2015 STAR ICVS
instrument Performance Review
Session 3 – ICVS Instrument Survey

S-NPP VIIRS Anomalies

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Outline

- Single Board Computer (SBC) Lock-Up Events
- Reflective Solar Band (RSB) F and H factor Trend Changes
- Delta C0=0 Coefficient Update
- Day Night Band (DNB) Low Gain State (LGS) Gain Changes
- Summary

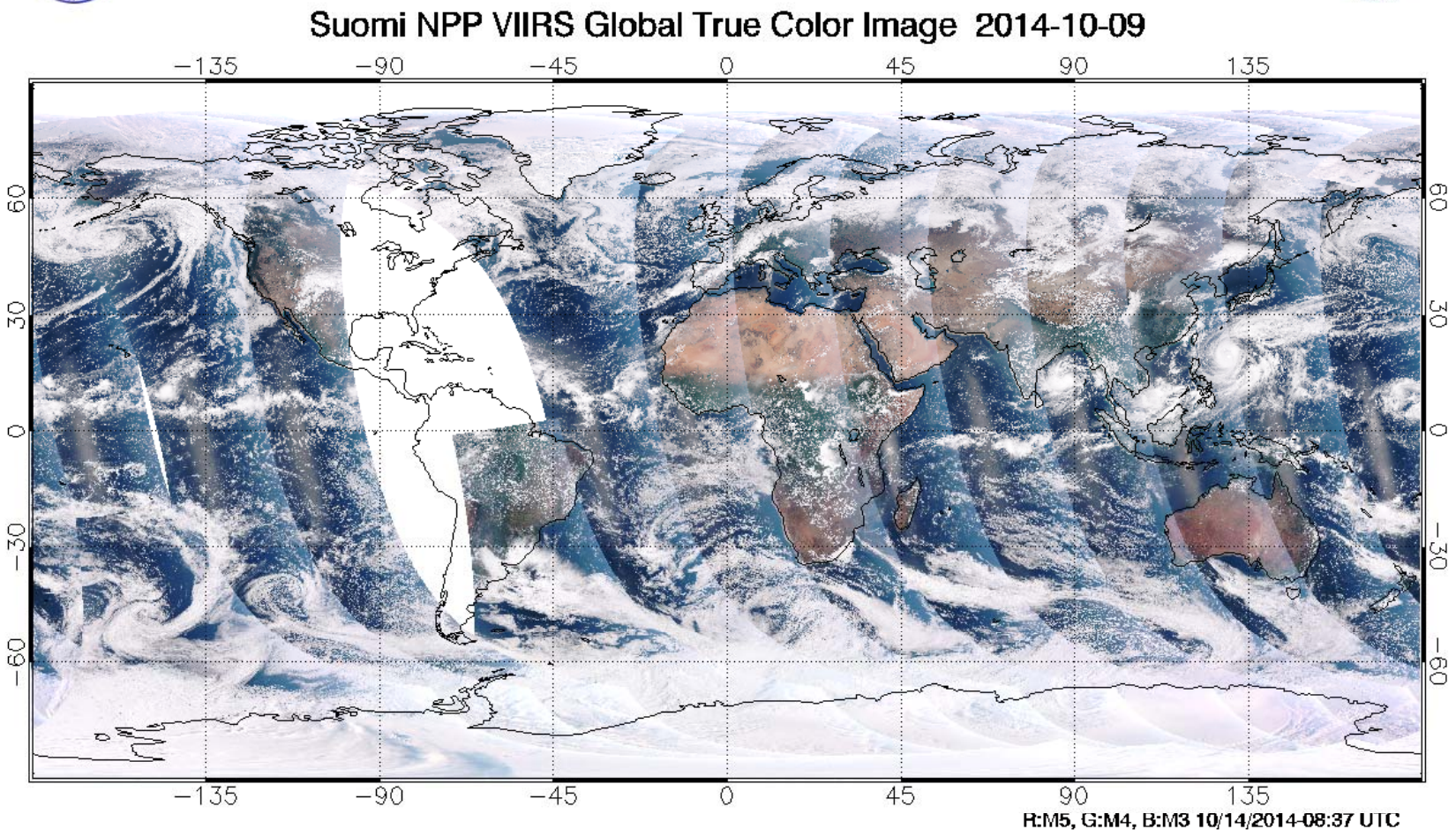
Single Board Computer (SBC) Lock-Up Events

- Over the VIIRS lifetime, there were 10 SBC lock-up events.
- The reason of the SBC lock-up event is unknown.
  - high energy particle hit could be possible reason.

Event #	Date	Start Time	End Time	Duration
1	11/25/2011	16:36	N/A	N/A
2	2/10/2012	04:43	08:56	4:13
3	2/18/2012	04:14	12:00	7:17
4	3/10/2012	04:03	14:03	10:00
5	3/28/2012	04:22	11:25	7:03
6	11/22/2012	16:32	01:26*	8:54
7	2/4/2014	17:38	21:35	3:37
8	8/8/2014	14:20	18:50	4:30
9	9/26/2014	18:25	18:35	0:10
10	10/9/2014	17:22	19:31	2:09

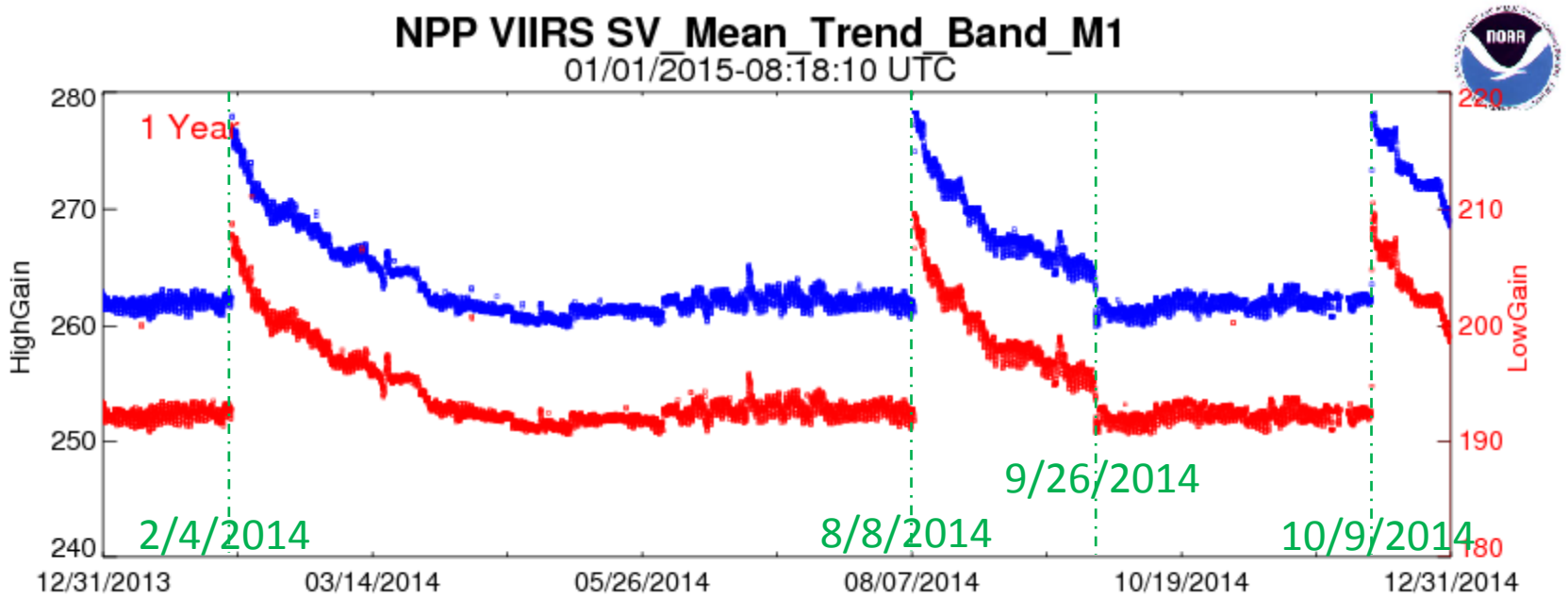
* Continued until the next day

Single Board Computer (SBC) Lock-Up Events



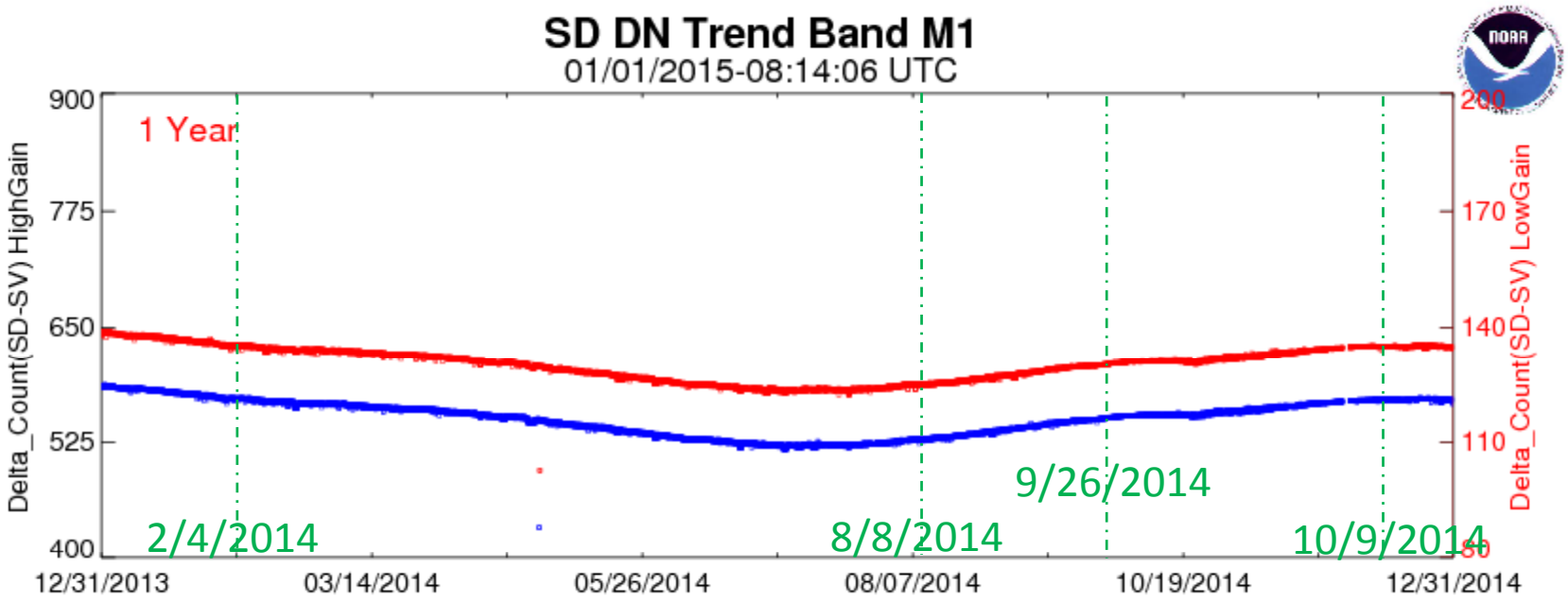
Single Board Computer (SBC) Lock-Up Events

- After the event, the VIIRS SV counts were reset to a higher value because of new DC restore values.
  - It gradually goes down to a stable DN level.



