Fires, flares, boats and lights: product lines from nighttime VIIRS data

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Lights At Night!

Cities and human settlements

Boats

Industrial Sites

Gas Flares

Fires

VIIRS Collects Two Styles of Low Light Imaging Data

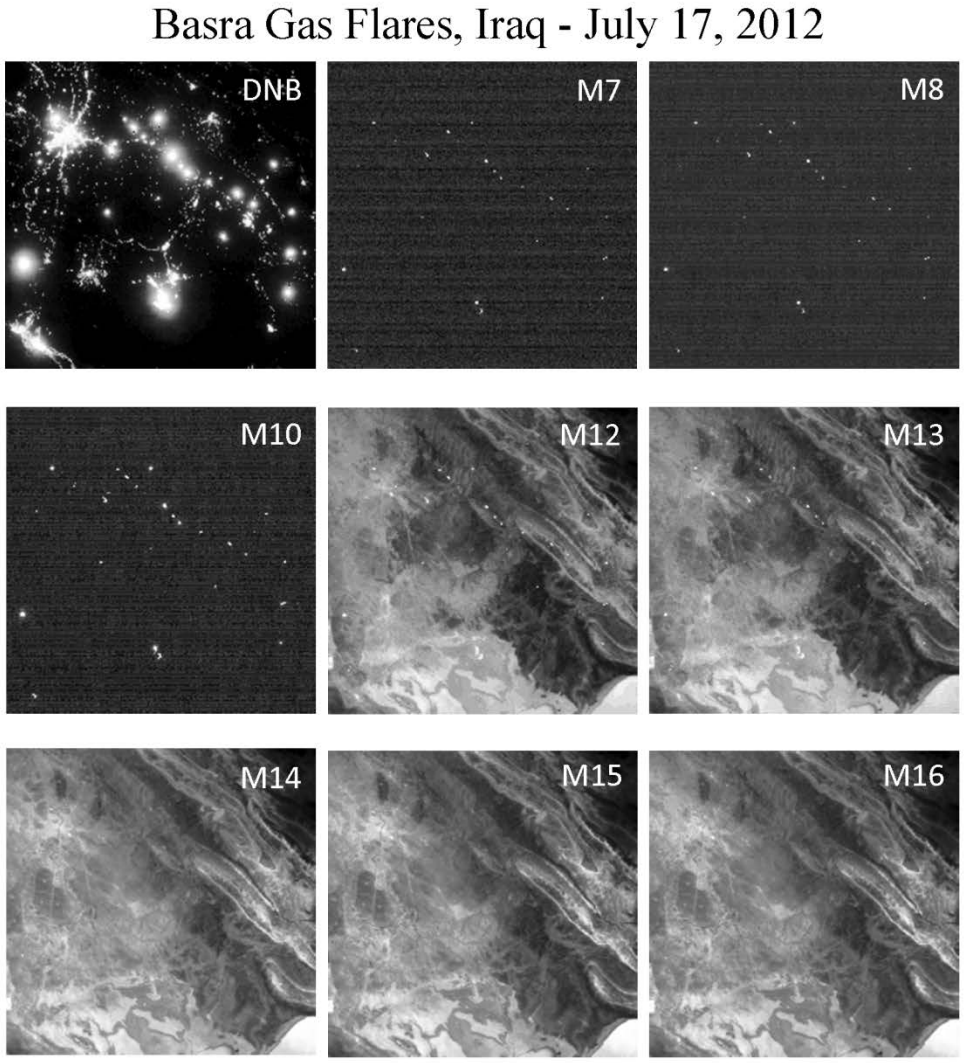
1. Signal intensification to detect faint radiant emissions in the visible and near infrared – the Day Night Band (DNB).
2. Daytime channels at night – enabling the detection of radiant emissions that are obscured by reflected sunlight. VIIRS collects the following at night:

   M7 at 0.865 um

   M8 at 1.24 um

   M10 at 1.61 um

   M11 at 2.25 to be added soon!

