GOES IPM for STAR ICVS – Past, Present, and Future

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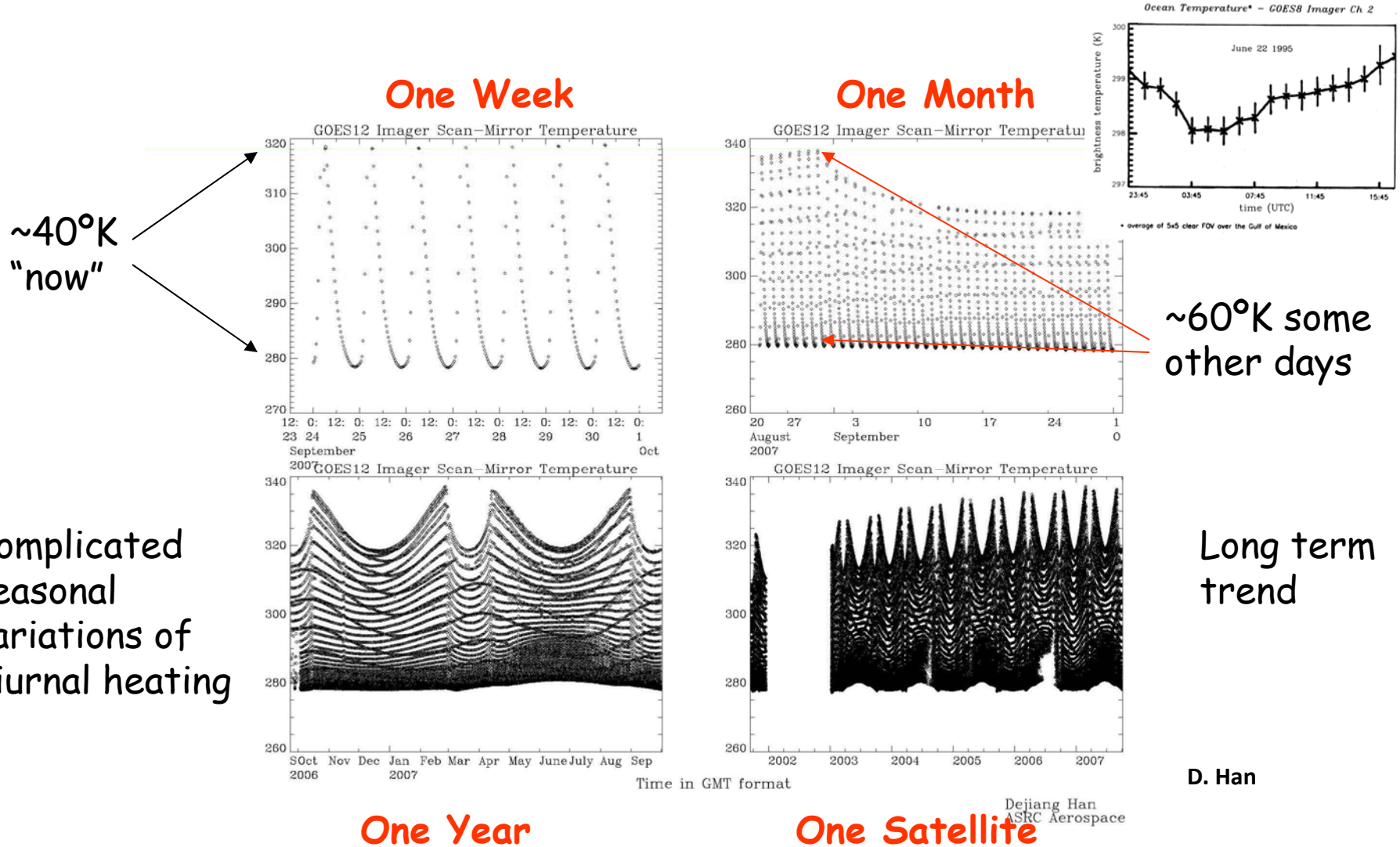
And many contributors

2015 STAR ICVS Review
NCWCP Conference Center
May 8, 2015

GOES IPM in the Past (1/3)

- Telemetry (temperature, voltage, etc.) has always been monitored by satellite operator.
  - For instrument health and safety.
  - Real time, 24/7.
  - Probably archived, but rarely need or can to dive into.
- In early 1990's, during the final preparation for the new (2nd) generation of GOES-I/M, it was suggested (by M. Weinreb?) to add a "Product Monitor (PM)" and "History File".
  - In addition to instantaneous BB/SP counts, now we also need history.
    - Unlike previous GOES and other POES instruments.
  - Began to monitor calibration and L1b product (time series).

GOES IPM in the Past (2/3)



