Integrated Calibration/Validation System (ICVS) Overview

Name of the Product: ICVS

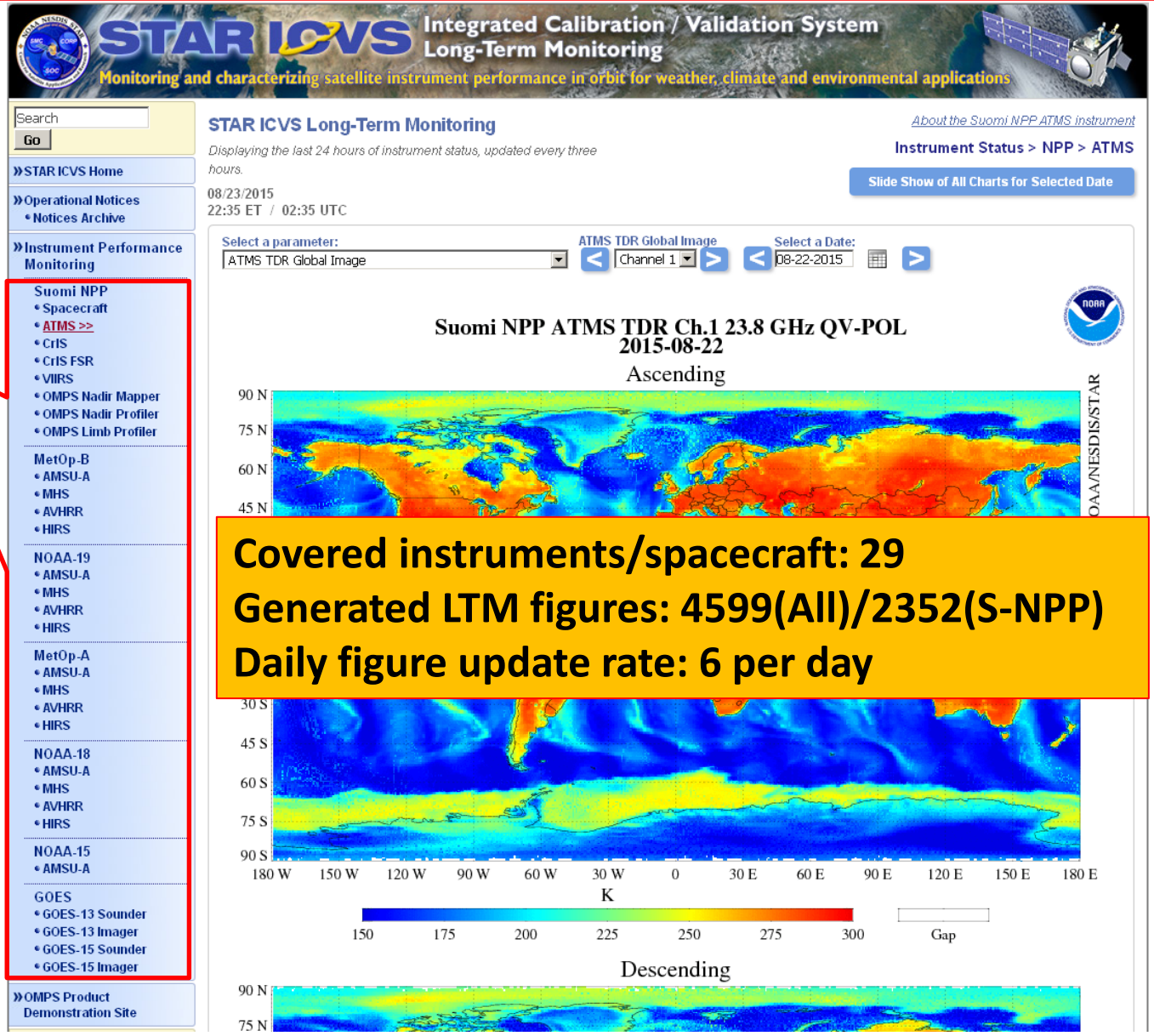
Contributors: ICVS Team

Presenter: Ninghai Sun

Date: August 24, 2015

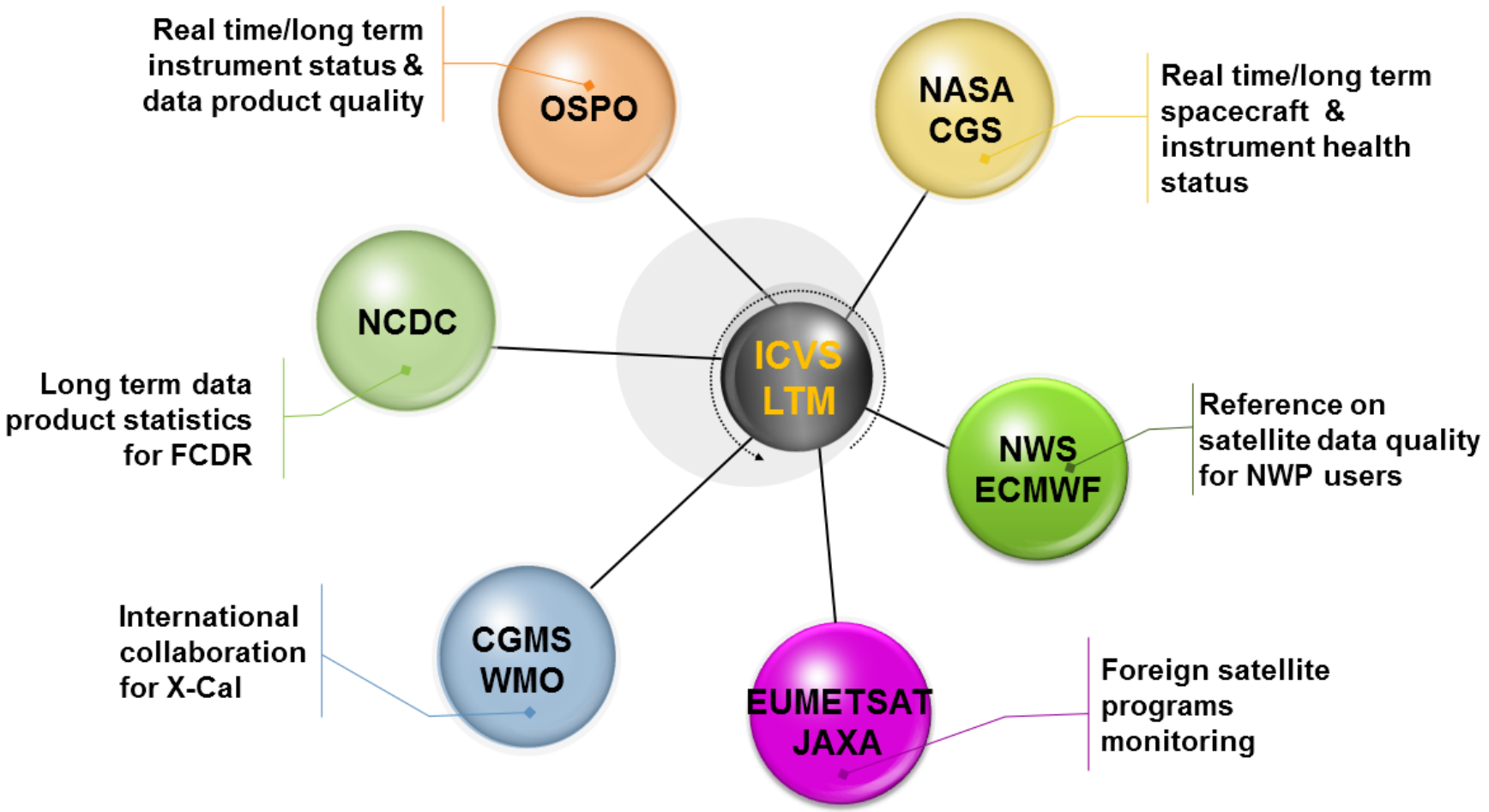
STAR ICVS Overview

- Suomi NPP
  - Spacecraft
  - ATMS >>
  - CrIS
  - CrIS FSR
  - VIIRS
  - OMPS Nadir Mapper
  - OMPS Nadir Profiler
  - OMPS Limb Profiler
- MetOp-B
  - AMSU-A
  - MHS
  - AVHRR
  - HIRS
- NOAA-19
  - AMSU-A
  - MHS
  - AVHRR
  - HIRS
- MetOp-A
  - AMSU-A
  - MHS
  - AVHRR
  - HIRS
- NOAA-18
  - AMSU-A
  - MHS
  - AVHRR
  - HIRS
- NOAA-15
  - AMSU-A
- GOES
  - GOES-13 Sounder
  - GOES-13 Imager
  - GOES-15 Sounder
  - GOES-15 Imager



Covered instruments/spacecraft: 29
Generated LTM figures: 4599(All)/2352(S-NPP)
Daily figure update rate: 6 per day

STAR ICVS Overview



NOAA STAR ICVS are now providing more parameters for applications by broader communities including NWP. It is a very powerful tool and should be set up as a gold standard for all the space agencies to follow in satellite instrument monitoring and trending ***- Stephen English (ECMWF DA Head)***

STAR ICVS Team Members

Name	Organization	Major Task
Fuzhong Weng	NOAA/STAR	Team lead, technical oversight, budget and schedule
Ninghai Sun	ERT Inc.	System designer and Spacecraft/ATMS/AMSU/MHS LTM developer; Big data analysis lead
Ken Carey	ERT Inc.	ICVS outreach
Xin Jin	ERT Inc.	CrIS SDR LTM developer
Jason Choi	ERT Inc.	VIIRS SDR LTM developer
Ding Liang	ERT Inc.	OMPS SDR LTM developer
Wanchun Chen	ERT Inc.	System developer
Haifeng Qian	ERT Inc.	POES AVHRR/HIRS LTM developer
Miao Tian	ERT Inc.	Microwave trending analyst; Big data statistic analyst
Jian Li/Emily Duff	ERT Inc.	Multiple sensor imaging visualization developer

