Remote Sensing Systems

An Evaluation of WindSat Long-Term Stability
Frank J. Wentz

The usual comparisons of WindSat SST and winds with ocean buoys and WindSat vapor with GPS-derived vapor have shown no obvious evidence of a drift in the WindSat brightness temperatures (T_B). However, more detailed comparisons of wind speed retrievals from WindSat with similar retrievals from other satellites reveal a small trend difference of about 0.2 m/s/decade in the sense that the WindSat winds are slowly increasing over time relative to the other satellites: the F13 and F17 SSM/I, QuikScat, and AMSR-E. In view of the consistency among the other satellites, WindSat appears to be the outlier.

In view of the above, we took a closer look at all of the WindSat retrievals. In particular, we looked at the internal consistency of retrievals of the same parameters. For example, two sea-surface temperatures (SST) are computed as part of standard processing: one that uses all WindSat channels (SSTVL) and a higher-resolution retrieval that does not use the 7 GHz channels (SSTLO). The top image in Figure 1 shows the difference of SSTLO minus SSTVL plotted versus time for the complete 9-year mission of WindSat. There were two prolonged spacecraft safeholds during which WindSat was turned off. The first safehold was February to June 2005 and the second was June to August 2007. In Figure 1, a different color is used to highlight the three periods before and after these safeholds. There is an internal inconsistency in the retrievals of SSTVL and SSTLO that is different for the three time periods.

To investigate this more, we computed antenna temperature (T_A) biases between the WindSat observations and a radiative transfer model (RTM) that uses AMSR-E retrievals as input. Biases were computed for all 10 WindSat channels. Three sets of 10 biases were computed, with each set corresponding to a different time period. There were small differences of the order of 0.1 K or less between the 3 sets of biases (i.e., the 3 time periods). These WindSat minus RTM(AMSRE) biases were then subtracted from the WindSat observations, and all geophysical retrievals were redone.

The new WindSat retrievals with the T_A step biases applied display two improvements. First the SSTLO-SSTVL difference becomes consistent over time as is shown by the bottom image in Figure 1. Note there is absolutely no guarantee that biases derived from AMSR-E would fix the internal inconsistency between SSTVL and SSTLO. The second improvement is that the WindSat trend difference of 0.2 m/s/decade relative to the other satellites goes away. In view of these improvements, we decided to implement the AMSR-E derived T_A step biases into our standard WindSat processing.

It may be that the drift we see in WindSat is not related to turning WindSat off for an extended period of time. Rather, the timeseries in the top image could be interpreted as an exponential decay. However since the effect is small, the choice of modeling of the effect as two step functions versus an exponential decay has little effect on retrievals. The more important point is that there is most likely a small drift in the WindSat calibration as is evidence by the drift in SSTLO minus SSTVL.

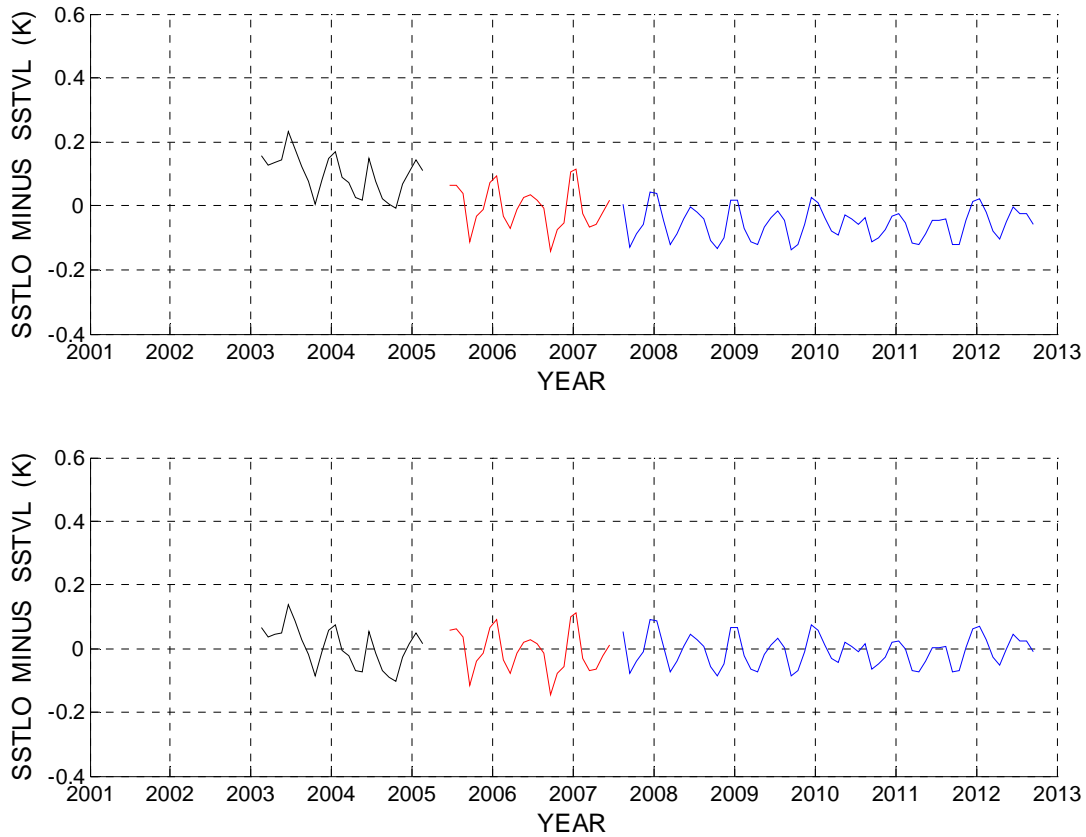After 2008, WindSat appear to be highly with no evidence of drift.

Figure 1. Time inconsistency in two WindSat SST retrievals before (top image) and after (bottom image) applying antenna temperature step biases. SSTVL is the SST retrieval that uses all 10 WindSat channels. SSTLO only uses 8 channels; it does not use 7 GHz. The top image shows the difference of SSTLO – SSTVL changes over time. A different color is used to highlight the three periods before and after prolonged safeholds. The bottom image shows the results after applying antenna temperature biases derived from AMSR-E.