D. Han

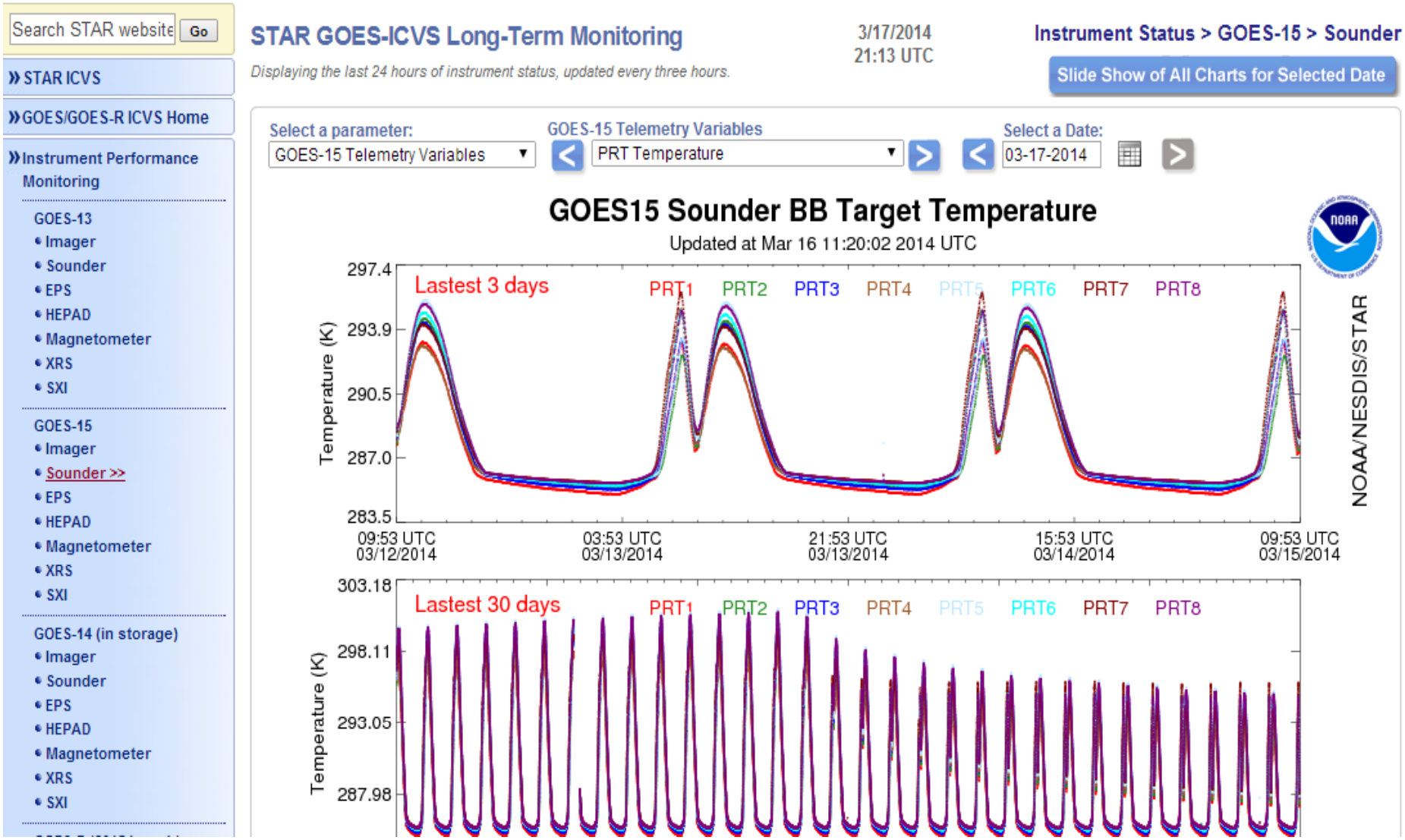
Goes-12 Scan Mirror Temperature

GOES IPM in the Past (3/3)

- Transition to STAR
  - Learned about the PM/RPM and the access limitation.
  - GSICS made much better monitoring of L1b.
  - Started to monitor using web.
- Lessons Learned:
  - New problems, especially new instrument, prompted new needs for instrument calibration and monitoring.
    - What and how to monitor is somehow unpredictable – be flexible and adaptive to new needs.
  - However monitoring some of the basic parameters are always needed for calibration scientists and users:
    - Instrument Status.
    - Calibration Coefficients.
    - L1b data quality.

GOES ICVS-LTM

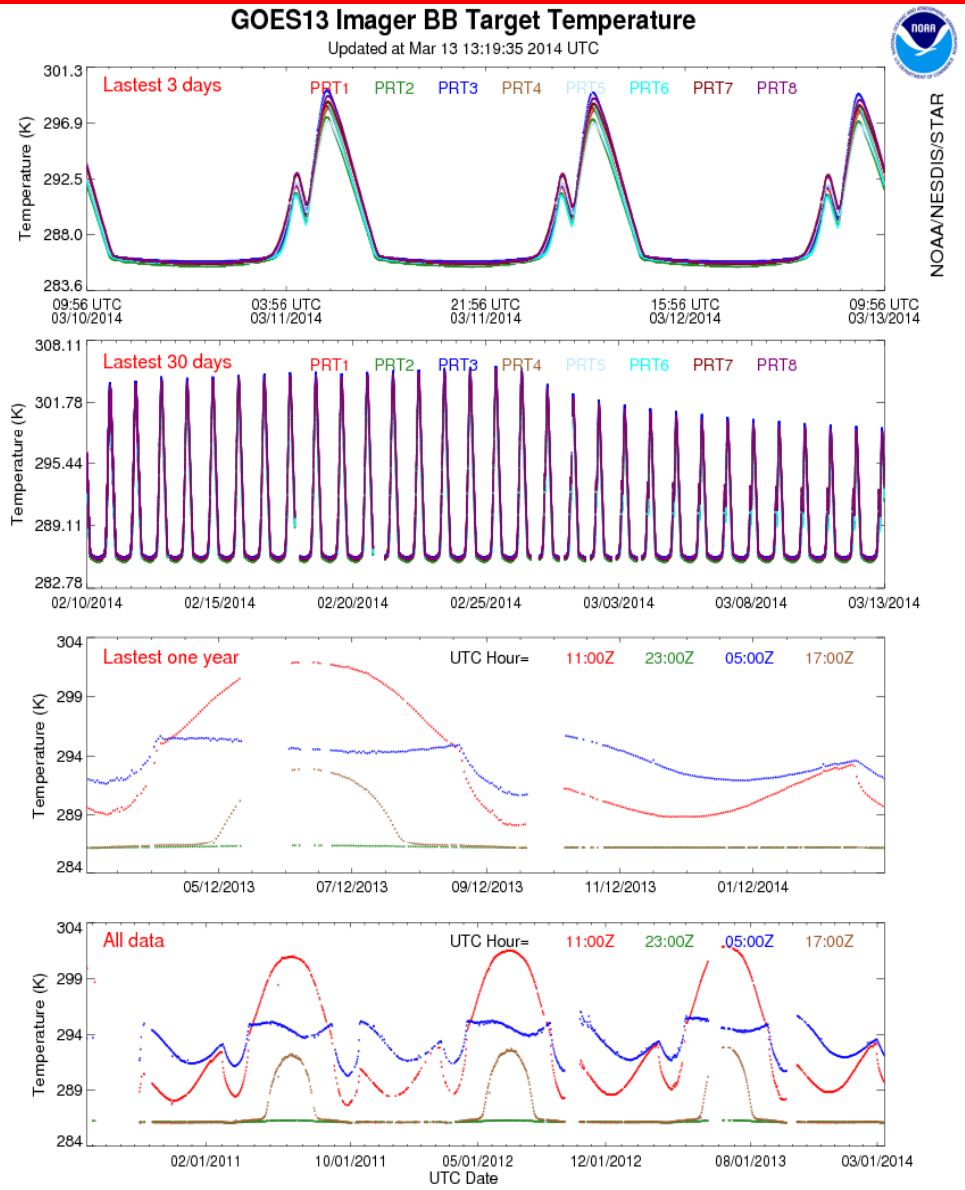
Website is at http://www.star.nesdis.noaa.gov/goes-icvs/



