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Simulation Study on the Impact of Initial Condition Errors on the Predictability of Precipitation*

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Initial condition and numerical model both have important impact on the precipitation prediction. Because of the imperfectness of today's atmospheric sounding technology and data assimilaltion methods, there exist uncertainties in the initial condition. As the evolvement of initial conditon errors in numerical model challenge the development of fine NWP, the impact of initial errors on preditability of precipitation should be studied.

By using the AREM model, some sensitivity experiments were performed to investigate the evolvement of initial errors and the mechanism of error growth:

It is found that the significant error growth is localized and it occurs in two sensitive regions: jet stream at different layers and rain-belt. In the high troposphere, the initial errors grow significantly near the high jet stream. While in the low troposphere, the sinificant error growth appears not only near the low jet stream but also in the vicinity of rain-belt. As the mechanism of the generation of precipitation is concerned, the high and low jet stream and their interaction have important effect on the transportationof water vapor, the formaion of instable layers and the trigger of ascending flows. Therefore, it can be concluded that while the evolvement of initial errors is determined by the basic flow, it is also correlated with the development of precipitation.

The geo-potential instability or CISK associated with moist physics and the dynamic instabilty associated with wind shear are found to be the two main mechanisms of error growth. In the high troposphere, as the error growth in the model is determined

by the “dry” dynamic process, the dynamic instability or baroclinic instability associated with wind shear is the important mechanism of error growth. While in the low troposphere, as the error growth is affectd by moist physics, geo-potential instability or CISK is found to be the error growth mechanism. In addition, the significant error growth appears first in the low troposphere and high troposphere and then propagates to the middle troposphere with a more obvious downward propagation.

In the precipitation predictin, due to the limited resolution of observational data, some initial meso-scale imformation are lost and this causes the initial uncertainty. Such initial uncertainty can be defined as “meso-scale feature error”. The simulation in this essay indicates that the meso-sclae feature errors present certain dynamic structurec over convective regions and grow fast in the model, which have a direct impact on the precipitation prediction.

As the basic flow in favor of precipitation is also in favor of error growth, it can be concluded that the develoment of precipitatiaon and error growth have the same energy source. Therefore, though a perfect numerical model is able to perform correct prediction of precipitation, it does provide the mechanism of error growth for initial condition errros. Since the significant error growth is alwasys correlated with the prediction of heavy-rain occurrence, determinstic forecasts from a single perfect numerical model have limited predictability of precipitation.

Key words: predictability of precipitation, initial condition errors, evolvement, mechanism of error growth, meso-scale feature error

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