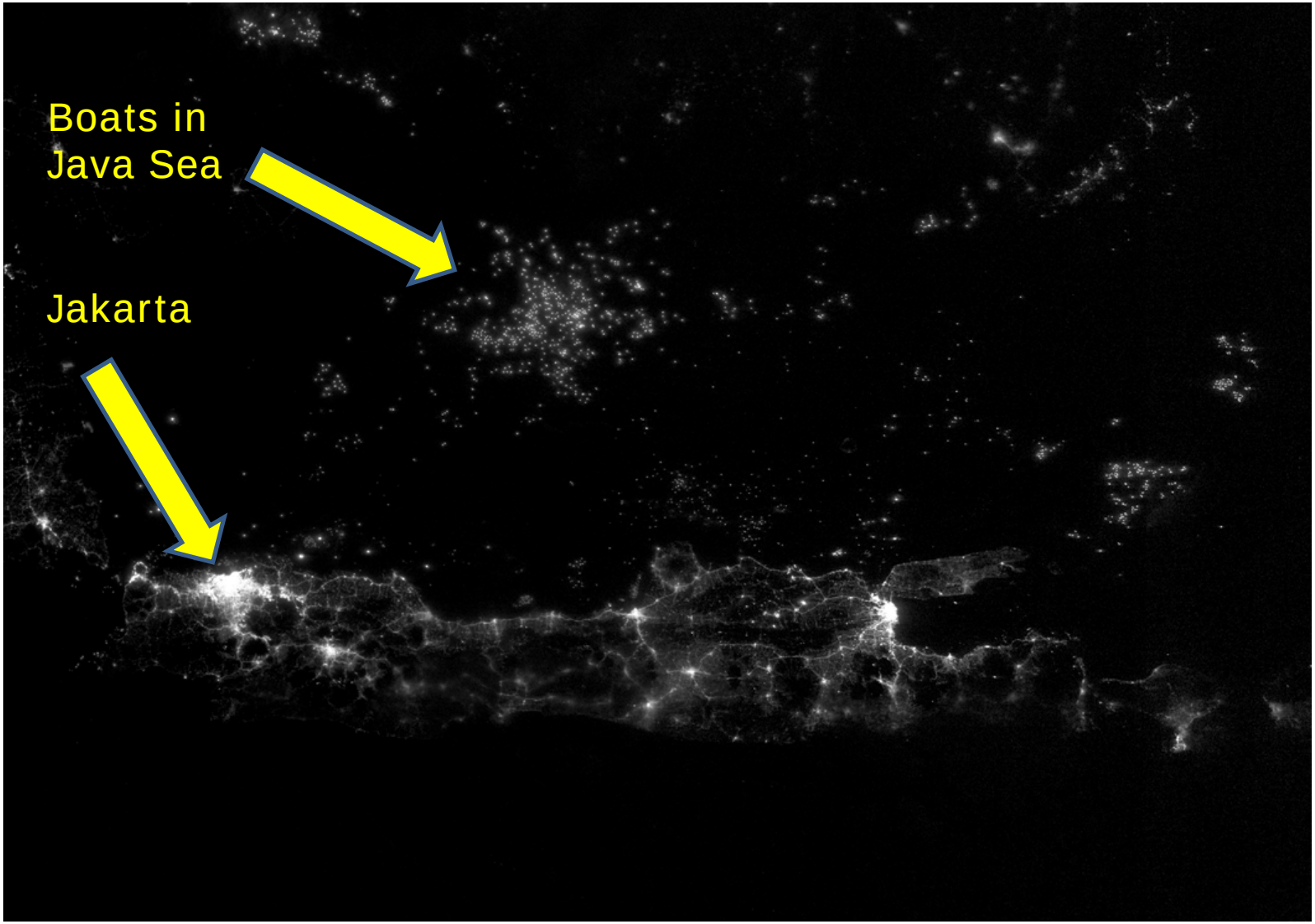


VIIRS low light imaging at night: DNB detects electric lighting, fires and flares. M7,8 & 10 detect combustion sources.

Three global product lines
https://ngdc.noaa.gov/eog/viirs/index.html

- **VIIRS boat detections (VBD):** Offshore detections of lights used by fishery agencies. Expanded to global in May, 2017. JPSS proving ground project (FY15-17). Four hour temporal latency. https://ngdc.noaa.gov/eog/viirs/download_boat.html
- **VIIRS nightfire (VNF):** Multispectral detections of fires, flares and other IR emitters. Used for annual surveys of gas flare locations and flared gas volumes. JPSS proving ground project (FY12-14). NASA carbon monitoring system (FY16-18). Four hour temporal latency. https://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
- **VIIRS nighttime lights (VNL):** Global annual average radiances filtered to remove sunlit, moonlit, and cloudy observations. Additional filtering to remove lightning, fires, aurora, and background noise. NASA VIIRS Science Team (FY15-17). Widely used in the sciences, social sciences, and development tracking communities. https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html

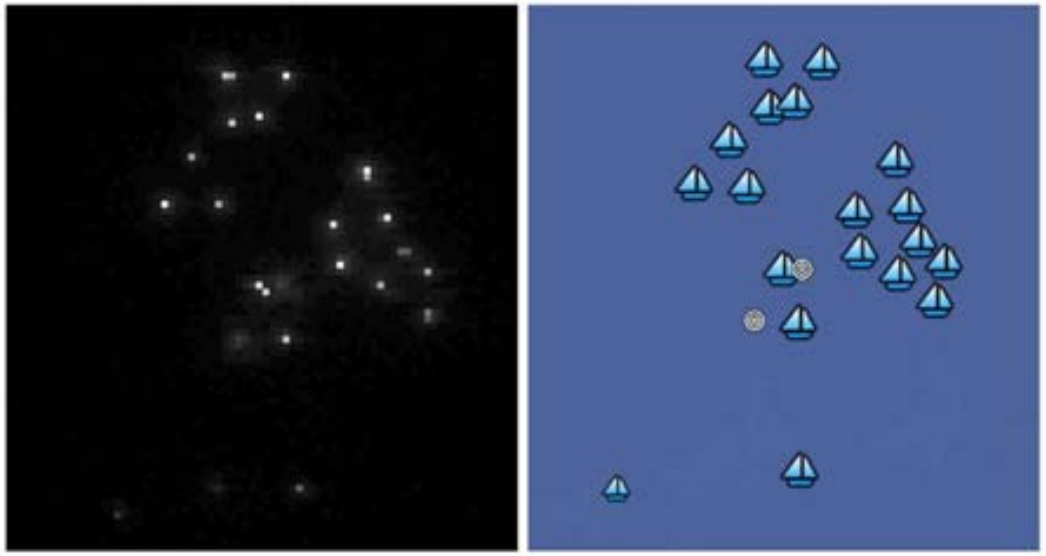
VIIRS boat detection (VBD)



Algorithms run on images, output points, vast data volume reduction

VIIRS day/night band (DNB) nighttime

Boat detection data (points)



Single Night of Detections (June 9, 2017)

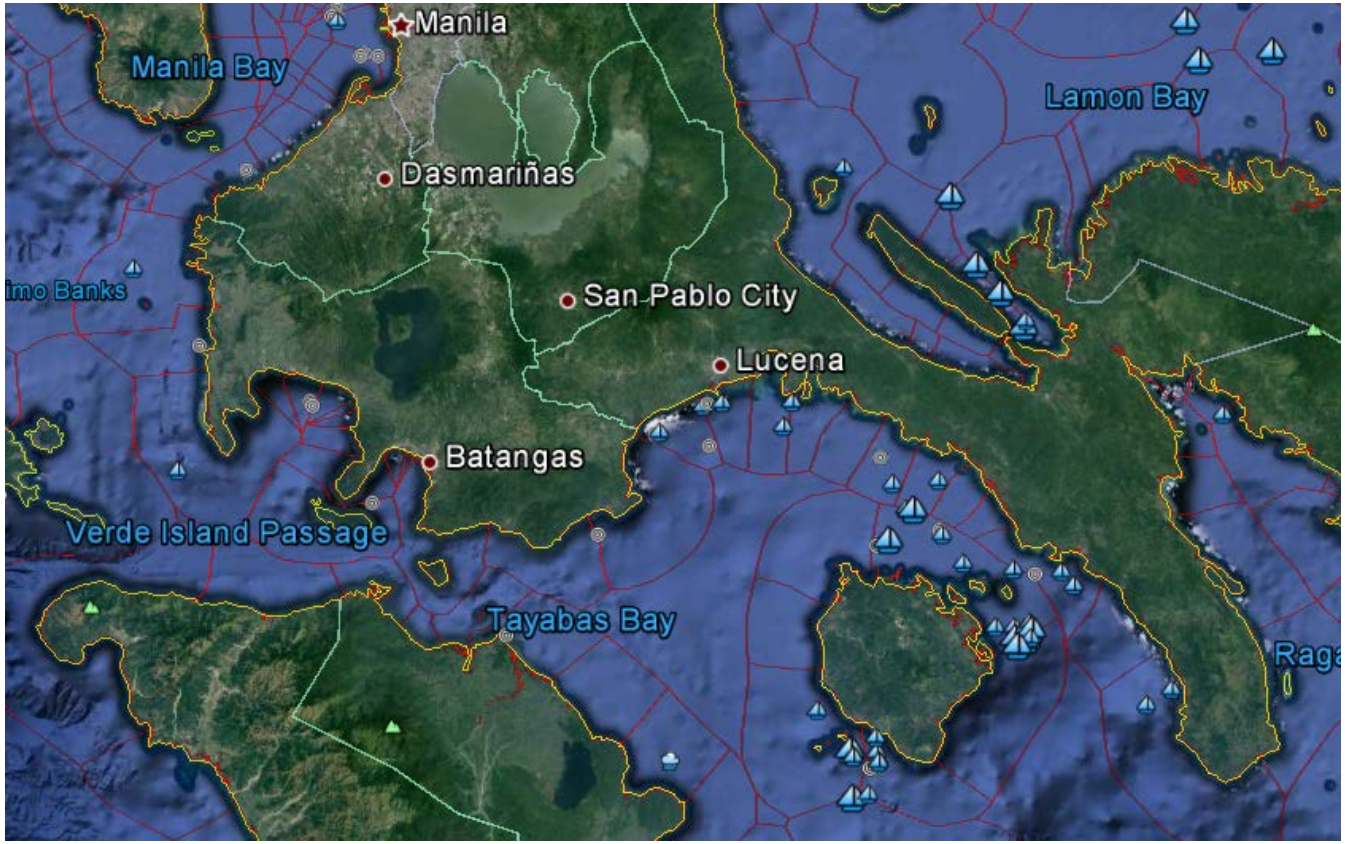
Standard is four hour temporal latency,
with files available at 06:00 local time