GOES ICVS-LTM Parameters

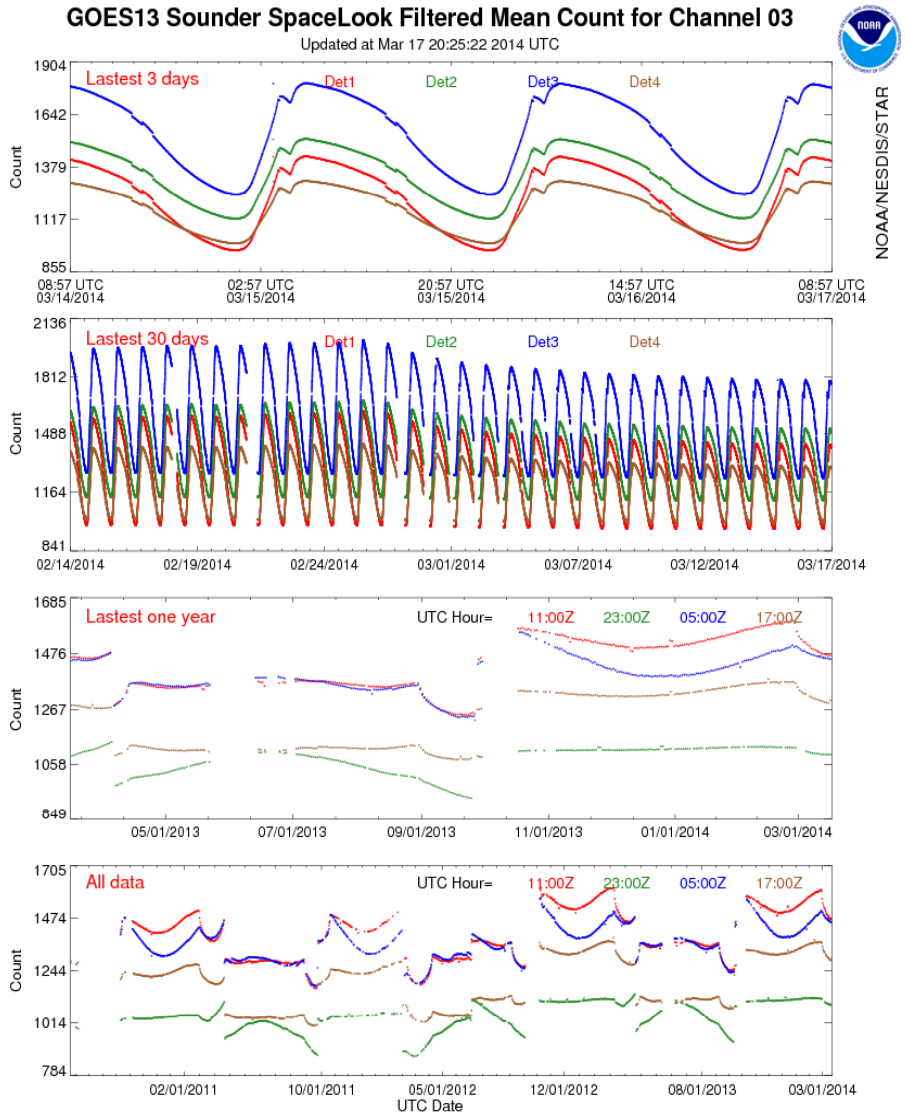
Satellite	Instrument	Calibration Related Telemetry Parameters	Calibration Target Signals	IR Calibration Coefficients	Detector Noise
GOES-13	**Imager**	14	4x5channels (2-8 det/chan)	2x4 channels (2 det/chan)	2x5chan (2-8 det/chan)
	Sounder	16	2x19channels (4 det/chan)	2x19 channels (4 det/chan)	2x19 channels (4 det/chan)
GOES-15	**Imager**	14	4x5 channels (2-8 det/chan)	2x4 channels (2 det/chan)	2x5 channels (2-8 detectors)
	Sounder	16	2x19 channels (4 det/chan)	2x18 channels (4 det/chan)	2x19 channels (4 det/chan)

