RSBAutoCal Status and Path Forward

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Introduction (1 of 2)

- Since the launch of the Suomi National Polar-orbiting Partnership (SNPP) satellite the VIIRS reflective bands have been calibrated via updates to look-up tables (LUTs) ingested by the Joint Polar Satellite System (JPSS) Interface Data Processing Segment (IDPS) operational ground processing software
- The calibration parameters in these LUTs are calculated from instrument science and telemetry data captured in On-Board Calibrator Intermediate Products (OBC IPs) generated by IDPS
- Currently, VIIRS Reflective Solar Band (RSB) calibration quantities are calculated manually, delivered on a weekly basis, and put into operations one week after delivery
  - *This process is undesirable due to 1-2 week predict ahead errors*
  - *This process is incapable of maintaining SDR calibration quality even at the required 2% level when unexpected changes in H trend have occurred*
    - Too much time required to recognize trend change and take remedial actions
  - *This process is also manually intensive*

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Introduction (2 of 2)

- VIIRS Day Night Band (DNB) has 3 calibration quantities that are calculated on either a weekly or monthly basis
  - *This process is undesirable due to predict ahead errors and infrequency of updates (particularly for monthly updates)*
  - *DNB offsets degraded by airglow effects that are difficult to mitigate entirely*
  - *This process is also manually intensive*
- RSBAutoCal is the most extensive VIIRS SDR code change to date and provides automatic per orbit calibration quantities
  - *Eliminates predict ahead errors*
  - *Changes engineer's role from LUT production to data review and reduces manually time intensive processes*
  - *Automatically and accurately tracks unexpected trend changes due to per-orbit calibration cadence*
- Integrated into ground processing code and operational in manual mode in December 2013
  - *Re-initialization, parameter tuning, and fixes applied since integration*
  - *Weekly calibration factors are ready to switch to automated mode, while monthly calibration factors require more time for study*

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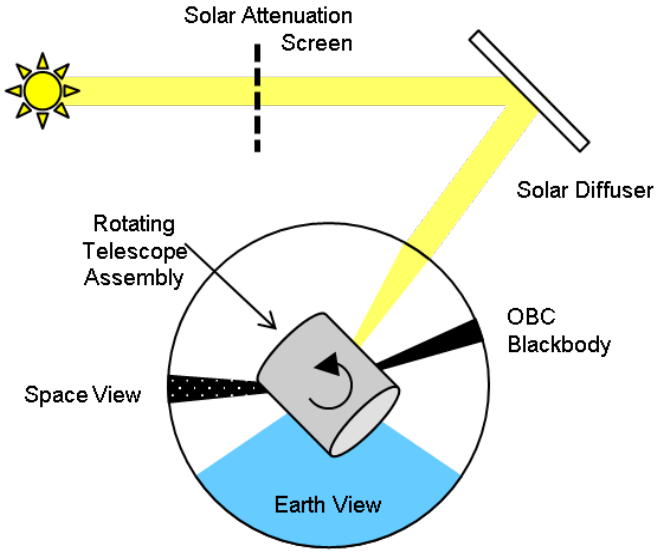
Background: 5 Calibration Quantities (1 of 2)

- H factor: Compensates for the degradation in SD reflectance over the lifetime of the mission
  - *Calculated from LUTs and OBC IP data from the Solar Diffuser Stability Monitor (SDSM), a ratioing radiometer incorporated in VIIRS that alternately views the SD, the sun and an internal dark reference*
  - *RSBAutoCal provides per orbit smoothed values that get updated whenever the SDSM is used, rather than once per week in the current operational methodology*
- F factor: Compensates for the RSB's change in response while on orbit
  - *RSBAutoCal provides per orbit smoothed values that are updated each orbit, rather than once per week as in the current operational methodology*



Background: 5 Calibration Quantities (2 of 2)

