On the Study of the Absolute on-orbit Calibration Consistency between ATMS Instruments

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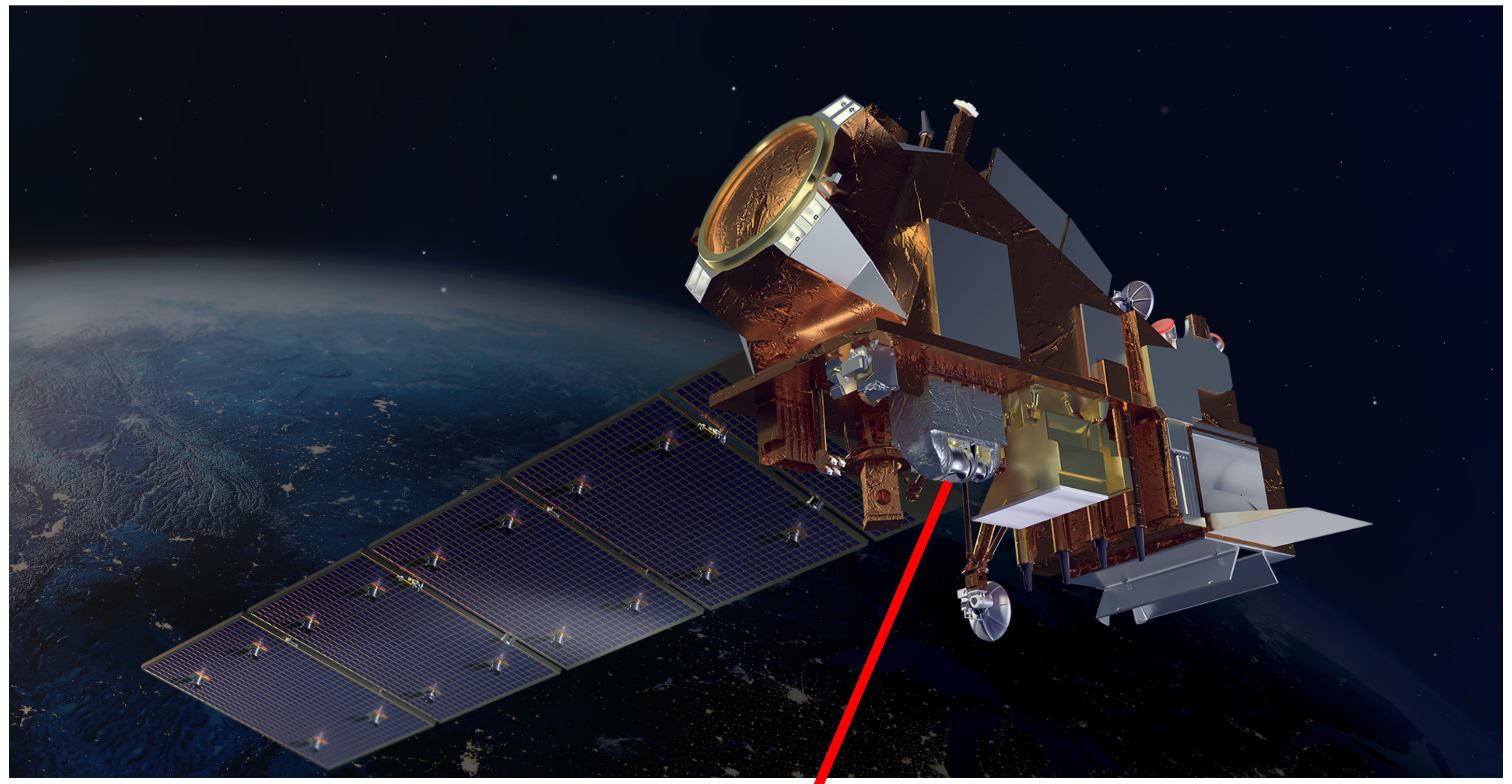
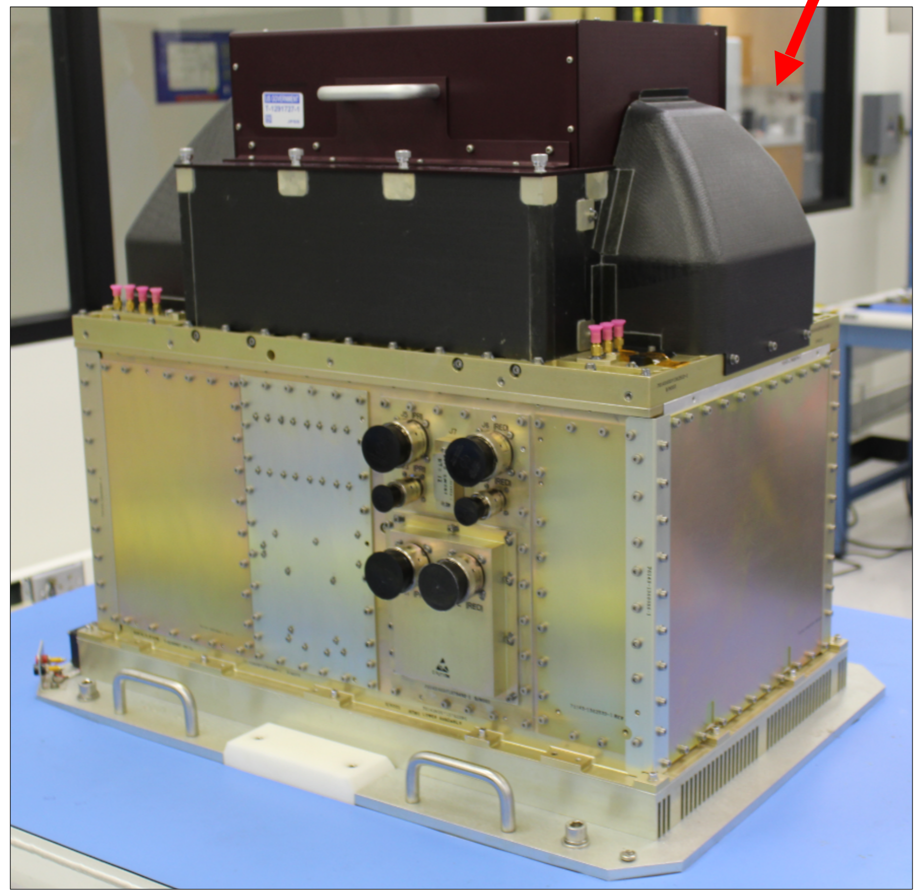
Outline

- Introduction of NOAA 21 ATMS post launch test status and on-orbit performance evaluation results
- Assessment for ATMS TDR/SDR on-orbit calibration consistency between SNPP, NOAA 20 and NOAA 21
- Analysis of ATMS calibration error sources and the improvements in NOAA 21 calibration algorithm
- Conclusion and future work

JPSS-2 launched at 1:49 AM PST on November 10, 2022

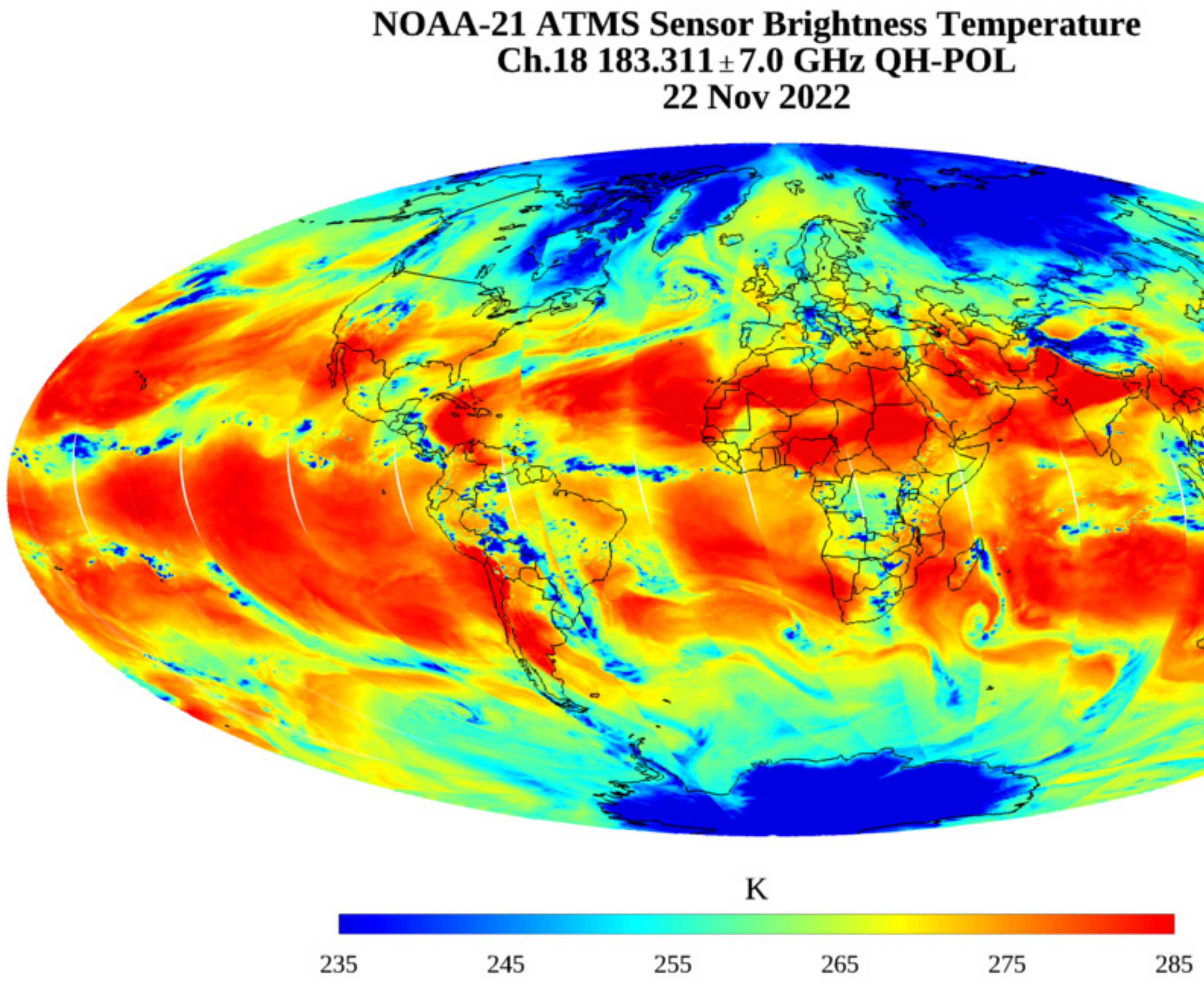
ATMS in operation mode from 15:21 UTC on November 21, 2022

