NOAA Satellites and Information

National Environmental Satellite, Data, and Information Service

Toward a Long-Term Climate Change Monitoring in the JPSS Era

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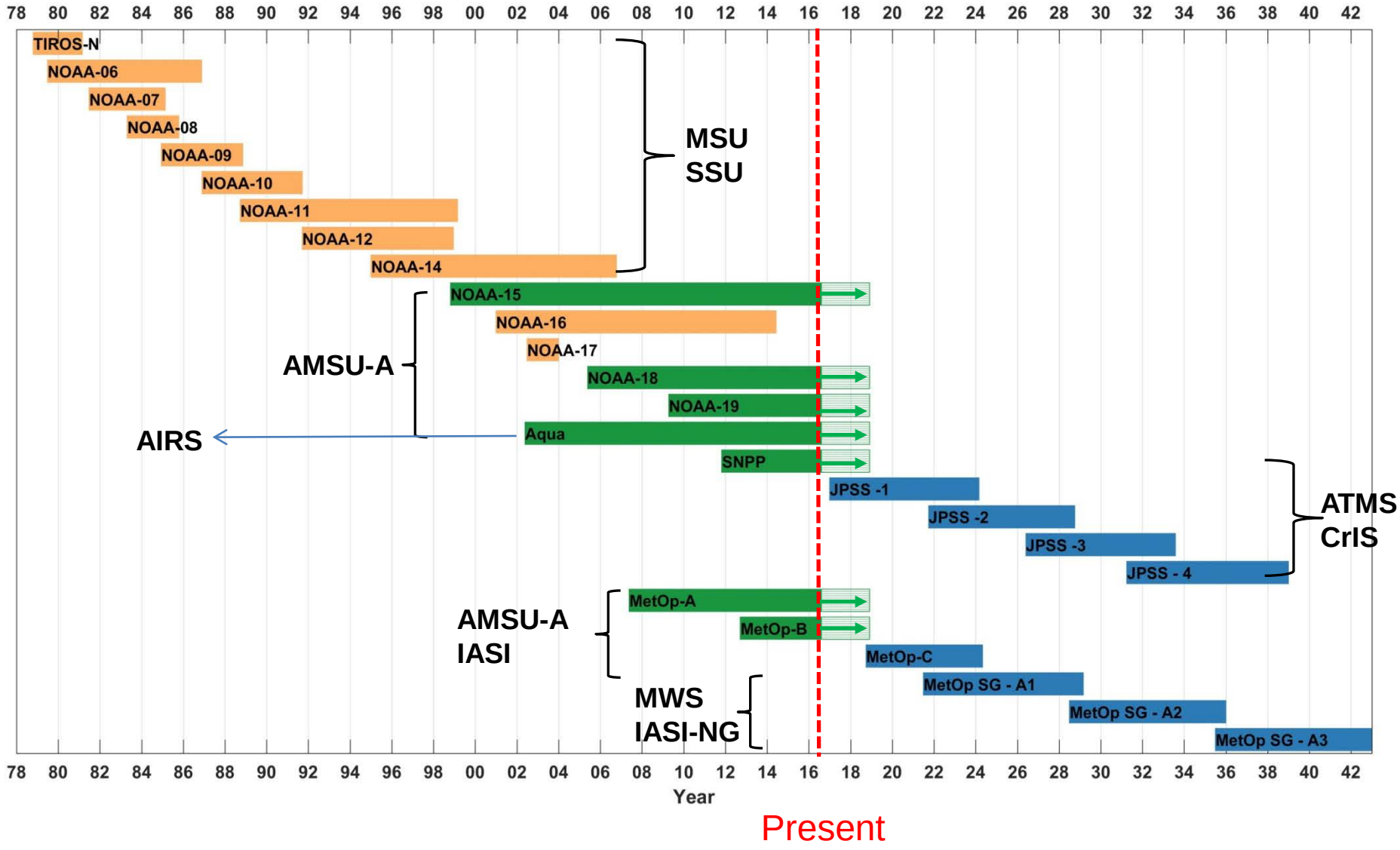
NOAA/NESDIS/Center for Satellite Applications and Research

2016 STAR JPSS Annual Meeting, July 8-12, 2016

Outline

- The NOAA/NASA/MetOp POES Temperature Sounders
- Current Capability at STAR
- Applications of Atmospheric Temperature CDR
- Perspective

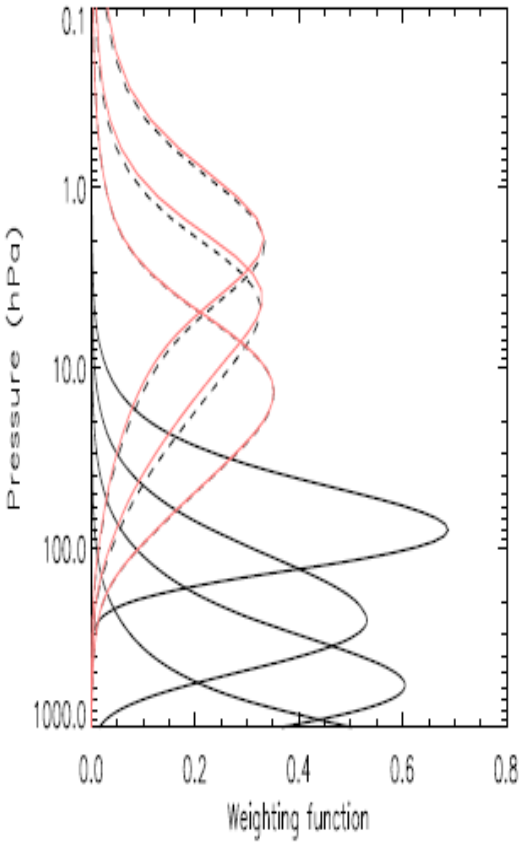
NOAA/NASA/MetOp Satellite Series Carrying Microwave/Infrared Sounders



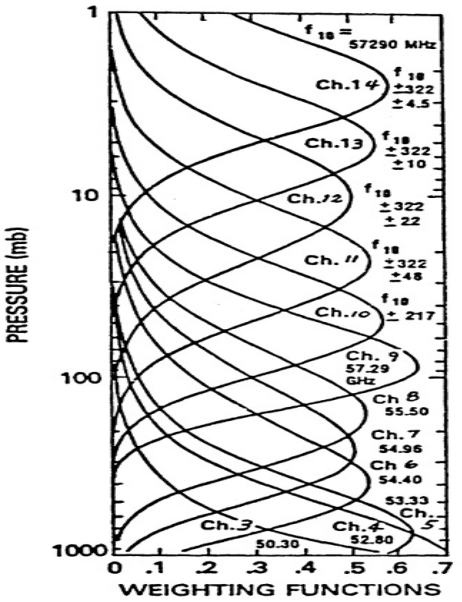
The NOAA/NASA/MetOp Temperature Sounders

- Have been measuring atmospheric temperature profiles from surface to stratosphere
- Nearly 40 years of observations with global coverage
- MSU : From surface to lower-stratosphere
- SSU: From mid-stratosphere to lower-mesosphere
- AMSU-A: From surface to upper-stratosphere

MSU+SSU;



