National Weather Service
Office of Meteorology

# Technical Procedures Bulletin

**Subject: Changes to the 1999 NCEP Operational MRF/AVN Global Analysis/Forecast System**

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This bulletin was written by Peter Caplan and Hua-Lu Pan of the National Centers for Environmental Prediction. It describes the restoration of the resolution of the model to T170L42 and other changes as implemented on 1200 UTC, 24 January, 2000.

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**U.S.DEPARTMENT OF COMMERCE** **National Oceanic and Atmospheric Administration**

**Changes to the 1999 NCEP Operational MRF/AVN**
**Global Analysis/Forecast System:**

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**The changes described below will be implemented 1200 UTC, 24 January, 2000.**

The currently operational T126L28 MRF Analysis/Forecast System has been restored to a resolution of T170L42. Aside from the upgrade of resolution, there are no other changes to the analysis/forecast system. The changes made on 5 October 1998 (allowing better fits to observations) are carried through in the present implementation. The results shown below concentrate mostly on a comparison of these two models with some reference to the operational model of June-September 1998 which also had a resolution of T170L42.

**1. Verification against analyses:**

The two resolutions were compared side by side in two series of parallel runs, one for over a month in July-Aug of 1998, the other during three weeks of February, 1999. The February results for 500-hPa anomaly correlations for forecast lengths of 0-5 days are shown in **Fig. 1**. The dashed lines(pry) are for the T170; the solid lines(prs) are for the operational T126; Northern Hemisphere is above, Southern Hemisphere below. These results are further broken down by wave numbers in the four panels of each scatter diagram in **Fig. 2**. Here, the markers represent different forecast lengths.

Where the markers lie above the diagonal, the T170 has the higher correlation with the verifying analysis. The average of the above cases is shown in the anomaly correlation die-off curves in **Fig. 3** The solid line (MRF) is the T126; the dotted line (y) is the T170; verifications are against each model's analysis. We believe that the slightly better results of the T170 in the Northern Hemisphere may be the result of the higher horizontal resolution and that a further increase in the future will benefit the winter synoptic scale forecasts. In the southern hemisphere, there the slight advantage at day 3-4 disappears by day 5, which is often seen here for high-resolution models.

The corresponding July-Aug results are shown in **Fig. 4** In this diagram we have also included the then-operational MRF (black), as well as the models of interest, plotted here with a solid green line for the T170 and a dotted red line for the T126. It can be seen that the new models are comparable in the Northern Hemisphere and the T170 a little better in the Southern Hemisphere, and as in the winter cases, the advantage in the Southern Hemisphere disappears by day 5. It is also clear that both new models performed much better than last summer's operational. Comparison of the rms vector wind errors of the two models in the tropics, **Fig. 5**, reveals a somewhat higher error at 850 mb for the T170.

**2. Verification against rawinsonde observations:**

The wind forecasts for the northern hemisphere and for North America are uniformly improved in the T170 in the upper troposphere (100-400 hPa) where the 24-hour rms vector error is about .1 to .2 m/s less than that of the T126 forecasts. The T170 here is comparable to the UK Met Office forecast and slightly better by 72 hours, especially around 400-300 hPa, as can be seen in **Fig. 6**, in which are plotted vertical profiles of rms vector error at 72 hours for the MRF at three resolutions and the UKMO, all verified against rawinsondes. The results shown here for North America are consistent with results obtained for these cases for the Northern Hemisphere and for shorter forecasts. We believe that improvement here of the T170L42 over the MRF (T126L28) is due mainly to increased vertical resolution. In addition, the wind forecasts for the stratosphere, where most of the increased resolution is located, are also uniformly improved. Continued increase in vertical resolution will likely continue the improvement in the jet level wind forecasts. The improvement in the southern hemisphere is negligible.

In the tropics, shown in **Fig. 7**, 72-h forecasts have slightly worse rmse (by about .1-.2 m/s for all levels). The errors in these profiles are generally larger than those shown in Fig. 5, since the verification here is against rawinsondes rather than analyses. For temperature forecasts (not shown) there is uniform improvement in the tropics as well as in the Northern Hemisphere (.1-.2 K rmse difference at hour 72).

**3. Short-term precipitation forecasts for North America:**

The 12-36 hour quantitative precipitation scores for the T170L42 tests were about the same as for the T126L28. QPF scores are better for some amounts and worse for others. The test period were too short to do a definitive test of this aspect. We did not expect the scores to differ only due to the resolution increase.

**4. Summer tropical cyclone forecasts:**

While the then-operational T170L42 model did very poorly for the summer 1998 season, the corrected T126L28 (implemented in October 1998) and the new T170L42 both did much better. In terms of false alarm storms in the initial conditions, the corrections in the October implementation have dramatically reduced that problem (false alarm during from 23 July to 31 October 1998 was 27 for the old operational system, 5 for the new T126L28 system and 7 for the new T170L42 system). The model tropical storms were stronger in the new T170 than in the new T126 and had a larger error against rawinsonde observations and an increase of false alarm storms in the forecasts during the August tests. However, the track errors with the higher resolution were somewhat better as can be seen from the diagrams created by Tim Marchok, **Fig. 8**. which show the new model (PRT126 and PRT170) tracks and old (15AVNFO and 16MRFO). In addition, the initial conditions generated during the summer rerun were used to initialize the GFDL hurricane model and resulted in significant increase in skill in the track forecasts compared to the then-operational model in the two available cases, shown in a diagram made by Morris Bender of GFDL, **Fig. 9**.