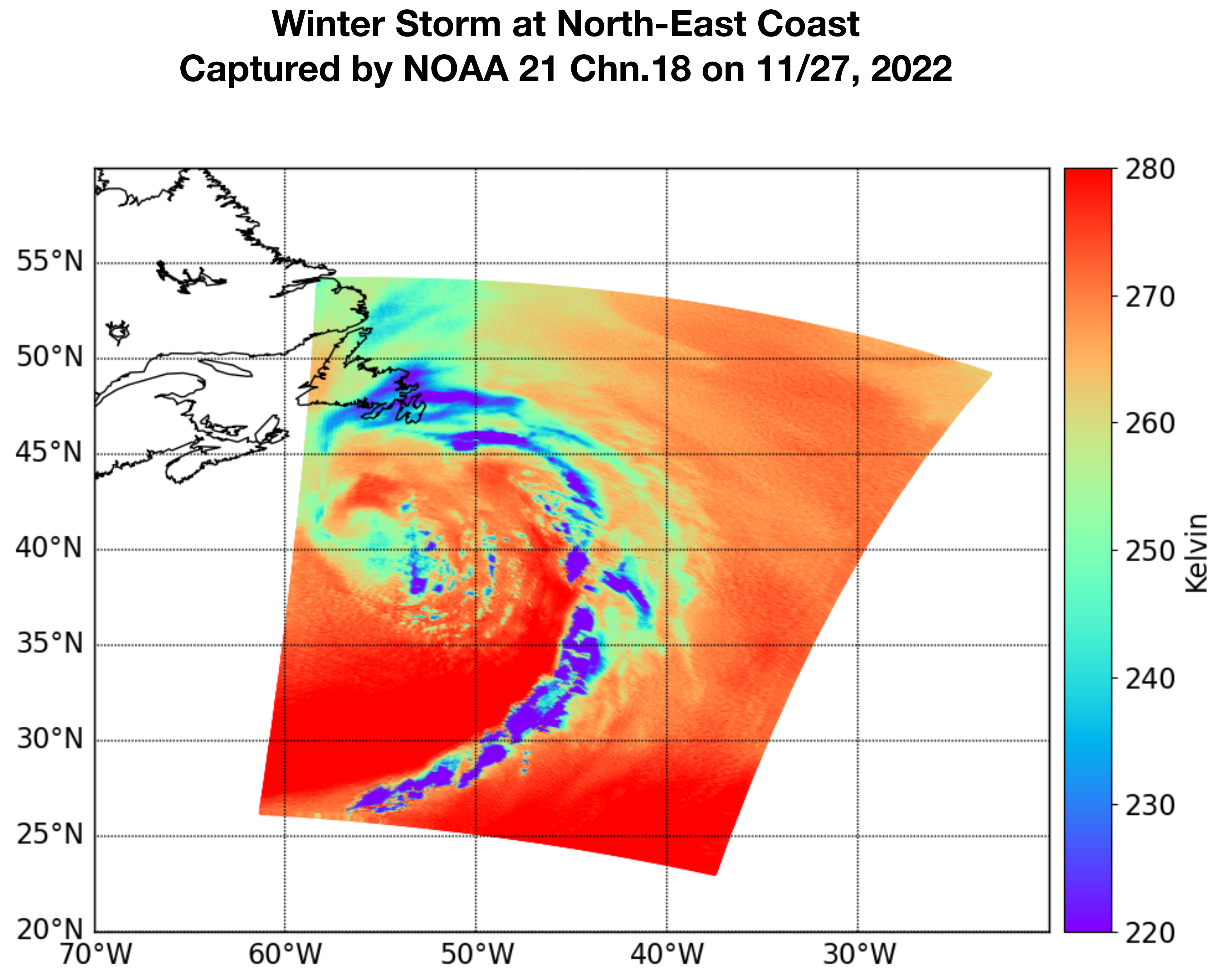




The JPSS-2/ATMS Instrument. Courtesy of Northrop Grumman

- ATMS instrument status is stable and the TDR products reached pre-maturity level two weeks after the launch
- No global coverage data downlink between 12/16, 2022 and 02/01, 2023, due to the failure of the primary Ka-band transmitter
- The ATMS is still under intensive post-launch test, will reach the maturity level in May.



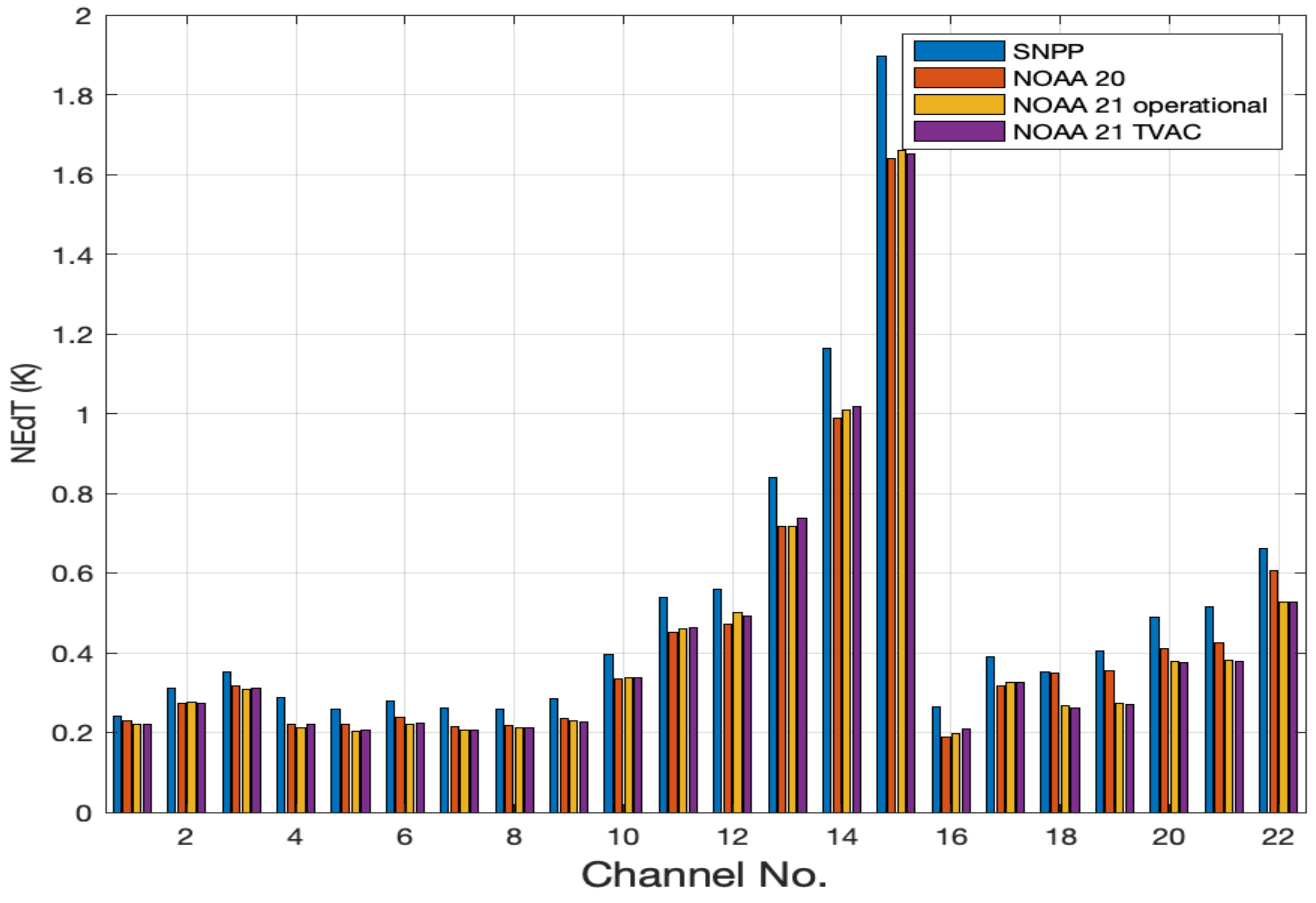


https://www.nesdis.noaa.gov/news/first-light-image-noaa-21s-atms-sensor

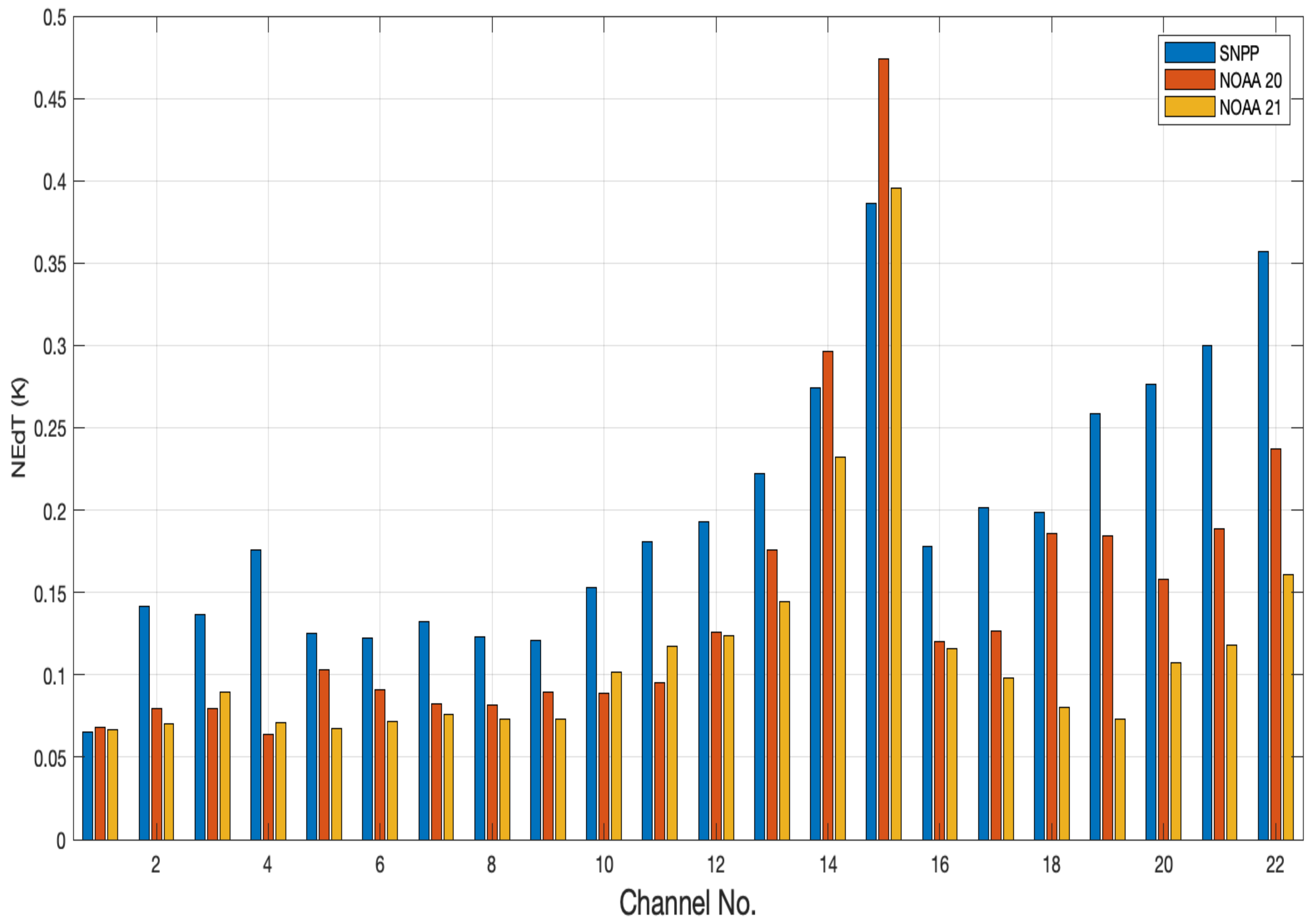
Noise Trending for ATMS Instruments

- General improvement in noise characteristics is observed in NOAA 21 compare to SNPP
- Significant improvement for reduced 1/f noise in G band is observed in NOAA 21

