Suomi NPP Reprocessing Status

8/11/2016

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Outline

• Introduction

• Algorithm Updates and Issues
  – Reflective Solar Bands (RSB)
  – Thermal Emissive Bands (TEB)
  – Day Night Band (DNB)

• Provisional Schedule
  – Processing capability

• Summary
Introduction

• S-NPP VIIRS SDR product needs to be reprocessed
  – To improve early lifetime SDR data in all RSB, TEB and DNB.
• Anomalies in RSB
  – Sudden H-factor updates in 2014
  – Long-term differences between SD and lunar F-factors
  – Possible degradation in SWIR bands
  – Applying lunar F-factor into SD F-factors
• TEB Warm-Up-Cool-Down (WUCD) issues with SST
  – Option 1: Aerospace solutions
  – Option 2: NOAA VIIRS SDR team’s current progress
• DNB improvements
  – Initial calibration changes
  – DNB Relative Spectral Response (RSR) changes
  – Updated VROP for DN0 (bias)
  – Stray light LUT update
Algorithm Updates & Issues in RSB

- Significant F-factor discontinuities were found in bands M1~M4 (up to 1.5% differences in band M1) caused by sudden H-factor (Solar Diffuser degradation).
- Initial VIIRS SDR products in early 2012 need to be updated with new RSB F-factors.

**Figure 1.** S-NPP VIIRS RSB Operational (Symbols) and ICVS F-factors (lines)
• F-factor ratio (NASA VCST/ NOAA RSBAutoCal)
  – VIS/NIR bands
    • There are initial offsets and long-term drifts.
    • The differences are larger in short wavelength bands and getting smaller in longer wavelengths.
    • Because of NASA’s lunar corrections into the SD F-factors.
  – SWIR bands
    • H-factor (SD degradation) free bands show long-term drifts.
    • Because of NASA’s update SD degradation into the SD H-factors.
The two F-factors need to be normalized (or scaled) properly because of the different solar irradiance models.

The SD F-factors (solid lines) are normalized for better comparison and visualization in the figures.

The best fitting scaling factors are calculated and applied for lunar F-factors (symbols).

Lunar and SD F-factors are showing similar annual trends in starting from end of 2014 to current time.

The first two lunar points are below the SD F-factors.
  – Potential errors in SD F-factors.
Corrected F-factors are very similar to the NASA’s LUTs.

Our version of the corrected F-factors have more curvature than NASA LUTs in early lifetime.
• **SD Calibration**
  – SD degrades non-uniformly, resulting long-term drifts
  – Results are stable and smooth
  – Observation in every orbit

• **Lunar Calibration**
  – No degradation issue
  – Infrequent and no observation in three months every year

• **Hybrid Approach**

\[
\mathcal{F}(B, D, M, G) = R(B, t) \cdot F(B, D, M, G)
\]

\[
R(B, t) = \left \langle f(B, M, t) \right \rangle_M / \left \langle F(B, D, M, 0, t) \right \rangle_{D, t-15 < t < t+15, M}
\]

– Lunar calibration provides long-term baseline
– SD calibration provides smoothness and frequency

Earth-based SDR studies show that Hybrid-mitigated SDRs give correct time series.

• A tentative decision was made recently for VIIRS RSB calibration.

• NOAA Ocean Color group will provide
  – Ocean Color RSB calibration coefficients to STAR VIIRS SDR team for testing.

• The OC group’s RSB F-factors will be scrutinized before making the further decision.
  – From inputs from other working groups such as Land/Fire and Atmosphere.
Algorithm Updates & Issues in TEB

WUCD Events – ~0.3K spikes every 3 month

- Medians, SST - Drifter
- Level2 High Res
- NPP VIIRS L2 (ACSPQ), Night
- NPP VIIRS L2 (ACSPQ), Day

Specs: ±0.2K

Day Night

00:00 01 Jan 12
00:00 01 Jan 13
00:00 01 Jan 14
00:00 01 Jan 15

Archived May 2014 - on

Artifacts in time series

Courtesy of Dr. Ignatov, 2015 JPSS Annual Science Team Meeting

- VIIRS SST product is generally consistent with drifter measurements, except
- Issue 3: “Global warming of ~0.3K” occurs in VIIRS SST every 3 months, due to warm up cool down (WUCD) calibration anomaly.
Algorithm Updates & Issues in TEB

- Aerospace proposed a method to reduce F-factor anomalies and scene temperature biases during WUCD (October 7, 2015, Option 1):
- The initial proposed method was further updated to flatten F-factors during WUCD by implementing (August 3, 2016, Option 2):

