16B.4 THE IMPACT OF CONVECTIVE PARAMETERIZATION ON NAM FORECASTS FOR THE FEBRUARY 25 2005 WINTER STORM

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1. INTRODUCTION

The east coast storm of 27-28 February 2005 caused many problems for forecasters in the northeast and mid-Atlantic. This event threatened the cities of the northeast megalopolis with potentially very heavy snow, but Inconsistent and conflicting model guidance led to low-confidence forecasts. The situation evolved with a surface low developing along the coast (Fig. 1), bringing a range of winter precipitation types from the southern Appalachians to New England.

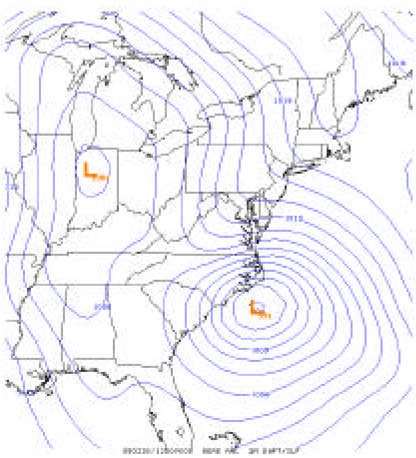

Fig. 1. Sea level pressure analysis from the Global Data Assimilation System (GDAS) valid 1200 UTC 28 February 2005. Contour interval is 2 mb.

As the event neared, NAM and GFS forecasts differed significantly, with the 60-hour predictions from the NAM and GFS displayed in Figs. 2 and 3. The GFS had the better depiction of a coastal event, while the NAM predicted a solution well inland. Still, the GFS does indicate a secondary center over eastern Kentucky, close to the location of the primary NAM low, and the NAM does attempt to develop a secondary storm further east over North Carolina, although too far to the west.

NCEP implemented a new SREF (Short

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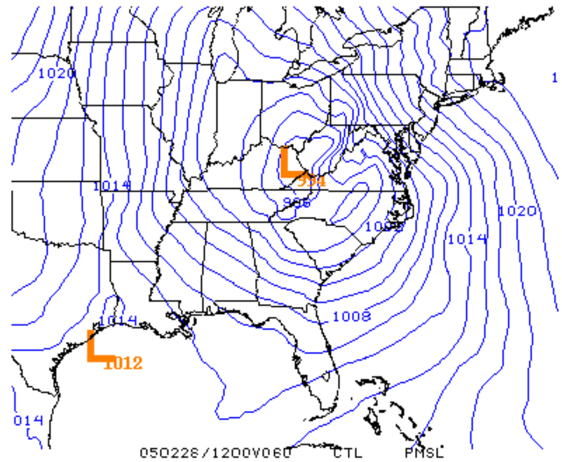

Fig. 2. 60-hour NAM sea level pressure forecasts from the 0000 UTC 26 February 2005 cycle.

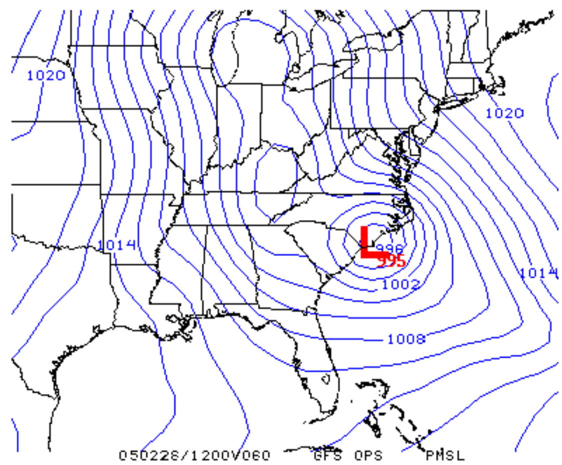

Fig. 3. Same as in Fig.2, except for the GFS model.

Range Ensemble Forecasting, Tracton et al. 1998) system in the late summer of 2004. This system attempts to have greater accounting for the uncertainty in the parameterizations of the models while maintaining the role of initial condition uncertainty. The amount of possible changes to the model physics is infinite; this version of the SREF uses different convective parameterizations. For the Eta (NAM) members, 3 members are run with the Betts-Miller-Janjic (BMJ) convective parameterization (Betts 1988, Janjic 1994) and two members with initial condition perturbations, 3 members are run with the Kain-Fritsch (Kain and Fritsch) scheme (again, 1 control and 2 perturbed), and four runs are made using different versions of the BMJ and KF schemes. The extra BMJ members use a set of more moist reference profiles to delay the onset of deep convection, as the pure scheme tends to overturn too early in the day. The extra KF runs use enhanced detrainment of convective condensate onto the grid scale, again with the goal of delaying the onset of deep convection. There are five RSM members, 2 perturbed runs with the simplified Arakawa-Schubert convective parameterization (SAS) (Arakawa and Schubert 1974) and 3 runs (one control and 2 perturbed) with a relaxed Arakawa-Schubert convective parameterization. (Moorthi and Suarez, 1999)

The mean forecast from the SREF run 3 hours prior to the cycle in question is shown in Fig. 4. With a primary surface low closer to the coast, it certainly promotes a solution more like the GFS than the NAM. It also suggests strong sensitivity to both initial conditions and convective parameterization.