Placemarks sized based on radiance and have information panels

VIIRS Boat Detection (VBD)

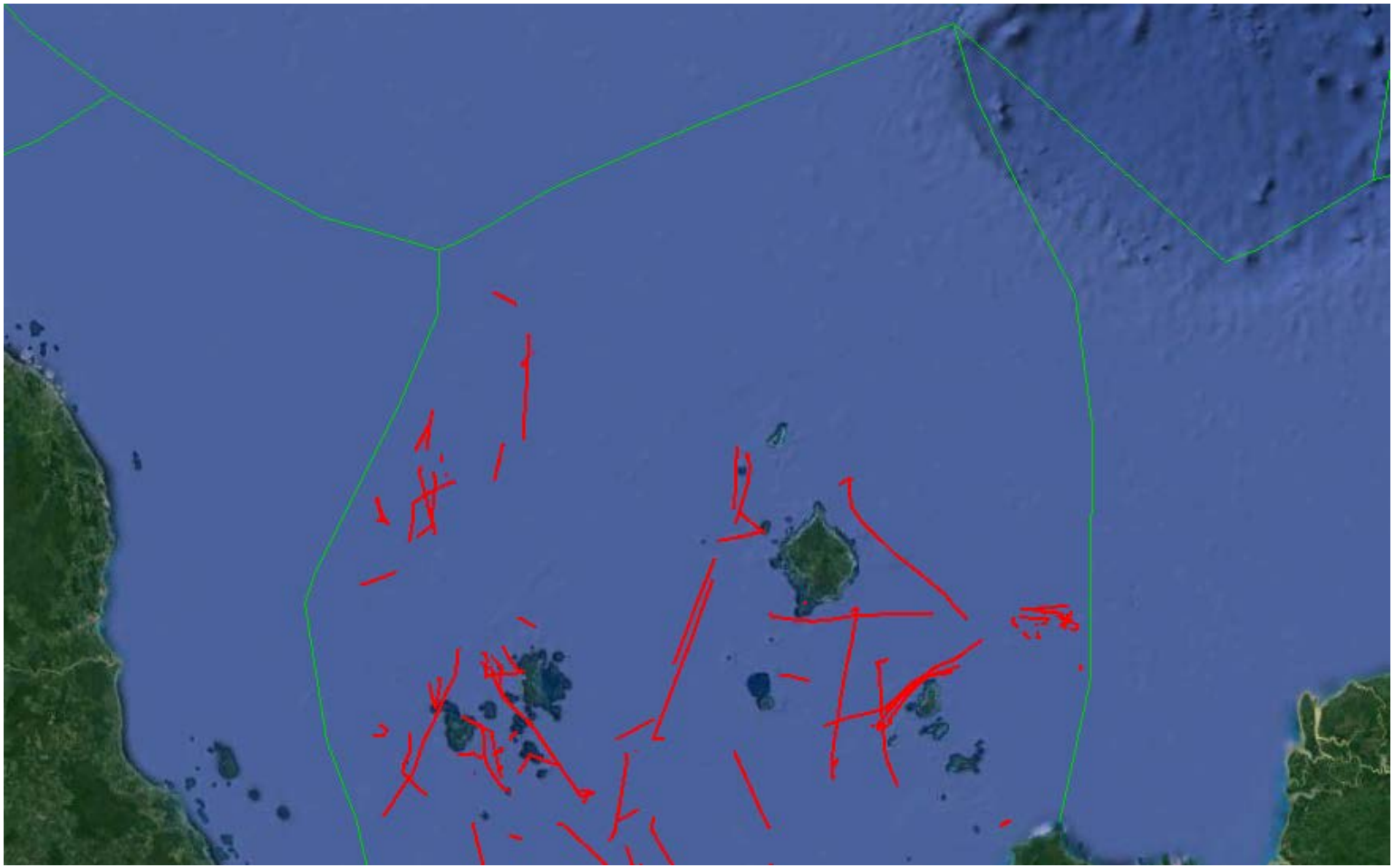
- Expanded from Asia-Pacific to global May, 2017.
- Temporal latency is ~4 hours, with last night's data files available at 06:00 local time.
- Files are available at: https://ngdc.noaa.gov/eog/viirs/download_boat.html
- Services running for 44 countries (in addition to global).
- Alerts running for MPAs, restricted coastal waters, and seasonal fishery closures in Indonesia and Philippines. BFAR region 5 (Philippines) reported 14 apprehensions in 2016 based on VBD alerts.
- Methods developed for identification of "dark" vessels that lack VMS (vessel monitoring system).