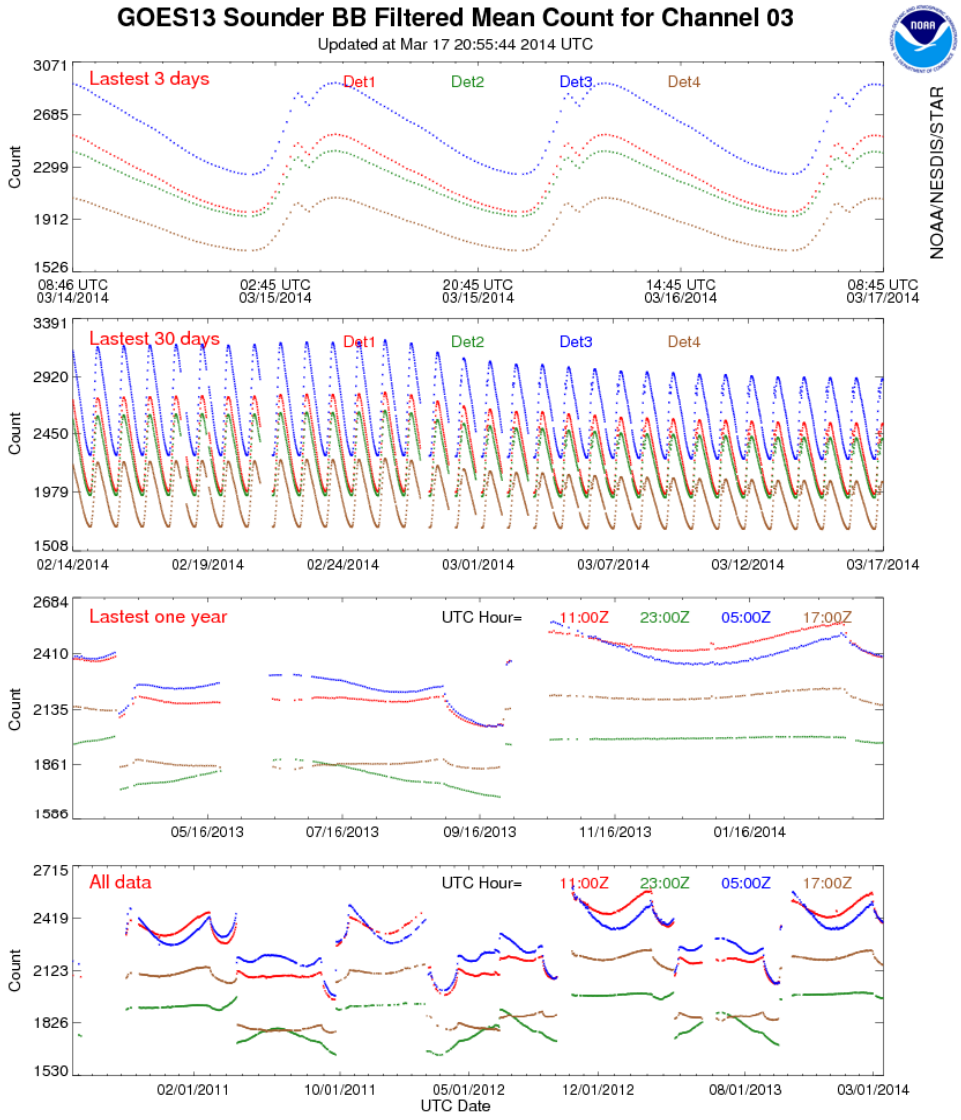
Instrument Status



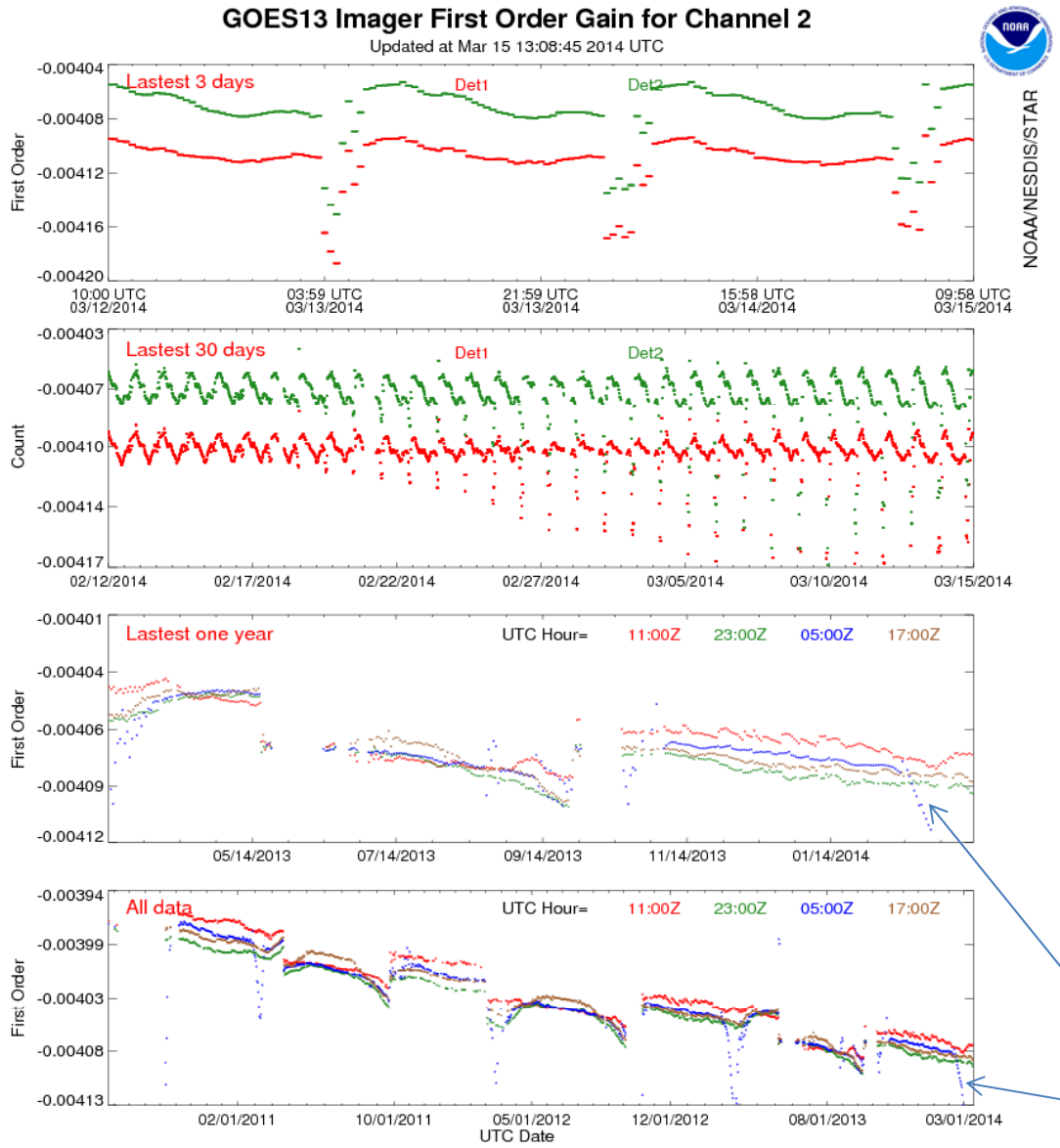
- Multiple panels for a variety of temporal scales
- Diurnal variation for different PRT detectors
  - Inhomogeneous heating of BB
  - midnight heating and the latency
- Seasonal Variation
  - strongest after-midnight heating around the summer solstice
- Long-term trending
  - more apparent at certain time

