



# J1 VIIRS DNB Waiver Validation Readiness

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# Outline

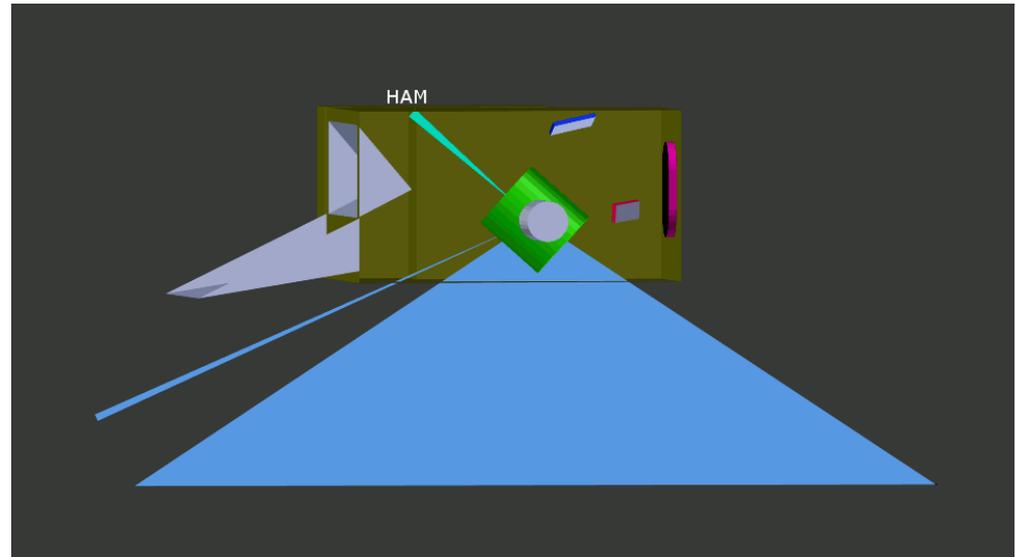


- **J1 VIIRS DNB Calibration/Validation**
- **Challenges from J1 DNB waiver**
- **Mitigations**
  - Stability trending with stable point light source (Bridge/Oil platforms/Power Plant)
  - Monitoring radiometric response versus scan angle
  - VIIRS DNB geolocation validation site time series
  - Active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

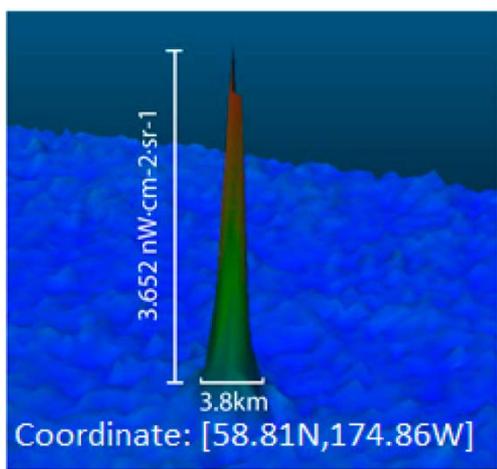
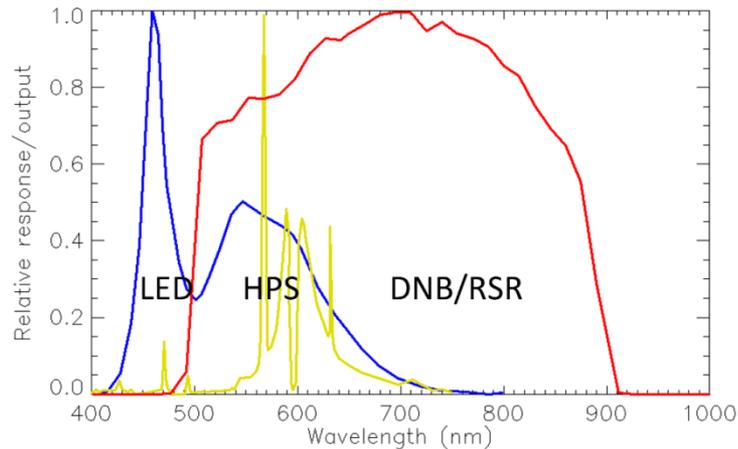
# The VIIRS DNB Calibration

