Applications of JPSS and GOES-R for long-term monitoring: The Case for Making (Imager) Climate Data Records

Andrew Heidinger, NOAA/NESDIS

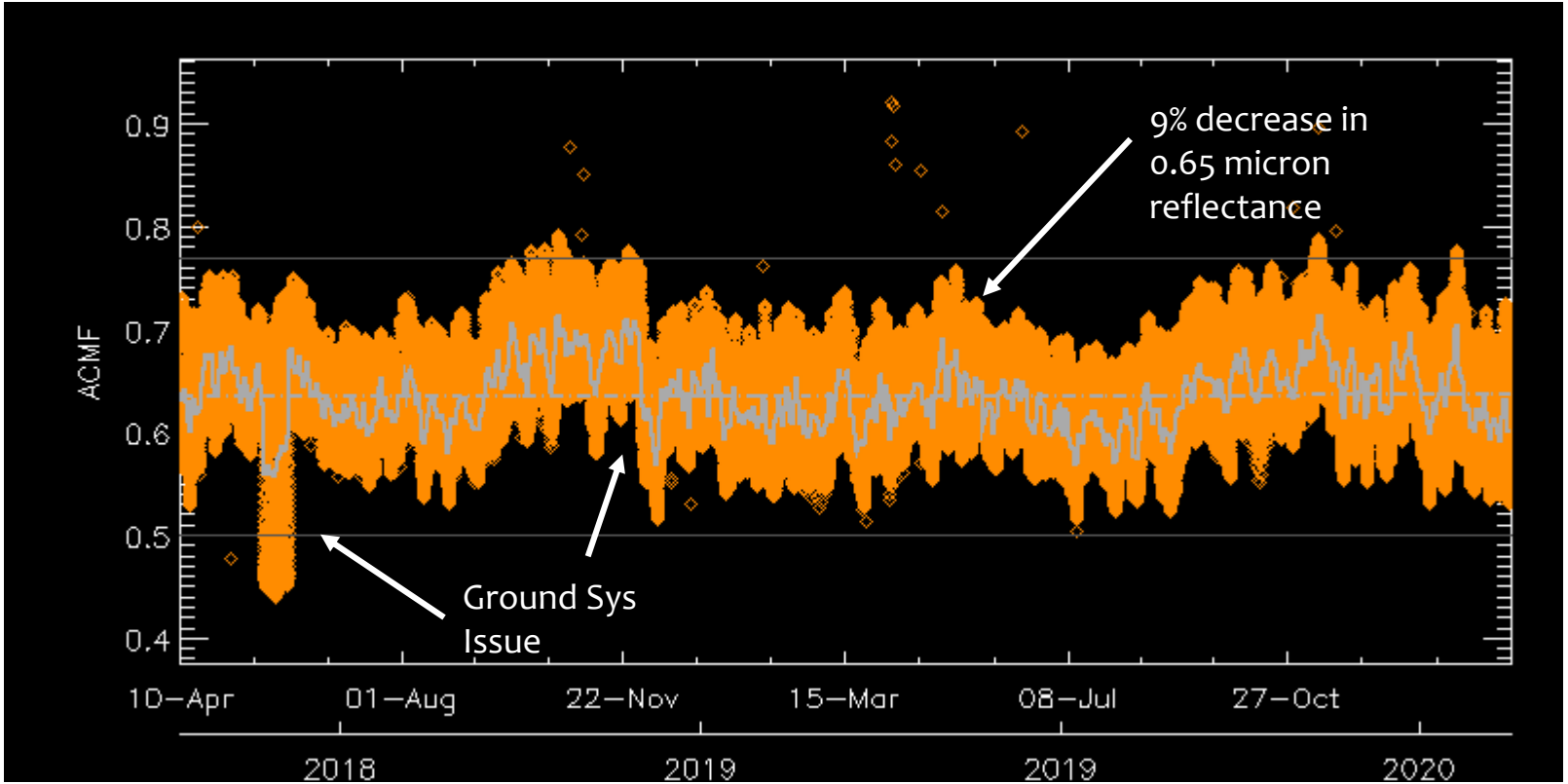
PGRR Summit, Feb 22-25, 2020 NCWCP

Main Points

- Climate projects have users: Reanalysis, Climate Reports (IPCC, Bams SOC), general science.
- NESDIS calibration and algorithm efforts benefit a lot from making and analyzing climate data records. Complements our real-time mission.
- Reprocessing L1 records is important. But so is subsetting them in ways that make climate products useful to a wide audience. (*A reprocessed L2 is not a useful climate product*).
- If we don't reprocess our data, others (EUMETSAT or NASA) will.
- ISCCP-NG is an important multi-agency effort to make homogenize cloud climate records from the advanced geo record. Similar efforts underway for polar (NCEI/VGAC). NESDIS and its climate users should engage in these efforts.

Another Need for Reprocessing: Long-term Stability of GOES-16 Operational Products

Archives of operational products do not typically provide climate data records.



Climate Users: Reanalysis

NESDIS makes all of these products.

ERA uses EUMETSAT/ CM-SAF Versions.

MERRA and CFSR use similar information and what are their needs?