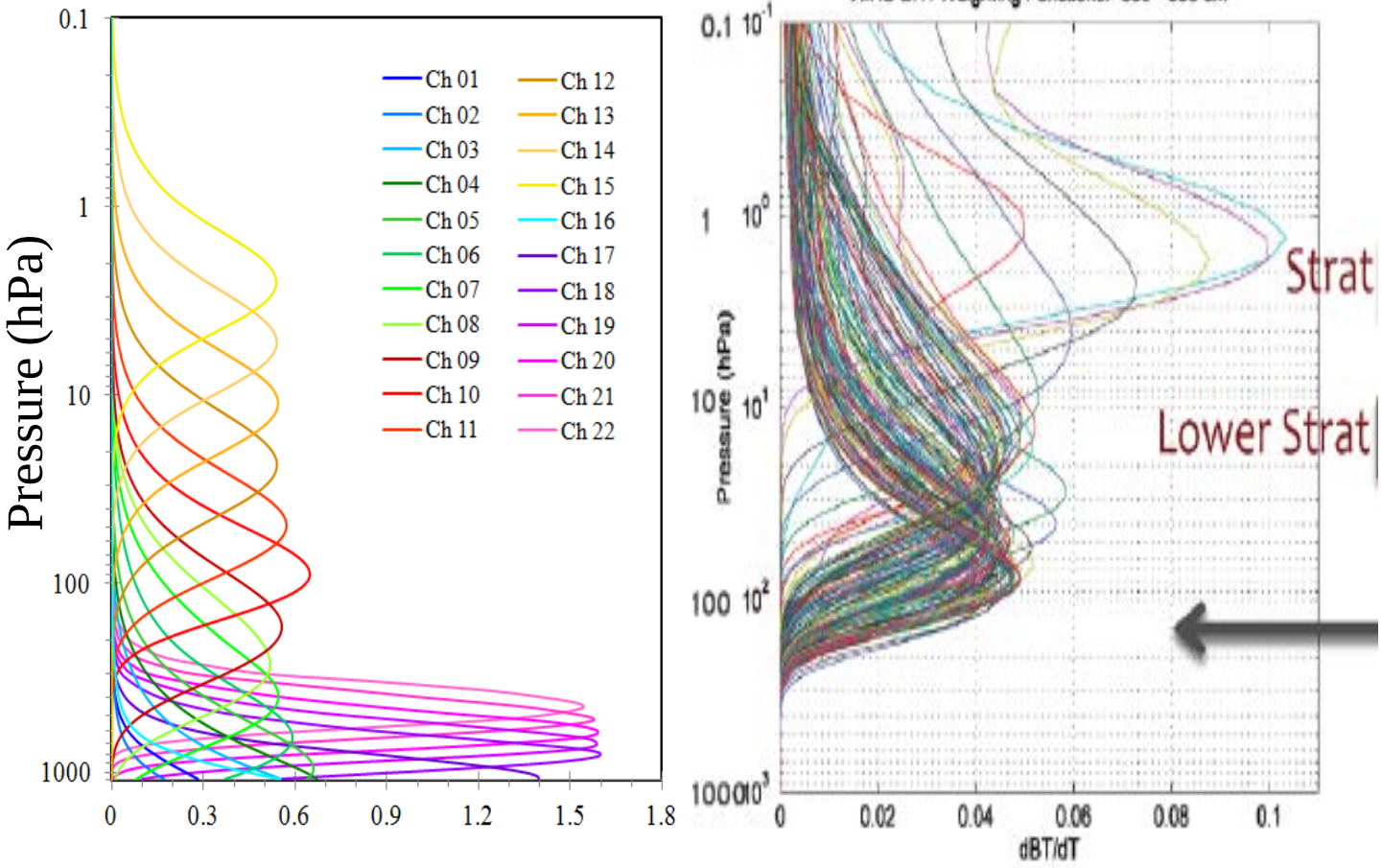
AMSU-A



The NOAA/NASA/MetOp Atmospheric Temperature Souder Series

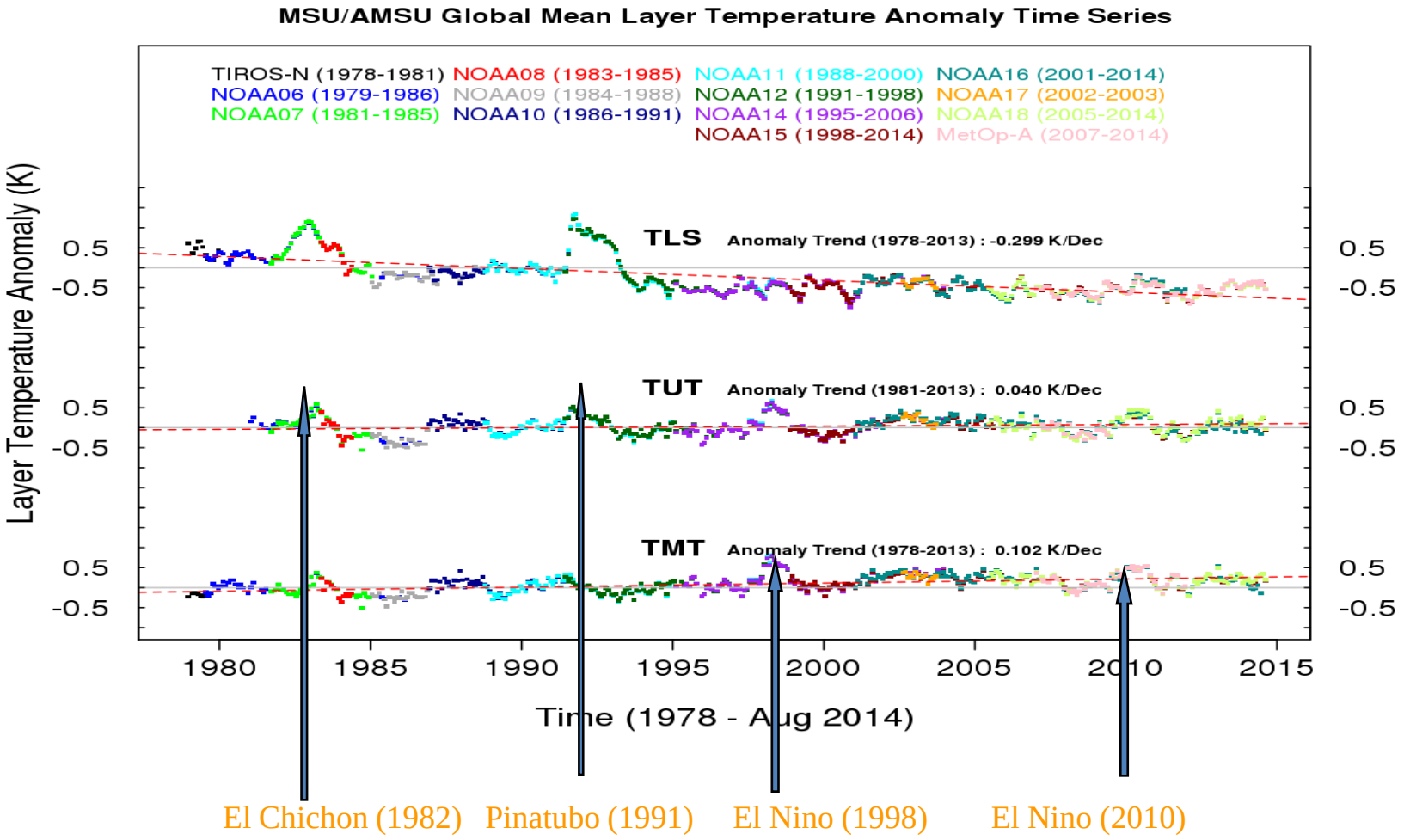
- ATMS: From surface to upper-stratosphere

