Impact of Loss of Microwave and Radio Occultation Observations in Operational Numerical Weather Prediction in Support of the US Data Gap Mitigation Activities

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Motivation

- ATMS observations on Suomi-NPP were assimilated into the operational NCEP's global data assimilation system starting in May 2012
- Suomi-NPP was placed in early afternoon orbit, providing similar information to the existing polar orbiting satellites with MW sounders (AMSU-A and MHS on NOAA-18/19, AMSU-A on Aqua, and AMSU-A on NOAA-15)
- As a consequence, previous studies showed in general neutral impact of ATMS in the NCEP's system
- Due to the delay in the launch of JPSS-1, a "gap" or significant reduction in the U.S. MW satellite data is possible
- MW soundings are consistently the number one observing system contributing to NWP forecast accuracy
- In addition, there might a significant loss of RO observations
- RO observations are complementarity to MW and IR observations and have been shown a significant positive impact on global NWP forecasts worldwide

Motivation (cont'd)

- Goal of the study is to investigate the impacts on the skill of NCEP global forecasts due to a loss of the NOAA and AQUA MW and all RO soundings
- Two extreme scenarios are considered
  - MW instruments from NOAA-15/18/19 and AQUA have not reached the end of their life before JPSS-1 is launched
  - MW instruments from NOAA-15/18/19 and AQUA are lost before JPSS-1 is launched
- Evaluate the impact of losing all RO observations in both extreme scenarios
- Results of the study might be considered pessimistic (worse case) as all systems are not likely to fail before there are some replacements
- Extreme cases will indicate relative importance of these losses – will provide significant signal

Experiment Design

Experiment	Description
1 CTL	Control experiment, March-April 2013 operational NCEP's global data assimilation system.
2 noRO	*CTL* without RO observations
3 noATMS	*CTL* without ATMS observations
4 noUSAMSU	*CTL* without AMSU-A/MHS on NOAA-18/19, AMSU-A on Aqua, and AMSU-A on NOAA-15
5 ATMS Only	*CTL* without AMSU-A/MHS on NOAA-18/19, AMSU-A on Aqua, AMSU-A on NOAA-15, and RO
6 RO Only	*CTL* without AMSU-A/MHS on NOAA-18/19, AMSU-A on Aqua, AMSU-A on NOAA-15, and ATMS

Experiment Design (cont'd)

- All forecasts begin at 00 GMT and ran for 8 days from 21 February to 30 April 2013. The first seven days are used for model spin-up and the forecast comparisons cover the period 28 February – 30 April 2013
- Horizontal resolution of the operational NCEP's global data assimilation system at the time of this study is T574 (~ 27 km) with 64 levels in the vertical
- All the experiments used the hybrid version of the NCEP's global data assimilation system
- RO observations (~ 0.4 M/day) versus U.S. MW observations (~ 2.1 M AMSU-A/day)
- Results of this study are a summary of paper submitted to *Weather and Forecasting* and in review

