



An update on the NOAA MSU/AMSU CDR development

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Outline

- ❑ Project Goal
- ❑ MSU/AMSU CDR Development
- ❑ CDR Comparison Results from Recent CDR Workshop on Satellite Microwave Radiometry
- ❑ Data Set Archive and Web Service
- ❑ Summary



MSU/AMSU CDR Project Goal

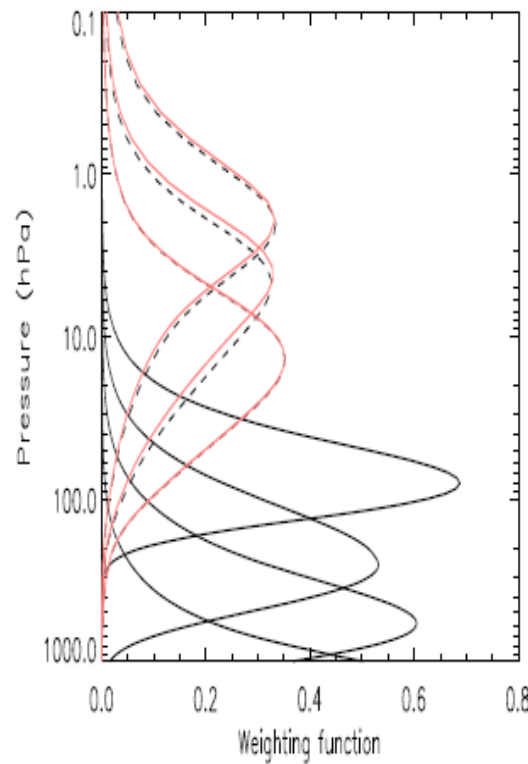
- ❑ Develop consistent radiance Fundamental Climate Data Record (FCDR) to support consistent modeling reanalysis and consistent satellite retrievals
- ❑ Develop consistent atmospheric temperature thematic climate data record (TCDR) for climate service support – climate change research, climate change monitoring, validating climate model simulation...



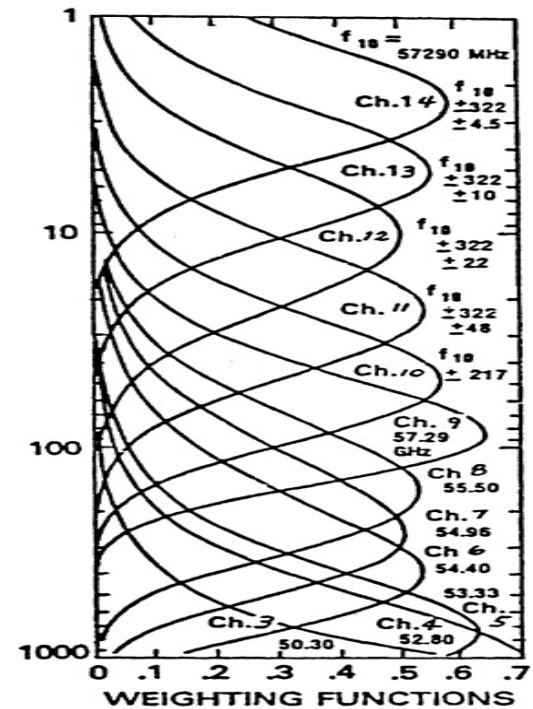
MSU/AMSU/SSU channels

- MSU/AMSU/SSU has total of 22 channels
- Working on 15 atmospheric channels
- Generally, each channel has its own characteristics for calibration
- Involving 15 satellites