- AIRS/IASI/CrIS: From surface to lower-mesosphere



Weighting functions of ATMS and AIRS

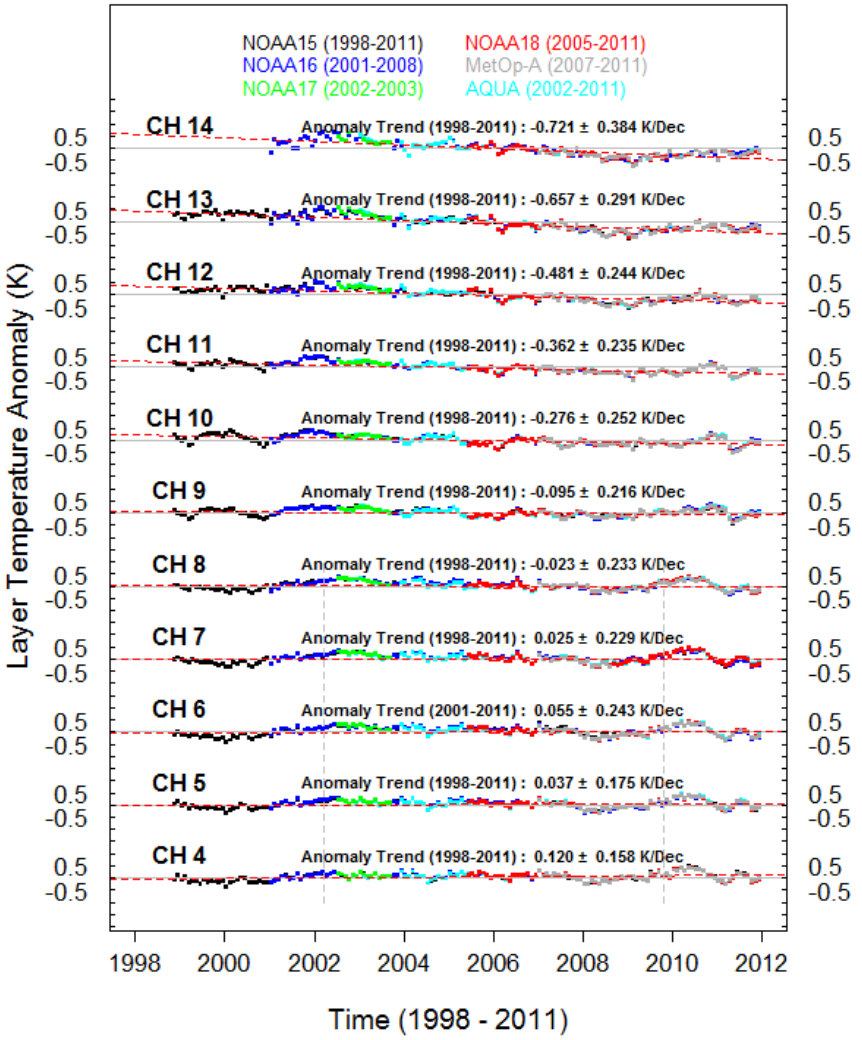
Current Capability at STAR – Merged MSU/AMSU-A Time Series (1978-present)



Monthly and global-mean temperature anomaly time series, Updated and delivered to NCEI every month for 'operationally' archiving and distribution

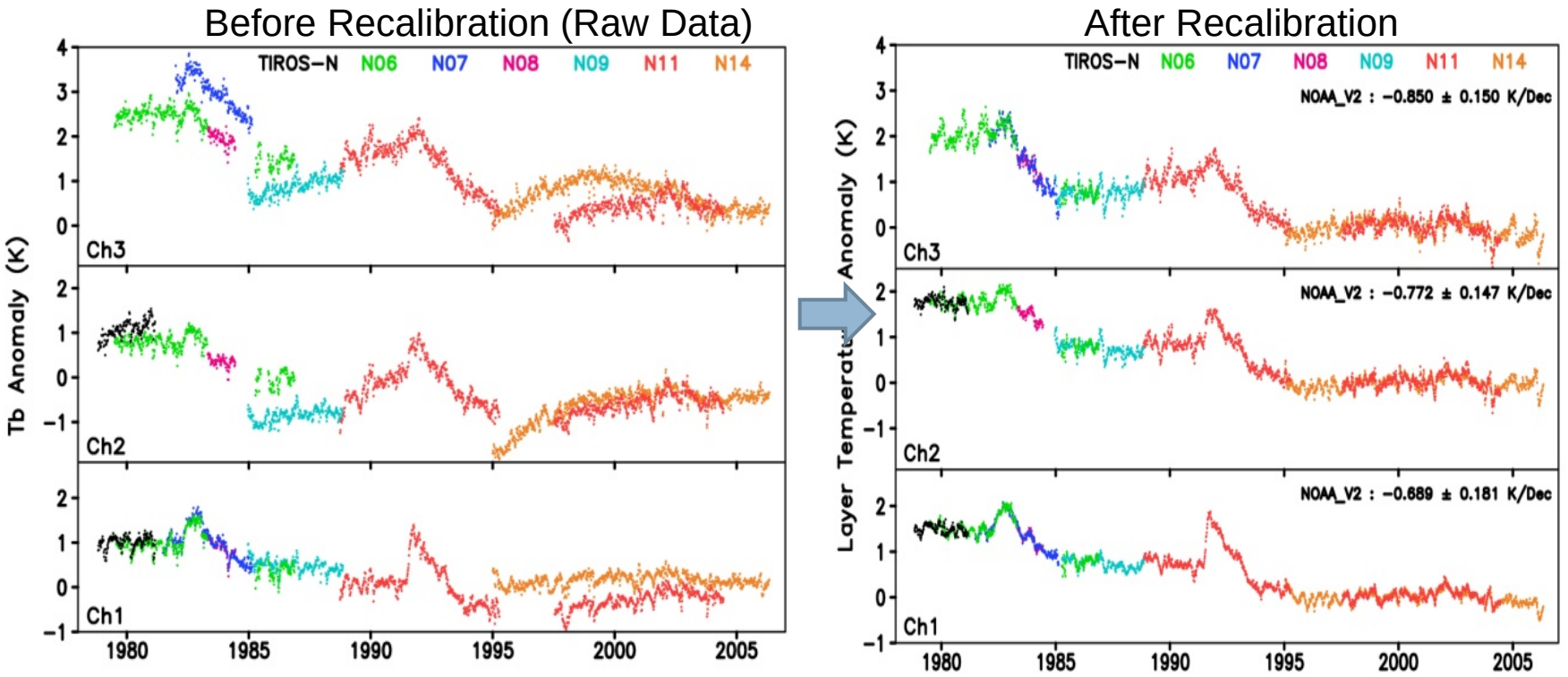
AMSU-A Only Time Series (1998-present)

- Similar procedure and Methodology
- More channels and thus better vertical resolution
- Shorter time period (1998-present)
- Diurnal effect in stratospheric channels are larger and was removed



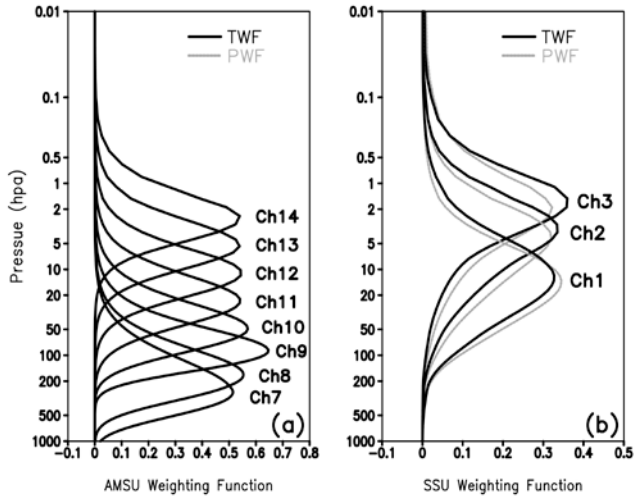
SSU-only Time Series (1978-2006)