STAR ICVS Accomplishments

1. Transitioned S-NPP instrument health status and data product quality monitoring package (ICVS-Lite) to GRAVITE for OSPO 24/7 operational uses
2. Supported S-NPP ATMS scan drive main motor current anomaly analysis and scan reversal activities
3. Defined SI traceable channel noise evaluation algorithm using Allan deviation method for both ATMS and CrIS
4. Explored Big Data applications in database construction, statistic analysis, prediction model construction, data mining algorithm development for ICVS
5. Held the first STAR ICVS annual meeting and published STAR ICVS instrument status annual technical report
6. Updated ICVS to improve the instrument status and data quality monitoring capability
   - Added VIIRS band averaged and detector level F/H-factor trending
   - Added ATMS dwell telemetry RDR trending
   - Added CrIS full spectral resolution (FSR) SDR trending
   - Added ATMS/CrIS TDR/SDR bias characterization trending
   - Added VIIRS Imagery over Alaska real time monitoring
   - Rejuvenated OMPS NP/NM/LP SDR trending packages
   - Updated STAR ICVS website to improve user experience

ICVS-Lite Transition to GRAVITE

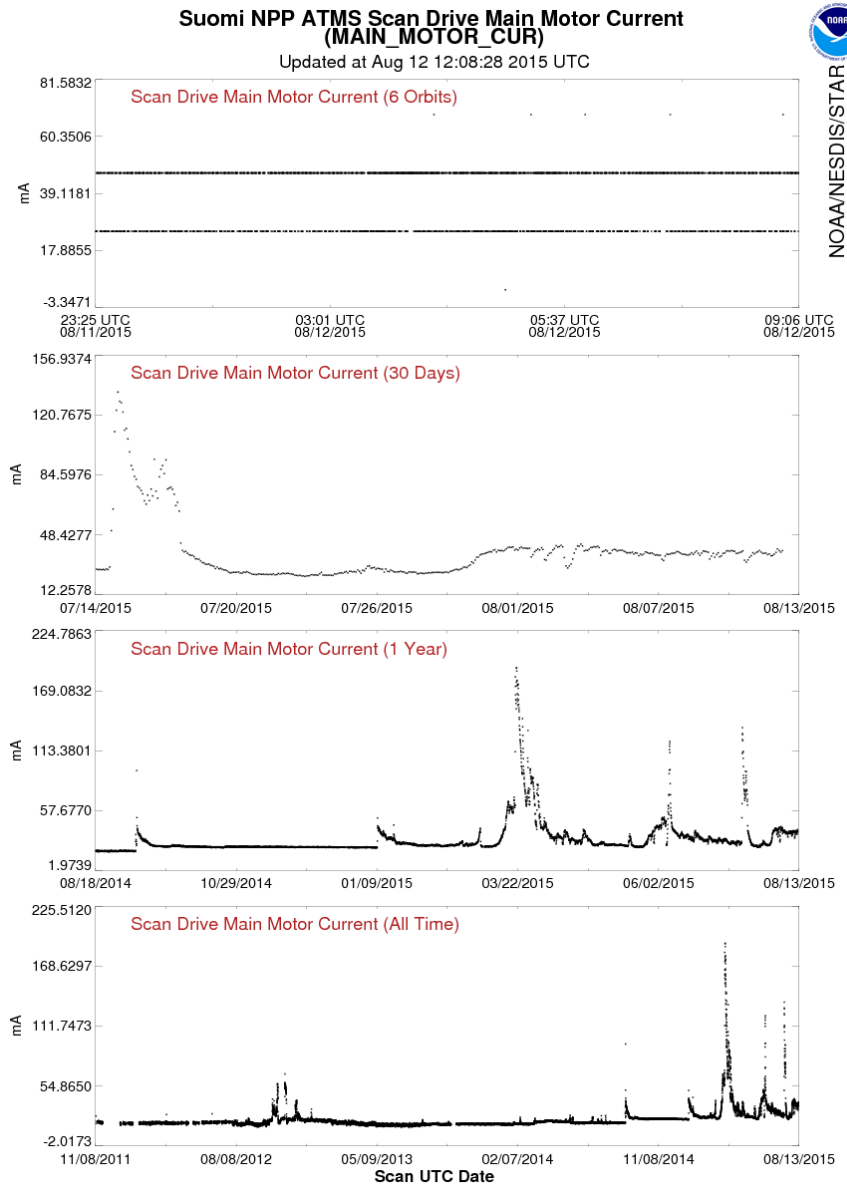
S-NPP Spacecraft and onboard instruments health status, performance, and SDR data quality long term monitoring (LTM) from STAR ICVS has been transitioned to GRAVITE

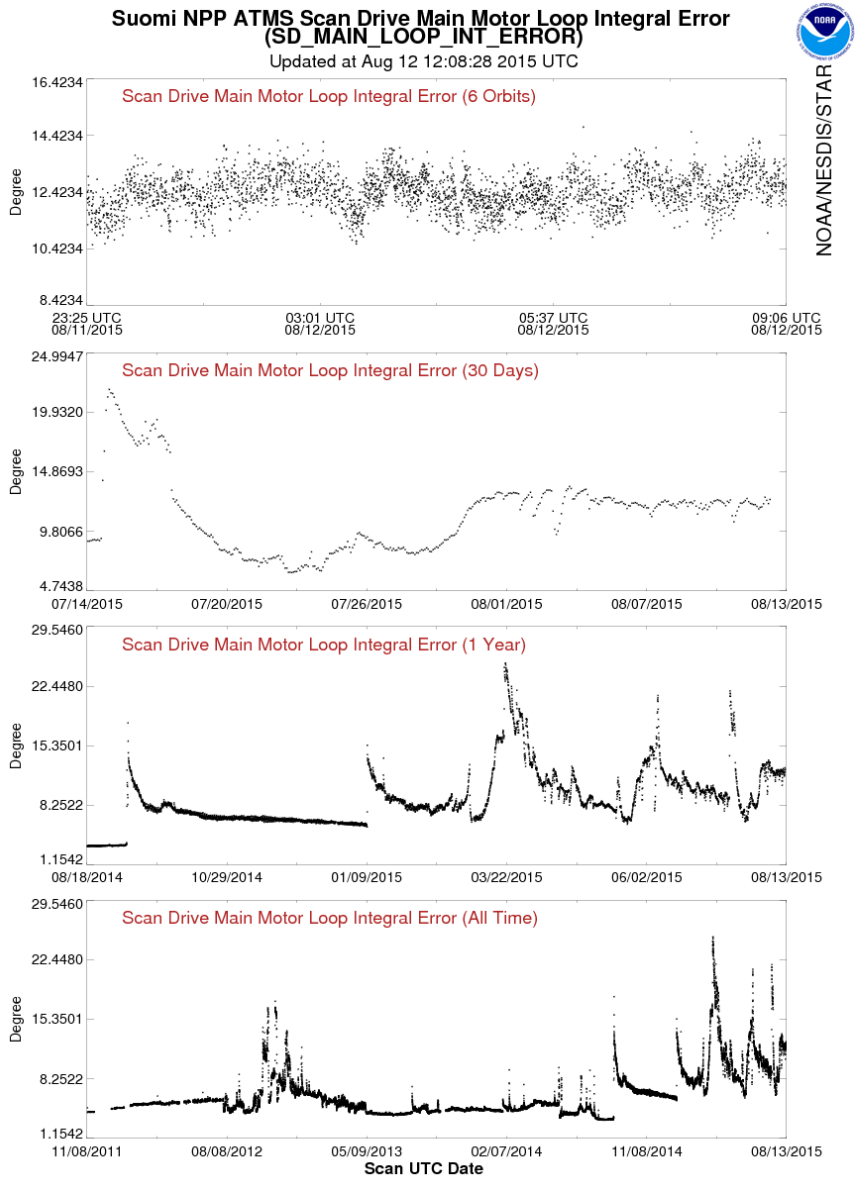
Modules includes,

1. S-NPP Spacecraft health status LTM
2. S-NPP ATMS instrument health status/performance and TDR data quality LTM
3. S-NPP CrIS instrument health status/performance and SDR data quality LTM
4. S-NPP VIIRS instrument health status and key calibration parameters LTM
5. S-NPP OMPS instrument health status LTM
6. S-NPP VIIRS Imagery real time monitoring

