Neural network emulator for melting processes in a bulk-type cloud microphysics parameterization

Kyo-Sun Sunny Lim,[1,2], Jeong-Su Ko[1], Sung-Bin Jang[1],
Joong-Hyun Jo[2]
[1]Department of Atmospheric Sciences, Kyungpook National University
[2]Department of Earth System Sciences, Kyungpook National University

It has been analyzed in previous researches that the melting process is a key process to generate rain mass in bulk-type cloud microphysics parameterizations when simulating deep convective precipitation systems. In this study, the melting process of the Weather Research and Forecasting (WRF)Double-Moment 7 class (WDM7) scheme is replaced by one of the Hebrew University of Jerusalem (HUJI) Spectral Bin Microphysics (SBM) scheme in the WRF model. Therefore, the efficiency of melting in WDM7 can vary with the size of solid-phase hydrometeors. To emulate the melting process of WDM7 implementing bin-type melting (WDM7_BIN), a single-layer neural network (SNN) emulator is developed. The training data set for the emulator development is produced through the simulations with WDM7_BIN under the idealized 2 dimensional squall-line framework. From the validation for the squall line case, we find out that the computation time of WDM7_BIN increased by 52% compared to the one of WDM7. Meanwhile, SNN emulator with 200 neurons decreased the computational time by 24%, relative to the one of WDM7_BIN. SNN emulator also simulates the maximum altitude of graupel/snow/hail melting around the level of 0℃, which is consistent results with WDM7_BIN. Both SNN and WDM7_BIN simulate stronger bright band than WDM7.

Key words: Cloud microphysics parameterization, WDM7, SBM, SNN emulator

※ This work was funded by the Korea Meteorological Administration Research and Development Program “Developing AI Technology for Weather Forecasting. (KMA2021-00121)