Satellite data used in ERA-Interim

Microwave radiances
- temperature sounding
- water vapor sounding

Infrared radiances
- temperature and water vapor sounding
- stratospheric temperature sounding

Imagery — visible, near infrared, water vapor

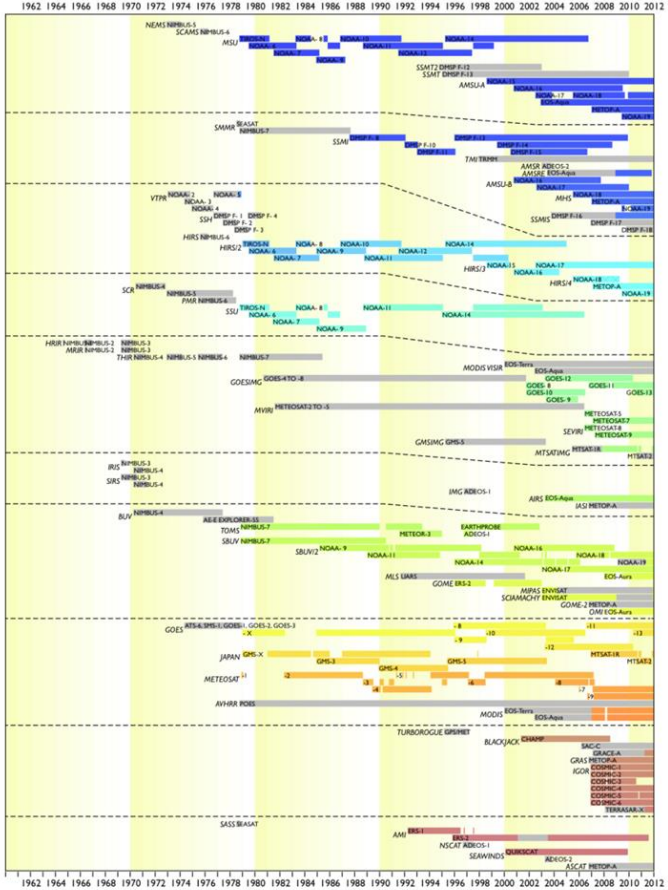
Hyper-spectral infrared

Ozone — mostly ultra-violet, some limb-viewing infrared

Atmospheric motion vectors
- geostationary (GEO)
- low-earth orbit (LEO)

Bending angles from GPS radio occultation

Backscatter — near-surface wind above ocean



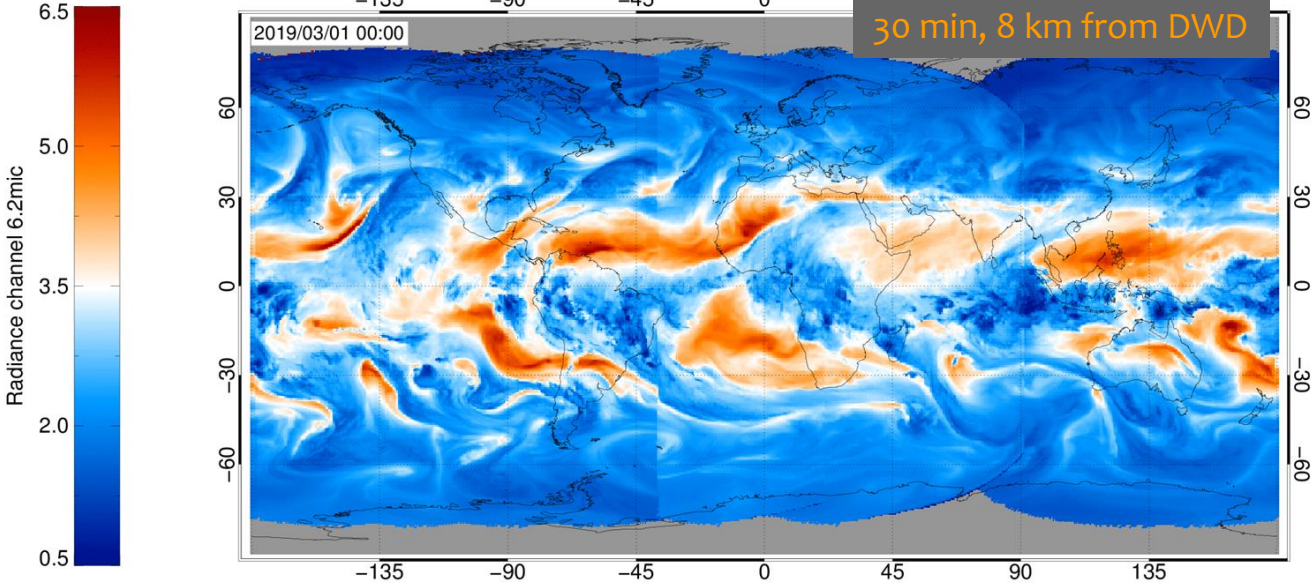
ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

https://www.ecmwf.int/sites/default/files/elibrary/2014/14665-use-satellite-data-reanalysis.pdf

Need for Subsampling for Climate Studies: International Satellite Cloud Climatology - Next Gen (ISCCP-NG)

- ISCCP v1 is one of the oldest satellite climate projects (1983-2020+) and operational at NCEI.
- ISCCP-NG is a reboot of ISCCP that exploits capabilities of next gen geo imagers.
- ISCCP-NG aims to combine the all advanced geo-images into one homogeneous radiance and cloud product climate record.

- **Compared to ISCCP, ISCCP-NG is 2000x bigger in Volume w/o subsetting.**
- How do we subsetting to keep info on cloud dynamics?
- An international effort to define ISCCP-NG is underway!