Detection of illegal fishing boats in restricted coastal waters

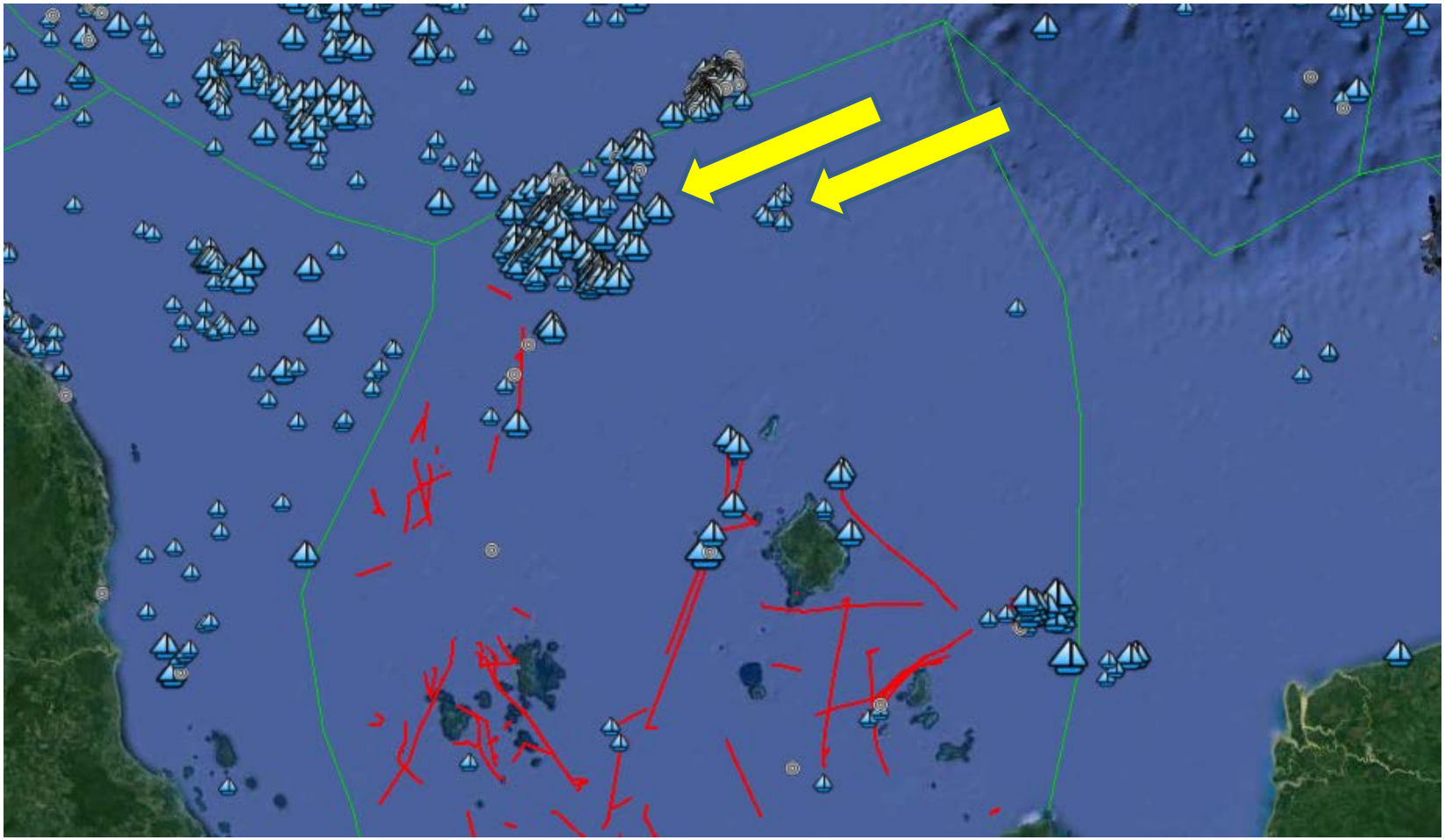


June 1, 2017 alert for municipal waters in the Philippines. Commercial fishing is banned in these coastal waters.

VMS Tracks in Natuna Sea
October 1, 2016



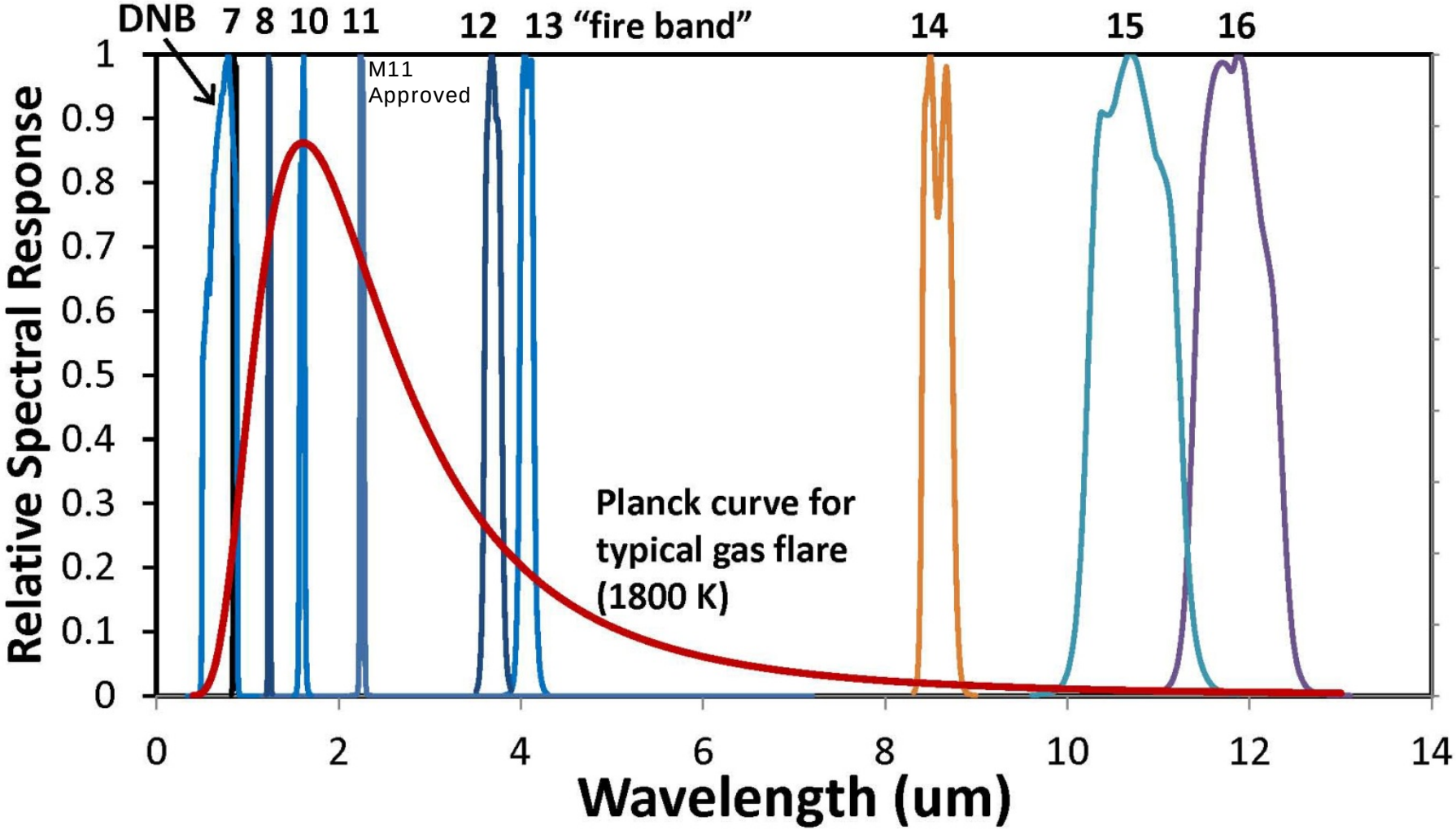
October 1, 2016 boats detected by VIIRS but lacking VMS are suspect



