P3.3

REGIONAL AND GLOBAL NWP OBSERVING SYSTEM DATA DENIAL EXPERIMENTS USING NCEP OPERATIONAL MODELS

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1. INTRODUCTION

Through collaboration with personnel from the National Centers for Environmental Prediction (NCEP), the Cooperative Institute for Meteorological Satellite Studies (CIMSS) has maintained the capability to run impact studies of all data types used in the Eta Data Assimilation/Forecast system (EDAS) since 1997. These impact studies have for the most part been completed locally at CIMSS using a workstation version of the EDAS. From project onset, a primary goal of the CIMSS EDAS effort has been to maintain a system that is consistent with the operational EDAS, both in terms of the assimilation methodology and forecast model.

If consistent with the NCEP operational algorithms, the EDAS running at CIMSS is a viable source for parallel runs that can be used to investigate the impact of current and planned satellite data sources on operational numerical weather prediction models. Such studies have allowed a better understanding of how to utilize current and future in-situ and remotely sensed data types in present-day three-dimensional assimilation systems.

More recently, CIMSS has been granted permission to undertake denial studies in the NCEP Global Forecast System (GFS). The methodology used in these studies is nearly identical to the studies performed in the EDAS. There are several advantages of the global studies over the previously completed regional EDAS studies. First, the global experiments remove contamination from the lateral boundary conditions of the model. Second, the global studies allow investigation of data types not available within the regional EDAS domain.

While in its early stages, the global studies have already identified results of interest about existing data types. These studies also have the ability to provide impact studies of new data types coming on-line in the future before they are accepted into the operational data stream. Finally, perhaps the biggest advantage of these global studies is that appropriate computer time was allocated such that they are computed at the operational resolution of the model. Prior to this study, both computer

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and human resources limited the ability of NCEP personnel to complete such studies.

1.1 EDAS Background

All EDAS simulations reported here were executed at the resolution NCEP was using for their parallel development at the time their operational version of the EDAS, which included radiance assimilation, came online. As such, these experiments were run at 32 km horizontal resolution with 60 vertical levels and in a manner identical to NCEP's parallel tests. Initial data and boundary conditions were obtained twice-daily from NCEP's parallel runs with the assistance of Eric Rogers and Dennis Keyser.

Experiments were run on the native Eta model E-grid, but all results were interpolated to, diagnosed and displayed on either the 91 km NGM Super C grid (104 grid, NCEP Office Note 388) or the AWIPS regional 40 km grid covering the continental United States and adjacent costal waters (CONUS 212 grid, NCEP Office Note 388). Horizontal and vertical interpolations of the Eta model variables to isobaric surfaces and diagnostic grids were performed within the NCEP Eta post-processor (Treadon 1993).

1.2 GFS Background

The GFS simulations studied have been within periods which span 1 January to 15 February 2003 and 1 August to 20 September 2003 and executed at the resolution equivalent to NCEP's operational resolution out to 17 days. These resolutions are T254 with 64 vertical levels out to 84 hours, T170 with 42 vertical levels to 180 hours and T126 with 28 vertical levels to completion.

The forecast model was identical to NCEP's operational model as of late 2003. The Spectral Statistical-Interpolation Analysis System (SSI) originally developed by Parrish and Derber (1992) was nearly identical to NCEP's operational SSI. The only difference between the SSI versions was that for the experiment herein, the SSI was setup to assimilate the Atmospheric Infrared Sounder (AIRS) data (which were not used).

Initial conditions and all data assimilated during this experiment were taken from NCEP's operational archives. The transformation from spectral to grid space and the anomaly correlation calculations were done using NCEP's post processing and verification software.

2. EDAS RESULTS

In this work the EDAS studies used four 15 day time periods, one during each season of the year. The time periods were 24 October to 7 November 2001, 15-31 January 2002, 12-26 April 2002 and 24 June to 07 July 2002.