MSU+SSU; 1978-2007



AMSU; 1998-present

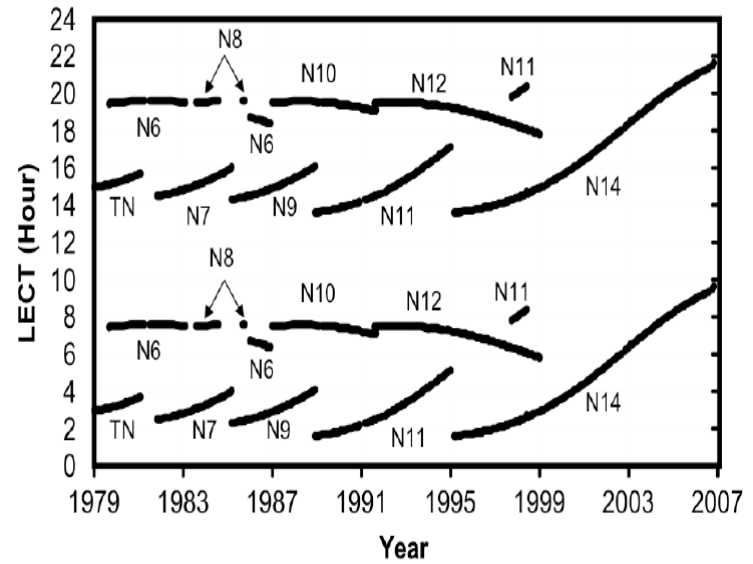


Left: Weighting functions for the MSU and SSU instruments, where the black curve represent the MSU weighting functions and the dashed and red curves are the SSU weighting functions for different time period, showing a shift due to an instrument CO₂ cell pressure change; Right: Weighting functions for AMSU-A. All weighting functions are corresponding to nadir or near-nadir observations.



