Nighttime VIIRS products: Fires, Flares, Lights, and Boats

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Lights At Night!

Cities and human settlements

Industrial Sites

Boats

Gas Flares

Fires
UN Initiative to end routine flaring by 2030

How will progress be tracked? VIIRS!
Gas flares are readily detected in the VIIRS M10 spectral band.
VIIRS Nightfire (VNF): A global multispectral fire product
Nine channels of data are collected at night

Nighttime collection of channel 11 is expected to start in 2015
Why Multispectral?

To get at the Planck curves!

Daily files are in csv and kmz formats.
Typical Biomass Burning Detection

Lower temperature than gas flaring. Often these have larger source size than gas flares.
Detection Limits

At 1800 K flares as small as 0.25 m² are detectable
Daily VNF data are available at:
http://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html

Current processing typically runs with a four hour delay
Temperatures are bimodal

Fires

Flares
Calibration for estimating BCM from radiant heat.

\[ y = 0.0031x \]
\[ R^2 = 0.84 \]
Gas flaring volumes estimated at 7438 sites worldwide

929 flare sites in North Dakota

Rank 4310

Country: USA
Combustion parameters:
Lat=47.747852, Lon=-102.244143 deg.
Freq. detect.=19.95 %
BCM=0.00325

Flare ID: vnfdb_2012_02226
Tavg=1900.97 K, RHsum=1.04976 MW
Area=0.13 m2
Type: flare

Directions: To here - From here
Upstream gas flaring by country in billions of cubic meters (BCM)

Global total
145 BCM
Downstream flaring by country in billions of cubic meters (BCM)

Total = 15.1 BCM
Flare site numbers by country

30% of flare sites are in the USA
Gas flaring site numbers by country.

Half of the flaring is at the top 397 flares.

90% of the flaring is at the top 2285 flares.
Discrimination of flaming and smoldering combustion

- There are two distinct combustion phases
- Flaming: higher temperature 700-1200 K, good oxidation, low smoke
- Smoldering about half as hot as flaming 350-450 K, poor oxidation, high smoke production
- Discriminating between flaming and smoldering could improve emission modeling
- There is a 400-500 K temperature differential
- Is the temperature differential sufficient to discriminate flaming and smoldering with VIIRS data?
Approach

• Prototype method developed with nighttime Landsat 8 data

• Model the flaming phase by Planck curve fitting the M10 & M11 radiances, producing flaming phase radiance estimates in long wave bands

• Subtract the flaming phase radiance and background radiance in bands M12,13,14,15,16

• Residual thermal anomalies suggest smoldering
Sumatra Peat Fire Study
With M11 – September 26, 2014

M7  M8  M10  M11
NIR  SWIR

M12  M13
MWIR

LWIR

M14  M15  M16
Temperature and source area from M10 & M11 Planck curve fitting
Residuals

After subtracting flaming phase and average background radiances

M12  M13

M14  M15  M16
Temperatures from M10 & M11 Planck curve fit – Sumatra September 26, 2014
Source areas from M10 & M11 Planck curve fit – Sumatra September 26, 2014
Summary on Flaming vs Smoldering with VIIRS

• M10 & M11 radiances can be used to extract flaming phase temperatures and source areas
• The presence of residual hotspot radiances in mid-long wave infrared channels after subtracting flaming phase and background radiances suggests the presence of smoldering in Sumatra peat fires.
• Can smoldering phase temperatures and source areas be estimated?
• The method needs to be tested more widely.
VIIRS detects lights from boats at night

Near real time service running for Indonesia. Expansion to other regions begins later this year.

http://www.ngdc.noaa.gov/eog/viirs/download_indo_boat.html
Applications for VIIRS boat detections

- Supply alerts for boats detected in “no-take” and Marine Protected Areas
- Cross correlate with GPS beacon data to ID potentially illegal fishing
- Monitor for transboundary foreign vessels
- Assess the impacts of new regulations and enforcement regimes
Boat Detections Running for Indonesia
Documenting effectiveness of regulations
Aru Island, Arafura Sea

Ban on foreign fishing vessels
VIIRS Nighttime Lights Algorithm Development

- Algorithms developed to remove lighting and fires.
- The DNB based fire removal algorithm should work well for removing South Atlantic Anomaly (SAA) detector hits and may also remove aurora.
- Last major hurdle is removal of background.
South Asia
DNB
cloud-free composite
Background
Background with infrequent light
Minor urban area
Brighter urban area
Daytime DNB Cloud-free Composite

Ten brightness classes
Summary

• There are four unique types of nighttime VIIRS products:
  • VIIRS Nightfire (VNF) produced globally on 24 hour increments. Gas flaring observations used to estimate flared gas volumes worldwide. Research is ongoing on discrimination of subpixel flaming and smoldering.
  • VIIRS boat detections (VBD) currently running for Indonesia. Will begin the expand to other areas this year.
  • VIIRS nighttime lights (VNL) last hurdle is the background removal algorithm.
EOG Publications

• Long-wave infrared identification of smoldering peat fires in Indonesia with nighttime Landsat data  http://iopscience.iop.org/1748-9326/10/6/065002/

• Automatic Boat Identification System for VIIRS Low Light Imaging Data http://www.mdpi.com/2072-4292/7/3/3020

• VIIRS Nightfire: Satellite pyrometry at night http://www.mdpi.com/2072-4292/5/9/4423

• What is so great about nighttime VIIRS data for the detection and characterization of combustion sources? http://dx.doi.org/10.7125/APAN.35.5

• Using the short-wave infrared for nocturnal detection of combustion sources in VIIRS data http://dx.doi.org/10.7125/APAN.35.6

• Why VIIRS data are superior to DMSP for mapping nighttime lights http://dx.doi.org/10.7125/APAN.35.7

• Nighttime lights compositing using the VIIRS day-night band: Preliminary results http://dx.doi.org/10.7125/APAN.35.8