VIIRS Nightfire (VNF)

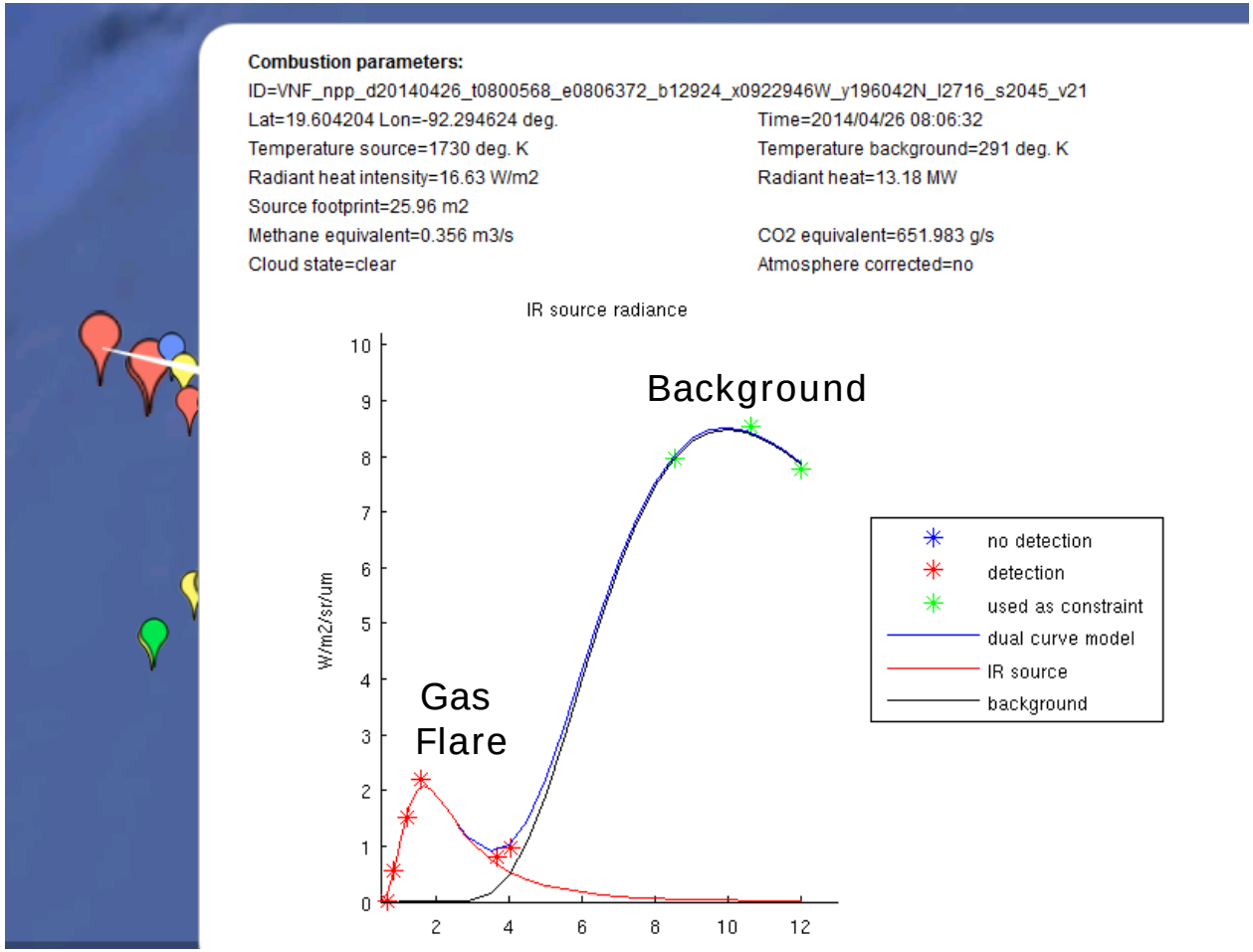
- A multispectral global fire product
- Makes use of near-infrared and shortwave infrared data.
- What is different from other global fire products?
  - Two independent hot source detection algorithms:
    - M10 in the shortwave infrared
    - M12-M13 in the midwave infrared
  - Dual Planck curve fitting (background and hot source) followed by calculations using physical laws
  - Temperature calculation based on Wien's Displacement Law
  - Source area estimation based on Planck's Law
  - Radiant heat (W/m2) calculated using the Stefan-Boltzmann Law
- Nightly global data are available at: http://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
- Global gas flaring data are available at: http://www.ngdc.noaa.gov/eog/viirs/download_global_flare.html

VIIRS Nightfire (VNF): A global multispectral fire product
Nine channels of data collected at night