Known Issues on MSU/AMSU CDR Development (contributions from many investigators)

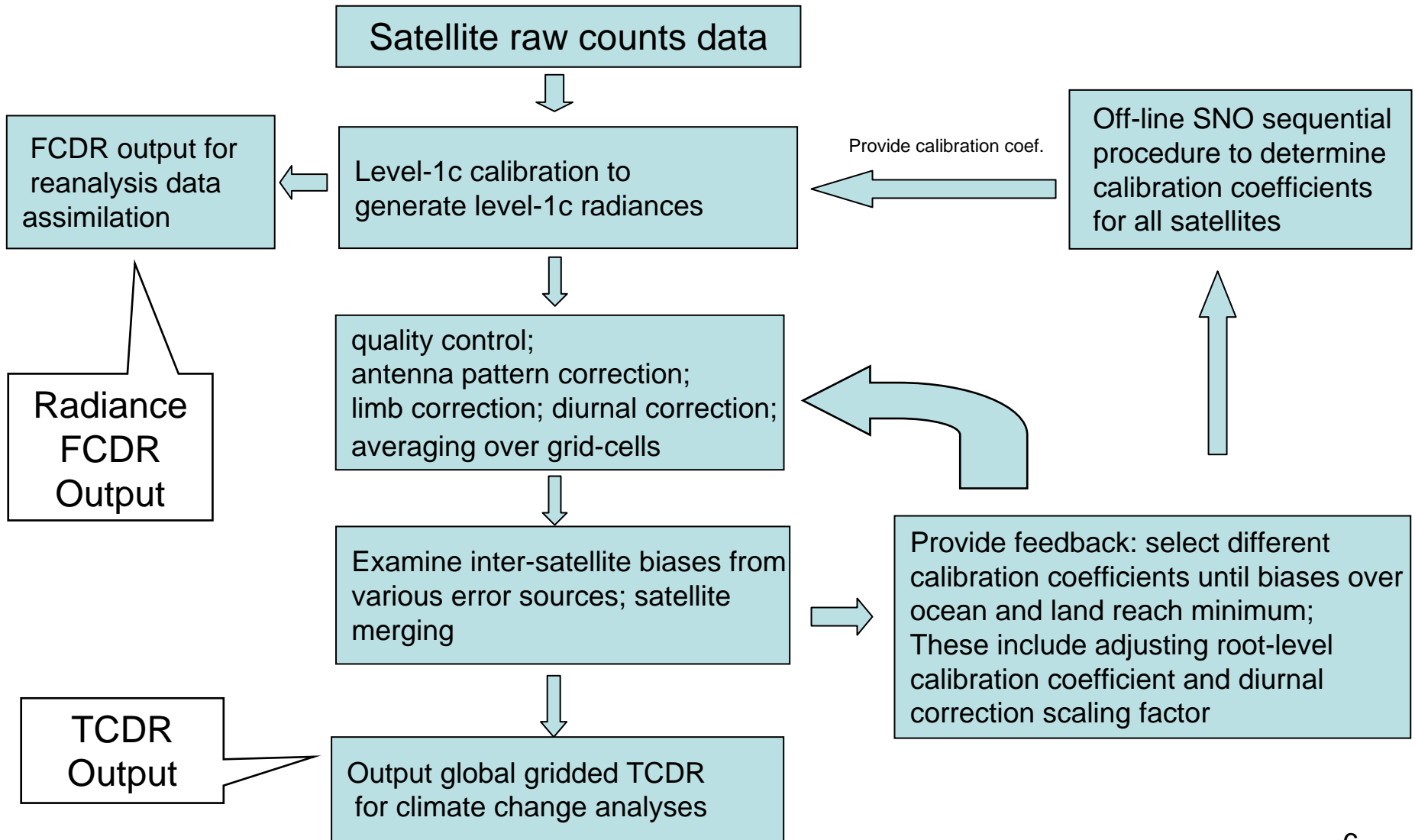
- Instrument signal contamination on radiances
- Diurnal drift effect
- Residual bias correction
- Short overlaps between NOAA-9 and NOAA-10
- Lat/Lon and time dependency in biases
- Orbital-decay
- Antenna pattern correction
- Incident angle errors
- Stratospheric effect on MSU ch2
- Atmospheric O₂ decreasing?
(not considered yet)
- Noises in TLT