Calibration Measurements





Calibration Coefficients

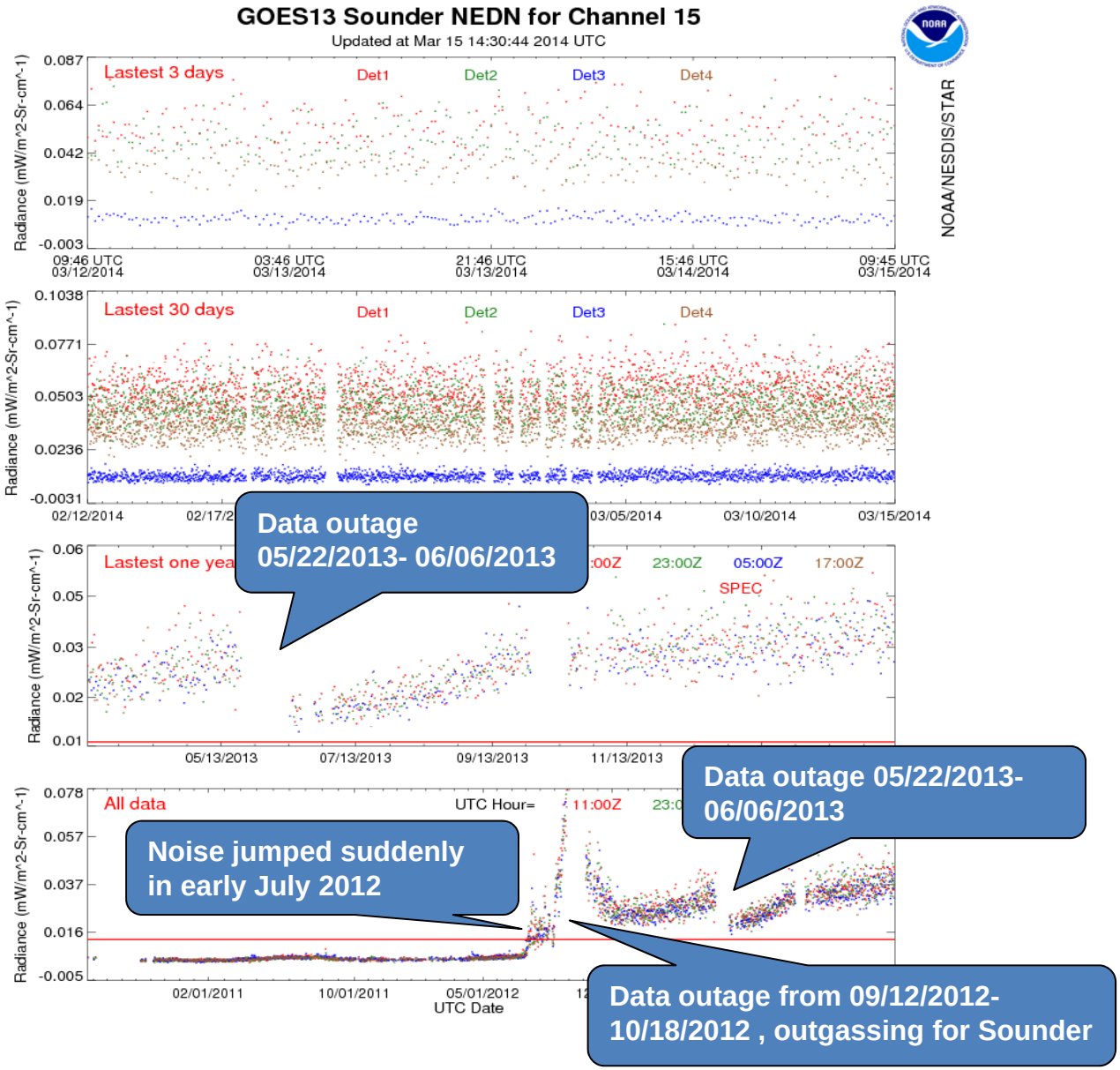


Nominal calibration coefficients

- Diurnal variation
  - Erroneous Midnight calibration coefficients
- Seasonal variation
  - erroneous midnight calibration coefficients increase as approaching summer
  - jump with patch temperature switch
- Long-term trending
  - Increasing absolute coefficients values as sensor degrades

