A scale-aware convective parameterization scheme

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Abstract

A method that enables a mass-flux cumulus parametrization scheme (CPS) to work seamlessly in various model grids across CPS gray-zone resolutions is proposed. The convective cloud base mass flux, convective inhibition, and convective detrainment in the simplified Arakawa-Schubert (SAS) scheme are modified to be functions of the convective updraft fraction. The combination of two updraft fractions is used to modulate the cloud base mass flux; a function of the horizontal fraction of the model grid box occupied by convective updrafts, and the other is a function of the grid-scale vertical velocity. The convective inhibition and detrainment of hydrometeors are also modified to be a function of the grid-size dependent convective updraft fraction.

A set of sensitivity experiments with the Weather Research and Forecasting (WRF) model is conducted for a heavy rainfall case over Korea. The results show that the revised SAS CPS outperforms the original SAS. At km and 1km, the precipitation core over Korea is well reproduced by the experiments with revised SAS scheme. On the contrary, the simulated precipitation is widespread in the case of the original SAS experiment and there are multiple spurious cores when the CPS is taken out. The modified mass flux at the cloud base is found to play a major role in organizing the grid-scale precipitation at the convective core. A one-month simulation at 3 km confirms that the revised scheme produces slightly better summer monsoonal precipitation as compared to the typical model setup without CPS.