Total Noise



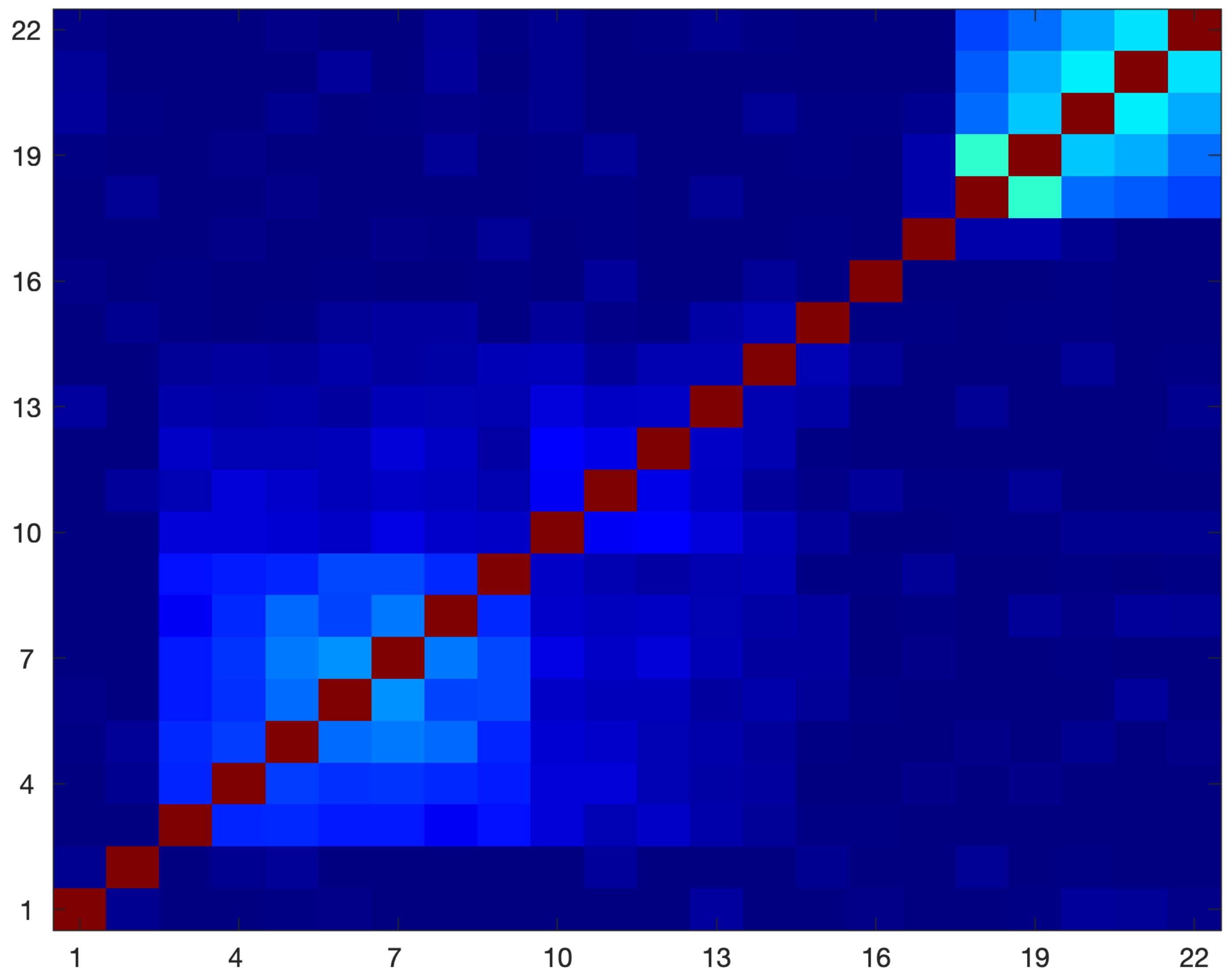
1/f Noise



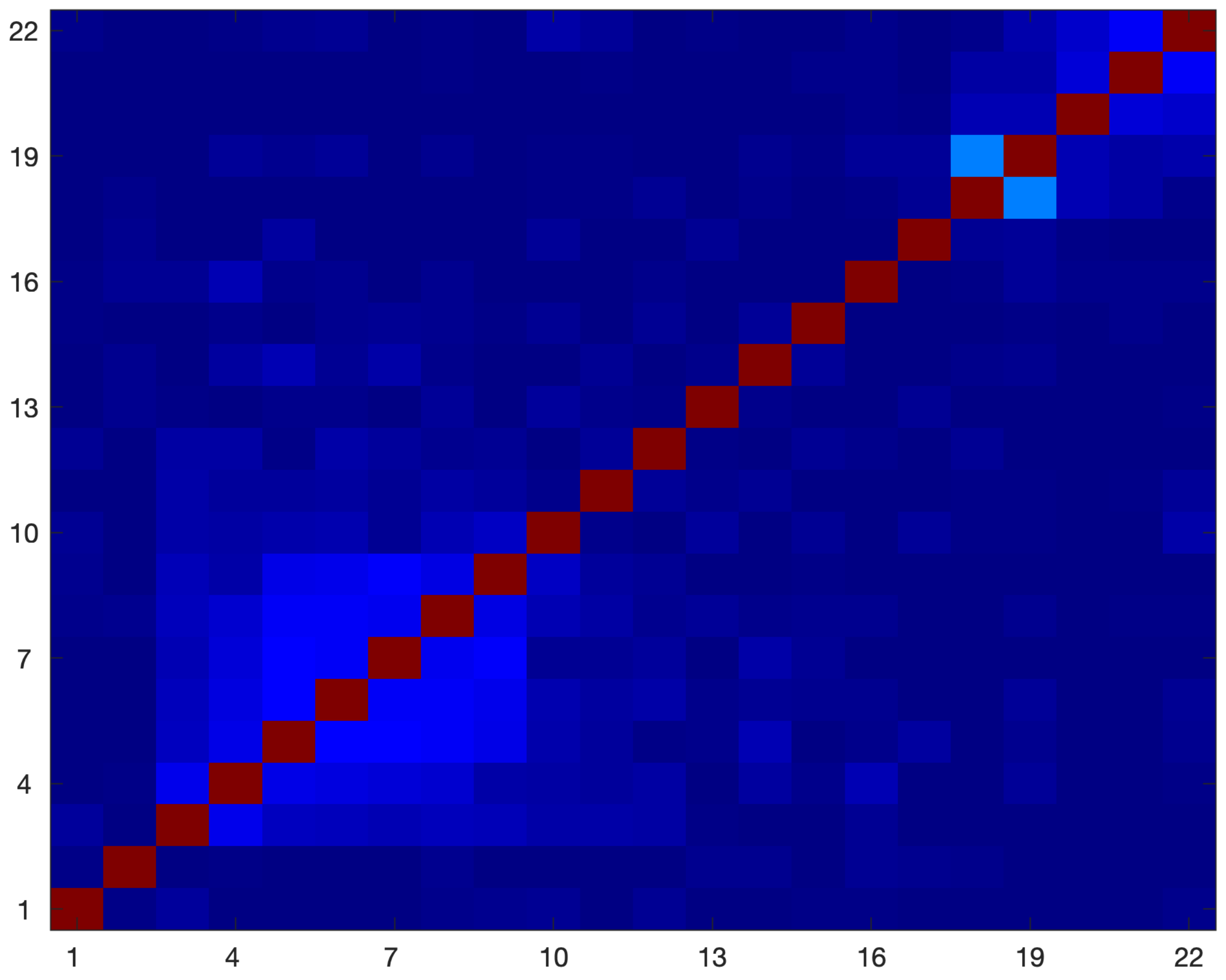
Channel Correlation

- Warm load observations was collected from the overlap orbit between J2 and SNPP on 12/06 for channel correlation calculation of SNPP and J02 ATMS
- Warm load observations was collected from the overlap orbit between J2 and NOAA 20 on 11/25 for channel correlation calculation of NOAA 20
- Continuous improvements on the channel correlation is observed for ATMS from SNPP to J02

