Resolution Update in the KIM model: Advancing from 12 to 8 km with Associated Refinements in Physics and Dynamics

Eun-Hee Lee, Rae-Seol Park, Sooya Bae, Ji-Young Han, Myung-Seo Koo, Hyun Nam, Tae-Jin Oh

Korea Institute of Atmospheric Prediction Systems (KIAPS), Seoul, South Korea
Email: ehlee@kiaps.org

1. Introduction

Numerical models are the essential for achieving prediction capability to give vital information of weather and climate, combat to high-impact weather events, enhance our understanding of weather and climate systems. Thus, it is natural to put efforts to enhance numerical modeling capabilities across various fields. The Korea Institute of Atmospheric Prediction Systems (KIAPS) was established with the mission to develop numerical prediction systems to ensure national safety from adverse weather and climate conditions. During the initial 9-year KIAPS project (2010 to 2019), the Korean Integrated Model (KIM) was successfully developed for the operational global predictions at a ~10 km resolution (Hong et al., 2018, Jung et al., 2024). Now, in the second phase of the KIAPS project (2020~2026), efforts are underway to develop a next-generation model and data assimilation system for seamless predictions by expanding KIM applications. As part of this effort, KIAPS released the 8-km resolution KIM4.0 this year, incorporating several modifications based one intensive validation over the past one year (Lee et al., 2024). A key feature of this upgrade is the revision of scale-aware parameters in the KSAS convection scheme, which significantly affects to precipitation predictions, particularly in South Korea and East Asia. KIM4.0 is finalized and ready to become the next operation version at Korea Meteorological Administration.

2. Major updates and performance

The major upgrade of KIM4.0 involves enhancing the horizontal resolution from 12 km to 8 km. At the same time, the convection scheme has been revised with modifications to scale-ware parameter optimization to improve predictions for heavy rain events over South Korea. A performance evaluation was conducted using a year-round testbed for 2022, to assess improvements in global skill and high-impact weather predictions in South Korea. The results revealed that the increase in resolution reduces significantly global errors, which is more apparent in mid-latitude regions during the winter season (Fig. 1). The new version also shows improved performance in high-impact weather events such as Typhoons, and heatwaves, along with better simulation of terrain-related weather over the Korean Peninsula (not shown). Furthermore, the revised convection scheme improves predictions for heavy rain events over South Korea. It is worth mentioning sensitiveness of scale-aware parameters within the 10 km range, which has been adjusted to minimize excessive convection activation in the upwind regions of the West Sea of Korea as suggested by Lee et al (2024). Figure 2 displays the impact of the modification to the scale-aware parameter for the high-impact weather event on August 8, 2022. Additional development challenges have emerged in applying high-resolution modeling, including refinements in surface boundary conditions such as sea-ice boundaries and lakes. It was also found that the hyper-viscosity setup also influences model systematic errors with sensitivity arising from the response of microphysics to changes in moisture traces.

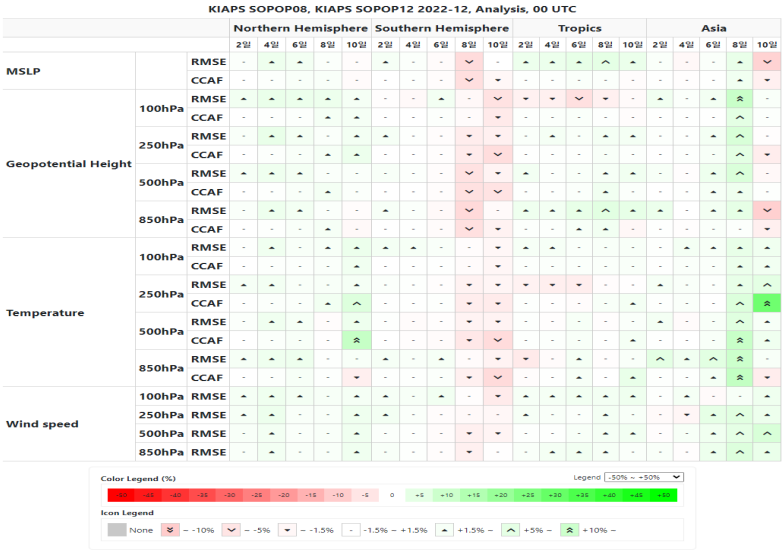

Figure 1: Scorecard of forecast skills comparing 8 km vs 12 km KIM for December 2022 verified against analysis. As indicated in the color legend below, green (red) indicates improvement (degradation)

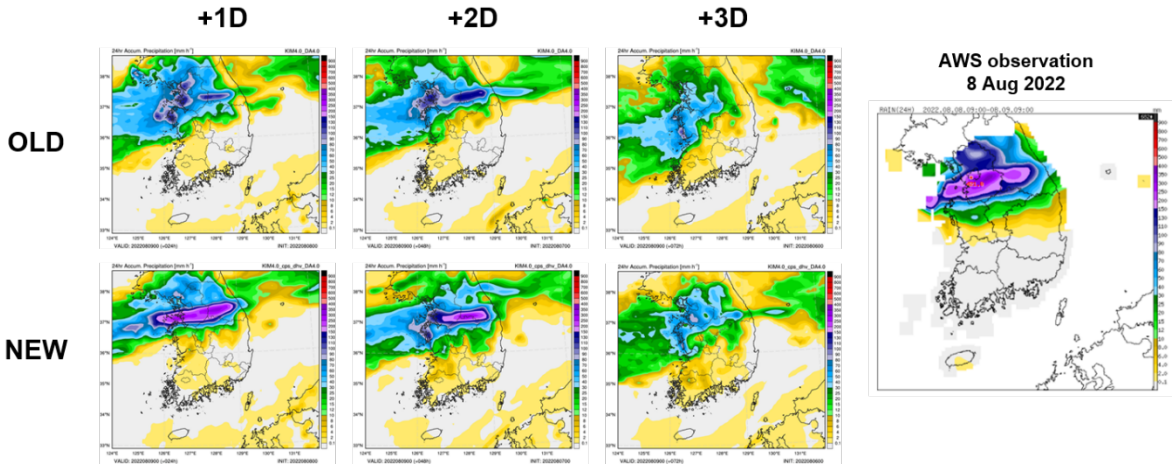

Figure 2: 24-h accumulated precipitation (mm) simulated by the KIM model using the original convection scheme (OLD) and the revised scale-aware parameter (NEW). AWS observations are given on the right

References

Hong, S.-Y. Y. C. Kwon, T.-H. Kim, J.-E. E. Kim, S.-J. Choi, I.-H. Kim, E.-H. Lee, R.-S. Park, D.-I. Kim (2018). The Korean Integrated Model (KIM) system for global weather forecasting. *Asia-Pac. J. Atmos. Sci* (54), 267−292. https://doi.org/10.1007/s13143-018-0028-9

Lee, E.-H., S. Cho, K.-H. Cho, J.-Y. Han, Y. Lee, J. Kim (2024). Forecast accuracy and physics sensitivity in high-resolution simulations of precipitation events in summer 2022 by the Korean Integrated Model. *Asia-Pac. J. Atmos. Sci,* https://doi.org/10.1007/s13143-024-00358-4

Jung, J., M. Chang, E.-H. Lee, K.-K. Sung (2024). Verification of Tropical Cyclogenesis Forecasts of the Korean Integrated Model for 2020–21. *Weather and Forecasting.* https://doi.org/10.1175/WAF-D-23-0175.1