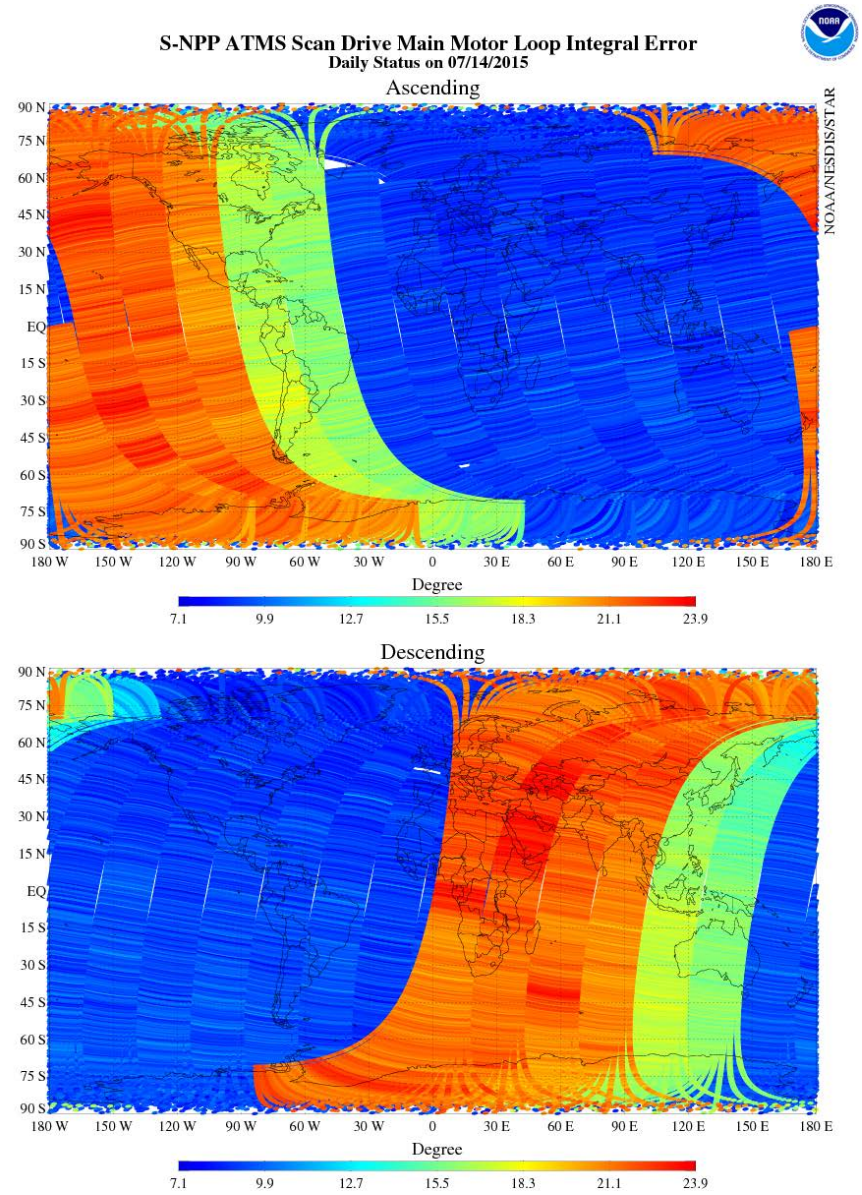
STAR ICVS team and GRAVITE data quality monitoring team work closely to make ICVS-Lite work stable for OSPO 24/7 operational missions

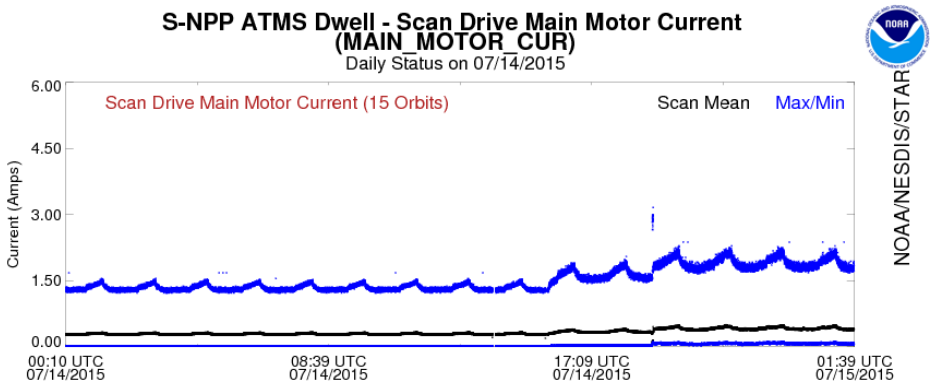
ATMS Scan Drive Main Motor Monitoring

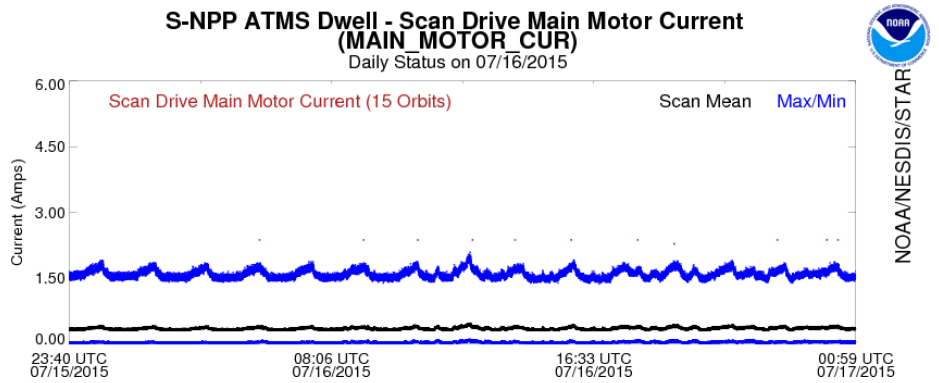


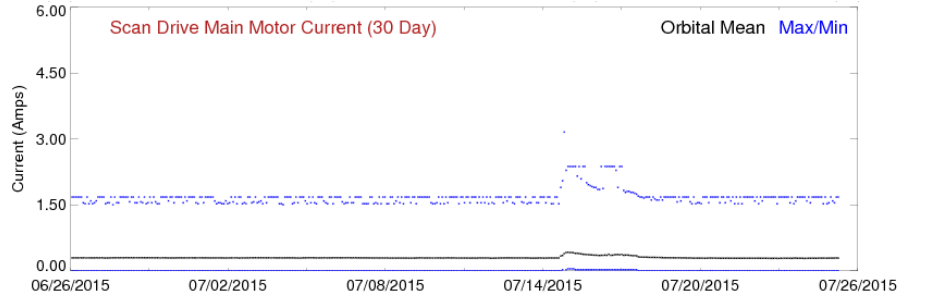


ATMS Scan Drive Main Motor Monitoring

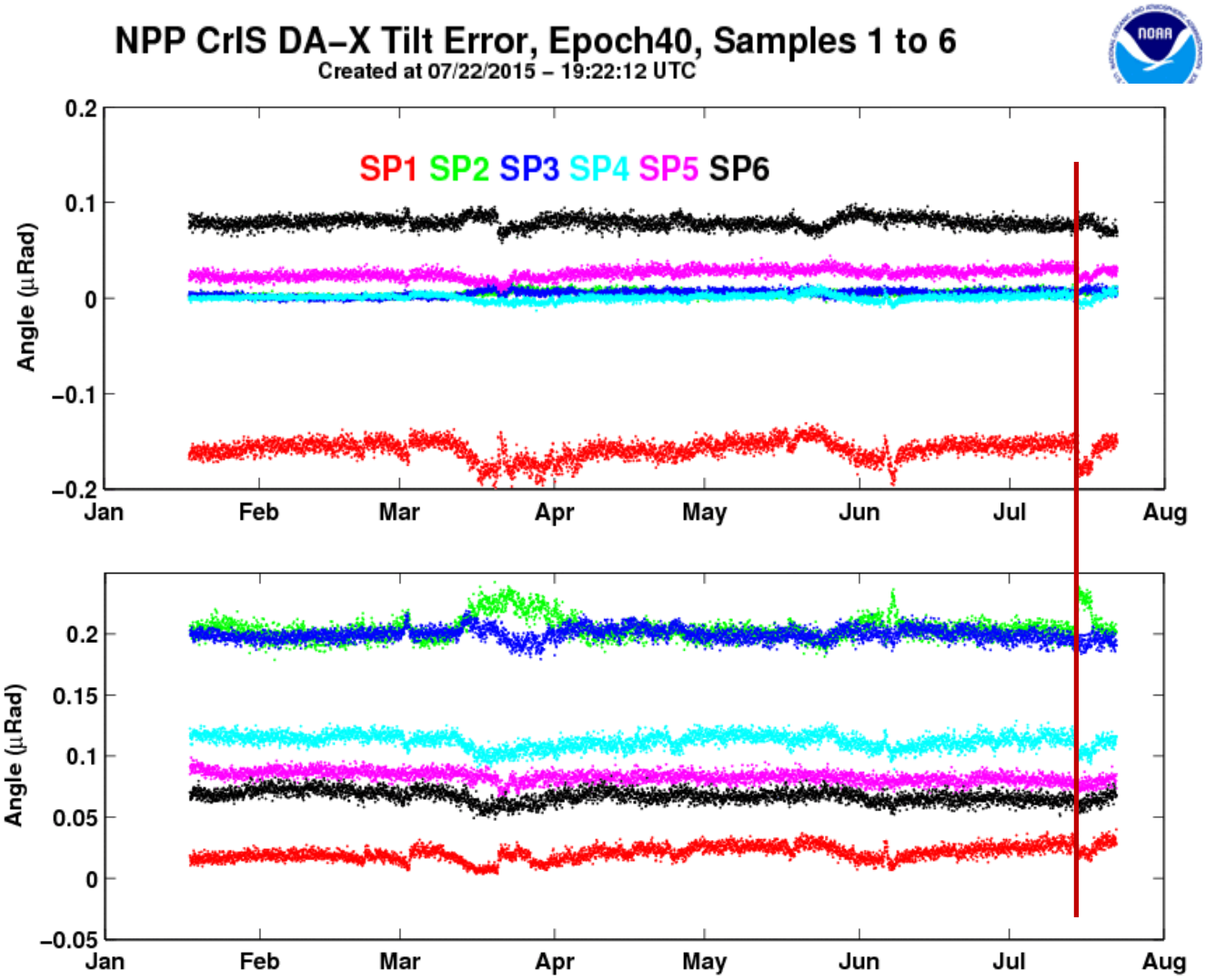








ATMS Scan Drive Main Motor Monitoring



SI Traceable Noise Evaluation Method

Current operational NEΔT calculation method,

$$NE\Delta T_{ch} = \sqrt{\frac{1}{NM}\sum_{i=1}^{N}\sum_{j=1}^{M}\left(\frac{C_{ch}^{w}(i,j)-\overline{C_{ch}^{w}}(i)}{\overline{G_{ch}}(i)}\right)}$$

where C_{ch}^{w} represents the warm count readings at each scan, $\overline{G_{ch}}$ is the averaged calibration gain.