## a complex calibration system

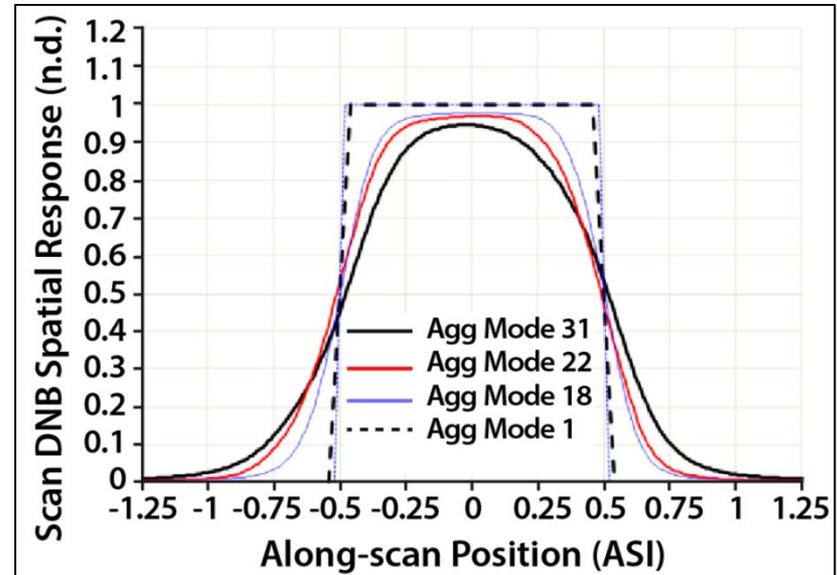
- Only the low gain stage (LGS) of DNB is calibrated using the solar diffuser; then transferred to the medium and high gains based on gain ratio
- DNB onboard calibration is performed per scan, per half angle mirror side (HAM), and per detector
- DNB space view cannot be used as offset because it's "too 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 view of fishing boat  
(Cao & Bai, 2014, Remote Sens.)



Courtesy of G. Lin

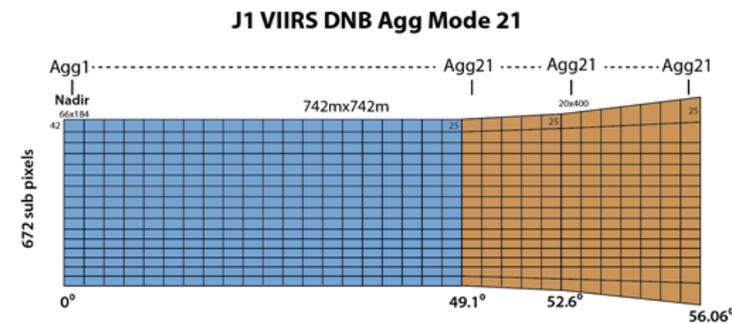
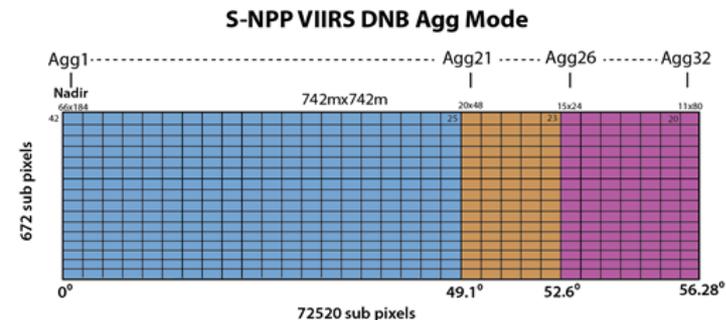
- DNB has 32 aggregation zones from nadir to edge of scan, each with its own calibration
- The response across the 32 zones are not the same and may not be linear at high scan angles
- Point spread function is also aggregation zone dependent, with a near square response at nadir

