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Improve GSI Thinning Scheme for the Use in Global and Regional NWP Modeling Systems

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Abstract

A new thinning scheme is developed to optimize satellite data selection in GSI data assimilation procedure for global and regional modeling systems. The thinning strategy is based on the derived standard deviation (STD) of the satellite data that to be thinned. High density observations will be kept within data high variational regions, such as tropical cyclone and front systems. High density data can also be selected by giving the locations of the interested regions. The analyses of NOAA-15 AMSU-A brightness temperature indicate that the STDs of lower level channels can show variations related to cloud/weather features. The STDs for upper level channels are relatively small and uniform.

Two issues were found for the derived STD (i.e. observation overlay in two polar regions and large scan angle effect). The large STDs due to the overlay in polar regions can be removed by applying a time filter during the calculation. The systematic large STDs near the two ends of the scan angles are generated because of the brightness temperature angular dependent bias due to the cross-track scan strategy for AMSU-A instrument. The number of observation points kept for AMSU-A lower level channels after the new thinning process is comparable to the result by using GSI 145-km thinning mesh. There is about 30% less data kept for upper level channels. We are working on removing the high density data kept over coast and sea-ice edge areas.

Objective and Methodology

Objective:

- Current GSI analysis system uses 145-km or 60-km thinning meshes for global (GFS) or regional (HWRF) models, respectively,
- We plan to develop a unified satellite data thinning scheme for global modeling system, and also increase data usage within weather active regions, such as tropical cyclone, ITCZ regions,
- The thinning scheme will identify and select observations within satellite data high variational regions.

Methodology:

- The density of the selected satellite data is based on the derived standard deviation of the data that to be thinned,
- High density data will also be used when provide the locations of the interested regions, such as TC regions.

Satellite observation data kept using GSI 60-km and 145-km thinning meshes

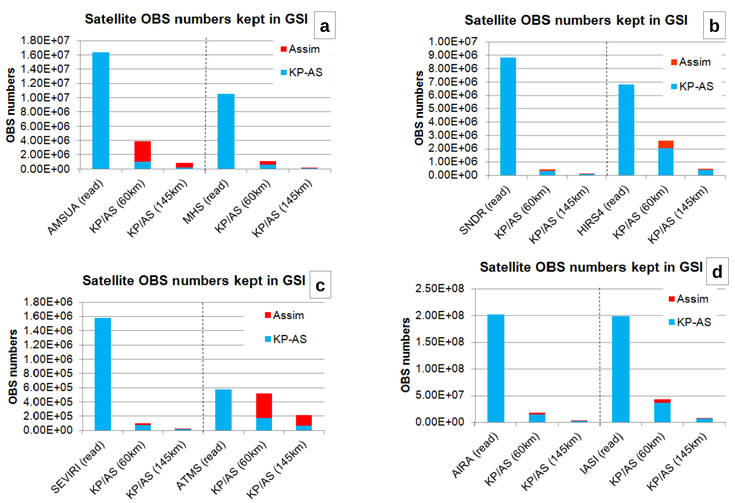

Fig. 1. Histograms of observation numbers kept after GSI 60-km or 145-km thinning process for sensors: (a) AMSU-A and MHS, (b) GOES Sounder and HIRS4, (c) MSG-2 SEVIRI and NPP ATMS, and (d) AIRA and IASI, at 0600 UTC, 25 October 2012.

Standard Deviation Analysis

Standard deviation derived before and after remove overlay observations

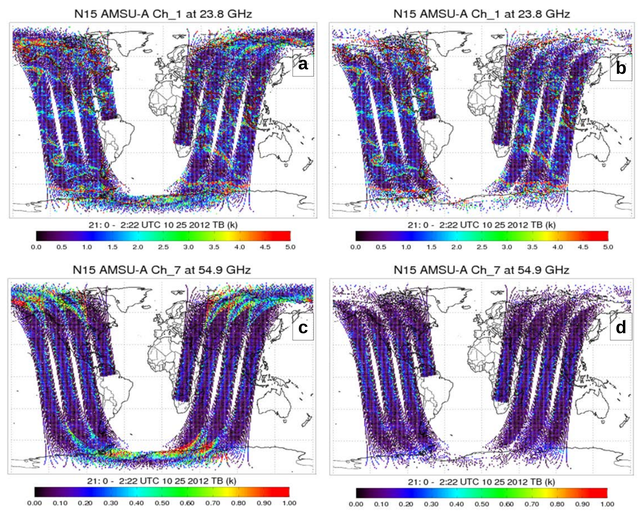

Figure 2. Standard deviations calculated for NOAA-15 AMSU-A at 0000 UTC 25 October 2012 for (a) Ch-1 before, (b) Ch-1 after, (c) Ch-7 before, and (d) Ch-7 after removing overlay observations.

