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Unusual behavior in FV3-LAM simulations of the Midwestern U.S. Derecho of August 10, 2020: forecast degradation with improved resolution and a need for a convective parameterization with 3 km grid spacing

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In this presentation, results will be discussed from a series of tests that were performed with the FV3-LAM model using 25, 13, and 3 km horizontal grid spacing, and two physics suites, to simulate the August 10, 2020 Midwestern Derecho, the most damaging single thunderstorm event in U.S. history. The two physics suites resemble those used in the HRRR model (referred to as RRFS, Rapid Refresh Forecast System) and the GFS model.

This derecho was poorly forecast by most models in the days and even hours before the event occurred. Only some hourly runs of the HRRR and an experimental version of the HRRR the night before correctly captured an intense bowing line of storms occurring on August 10. Therefore, experimental HRRR output from 00 UTC was used to initialize and provide lateral boundary conditions to the FV3-LAM runs. Runs were performed with and without the Grell-Freitas convective parameterizations in the RRFS suite for all grid spacings.

It was found that both the 13 km and 25 km runs that did not use convective parameterizations did a good job showing very intense convection in the correct area and time. When the convective schemes were turned on, the 25 km results were degraded, but the 13 km results did not change much. However, when grid spacing was refined to 3 km, neither runs with the RRFS or GFS physics suites simulated the derecho. The big difference from the coarser grid spacing runs was that anomalous convection formed during the night in the 3 km runs, removing the convective available potential energy, and not allowing substantial convection to form during the day on August 10. Instead, the stronger storms were well to the south and east of Iowa. Although this was a common problem with many convection-allowing models run in real time when the event occurred, this result is potentially troubling since the experimental HRRR run that provided the initial and lateral boundary conditions used the same grid spacing of 3 km, but did not produce the anomalous convection at night and thus correctly showed the intense mid-day derecho. The spurious convection in FV3-LAM seems to be due to stronger ascent prior to initiation of the spurious nocturnal convection than was present in the HRRR. Of note, when the Grell-Freitas deep and shallow convective schemes are turned on in the 3 km FV3 run, the spurious convection is

eliminated and the simulation is remarkably accurate, producing an intense derecho with over 30 m s-^{1} sustained winds at 10 m, with gusts to 45 m s^{-1}, in the same general location at the same time as the observed event. The use of the convective scheme results in a layer around 720 hPa with 1-2 C of warming around the time that spurious convection had formed in the 3 km run lacking the convective scheme. This modest warming in a narrow layer is sufficient to prevent the spurious convection, completely changing the forecast of the daytime derecho from an absolute failure to a remarkable success.