GLOBAL SPACE-BASED INTER-CALIBRATION SYSTEM (GSICS) SENSOR INTERCOMPARISONS AND CORRECTIONS

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The Global Space-based Inter-Calibration System (GSICS) is a new international program to assure the comparability of satellite measurements taken at different times and locations by different instruments operated by different satellite agencies. Sponsored by the World Meteorological Organization and the Coordination Group for Meteorological Satellites, GSICS will inter-calibrate the instruments of the international constellation of operational low-earth-orbiting (LEO) and geostationary (GEO) environmental satellites and tie these to common reference standards. The inter-comparability of the observations will result in more accurate measurements for assimilation in numerical weather prediction models, blended products from multiple sensors, construction of more reliable climate data records, and progress towards achieving the societal goals of the Global Earth Observation System of Systems. GSICS includes globally coordinated activities for pre-launch instrument characterization, on-board routine calibration, sensor inter-comparison of near-simultaneous observations of individual scenes or overlapping time series, vicarious calibration using Earth-based or celestial references, and field campaigns. An initial strategy uses high accuracy satellite instruments, such as the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) and Atmospheric Infrared Sounder (AIRS), and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) – Centre National d'Etudes Spatiales (CNES) Infrared Atmospheric Sounding Interferometer (IASI), as space-based reference standards for inter-calibrating the operational satellite sensors. Agencies participating in the program include Centre National d'Etudes Spatiales, China Meteorological Administration, EUMETSAT, Japan Meteorological Agency, Korea Meteorological Administration, NASA, National Institute of Standards and Technology, and NOAA.

GSICS will provide coefficients to the user community to adjust satellite observations to a common reference. The first major deliverable is the GSICS correction algorithm for the geostationary infrared imagers. The correction adjusts the geostationary data to be consistent with IASI and AIRS. The user simply applies the correction to the original data using GSICS supplied software and coefficients. The coefficients will be a function of channel and time and will have the form $R_C = a_0 + a_1 R_O$ where R_C is the corrected radiance, a_0 and a_1 are the coefficients, and R_O is the observed radiance. The coefficients for the geostationary imagers are derived from their collocations with IASI/AIRS.

Many GSICS members have contributed to the baseline algorithm for GSICS GEO/LEO IR instrument inter-calibration, which uses the AIRS and IASI hyperspectral instruments as references (e.g., Wang et al., 2009). It incorporates the gap-filling algorithm developed by JMA (Tahara and Kato, 2009) that is critical in using AIRS data. The algorithm collocates GEO and LEO data in time (within 5 minutes), viewing geometry (difference in optical path of the two satellites less than 1%), and space (accurate to both instruments' geolocation uncertainty). It then spatially averages the GEO pixels within each LEO pixel and spectrally convolves the LEO hyperspectral radiances with GEO's SRF. This algorithm has been implemented operationally at NOAA for GOES Imager IR data, at EUMETSAT for MSG Imager data, at JMA for MTSAT Imager IR data, and experimentally at KMA using MTSAT in preparation for Korea's Communication, Ocean and Meteorological Satellite (COMS) Program.

An example of the application of this method is shown in Fig. 1, which compares (upper panel) the GOES 13.3 μm channel to both AIRS and IASI (Wang et al., 2010). The jumps on July 2, 2008 and January 2, 2009 are due to a decontamination procedure that was applied to the GOES Imager. Differences between AIRS and IASI, obtained by a double-differencing technique, with GOES as the transfer radiometer, are shown. The difference between AIRS and IASI is small and stable despite the fact that their differences from GOES are large and variable. The lower panel of Fig. 1 illustrates the elimination of the GOES bias error resulting from the decontaminations by applying the GSICS Correction procedure, which is based on the differences between GOES and AIRS shown in the upper panel of the figure. The lower panel shows the difference between observed brightness temperatures and brightness temperatures computed using a radiative transfer model and the NCEP analysis atmospheric state parameters for GOES-12 channel 6, before and after the correction, respectively. The bias is reduced from 3 K to nearly zero, a significant improvement for both weather and climate users.

The Global Space-based Inter-Calibration System (GSICS) is off to a good start toward achieving its overarching goal of ensuring the comparability of satellite measurements taken at different times, by different instruments, operated by different agencies, and tying these measurements to the international system of units (SI). Eight international agencies are already participating in this program of the WMO and the Coordination Group for Meteorological Satellites.

The GSICS infrastructure is in place: the GSICS Coordination Center (GCC) infrastructure at NESDIS to coordinate the inter-calibration activities, archive and disseminate results, and operate the GSICS website; the GSICS Processing and Research Centers (GPRCs), responsible for pre-launch calibration, inter-calibration of their own agency's sensors with other satellite sensors, and supporting research activities; the GSICS Research Working Group (GRWG) and GSICS Data Working Group (GDWG) to assist in the coordination, planning and implementation of GSICS research and data management activities; and the Calibration Support Segments, which are leveraged on-going or collaborative relevant activities at other institutions, to enhance the GSICS program.

At the conferences, an overview of GSICS will be presented with many examples including GEO to LEO intercalibration and LEO to LEO intercalibration as well as examples of improved climate data records, blended products and impacts on data assimilation.