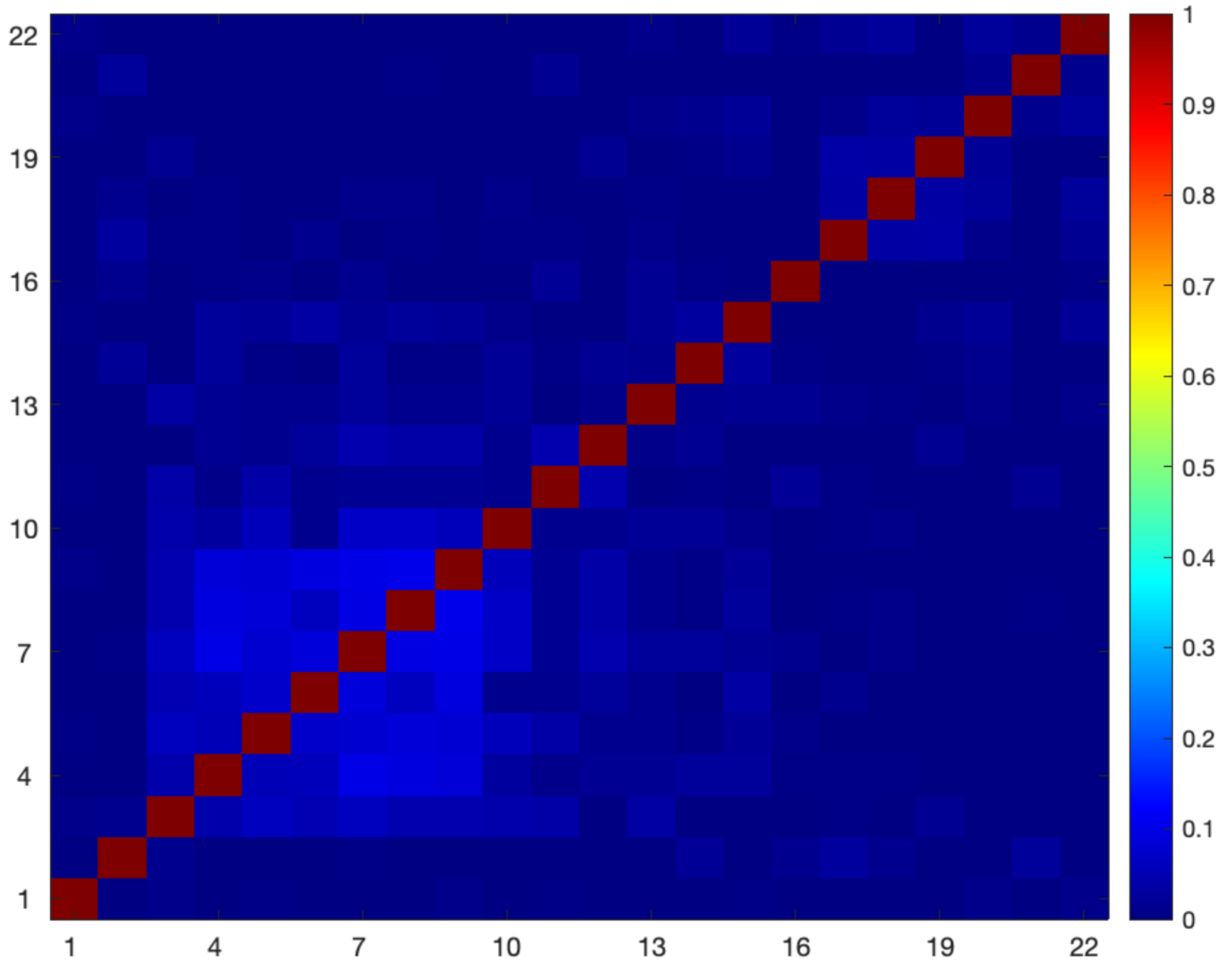
SNPP



NOAA 20



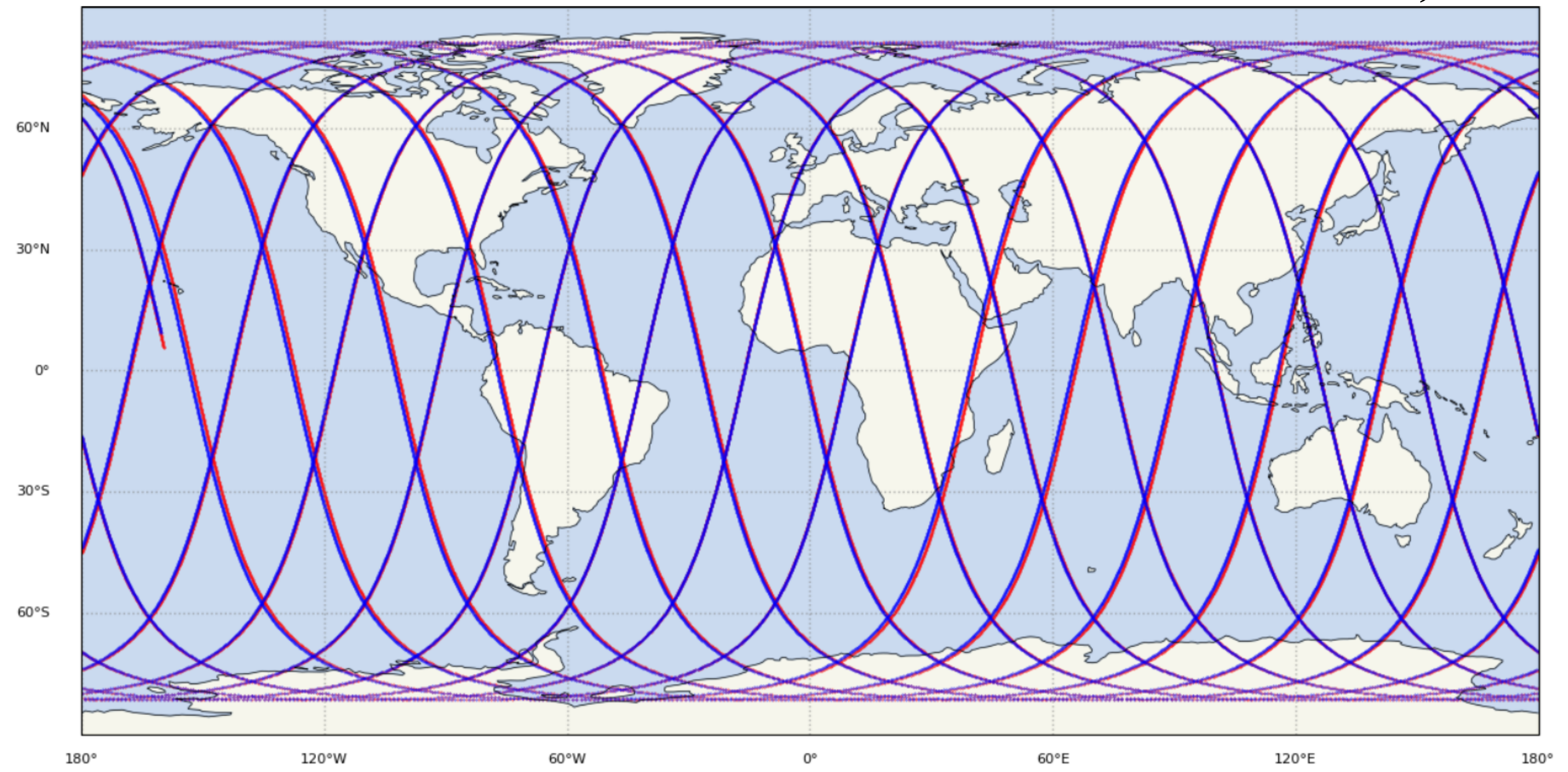
NOAA 21



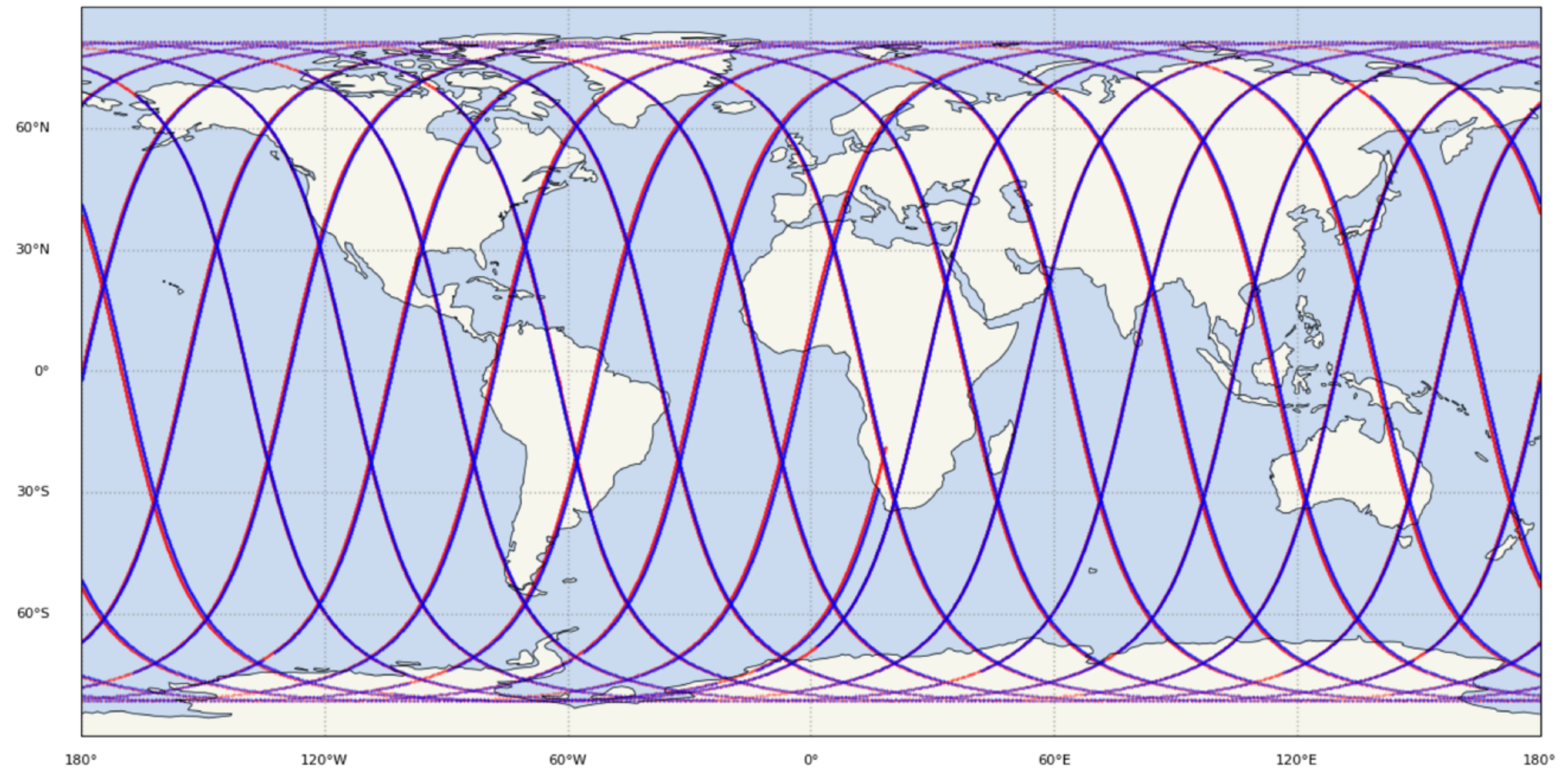
TDR Calibration Consistency between SNPP, NOAA 20 and NOAA 21