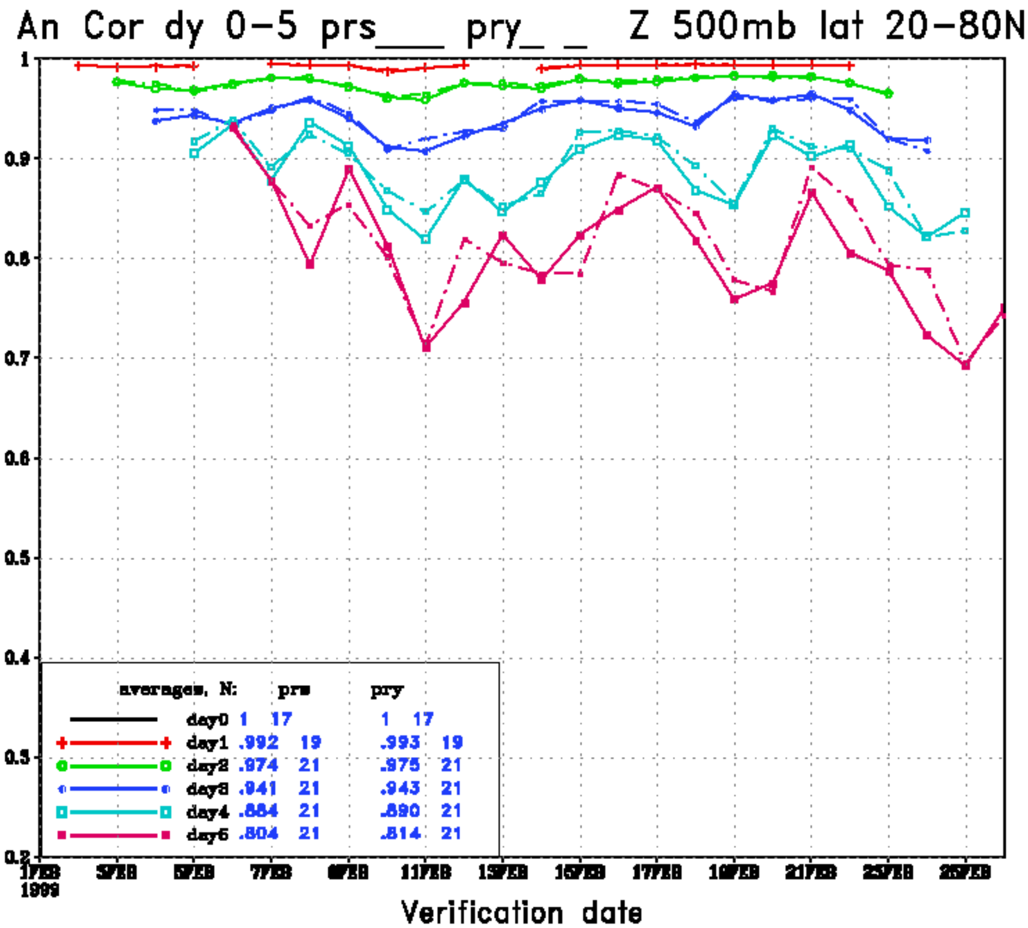


Figure 1a - Time series of 500-mb anomaly correlations for geopotential for forecast lengths of 0 through five days. The solid lines (prs) are the T126; the dashed (pry), T170 for the Northern Hemisphere.

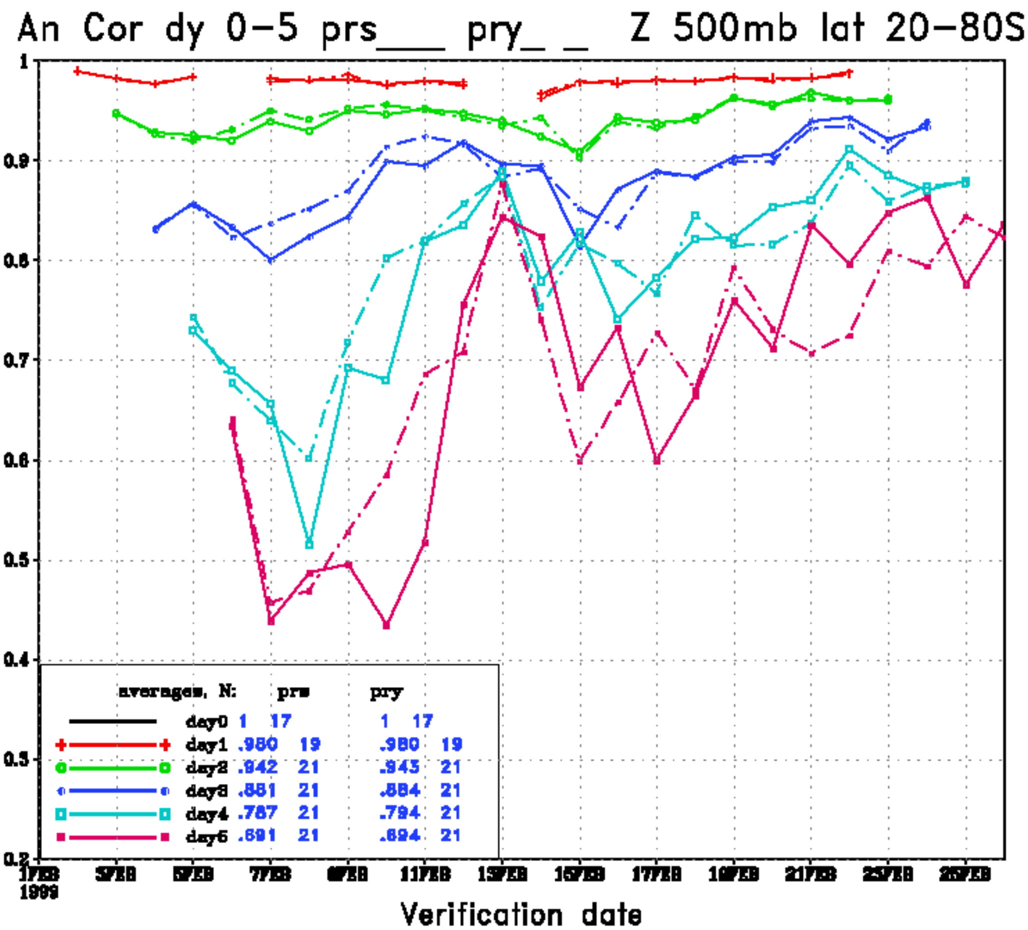


Figure 1b - Time series of 500-mb anomaly correlations for geopotential for forecast lengths of 0 through five days. The solid lines (prs) are the T126; the dashed (pry), T170 for the Southern Hemisphere.