AC 250-mb Temperature

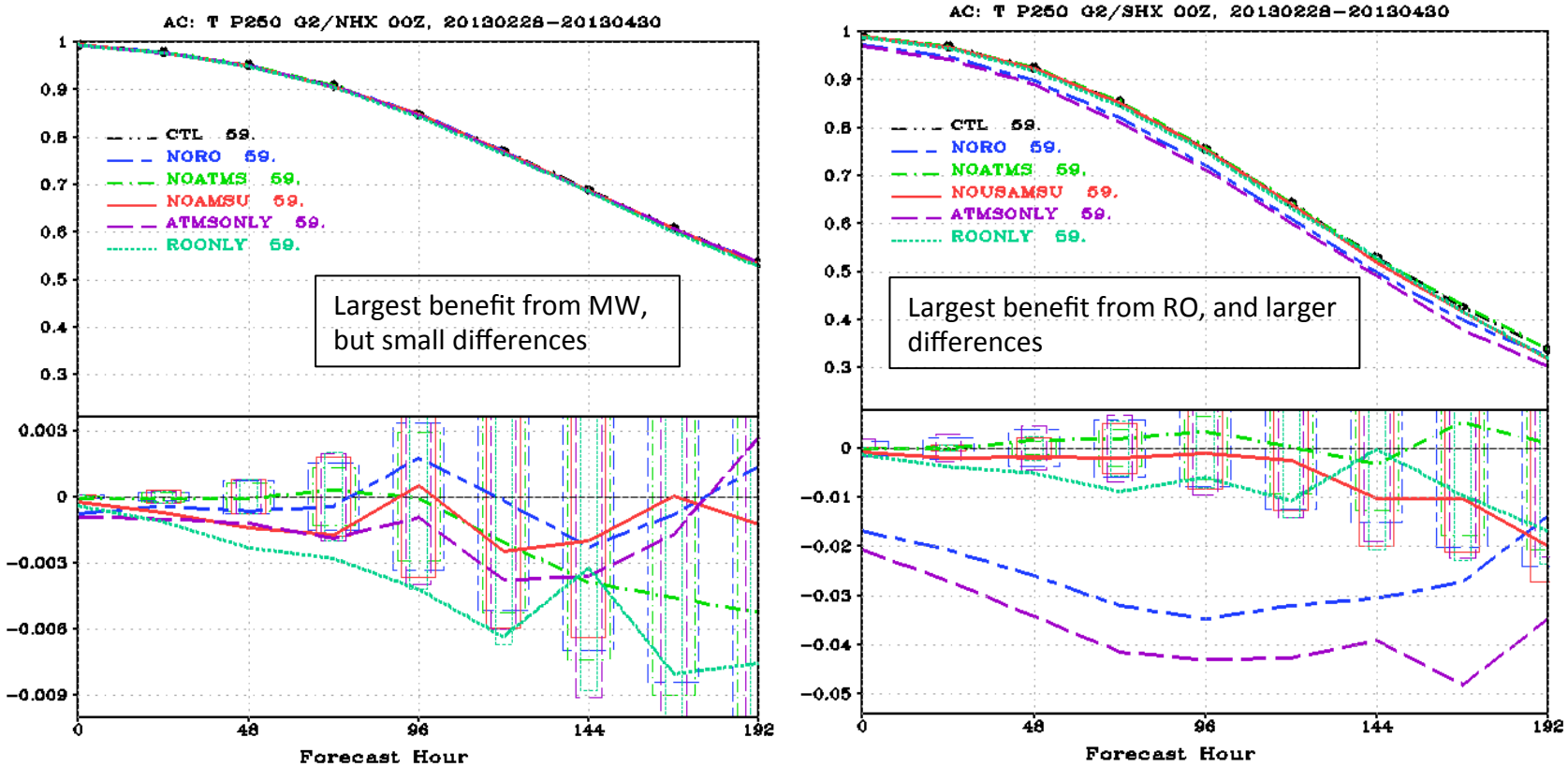
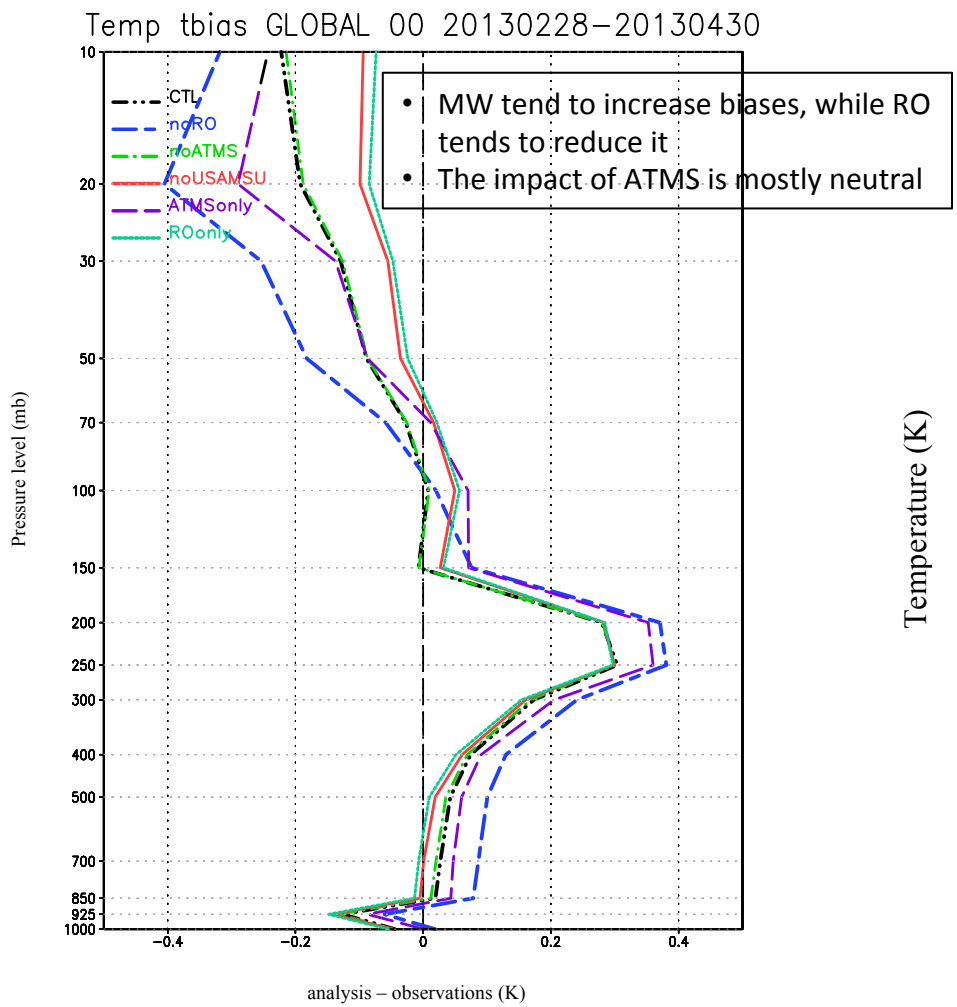