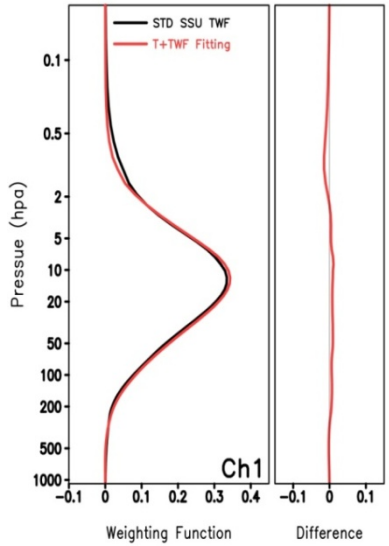
SSU Temperature Anomaly Time Series

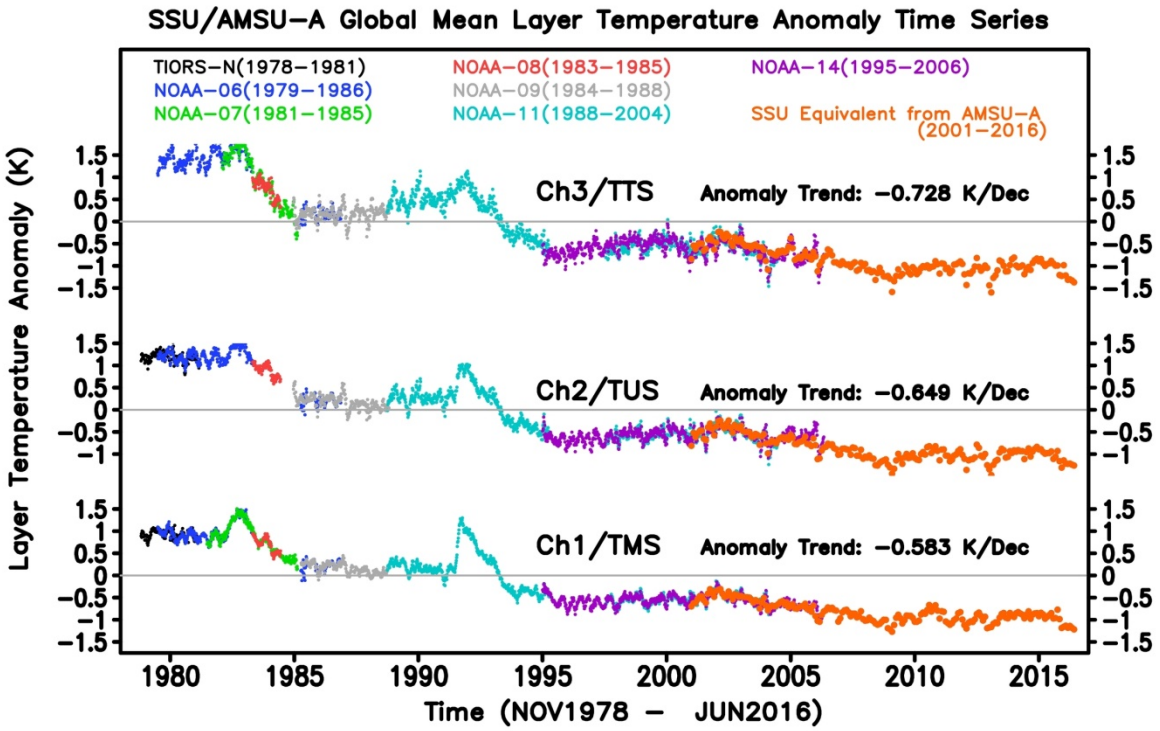


Recalibration successfully rehabilitated the SSU data record, making the inconsistent raw SSU time series with large time-varying biases between satellites before correction (left) to a consistent, well-intercalibrated and -merged satellite time series suitable for climate change studies after correction (right).

Merged SSU and AMSU-A Time Series (1978-present)

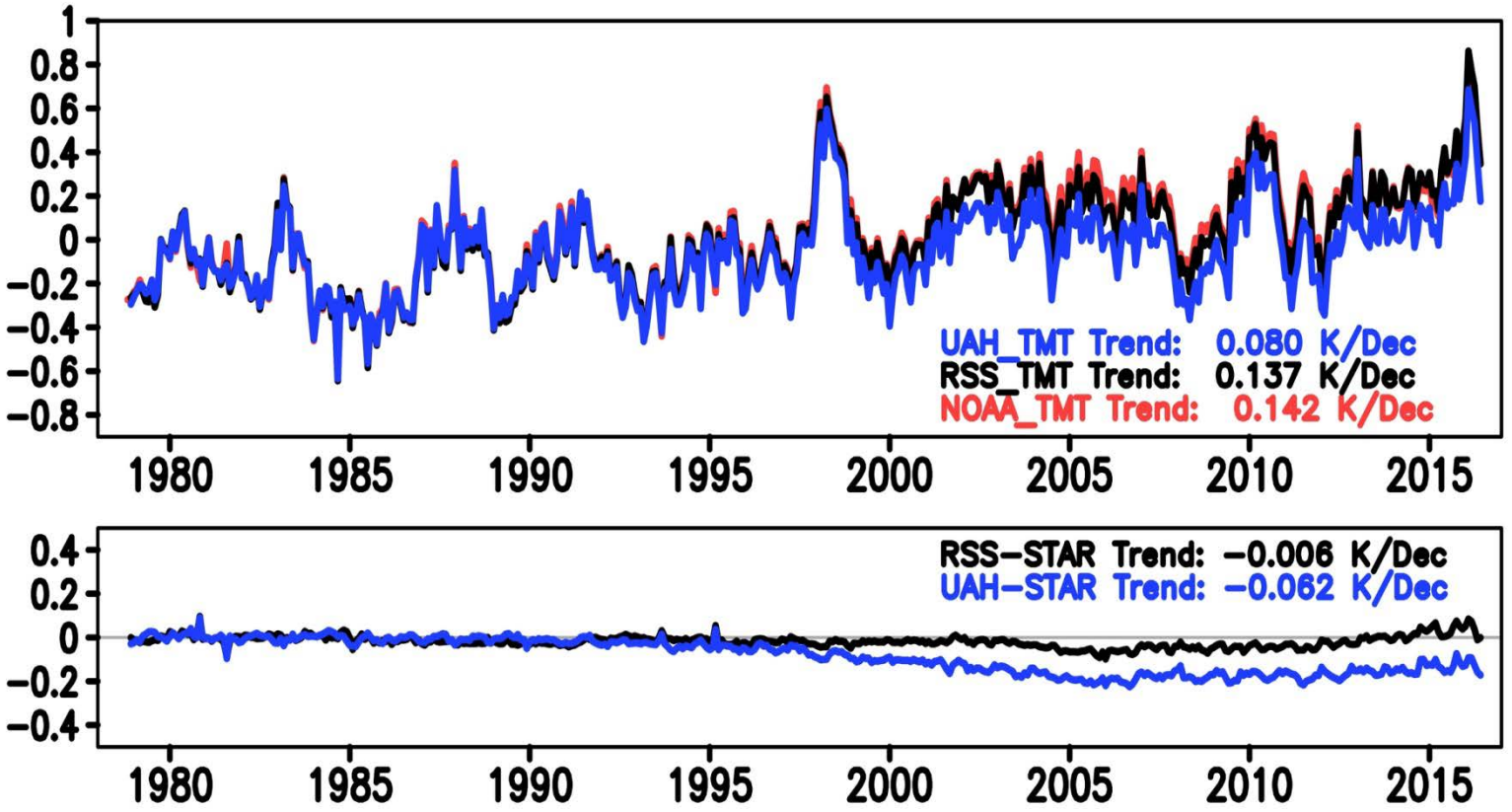






Merged SSU and AMSU-A time series

Application -- Involves in Global Warming Debate



Three groups, University of Alabama at Huntsville (UAH), Remote Sensing Systems (RSS), and NOAA/STAR produce the same variable, Temperature of Mid-Troposphere (TMT), but having different long-term trend values