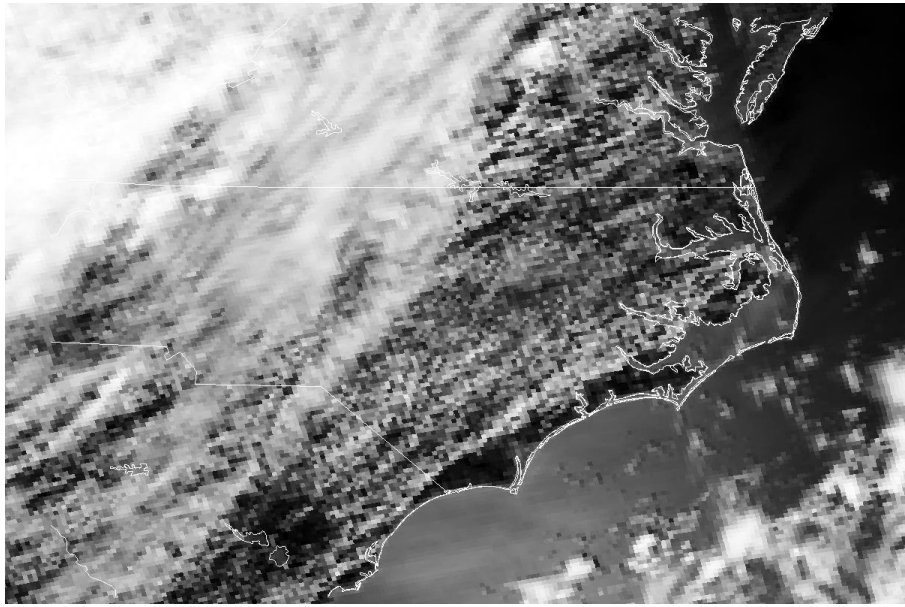


ISCCP-NG will certainly use NESDIS Geo Data. NESDIS can also play a role in CDRs and NOAA Climate Users should provide feedback.

Need for Subsampling for Climate Studies: VIIRS - (VGAC)

- VIIRS is difficult use for climate data records.
- One day of VIIRS is roughly 20000 files and 20 Gb.
- Most climate records are highly averaged or sampled in space and time.
- **Ken Knapp (NCEI)** is proposing a VIIRS - GAC (VGAC) which is 1/30th the size of the VIIRS M-bands (image to the right).
- **A sampled VIIRS L1 would allow many to assess the STAR L1 reprocessed record.**

A subsampled VIIRS would allow for quick generation and assessment of proposed calibration or algorithm modifications. (VGAC is VIIRS for the rest of us)



VGAC sample over the Carolinas

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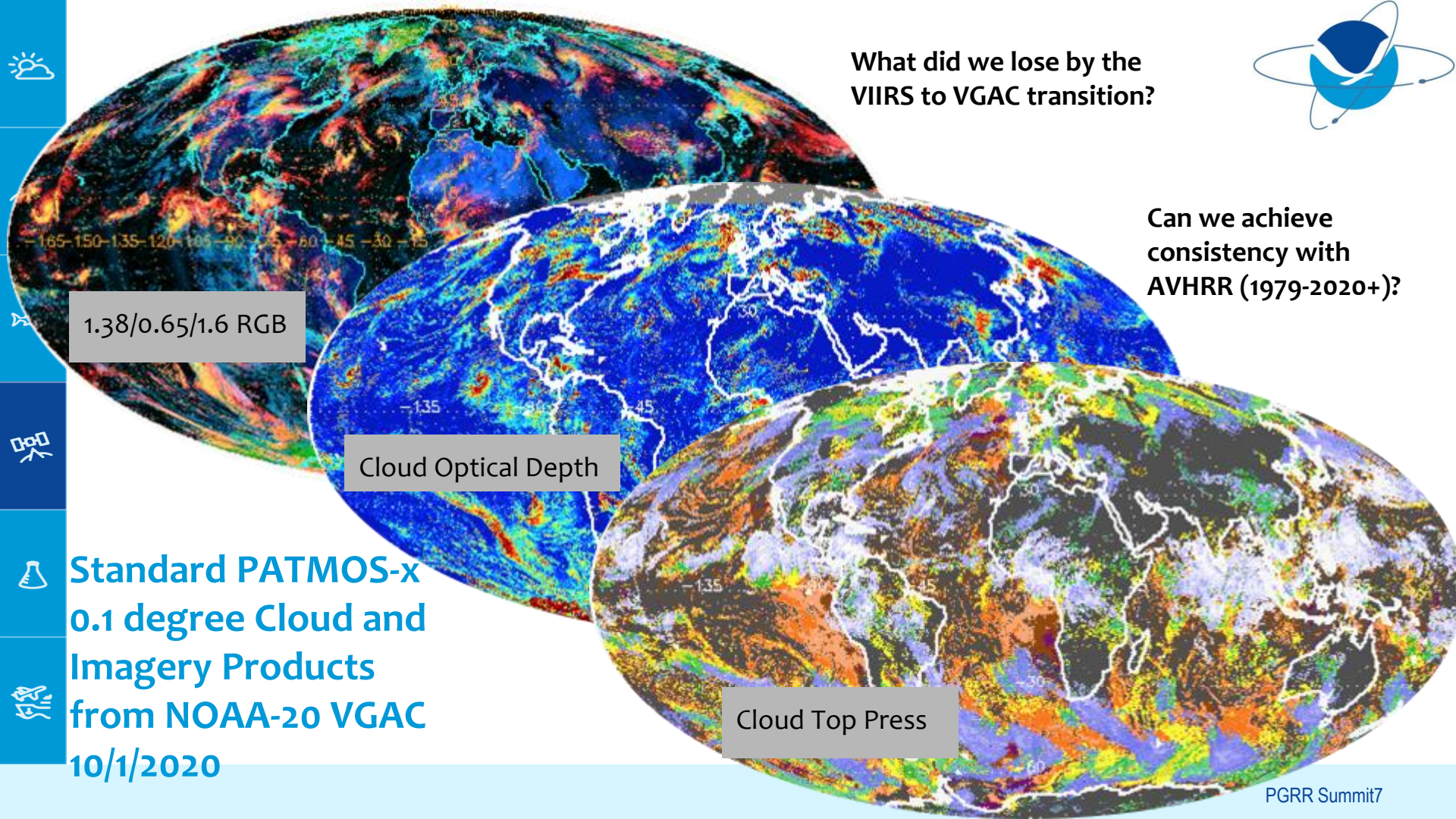
What did we lose by the VIIRS to VGAC transition?
Can we achieve consistency with AVHRR (1979-2020+)?
1.38/0.65/1.6 RGB
Cloud Optical Depth
Cloud Top Press
Standard PATMOS-x 0.1 degree Cloud and Imagery Products from NOAA-20 VGAC 10/1/2020
PGRR Summit7

Main Points

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- Reprocessing L1 records is important. But so is subsetting them in ways that make climate products useful to a wide audience. (*A reprocessed L2 is not a useful climate product*).
- If we don't reprocess our data, others (EUMETSAT or NASA) will.
- ISCCP-NG is an important multi-agency effort to make homogenize cloud climate records from the advanced geo record. Similar efforts underway for polar (NCEI/VGAC). NESDIS and its climate users should engage in these efforts.

