Release Note

On the NESDIS/STAR SNO-calibrated MSU Radiances and Deep-Layer Atmospheric Temperature Climate Data Records

Version 1.2

This release note describes the basic characteristics of the NESDIS/STAR MSU/AMSU long-term climate data records (CDR), which include fundamental radiance CDRs calibrated using simultaneous nadir overpass (SNO) method, and the deep-layer atmospheric temperature CDRs developed from the SNO-calibrated radiance CDRs.

Differences between Version 1.1 and Version 1.2 (only on section II.11):

- Radiances for V1.0, V1.1, and V1.2 are identical;
- V1.1 of T2, T3, and T4 uses geographic location dependent constant bias correction to remove residual intersatellite biases for the gridded products before merging;
- V1.2 uses Christy empirical approach to remove residual warm target temperature contamination at the gridded product level after the SNO calibration. Target factors determined from ocean-mean data were applied globally. Finally, a geographic location dependent constant bias correction was applied to remove lat/lon-dependent residual intersatellite biases for the merging.

I. Radiance CDRs:

1. Calibration method: Sequential procedure to obtain calibration coefficients (offsets and nonlinear coefficient) from SNO matchups (Zou et al. 2006, 2009).
2. Calibration coefficients: calibration coefficients for MSU channels 2, 3, and 4 for all nine NOAA TOVS satellites are provided on the NESDIS/STAR website
3. Dataset period: October 13, 1978 to September, 27 2006
4. Satellites: TIROS-N, NOAA-6, -7, -8, -9, -10, -11, -12, and -14
5. Channels: 2 (53.74GHz), 3 (54.96GHz), 4 (57.95GHz)
6. Accuracy : Intersatellite biases for the SNO datasets have been completely removed ; global-mean inter-satellite biases are O(0.05K to 0.1K) for most overlaps; bias drift owing to orbital-drift related warm target contamination reduced to a minimum (e.g., 4% for channel 2, Zou et al. 2006)
7. Application Area: Reanalysis data assimilation to generate consistent reanalysis climate products; Retrievals of consistent thematic CDR products; Others

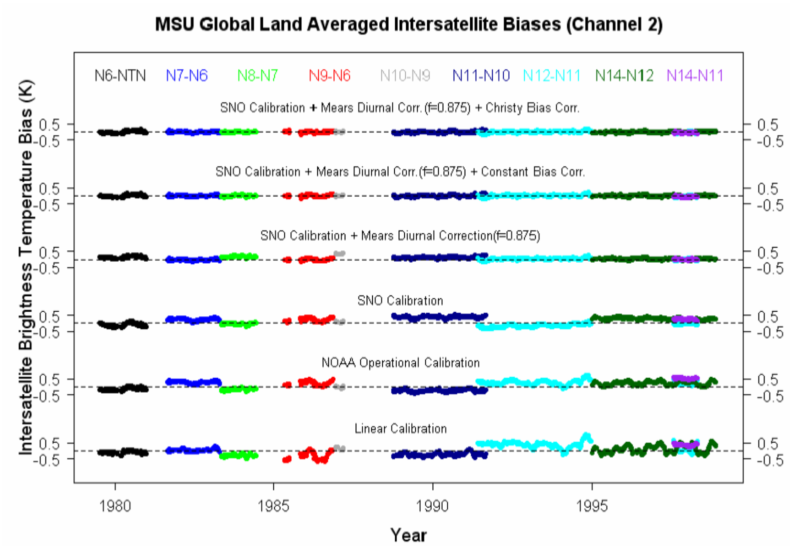
8. Dataset availability: Radiance data can be directly downloaded from STAR website; Reprocessing subroutine to generate SNO-calibrated radiances is available upon request.

II. Deep-Layer Atmospheric Temperature CDRs:

1. Available products: Temperature Mid-Troposphere (MSU ch2 or T2)
   Temperature Tropopause and Stratosphere (MSU ch3 or T3)
   Temperature Lower-Stratosphere (MSU ch4 or T4)
2. Spatial Resolution: 2.5 latitude by 2.5 longitude
3. Spatial Coverage: Global
4. Time Resolution: Both monthly averaged and 5-day averaged (pentad) are provided
5. Product Period: November 1, 1978 to September 26, 2006 for T2 and T4; January 1, 1981 to October 2, 2006 for T3
6. Root-level (level 1c) calibration: SNO nonlinear sequential method developed by Zou et al. (2006, 2009)
7. Orbital-drift related warm target contamination: Removed from the radiances using the nonlinear SNO method (Zou et al. 2006, 2009)
8. Total number of footprints used: 7 near-nadir pixels from 3 to 9
9. Incident angle effect: Limb-adjustment applied using limb-correction coefficients developed by Goldberg et al. (2001)
10. Diurnal drift effect: Corrected for T2_V1.1 using RSS model-based diurnal anomaly dataset (Mears et al. 2003). A scaling factor f=0.875 was used to multiply the RSS dataset to minimize the intersatellite differences over land for a best merging. No diurnal drift correction for T3, T4 and T2_V1.0
    Note: Global T3 and T4 products and T2 over the ocean areas are not affected by this effect; T2 trend over land areas are significantly affected by this effect.
11. Merging method at the gridded product level: Christy empirical approach was applied first to remove residual warm target temperature contamination at the gridded product level after the SNO calibration. Target factors determined from ocean-mean data were applied globally. Finally, a geographic location dependent constant bias correction was applied to remove lat/lon-dependent residual intersatellite biases before merging.
12. Performance Measure: The two plots below show intersatellite difference time series for MSU T2 to demonstrate the validity of the MSU intercalibration and other procedures over both the land and ocean areas. We compare time series of the linearly calibrated, NOAA pre-launch calibrated, and the SNO-calibrated observations to characterize the biases. In the linear and pre-launch “NOAA operational calibration” (the bottom two traces), time-varying intersatellite biases on the order of 0.5 K with an averaged standard deviation of 0.1-0.2 K were found, which are especially true for NOAA-10 to NOAA-14. In the post-launch “SNO