- DNB Low Gain Stage (LGS) Gain: Compensates for the DNB's change in response for the LGS
  - *DNB has three gain stages: LGS, Mid Gain Stage (MGS) and High Gain Stage (HGS), which allow the DNB to image in a wide range of illumination conditions*
  - *The LGS is not saturated while viewing the SD, so it can be calibrated similarly to the RSBs*
  - *RSBAutoCal provides per orbit smoothed values that are updated each orbit, rather than once per week as in the current operational methodology*
- DNB Dark Signals: Used to generate offset change over time and in calculation of DNB Gain Ratios described below
  - *DNB dark signals are collected from all gain stages in all calibration sectors, the space view, the OBC BB view and the SD view, when the satellite is fully eclipsed by the earth, so that no sunlight can reach the DNB focal plane when viewing any of these sources*
- DNB Gain Ratios: Used to determine MGS and HGS gains, since they cannot be calculated directly with the LGS gain methodology above
- DNB Dark Signals and Gain Ratios are updated by RSBAutoCal whenever illumination conditions are suitable, rather than once per month with the current operational methodology, providing more responsive and accurate calibration

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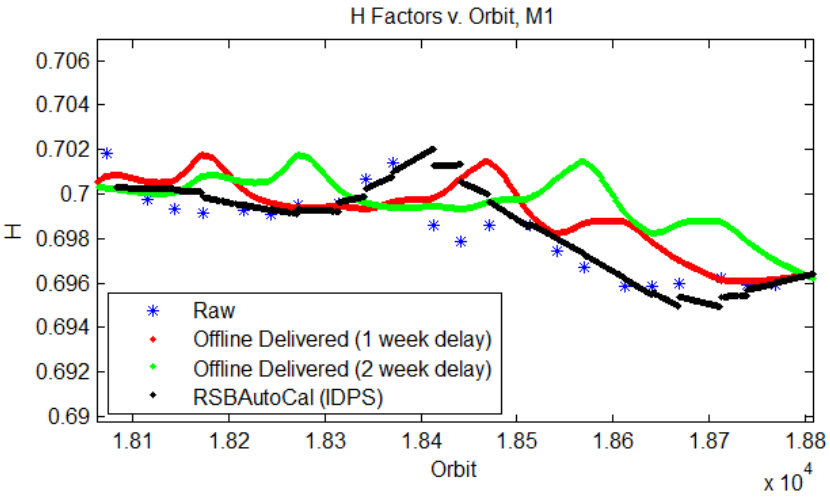
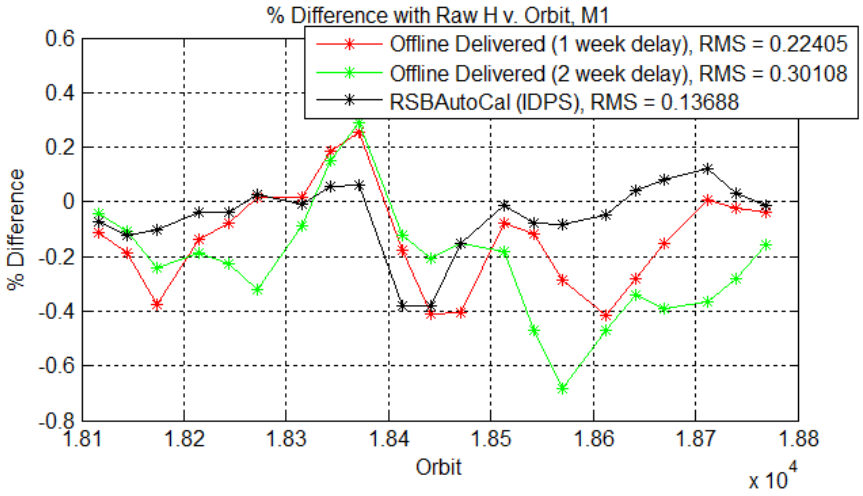
Background: Robust Holt Winter Filtering

