comparison with the simulated result using the diffusion scheme provided in the model for the same purpose, the model performance was improved, especially in track prediction. The 1-day accumulated precipitation of the test simulation using the spectral filter exhibits the most similar pattern to the observation. The spectra analysis of vertical velocity field showed that the spectral filtering scheme restrains the undesirable small upturned spectral energy usually produced in limited-area models.