Thank You

JPSS and GOES-R L1 and L2 Advances can Improve Old CDRs

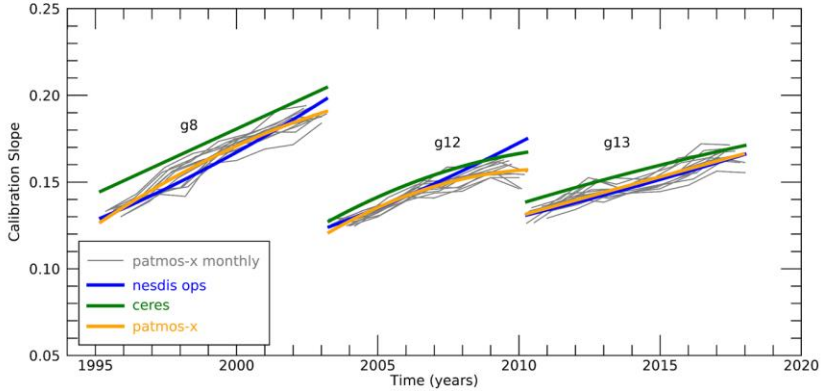
GOES-R/ABI and JPSS/VIIRS are the first operational sensors with on-board solar reflectance calibration.

Make case of using these new sensors with on-board calibration (first for operational sensors) to improve our climate records.

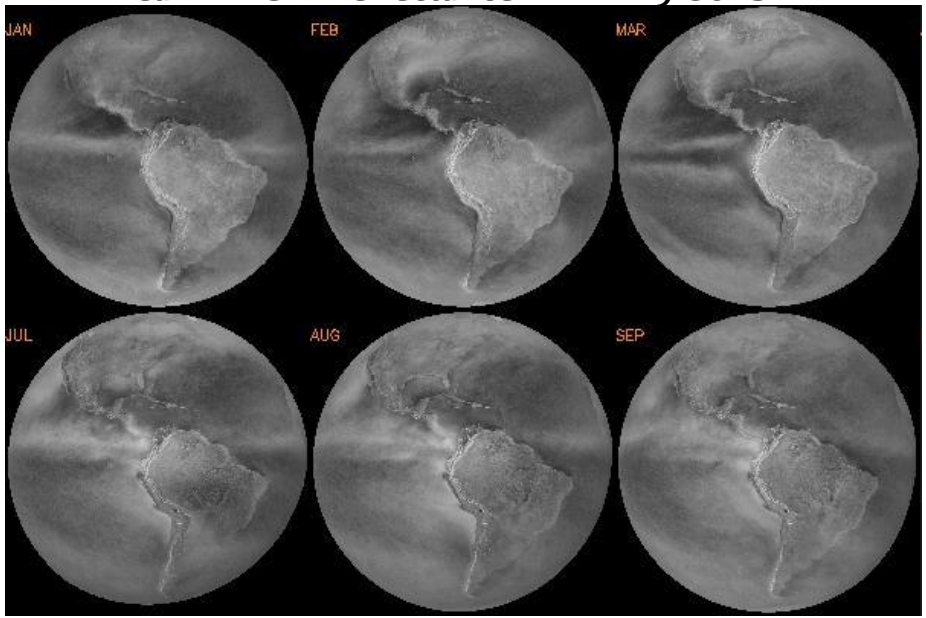
In addition, new processing techniques like AI and Fusion developed on latest sensors can be applied to the old sensor records.

This can also test long-term stability of the new techniques.