During these time periods the EDAS was run with a control atmosphere which included all data types used in the EDAS at the time as well as nine twice daily experiments. In the experiments one data type at a time was removed from the EDAS. The nine data types removed included rawinsonde mass (RAOBM), rawinsonde wind (RAOBW), SSM/I wind (SSMIW), SSM/I precipitable water (SSMIPW), AMSU radiances, HIRS radiances, GOES wind (GOESW), GOES radiances (GOESM) and MSU radiances.

The twice daily forecast differences from the control simulation were then summed for the four seasons discussed above and presented in the bar charts of Fig. 1. This figure displays the percent improvement of the forecast with the data included over the entire horizontal Eta model Domain. The four-season summary of all experiments on the 212 grid is not shown, since those results are quite similar to the 104 grid results just presented. They are also discussed in detail in Zapotocny et al. (2004a and b).

In Fig. 1, the GOESM, HIRS and MSU impacts are negligible for all fields and levels displayed. AMSU data is almost always the largest contributor, with the GOESW contribution comparable in size to the RAOBW contribution. RAOBW is also larger than RAOBM. These statements are further substantiated by the seven level average displayed near the top of each data box in Fig. 1. Finally, of all values presented in Fig. 1, only HIRS and SSM/IW data provide any degradation to the 24-hr forecast over the four season average.

The columns labeled RAOB, GOES and POES in Fig. 1 are the contribution when all the sub-component data types are removed at once. For example, the RAOB column is when both RAOB winds (RAOBW) and RAOB mass (RAOBM) are removed at once. This set of experiments represents what would happen if all rawinsonde data were removed at once or if several satellites failed simultaneously. Note that the effect of the components rarely sums to the aggregate denial.