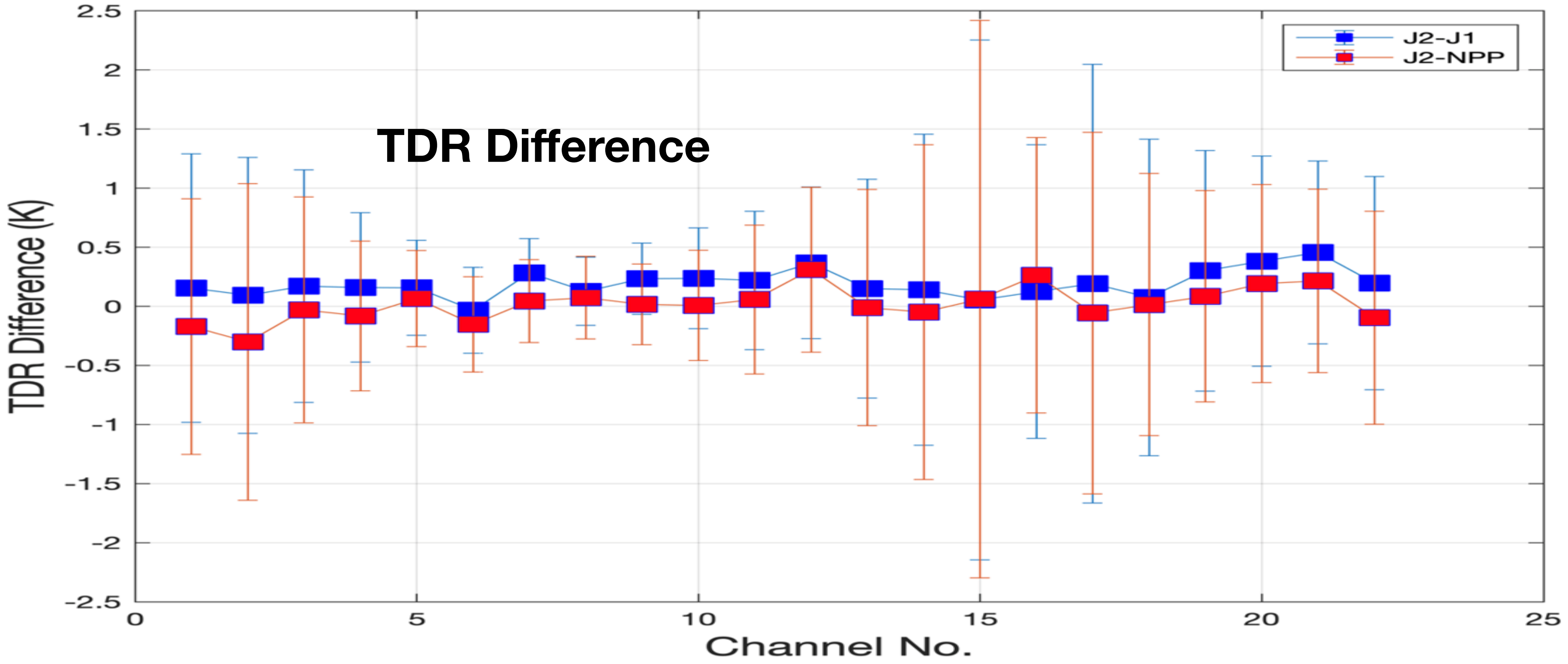
- Unique opportunity for direct comparisons between NOAA-21 and NOAA-20/S-NPP ATMS during their orbital overlapping because of the orbit adjustment activities
- Collocated data at each scan angle are collected with maximum time difference less than 5 minutes, and maximum space distance of FOV center no larger than 10km
- By using the current PCT table, the TDR calibration difference between J2 and SNPP is smaller than the difference between J2 and J1. For V-band, the mean TDR difference between J2 and SNPP is within 0.1K
- With the updated SDR correction coefficients, the Tb difference in SDR products has been further reduced

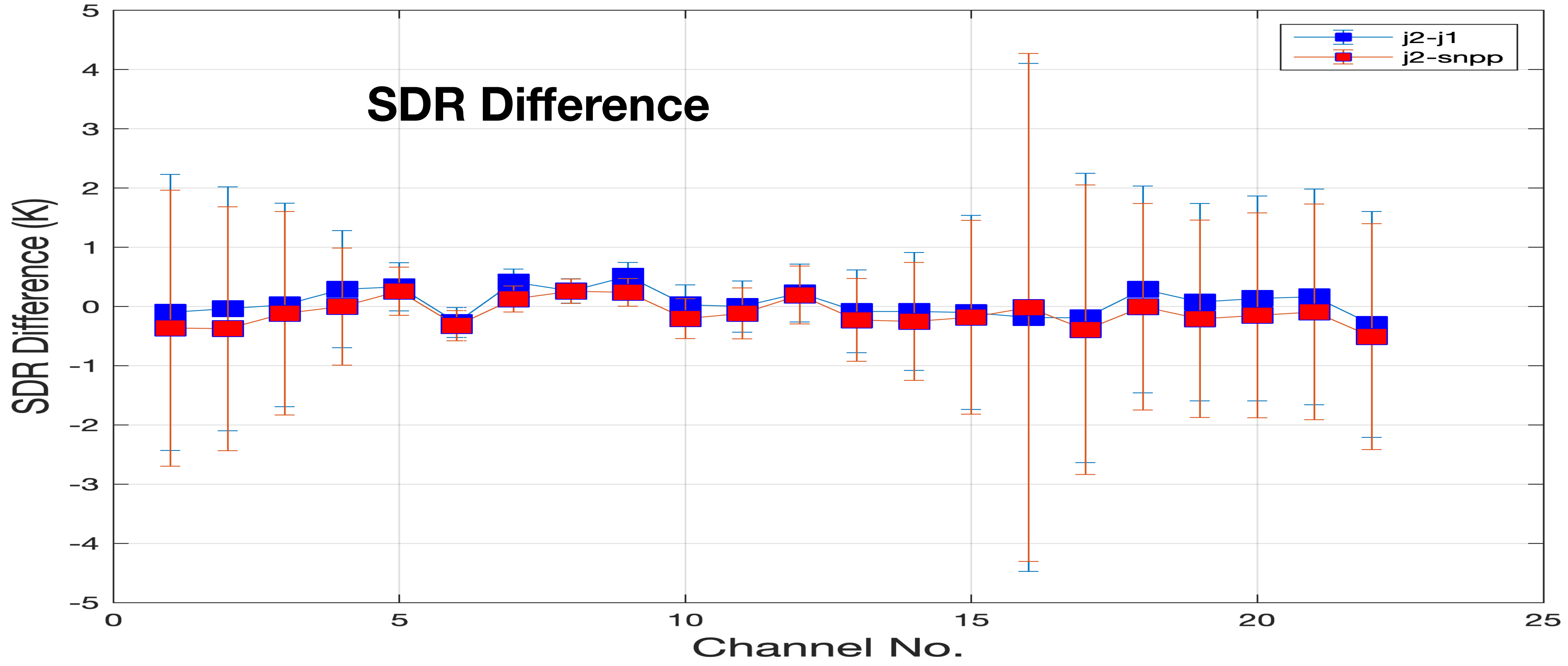
NOAA-21 and NOAA-20 Nadir Track on November 25, 2022



NOAA-21 and SNPP Nadir Track on December 6, 2022



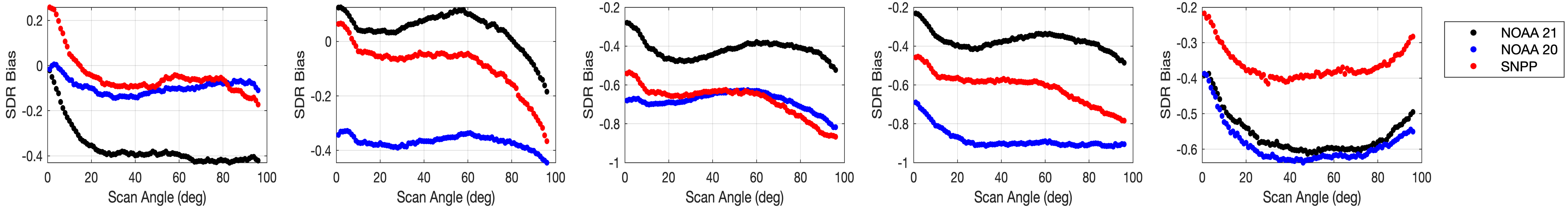




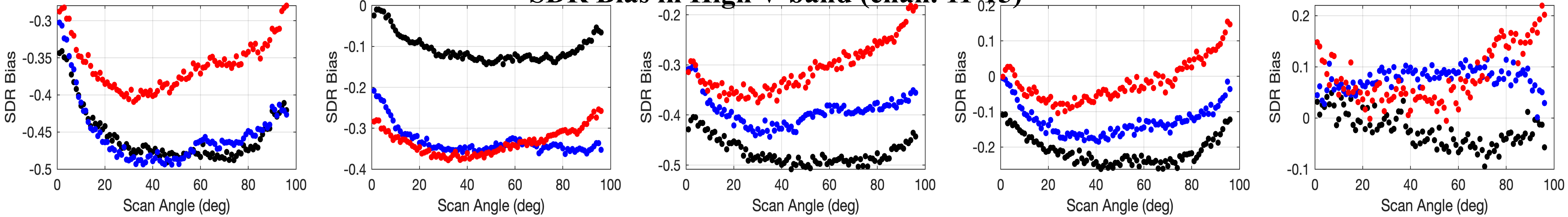
SDR Calibration Consistency between SNPP, NOAA 20 and NOAA 21

- Clear sky satellite observations over ocean were simulated by using CRTM 2.4.0, with ECMWF forecasts as model inputs
- Consistent scan angle dependent feature in SDR O-B biases are observed for SNPP, NOAA 20 and NOAA 21
- General improvements in G band and some of the V band are attributed to the improved antenna pattern measurements and the additional satellite contamination correction

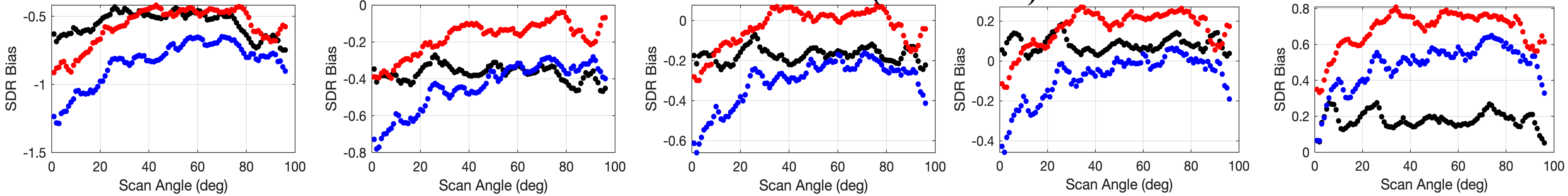
SDR Bias in Low V-band (chan. 6-10)