# J1 VIIRS SDR Algorithms (Waiver Mitigation)

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

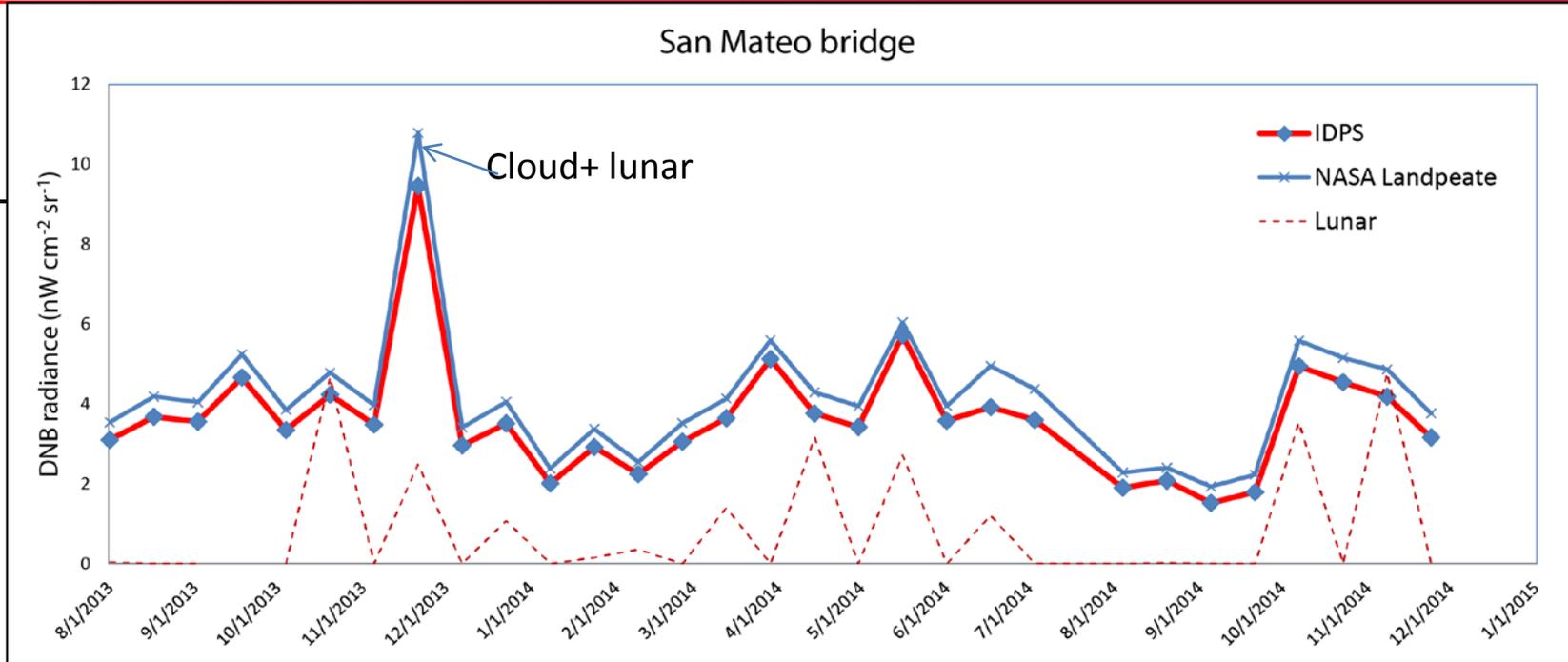
- **DNB nonlinearity at high scan angles (Requires change in Aggregation Mode)**

- 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)