GOES-8,12,13 Visible Channel Calibration from GOES-16 18Z Full-Disk Reflectance

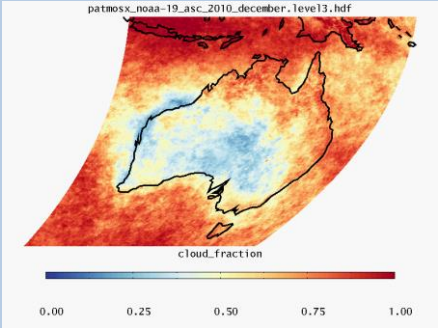


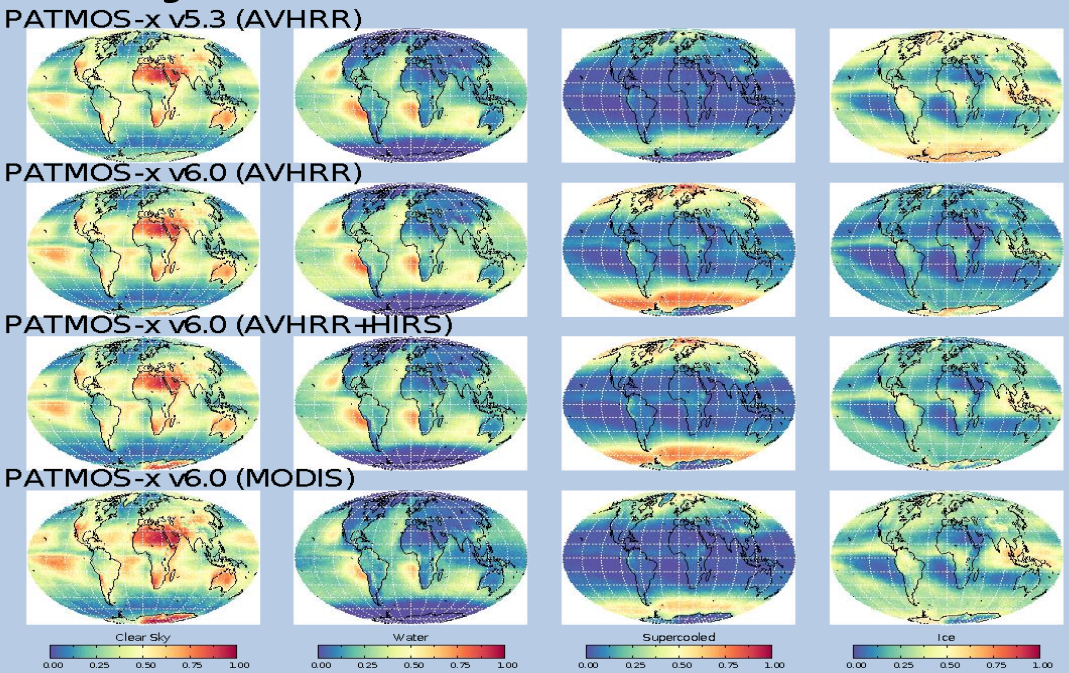
Mean 18Z Ch2 Reflectance 2018-2019 GOES-16



PATMOS-x Cloud Climate Products and Projects

- NOAA National Centers for Environmental Information
  - A ‘fusion’ record has been generated that interpolates HIRS to the AVHRR spatial and sampling resolution
  - This AVHRR+HIRS record serves as the basis for PATMOS-x Version 6.0
- Curtin University in Australia
  - Generating PATMOS-x cloud record in a new level 3 format for collaborative climate studies over Australia





Clear Sky Water Supercooled Ice

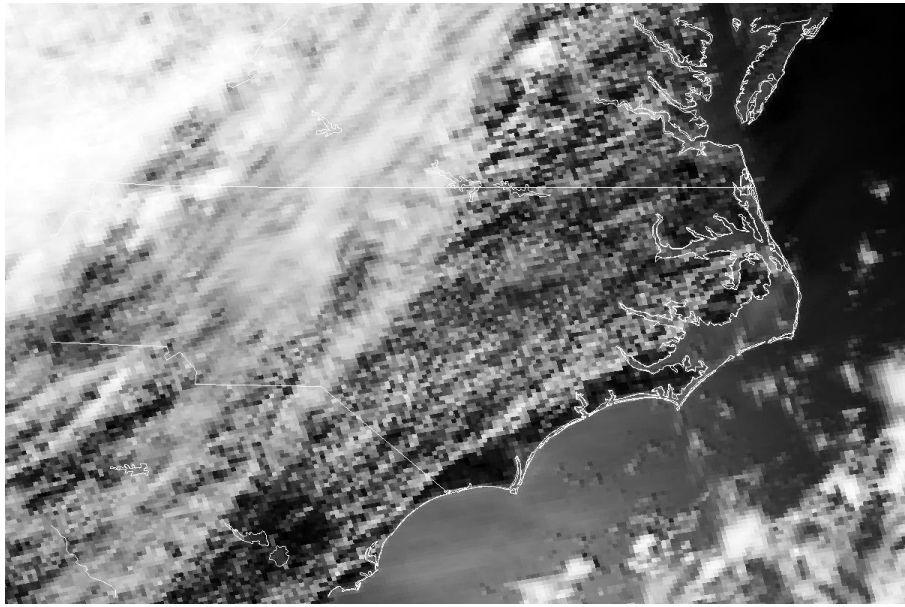
Space Science and Engineering Center
University of Wisconsin-Madison

Mike Foster, Andrew Heidinger, Paul Menzel, Elisabeth Weisz, Denis Botambekov, Ray Garcia, Andi

Need for Subsampling for Climate Studies: VIIRS - (VGAC)

- VIIRS is difficult use for climate data records.
- One day of VIIRS is roughly 20000 files and 20 Gb.
- Without remapping, the data is not spatially continuous (gaps and overlaps)
- While cloud computing offers opportunities to handle this, most climate records are highly averaged or sampled in space and time.
- **Ken Knapp (NCEI)** is proposing a VIIRS - GAC (VGAC) which is 1/30th the size of the VIIRS M-bands (image to the right).
- VGAC is M-band only and roughly 4km (missing DNB, I-bands).
- Something like VGAC will put the VIIRS record into the hands of many users. (*VGAC is VIIRS for the rest of us*)

A subsampled VIIRS would allow for quick generation and assessment of proposed calibration or algorithm modifications.