Support Congress Hearing on Climate Change Debate

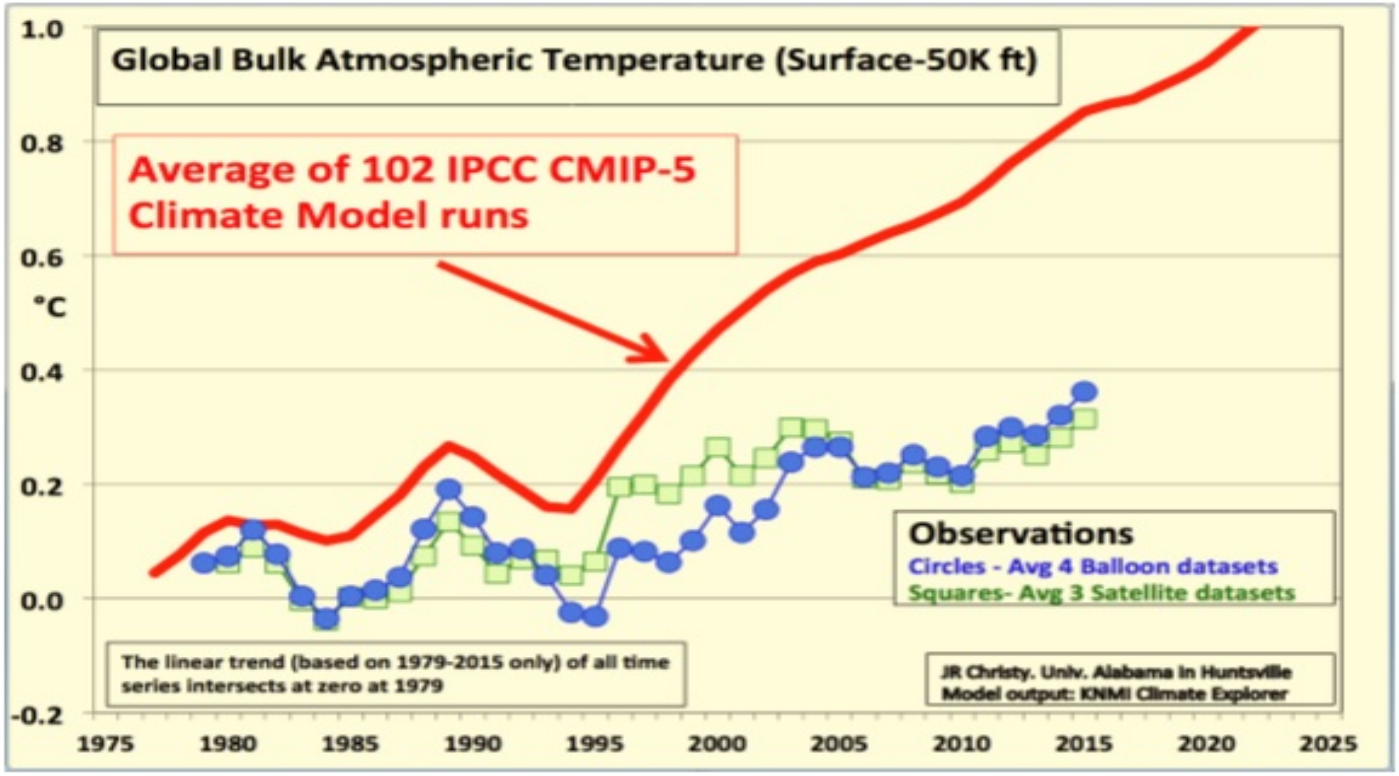
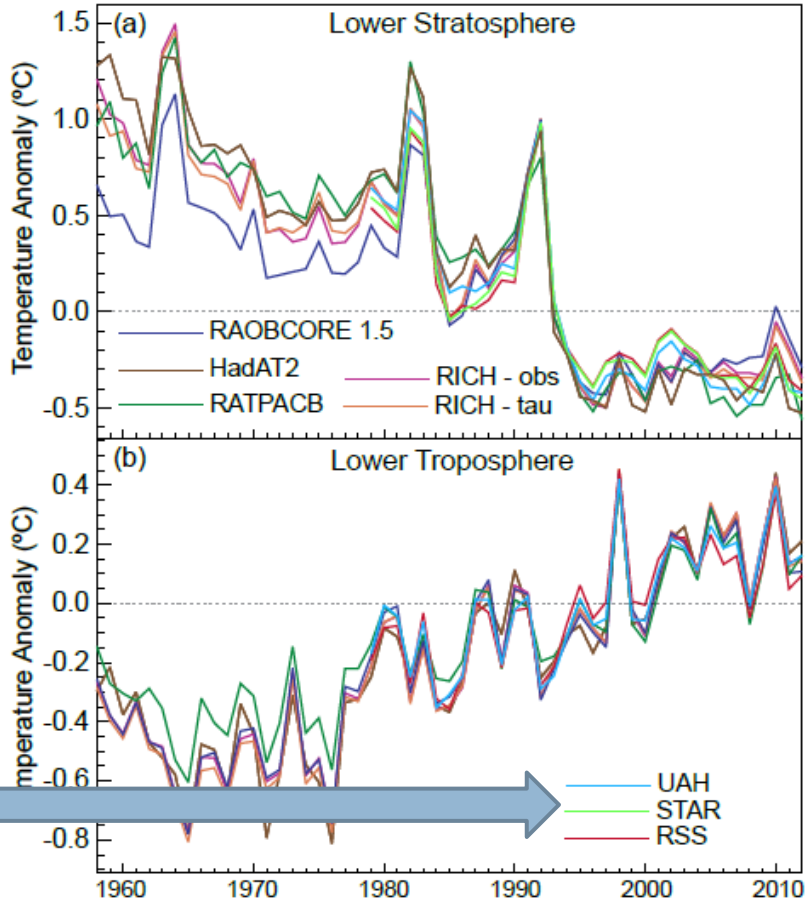


Fig. 1: Five-year averaged values of annual mean (1979-2015) global bulk (termed "mid-tropospheric" or "MT") temperature as depicted by the average of 102 IPCC CMIP5 climate models (red), the average of 3 satellite datasets (green - UAH, RSS, NOAA) and 4 balloon datasets (blue, NOAA, UKMet, RICH, RAOBCORE).