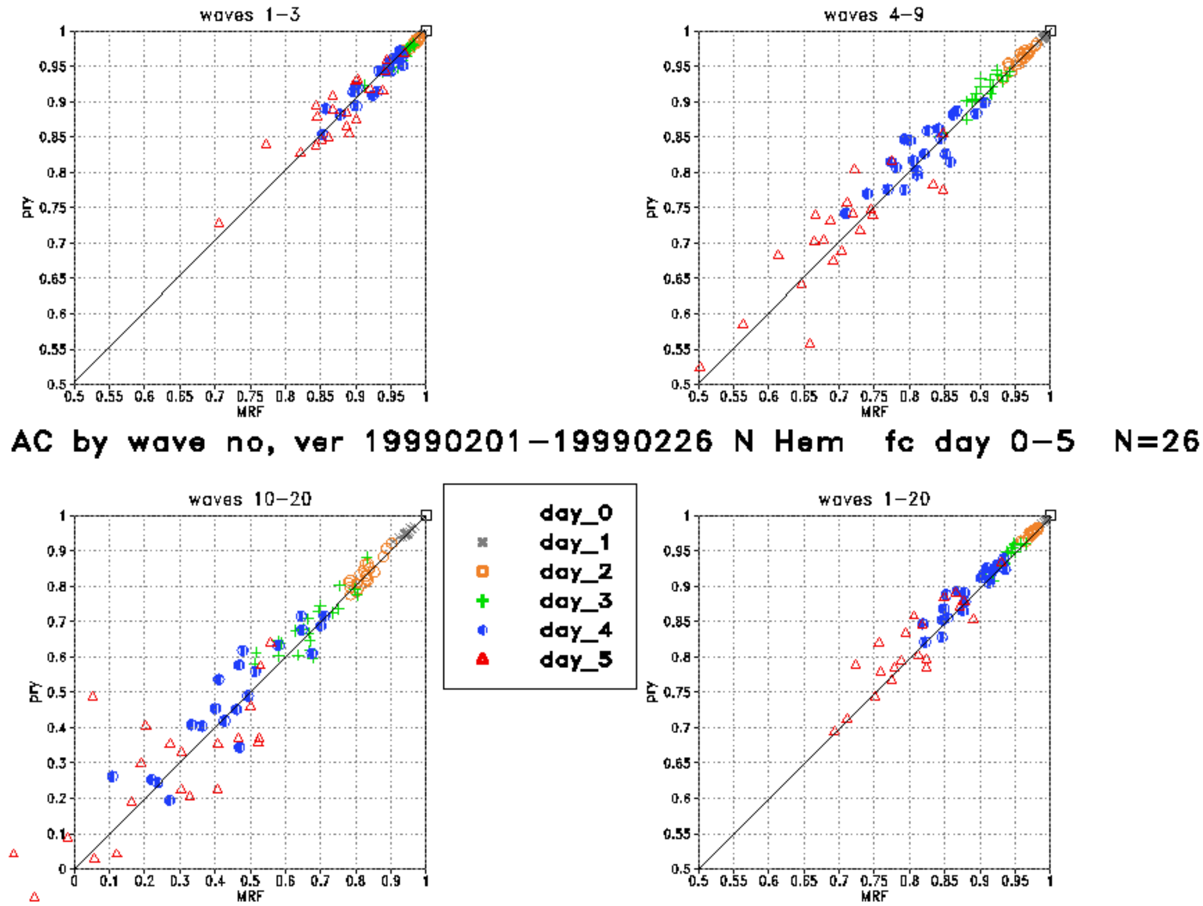


Fig. 2a - Scatter plots of 500-mb anomaly correlations (T170 vs. T126) for geopotential as a function of zonal wave number group (one group in each panel) and forecast length (markers of different colors). Where the markers lie above the diagonal, the T170 is better; For the Northern Hemisphere.

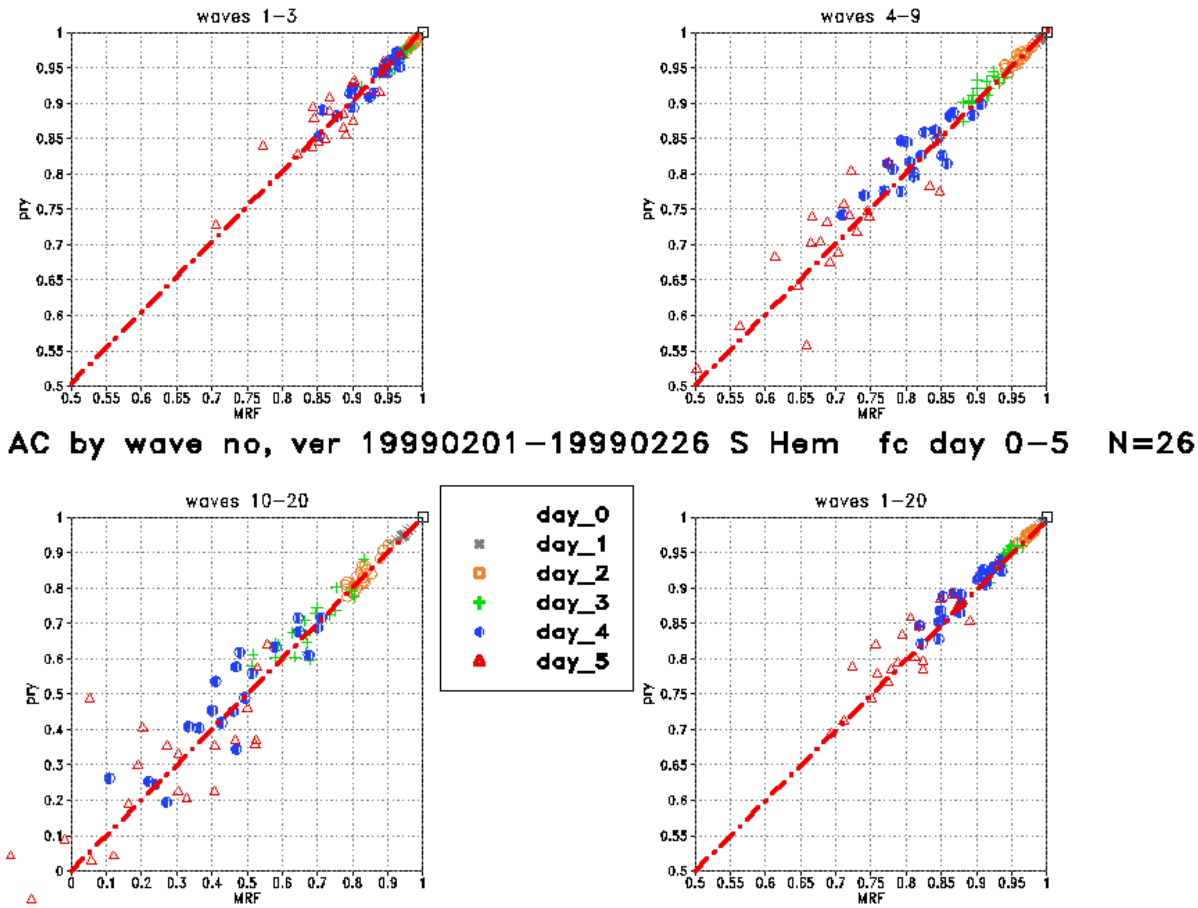


Fig. 2b - Scatter plots of 500-mb anomaly correlations (T170 vs. T126) for geopotential as a function of zonal wave number group (one group in each panel) and forecast length (markers of different colors). Where the markers lie above the diagonal, the T170 is better. For the Southern Hemisphere.