By using overlapping Allan deviation, NEΔT can be calculated via

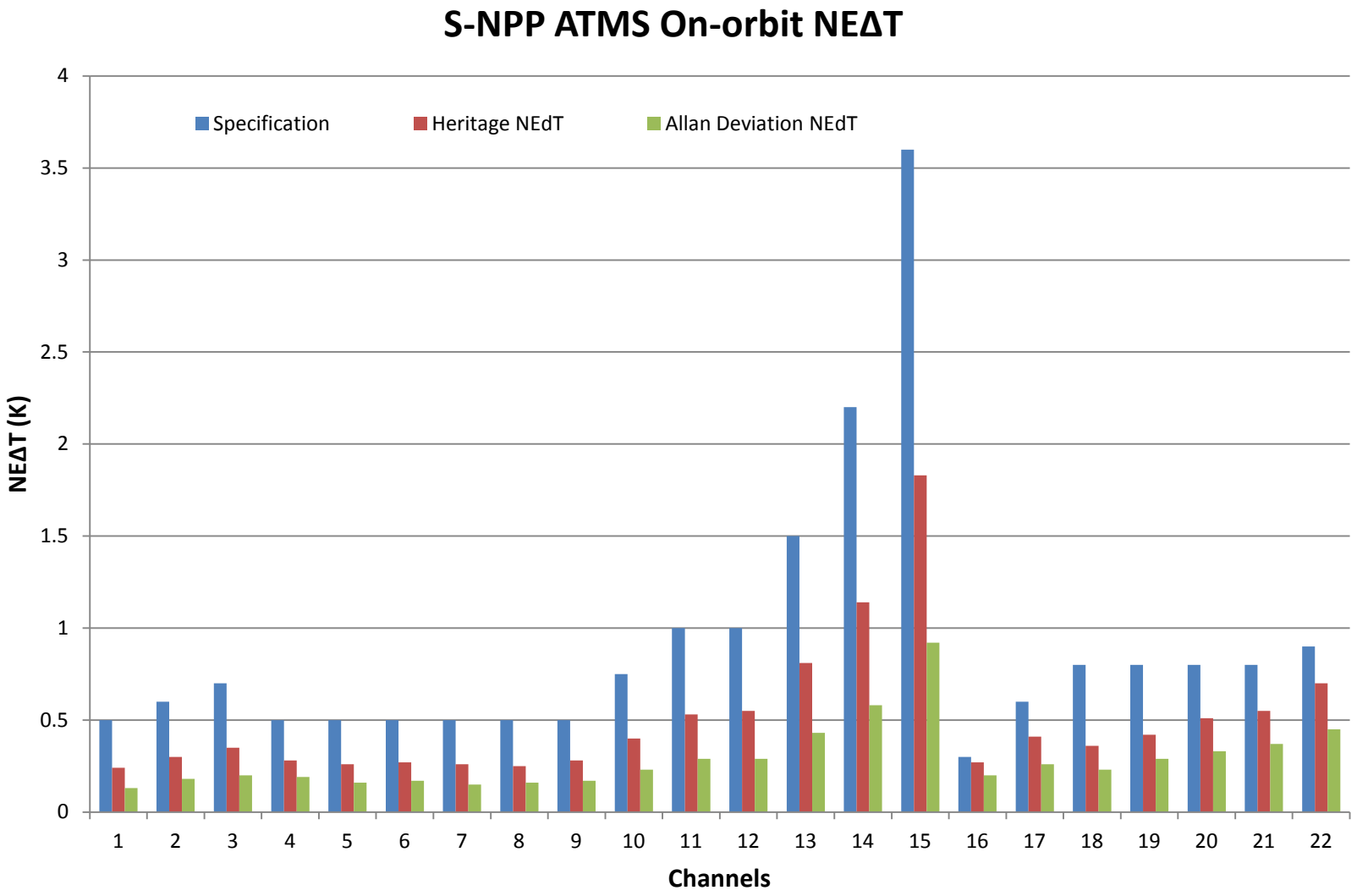
$$NE\Delta T_{ch}^{Allan}(M,m) = \sqrt{\frac{1}{2m^2(M-2m+1)}\sum_{i=1}^{M-2m+1}\sum_{k=i}^{i+m-1}\left[\frac{C_{ch}^{w}(k+m)-C_{ch}^{w}(k)}{\overline{G_{ch}}}\right]^2}$$

when $m = 1$, NEΔT can be calculated using neighborhood Allan deviation

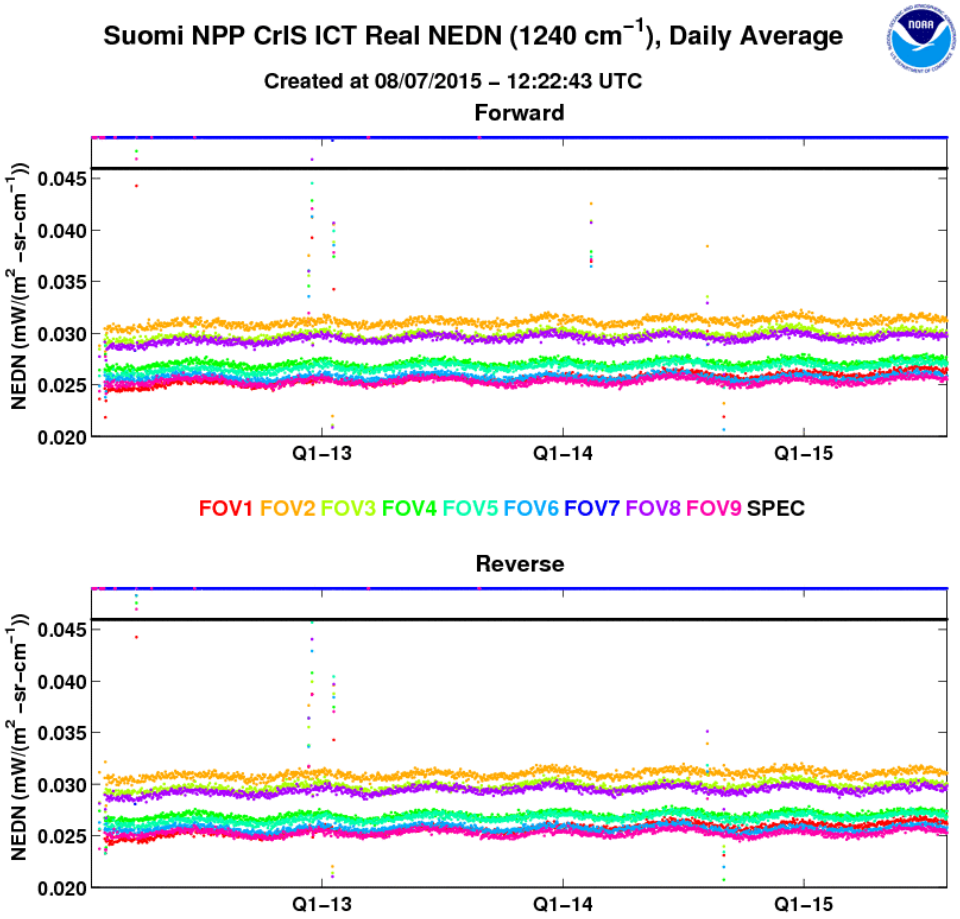
$$NE\Delta T_{ch}^{Allan} = \sqrt{\frac{1}{2(M-1)}\sum_{i=1}^{M-1}\left[\frac{C_{ch}^{w}(i+1)-C_{ch}^{w}(i)}{\overline{G_{ch}}}\right]^2}$$

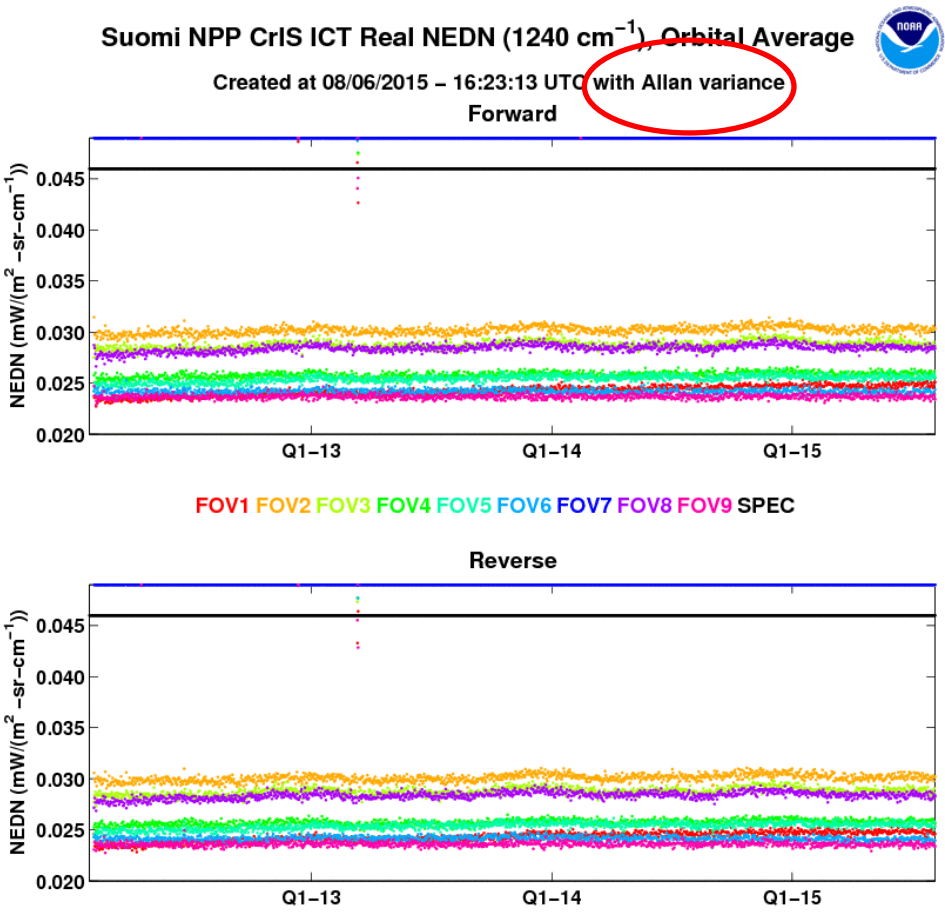
M. Tian, X. Zou and F. Weng, "*Use of Allan Deviation for Characterizing Satellite Microwave Sounders Noise Equivalent Differential Temperature (NEDT)*", IEEE Geosci. Remote Sens. Lett., (Accepted).