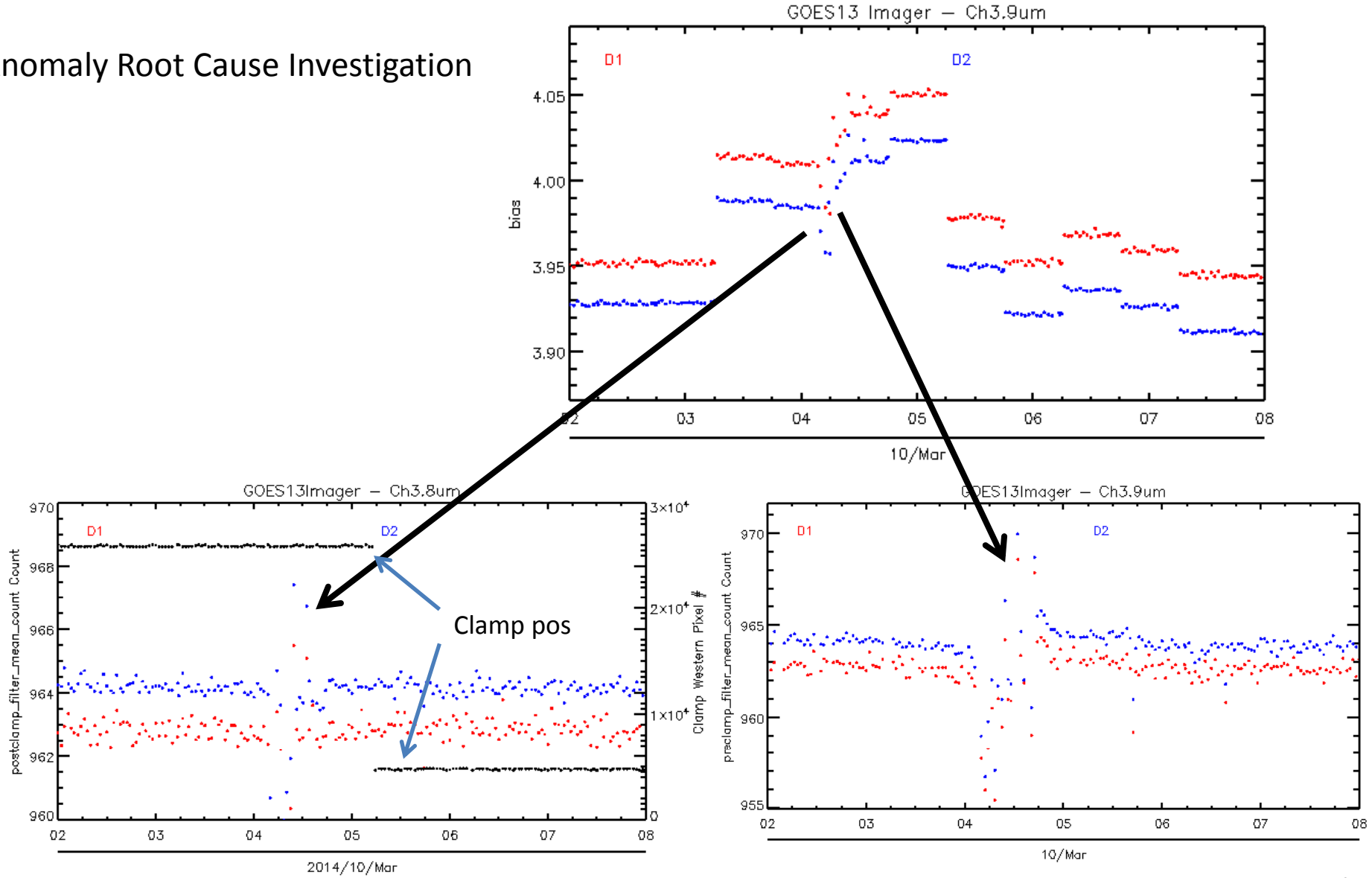
anomaly

Instrument Performance

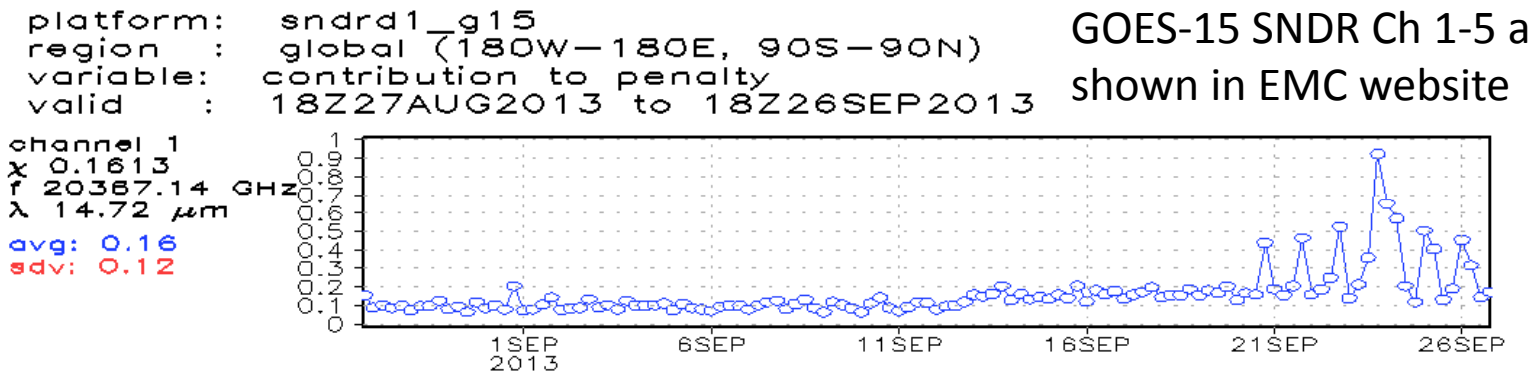


Support for GOES Calibration

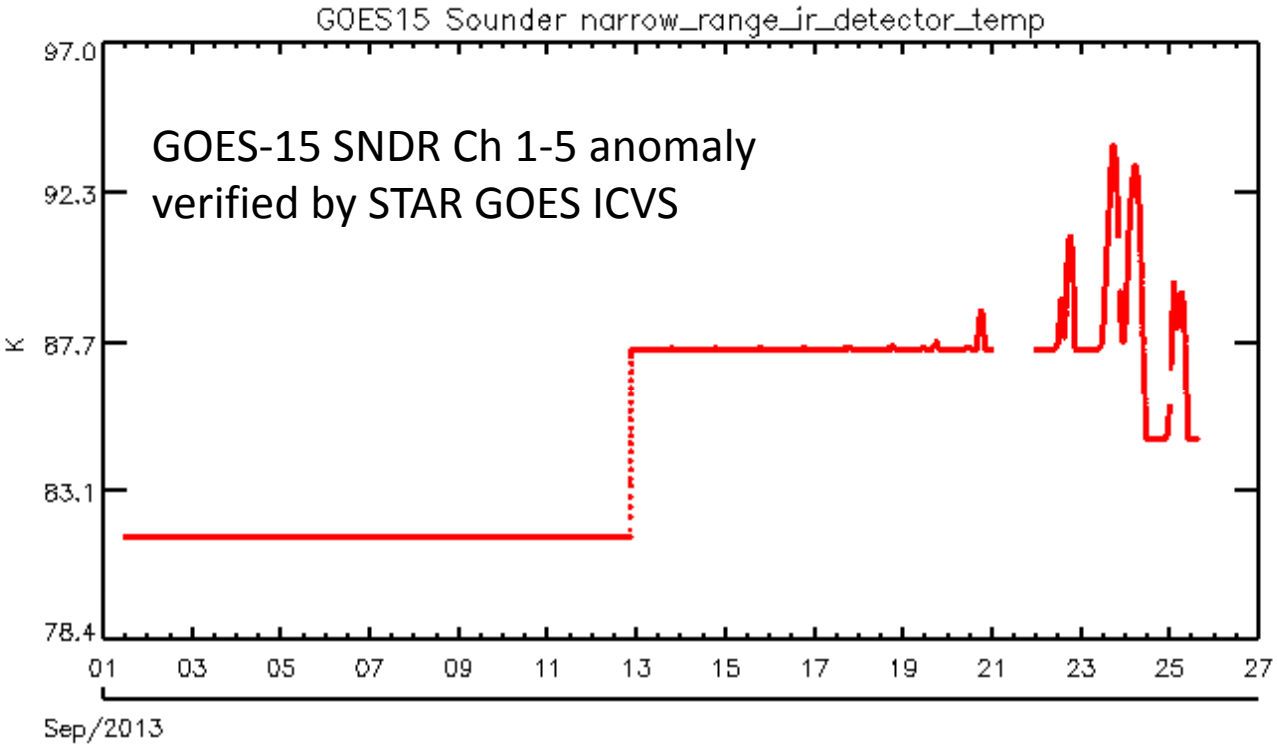
Anomaly Root Cause Investigation

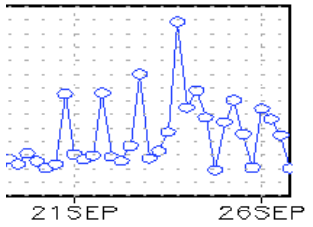


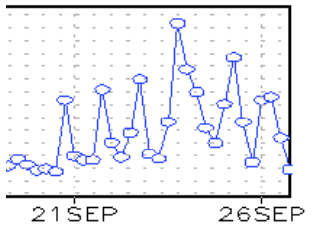
Support for NWP Operations

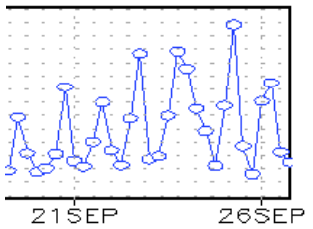


GOES-15 SNDR Ch 1-5 anomaly shown in EMC website



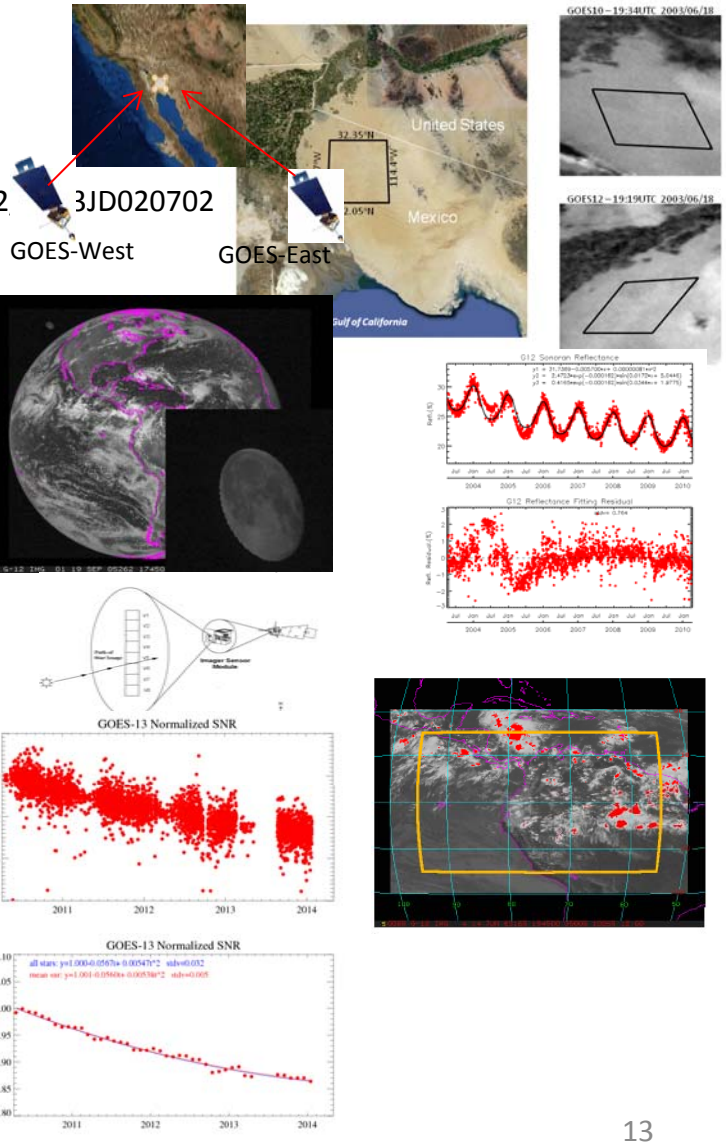






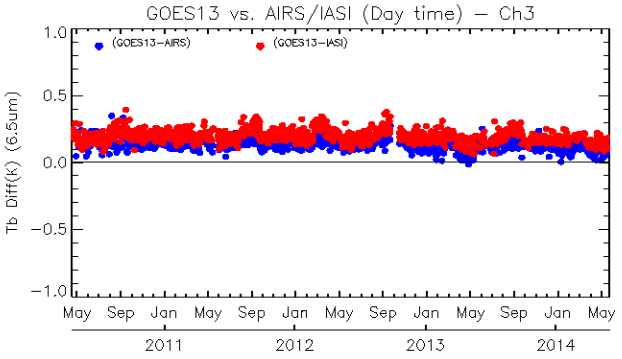
L1B Data Quality (Visible)

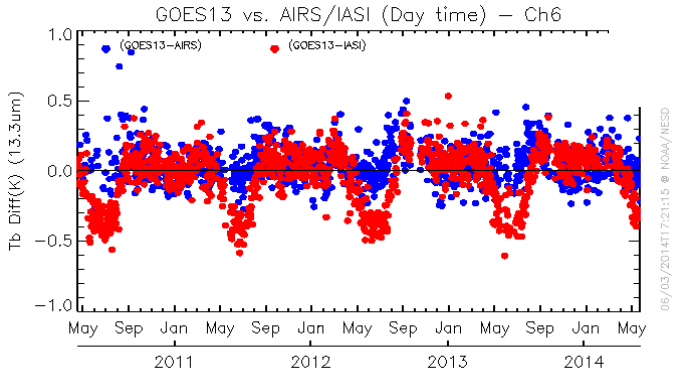
- Stable targets for the VNIR channels
  - Desert