Nighttime collection of channel 11 is expected to start in 2017

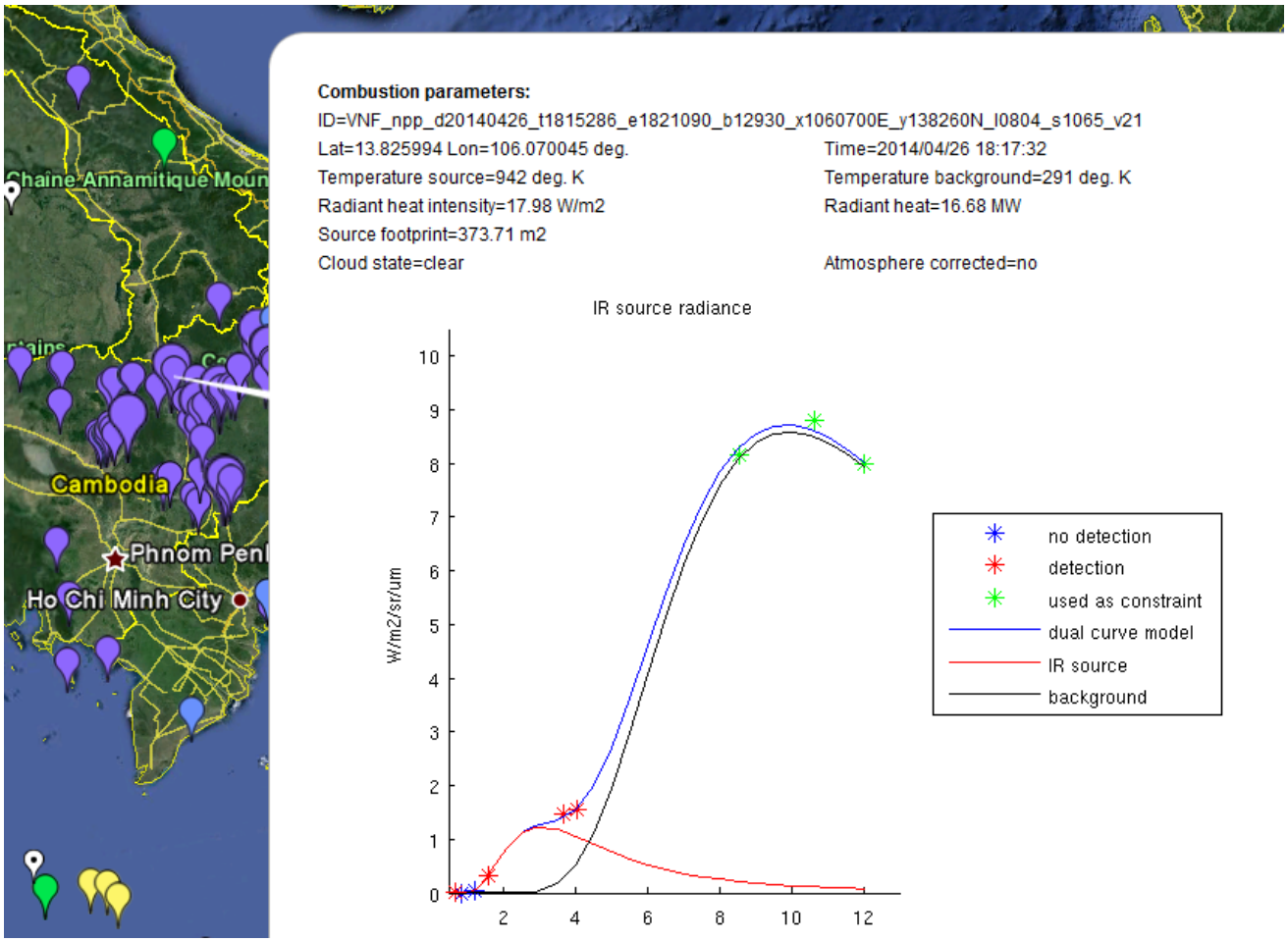
Why Multispectral?



To get at the Planck curves!