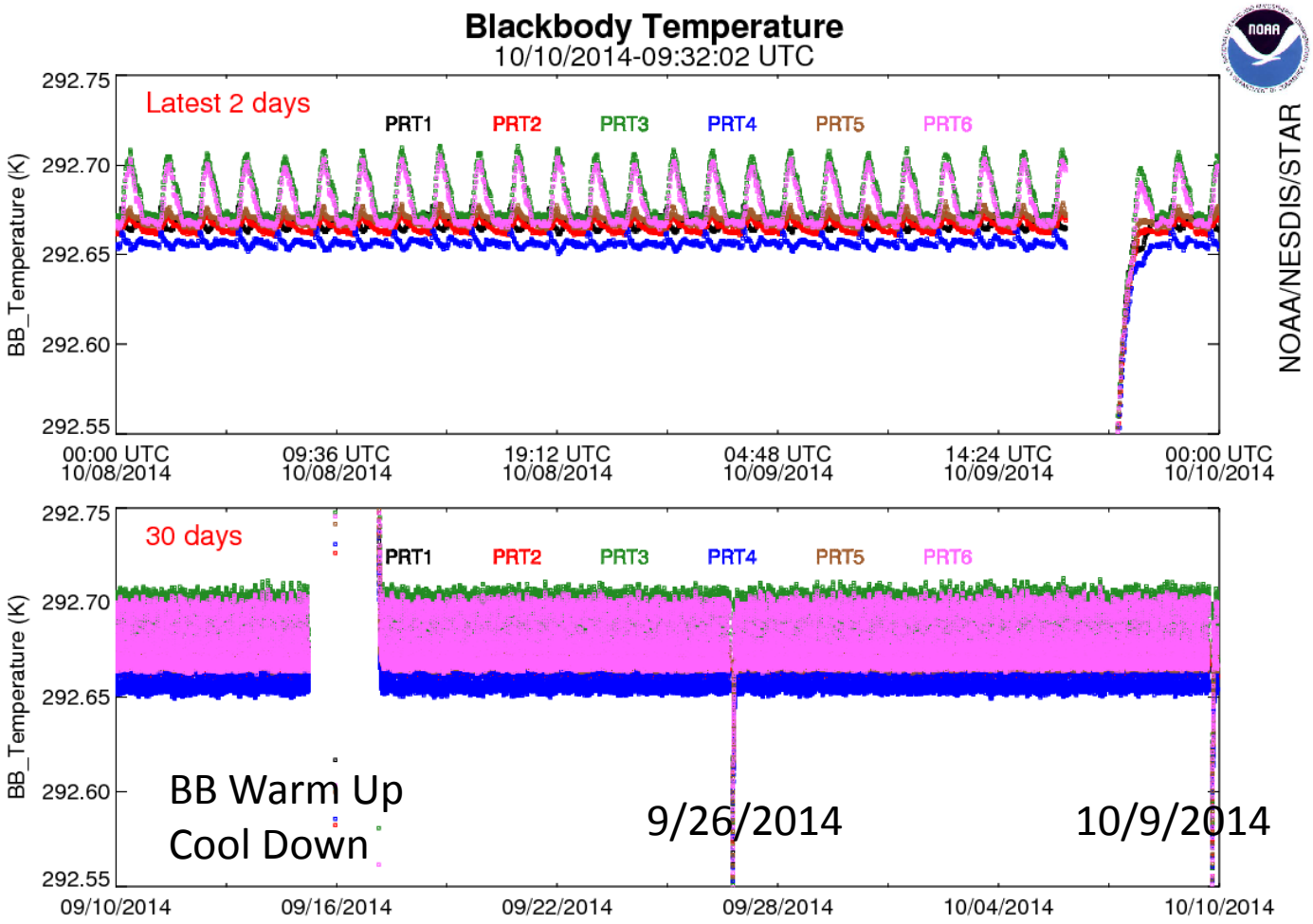
Single Board Computer (SBC) Lock-Up Events

- The reflective solar band calibration was not affected.
- The bias removed Solar Diffuser (SD) counts did not show sudden changes.
  - SV and SD levels moved together.



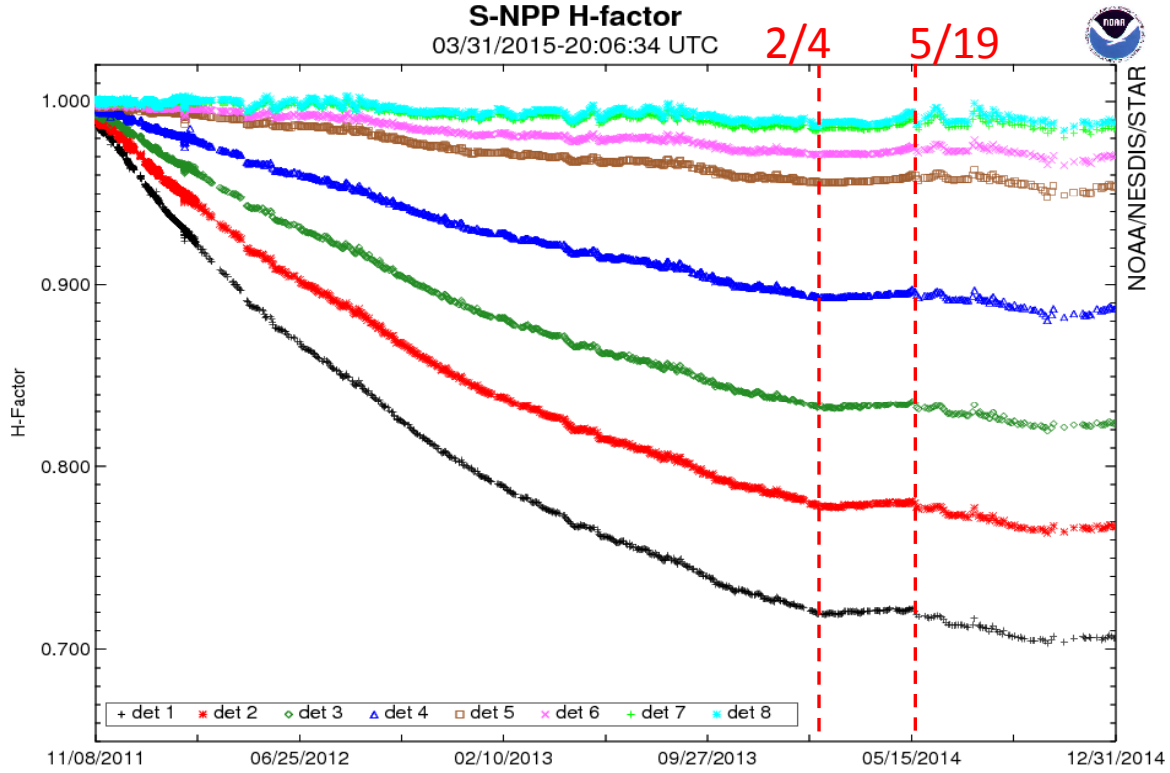
Single Board Computer (SBC) Lock-Up Events

- The thermal band calibration, there was no big impact.
- The blackbody (BB) temperature immediately went back to the normal controlled temperature level of 292.66K