Plot from Jan. 2016 Congress Climate Change Hearing

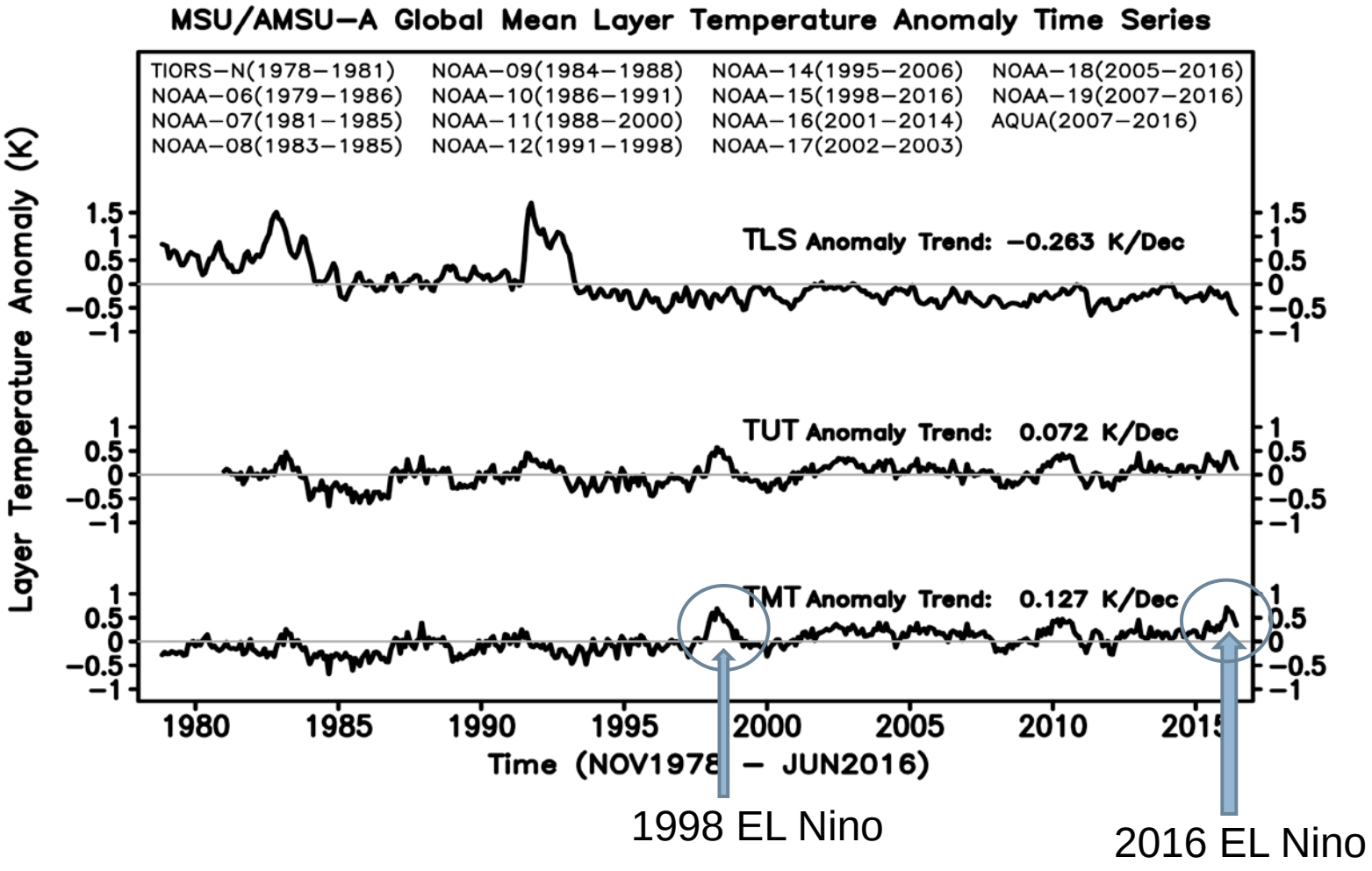
Support NOAA and IPCC climate change assessment

- IPCC provide climate change assessment every few years
- NOAA/NCEI provide climate assessment every year
- STAR data used as a reference in characterizing atmospheric temperature changes



Global mean temperature time series in Lower-troposphere and lower-stratosphere (Plot from IPCC AR5 Report)

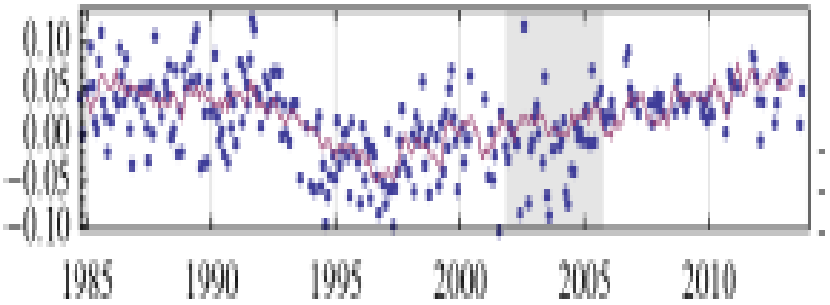
Monitoring Climate Change in Near Real Time

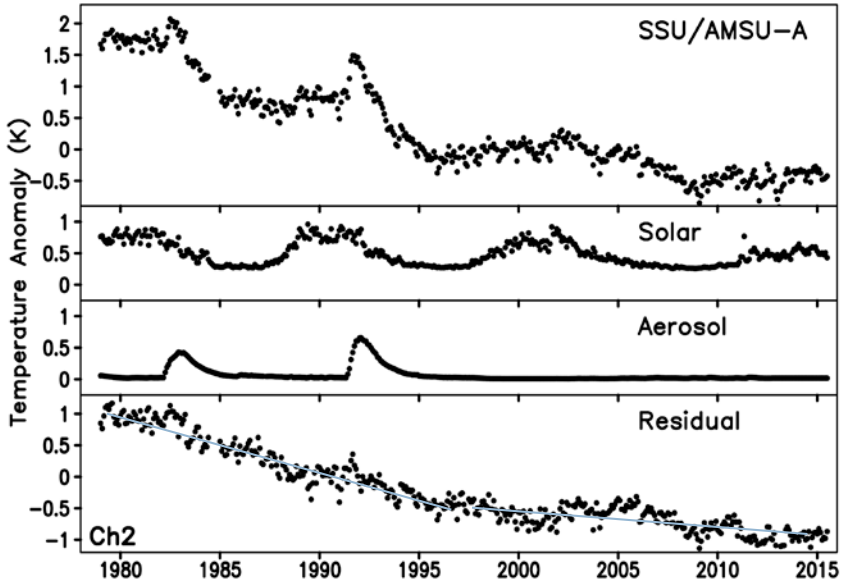


Investigation of Climate Change Phenomenon —Temperature trends responding to ozone trends

Linear trends (K/Dec) and 2-sigma uncertainty of the residual time series after the 11-year solar cycle and aerosol effect were removed from the extended SSU global mean time series.

