J1 VIIRS DNB Waiver Validation Readiness

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Outline

- J1 VIIRS DNB Calibration/Validation
- Challenges from J1 DNB waiver
- Mitigations
  - Stability trending with stable point light source (Bridge/Oil platforms/Power Plant)
  - Monitoring radiometric response versus scan angle
  - VIIRS DNB geolocation validation site time series
  - Active Nightlight Source (SBIR Project)
The VIIRS DNB Calibration

a complex calibration system

• Only the low gain stage (LGS) of DNB is calibrated using the solar diffuser; then transferred to the medium and high gains based on gain ratio

• DNB onboard calibration is performed per scan, per half angle mirror side (HAM), and per detector

• DNB space view cannot be used as offset because it’s “too bright”. Blackbody and solar diffuser night views are better but also have issues

• Operationally the offset is determined using earth view during new moon in the darkest part of the pacific ocean (with airglow removed)

• Each DNB scan (LGS) only calibrates one of the 32 aggregation zones. As a result, a complete calibration involves at least 36x2 scans
Spectral, Spatial, and Radiometric Response of the VIIRS DNB

DNB has 32 aggregation zones from nadir to edge of scan, each with its own calibration.

- The response across the 32 zones are not the same and may not be linear at high scan angles.
- Point spread function is also aggregation zone dependent, with a near square response at nadir.

Courtesy of G. Lin

(Cao & Bai, 2014, Remote Sens.)
**J1 VIIRS SDR Algorithms (Waiver Mitigation)**

**Challenge:** added complexity due to J1 Waivers (scan angle dependency)

- **DNB nonlinearity at high scan angles (Requires change in Aggregation Mode)**
  - Baseline is Agg Mode 21
    - Radiometric calibration:
      - Develop LUTs;
      - Do not expect code change
    - Geolocation (require code change)
      - Change LUT
      - Code Change
  - DNB other Agg mode (Agg21/26)

Notional drawing, not to scale; all values subject to change
Mitigation 1: VIIRS DNB Stability Monitoring using Night Bridge Lights

- Enable J1-DNB radiometric stability monitoring using nadir observation of San Mateo bridge lights near Lmin
- LEDs have replaced traditional light bulbs according to California Dept. of Transportation
- LandPeate ~15% higher than IDPS radiances
- Lunar has minimal impact in clear sky due to narrow bridge width
- Lunar has large impact in cloudy cases

After Cao and Bai, RS, 2014
Mitigation 2: Monitoring Radiometric Response versus Scan Angle

- Baseline of scan-angle dependence from SNPP DNB
- Useful for diagnosing the J1 aggregation mode
Mitigation 3: Oil Platform Holly Geolocation Validation
(Spatial distribution)

- 28 samples from March-April, 2015
- All within 750x750m pixel
- Centered around the Oil Platform Holly

Statistics:
- Mean bias: 29m (or <4% of a pixel)
- N Samples: 28
- Single point uncertainty: ½ pixel
- Larger errors when cloudy

28 Samples from March-April 2015, all within one pixel

Fill gap of DNB geolocation validation with point light source tracking
Mitigation 3: Suomi NPP VIIRS DNB Geolocation Validation Site Time Series

- Sites include power plants, oil platforms, gas flares, volcanoes, and bridges
- Single pixel geolocation uncertainty about ½ pixel
- Mean bias: 29m (or <4% of a pixel) for Oil Platform Holly
- Distance error not correlated with scan angle or frame number
- Support J1-DNB geolocation validation at different scan angles using point sources
Mitigation 4: Active Nightlight Source SBIR Project

New SBIR initiative to develop active nightlight for VIIRS DNB validation, working closely with NIST and NASA scientists.
Potential use of the Active Night Light Source

- **VIIRS/DNB Cal/Val**
  - Reduce absolute radiometric uncertainties
  - Improve calibration stability over time
  - Validate the scan vs. radiance bias across aggregation zones (especially useful for J1 VIIRS due to nonlinearity at high scan angles)
  - Geolocation/geometric validation at different scan angles

- **Enables active remote sensing using passive instrument with well known ground truth**
  - Use as a reference for existing point sources (boat light, etc)
  - Study night atmosphere (aerosol, cloud, etc)
  - Validate radiative transfer for point sources
  - Perform spectral studies using different color LEDs, Tungsten-Halogen, Incandescent, etc. as source

- **Collaborate with UAS programs to support cal/val, and nightlight remote sensing**

Cao et al, SPIE/EOS 2015
Ideal Sites

Site requirements
- Clear sky
- Low aerosol loading
- Dry and thin atmosphere
- No lights nearby
- Large water body (such as lakes)

Cao et al, SPIE/EOS 2015
Summary

• STAR VIIRS SDR team has made great progress developing DNB radiometric and geolocation trending capabilities for J1 waiver mitigations
  o Radiometric trending using bridge lights and oil platforms;
  o Radiometric response versus scan angle
  o VIIRS DNB geolocation validation using point sources at different scan angles

• Capabilities will be extremely useful for J1 VIIRS DNB waiver mitigation and aggregation mode validation

• Studies of existing night light source is encouraging that a ground based source can be developed for improved accuracy