Daily files are in csv and kmz formats

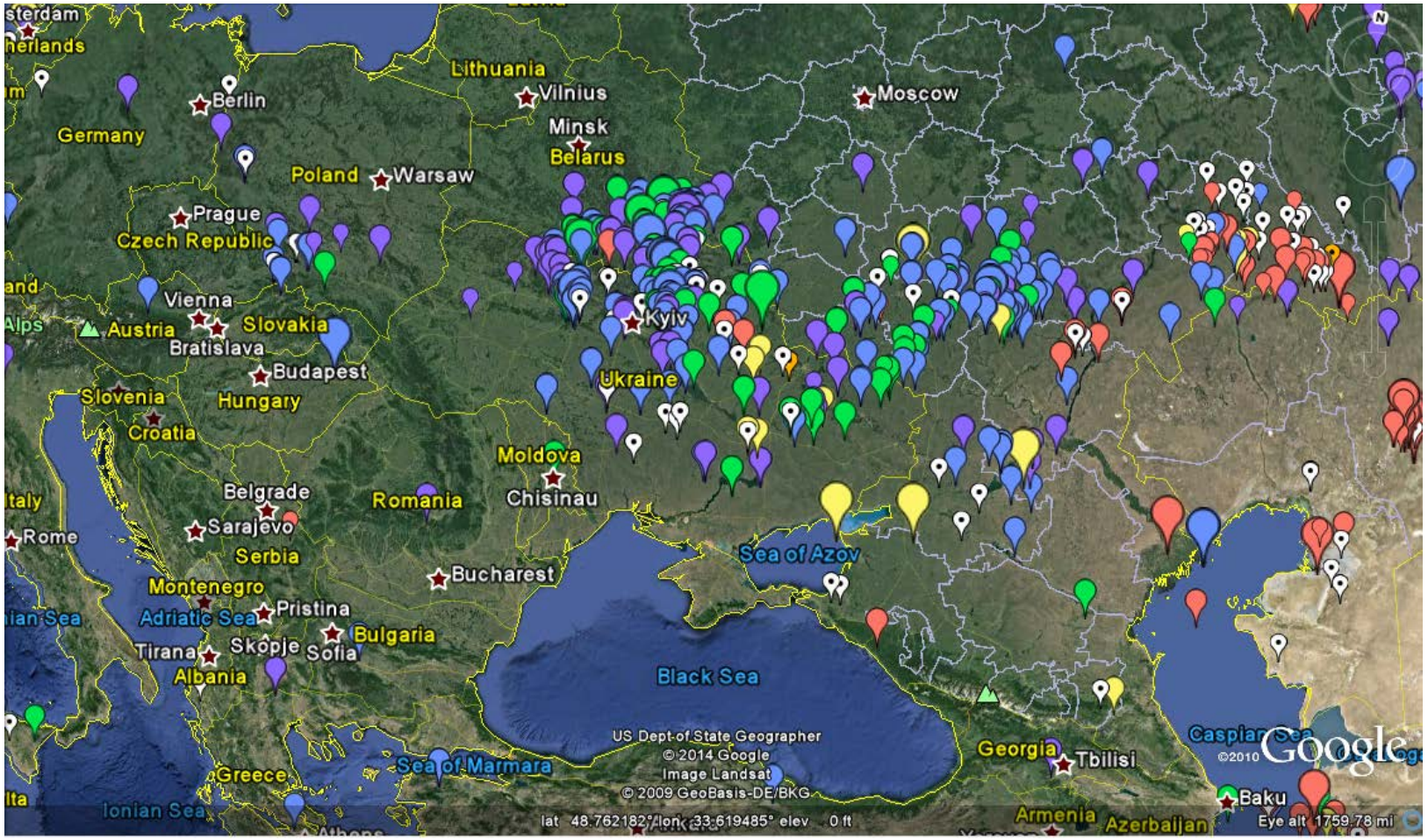
Typical Biomass Burning Detection



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

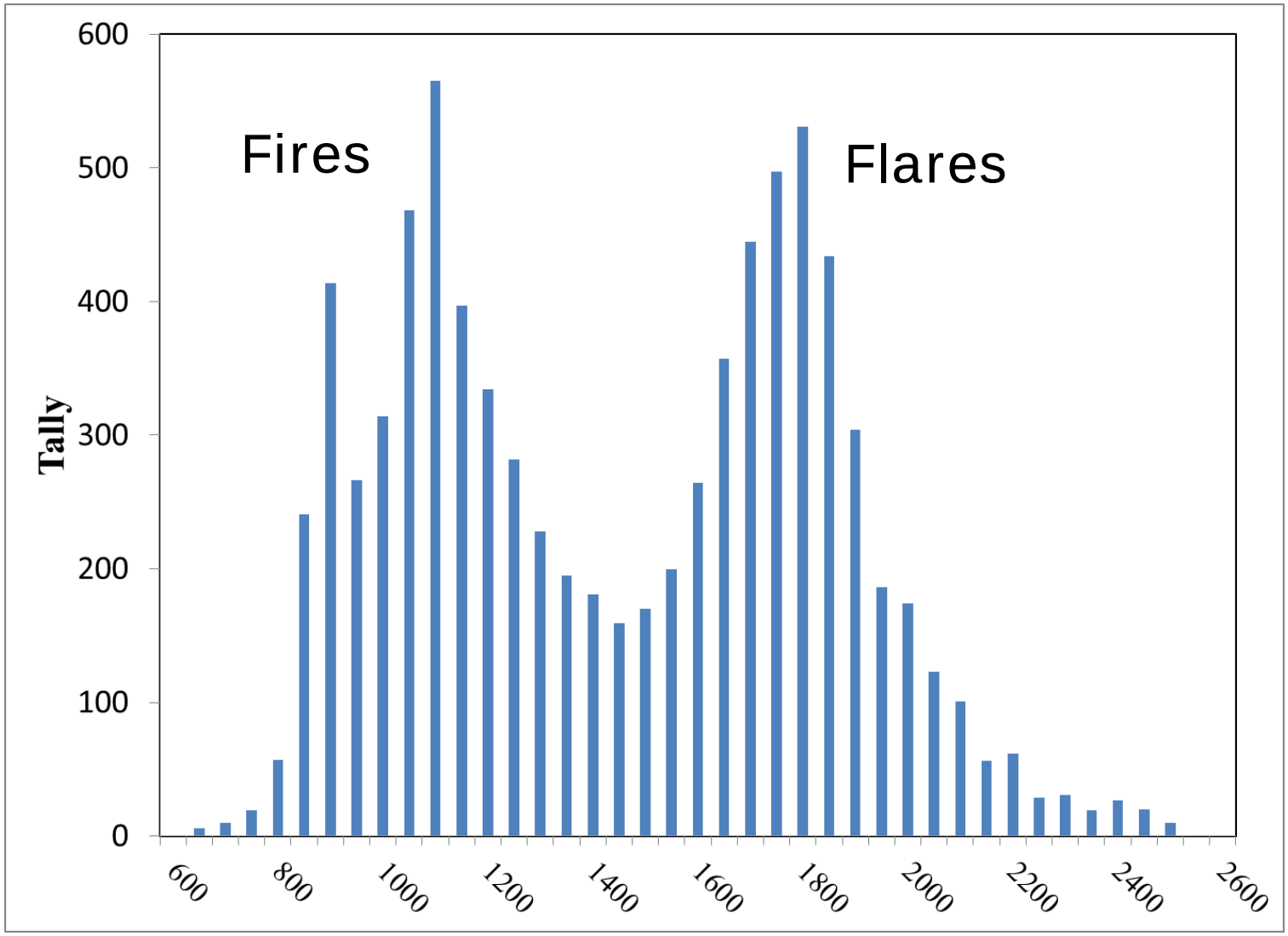
Daily VNF data are available at:

http://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html



Current processing typically runs with a four hour delay

Temperatures are bimodal



Gas Flaring

- A widely used practice to dispose of natural gas that cannot be utilized or brought to market due to lack of infrastructure.
- VNF is ideally suited for detecting and estimating flare volumes because the M10 band covers the peak radiant emissions for flares.
- Using VNF data we have identified 18,129 flares from 2012-2015.
- Russia has the largest flare volume.
- USA has the largest number of flares.
- VIIRS data can be used for Monitoring, Reporting, and Verification (MRV) of gas flaring reductions:
  - Greenhouse gas emission reduction commitments under the Paris Climate Agreement
  - UN & Worldbank “Zero routine flaring by 2030” inititative.

UN Initiative to end routine flaring by 2030

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Zero Routine Flaring by 2030

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The Zero Routine Flaring Initiative

May 22, 2015 — The initiative was launched by UNSG Ban Ki-moon and WBG President Jim Yong Kim with governments, oil
Read More »

