Title: Generating consistent radiance SDRs and deep-layer atmospheric temperature TCDRs from the MSU/AMSU/SSU temperature-sounding channels

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The Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit (AMSU) on board the NOAA polar-orbiting satellites and NASA EOS and European MetOp satellites have provided critical atmospheric temperature measurements during the past 30 years. The Advanced Technology Microwave Sounder (ATMS) to be flown on the NPP/NPOESS program will carry the microwave sounding capability into the future. Before AMSU was available, the SSU (Stratospheric Sounding Unit) was the only instrument that made stratospheric temperature observations from 10 to 1 hPa. Together the MSU, AMSU, ATMS, and SSU comprise an indispensable Fundamental Climate Data Record (FCDR) for historical temperature change monitoring from the surface to the stratosphere.

Time-varying intersatellite biases exist in the pre-launch calibrated radiances that may cause spurious climate signals when these satellite measurements are used for climate product retrievals and reanalysis data assimilation. Deep-layer atmospheric temperature time series have been derived from the microwave sounder observations by different research groups; however, diverse trend results were obtained due largely to uncertainties in pre-launch calibrations. Post-launch intercalibration is required to reduce these biases for reliable climate monitoring and data assimilations in seamless weather and climate modeling.

We have developed intercalibration algorithm for the MSU instrument using simultaneous nadir overpasses, which results in a more accurate radiance dataset than pre-launch calibration in terms of significantly reduced intersatellite biases and bias drift. The improved radiances have been assimilated into the NCEP CFSRR (Climate Forecast System Reanalysis and Reforecast) and NASA MERRA (Modern Era Retrospective-analysis for Research and Applications) reanalysis systems. A historical MSU-based deep-layer atmospheric temperature *MSU/AMSU/SSU Radiance SDRs and Temperature TCDRs* 3 TCDR (Thematic Climate Data Record) has been generated from the recalibrated radiances and robust atmospheric temperature trends were obtained. In addition, community radiative transfer models (CRTM) were developed capable of dealing with critical calibration issues such as the CO2 gas leaking in the SSU instrument and Zeeman splitting effect in the AMSU stratospheric channels, providing feasibilities for construction of individual and further merged MSU/AMSU/SSU SDR and TCDR products.

We propose to develop climate quality, recalibrated radiance SDRs and deep-layer atmospheric temperature TCDRs from the raw measurements of the MSU/AMSU/SSU atmospheric temperature channels. This will include products form a single instrument on multiple satellites as well as merged products from different instruments, and it extends the current mature MSU SDR and TCDR to the AMSU/SSU instruments. The development will be built upon applications of state-of-art calibration technologies existing in the literature and an extensive research activity aimed at reducing intersatellite errors. Calibration issues to be dealt with include, but are not limited to, satellite orbital-decay, short overlaps between certain satellite pairs, orbital-drift related warm target contamination, nonlinear calibration, earth-location dependency in biases, antenna pattern effect, diurnal drift adjustment, limb-adjustment, residual bias correction and merging at the gridded product level, and stratospheric cooling effect in the MSU/AMSU mid-troposphere channels. The simultaneous nadir overpass (SNO) method will be used to help diagnose and remove intersatellite biases of different causes. The most-recently developed CRTMs for AMSU and SSU will be applied for bias removal of effects due to CO_2 cell gas leaking and long-term atmospheric CO_2 changes in the SSU measurement. Zeeman splitting effect in the AMSU stratospheric channels will be considered. Optimal view combinations will be applied to rectify frequency and scanning pattern differences between different satellites for satellite merging. Extensive and comprehensive validation efforts are designed to quantify the quality of the proposed SDRs and TCDRs using homogenized radiosonde, GPSRO, as well as inter-comparisons of the same TCDR product but derived by different research groups.

The project will be carried out through a collaborative effort among the science team members. The team will also collaborate with other teams within and external to NOAA to investigate different calibration issues and implement mature techniques into the proposed SDRs and TCDRs. If the proposal is successful, this team is willing to host a workshop to establish community consensus approaches through discussions with the calibration and data generation community and the SDS program management. The proposed research will take place over a three-year period.