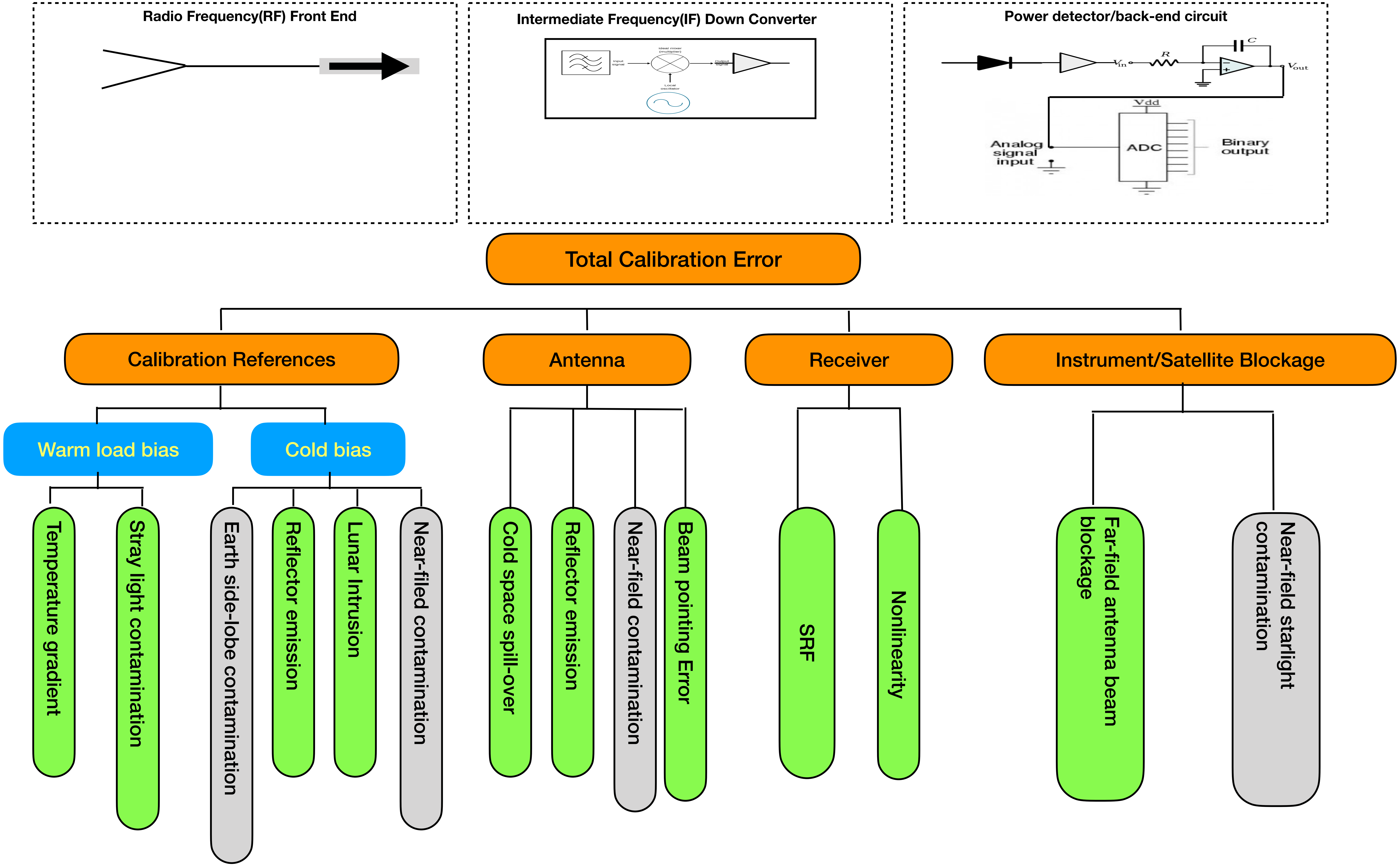
SDR Bias in High V-band (chan. 11-15)



SDR Bias in G-band (chan. 18-22)



Error Tree Analysis for ATMS Calibration



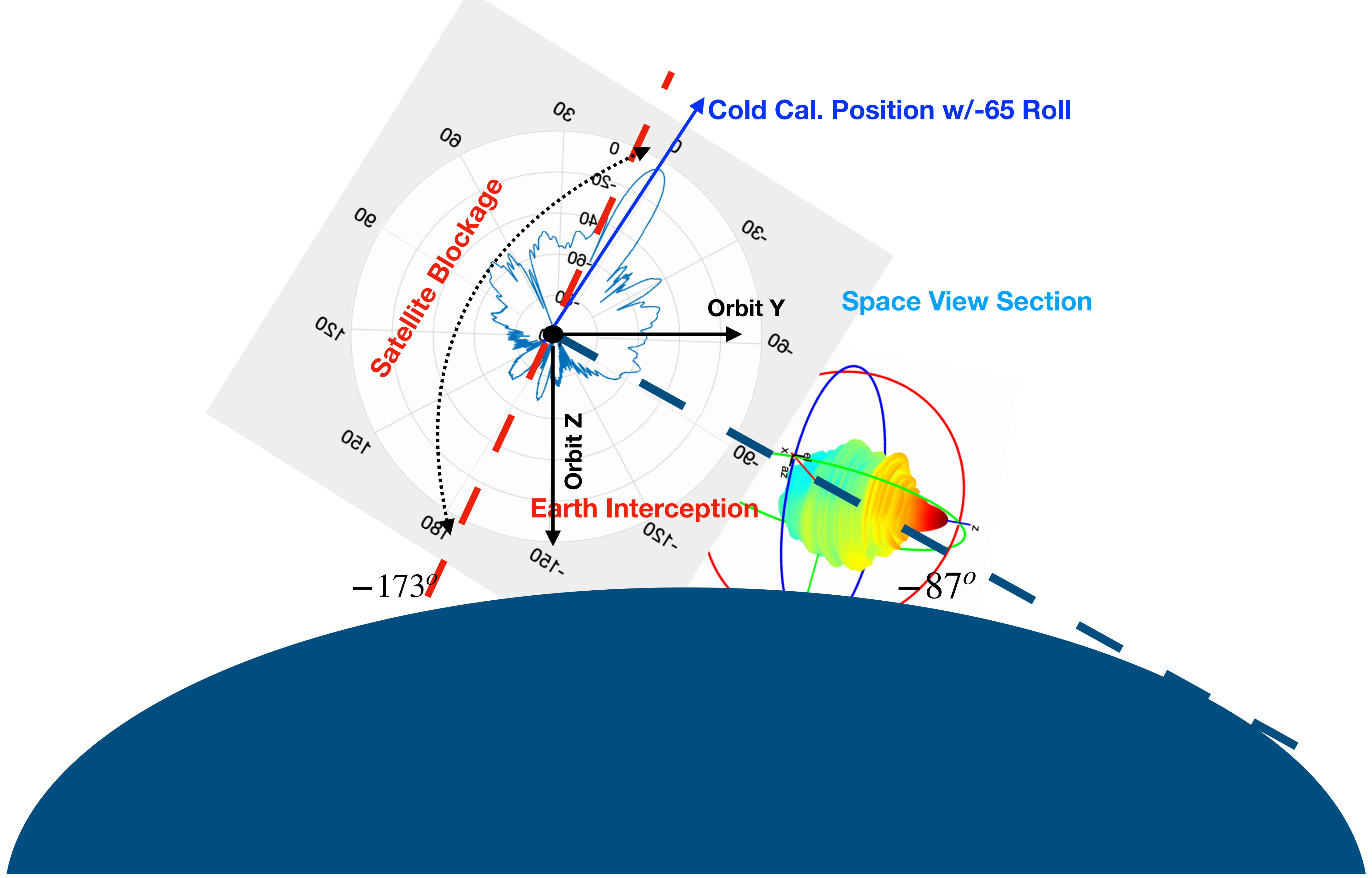
Improved Algorithm to Calculate the Earth Side Lobe Contamination

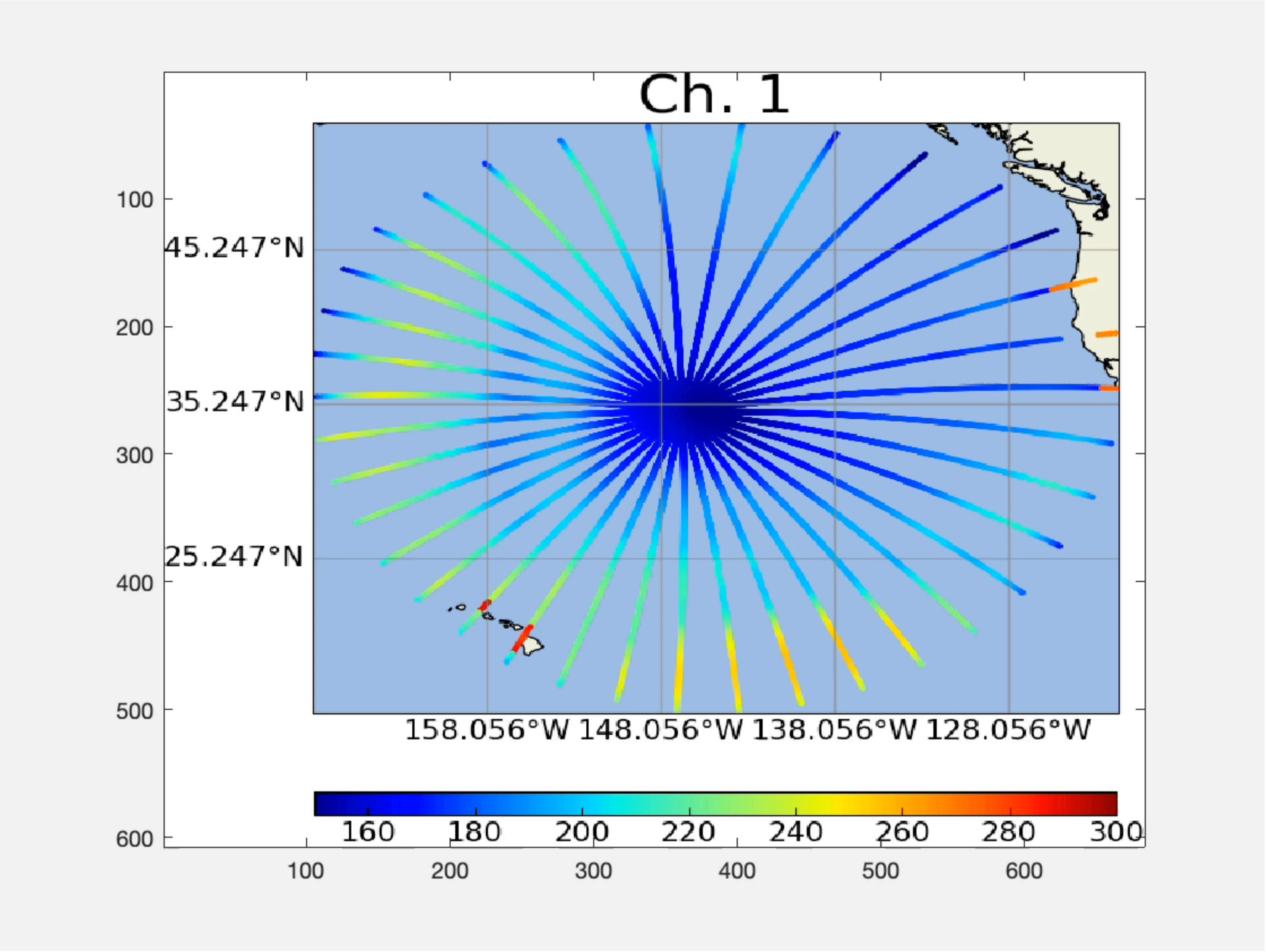
- Antenna pattern is projected onto the Earth surface with resolution of 0.1 deg in elevation direction and 10 deg in Azimuth direction
- The Earth brightness temperature at each sub-grid is calculated from CRTM simulations
- The Earth side lobe can be determined by using calibrated antenna temperature and the model simulations

