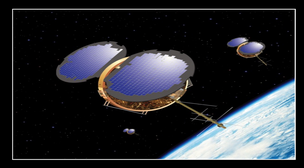

NOAA's Climate Data Record Program
Global Positioning System Radio Occultation Calibrated AMSU-A Temperature in the lower stratosphere (TLS)

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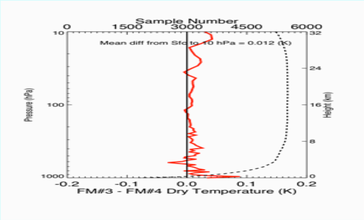
1. Introduction

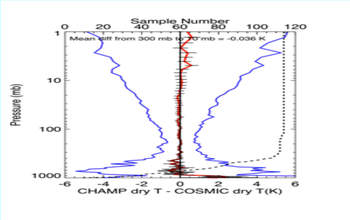
The objective of this study is to use Global Positioning System (GPS) radio occultation (RO) calibrated AMSU temperature measurements from 2001 to 2010 to independently assess AMSU temperature in the lower stratosphere (TLS) climate data records generated by several groups. Because the fundamental observable for the GPS RO technique is of high precision and stability that can be traced to the SI unit of second, RO data do not contain mission-dependent biases and are very suited to be used as benchmark data to calibrate other datasets.

Characteristics of GPS RO Data **(Ho et al., 2009a, b, c, 2011)**

- **Measure of time delay (SI traceability) : no calibration is needed**
- **Requires no first guess sounding**
- **Uniform spatial/temporal coverage**
- **High precision and no satellite (<0.05K) (Anthes et al., 2008)**
- **Insensitive to clouds and precipitation**
- **No mission dependent bias**



Precision < 0.05 K



Satellite-Satellite bias < 0.05 K

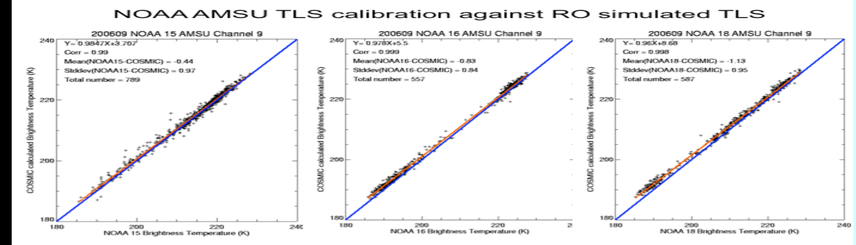
2. Calibration and Construction of Microwave Sensor Temperature Records Using GPS RO data

AMSU Channel 9 brightness temperatures : NOAA 15, NOAA 16, NOAA 18, Aqua and Metop-A AMSU from 2001 to 2010.

RO temperature profiles : CHAMP (2001-2008), COSMIC (2006-2010)

Here we first apply CHAMP and COSMIC RO temperature profiles to AMSU forward radiative transfer model to simulate AMSU TLS. The calibration coefficients for the monthly AMSU TLS for different missions can be found by the scattering plots. The RO calibrated TLS is defined as $Tb_{AMSU\text{-}calibrated} = SLOPE \times Tb_{AMSU} + OFFSET$ (Ho et al., 2009b, c, 2011)

NOAA AMSU TLS calibration against RO simulated TLS

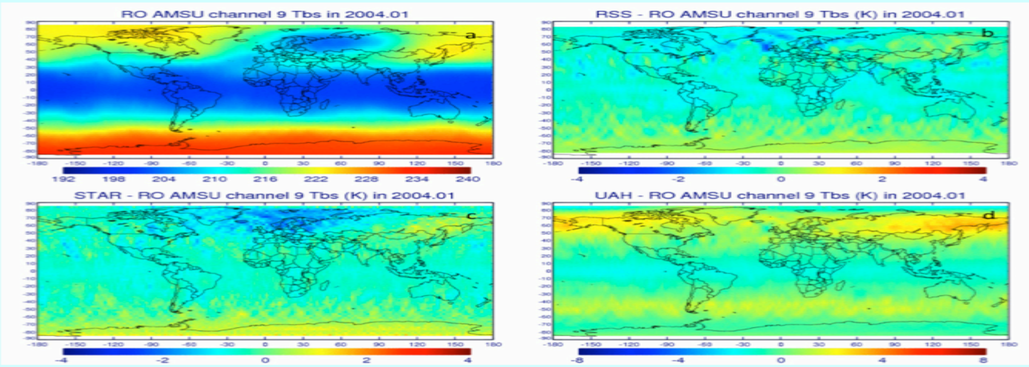


NOAA 15 **NOAA 16** **NOAA 18**

3. Global Monthly Mean Maps of RO_AMSU TLS and RSS, UAH, and STAR TLS

The derived RO calibrated TLS record is used to compared with the newly available TLS datasets provided by Remote Sensing Systems (RSS), University of Alabama in Huntsville (UAH) and NOAA Center for Satellite Applications and Research (STAR, using SNO method) since 2001 to 2010.