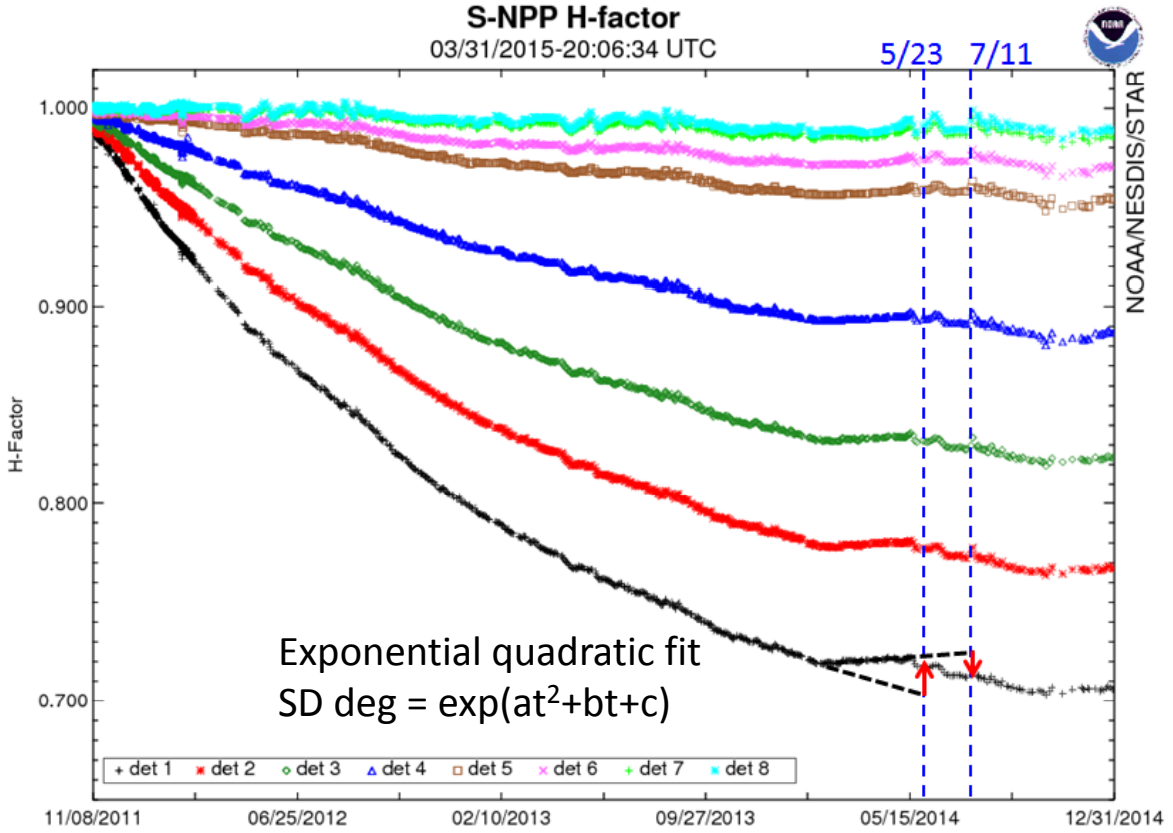
Reflective Solar Band (RSB) F / H factor Trend Changes

- The H and F factors are linearly related to the radiometric calibration.
- Due to the Solar Diffuser (SD) degradation flattening anomaly from 2/4/2014 to 5/19/2014.



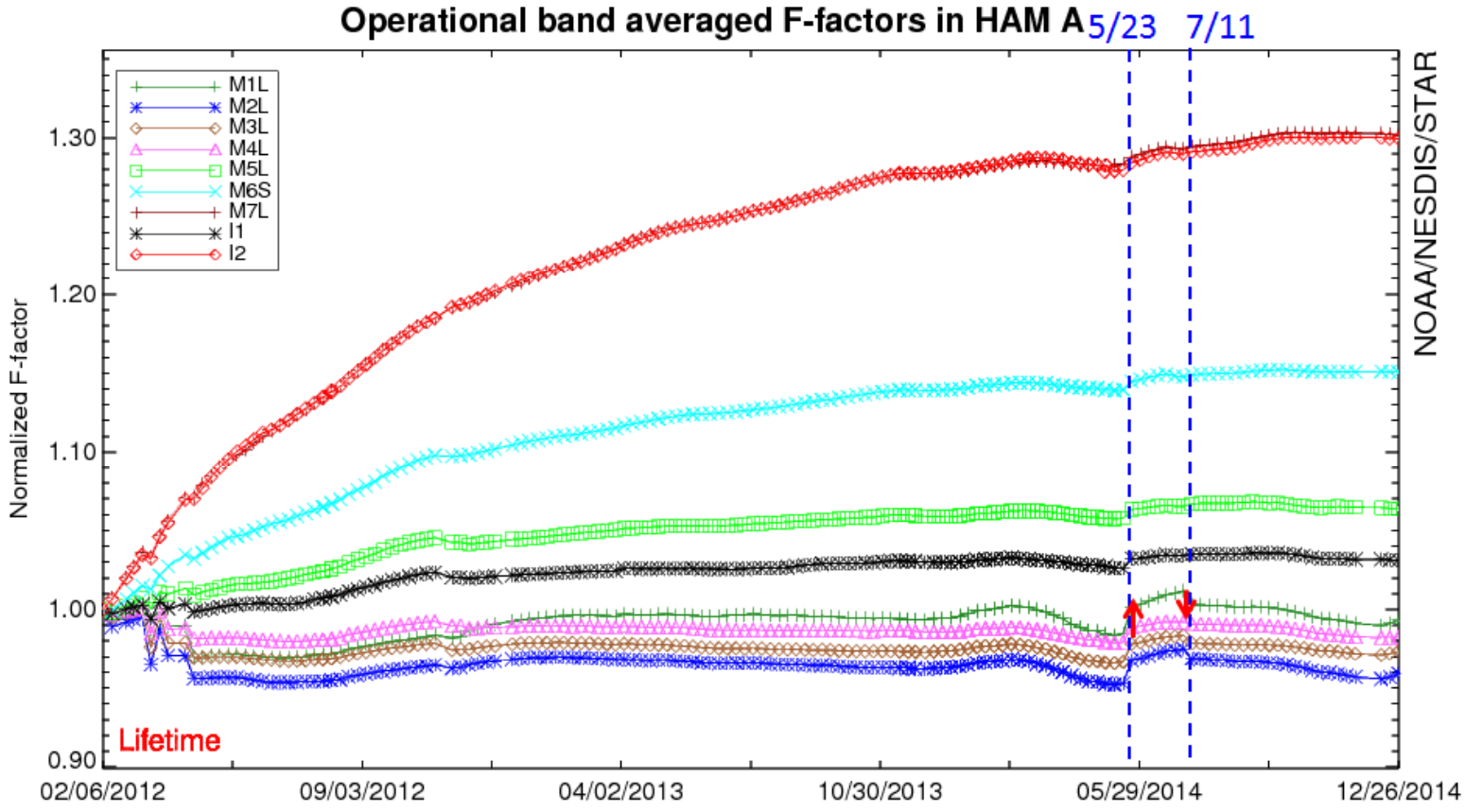
Reflective Solar Band (RSB) F / H factor Trend Changes

- During the first JPSS Science Team Meeting (STM) in May of 2014,
  - there was a mutual consensus that the H-factor needed to be updated.
- To compensate the flattening effects
  - Two sudden changes in operational H factor on 5/23 and 7/11.



Reflective Solar Band (RSB) F / H factor Trend Changes

- The H-factor is direct related to the F-factor.
- The changes in the H-factors were affected short wavelength bands in M1 to M4.



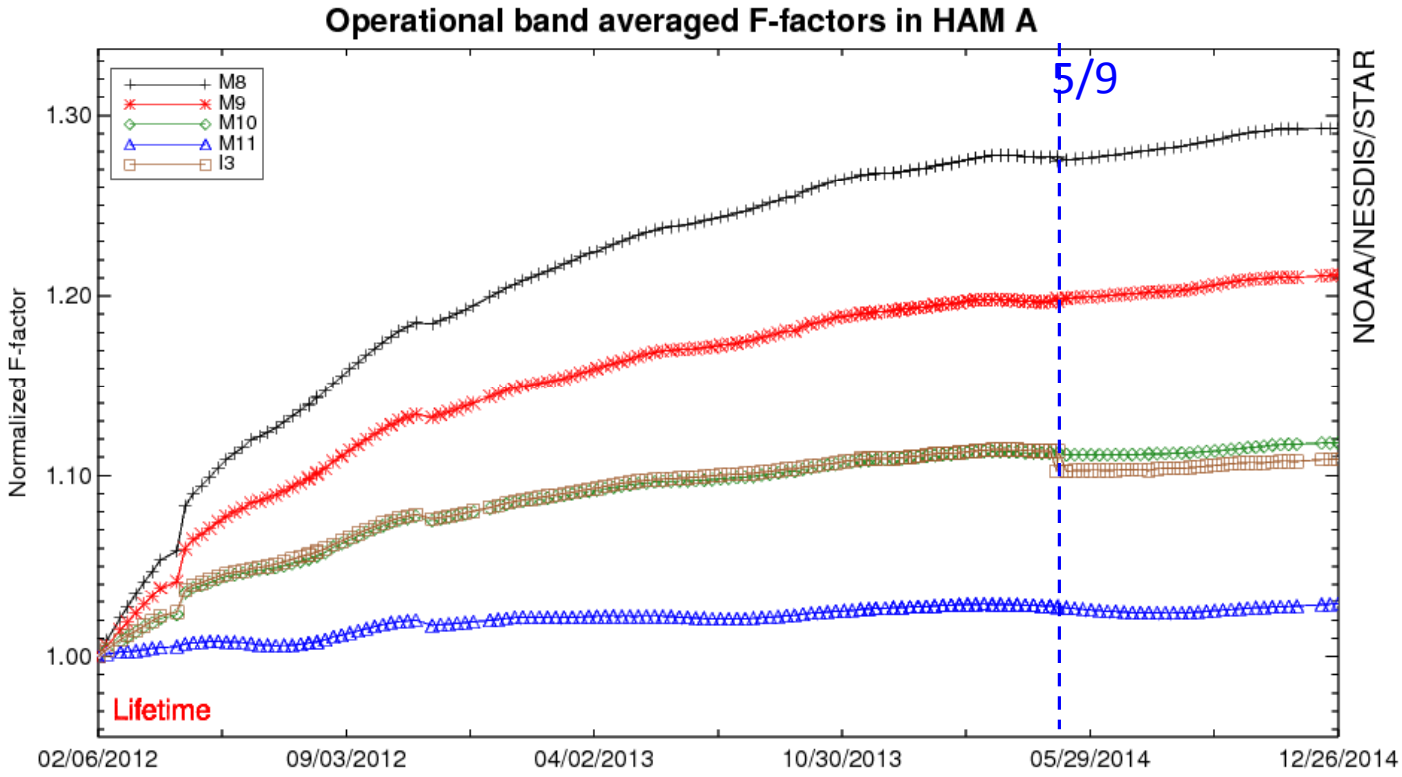
Delta C_0=0 Coefficient Update

- The C coefficients represent combined thermal response of the detectors and the electronics.
- The C0 values are set to zero for all RSB bands
  - Starting from May 9, 2014.
- The C2 values are re-derived by the pre-launch tests.
  - Improving radiometric errors in the low radiance levels.
    - 1~2% Hawaiian ocean scenes.
    - 0.5~1% at the high radiance levels.
- Improving radiometric accuracy in the similar spectral response bands pairs such as I2/M7 and I3/M10.

$$F = \frac{\cos(\theta_{inc}) \cdot \left[E_{sun} \cdot \tau_{sds} \cdot BRDF(t)\right] \cdot RVS_{SD}}{c_0 + c_1 \cdot dn_{SD} + c_2 \cdot dn_{SD}^2}$$

Delta C_0=0 Coefficient Update

- Starting from 5/9/2014, F-factor plots have very small changes < 0.5%.
  - Except band I3 showed approximately 1% drop at the SD radiance level.
- Need to set C0=0 for future missions.