$$\eta_{earth}^{mdlcorr} = \frac{Ta_{obs} - Tc}{TE' - Tc}$$

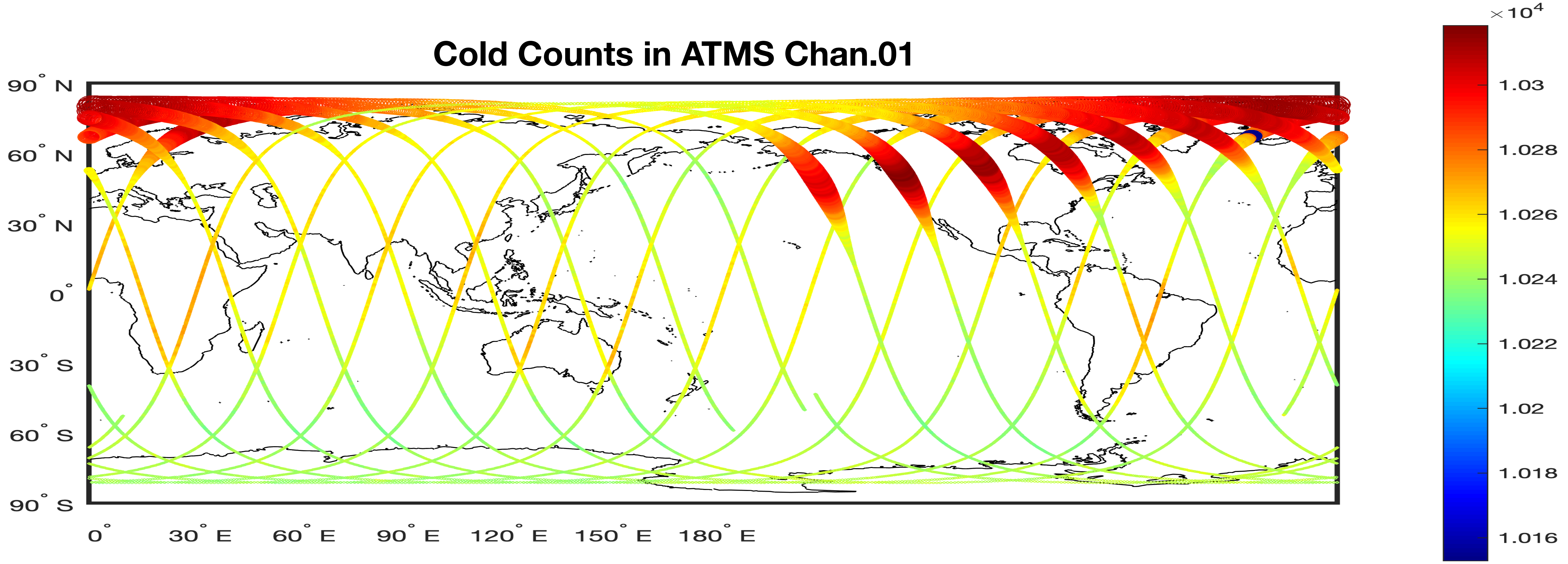
$$TE' = \frac{\int\int_{\Omega_{Earth}} G(\theta,\phi) \cdot T_b^{earth}(\theta,\phi) sin\theta d\theta d\phi}{\int\int_{\Omega_{Earth}} G(\theta,\phi)}$$