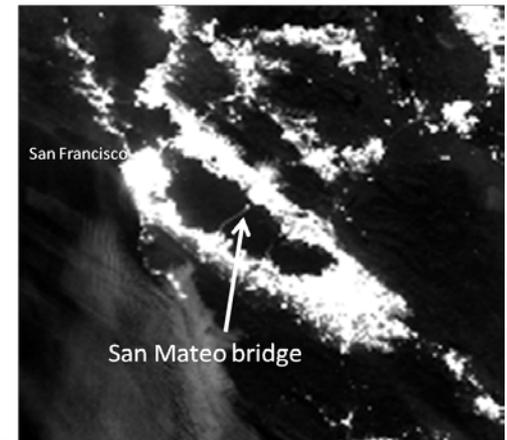


Notional drawing, not to scale;  
all values subject to change

# Mitigation 1: VIIRS DNB Stability Monitoring using Night Bridge Lights

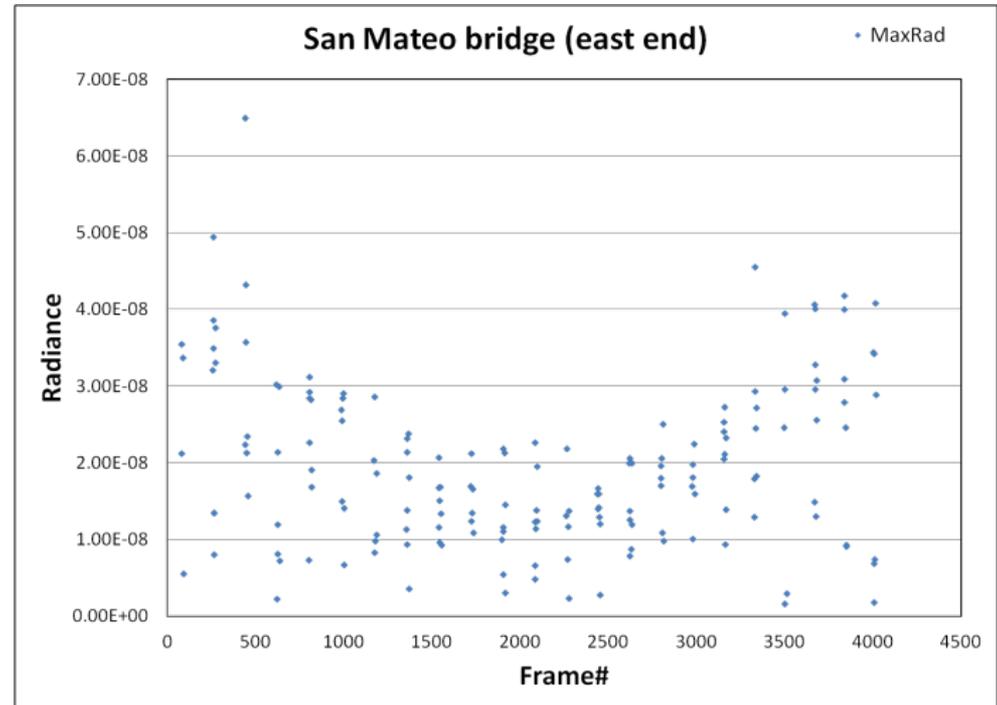
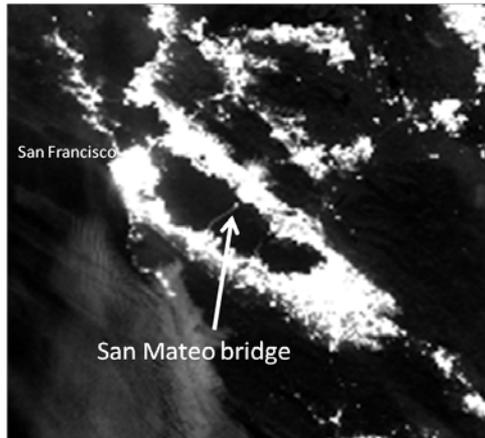
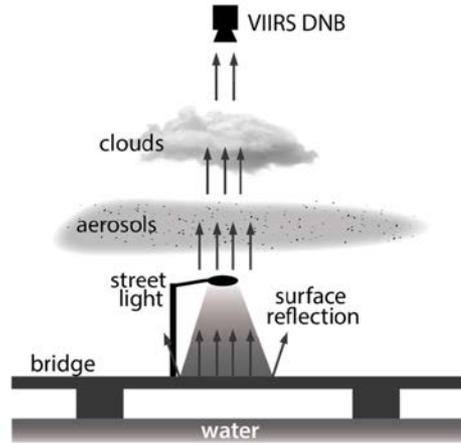


- Enable J1-DNB radiometric stability monitoring using nadir observation of San Mateo bridge lights near Lmin
- LEDs have replaced traditional light bulbs according to California Dept. of Transportation
- LandPeate ~15% higher than IDPS radiances
- Lunar has minimal impact in clear sky due to narrow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