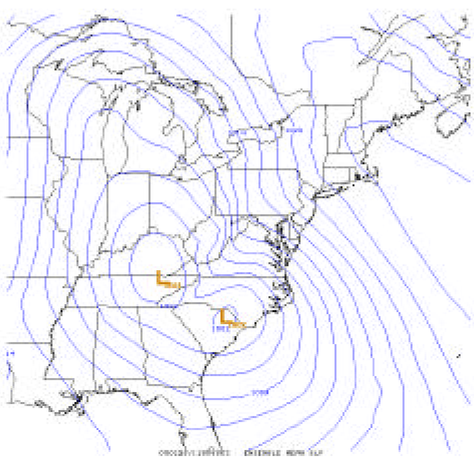

Fig. 4. 63- hour mean seal level pressure forecast for the mean of the 15 SREF members from the 2100 UTC cycle 25 February 2005.

2. INITIAL CONDITION SENSITIVITY

Given the superiority of the GFS run compared to the NAM, the NAM was rerun (at 12 km) using interpolated initial conditions from the GFS. Shown in Fig, 5, the forecast is superior to the control NAM, but it is not quite as good as the GFS run. The primary surface low, though closer to the coast, is still inland, and the run maintains too strong of a system over eastern Tennessee,

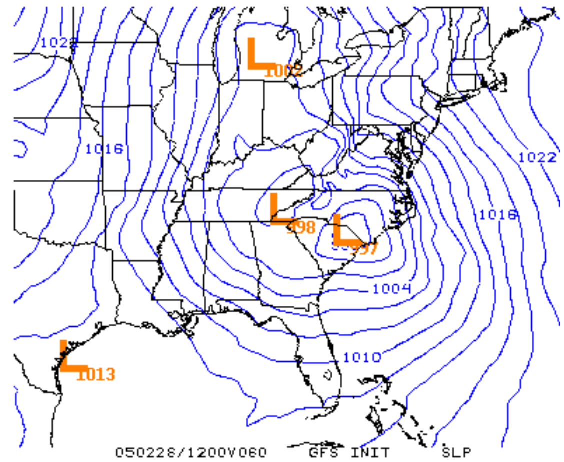

Fig. 5: Same as in Fig. 2, except for the NAM rerun using the initial conditions for the GFS.

The primary source for the disagreement appears to the handling of the evolution of a northern stream trough. Fig. 6 shows the 60-hr-500 mb height error for the NAM run, while Fig. 7 shows the same for the GFS. The NAM run is too high with the heights over the northern Plains and along and east of the mid-Atlantic coast. This allows for amplification of a short wave trough in between these two regions, leading to a small but significant area of too low heights across the Ohio Valley. The coverage and magnitude of the northern Plains and coastal errors is not as great in the GFS run, so the handling of Ohio Valley heights is improved.

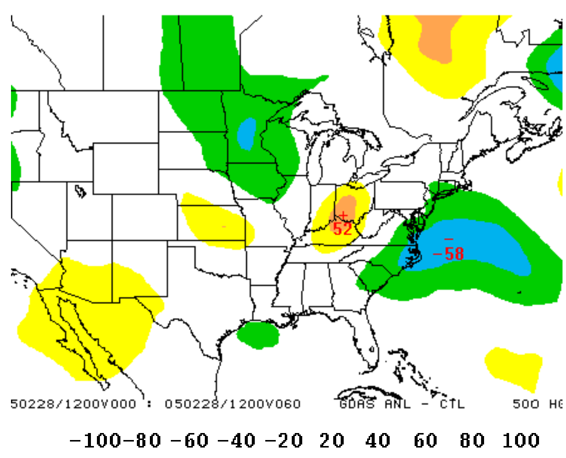

Fig. 6. 500 mb height field from the 60-hour NAM forecast valid 1200 UTC 27 February 2005 subtracted from the GDAS analysis valid at the same time.