- Analyzed the standard deviation (STD) of NOAA-15 AMSU-A Tb. It is found that the STD for surface channels can show some variations related to cloud/weather features (Fig2.b).
- The STDs for AMSU-A upper level channels are relatively small and uniform (Fig.2.d), but with systematic large STDs near the two ends of the scan angles. This pattern is generated because of the brightness temperature angular dependent bias due to the cross-track scan strategy for AMSU-A instrument.
- There are large STDs over two polar regions because of the overlay observations from two different orbits. By using a observation time filter, the large STD over these regions can be removed.

Comparison of Tb observation points with GSI 60-km, 145-km thinning mesh and the advanced thinning method

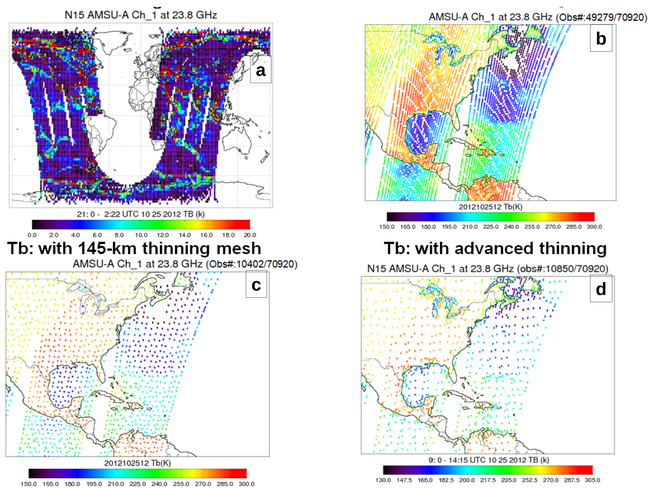

Figure 3. (a) Standard deviation calculated at 0000 UTC, 25 Oct., (b) brightness temperatures kept with GSI 60-km thinning mesh, (c) with GSI 145-km thinning mesh, and (d) with the new thinning scheme at 1200 UTC, 25 Oct. 2012.

New Thinning Results

NOAA-15 AMSU-A observation points kept for Sandy case

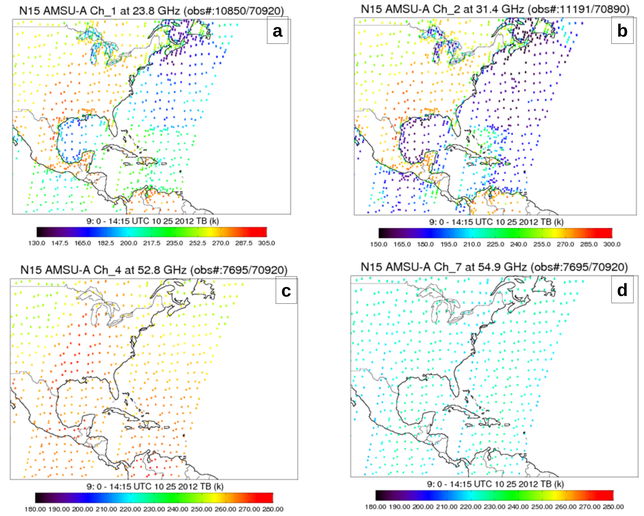

Figure 4. The brightness temperatures kept after new thinning process for NOAA-15 AMSU-A at 1200 UTC 25 Oct. 2012 (a) Ch-1, (b) Ch-2, (c) Ch-4, and (d) Ch-7.

Preliminary Results:

- The new scheme is applied for Superstorm Sandy case study.
- At 1200 UTC, Oct. 25 2012, GSI global 6-hr analysis window, there are 10850 or 11191 points selected for NOAA-15 AMSU-A Ch-1 and 2, which is comparable to the 10402 points selected by GSI 145-km thinning mesh.
- High density brightness temperatures are selected within Sandy and other weather active regions.
- For upper level channels, with relatively uniform pattern, the observation points kept is about 30% less than that of surface channels.
- Need to remove the high density data that selected near coast and sea-ice edge areas.

Summary and Future Plan

Summary:

- Analyzed NOAA-15 AMSU-A Tb standard deviation (STD), and compared with GOES-13 Imager for Hurricane Sandy case.
- The STDs for surface channels can show variations related to cloud/weather features. The STDs for upper level channels are relatively small and uniform.
- Found two issues for the derived STD (i.e. observation overlay in two polar regions and large scan angle effect). The large STDs due to the different observation time can be removed by applying a time filter during the calculation.
- Compared satellite data usages with 60-km and 145-km GSI thinning mesh. There are about 5 time more observation points kept or assimilated for 60-km mesh than that of 145-km mesh.
- The number of observation points kept for AMSU-A lower level channels after the new thinning process is comparable to the result by using GSI 145-km thinning mesh. There is about 30% less data kept for upper level channels.

Future Plans:

- Keep working on developing a new thinning scheme for both global and regional modeling systems.
- Conduct control and sensitivity GSI/GFS experiments to study the impact of the new scheme.

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