Title: Construction of Consistent Microwave Sensor Temperature Records and Tropopause Height Climatology using MSU/AMSU Measurements, GPS RO Data and Radiosonde Observations

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Accurate temperature trend estimates are crucial for monitoring decadal climate variability and for understanding climate change forcing mechanisms. Over the past decade, the roughly 30 years of Microwave Sounding Unit (MSU) and the Advanced Microwave Sounding Unit (AMSU) measurements that are on board the National Oceanic and Atmospheric Administration (NOAA) series of polar-orbiting satellites have been extensively used for climate temperature trend detection. Even though these satellite missions use similar instruments, the equatorial crossing times of the NOAA satellite orbits drift in local time after launch. Because the MSU/AMSU operational calibration coefficients were obtained from pre-launch datasets, the orbital changes on MSU/AMSU measurements after launch may not be completely accommodated by these calibration coefficients. Different MSU/AMSU missions do contain different measurement biases that actually vary with times and locations due to on-orbit heating or cooling of the satellite components. This leads to extra difficulties for the usage of MSU/AMSU temperature trends for climate analysis. Identification of the long-term changes in tropopause temperature structure (i.e., tropopause height) in the upper troposphere and lower stratosphere (UTLS) has, over the past decade, become a focus for understanding important climate variations and processes. However, due to poor vertical resolution and/or measurement uncertainty, traditional observations and most satellite measurements in this region have not been well suited for these studies. Recently, the Global Positioning System (GPS) Radio Occultation (RO) technique has been proven to be a mature global observation technique and is ideally suited for climate trend detection. GPS RO produces global data coverage without the need for calibration or bias correction. In addition, because GPS RO data do not contain orbit drift errors and are not affected by on-orbit heating and cooling of the satellite components, they are very useful for identifying the MSU/AMSU time/location dependent biases for different NOAA missions. With very high precision and vertical resolution, GPS RO data are also very suitable for use in detecting the change of tropopause height in the UTLS. Building on the previous NOAA SDS grant NA07OAR4310224, in this study, we propose to carry out three tasks: (i) To use GPS RO data from 2001 to 2012 as climate benchmark datasets to quantify the MSU/AMSU temporal and spatial temperature anomalies, which would help to define a better approach for constructing MSU/AMSU temperature records from 1979 to 2012; (ii) To generate a long-term climate quality temperature dataset by reprocessing thirty-three years (1979-2012) of MSU/AMSU data. The 'adjusted' MSU/AMSU data and identified RO-consistent radiosonde data in the period of 2001 to 2009 (from the previous study) and from 2009 to 2012 will serve as reference data to calibrate other overlapped MSU/AMSU data from 1979 to 2001; (iii) To use GPS RO soundings collected from multi-RO missions but processed using a consistent processing package to construct tropopause height climatology from 2001 to 2012 that is consistent with changes in temperature and tropopause structure estimated by radiosondes.