Recent advances of radiative transfer emulator in WRF model

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Radiative transfer processes, which describe the energy exchange between the Sun and the Earth, are parameterized in numerical weather prediction (NWP) model. The radiation parameterization can occupy nearly 90% of the total computational cost in a NWP model when it is used every model time step (same as other parameterizations). Because of the computational burden of radiation scheme, it is often infrequently called in operational NWP models (e.g., once every 15 times). As an alternative method, the neural network emulator for radiative transfer processes is developing to significantly improve the computational speed of the NWP model. This study summarizes scientific achievements for radiative transfer emulators of the WRF model developed in the NIMS/KMA. When longwave/shortwave processes of RRTMG-K radiation scheme were replaced by the emulator, it showed 60-fold speedup for radiation process and 87% reduction of total computational cost. Along with the computational benefits, the emulator exhibited high forecast accuracy for upward/downward longwave/shortwave fluxes compared with control simulations (7-day forecast correlation is 0.97), in addition to surface temperature and precipitation compared with surface observations (similar accuracy with RRTMG-K). This presentation will also introduce the optimization strategies of neural network training (e.g., stochastic weight averaging, batch sizes and learning rates, and Sherpa), as well as the universal applicability of radiation emulator for microphysics parameterizations, modeling frameworks, and horizontal resolutions different from the trained situation.

Key words: WRF, RRTMG-K, radiation, neural network, emulator

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