Local Equator Crossing Time for NOAA
POES satellites

The issues on blue colors have been investigated at NOAA. Algorithms either being developed, or adopted from research of other groups, or effects are too small for corrections.

NOAA MSU/AMSU CDR Development System



Inter-satellite calibration to remove instrument specific errors using SNO method

Nonlinear calibration

$$R = R_L - \delta R + \mu Z$$

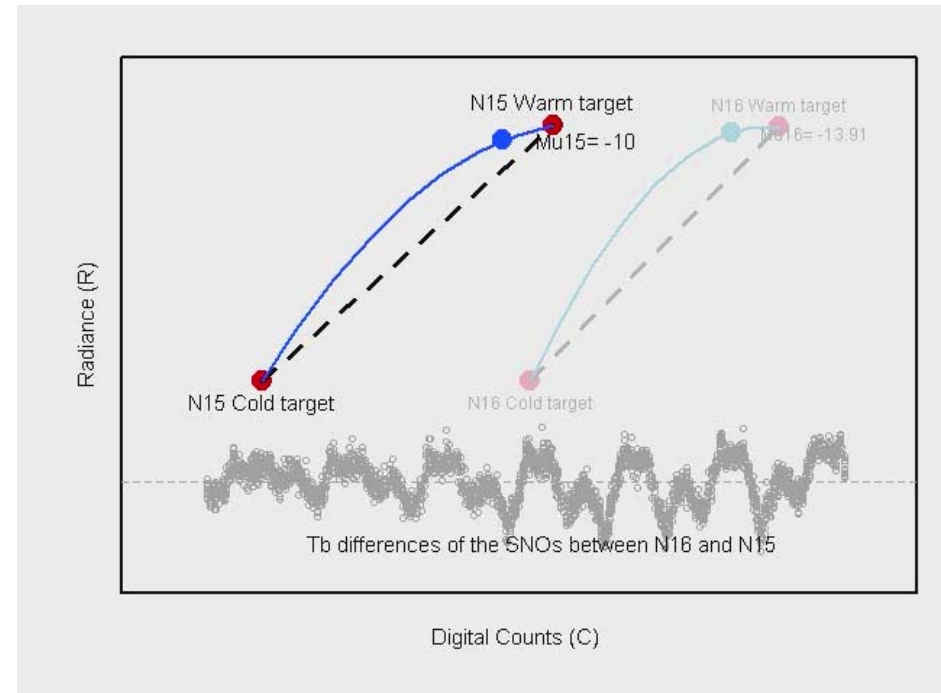
R_L is the linear calibration term

$$R_L = R_c + S(C_e - C_c)$$

$S \rightarrow$ Slope

$$Z = S^2 (C_e - C_c)(C_e - C_w)$$

Using SNOs to find best calibration coefficients

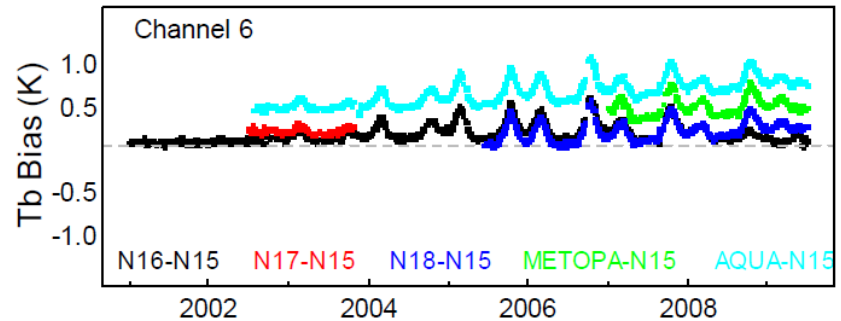




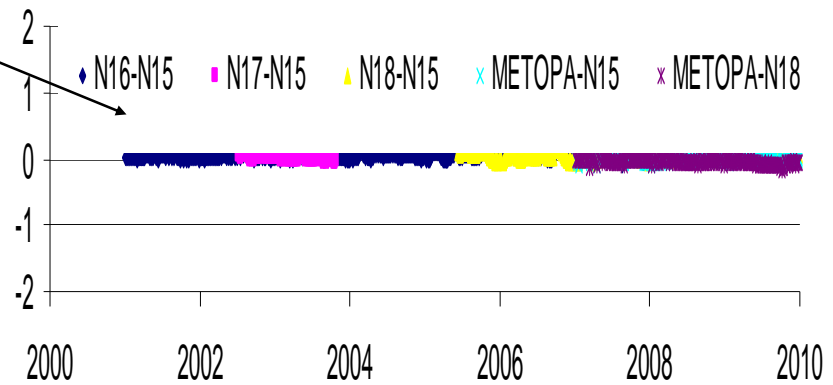
Before and After Inter-Satellite Calibration AMSU CH6

- ❑ NOAA-15 CH6 has strong calibration nonlinearity
- ❑ Time-dependent calibration coefficients for NOAA-15 are introduced at Level-1c
- ❑ After SNO recalibration, inter-satellite differences close to zero
- ❑ Recalibrated trend is expected to be different from NOAA-15

NOAA operational calibrated inter-satellite difference time Series (Before Inter-satellite calibration); Ocean Mean