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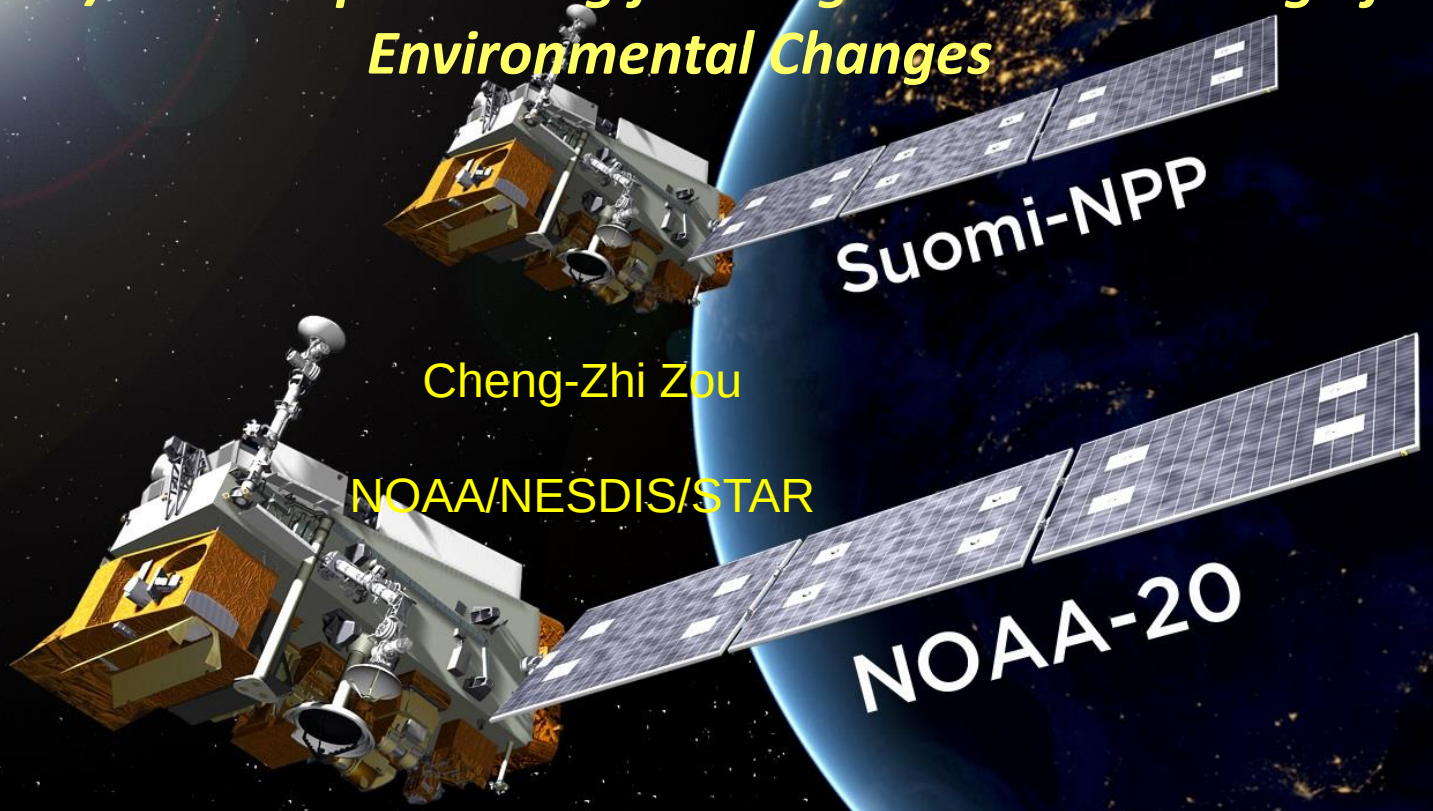
NOAA Satellites and Information

National Environmental Satellite, Data, and Information Service

JPSS/SNPP Reprocessing for Long-Term Monitoring of Environmental Changes



Cheng-Zhi Zou

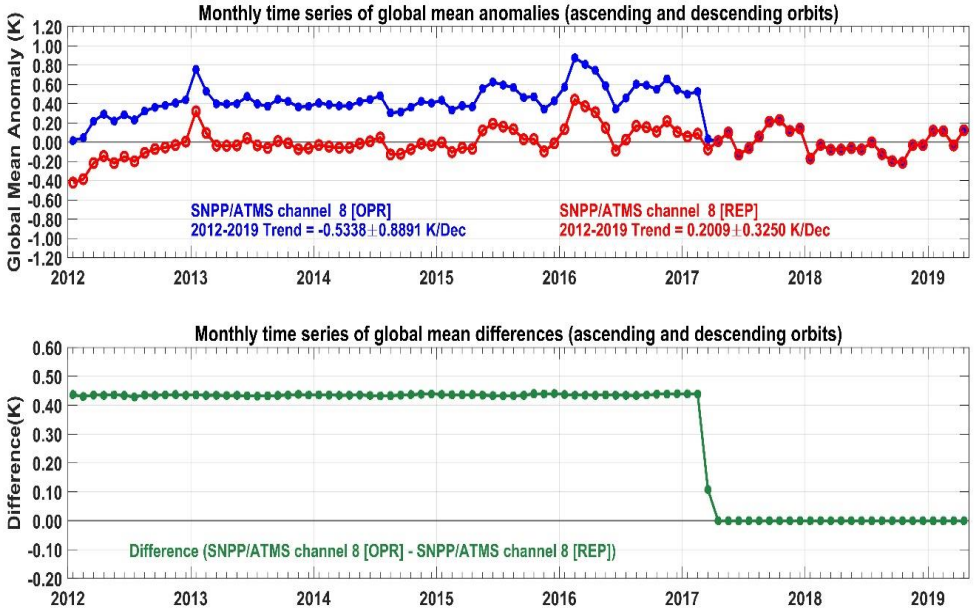
NOAA/NESDIS/STAR

JPSS/GOES-R PGRR Summit, College Park, MD, February 24-28, 2020

JPSS NOAA NASA

Reprocessing of JPSS/SNPP Sensor Data Records (SDRs)

- Operational calibration algorithms improve and update over time, resulting in bias jumps in SDR time series
- Generate reprocessed and consistent SDRs for each JPSS/SNPP instrument through their life-cycle using most recently updated, unified calibration algorithms
- Calibration accuracy achieves those from the latest operational calibration algorithm
- STAR has reprocessed four SNPP instruments: ATMS, CrIS, VIIRS, OMPS
- Reprocess JPSS instruments as data are long enough