DNB LGS Gain Changes

- Calibration requirements are fairly loose
  - 5% for Low Gain State (LGS) and 100% in HGS.

$$A(\det, N_{agg}, LGS) = \frac{RVS_{SD} \cdot \cos(\theta_{inc}) \cdot E_{sun} \cdot \tau_{sds} \cdot BRDF(t)}{dn_{SD}(\det, N_{agg}, LGS)}$$

$$dn_{SD}(\det, N_{agg}, LGS) = DN_{SD}(\det, N_{agg}, LGS) - DN_{SV}(\det, N_{agg}, LGS)$$

$$BRDF(t) = H_{Norm}(t) \cdot BRDF(t_0), \quad H_{Norm}(t) = H(t) / H(t_0)$$

$$H(t) = \frac{dc_{SD} \cdot \tau_{SDSM}}{dc_{SUN} \cdot BRDF(t_0) \cdot \tau_{SDS} \cdot \cos(\theta_{inc}) \cdot \Omega_{SDSM}}$$

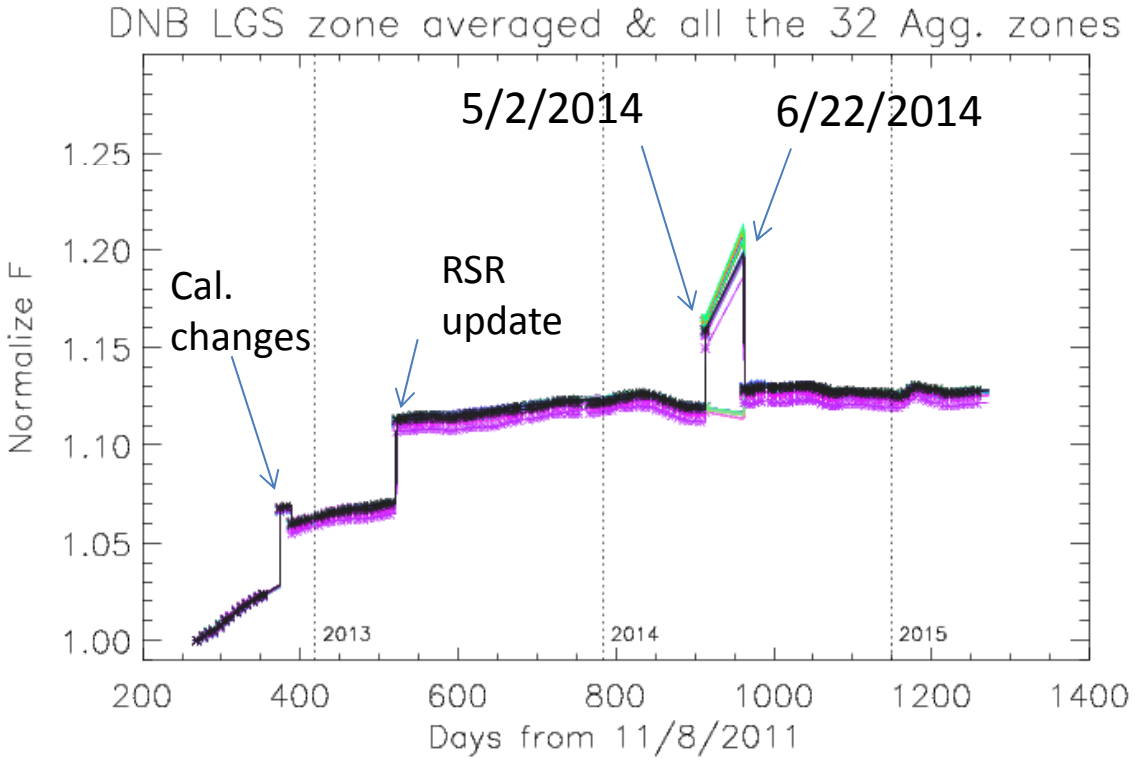
Gain transfer by ratios

$$A(\det, N_{agg}, MGS) = \overline{R}_{M:L}(\det, N_{agg}) \cdot A(\det, N_{agg}, LGS)$$

$$A(\det, N_{agg}, HGS) = \overline{R}_{H:M}(\det, N_{agg}) \cdot A(\det, N_{agg}, MGS)$$

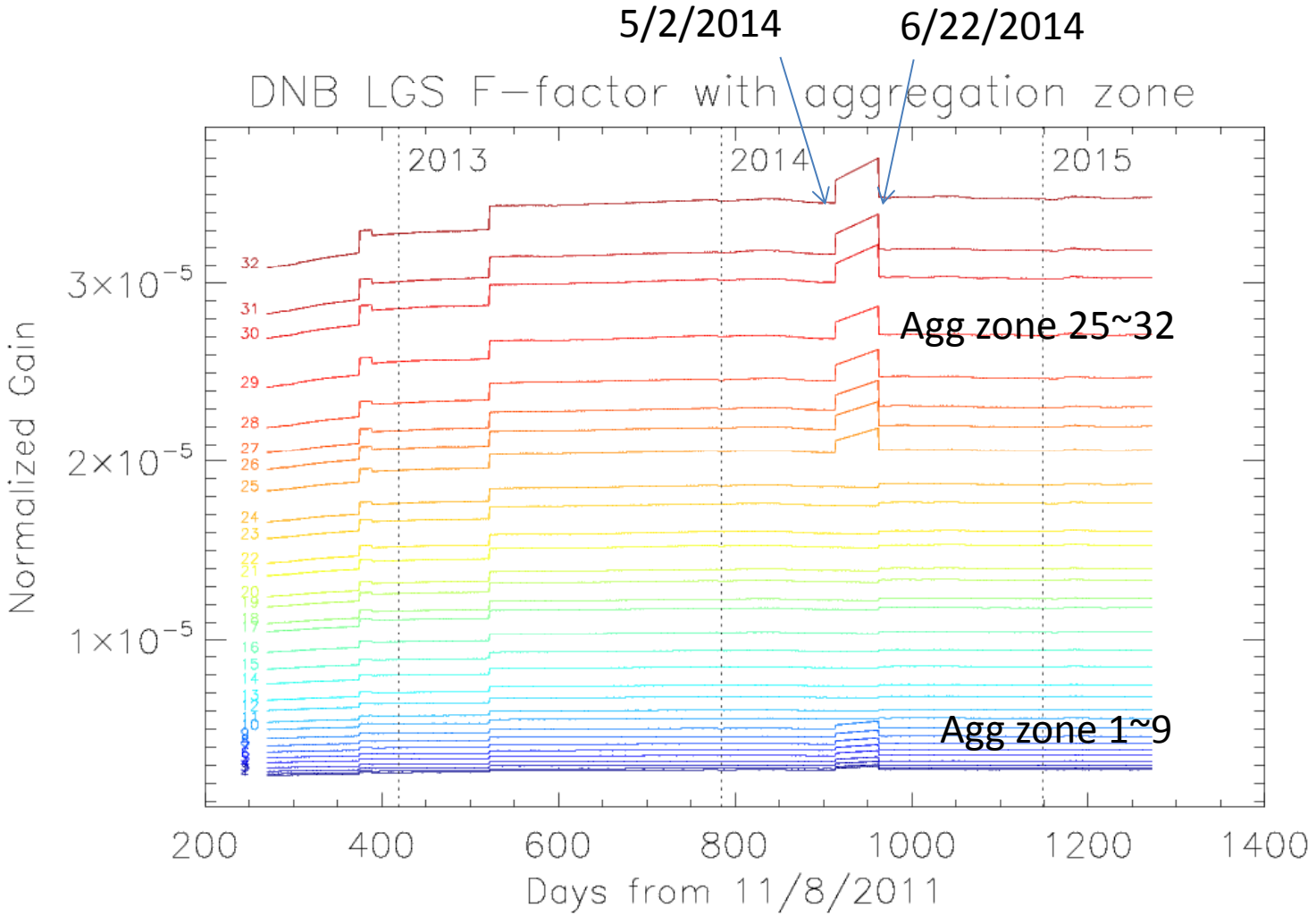
DNB LGS Gain Changes

- DNB gain LUT name and format changes
  - DNB gain LUT name was changed around May to June of 2014.
    - VIIRS-SDR-DNB-F-PREDICTED-LUT → VIIRS-SDR-DNB-LGS-GAINS-LUT
    - 24.5kb → 27.6kb
  - LUT format changed with number of Agg zones.



DNB LGS Gain Changes

- DNB gain LUT Changes: Aggregation zone dependent.



Summary

- SBC Lock-Up Events
  - Data loss occurs but no significant effects on calibrations
- F / H factor Trend Changes
  - Because of the H-factor flattening anomaly.
  - Delay in the SD degradation model.
  - Significant effects on radiometric accuracy.
- Delta C_0=0 Coefficient Update
  - I3 F-factor showed 1% drop
- DNB LGS gain showed sudden jumps in 2014 from 5/2 to6/22 in aggregation zone 1~9 and 25~32.