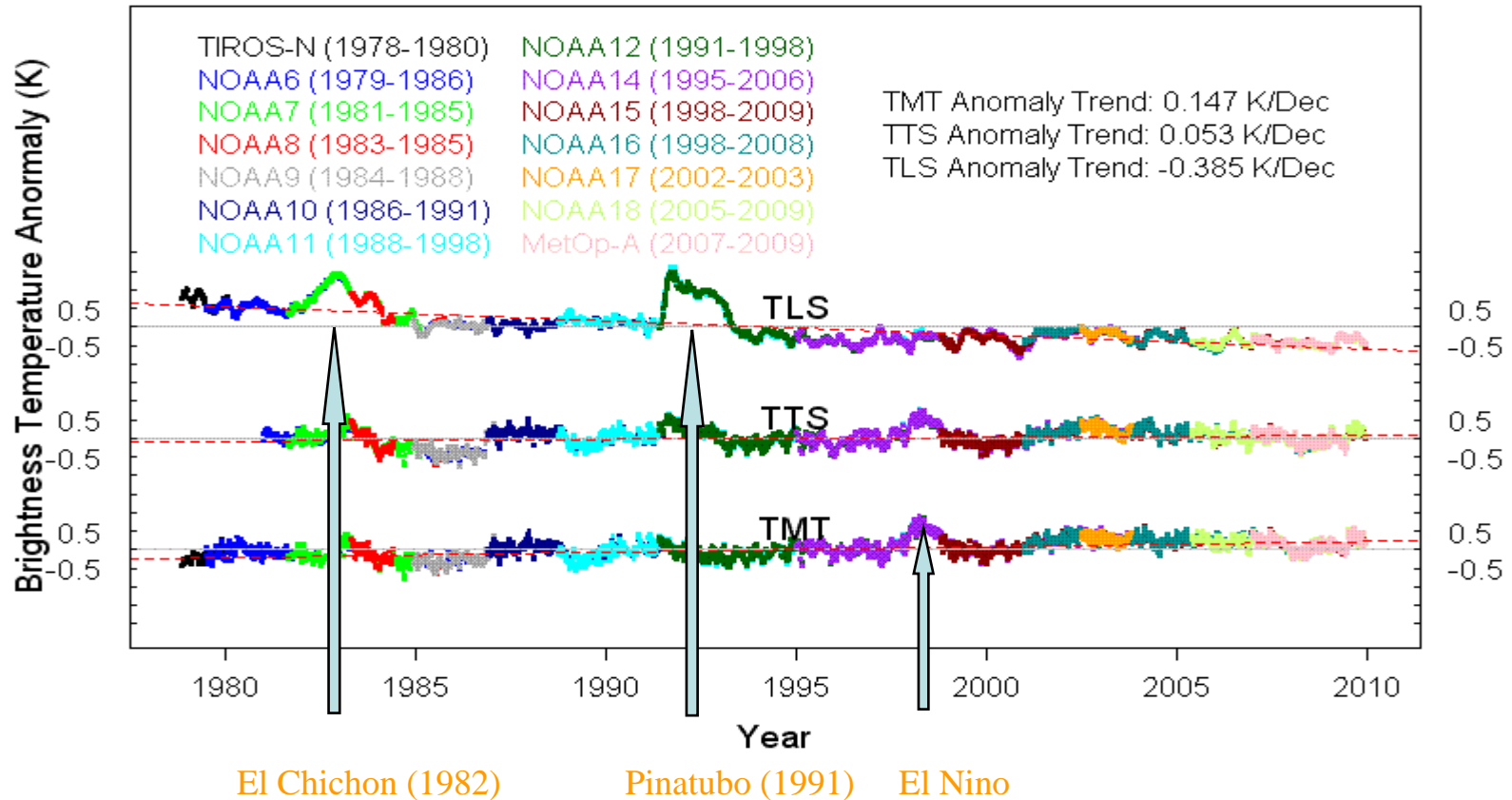
Inter-satellite difference time series after SNO Inter-satellite calibration, AMSU-A CH6