After Cao and Bai, RS, 2014

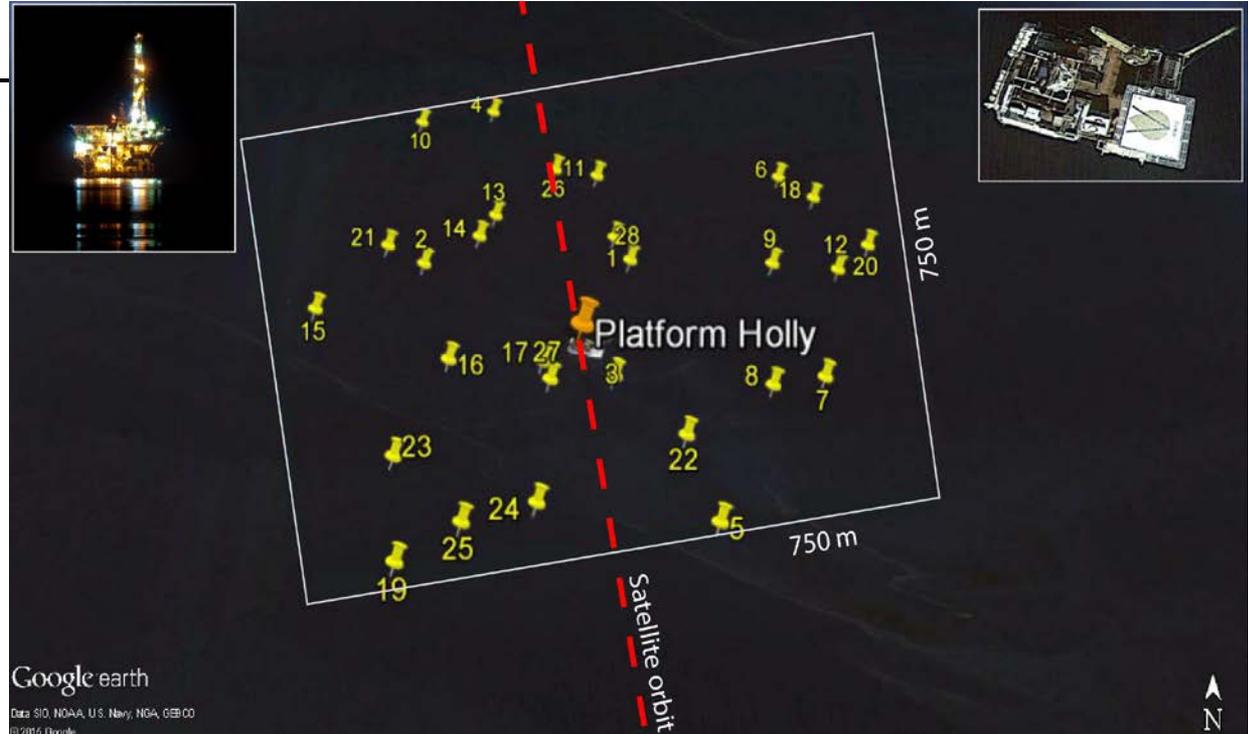
# Mitigation 2: Monitoring Radiometric Response versus Scan Angle



- 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:  $\frac{1}{2}$  pixel
  - Larger errors when cloudy



