TES Calibration Modifications 2010

New Calibration

From launch until late 2009, TES gathered calibration data, viewing both the on-board blackbody (BB) and cold space (CS) with each instrument sequence. Thus for every set of target scans (3 for the all but the earliest global survey data), a BB scan and CS scan were acquired. In the latter half of 2009, however, the TES pointing control system (PCS) started showing errors and late in 2009 the errors resulted in loss of science data. The TES instrument team decided to temporally suspend global survey data collection while investigating the errors.

The cause of the errors is most likely a shorting of one of the signal lines in the flex cable that supplies power and control signals to the mirror axis that controls the along-orbit movement. In order to minimize the chance of further TES errors and the possibility of cable failure, it was decided that future TES observations must minimize movement of the PCS to view the on-board blackbody calibration source.

Through alternate calibration methodology simulation tests and consultation with the TES science team a new calibration methodology was derived. The goal of the new methodology was to both minimize the difference in data acquisition and retrieved TES results when compared with the existing TES record, and minimize the exercise of the PCS flex cable. The new calibration data acquisition methodology gathers a set of BB data before and after a 16 orbit global survey and gathers CS data with each instrument sequence (as before). The scan in each sequence that was previously a BB scan was changed to a nadir target scan, resulting in four target scans per sequence instead of three.

Changes in NESR

Based on the changes in the calibration routines we could expect some changes in the NESR. The new NESR estimates for global surveys from June, 2010 are different (lower) than for global surveys from June, 2009 but are within the range of NESR values observed by TES which can fluctuate depending on ice buildup. Examination of the residual RMS in Level 2 indicate that the new calibration NESRs are well characterized as the retrievals converge to the noise level as was previously observed.

Radiance comparison with AIRS

We plan to automate TES radiance comparisons with AIRS, similar to those reported in Shephard et al, 2008, in order to test TES radiances from data collected with the 2010 calibration mode. The previous comparisons showed agreement in equivalent brightness temperature for cloud-free ocean scenes with to within 0.3K after TES spectra were convolved with the AIRS spectral response function.

Reference

- Shephard, M. W., H. M. Worden, K. E. Cady-Pereira, M. Lampel, M. Luo, K. W. Bowman, E. Sarkissian, R. Beer, D. M. Rider, D. C. Tobin, H. E. Revercomb, B. M. Fisher, D. Tremblay, S. A. Clough, G. B. Osterman, M. Gunson (2008), Tropospheric Emission Spectrometer Nadir Spectral Radiance Comparisons, *J. Geophys. Res.*, **113**, D15S05, doi:10.1029/2007JD008856.

Comparison of L2 retrieval rms and bias: new versus old calibration strategy

The effects of changing from 'embedded' BB calibration (pre 2010) to 'split' BB calibration (2010) on TES L2 products were examined by processing a Global Survey run in both calibration strategies through Level 2 retrievals. The TES Global Survey chosen for this experiment is run 6789 taken April 1-2, 2008 of which the pre and post SO BB calibrations were readily available. An additional complication in the evaluation is that the new 'split' BB calibration processing has also applied new L1B 'controlled' phase alignment algorithm. The summary below has therefore the effects of 'split' BB calibration and the new L1B phase alignment algorithms. The summary below summarizes the differences between the L2 retrieval results from the new 'split' BB calibration / new L1B phase alignment algorithm and the TES V004 standard products (with the 'embedded' BB calibration).

1. Number of success and good quality retrievals are about the same as the standard processing.
2. **Atmospheric Temperature**: no global pattern of systematic differences. The global mean differences are negative 0.25-0.1K with RMS = 0.8-0.5K in the lower-upper troposphere.
3. **Ozone**: no global pattern of systematic differences. The global mean differences is -5% in the lower troposphere with RMS = 7%. DOF dropped very slightly.
4. **CO**: no global pattern of systematic differences. No change in global mean with RMS = 4-6% in the lower-upper troposphere.
5. **CH4**: no global pattern of systematic differences. No change in global mean with RMS = 0.5-1.2% in the lower-upper troposphere.
6. **H2O**: no global pattern of systematic differences.No change in global mean with RMS = 13-7% in the lower-upper troposphere.

7. **HDO (delta-D)**: no global pattern of systematic differences. No change in global mean with RMS = 14-6% in the lower-upper troposphere.

Sonde comparison with new calibration retrievals

Ozonesonde and radiosonde comparisons with TES TATM, H2O, and O3 provide a check on the quality of the TES v004 retrievals from the new calibration (2010) compared to the old calibration (pre 2010). Global survey retrievals with the new calibration from the month of June, 2010, are compared with sonde profiles, and the differences are compared with TES-sonde matches with the old calibration (June 2009).

TES ozone retrievals have been compared with ozonesondes within +9 to -9 hours and 300 km distance criteria. The ozonesondes come from a compilation of WOUDC and SHADOZ sites. With a couple dozen TES-ozonesonde matches, we find that the June 2010 new calibration provides results that are similar to the old calibration (June 2009). Ozone bias is within 10-15% of ozonesondes in the troposphere and stratosphere.

TES atmospheric temperature retrievals with both old and new calibration show similar biases with respect to radiosondes and the GMAO GEOS-5 apriori. Fourteen global surveys from June 2010 and June 2009 were compared to sondes matched within 300 km and +3 to -2 hours. The radiosonde data come from the NCDC Integrated Global Radiosonde Archive (IGRA). Over 1700 pairs of TES-sonde matches were identified for TATM. The TES operator has been applied to the sonde profiles for the comparison. The only noticeable difference between old and new calibration is that in the lower troposphere (1000 to 800 hPa), the new calibration TES-sonde difference is not as good as the old calibration TES-sonde difference (the new one is approximately 0.2 K colder).

TES water vapor retrievals with both old and new calibration have been compared with radiosonde profiles. The radiosonde data come from the NCDC Integrated Global Radiosonde Archive (IGRA). For global surveys in June 2010 and June 2009, more than one hundred TES-sonde matches were found within tight distance and time criteria (within 100 km and +2 hr to -1.5 hr). The distance criterion was set to 100 km to minimize the impact of atmospheric water variability. The old and new calibration retrievals are found to have similar bias and rms relative to radiosondes.