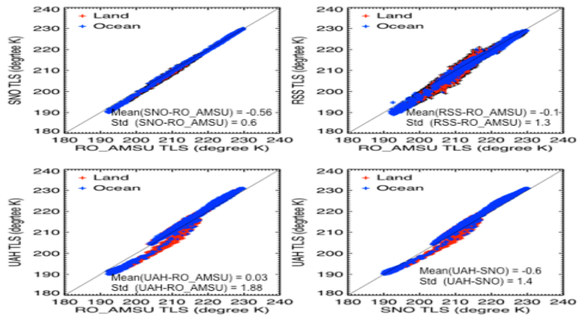
Here monthly mean TLS global maps in a 2.5x2.5 degree from different centers are compared.



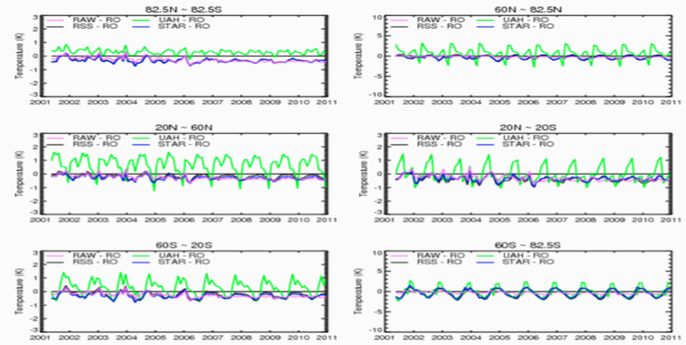
The global monthly map in a 2.5 degree x 2.5 degree grid on January 2004 for (a) RO-simulated AMSU TLS (RO_AMSU), (b) RSS – RO_ AMSU, (c) UAH – RO_AMSU, and (d) STAR – RO_AMSU.

4. Global TLS Comparisons and TLS Time Series Comparisons among Centers

The 10x10 degree scattering plots for TLS (2001-2010) from 4 centers over lands and oceans are shown in the left panels. The time series of the TLS anomalies of the four centers vary with different latitudinal zones (right panels). The TLS anomalies from RSS and STAR generally agree well with those from RO calibrated AMSU TLS in all latitudinal zones.



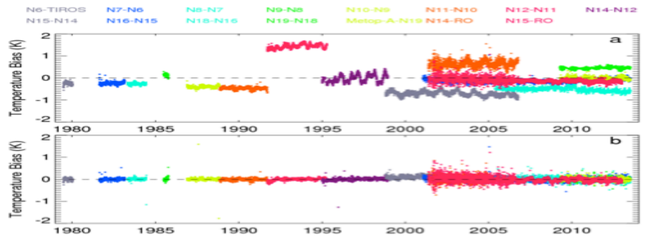
Global TLS (in 10 degree x10 degree) comparison among centers over lands and oceans. All available TLS data from 2001 to 2010 are used.



The time series of the TLS difference for RSS-RO_AMSU, UAH-RO_AMSU, and SNO-RO_AMSU for the entire globe (82.5°N-82.5°S, the left upper panel), the 82.5°N-60°N zone (the upper right panel), the 60°N-20°N zone (the middle left panel), the 20°N-20°S zone (the middle right panel), the 20°S-60°S zone (the bottom left panel), and the 60°S-82.5°S zone (the bottom right panel).

5. Intersatellite biases of NOAA calibrated AMSU ch9, MSU ch4 BTs and CHAMP simulated AMSU Ch9

Because of the high precision and accuracy of RO data, they are useful in assessing the quality of other data, including radiosonde data (Kuo et al., 2005; He et al., 2009; Ho et al., 2010a) and infrared and microwave satellite sounding systems (Ho et al. 2009a,b, 2010a,b, 2013,2014a,b). The synergy of RO observations with IR and microwave observations has been demonstrated in numerous studies, including comparison of Microwave Sounding Unit (MSU)/Advanced Microwave Sounding Unit (AMSU) climate records with RO data in the upper troposphere (Ho et al., 2009a; 2013).



Use of GPS RO data to reduce biases in other satellite sounding systems. a) Temperature biases in MSU/AMSU satellites before calibration with RO. B) Temperature biases after calibration with GPS RO data from 2001 to 2013 are used as calibration references. The calibrated MSU/AMSU data during the RO era are used to calibrate overlapped MSU data before 2001.

6. Summary

AMSU-A CLIMATE DATA RECORD SPECIFICATIONS

- **Global coverage**
- **144x72 Grid**
- **monthly time steps**
- **1978 - 2014**
- **Updated quarterly**

SOME USES OF THE AMSU-A CLIMATE DATA RECORD

- **Study Long Term Climate Changes**
- **Climate model Initialization**
- **Improving the reprocessing of other data sets and re-analyses**
- **Improvement of predictions in multiple time scales**

INPUTS TO THE *AMSU-A* CLIMATE DATA RECORD

- **Daily GPS RO temperature profiles**
- **Daily AMSU-A channel 9 brightness temperatures**
  - **sensor viewing angle**
  - **quality flags**

***AMSU-A* CLIMATE DATA RECORD**

http://www.ncdc.noaa.gov/cdr/operationalcdrs.html

CLIMATE DATA RECORD PROGRAM INFORMATION

http://www.ncdc.noaa.gov/cdr/index.html

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