Backup Slides

Reflective Solar Band (RSB) F / H factor Trend Changes

- F: RSB Calibration coefficient.
- H: SD degradation factor.

$$L_{EV} = \frac{F \cdot (c_0 + c_1 \cdot dn_{EV} + c_2 \cdot dn_{EV}^2)}{RVS_{EV}}$$

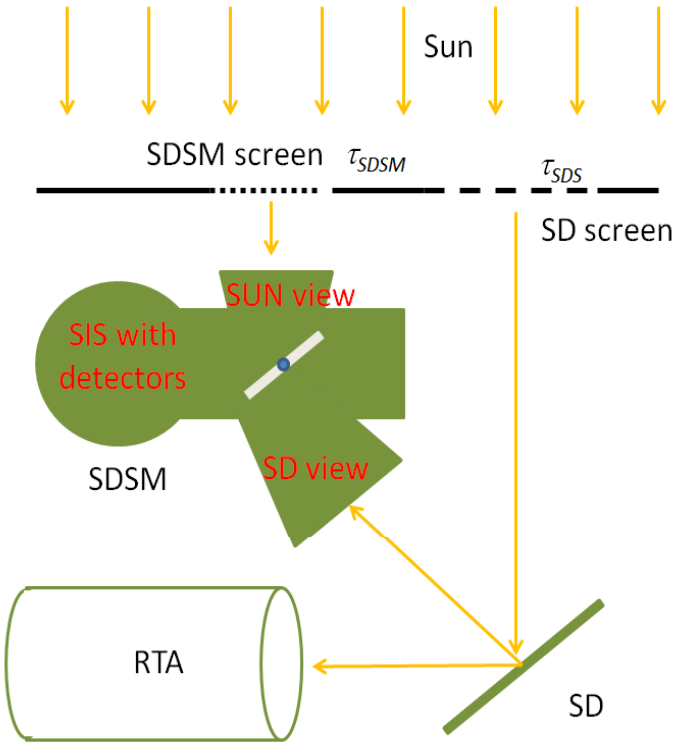
$$F = \frac{L_{Sun\_Model}}{L_{Sun\_Observation}} = \frac{Computed\_L_{Sun}}{Observed\_L_{Sun}}$$

$$F = \frac{\cos(\theta_{inc}) \cdot [E_{sun} \cdot \tau_{sds} \cdot BRDF(t)] \cdot RVS_{SD}}{c_0 + c_1 \cdot dn_{SD} + c_2 \cdot dn_{SD}^2}$$

$$BRDF(t) = H_{Norm}(t) \cdot BRDF(t_0)$$

$$H_{Norm}(t) = \frac{H(t)}{H(t_0)}$$

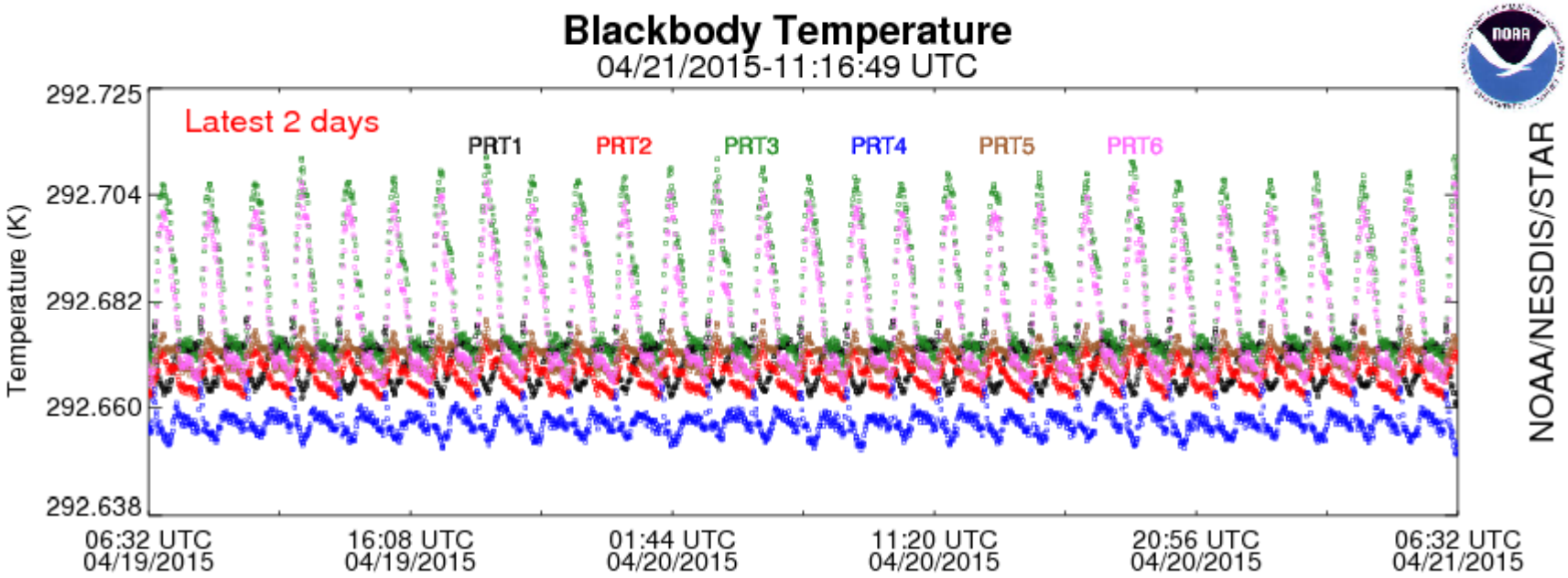
$$H(t) = \frac{dc_{SD} \cdot \tau_{SDSM}}{dc_{SUN} \cdot BRDF(t_0) \cdot \tau_{SDS} \cdot \cos(\theta_{inc}) \cdot \Omega_{SDSM}}$$



dn: VIIRS bias removed response
dc: SDSM bias removed response

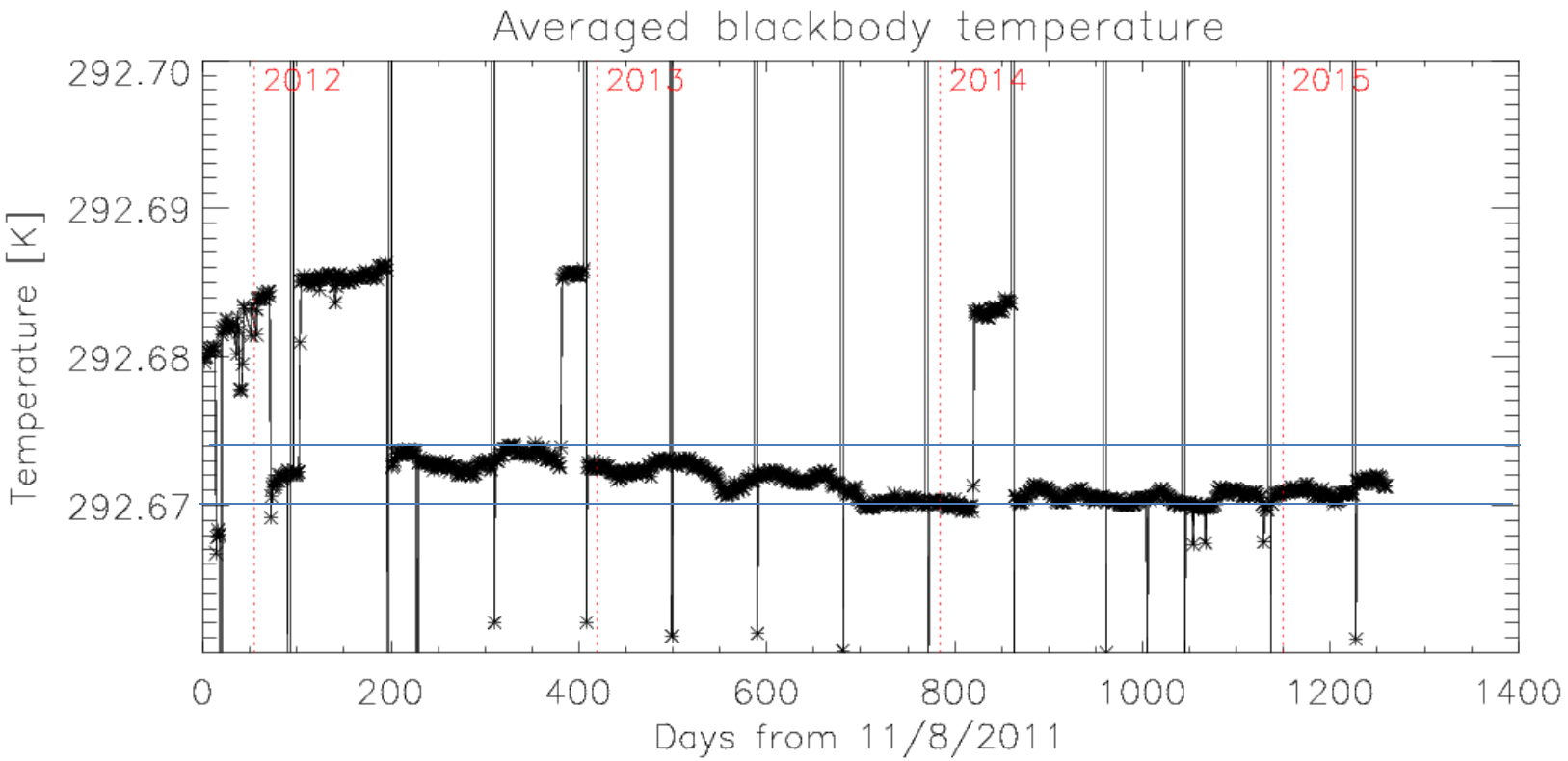
TEB Calibration

- Calibration sources for TEB are BB and SV.
  - There are six thermistor in the BB.
  - Daily BB temperatures are very stable within 5mK!