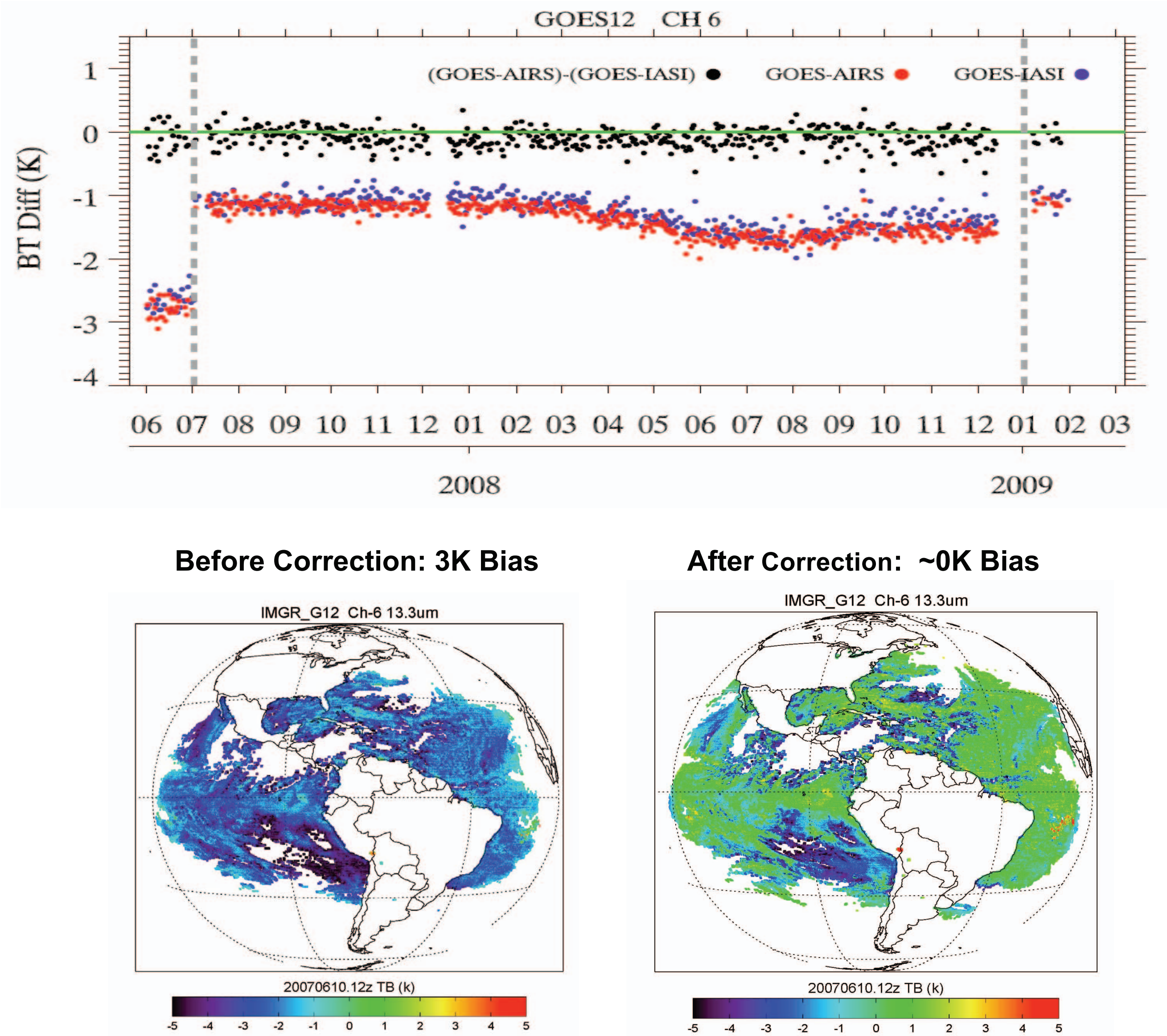

Fig. 1. **Upper panel:** Time series of daytime Brightness Temperature (BT) differences between the GOES-12 13.3 μm channel and AIRS (red)/IASI (blue) from June 2007 to January 2009. **Lower panel:** The difference between observed and calculated brightness temperatures for GOES-12 13.3 μm channel before and after the GSICS correction is applied. The GSICS correction is determined from the GOES- AIRS differences in the upper panel.

References

Tahara, Y. and K. Kato, 2009: New Spectral Compensation Method for Intercalibration Using High Spectral Resolution Sounder, Japanese Meteorological Satellite Center Technical Note, No. 52.

Wang L., C. Cao, and M. Goldberg, 2009a: Inter-calibration of GOES-11 and GOES-12 water vapor channels with MetOp/IASI hyperspectral measurements. *J. Atmos. Oceanic Technol.* (Accepted upon revision).

Wang, L., X. Wu, Y. Li, M. Goldberg, S.-H. Sohn, and C. Cao, 2010: Comparison of AIRS and IASI radiances using GOES imagers as transfer radiometers toward climate data records. *J. Appl. Meteor. Climate* (accepted).

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