Merged MSU/AMSU time series, Version 2.0

MSU/AMSU-A Global Mean (Land+Ocean) Temperature Anomaly Time Series

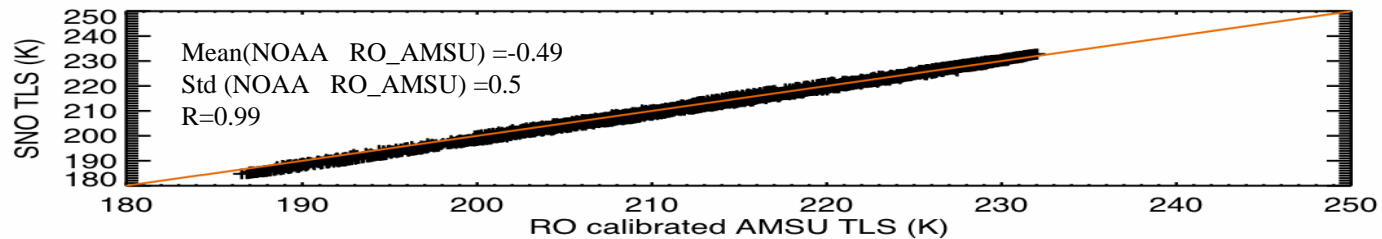
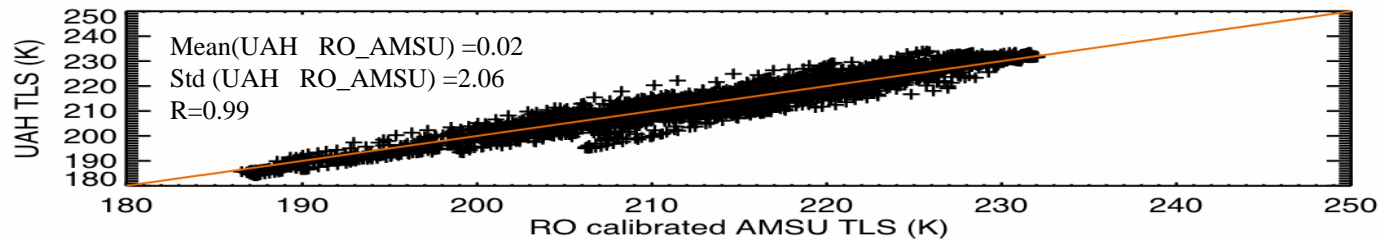
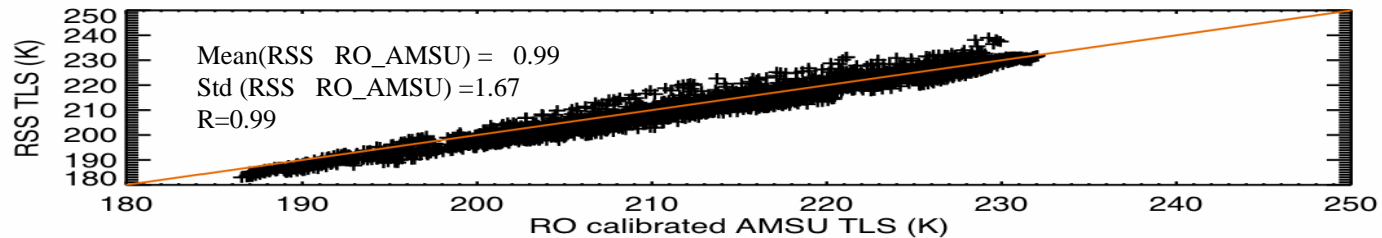