TEB Calibration

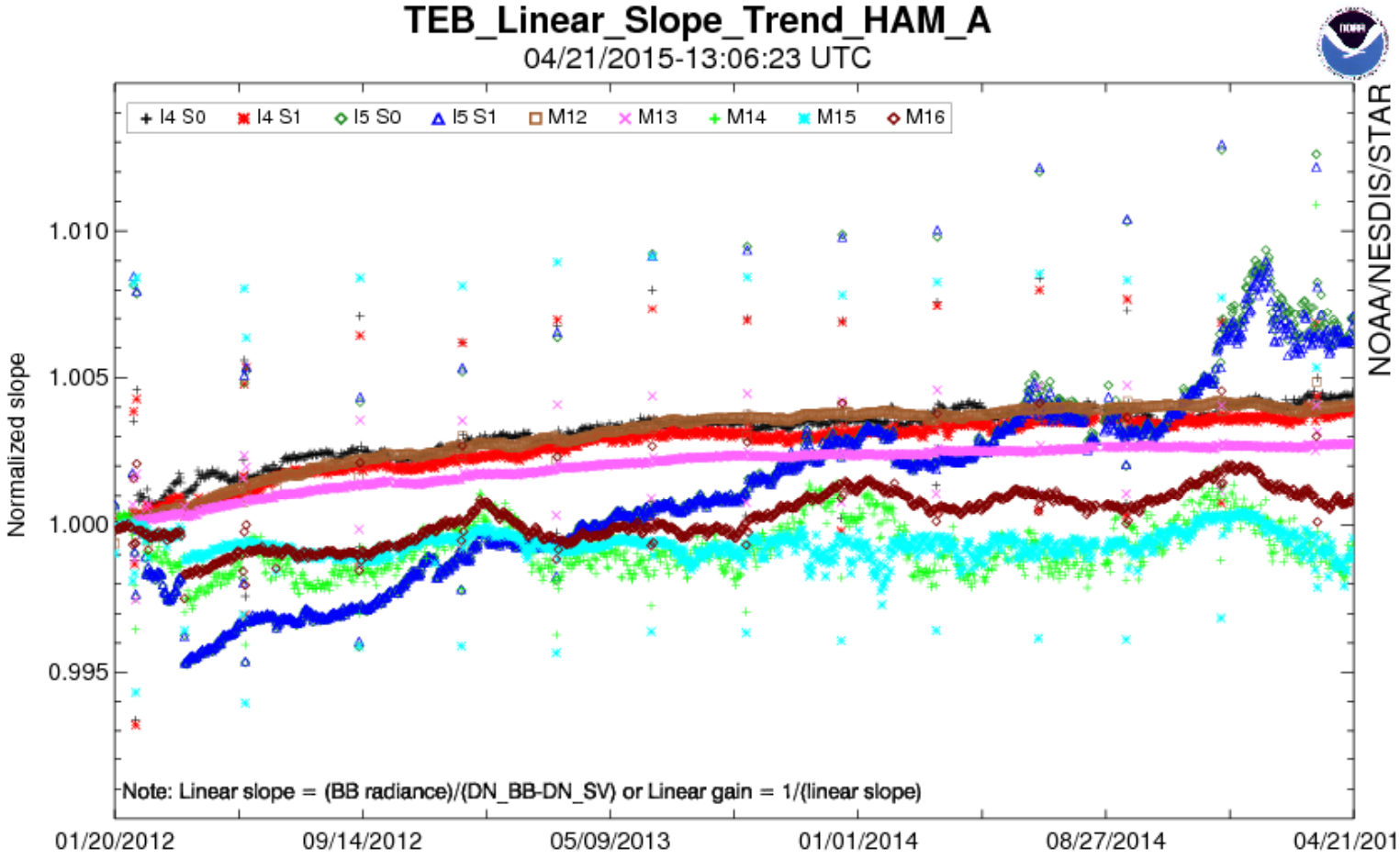
- Lifetime averaged BB temperature.
  - Stable within 4mK over 3+ years.
  - The sudden changes (approx. 15mK) are cause by different operational settings.



TEB Calibration

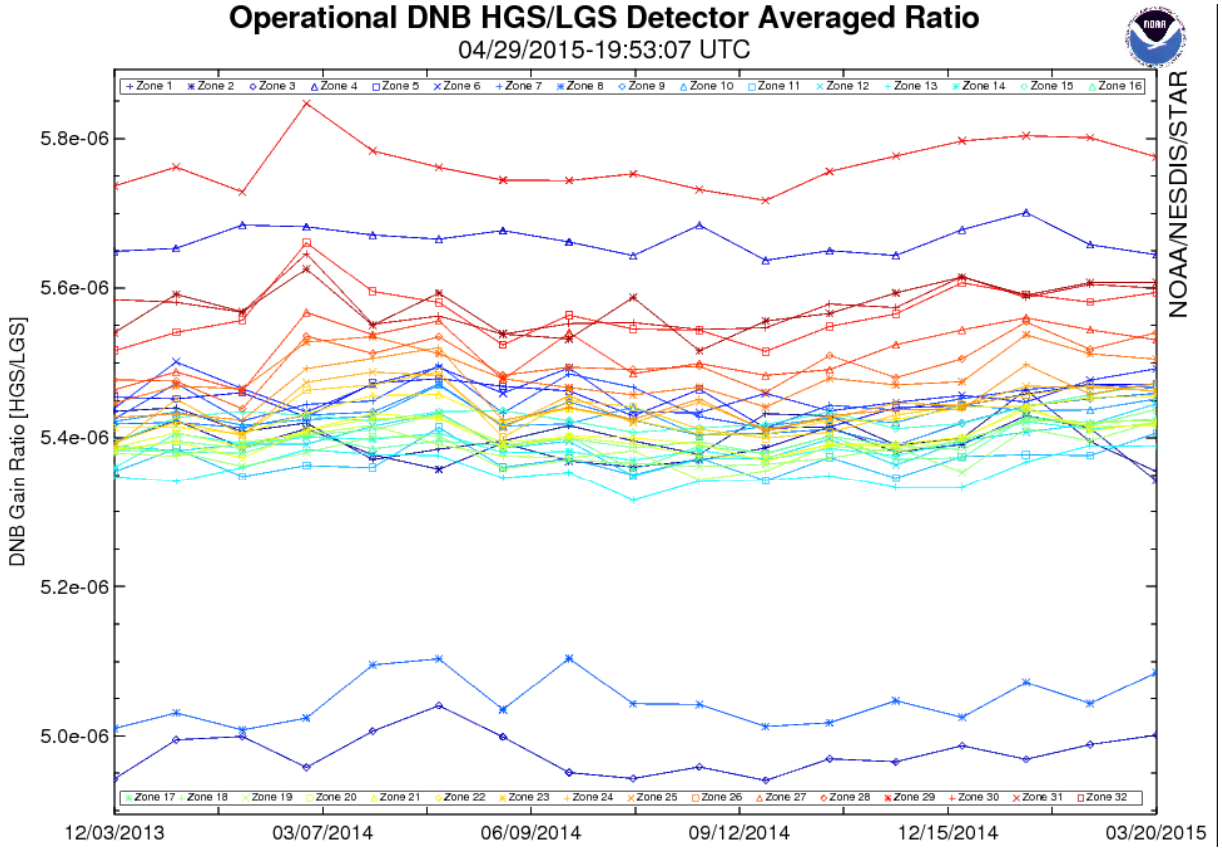
- The linear slopes (or gains) are very stable.

