Role and Impact of a Deep Convective Parameterization on Km-Scale Atmospheric Forecasts

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Convective precipitation over continents is a challenge for Numerical Weather Prediction (NWP) models, since initiation both in time and space, propagation and intensity are all important characteristics that may have great impacts for the public. Moreover, these systems spatio-temporal scales are only partially resolved by model grids.

Within the Canadian 48-h forecast system, the High Resolution Deterministic Prediction System (HRDPS), summer precipitation over Canada and northern U.S. shows delayed initiation, too heavy rain rates and a lack of spatial organization when deep convection was not parameterized. The model has a 2.5-km horizontal grid spacing.

With regards to these problems, the Kain and Fritsch (KF) deep convective parameterization was tested in the model with parameters adapted to high resolution in order to detect subgrid deep convective events, stabilize the atmosphere faster and to allow the explicit microphysics scheme to condensate earlier.

A subjective evaluation was performed with a squall line case. It showed that KF allows the first precipitation band to be correctly initiated, allowing the model to produce a smoother subsequent precipitation pattern with a faster spatial propagation, all in better agreement with observations.

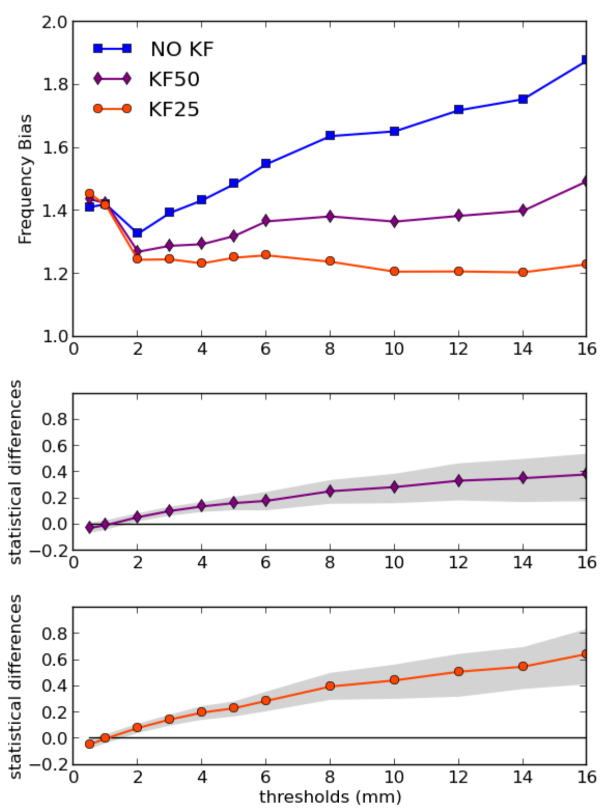

Figure 1: Top: frequency bias for 6-h accumulated precipitation as a function of precipitation thresholds at 2400 UTC for simulations without KF (blue) and two settings of KF (purple and orange). Bootstrap statistical differences (with the 90% levels of confidence in gray) between KF50 and NO KF (middle);and KF25 and NO KF (bottom).

An objective evaluation was also completed with 80 summer cases of 48-h hindcasts validated against station observations. It showed that KF substantially and significantly improves all performance measures of precipitation, particularly for the local evening period (2400 UTC) and for high intensity rates.

In this case, KF effectively reduces false alarms for high intensity events, reducing the frequency bias (see figure 1) while keeping the same probability of detection. These results confirm that at this high resolution, by vertically mixing and stabilizing the atmosphere sooner than what can be achieved explicitly by the model dynamics, KF prevents grid point storms to be produced by the explicit microphysics scheme, therefore reducing heavy precipitation frequencies.