calibration" (the third traces from the bottom), these biases have been reduced to smaller than 0.05 K (except for N10-N9) with an averaged standard deviation of 0.035 K over the oceans. In the fourth traces from the bottom, a diurnal drift correction with RSS diurnal anomaly dataset multiplied by a scaling factor 0.875 was applied, which further reduces the intersatellite biases over land. In the fifth traces from the bottom, a simple constant bias correction is applied on top of the SNO calibration and RSS diurnal correction to remove the small residual biases so that the difference time series for all satellites are now aligned exactly on the zero line with no obvious trends. This demonstrates that the SNO method results in a very well inter-calibrated radiance dataset. Finally, the Christy merging method (the top traces, which empirically remove the warm target contamination effect from the gridded dataset) was used to remove the residual intersatellite biases instead of using a constant bias correction. The effect of Christy correction is similar to the constant bias correction. This further confirms the validity of the SNO intercalibration and diurnal drift correction.

Channels 3 and 4 have similar performance. For operational calibration, reasonable merging for channel 3 can be done only for the period 1987 to 2006. For SNO calibration, however, a good merging can be achieved from 1981 to 2006.



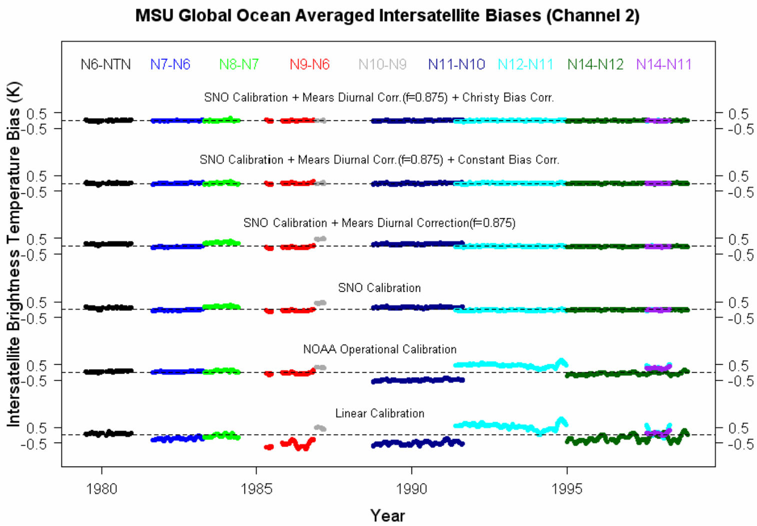


Figure 1 Intersatellite difference time series for TIROS-N to NOAA-14 of the MSU channel 2 global land (upper panel) and oceanic (lower panel) atmospheric temperatures for different calibration and merging methodologies. The abbreviation "N11-N10" stands for NOAA-11 minus NOAA-10, and so on. Unit in Kevin.

13. Data format: Radiances are provided in binary format and reading programs are available upon request. Merged temperature products are in text format and reading programs are provided online. File names such as 'merged_msu_chX_pentad_1978-2006_v1.1.dat' or 'msu_chX_pentad_anomaly_1978-2006_v1.1.dat' are used to identify the specific channel product, data period, original temperature data or anomalies, and version information.

14. References:

Christy, J. R., R. W. Spencer, and W. D. Braswell, 2000: MSU tropospheric temperatures: Data set construction and radiosonde comparisons. *J. Atmos. Oceanic Technol*., **17**, 1153–1170.

Goldberg, M. D., D. S., Crosby, and L. Zhou, 2001: The limb adjustment of AMSU-A observations: methodology and validation. *J. Appl. Meteor*., **40**, 70–83.

Mears, C. A., M. C. Schabel, and F. J. Wentz, 2003: A reanalysis of the MSU channel 2 tropospheric temperature record. *J. Climate*, **16**, 3650–3664.

Zou, C.-Z., M. Gao, and M. Goldberg**,** 2009, Error structure and atmospheric temperature trends in observations from the microwave sounding unit, *J. Climate*, In press.

Zou, C.-Z., M. Goldberg, Z. Cheng, N. Grody, J. Sullivan, C. Cao, and D. Tarpley, 2006: Recalibration of microwave sounding unit for climate studies using simultaneous nadir overpasses. *J. Geophys. Res.* **111,** D19114: doi: 10.1029/2005JD006798, issn: 0148–0227.

15. Website address:

http://www.star.nesdis.noaa.gov/smcd/emb/mscat/mscatmain.htm

16. Contact: Cheng-Zhi.Zou@noaa.gov, wenhui.wang@noaa.gov