$$Linear\ Slope(B) = \frac{L_{BB}(B)}{dn_{BB}}$$

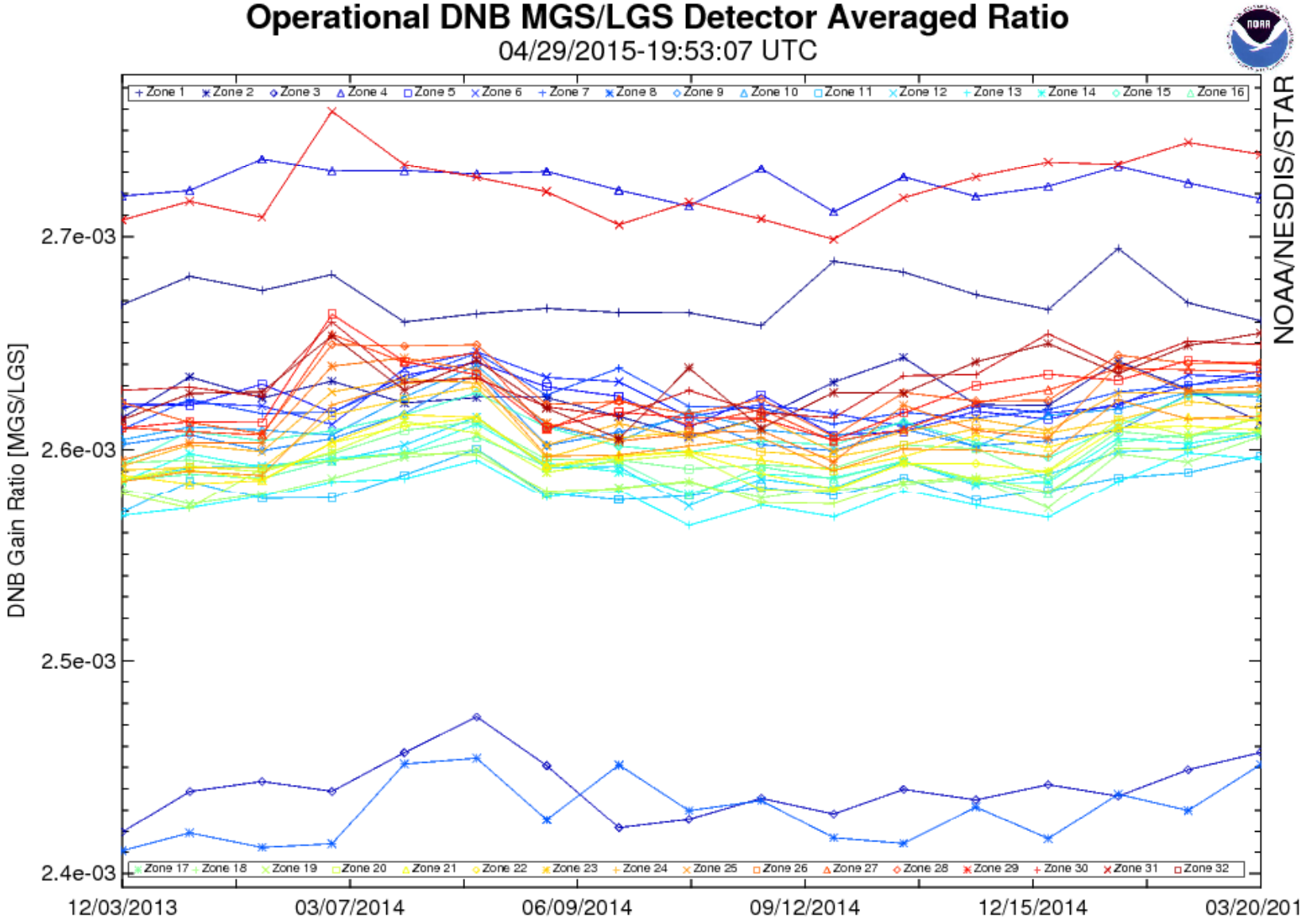


Operational DNB Gain Ratio

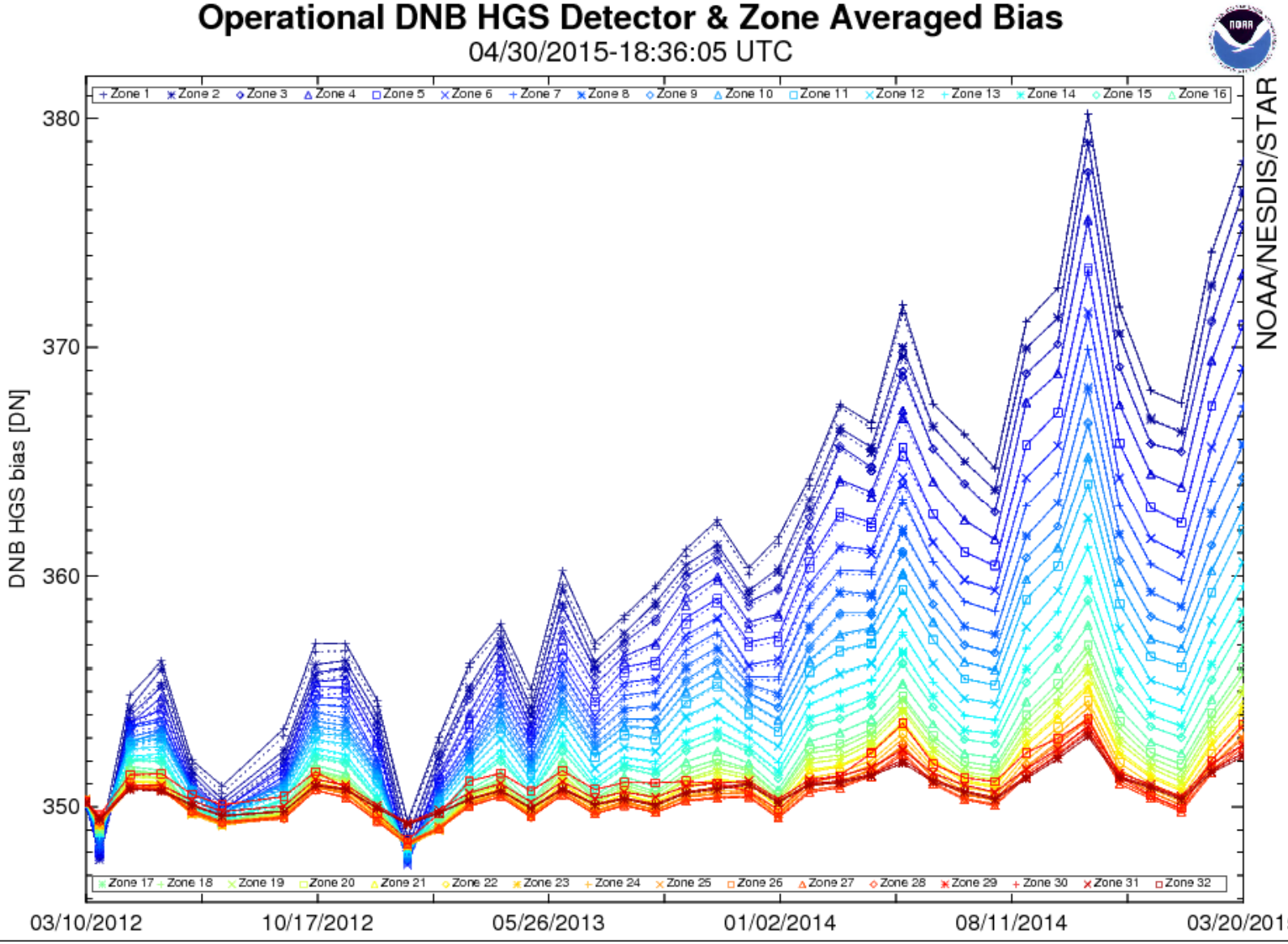
- Collection LUTs
  - From Common CM + U. of Wisconsin Website
  - 19 LUTs available.