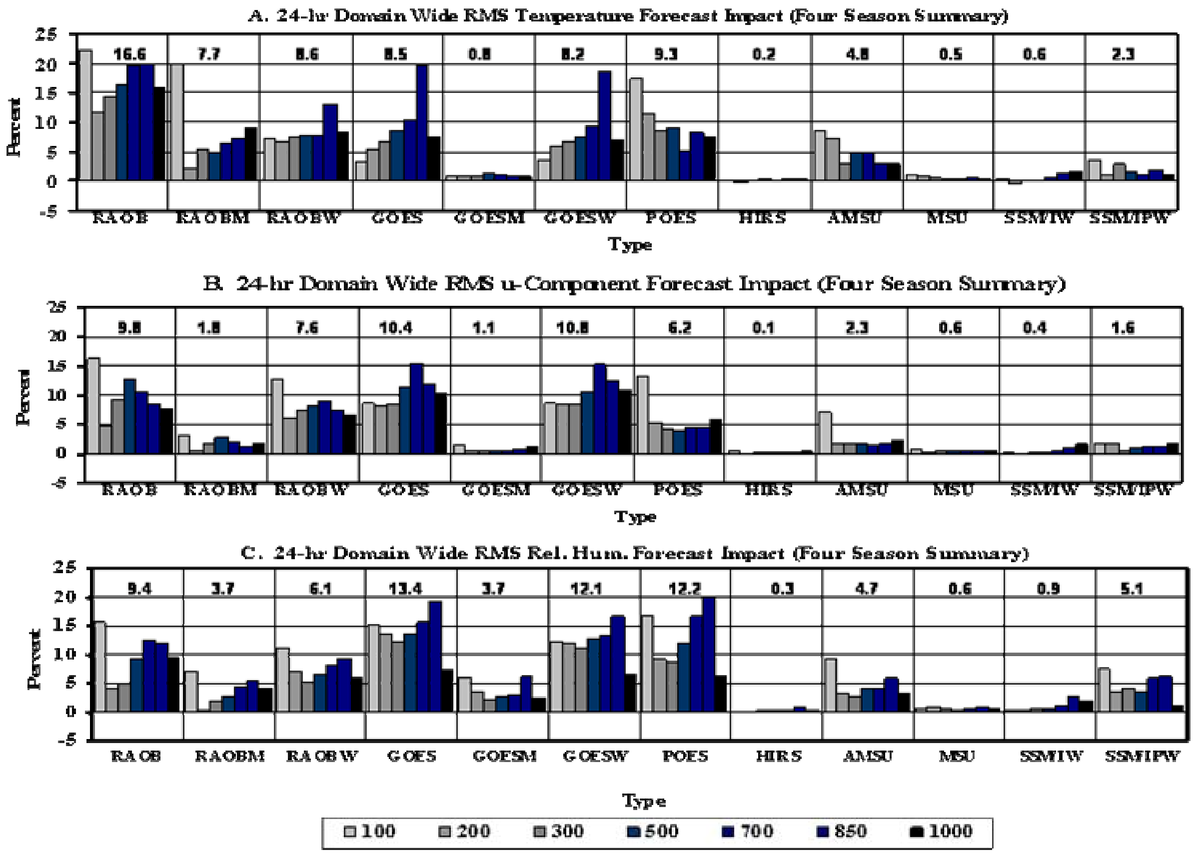

Fig. 1 The four season summary of RMS forecast impact (%) on the 104 grid for (a) temperature, (b) u-component and (c) relative humidity, after 24-hrs of Eta model integration. The three aggregate denials (RAOB, GOES and POES) and the nine individual denials are shown. The 104 grid is a 91 km grid covering almost the entire EDAS horizontal domain. The seven levels per data type proceed from the lower stratosphere on the left (gray) to near the earth's surface on the right (blue).

3. GFS RESULTS

Simulations completed include a variety of data sets during two seasons. The time periods studied span 1 January to 15 February 2003 and 1 August to 20 September 2003. The northern hemisphere summer time period is slightly longer than its winter counterpart in order to capture several tropical cyclone features of interest. Specifically, hurricane Isabel is included in the summer time window.

During these time periods the GFS was run with a control atmosphere which included all data types used in the GFS, then one data type was removed at a time, similar to the EDAS experiment methodology.

Forecast impacts are evaluated over both the entire domain and within the subsections traditionally verified for the GFS (20^{o}-80°North and South Latitude). Since these simulations are integrated to 17 days, a temporal evaluation of the forecast impact is also completed. A time series of 500 hPa geopotential height Anomaly Correlations (AC) for 20^{o}–80^{o} North and South for the control experiment, AMSU denial and HIRS denial are shown in Fig. 2. These results were truncated to isolate waves 1-20 only.

Fig. 3 shows the 31 day average difference in Sea Level Pressure (hPa) for the day 5 forecast between the Control and the AMSU denial simulations. Similar to the EDAS results, AMSU is a major contributor to forecast skill while the HIRS contribution continues to be small.

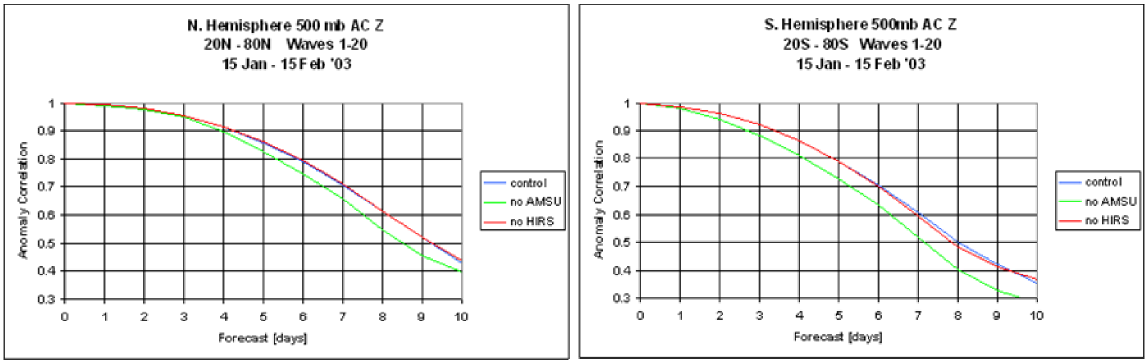

Fig. 2. A time series of Northern (20°N to 80°N) and Southern (20°S to 80°S) hemisphere 500 hPa geopotential height anomaly correlation coefficients for 15 January–15 February 2003. These results are truncated to isolate wave numbers 1-20. The control is displayed in blue, the AMSU denial is in green and the HIRS denial is in red.