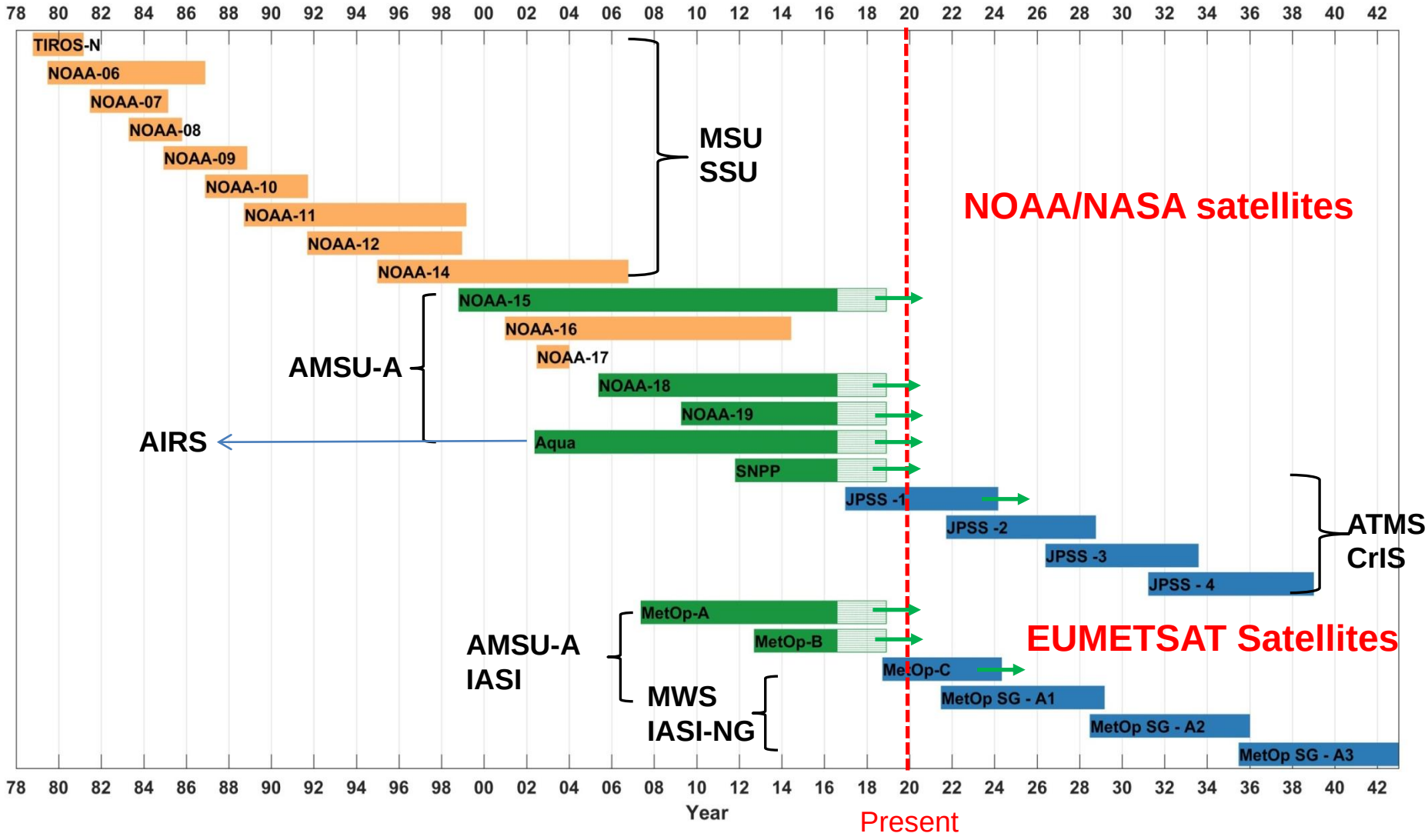


Monthly global mean T_b anomaly time series for ATMS channel 8 from operational calibrated (blue, top) and reprocessed (red, top) sensor data records and their differences (green, bottom). The global means are calculated using limb-adjusted scan positions from 29 to 68 for both operational calibrated and reprocessed datasets. The bias jump between the operational calibrated and reprocessed data found in March 2017 was caused by the calibration update for the operational calibration on 7 March 2017. After that date, the two datasets are identical since they use the same calibration algorithm.

Benefit of Reprocessing

- Allow stability assessment after removal of bias jumps due to operational calibration changes
- Consistent satellite retrievals
- Improve EDR products
- Building blocks for climate data record development
- Improve climate reanalyses as input datasets