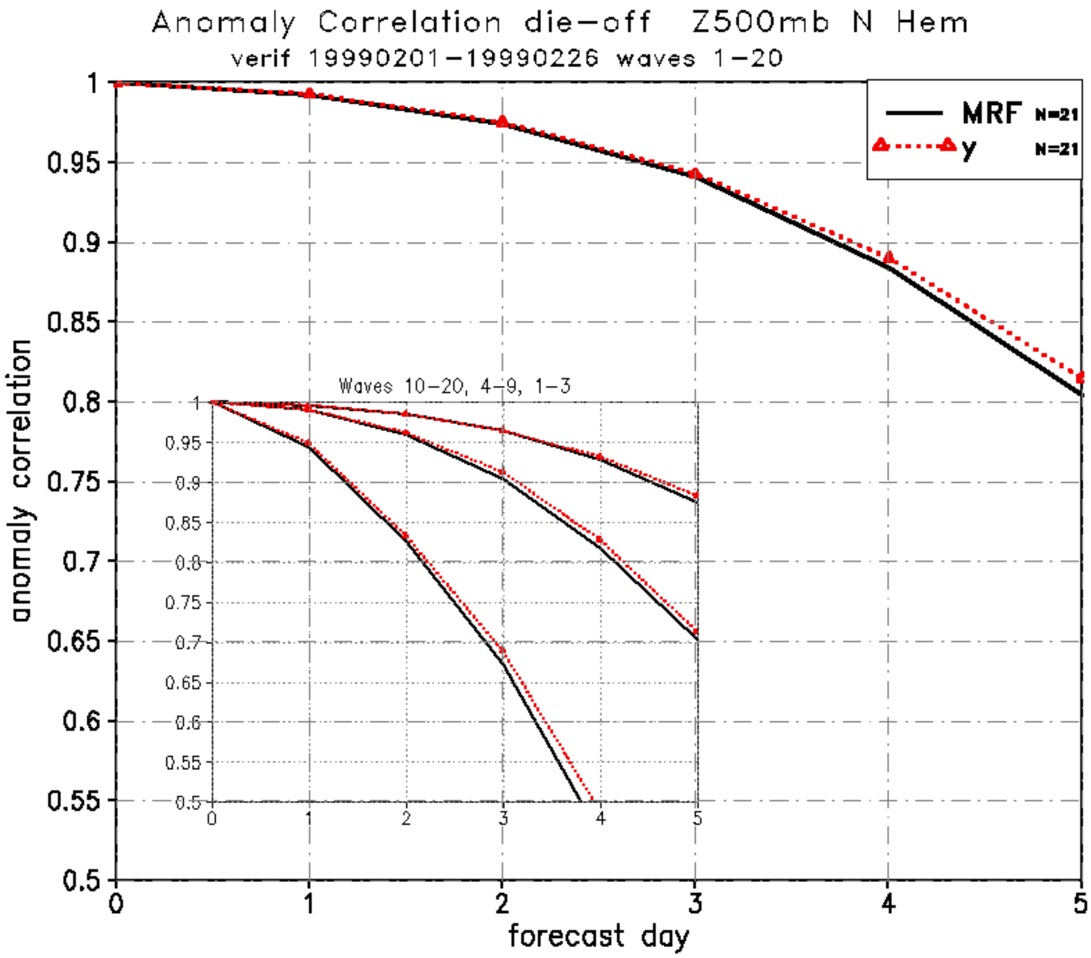


Fig. 3 Decay curves of 500-mb anomaly correlations (T170 vs. T126) for geopotential as a function of forecast length, averaged over all February cases (N=21) for the Northern Hemisphere.