    - Yu, F., X. Wu, M. Grotenhuis, and H. Qian, 2014, JGR, doi:10.1002/[illegible]3JD020702
  - Moon
    - Wu, X., T. Stone, F. Yu and D. Han, SPIE, 2006, SPIE
  - DCC
    - Yu, F. and X. Wu, 2012, GSICS annual meeting
    - Yu, F. and X. Wu, 2014, Remote Sens. Env., in review
  - Ray-matching
    - Wu, X. and F. Sun, 2005, SPIE
    - Yu, F., and X. Wu, 2014, CALCON
  - Stars
    - Chang, I. L. et al. 2008, 2012, SPIE
    - Yu, F. and X. Wu, 2014, CALCON
  - Integrated method
    - Yu, F. and X. Wu 2014, Remote Sens. Env. , in review

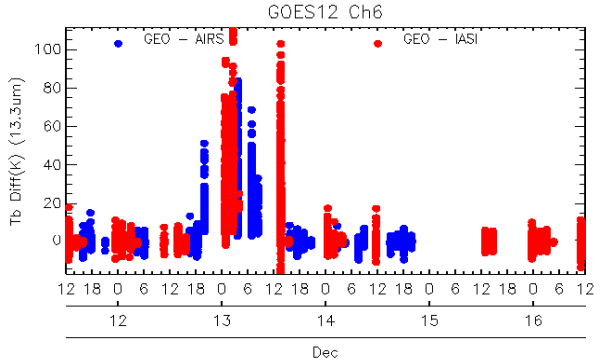


L1B Data Quality (IR)

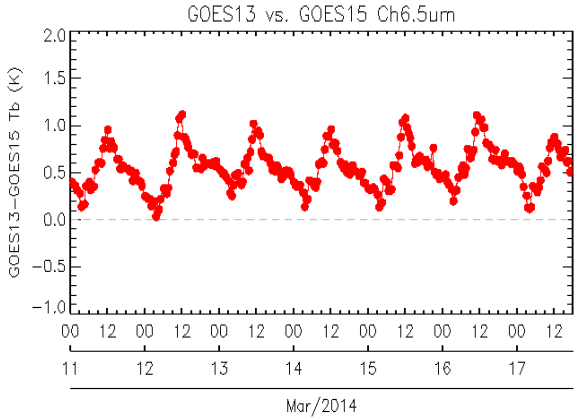
- GEO-LEO
  - ABI vs. IASI/CrIS/AIRS and ABI vs. VIIRS

