A study on radar data assimilation methods to improve precipitation forecast

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The effect of radar data assimilation (DA) and the accuracy of precipitation forecast by 3D-Variational (VAR) and Hybrid DA methods are studied. The radar data is used as input for DA because it provides direct information of 3-D distribution, intensity, and speed of precipitation and covers area where no weather stations are present. The 3D-VAR method has few equation constraints and requires less computation resources, but it only considers climatological background error (BE) and the effect of DA is homogeneous and isotropic. The hybrid DA method considers model error of the time and the effect of DA is flow dependent.
This study assimilated reflectivity and radial velocity into a numerical model for three heavy rainfall cases. Radar reflectivity information is classified into hydrometeors (rain, snow, hail) based on the background temperature field from the numerical model.
The radar DA improved the microphysical structure of clouds, the timing and intensity of precipitation events, and had more positive impact on the forecast skill than the non-DA experiment. In numerical experiments of 3D-VAR assimilation with climatological BE, the precipitation areas was narrower than the observations and total cumulative precipitation error increased. The most improvement of rainfall accuracy comes from hybrid DA with flow dependent BE for simulation cases when compared to other 3D-VAR methods. In addition, this study presents the effect of radar DA methods in terms of forecast skill and microphysical budget analysis.

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Keywords: 3D-VAR data assimilation, Hybrid data assimilation, quantitative precipitation forecast, radar data assimilation, high-resolution modelling

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Abstract

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