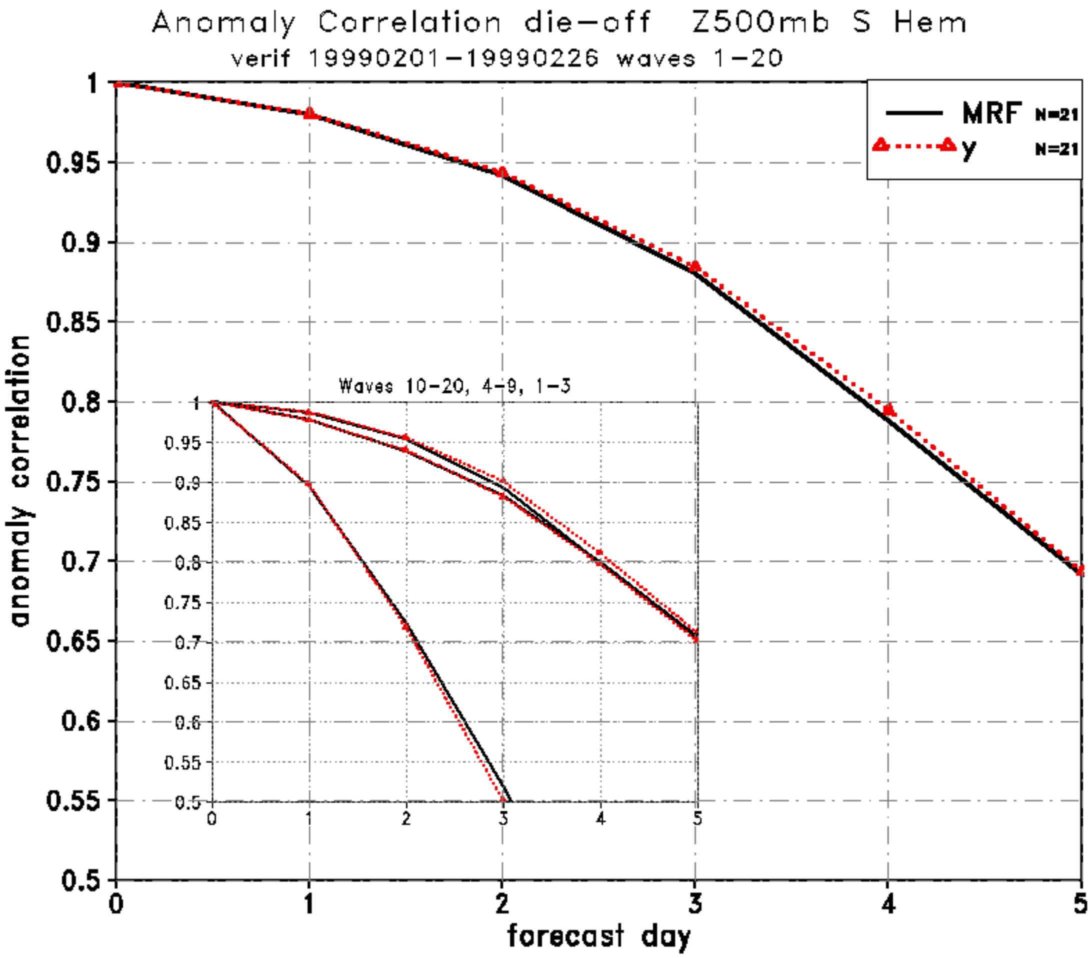


Fig. 3 - Decay curves of 500-mb anomaly correlations (T170 vs. T126) for geopotential as a function of forecast length, averaged over all February cases (N=21). For the Southern Hemisphere.

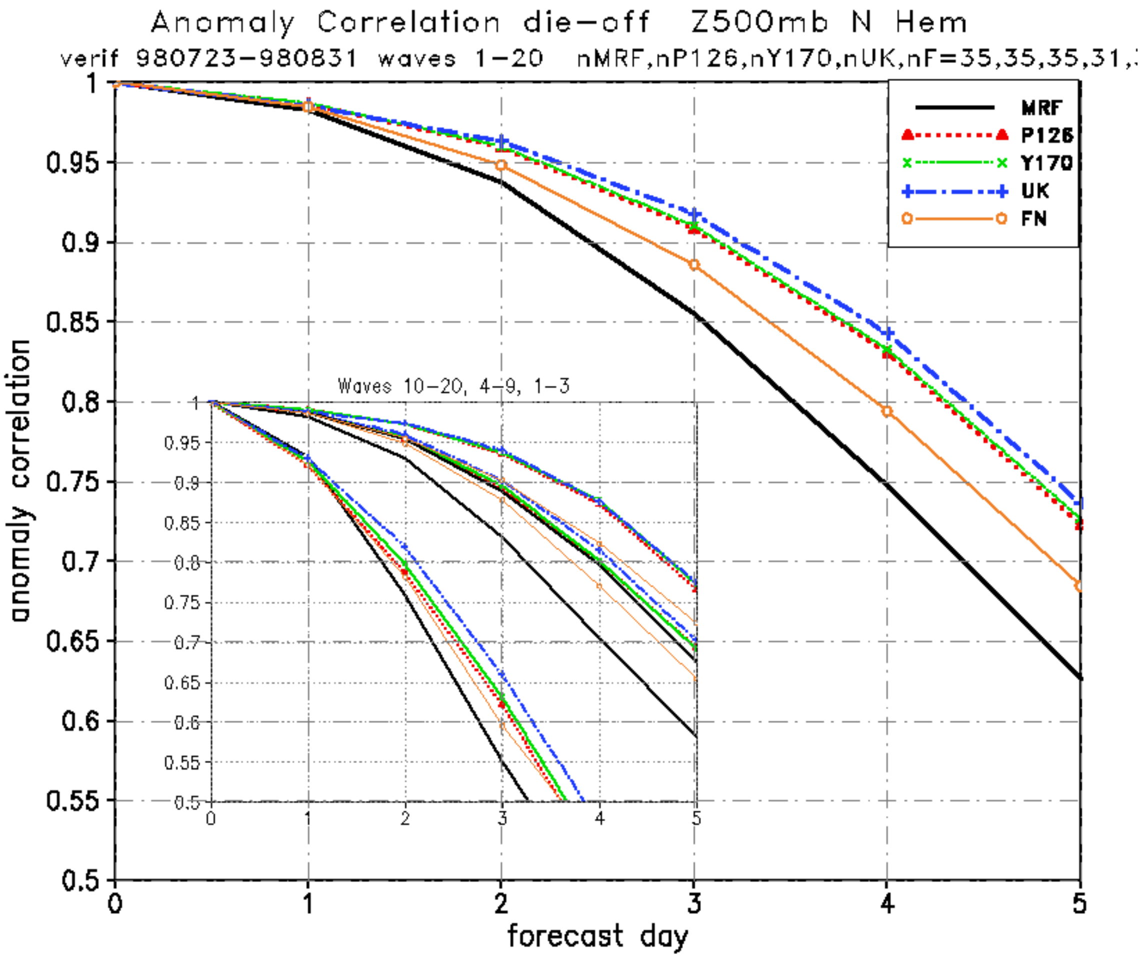


Fig. 4a - Decay curves of 500-mb anomaly correlations for geopotential as a function of forecast length, averaged over all July-Aug cases (N=35). Northern Hemisphere on top, Southern Hemisphere on the bottom. The three models of interest are the then-operational T170 MRF in black and the new T126 and T170 corrected versions under consideration here. The dotted red lines are the T126; the solid green lines are new T170. For the Northern Hemisphere is on top as in Fig. 3.