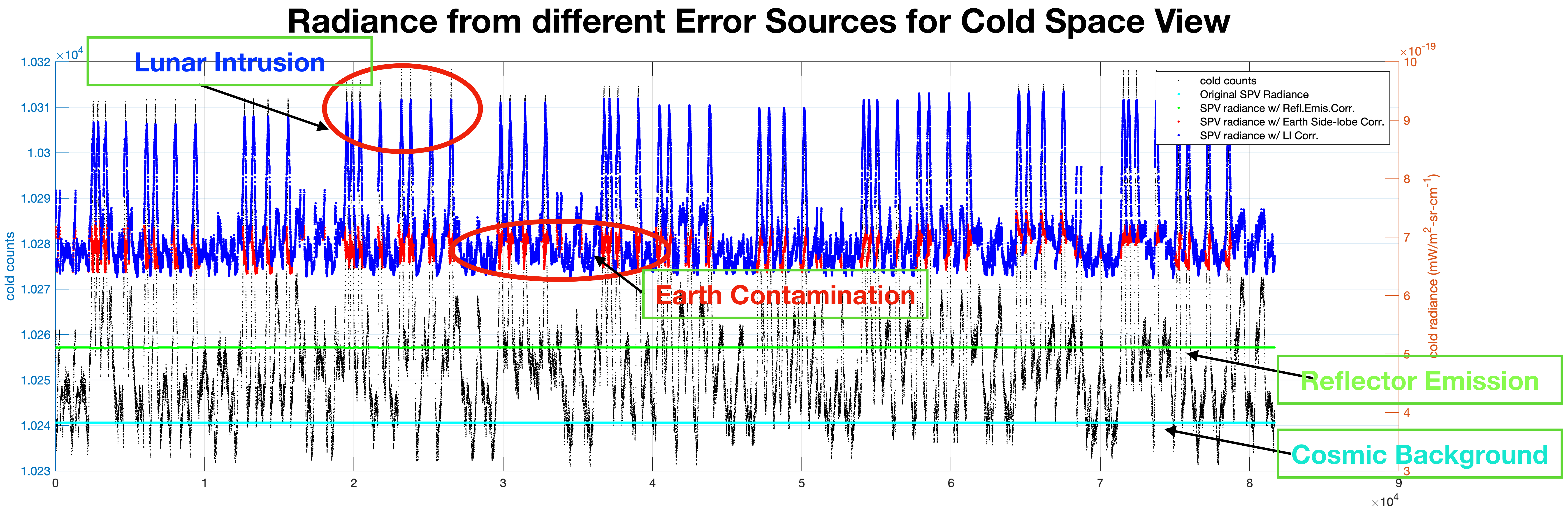
Scan Geometry under -65 deg Roll





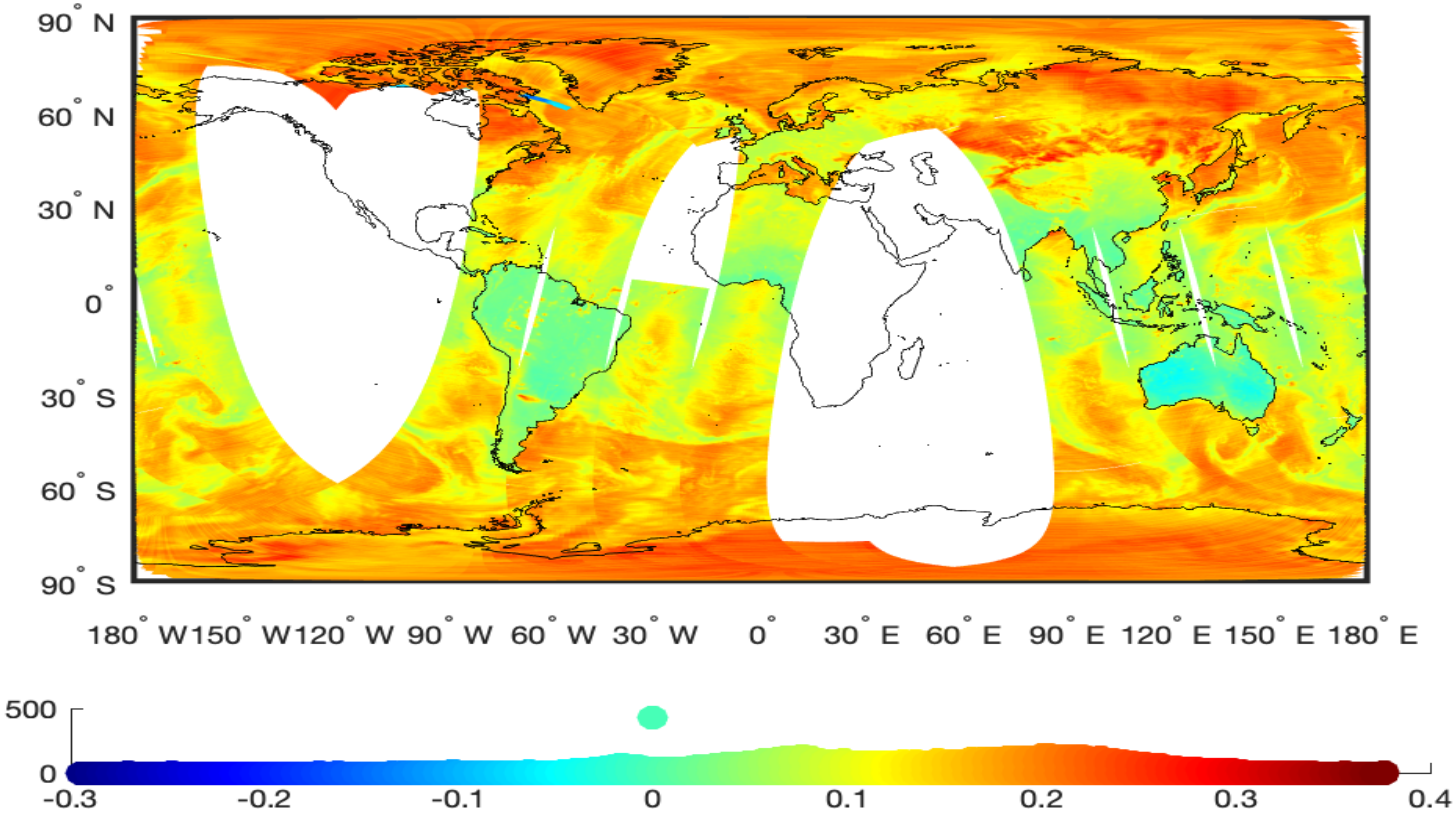
Major Error Sources in Cold Calibration





Impact of Dynamic Cold Bias Corrections on Calibration Results

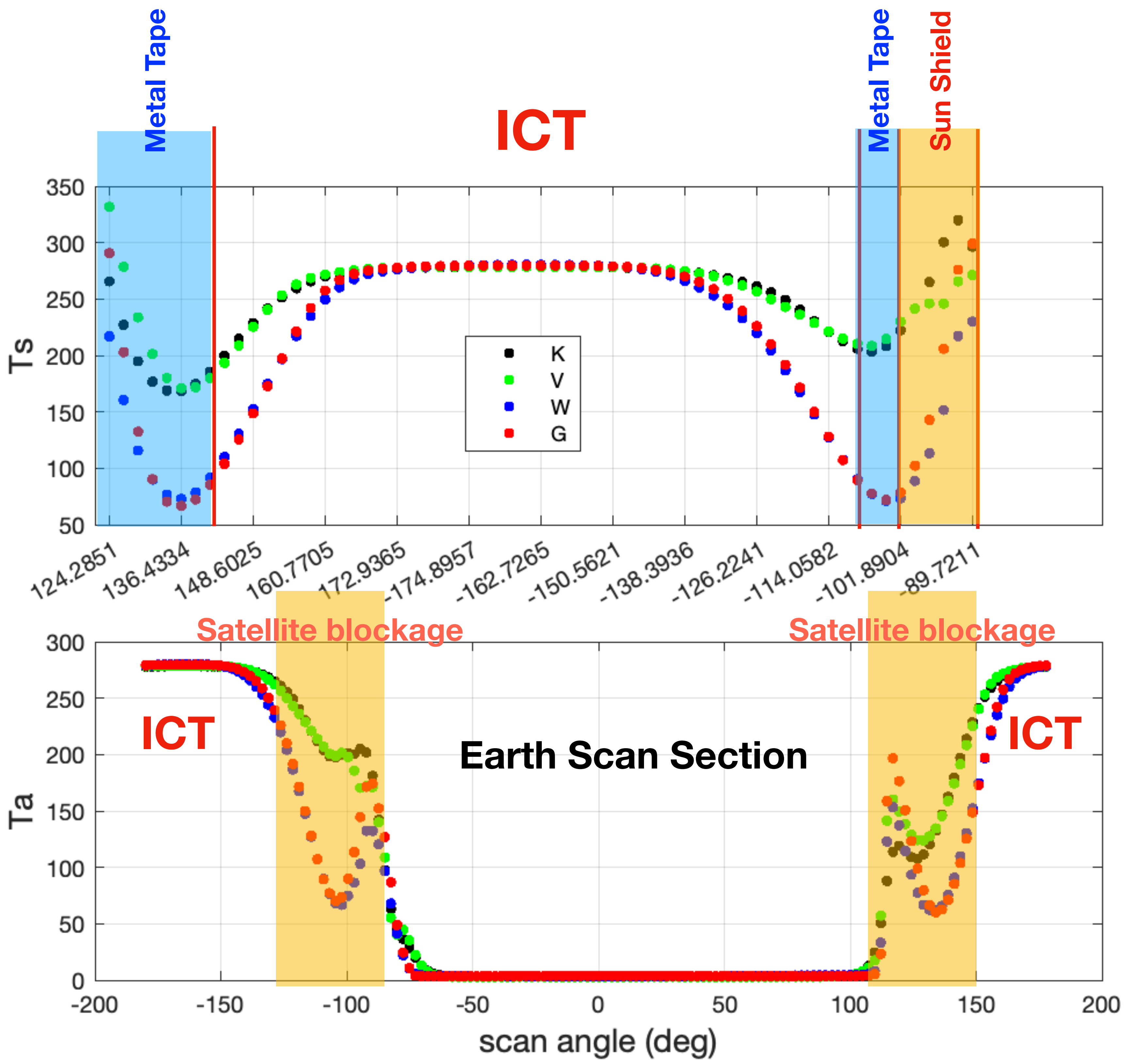
- Larger impacts on window channels with more surface contributions
- Corrections over cold scene are larger than warm scene

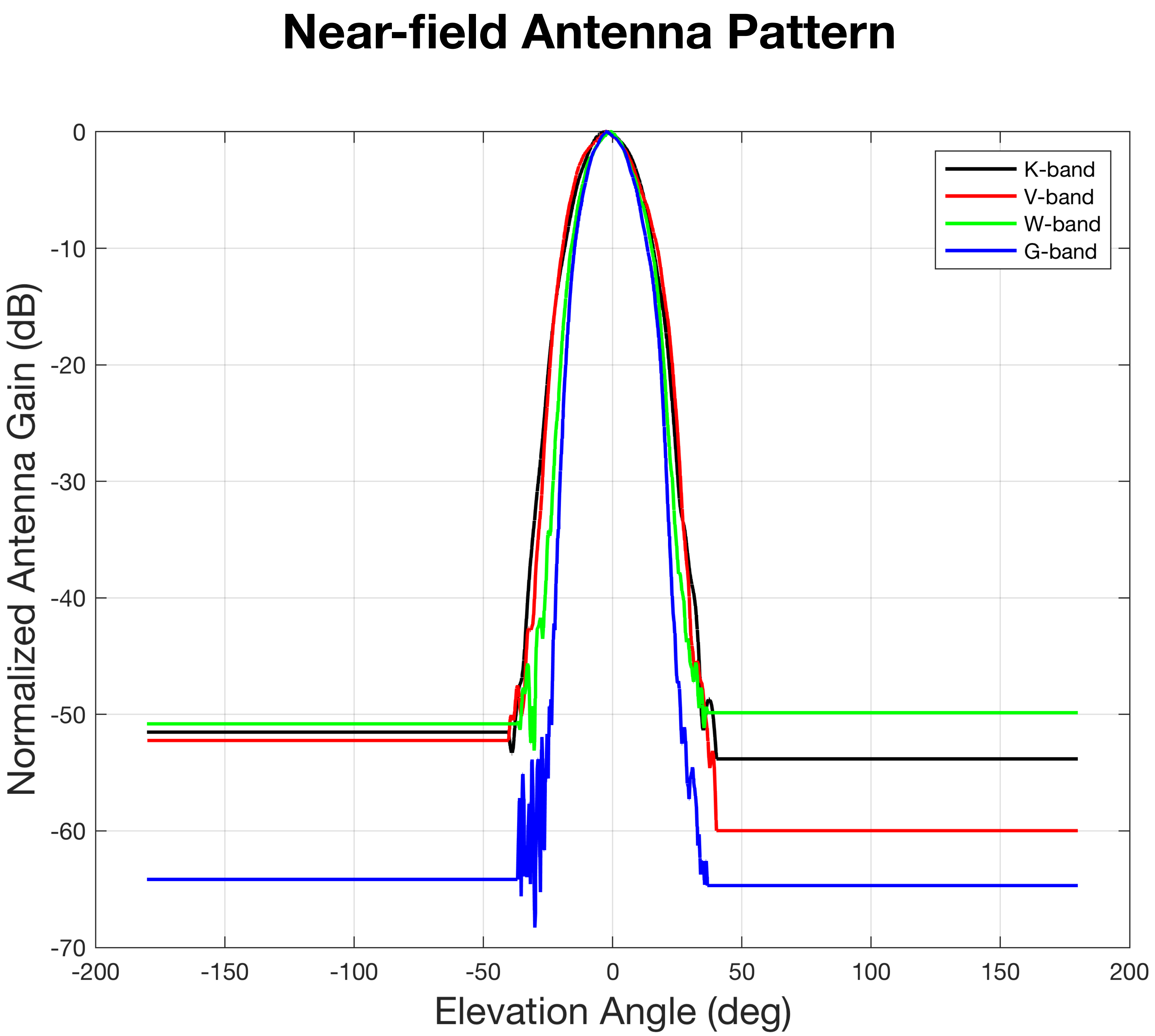


Calculation of Satellite Contamination

- The thermal profile is constructed by analysis of the brightness temperature profile inside the instrument chamber
- Simulated near-field antenna pattern is used to calculate the satellite blockage

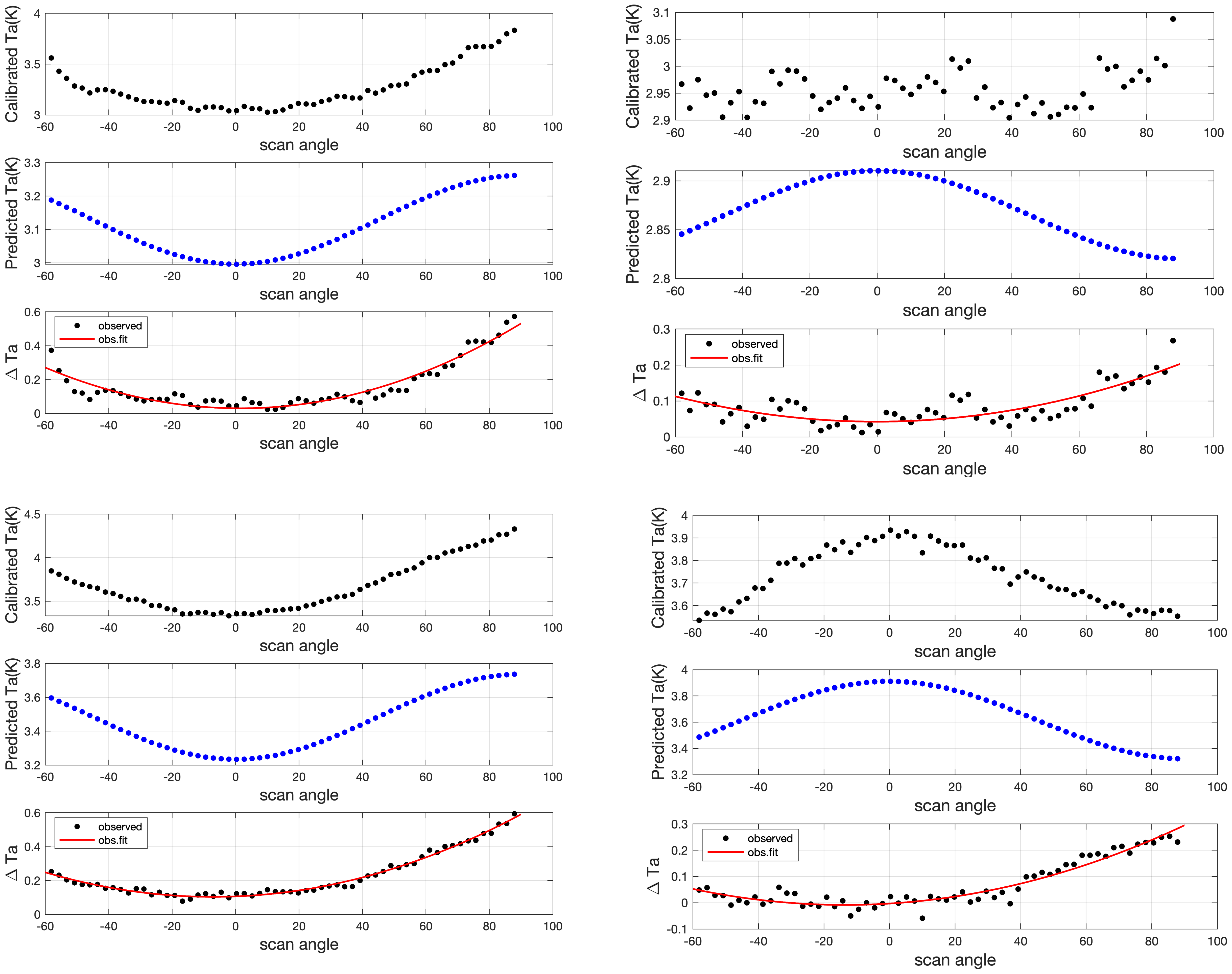
$$Ta_{sat} = \frac{\int_{\theta_1}^{\theta_2} G(\theta) \cdot Ts(\theta) \cdot sin\theta d\theta}{\int_{-\pi}^{+\pi} G(\theta) \cdot sin\theta d\theta}$$





Calculation Results for NOAA 21 Satellite Contamination

- The magnitude of satellite contamination is dominated by the near-field radiation, which is closely correlated with instrument chamber temperature
- The satellite contamination can be quantified by study the cold space scan data, it reaches the minimum at nadir and increase with scan angle
- The magnitude the contamination is larger in -Y side than +Y side, due to the different instrument blockage



Conclusion and the Future Work

- The TDR calibration of NOAA 21 ATMS is consistent with SNPP and NOAA 20. Direct comparison for overlapping orbits show warmer Ta than NOAA 20 and colder than SNPP

- The SDR calibration results for NOAA 21 show general improvements in G-band and comparable or improved results in V band

- The major root causes of the calibration difference between the different ATMS instruments are from satellite contamination, Earth side-lobe contamination, and the antenna spill-over correction.

- Several major updates will be made into operational IDPS ATMS SDR algorithm to mitigate the calibration difference