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

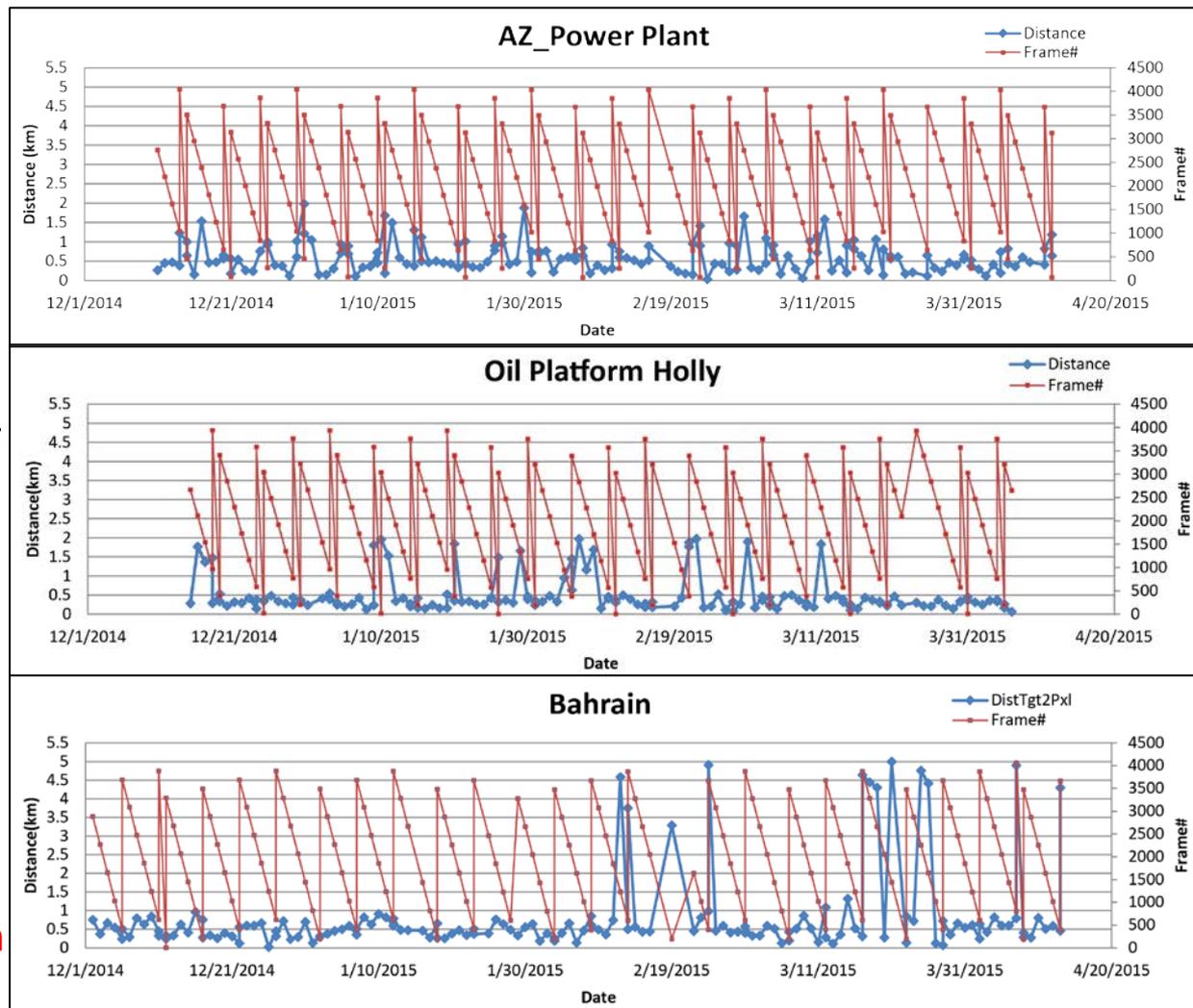
Fill gap of DNB geolocation validation with point light source tracking



# 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  $\frac{1}{2}$  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



## NOAA Small Business Innovation Research FY2015

Agency:	Department of Commerce	Release Date:	October 15, 2014
Program/Year:	SBIR / 2015	Open Date:	October 15, 2014
Solicitation Number:	NOAA-2015-1	Close Date:	January 14, 2015

- + 8.1: Resilient Coastal Communities and Economies
- + 8.2: Healthy Oceans
- + 8.3: Climate Adaptation and Mitigation
- 8.4: Weather-Ready Nation
  - + 8.4.1W: Monitoring Active Region Development on the Far-Side of the Sun
  - + 8.4.2R: Ultrasonic Anemometers/Thermometers with Increased Spatial Resolution
  - + 8.4.3D: Accurate Nightlight for Satellite Calibration for Weather and Climate Applications

New SBIR initiative to develop active nightlight for VIIRS DNB validation, working closely with NIST and NASA scientists