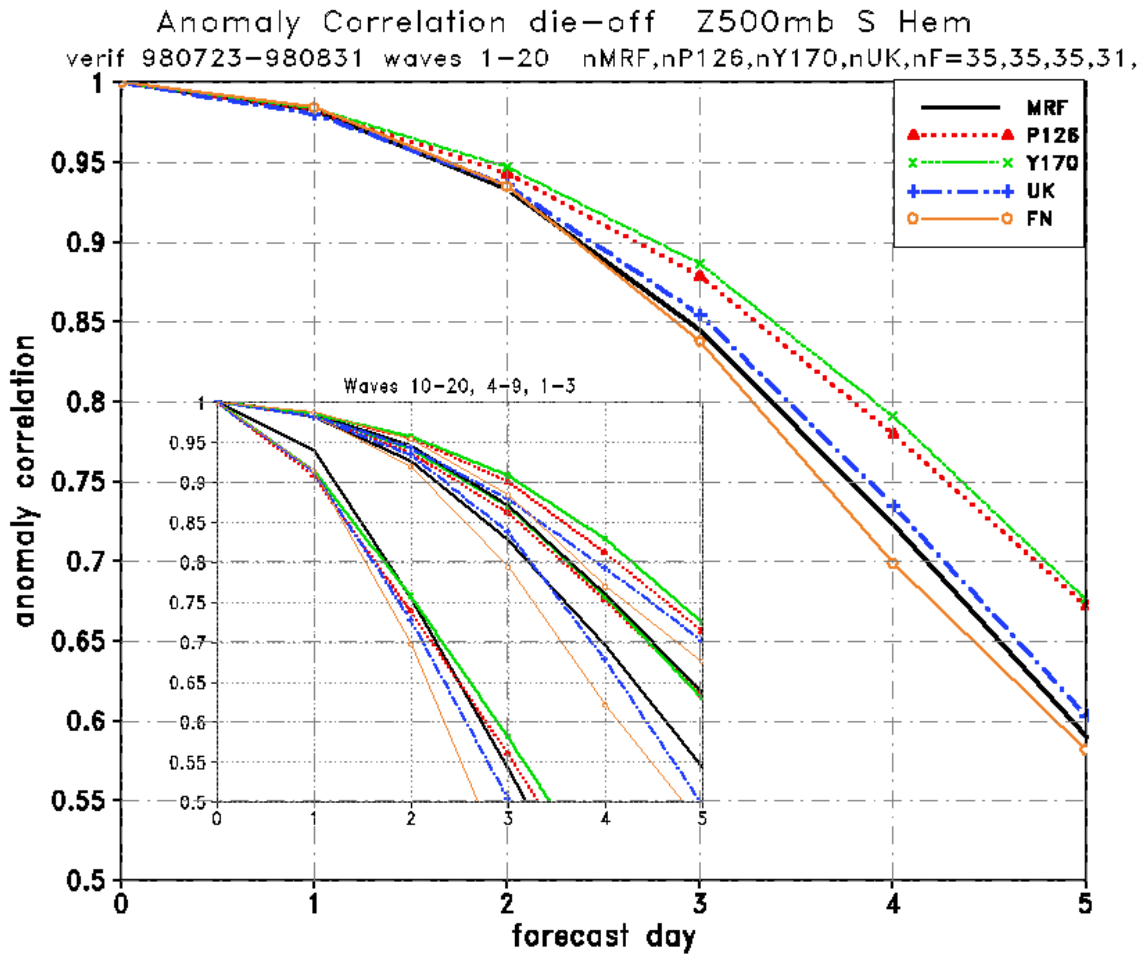


Fig. 4b - Decay curves of 500-mb anomaly correlations for geopotential as a function of forecast length, averaged over all July-Aug cases (N=35). Northern Hemisphere on top, Southern Hemisphere on the bottom. The three models of interest are the then-operational T170 MRF in black and the new T126 and T170 corrected versions under consideration here. The dotted red lines are the T126; the solid green lines are new T170. For the Southern Hemisphere as in Fig. 3.

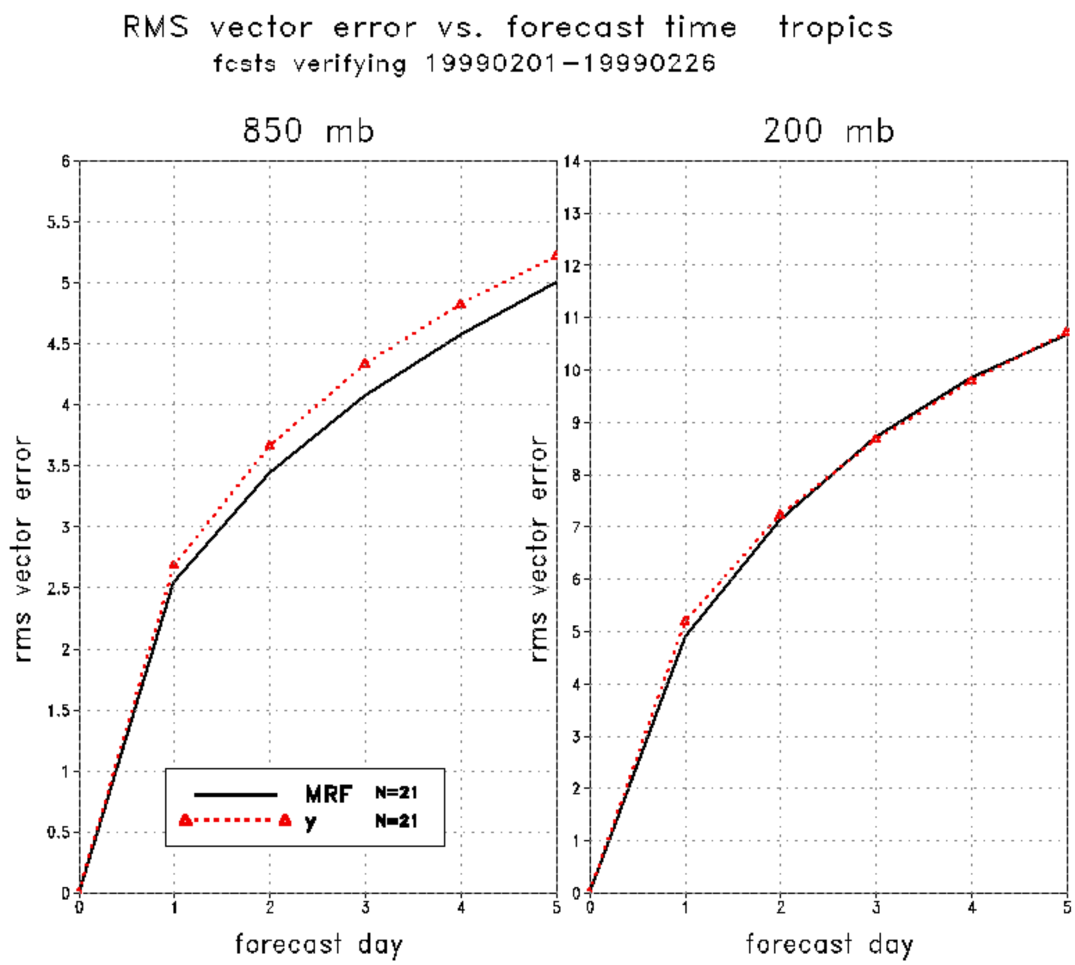


Fig. 5 - Growth curves of rms vector wind error in m/s for resolution T170 (dotted) vs T126, as a function of forecast length, averaged over all February cases (N=21).