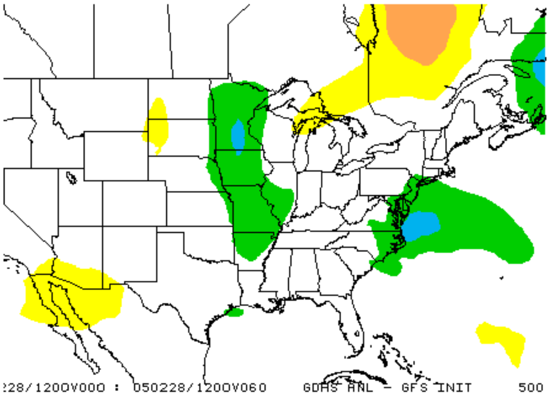

Fig. 7. Same as in Fig. 6, except the first field is the 60-hour GFS forecast.

These differences across the Ohio Valley and the surrounding regions are evident in zoomed-in inspections of 500 mb heights and vorticity. The NAM forecast in Fig. 8 shows a sharper short wave and lower heights around Ohio. The GFS forecast in Fig. 9 shows a sharper short wave trough and more vorticity in the southern stream, as well as a strong vorticity center just off of the Carolina coast. The SREF mean in Fig. 10 agrees with the GFS solution, most easily seen by examining the 540 dam lines.

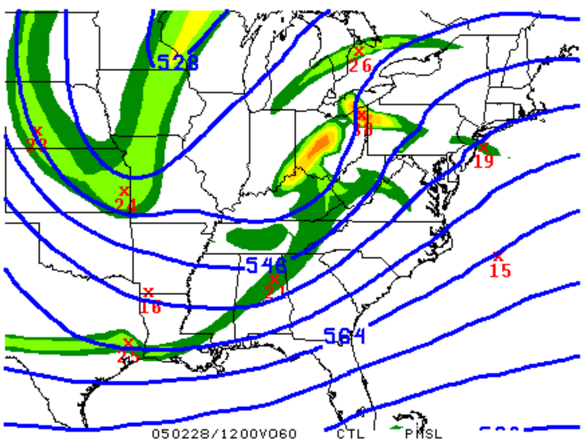

Fig. 8. 60-hour NAM forecast of 500 mb vorticity and heights in dam with a contour interval of 3.

3. CONVECTIVE SCHEME SENSITIVITY

As shown in Manikin et al. (2004), there can be significant feedback from the convective scheme to synoptic features. The NAM (run off of the NAM initial conditions) was rerun with the KF scheme. The forecast in Fig. 11 shows a much better sea level pressure forecast with a.

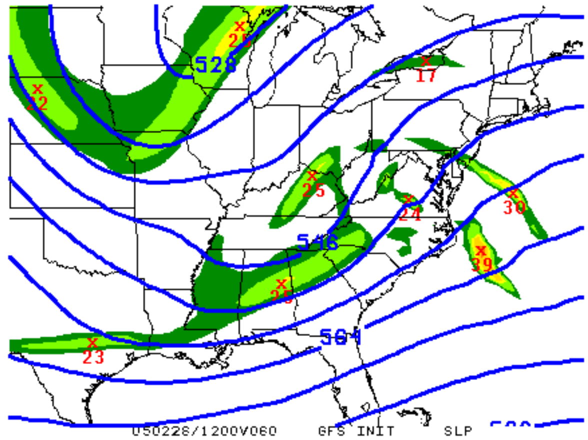

Fig. 9 Same as in Fig, 6, except for the GFS run.

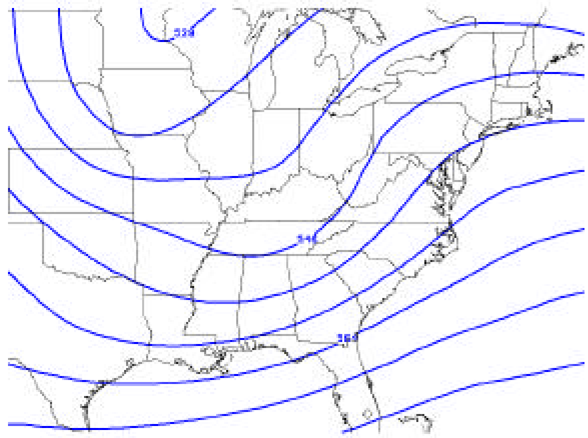

Fig. 10. Same as in Fig. 8, except for the 63-hour 500 mb height forecast from the SREF mean.