SI Traceable Noise Evaluation Method



SI Traceable Noise Evaluation Method

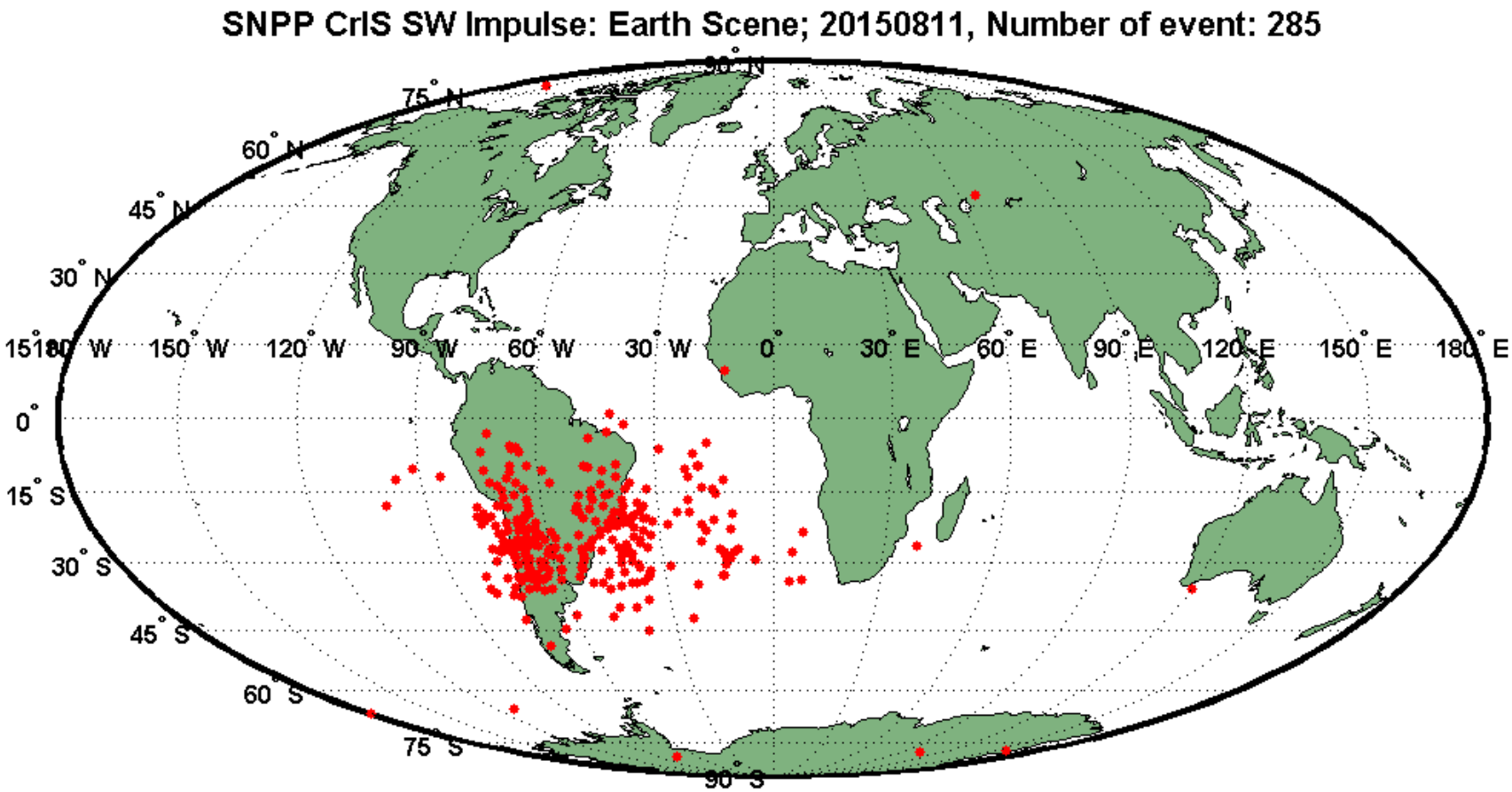




Y. Chen, F. Weng and Y. Han, "*SI Traceable Algorithm for Characterizing Hyperspectral Infrared Sounder CrIS Noise*", Applied Optics, (Accepted).

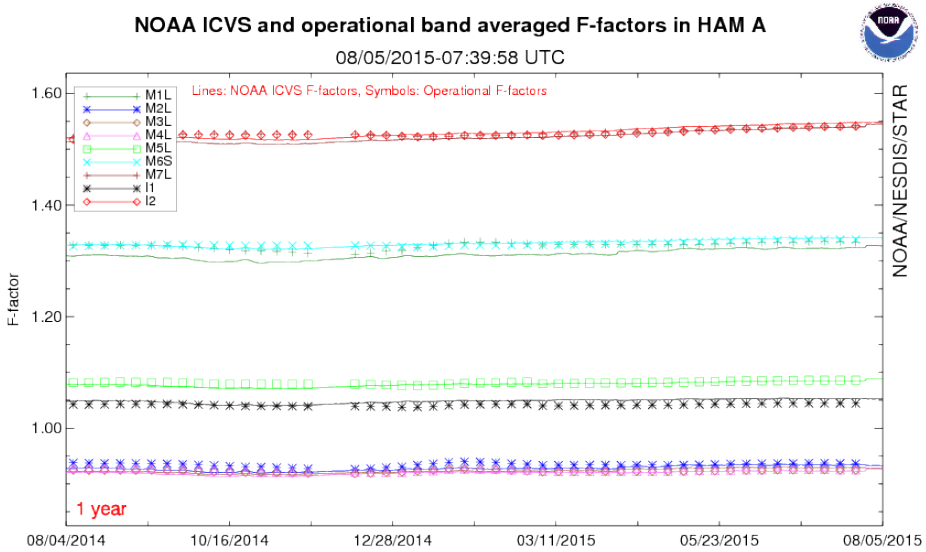
CrIS Full Spectral Resolution (FSR) Trending

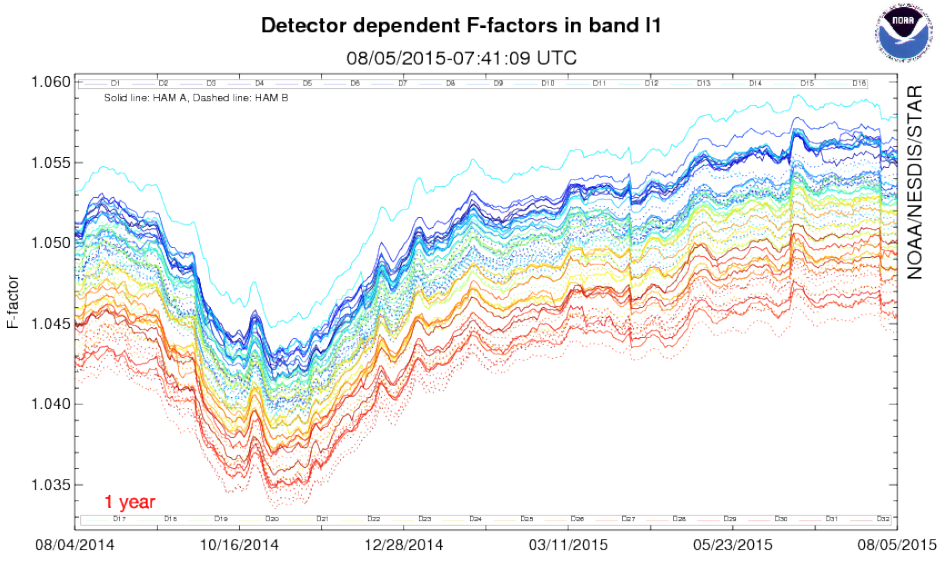
Detect CrIS Shortwave (SW) impulse noise events automatically through long term statistic results