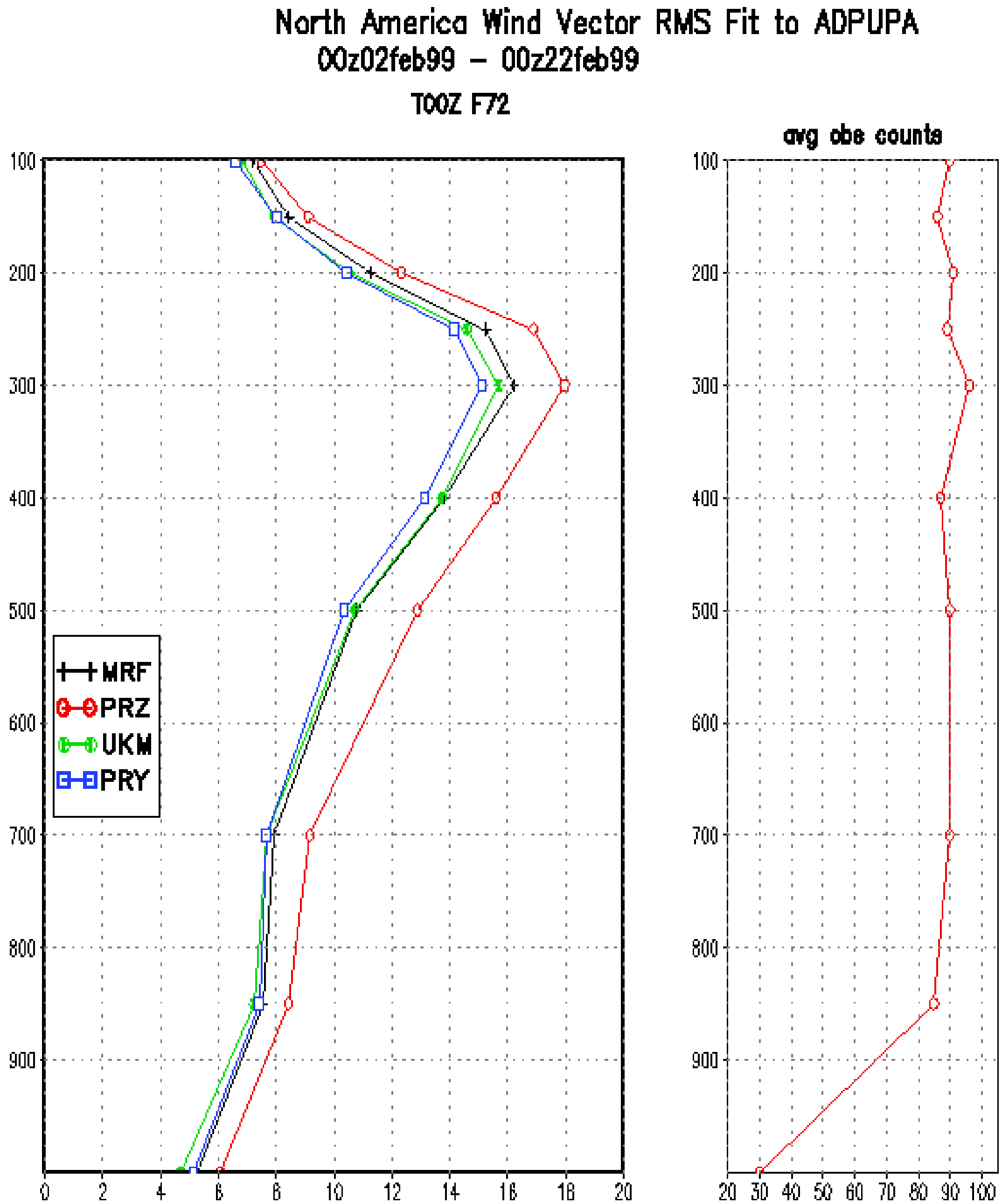


Fig. 6 - Vertical profiles of rms vector wind error (m/s) over N. America for forecasts of 72 h for resolutions of T170 (blue), T126 (black), T62 (red) and the UKMO (green) averaged over all February cases (N=21).