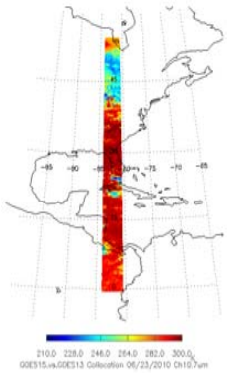


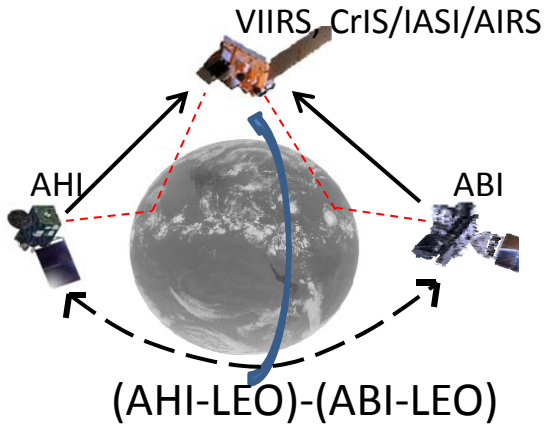




- GEO-GEO
  - ABI vs. AHI/GOES

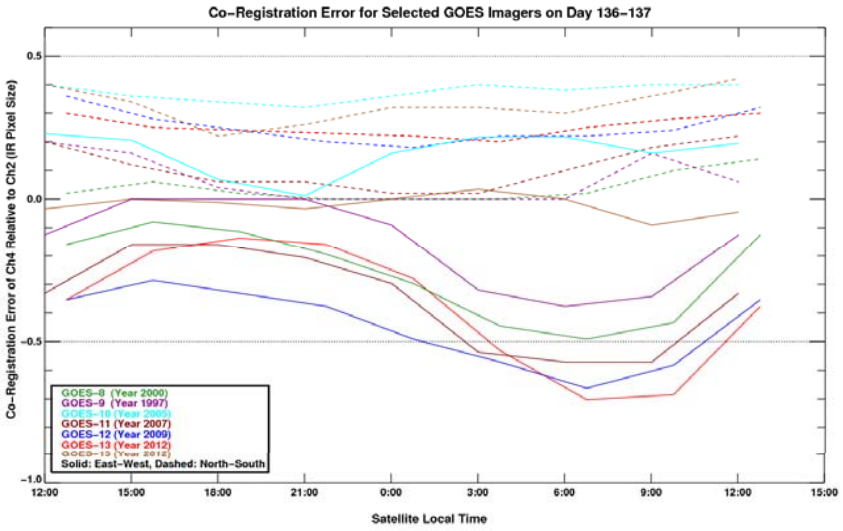




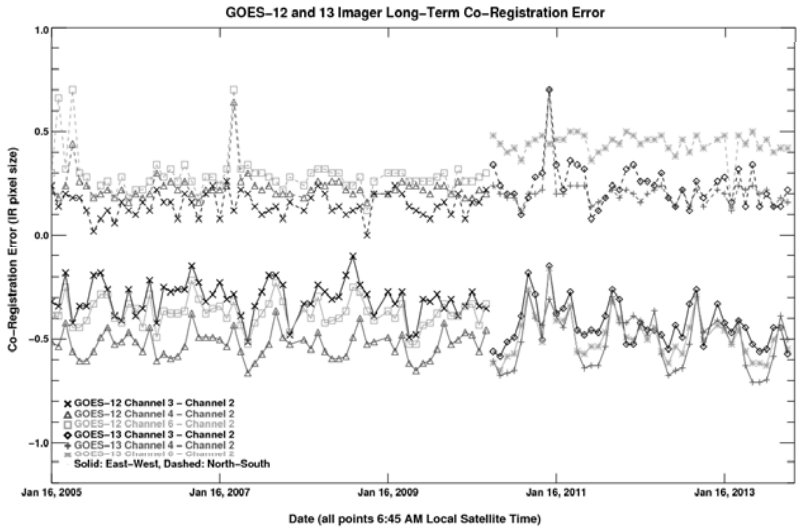


14

L1B Data Quality (Co-registration)



Diurnal co-registration errors at GOES-8 thru G15



GOES-12 and 13 Imager long-term East-West and North-South co-registration error trend.

Grotenhuis, M. et al. 2012 SPIE

ABI Instr. Status and Cal. Coeff.

Parameters	Descriptions	Dimensions	Usage
Telemetry/Temperature	Temperature or voltage of SCT, ICT(BB), scan mirrors, telescope mirrors, radiator, focal planes, optical bench, beamsplitter mount and wall etc.	>40	Instrument healthy status
Solar Calibration Target (SCT) counts	Solar diffuser observations for detectors at VNIR channels	>4000	Detector degradation trending
Blackbody (BB) counts	BB observations for detectors at IR channels	>3000	Detector degradation trending
Space View (SV) counts	Space view observations for ABI detectors	>7000	Background signal trending
SCT NEΔN	VNIR detector noise at SCT for the VNIR channels	>4000	Detector noise
SV NEΔN	Detector noise viewing at space	>7000	Detector dark noise
BB NEΔN	Detector noise viewing at BB	>3000	Detector noise
VNIR Signal-Noise Ratio (SNR)	SNR@100% albedo for each detector at VNIR channels	>4000	Detector noise and image quality
IR NEΔT	Noise at typical temperature at IR channels	>3000	Detector noise and image quality
VNIR calibration coefficients	Calibration gain and offset at VNIR channels	>4000	VNIR calibration trending
IR calibration coefficients	Calibration gain and offset at IR channels	>3000	IR calibration trending

Planning for GOES-R IPM

- Support calibration scientists and users to monitor instrument performance, calibration parameters, and L1b data quality for quality assurance, anomaly diagnosis & resolution, and algorithm improvement.
- CWG is generating the ABI requirements for ICVS:
  - Variable list
  - Imagery: what type & how often
  - Visualization strategy for large amounts of detector-specific data

ICVS Data		
Category	**Type**	**Examples**
Imagery	Full disk or CONUS images Quality flags	L1b, L1β
Calibration	Blackbody	counts, NEdL, NedT, cal coefficients, blackbody temperatures , scan mirror temperatures
	Solar diffuser	counts, NEdL, SNR, beta angle, generated cal coefficients
	Space	counts, NedL
Other telemetry		detector temperatures, detector bias voltages, other instrument temperatures

Capability Development

- Currently using AHI & DOE-0 data as proxy to prepare for monitoring in near-real time
- Investigating new needs and capabilities of monitoring.

Monitoring AHI Telescope Temperature

Monitoring AHI L1B Inter-Channel Consistency Using Planck Function

Figures Deleted per Data Protocol

GOES IPM for Future

- Who and where?
  - NSOF: engineering-oriented.
    - Real time, 24/7.
    - Focus on Instrument health and safety.
  - STAR: science-oriented.
    - Regular hours; deep dive into long term archive.
    - Focus on maintaining and improving L1B data quality.
  - Overlap and Collaborate.
- What and how to monitor at STAR?
  - For calibration scientists: more parameters, more ways, more details; flexible and adaptive.
  - For users / public: stable; consistent with other instruments In ICVS.
  - Overlap and collaborate
- Challenge:
  - Internal: GUI to interact with large amount of data.
  - External: ??