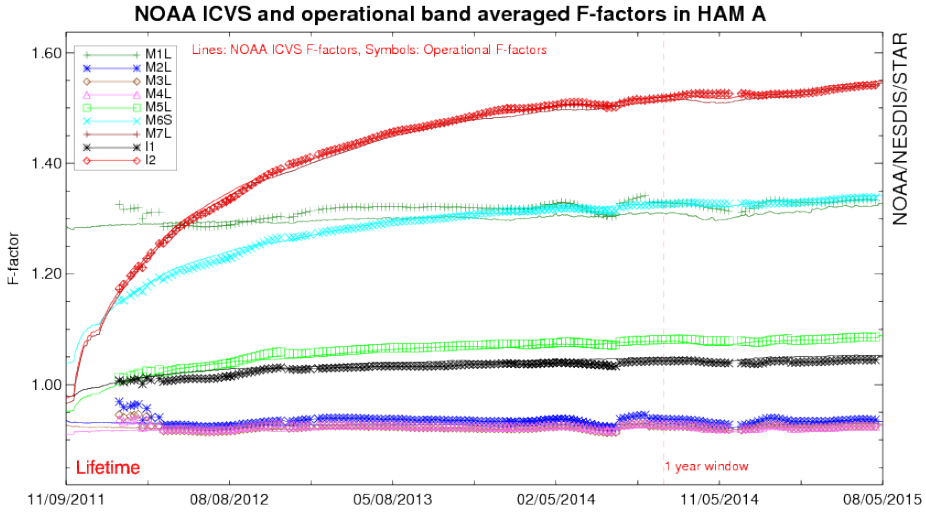


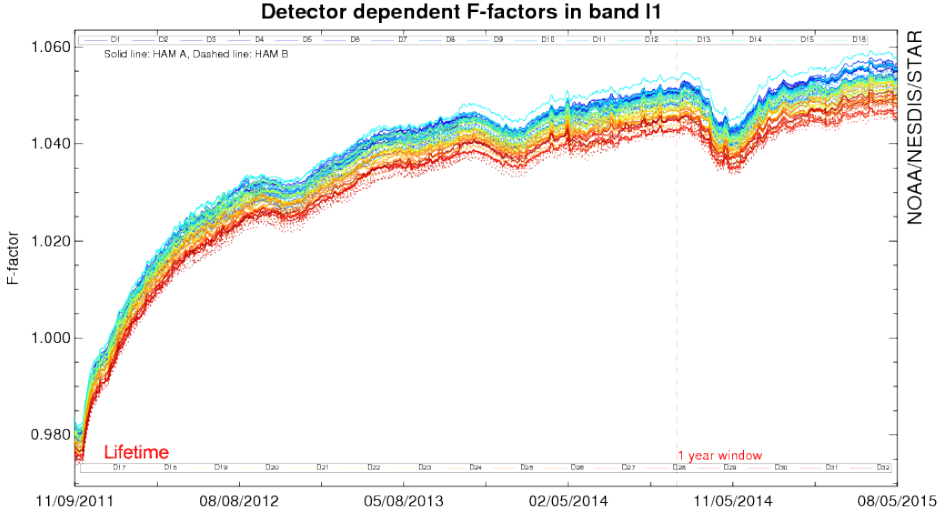
S-NPP VIIRS F-factor Trending

Detector Dependent F-factor plots added to ICVS

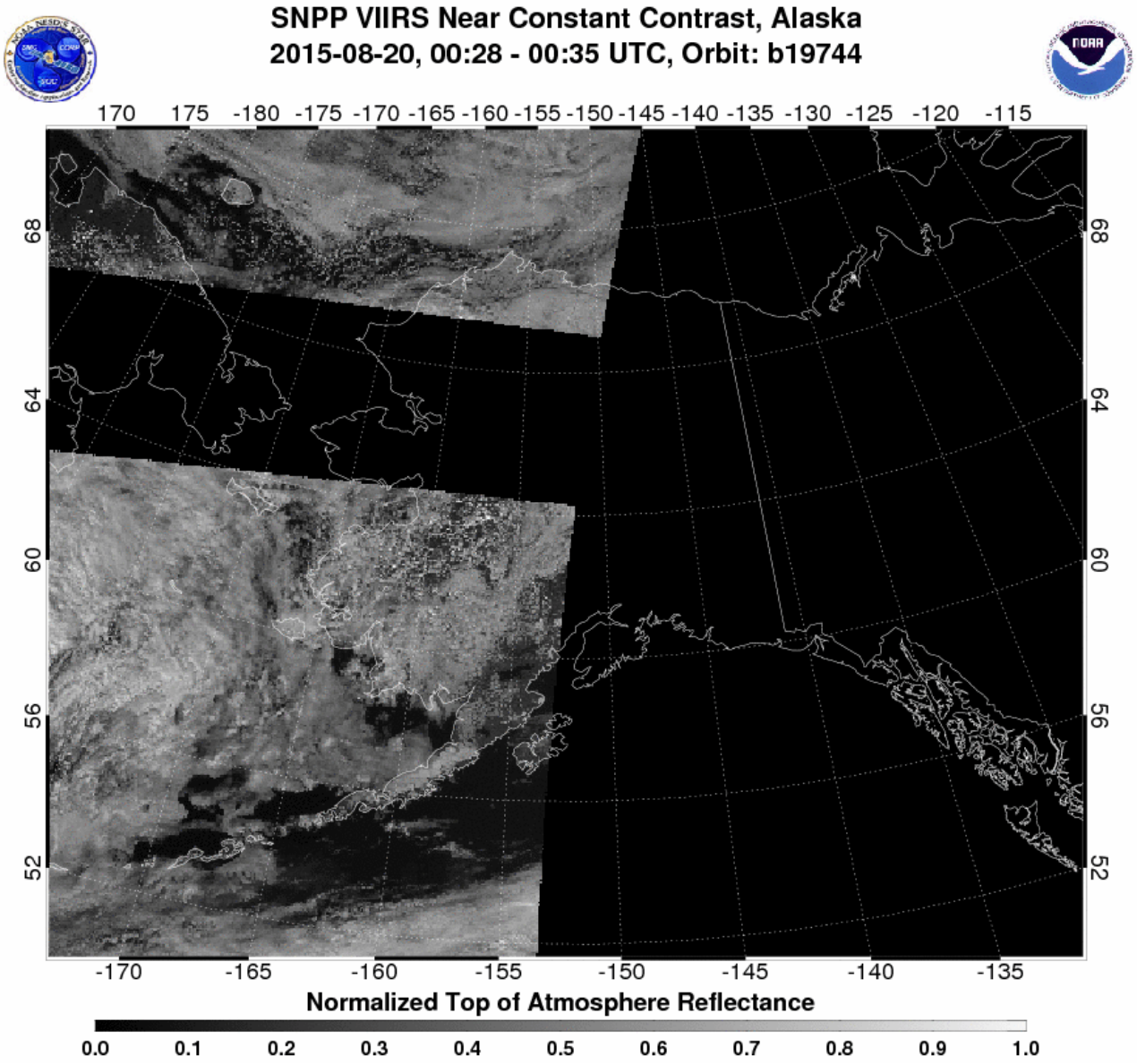








S-NPP VIIRS Imagery Monitoring



STAR ICVS Annual Report

NOAA Technical Report NESDIS XXX

2014-2015 Annual Instrument Performance Review as Monitored by the NESDIS/STAR Integrated Calibration/Validation System

Ninghai Sun, Xin Jin, Taeyoung Choi, Lawrence E. Flynn, Ding Liang, Chengzhi Zou, Greg Krasowski, and Fuzhong Weng

Washington, DC
August 2015,

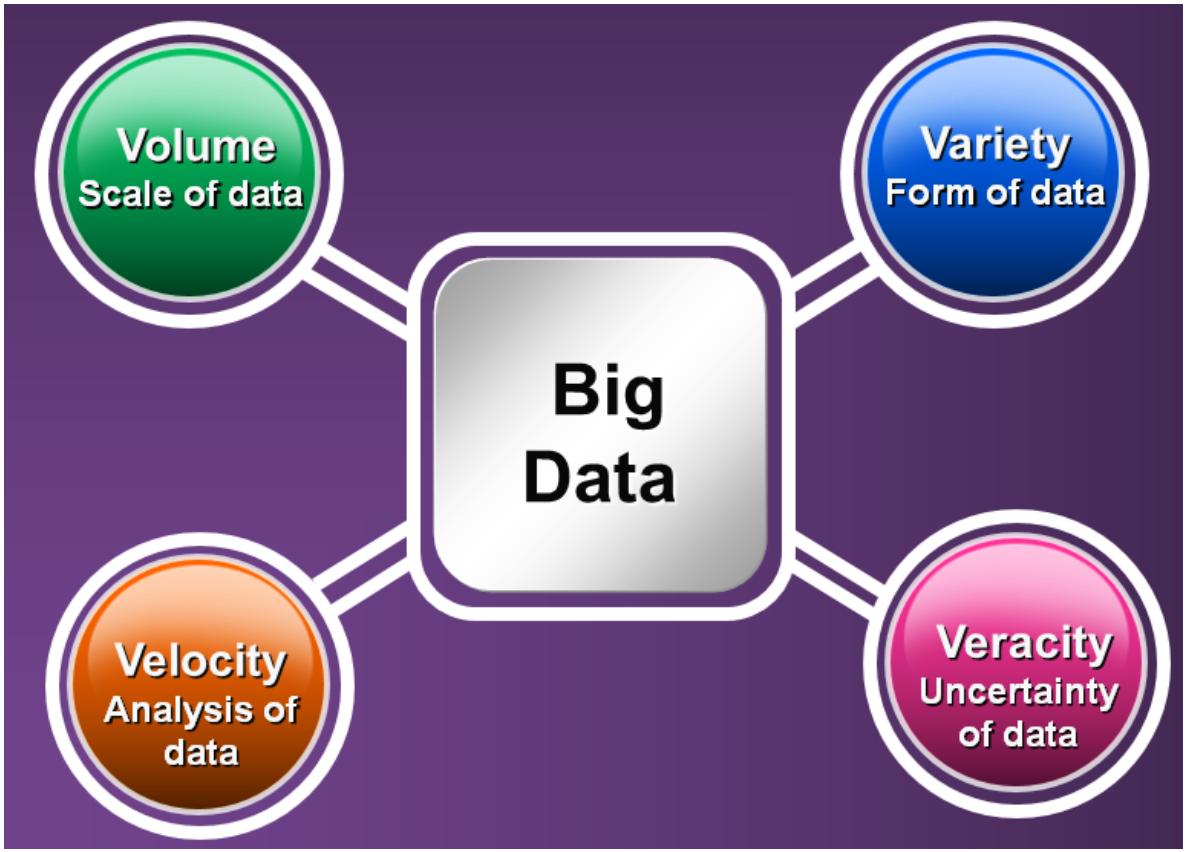
U.S. DEPARTMENT OF COMMERCE
Penny Pritzker, Secretary
National Oceanic and Atmospheric Administration
Dr. Kathryn Sullivan, NOAA Administrator
National Environmental Satellite, Data, and Information Service
Stephen Volz, Assistant Administrator