Five-day and global-mean temperature anomaly time series



GPS-RO calibrated MSU/AMSU vs SNO recalibrated MSU/AMSU products

Scattering plots of 10 x10 degree binned TLS from 200106 to 200812

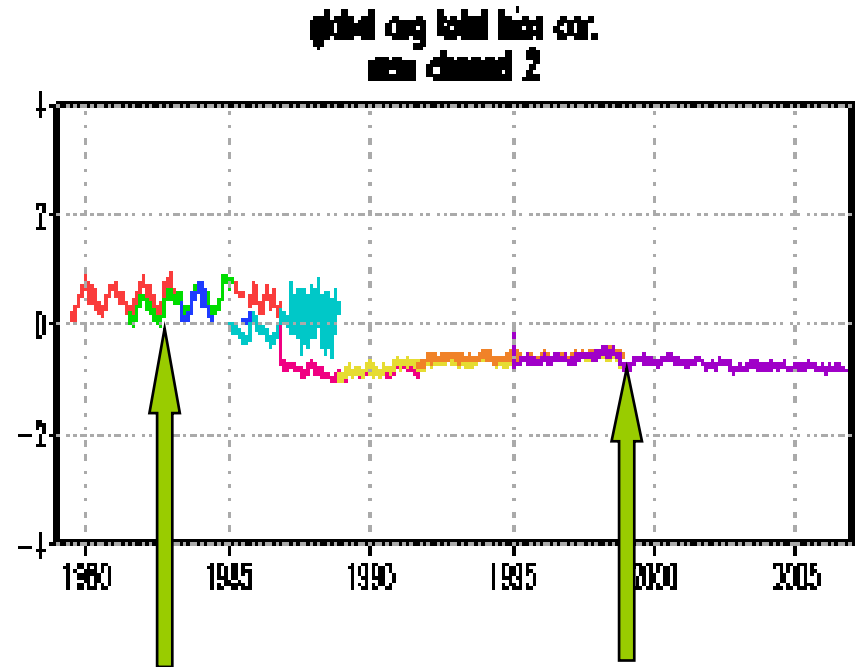


From Ben Ho of NCAR, NOAA CDR Workshop, Silver Spring, Maryland
March 22-24



Bias Correction of Recalibrated MSU data in NCEP CFSR Reanalysis

- ❑ Recalibrated MSU level-1c data were assimilated into NCEP CFSR and NASA MERRA reanalysis systems
- ❑ Bias correction pattern for recalibrated MSU data are much smoother, since instrument errors were removed before assimilation
- ❑ Need to adjust the absolute values of the recalibrated MSU/AMSU data so that the absolute value of the bias correction is close to zero



Before Recalibration After Recalibration

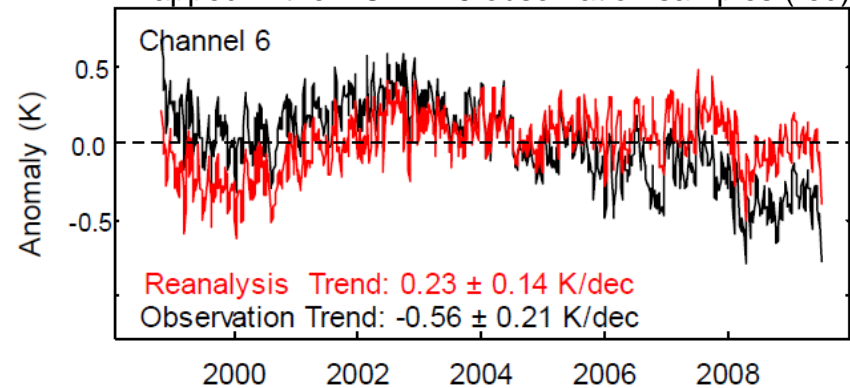
MSU Channel 2 bias correction patterns in NCEP CFSR reanalysis from 1978-2007. Recalibrated MSU data after 1987 were assimilated into CFSR (plot from Saha et al. 2010)



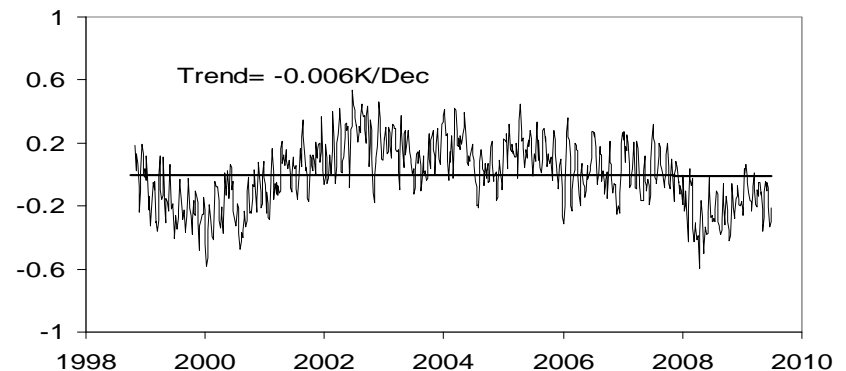
Trend comparisons between ERA-Interim Reanalysis and Merged MSU/AMSU Product:CH6

- ERA-Interim Reanalysis and NOAA operational calibrated data have large trend differences up to 0.8 K/Dec
- SNO recalibrated CH6 trend is different from either reanalysis or NOAA operational calibrated data
- Reanalysis trends are consistent with RAOB and aircraft data since these data are used as anchoring data in reanalysis data assimilation
- Future reanalysis is recommended to use recalibrated satellite data as anchoring data

NOAA-15 CH5 ocean mean time series and trend (black) as used in ERA-I and the ERA-I reanalysis mapped in the NOAA-15 observation samples (red)