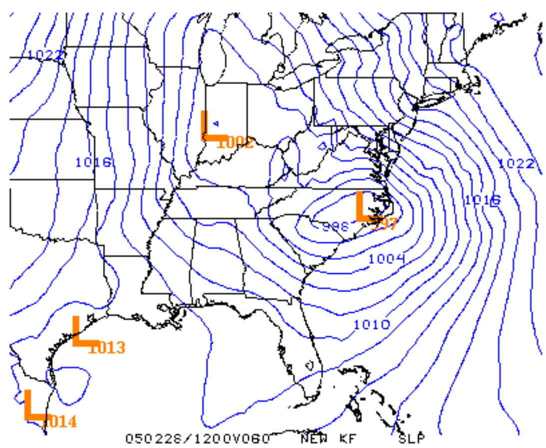

Fig. 11 Same as in Fig. 2, except for the NAM rerun using the Kain-Fritsch convective scheme.

better signal of the primary low pressure center being a coastal storm Oddly, however, the 500 mb height errors for this run shown in Fig. 12 look quite similar to the control BMJ run in Fig. 6. Heights are still too high along the mid-Atlantic coast, and the errors with the Ohio Valley trough are still significant. It is somewhat of a mystery that the KF run produces a better surface forecast.

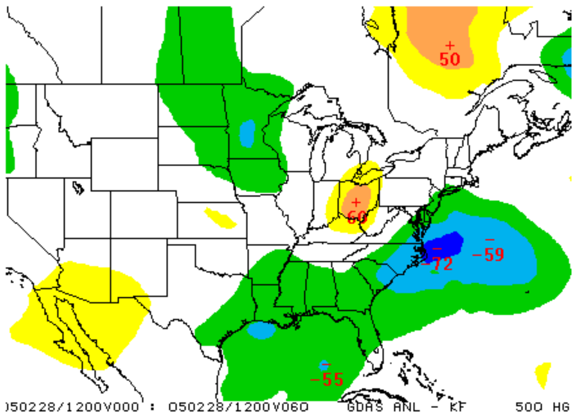

Fig. 12. Same as in Fig. 7, except for the run using the KF convective scheme.

Using the GFS analysis for initial conditions was an improvement over the NAM analysis, and using the KF scheme instead of the BMJ also yielded better results, so one might expect using the GFS analysis **and** the KF scheme in the same run might yield the best results. Fig. 13, however, shows that this is not the case.

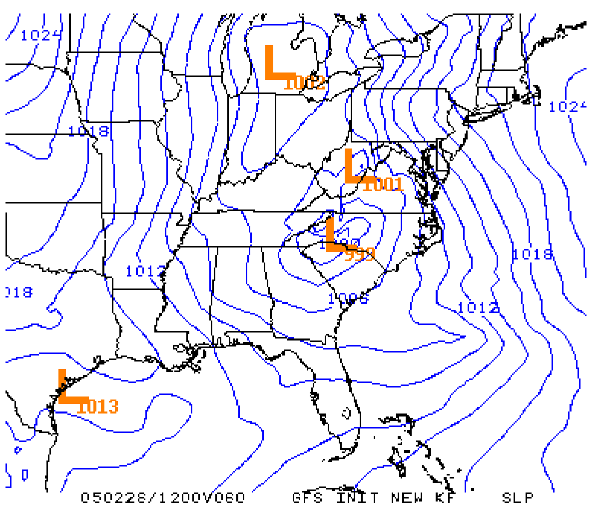

Fig. 13. Same as in Fig. 2, except for the NAM rerun using the GFS initial conditions and the KF scheme.

That said, the internal workings of the KF scheme clearly have a dramatic impact on this case. The first attempt at a rerun using this scheme, shown in Fig. 14, contained an error in which the scheme was not called by the model code nearly as frequently as it should have been. The result is two strong surface lows, one inland over North Carolina and a second over West Virginia. (compare to Fig. 11)

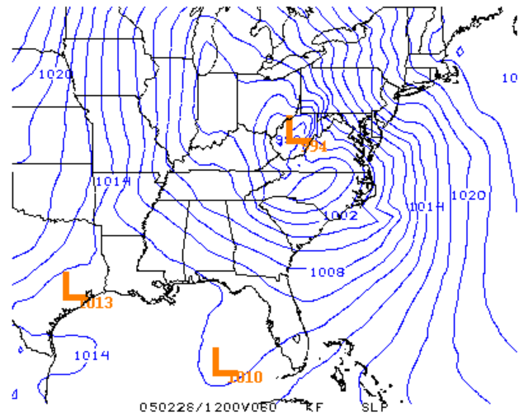

Fig. 14. Same as in Fig.2, except for the NAM rerun made using a version of the code in which the KF scheme was not activated as frequently as it should have been.

4. CONCLUSIONS

The winter storm case of 27-28 February posed many challenges for east coast forecasters, with significant model differences leading to low confidence. There was significant sensitivity to both initial conditions and convective parameterization, with the interactions between the two not well understood at this time. The SREF was valuable in this case for helping sort out differences between the operational NAM and GFS runs. News and updates on changes to the SREF system can be found at http://www.emc.ncep.noaa.gov/mmb/SREF-Docs .

5. REFERENCES

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