Fig. 4. Top: Anomaly correlation score as a function of the forecast length for the 250-mb temperature field in the NH (a) and SH (b) for all six experiments. The differences from the *CTL* are shown in the lower panels. Bottom: Difference of AC scores with respect to *CTL* in the (a) NH and (b) SH. Vertical bars indicate limits of statistical significance at the 95% confidence levels; curves within the corresponding bars are not statistically significant.

Fit to Radiosonde (Temperature)



- MW tend to increase biases, while RO tends to reduce it
- The impact of ATMS is mostly neutral

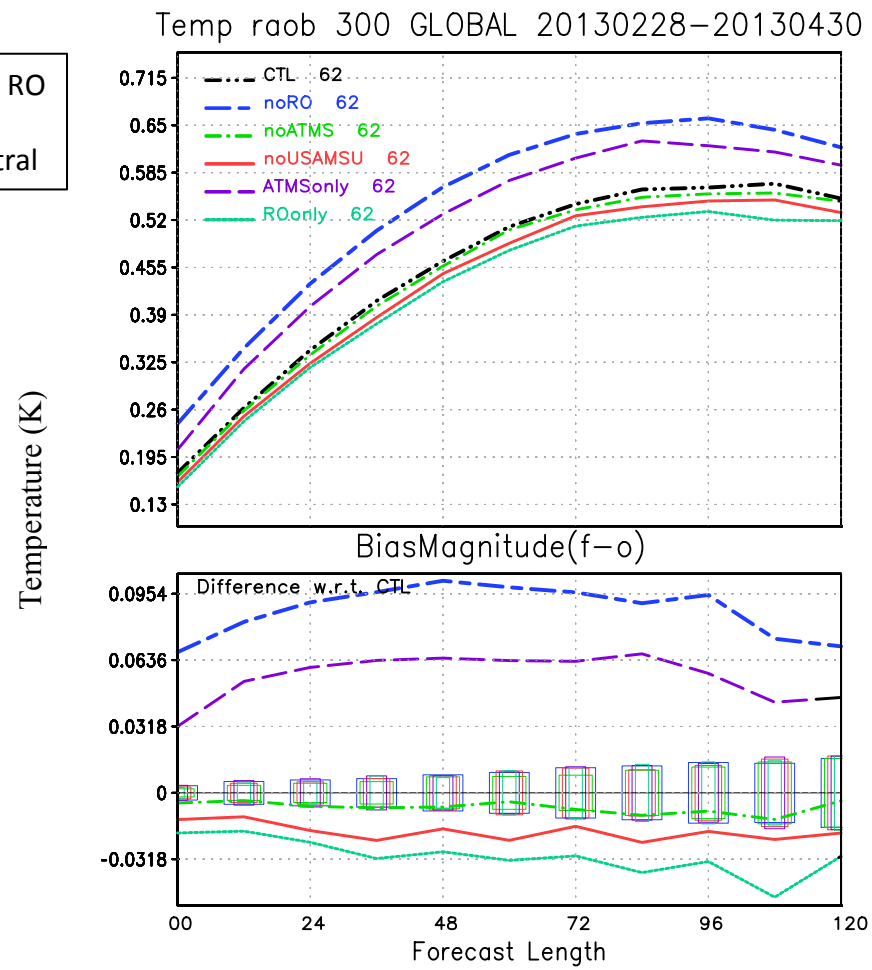


Fig.5. Global temperature biases of analyses relative to radiosondes in all six experiments.

Conclusions

- A slight loss of accuracy in the NH extratropics forecasts occurs with the loss of all U.S. MW data, and this loss is not mitigated with RO observations
- In the SH extratropics, the loss of RO data produces a much larger negative impact on the forecast than does the loss of the U.S. MW observations
- The role of ATMS in mitigating the loss of the other MW sounders is mixed, but generally neutral
- Thus the potential "gap" in RO may be a more serious risk to global forecasts accuracy than potential gaps in the U.S. MW observations
- The global biases in analyses and forecasts seem to increase as the number of MW observations increases, particularly in the stratosphere – the modest amount of unbiased RO only partially reduces these biases
- An increase of RO observations should further 'anchor' the model resulting in improved bias corrections of the satellite radiances