- All calculated calibration quantities are smoothed with a Robust Holt Winters Filter
  - *The filter only requires the last state (stored in a LUT) and current measurements to calculate the current state*
  - *If there are no updated measurements (e.g. infrequent SDSM usage for new H factors), the current state is linearly propagated from the previous state using the current trend*
  - *Provides automatic outlier rejection*
- Filter parameters were extensively studied and tuned for each calibration quantity based on SNPP mission history
  - *For H and F factors, parameters were optimally tuned to match a 2-day running mean – requested by NOAA/STAR*

Current SNPP RSBAutoCal Status: H factor

- RSBAutoCal H factors perform better than offline delivered H factors because offline delivered values have 1-2 week predict ahead error
  - *RSBAutoCal H factors track data better*
  - *Actual offline % differences will lie somewhere between the 1 and 2 week lines plotted to the right*
- Differences in current RSBAutoCal H factors with Raw values are the same order as noise in H factors
- Additional smoothing is performed after H factors are applied to F factors





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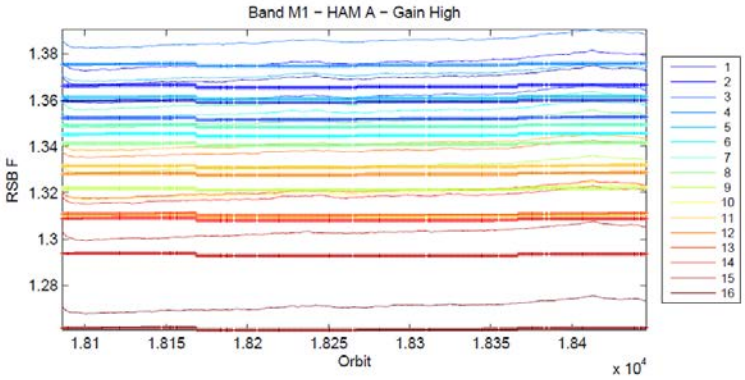
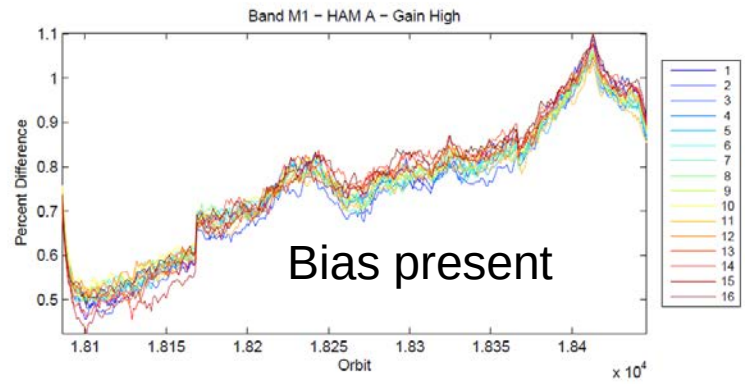
Current SNPP RSBAutoCal Status: F Factor (1 of 2)

- Careful comparison of F factors between RSBAutoCal and offline delivered LUTs revealed biases in some bands
- Careful debugging eventually led to the cause – VIIRS-RSBAUTOCAL-BRDF-SCREEN-TRANSMISSION-PRODUCT-RTA-VIEW-LUT wavelengths are not monotonic, but the RSBAutoCal interpolation code expected them to be
  - *Current offline code using Matlab did not have a problem because Matlab automatically sorts vectors prior to interpolation*
  - *LUT documentation did not specify wavelength ordering and RSBAutoCal code assumed ordering was monotonic*
  - *Simplest fix is to create a new LUT with monotonic wavelengths rather than a code change*

