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Evaluation of Wave Momentum Forcing in the Korean Integrated Model (KIM): Comparison Between Versions 3.8 and 4.0

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The Korean Integrated Model (KIM) has been operationally used at the Korea Meteorological Administration (KMA) since 2020. KIM is the first global numerical weather prediction (NWP) system based on a cubed-sphere grid, featuring a spectral-element non-hydrostatic dynamical core and a comprehensive physics parameterization package. The model top extends to approximately 80 km with up to 91 vertical levels defined using a hybrid-sigma coordinate system. KIM has evolved from version 3.8, which had a horizontal resolution of approximately 14 km, to version 4.0, a next-generation high-resolution model with an 8 km grid spacing. This refinement is expected to improve the simulation of various equatorial and midlatitude wave activities. In this study, we decompose wind and temperature fields from KIM versions 3.8 and 4.0 into multiple wave modes—including Rossby, Kelvin, mixed Rossby-gravity, and inertia-gravity waves—and compute the corresponding wave momentum forcing in terms of Eliassen–Palm (EP) flux divergence. The representation of these waves and their vertical propagation characteristics are analyzed and compared between the two versions in both the troposphere and stratosphere. We further evaluate the wave simulation performance of KIM 4.0 by comparing it with reanalysis datasets such as ERA5 and MERRA-2. In addition, gravity wave parameterization tendencies provided by KIM and MERRA-2 are compared to assess the gravity wave drag representation in KIM. The enhanced resolution in KIM 4.0 enables the model to explicitly resolve a broader spectrum of waves, leading to stronger wave forcing associated with vertically propagating waves. As a result, the spurious jet acceleration observed in the midlatitudes in KIM 3.8 is substantially reduced in KIM 4.0. These improvements are clearly reflected in diagnostics based on EP flux and EP flux divergence.

Keywords: Korean Integrated Model, Atmospheric waves, MODES

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