- Instrument overview including scan geometry
- Instrument health status summary
- Annual instrument anomaly event record
- Include NOAA-19/NOAA-18/Metop-A/Metop-B AMSU-A and MHS, S-NPP ATMS, CrIS, VIIRS, OMPS

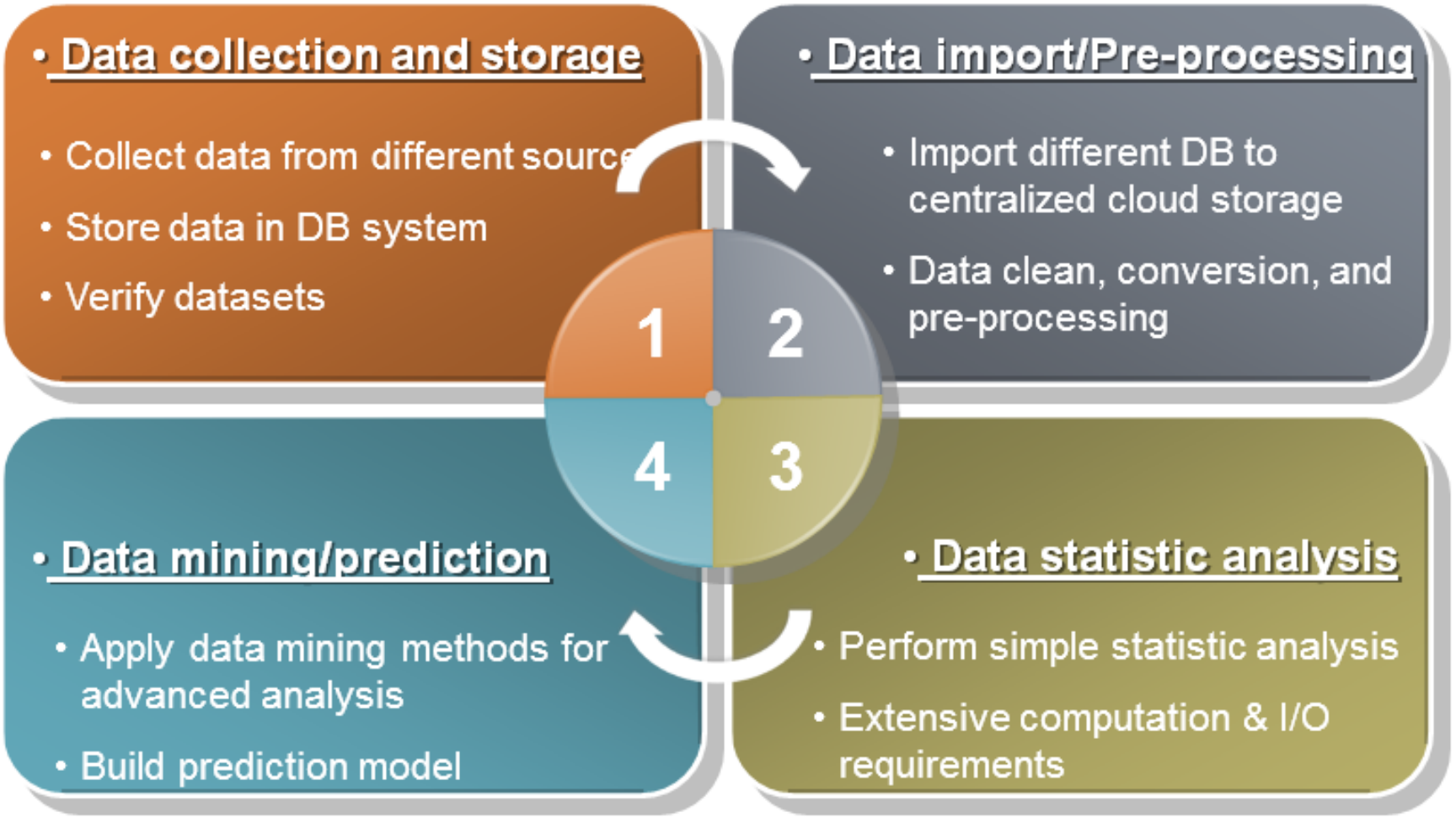
Big Data Analysis on ICVS

Big data exceeds the reach of commonly used hardware environments and software tools to capture, manage, and process it within a tolerable elapsed time for its user population (*Merv Adrian, Teradata Magazine, 2011*)

Big data refers to data sets whose size is beyond the ability of typical database software tools to capture, store, manage and analyze (*McKinsey Global Institute, 2011*)

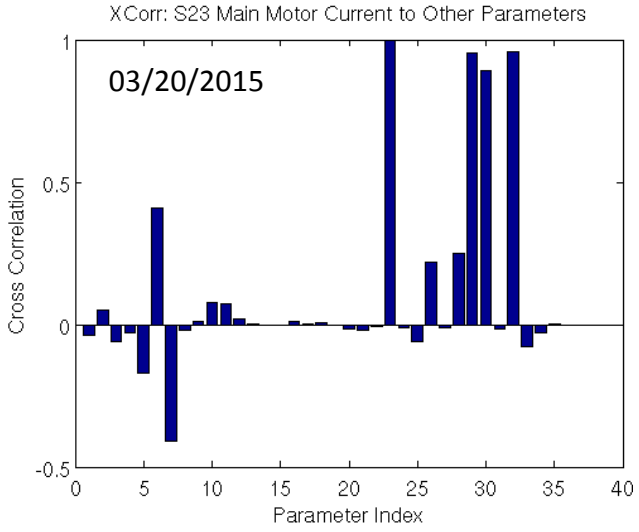


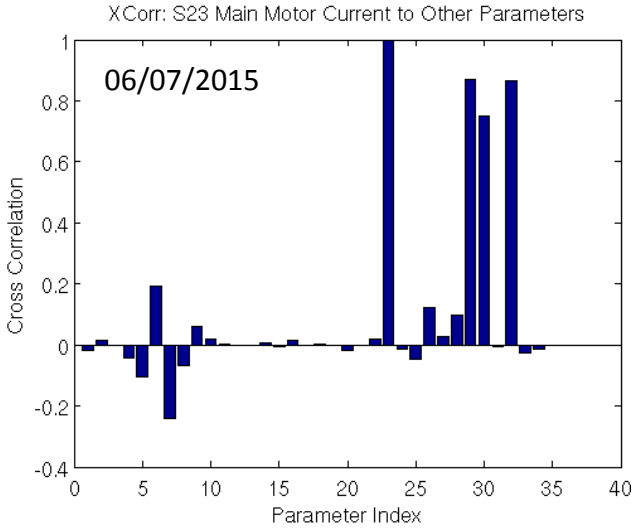
Big Data Analysis on ICVS

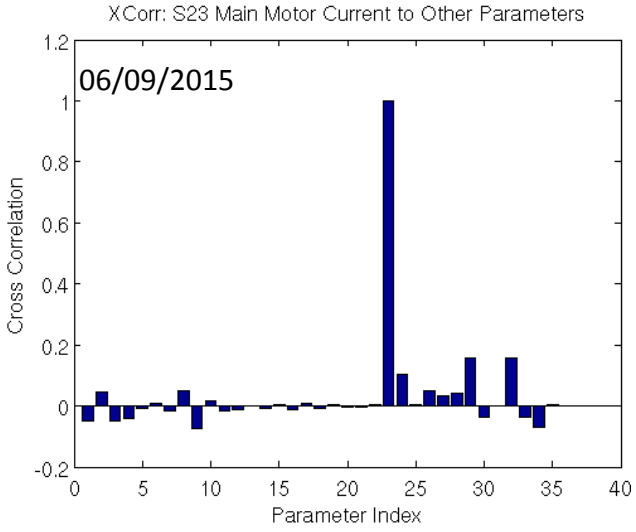


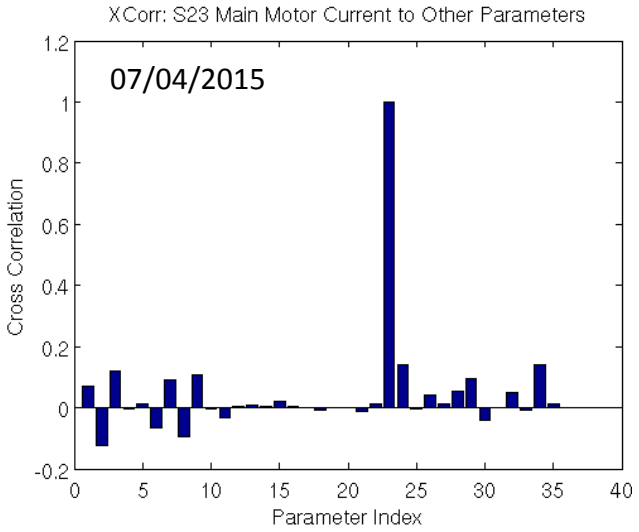
Big Data Analysis on ICVS

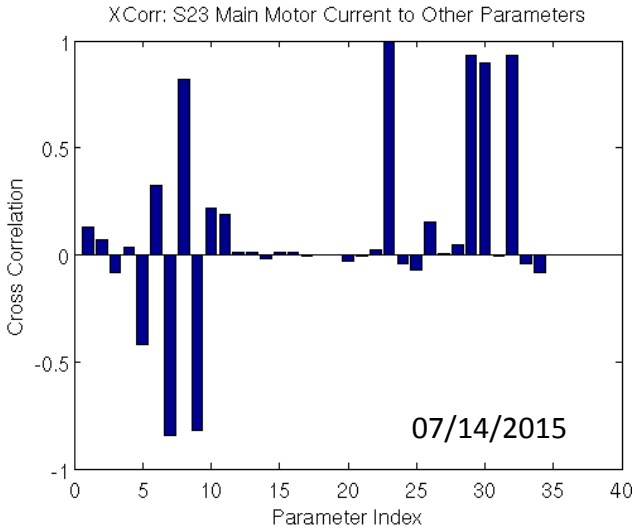
Data Statistic and Analysis for ATMS scan drive main motor current anomaly