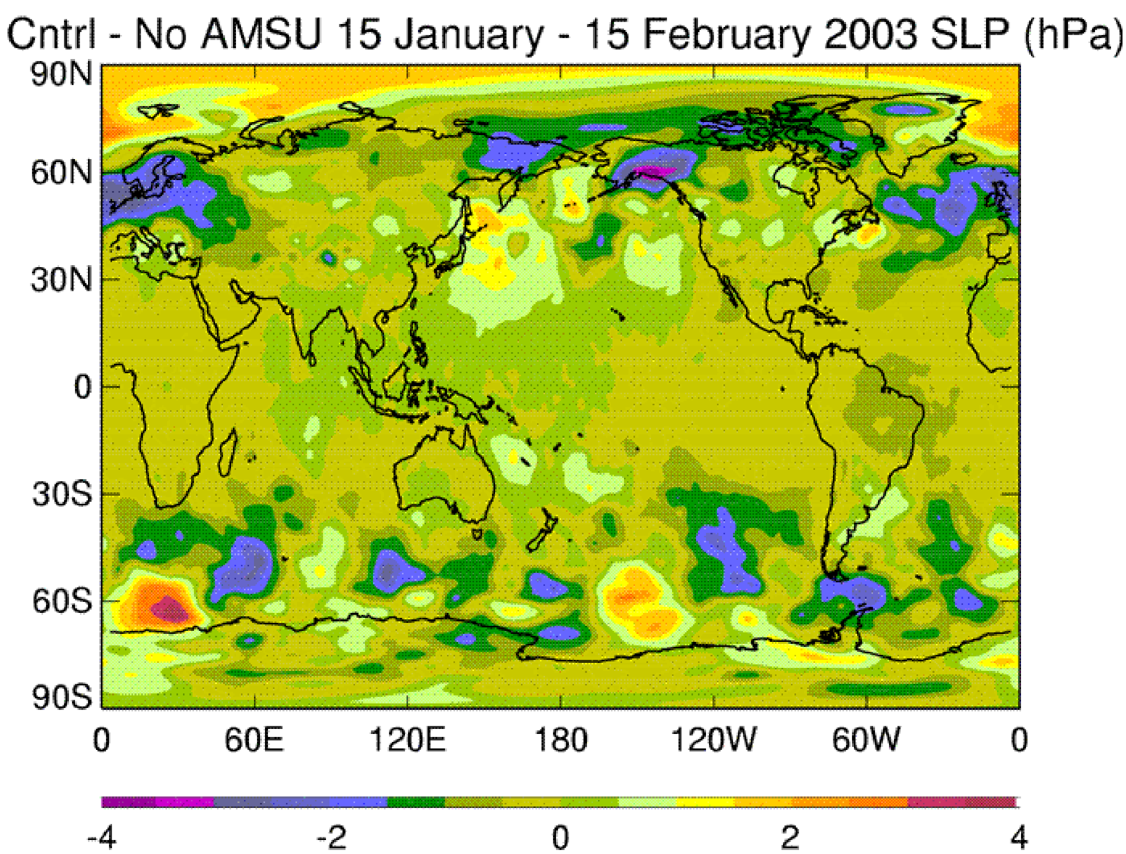

Fig. 3. The day 5 difference in Sea Level Pressure forecast (hPa) between the Control and the AMSU denial averaged for 15 January to 15 February 2003

4. SUMMARY

The impact of in-situ and remotely-sensed observations is being studied quantitatively at CIMSS via model data denial experiments, using both the regional (EDAS) and global (GFS) models supplied by NCEP. Each model was run either at or as close to NCEP's operational resolution as possible with the input data used by the operational runs. The model runs included a control run, which utilized all data types routinely assimilated and the subsequent denial of a particular data type.

Results indicate that the GOESM, HIRS and MSU impacts are small for all fields and levels displayed from the EDAS. AMSU data is almost always the largest contributor, with GOESW and ROABW also having large contributions.

Of the few runs completed with the GFS so far, results are consistent with the EDAS. AMSU has the greatest forecast impact, while the HIRS impact is small.

5. ACNOWLEDGEMENTS

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6. REFERENCES

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