VNL, VBD & VNF: VIIRS data gems from the night

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Cities and human settlements

Industrial Sites

Lights At Night!

Boats

Gas Flares

Fires
The Visible Infrared Imaging Radiometer Suite (VIIRS) primary mission is weather.
VIIRS low light imaging at night: DNB detects electric lighting, fires and flares. M7-11 detect combustion sources.
VIIRS Nightfire (VNF): A global multispectral fire product
Nine channels of data collected at night

Planck curve for typical gas flare (1800 K)
Three global product lines

https://payneinstitute.mines.edu/eog/

• **VIIRS nighttime lights (VNL):** 1) Monthly cloud-free average DNB radiances, filtered to remove sunlit, moonlit and cloudy pixels. 2) Annual product further filtered to remove fires, aurora, and background.

• **VIIRS boat detections (VBD):** Offshore detections of lights used by fishery agencies. Primarily fishing boats using lights. Four hour temporal latency target. https://ngdc.noaa.gov/eog/viirs/download_boat.html

• **VIIRS nightfire (VNF):** Multispectral detections of fires, flares and other IR emitters. Calculates temperature, source size and radiant heat using physical laws. Current R&D on subpixel analysis of flaming vs smoldering. Four hour temporal latency target.
VIIRS Nighttime Lights (VNL) 2015 Myanmar

- Raw cloud-free composite
- Outlier removed
- Nighttime lights
VIIRS boat detection (VBD)

Boats in Java Sea

Jakarta
Algorithms run on images, output points, vast data volume reduction.
Single Night of Detections (June 9, 2017)

Standard is four hour temporal latency, with files available at 06:00 local time
Placemarks sized based on radiance and have information panels.
For gas flares – the nighttime is the right time!
Bakken Oil Field, North Dakota

Gas flare peak radiant emissions are near 1.63 micrometers.
The flare radiance is lost during the day due to sunlight.
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.
Temperatures are bimodal

![Bar chart showing two peaks for Fires and Flares. Tally values range from 0 to 600. X-axis represents temperature in degrees Fahrenheit, and Y-axis represents tally count.]
Annual summaries of gas flare locations and gas flare volume estimates are available at:
https://ngdc.noaa.gov/eog/viirs/download_global_flare.html
Upstream Flaring in billions of cubic meters (BCM)

Flaring, BCM

2012 2013 2014 2015 2016 2017 2018

Russia  Iraq  Iran  USA  Venezuela  Nigeria  Algeria  Mexico  Kazakhstan  Angola  Libya  Malaysia  Indonesia  Egypt  Oman  Saudi Arabia  Turkmenistan  China  India  Canada
VNF Detection Limits
# VNF+ Pixel Types

Type 4 is amenable to flaming vs smoldering analysis

<table>
<thead>
<tr>
<th>Type</th>
<th>Spectral bands</th>
<th>Fitting</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>M11</td>
<td>None</td>
<td>Filter out solitary pixels</td>
</tr>
<tr>
<td>1</td>
<td>M7, 8, 10, 11</td>
<td>Single Planck curve fitting</td>
<td>Flaming phase combustion – primarily natural gas flares.</td>
</tr>
<tr>
<td>2</td>
<td>M11, 12, 13</td>
<td>Dual Planck curve fitting for IR emitter and background</td>
<td>Flameless glowing embers?</td>
</tr>
<tr>
<td>3</td>
<td>M12, 13</td>
<td>Dual Planck curve fitting for IR emitter and background</td>
<td>Rare occurrences.</td>
</tr>
<tr>
<td>4</td>
<td>M7, 8, 10, 11, 12, 13</td>
<td>Triple phase fitting for two IR emitters and background</td>
<td>Solve for temperature and source area for a flaming and a cooler combustion phases plus background.</td>
</tr>
<tr>
<td>5</td>
<td>M7, 8, 10, 11, 12, 13</td>
<td>Dual Planck curve fitting for IR emitter and background</td>
<td>Assembled from Type 4 detections that yielded spurious results in triple phase analysis.</td>
</tr>
</tbody>
</table>
Type 4 pixels are analyzed with triple Planck curve fitting. Flaming, smoldering and background.
VNF+ smoldering pixels are the source area for a smoke plume visible in Landsat 8 later the same day.
VNF+ temperature histogram
20190926 Sumatra
Summary: Three global products

- **VBD**: Nightly VIIRS boat detection (VBD) data is primarily detecting fishing boats using lights to attract catch. This is a common practice in Asia and several other areas. EOG also generates monthly and annual summary grids.

- **VNF**: VIIRS nightfire is a multispectral fire product reporting temperatures, source sizes and radiant heat. Used for annual global surveys of gas flaring sites and flared gas volumes. Current R&D on flaming versus smoldering subpixel spectral unmixing.

- **VIIRS nighttime lights** – monthly and annual cloud-free composites of DNB radiances.
Key EOG publications