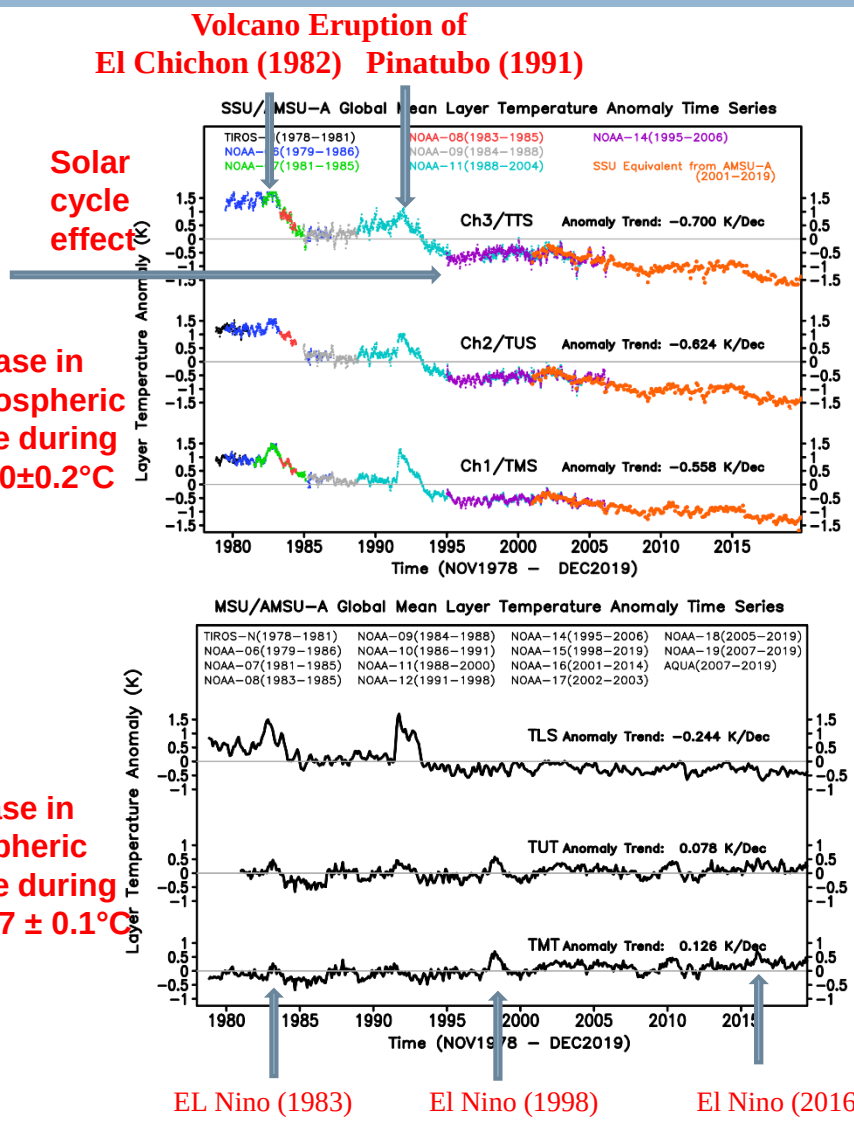
- Satellites are the only means available to provide upper-air temperature observations with global coverage for long-term monitoring
- NOAA satellites have been continuously observing upper-air temperatures for over 40 years
- JPSS Program carries the NOAA operational temperature sounding capability into the future
- Inter-satellite calibration and satellite merging are needed to develop climate data record (CDR) for long-term monitoring



Long-Term Monitoring of Upper-Air Temperatures

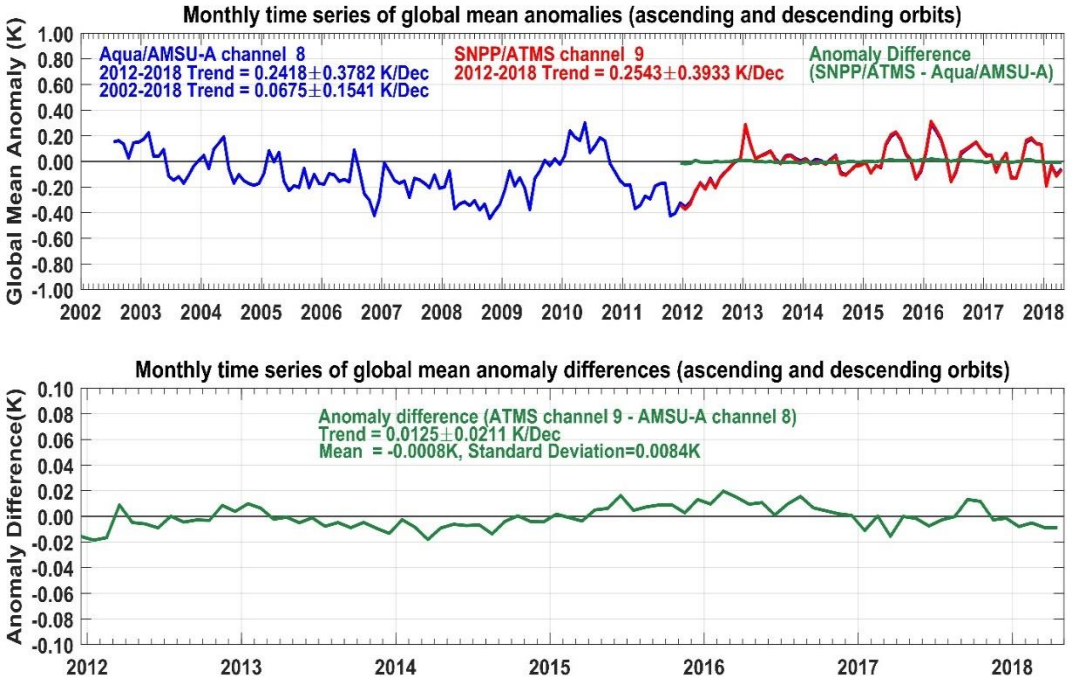
Benefit/Users:

- National and international climate assessment programs: IPCC, WCRP, NOAA/National annual State of Climate report, NOAA/NCEI monthly climate assessment report, etc.
- Climate modelers for validating climate model simulations of the past climate changes
- NWP centers for data assimilation in climate reanalyses and assessment of climate reanalysis products
- Provide references for satellite Cal/Val programs



Stable SNPP Orbit Makes ATMS A Reference for Long-Term Monitoring

- Comparison between Aqua/AMSU and SNPP/ATMS suggests that both instruments achieve a radiometric stability within 0.004K/Year
- Stable observations from SNPP and Aqua are being used as references in CDR development
- MSU/AMUS/ATMS merging is ongoing for long-term monitoring
- Higher merging accuracy is expected with stable SNPP/ATMS observations as references



Monthly global mean anomaly time series of brightness temperatures for AMSU-A channel 8 onboard Aqua (blue, top panel) versus ATMS channel 9 onboard SNPP (red, top panel) and their difference time series (green, top and lower panels). The AMSU-A and ATMS data are respectively from June 2002 and December 2011 to April 2018. The AMSU-A anomaly time series are overlaid by ATMS during their overlapping period with their differences shown as nearly a constant zero line in the same temperature scale. Amplified scale of temperature is used in the bottom panel to show detailed features in the anomaly difference time series. Both ATMS and AMSU-A data are from limb-adjusted views and averaged over ascending and descending orbits (plot from Zou et al. 2018).