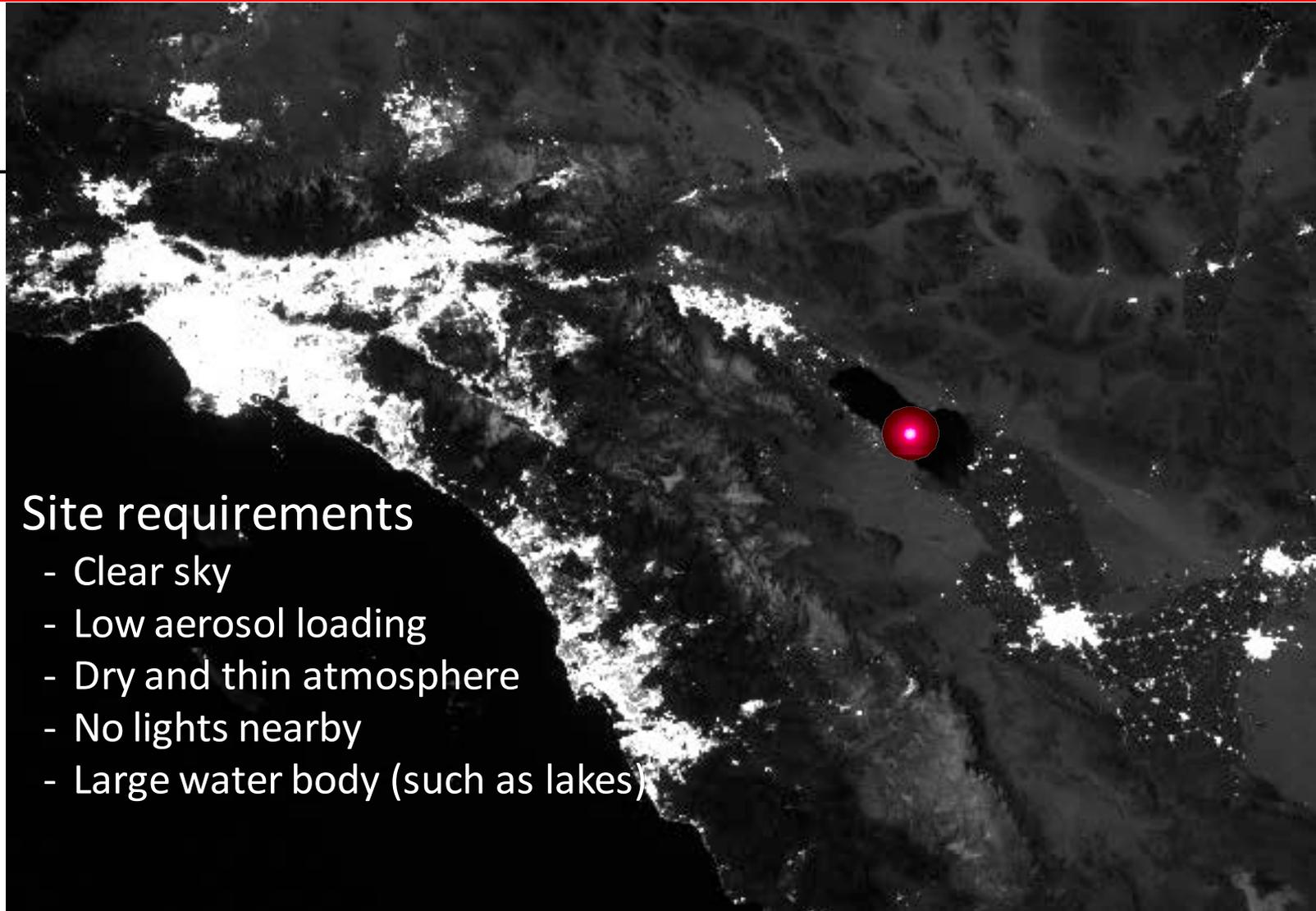


# Potential use of the Active Night Light Source



- 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

# Ideal Sites



## Site requirements

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



# Summary



- STAR VIIRS SDR team has made great progress developing DNB radiometric and geolocation trending capabilities for J1 waiver mitigations
  - Radiometric trending using bridge lights and oil platforms;
  - Radiometric response versus scan angle
  - 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