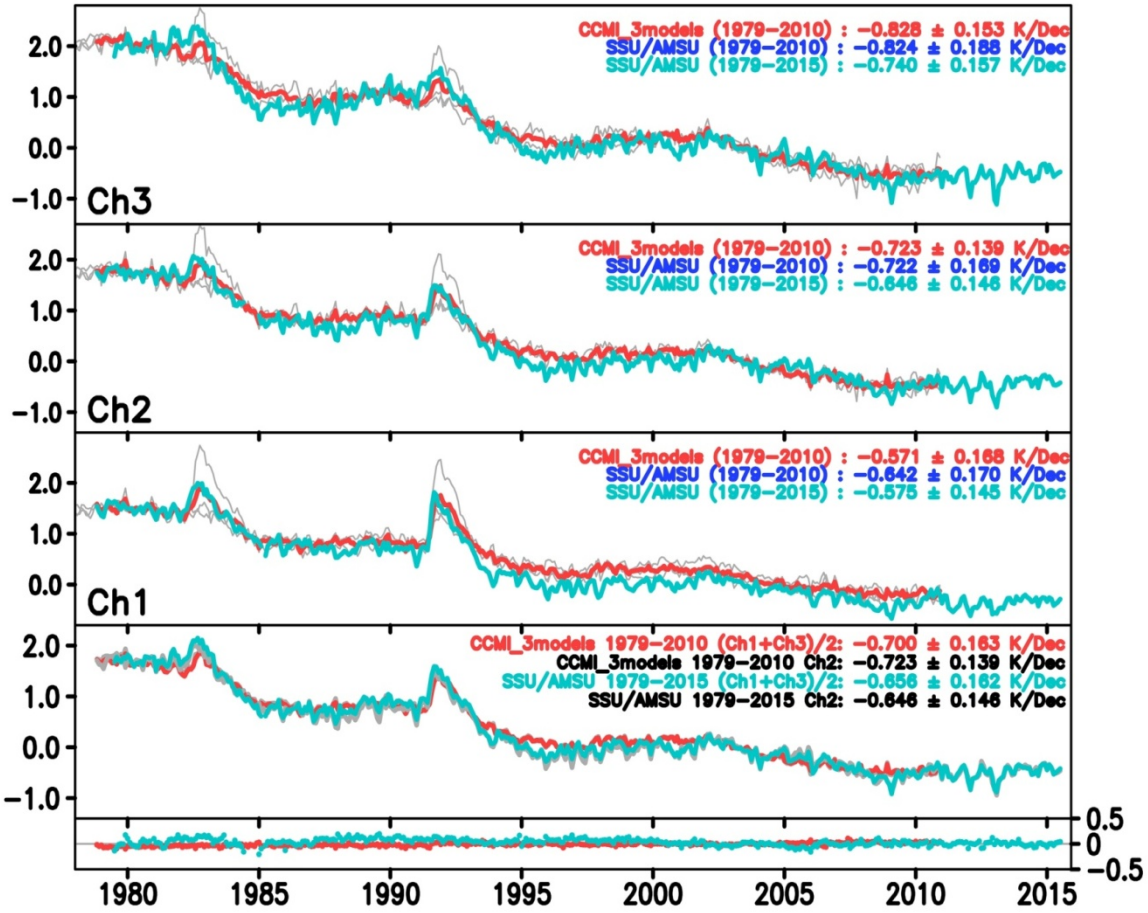
	9719-2015	1979-1997	1998-2015
SSU Ch3	-0.64 (0.06)	-0.93 (0.10)	-0.39 (0.10)
SSU Ch2	-0.55 (0.06)	-0.88 (0.07)	-0.30 (0.10)
SSU Ch1	-0.48 (0.06)	-0.76 (0.07)	-0.25 (0.07)