M15, HAM-A, D1

Other detectors/bands show similar patterns

F Factors Smoothed Over Orbits

This slide is taken from VIIRS TEB calibration potential improvements by Wenhui Wang et. al.
• NOAA SDR Team’s Recent Progress
• As a part of reconciling the pre/post calibration differences activities, a new CO coefficient update method was tested.
  – Only change one LUT, no other change is needed;
  – Effectively reducing 3 types of M15 scene BT biases:
    – 1) Cold scene bias; 2) Constant bias; 3) WUCD bias.
• Further analyzing the sensitivity of different terms, including C coefficients, on WUCD F-factor anomaly and scene temperature biases;
• Currently we have 2 options.
  – Continue to investigate for a better solution.
Algorithm Updates & Issues in DNB

March 2012
1st calibration update using VROP
- Updated both onboard and ground offset tables and gain ratio
- Improved the radiometric accuracy of esp. for HGS data.

April 2013
DNB RSR LUT updated with modulated RSRs
- Accounts for the RTA degradation impact on RSRs
- Improved the radiometric accuracy of all gain stages

August 2013
Straylight correction implemented
- Characterize and correct the straylight
- Improves the data quality

May 2015
DNB terrain correction implemented
- Improves the geolocation accuracy (accuracy from few pixels (over high altitudes such as Tibet) to sub-pixel level)
Algorithm Updates & Issues in DNB

- The DNB gain LUTs only applied one time Relative Spectral Response (RSR) update in 2013
  - causing approximately 5% jump in DNB calibration.

- ICVS DNG gain uses a continuous RTA Degradation Model.
  - Correcting the initial calibration changes, RSR update in 2013, and lunar eclipse anomaly in 2014.
Show DNB image over same location in earth after 16-day repeat cycle.
Figure on right shows improvement in DNB calibration after updating offset table (onboard and ground offset) and gain ratio tables for the first time on March 22, 2012 based on VROP.

This slide is taken from Preparation for DNB recalibration by Sirish Uprety and Yalong Gu
SNPP DNB Stray Light correction transitioned from NG to STAR in 2014

STAR supported the updates of operational stray light LUT for solar vector error correction.

All 12 LUTs were updated by the end of 2015

This slide is taken from Preparation for DNB recalibration by Sirish Uprety and Yalong Gu (Courtesy, Wenhui Wang)
Provisional Reprocessing Schedule

- **RSB (Not ready yet)**
  - NOAA Ocean Color group will provide RSB LUTs by September 15\textsuperscript{th}, 2016.
  - One year of VIIRS data will be ready by the end of November, 2016.
  - RSB LUTs for reprocessing will be ready by December 15\textsuperscript{th}, 2016.

- **TEB (Conditionally ready)**
  - The option 1 solution from Aerospace is ready as a baseline.
  - Currently working on better solution.

- **DNB (Ready)**
  - LGS gain LUTs are ready.
  - DN0 LUTs are ready.
  - Stray light correction LUTs are ready.
  - Currently working on better gain ratio LUTs.
    - With baseline operational gain ratio LUTs.
Provisional Reprocessing Schedule

One day processing scenario

RDRs IN
(55GB/1013 Granules)

Distribute ADLs
Link Terrain files (~55GB)
Create multiple ADL_HOME
(5/node, Limited by RAM size)

Determine total granule numbers
& total CPU numbers used
Assign evenly all granules to
each CPU/node

Unpacking RDRs at each local drive
(Directly read from storage)

Link TLE, PolarWanders, LUTs
Run ADL controller on 18 nodes,
No-cross talk

Directly output to storage

SDR OUT
(540GB)

Total: 33.4 Min
Total CPU hours: 229 (19/24 idle)

NOTE: Assuming that hardware works normally and resources are available (such as no power outage, no disk failure etc) Assuming all input data (RDR, TLE, Polar Wander and LUTs) are ready.
Summary

• RSB band improvements
  – The reprocessing LUTs will correct up to 1.5% sudden changes caused by sudden H-factor updates, C0=0 update, and F-fast track to RSBAutoCal LUT transition.
  – The unstable initial calibration LUTs will be updated.
  – A new OC group’s RSB F-factor LUTs with Lunar correction will be tested for their 0.1~0.3% radiometric uncertainty requirements.

• TEB band improvements.
  – TEB F-factor changes during the blackbody Warm-Up Cool-Down (WUCD) needs to be resolved before reprocessing (currently under study).

• DNB band improvements
  – The reprocessing LUTs will correct radiometric calibration up to 5%.
    • Caused by the initial calibration changes, RSR update, and lunar eclipse anomaly.
  – The new bias (DN0) LUTs will improve bias errors.
    • Using the VIIRS Recommended Operation Procedure (VROP) 702.
  – The new stray light correction LUTs will correct the contaminated scenes before August 2013.