Thin lines = RSBAutoCal
Thick points = Operational LUT Deliveries





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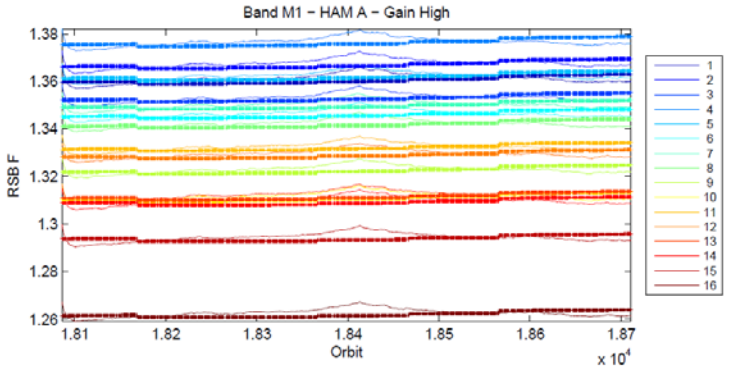
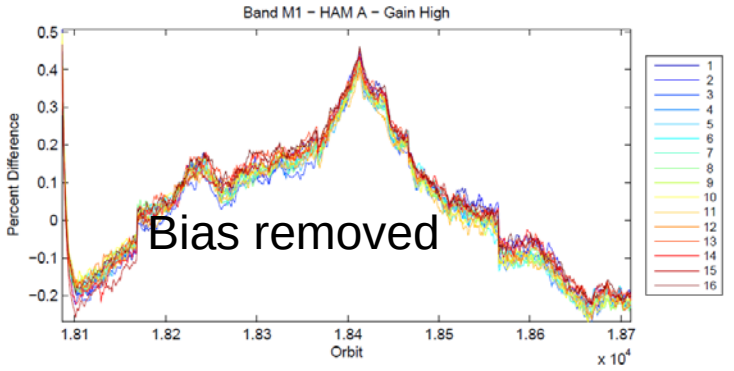
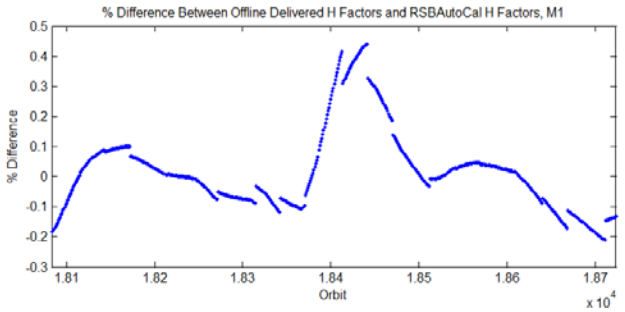
Current SNPP RSBAutoCal Status: F Factor (2 of 2)

- With new LUT, bias in F factors is gone
  - *Remaining differences are primarily due to two things:*
    - H factors differences (slide 4)
    - Predict ahead error in F LUTs
- Offline Matlab code is not affected by this change
- DR 8008 for LUT change being processed
  - *Estimated LUT implementation is August 28*







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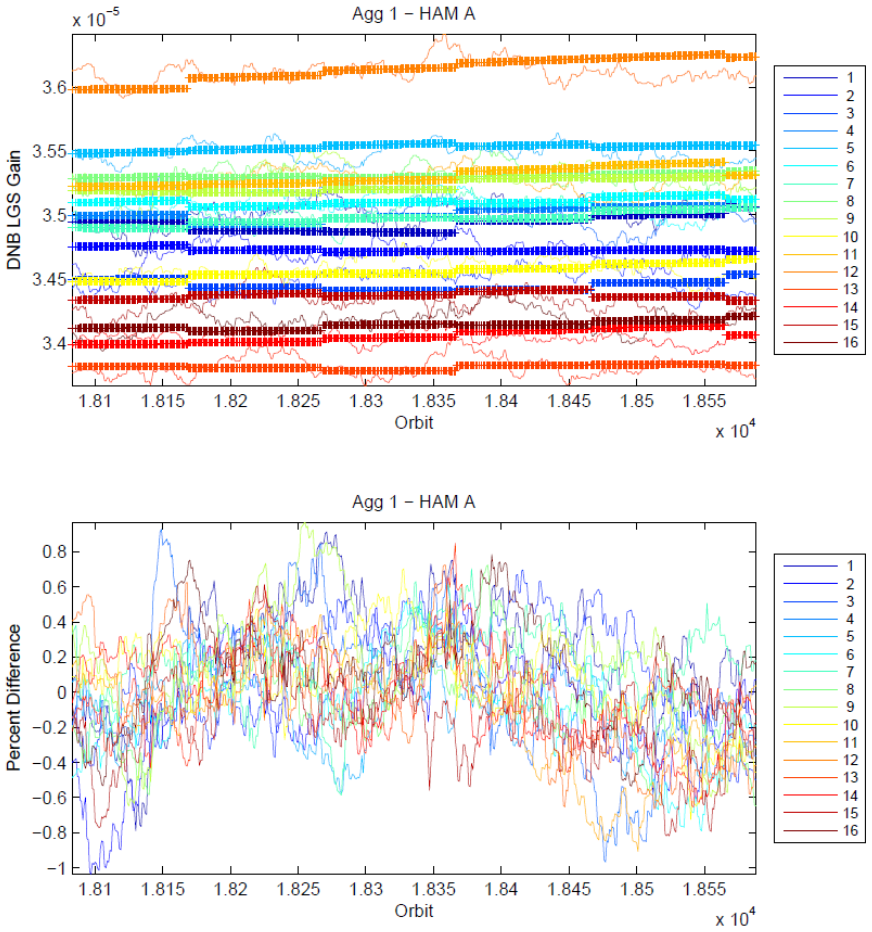
Current SNPP RSBAutoCal Status: DNB LGS Gain