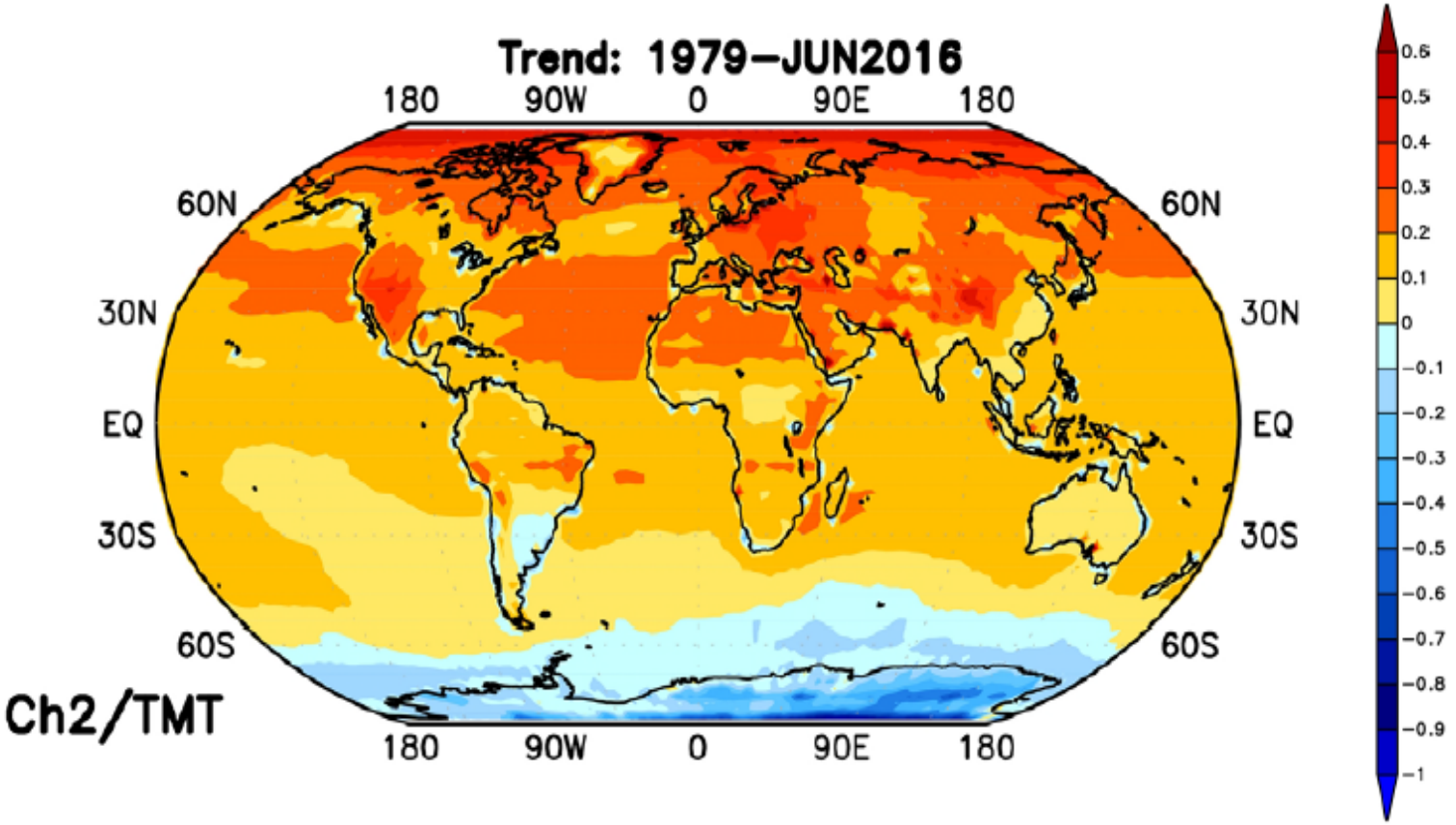


Validating Chemistry-Climate Model Simulations in the Stratosphere

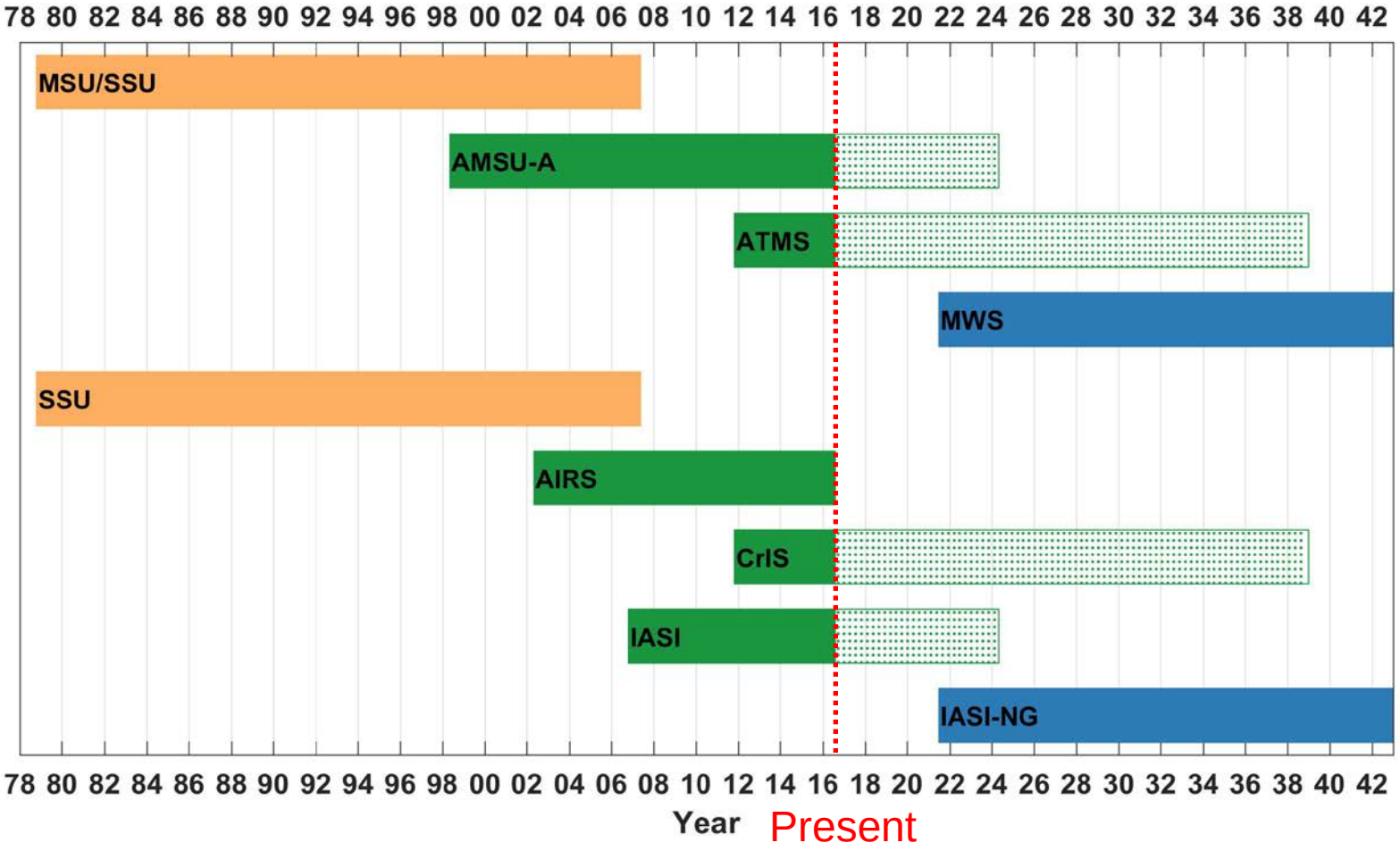
- Trends are nearly identical for channels 2 and 3
- Model cooling trends are slightly weaker for channel 1
- Solar cycle amplitude in models is weaker



Spatial Trend Pattern of the Mid-Tropospheric Temperature



Future Perspective



Perspective

- Merge ATMS channels 5, 7 and 9 to the existing MSU/AMSU time series for extended TMT, TUT, and TLS. This will extend the time series from 1978 to possibly 2038 in the JPSS era. The extended time series will span for over 60 years. It will provide more accurate estimate on tropospheric temperature trend: the typical time length for tropospheric temperature trend estimates with 20% error is about 35 years

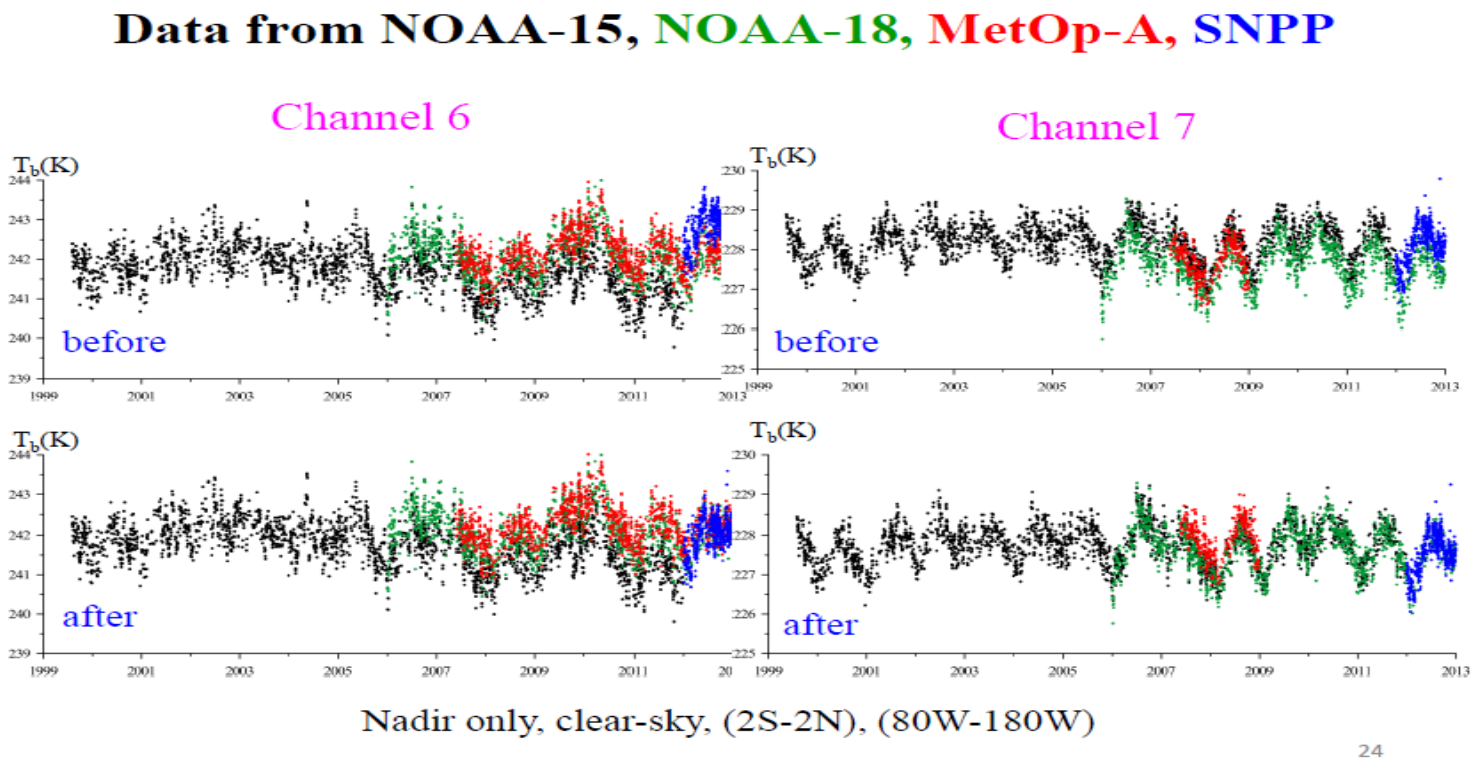
- Merge ATMS channels 4 through 14 to AMSU-A channels. This will extend the AMSU-A only time series from 1998 to 2038. The extended time series will span for 40 years with high vertical resolution for trend and variability studies

Perspective

- Merge ATMS channels to SSU/AMSU-A channels for extended TMS, TUS, and TSM. This will again extend the time series from 1978 to 2038. The extended time series will span for over 60 years with 6 complete solar cycles. This stratospheric temperature time series is expected to largely improve our understanding on the impact of the solar cycle and aerosol on the climate change

- Merge AIRS/IASI/CrIS stratospheric channels to SSU channel 3. Since AMSU-A/ATMS channel 14 is not high enough to cover the lower-mesospheric layers that the SSU channel 3 was sensing, this merging will likely provide a more accurate SSU extended time series over the lower-mesospheric layers

Preliminary Work on AMSU-A and ATMS Merging



Plot showing effect of inter-satellite calibration between AMSU-A and ATMS (from Zou X. et al. 2014)

Thank you!