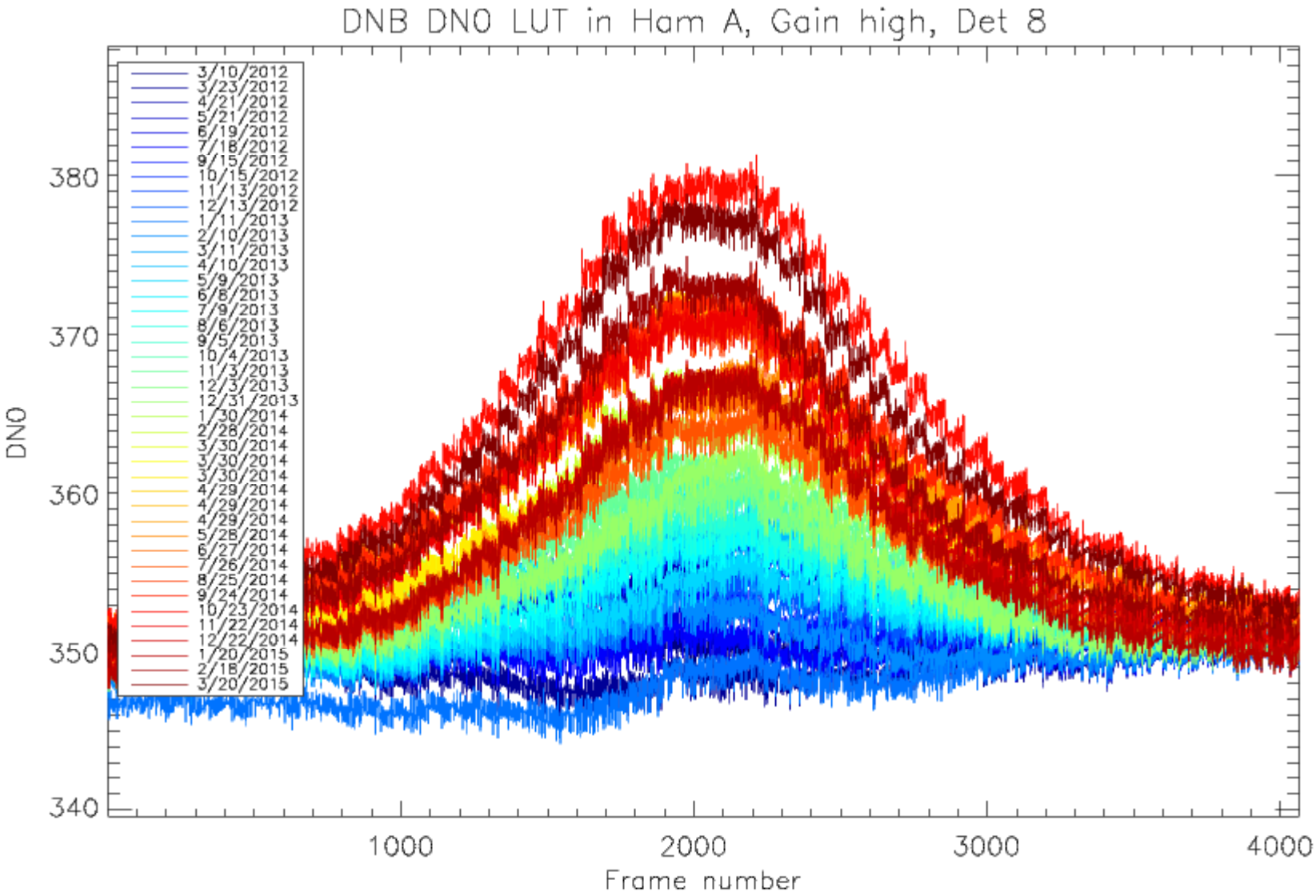
Operational DNB Gain Ratio



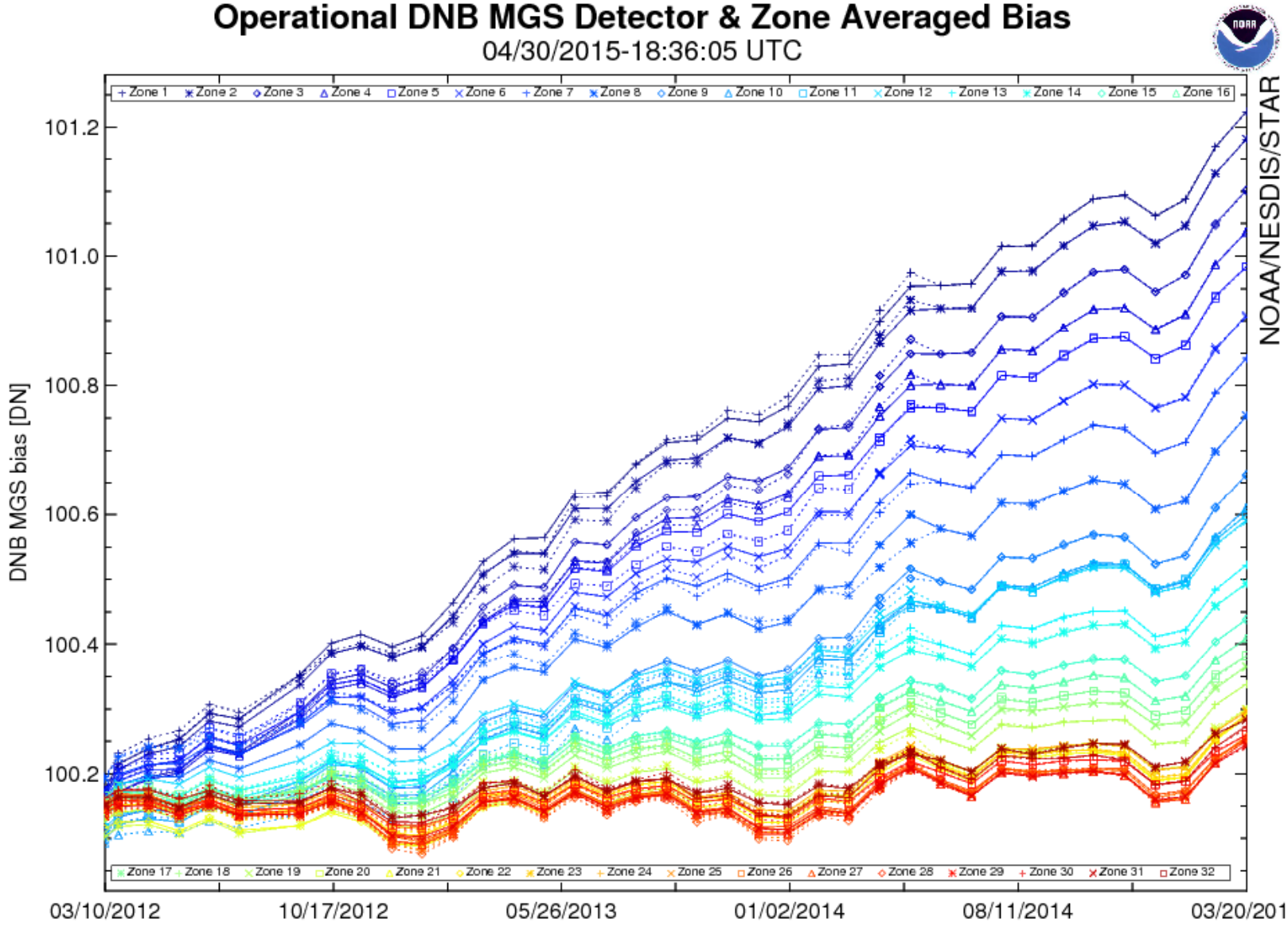
Operational DNB DN0



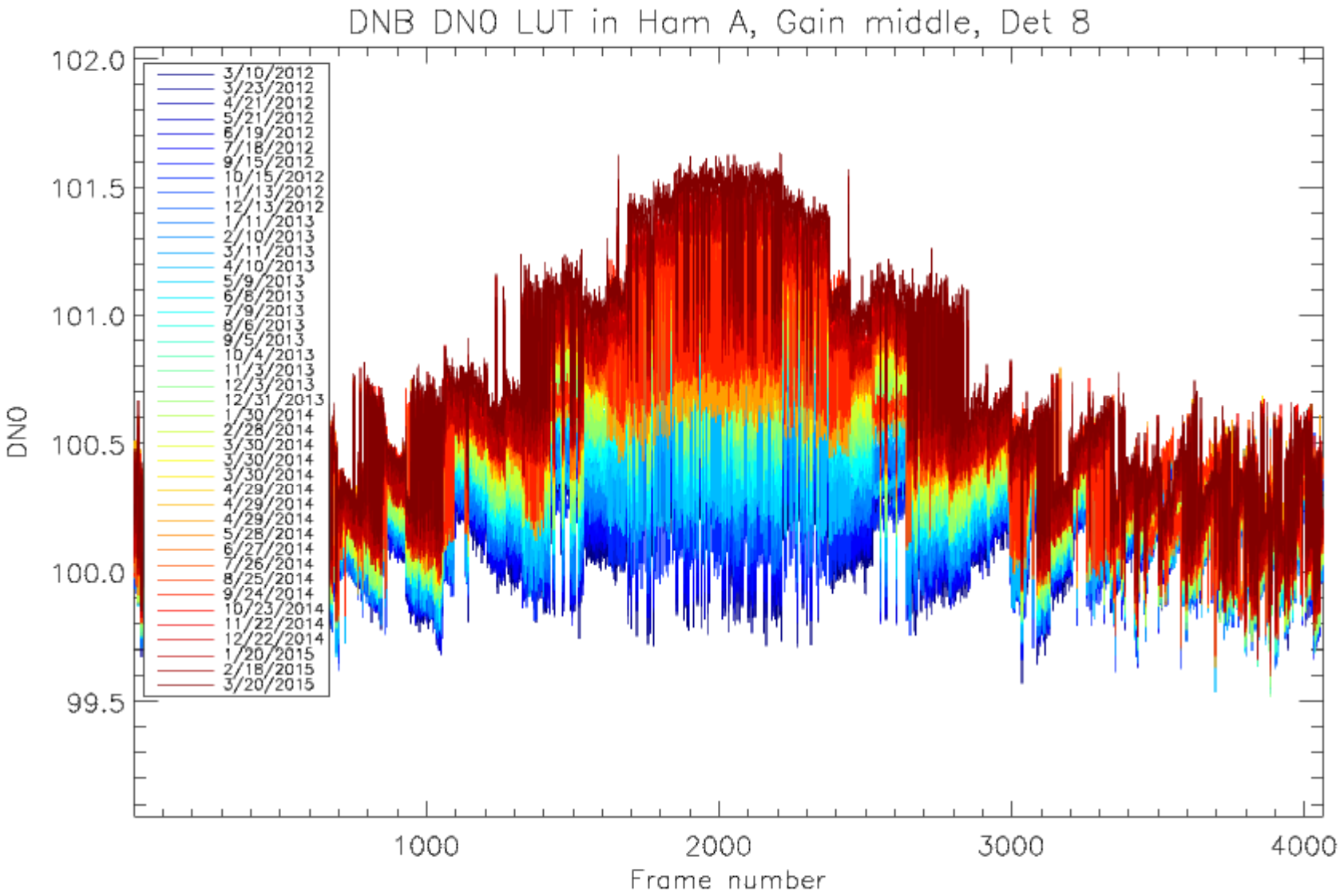
Operational DNB DN0



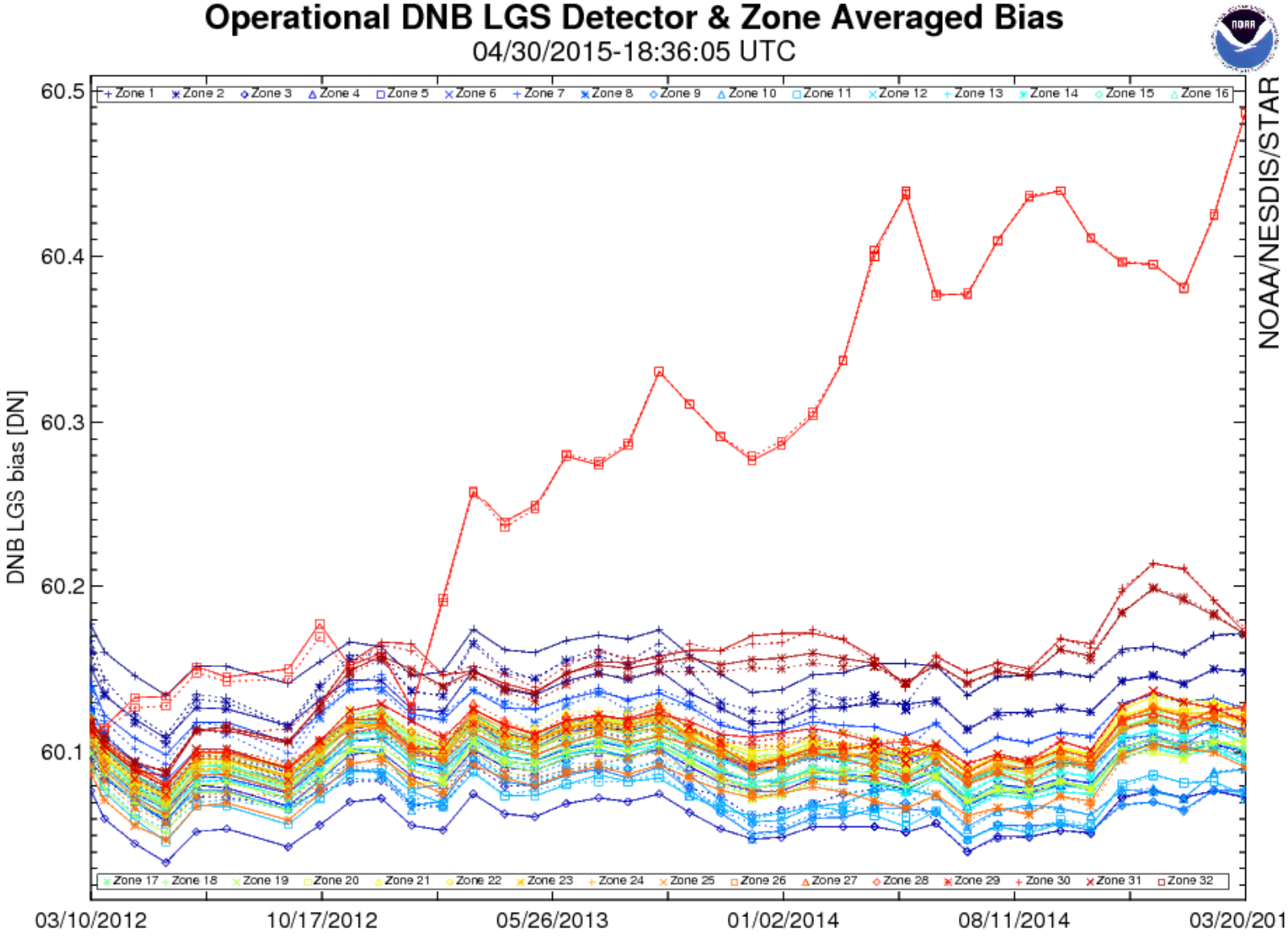
Operational DNB DN0



Operational DNB DN0



Operational DNB DN0



Operational DNB DN0