- Good agreement between offline LUT deliveries and RSBAutoCal
- Differences appear strictly due to the dynamics that the RHW filter allows through versus weekly updates



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Current SNPP RSBAutoCal Status: DNB Gain Ratio and Dark Signals

- More time is needed to study the DNB gain ratio and dark signals from RSBAutocal
  - *There appear to be differences between current DNB gain ratios and RSBAutoCal signals*
    - An objective study is underway to look at DNB SDR radiance continuity at gain transitions as a potential discriminator
    - Collection and analysis of data is fairly time consuming
  - *Dark signal behavior indicates gain drift correction will perform well*

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Path to Place RSBAutoCal in Automated Mode

- Pending implementation of new Transmission*BRDF LUT, H factors, F factors, and DNB LGS gains are ready to enter automated mode
  - *DR8008 LUT is expected to go into operations on August 28*
  - *RSBAutoCal will improve the quality of these factors compared to weekly LUT deliveries*

- DR 8012 for new CAL-AUTOMATE-LUT to switch H, F, and LGS gains to automated mode

- DNB gain ratios and dark signals need further evaluation before they are placed in automated mode

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J1 RSBAutoCal Preparation

- J1 Prelaunch RSBAutoCal filter parameter tables will match those of SNPP
  - *After sufficient J1 mission history is established, new optimal filter parameters should be calculated*
- RSBAutoCal code will be running when J1 launches, but it is advised that RSBAutoCal be in manual mode for launch
  - *RSBAutoCal filter values can be sensitive to initial conditions and tuning parameters*
  - *Initial post-launch data can be inconsistent and require additional engineering judgement for evaluation and proper calibration*
  - *Manual mode requires analysts to provide calibration LUTs*
- RSBAutoCal should be placed in automated mode once initial checkouts and algorithm initializations are complete

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Auxiliary Tool Development

- Aerospace has developed a tool to apply scale factors and offsets to the RSBAUTOCAL-HISTORY-AUX-LUT
  - *This method should be much easier to use to change/reset the state of RSBAutoCal quantities as compared to the current method*
    - The current method requires careful timing to make sure the new history file is actually used rather than skipped over by the code
    - The new method will allow scale factors and offsets to be applied to current quantities without such careful regard for timing
- Raytheon has checked out and approved the code
- We are waiting for final IDPS approval and implementation
- Having this tool will be valuable to support SNPP as well as J1 VIIRS

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Conclusion

- RSBAutoCal is on the cusp of being placed in automated mode for weekly calibration quantities
- Greater calibration accuracy and therefore SDR quality will be realized when RSBAutoCal is in automated mode
- We recommend that J1 not be placed in automated mode at launch, but rather start in manual mode to allow checkouts to be completed

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