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The predictability of heavy rainfall in MM5 mesoscale model in reference to physical parameterizations

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We investigate the predictability of the MM5 mesoscale model using different physical parameterizations for thirty heavy rainfall cases occurring in the Korean Peninsula from 1980 to 2003. The twenty experiments using different physical parameterizations are performed for each heavy rainfall case, and the predictability characters of physical parameterization schemes are analyzed. The physical parameterizations used in this study are the Anthes-Kuo scheme (AK), the Betts-Miller scheme (BM), the Grell scheme (GR), the Kain-Fritsch scheme (KF) and the control with no cumulus parameterization (NO) for the cumulus parameterization scheme (CPS) experiments, the Simple ice-phase scheme (SI) and the Reisener graupel scheme (RE) for the grid resolvable scheme (GRS) experiments, and the Blackadar scheme (BL) and Eta scheme (ET) for the planetary boundary layer scheme (PBL) experiments. The 30km and 10km horizontal resolution experiments are also conducted.

The results show that the prediction of heavy rainfall is the most sensitive to CPS, and PBL follows CPS. In the 30km resolution runs, the average position and amount errors of simulated heavy rainfall at the maximum rain point are about 150km and 30% respectively for all the experiments. In the 10km resolution runs, the position error is not reduced, but the rainfall amount error is reduced to half of the 30 km resolution results. AK and GR are good in the both position and amount at the maximum rainfall point in terms of forecast scores (threat and bias scores). The reason for the relatively better performance in AK and GR is attributed to dominant synoptic-scale conditions related to heavy rainfall over Korea. In the 10 km horizontal resolution experiments, the rainfall prediction in GR is improved in comparison with the 30 km resolution, but not in AK. The NO experiments show the best predictability in the maximum rainfall amount, but the worst in the position of the maximum rainfall. In the time series of area-averaged rainfall, GR is in good agreement with observation, and AK simulates the rainfall about 6 hours earlier than observation. NO shows a good trend in the first half simulation compared to observation, then it generates unrealistic rainfall peaks, because without CPS, convective instability is not removed properly.