

STAR V5.0 Mean Layer Temperature Climate Data Record Release Note

12/07/2023

This directory contains the monthly time series and their anomalies for STAR V5.0 mean layer atmospheric temperatures. STAR V5.0 is a global dataset with $2.5^{\circ} \times 2.5^{\circ}$ grid resolution covering the period from November 1978 to present. The dataset was inter-calibrated and merged from three generations of microwave sounders, MSU, AMSU-A, and ATMS, with 16 polar-orbiting satellites including TIROS-N, NOAA-6, NOAA-7, NOAA-8, NOAA-9, NOAA-10, NOAA-11, NOAA-12, NOAA-14, NOAA-15, NOAA-18, NOAA-19, MetOp-A, Aqua, SNPP, and NOAA-20. The dataset includes temperature mid-troposphere (TMT, MSU channel 2 merged with AMSU-A channel 5 and ATMS channel 6), temperature upper-troposphere (TUT, MSU channel 3 merged with AMSU-A channel 7 and ATMS channel 8), temperature lower-stratosphere (TLS, MSU channel 4 merged with AMSU-A channel 9 and ATMS channel 10), and temperature lower-troposphere (TLT, derived from combinations of TMT, TUT, and TLS). TLT, TMT, TUT, and TLS measure layer temperatures peaking roughly at 3km, 5km, 10km, and 17km, respectively, above the Earth's surface.

Features in the STAR V5.0 development include a use of backward merging approach, development of an observation- and semi-physically-based algorithm for diurnal drift adjustment, and removal of spurious calibration drifting errors in NOAA-15, NOAA-14, NOAA-12, and NOAA-11 through recalibration. Satellite microwave sounding observations in stable sun-synchronous orbits (Aqua, MetOp-A, SNPP, NOAA-20) were used as a reference in the backward merging process. Bias corrections and satellite recalibration have resulted in inter-consistent CDR records for climate change investigation. The following publication provided detailed information on the merging algorithms and temperature trend results from STAR V5.0:

Zou, C.-Z., H. Xu, X. Hao, and Q. Liu, 2023: Mid-Tropospheric Layer Temperature Record Derived from Satellite Microwave Sounder Observations with Backward Merging Approach, *J. Geophys. Res.-Atmosphere*. **128**, e2022JD037472. <https://doi.org/10.1029/2022JD037472>

STAR V5.0 has replaced the earlier versions (such as STAR V3.0, V4.0, and V4.1) since January 2023 for climate change investigations.

Additional information on the dataset:

- Time range for individual product:
TMT: November 1978 – present
TLS: December 1978 - present
TUT: January 1981 - present
TLT: January 1981 - present
- Base period for calculating anomalies: **Jan 2000-Dec 2019.**
- A sample code (sample_read_monthly.f) is provided to read the data. Please refer to comments in the source code for information about the data format.

- TLT calculation: The STAR V5.0 TLT is calculated by this formula: $TLT = 1.430 \cdot TMT - 0.462 \cdot TUT + 0.032 \cdot TLS$. The regression coefficients (1.430, -0.462, 0.032) were obtained by fitting AMSU-A channel 4 weighting function using the TMT, TUT, and TLS weighting functions with a slight adjustment so that the resulting TLT weighting function does not have negative values over the lower stratosphere. Figure 1 below shows weighting functions for AMSU-A channel 4 (TLT, pink curve), TMT (AMSU-A channel 5), TUT (AMSU-A channel 7), TLS (AMSU-A channel 9), and the obtained STAR V5.0 TLT (fitted TLT, thick black curve).

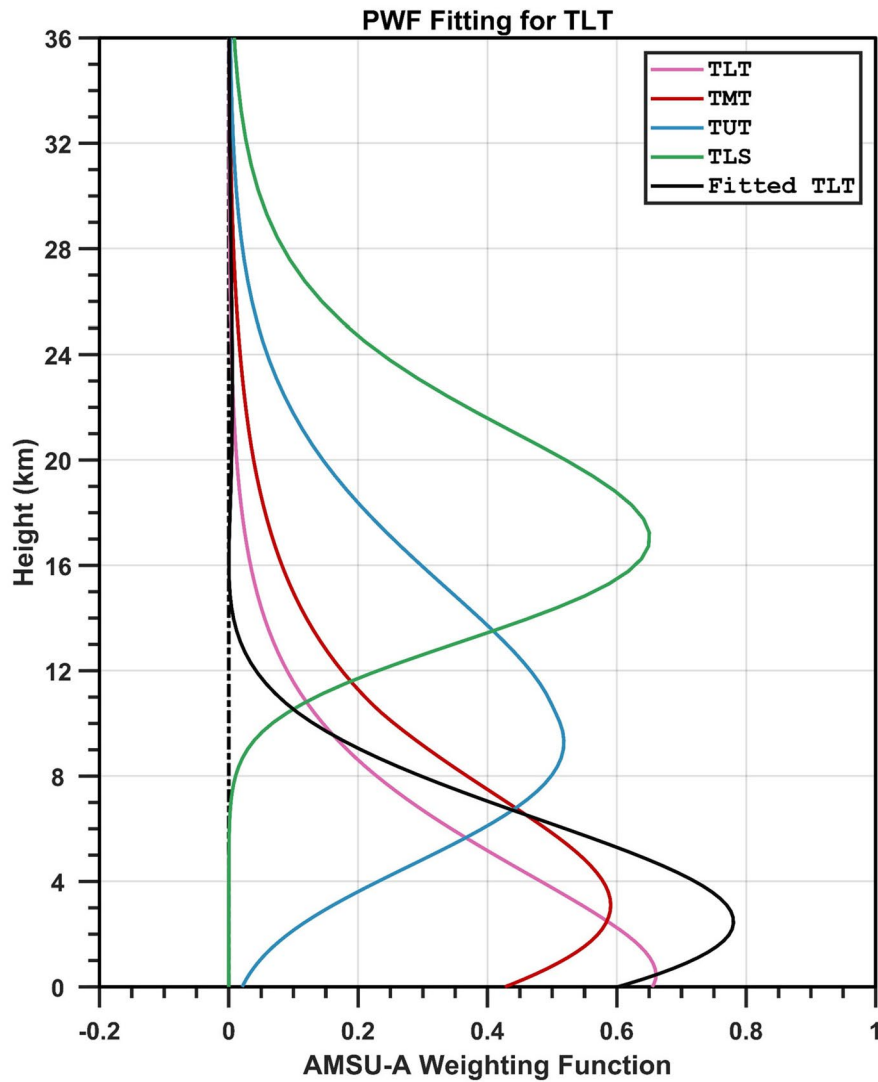


Figure 1: Weighting functions for AMSU-A channel 4 (TLT, pink curve), TMT (AMSU-A channel 5), TUT (AMSU-A channel 7), TLS (AMSU-A channel 9), STAR V5.0 TLT (fitted $TLT = 1.430 \cdot TMT - 0.462 \cdot TUT + 0.032 \cdot TLS$, thick black curve).

- Missing data: From 01/2023 to 05/2023, the released STAR V5.0 data contained missing data for the whole month of February 1985 in TUT and in 4 grid points in TMT after 2018. These missing data also appeared in TLT because TLT was generated from

combinations of TMT, TUT and TLS. These missing data problems were fixed in the updated monthly data after June 2023. We thank Eric Swanson for bringing up these missing data problems to our attention.