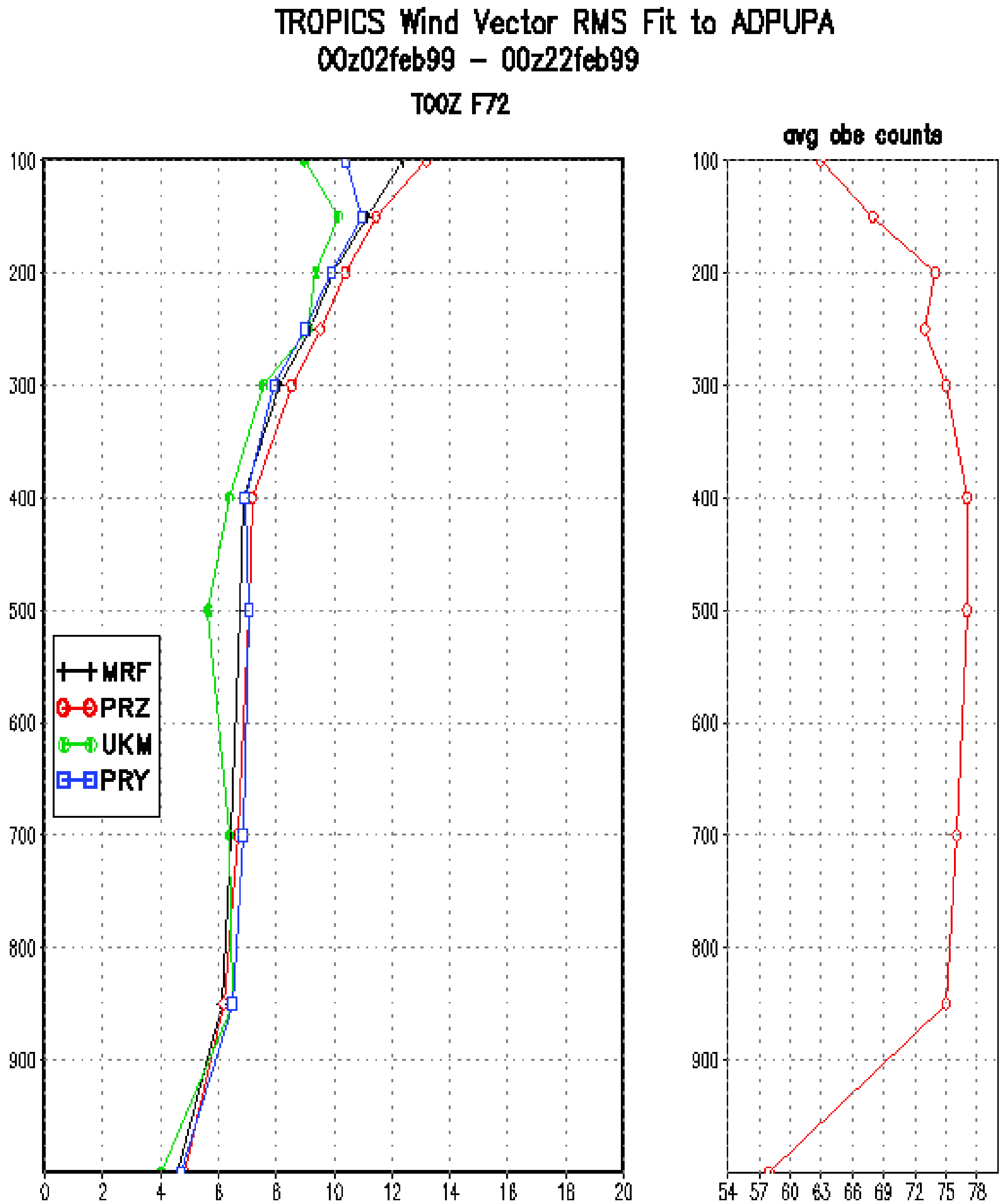


Fig. 7 - Vertical profiles of rms vector wind error (m/s) at 72h as in Fig. 8, but for the tropics (20S-20N).

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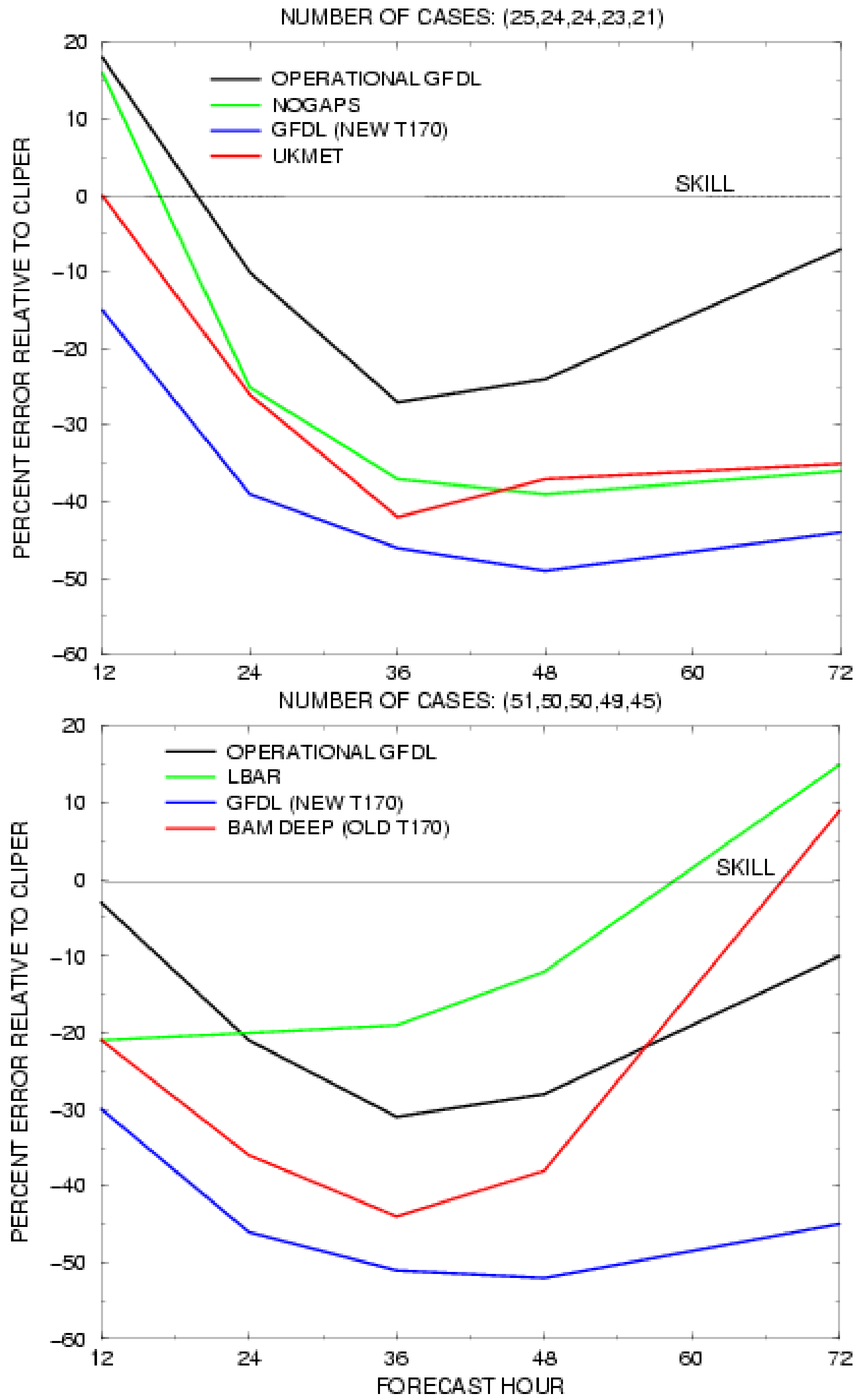


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