STAR SNO inter-calibrated MSU/AMSU ocean mean time series, Ch6





Recommendations

- ❑ Climate trend differences between satellites and reanalyses occur because radiosonde and aircraft data are used as anchor dataset for reanalysis data assimilation
- ❑ Unless fundamental problems are found in inter-satellite calibration processes, it is recommended that inter-calibrated satellite data such as MSU/AMSU be considered as the anchor dataset in future reanalysis data assimilation so that satellite and reanalysis trends will be consistent

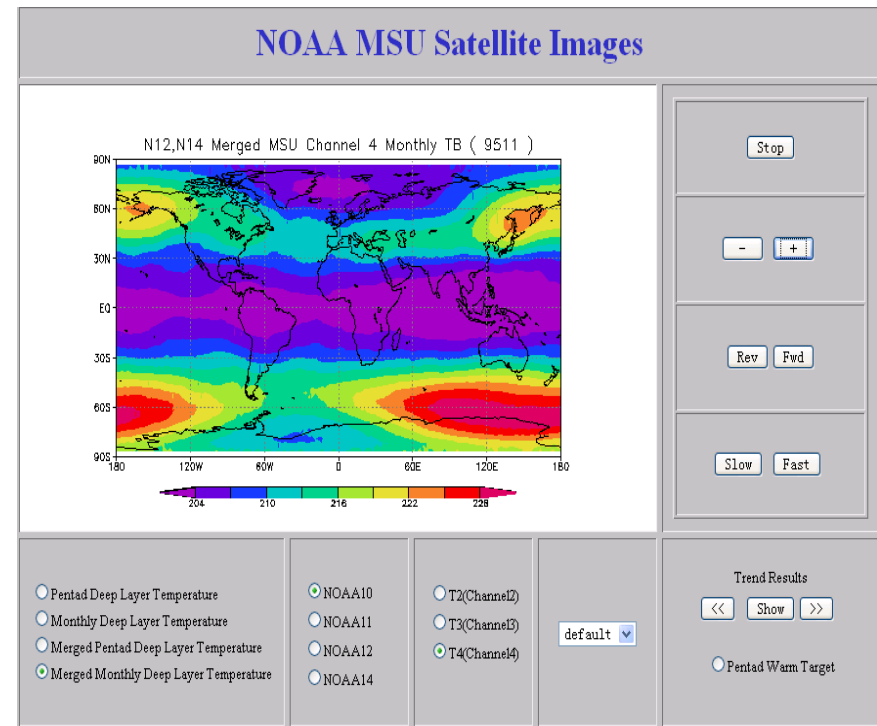
Data Archive and Download

❑ Website address:

<http://www.orbit.nesdis.noaa.gov/smcd/emb/mscat/mscatmain.htm>

❑ Datasets for public access:

- Level -1b calibration coefficients
- Level -1c radiance:
 - SNO calibrated
 - pre-launch (operationally) calibrated
- Level 3 gridded products: $2.5^0 \times 2.5^0$
 - MSU/AMSU merged pentad and monthly TMT, TTS, and TLS, Version 1.2 and 2.0
- Continue to add more channels when available





Status Summary

- Well-intercalibrated 28-year (1978-2006) MSU-only radiance FCDR is generated for reanalysis data assimilation which accounts for sun heating variability on instrument
- NCEP CFSR and NASA MERRA have already assimilated 20-year (1987-2006) recalibrated MSU level-1c data
- Version 1.2 well-merged 28-year MSU-only deep-layer atmospheric temperature TCDR is generated for climate change research
- AMSU channels 4, 5, 6, 7, 8, 9, 10 from NOAA-15 to NOAA-18 and MetOp-A have been inter-calibrated
- Version 2.0 merged MSU/AMSU (1978-present) deep-layer atmospheric temperature TCDR have been created and put online; merging include MSU2/AMSU5, MSU3/AMSU7; MSU4/AMSU9
- SSU recalibration and CDR development is ongoing



Thank You!

International TOVS Study Conference, 17th, ITSC-17, Monterey, CA, 14-20 April 2010.
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,
Cooperative Institute for Meteorological Satellite Studies, 2011.