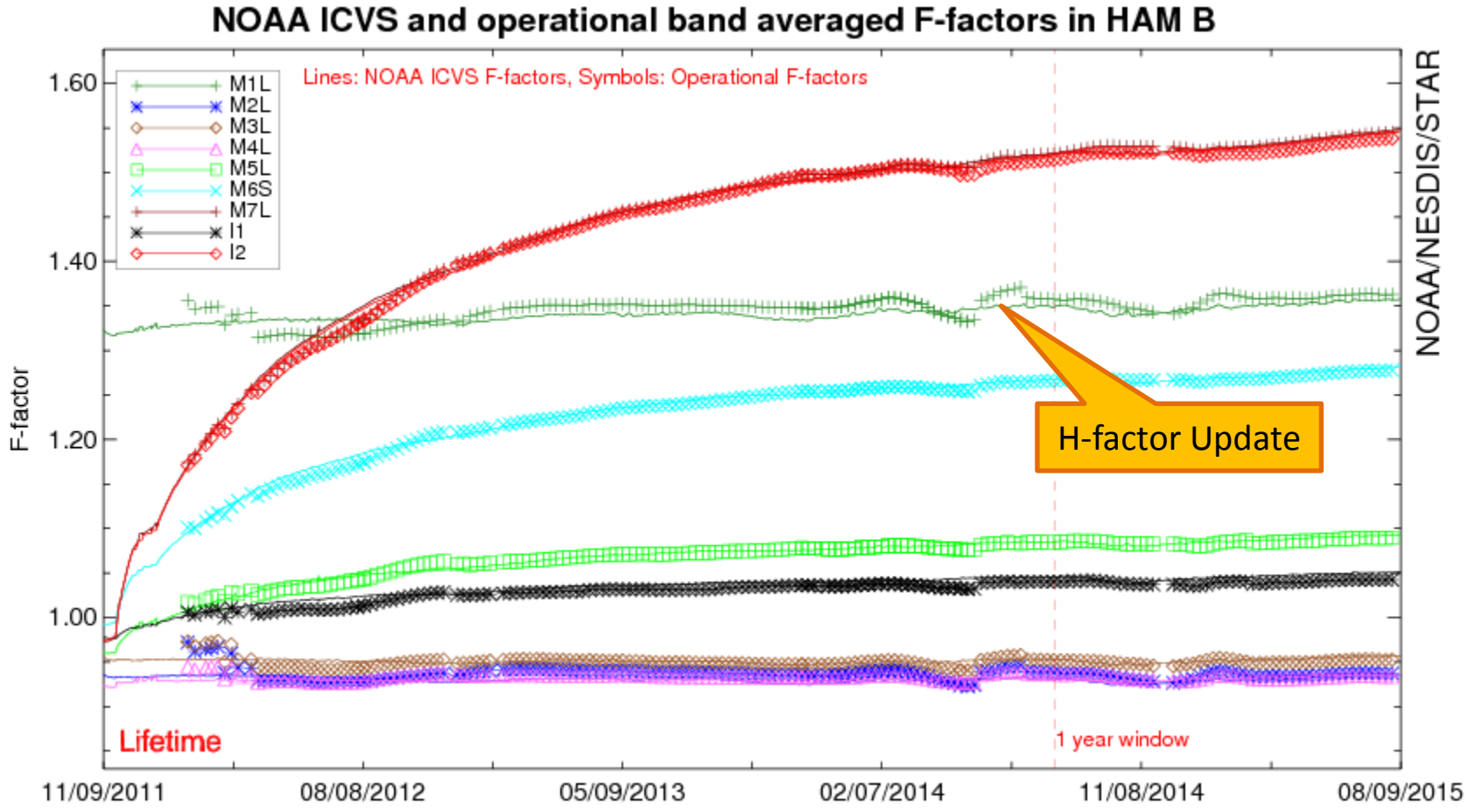




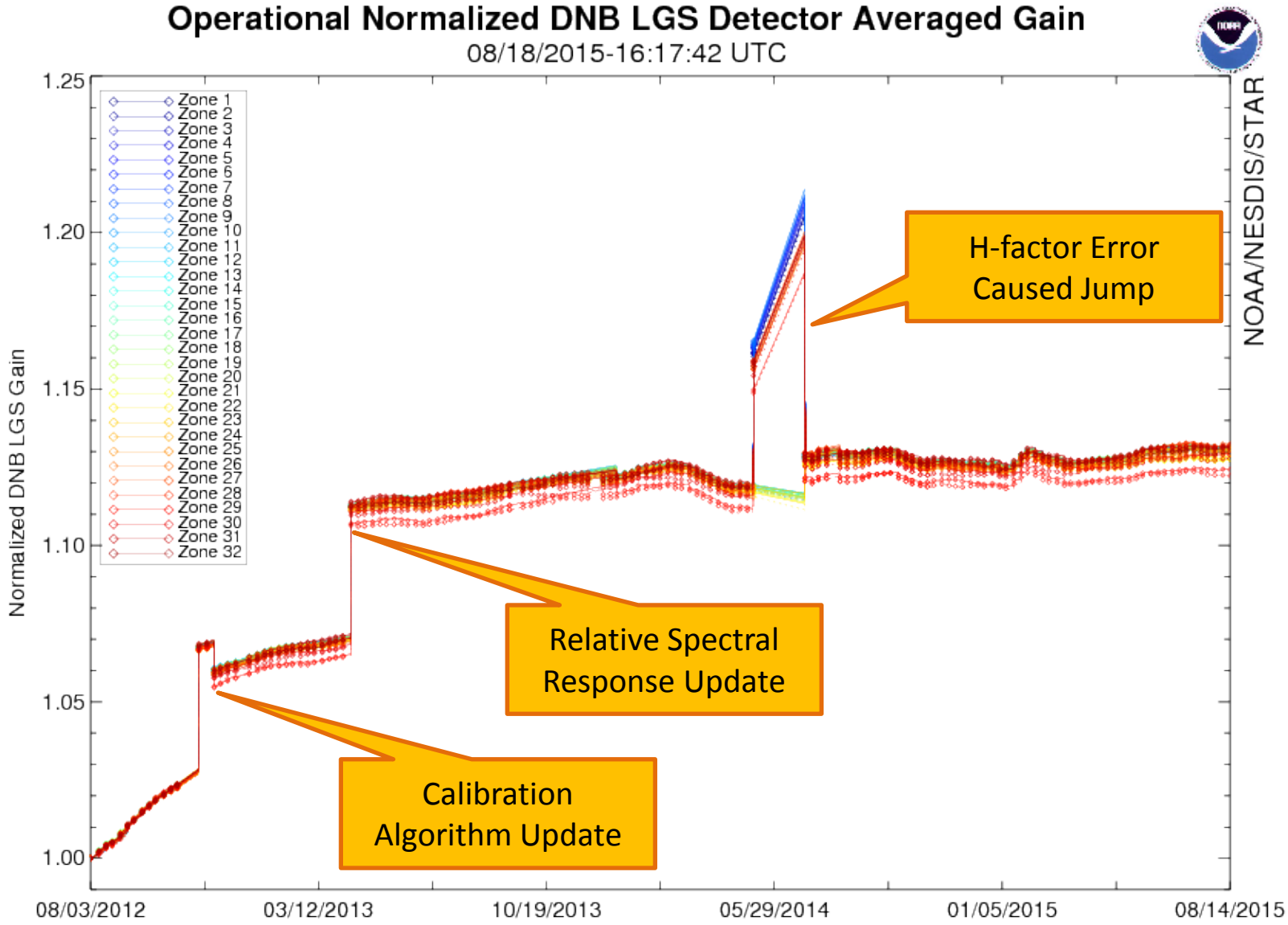


Mission Life-cycle Reprocessing

- Ensure the consistence of data quality with improved calibration algorithm
- Fundamental for reference environmental data record generation



Mission Life-cycle Reprocessing



Summary

- STAR ICVS is not only just instrument status monitoring system but also a calibration testing and quality evaluation system
- STAR ICVS keeps providing near real time and long term trending of NOAA instrument and automatically sending warning messages when anomaly is detected
- STAR ICVS will keep supporting GRAVITE ICVS-Lite 24/7 operational missions
- New functions and parameters are being added to ICVS to provide users better understanding of NOAA satellites/instruments operational status and support on calibration activities, as well as improving user experience by updating STAR ICVS website
- STAR ICVS has supported JPSS-1 pre-launch calibration activities and is ready for JPSS-1 post-launch instrument monitoring and calibration activities

Path Forward

- Keep developing STAR ICVS Big Data analysis enterprise system
  - Collect satellite observation and derived environmental data to increase ICVS Big Data analysis database volume
  - Start data importing and pre-processing to improve Big Data analysis efficiency
  - Begin initial statistic analysis on multi-dimensional database
  - Attempt to apply different data mining technical for advanced data analysis for different users
- Plan on S-NPP mission life-cycle reprocessing for reference environmental data record generation
- VIIRS DNB parameter trending
- Instrument geolocation accuracy trending