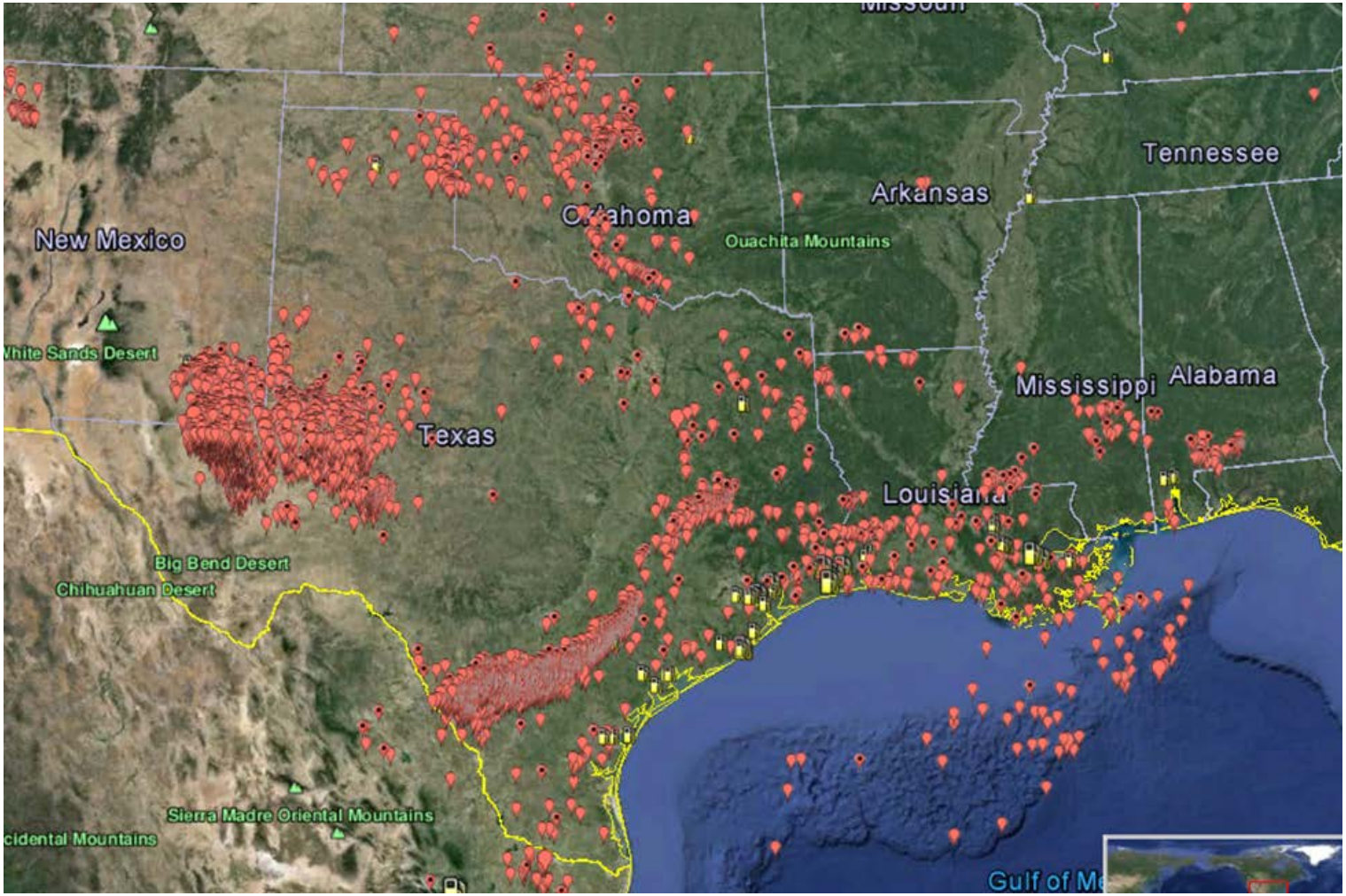
Initiative | Q&A | Quick Facts | Endorsers | Get Involved | Related Information | Flaring in the News

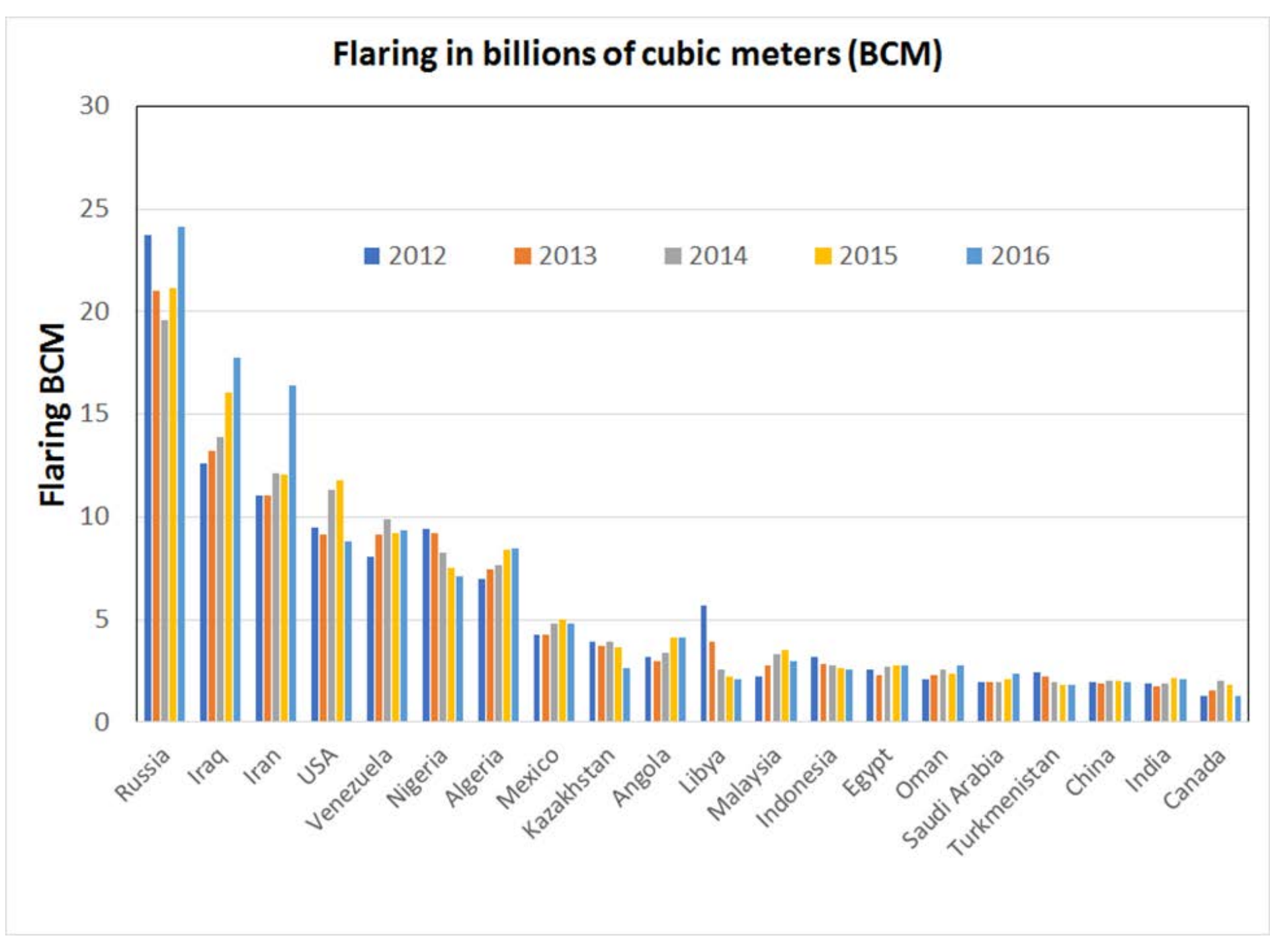
During oil production, associated gas is produced from the reservoir together with the oil.

How will progress be tracked? VIIRS!

Annual summaries of gas flare locations and gas flare volume estimates are available at:

https://ngdc.noaa.gov/eog/viirs/download_global_flare.html



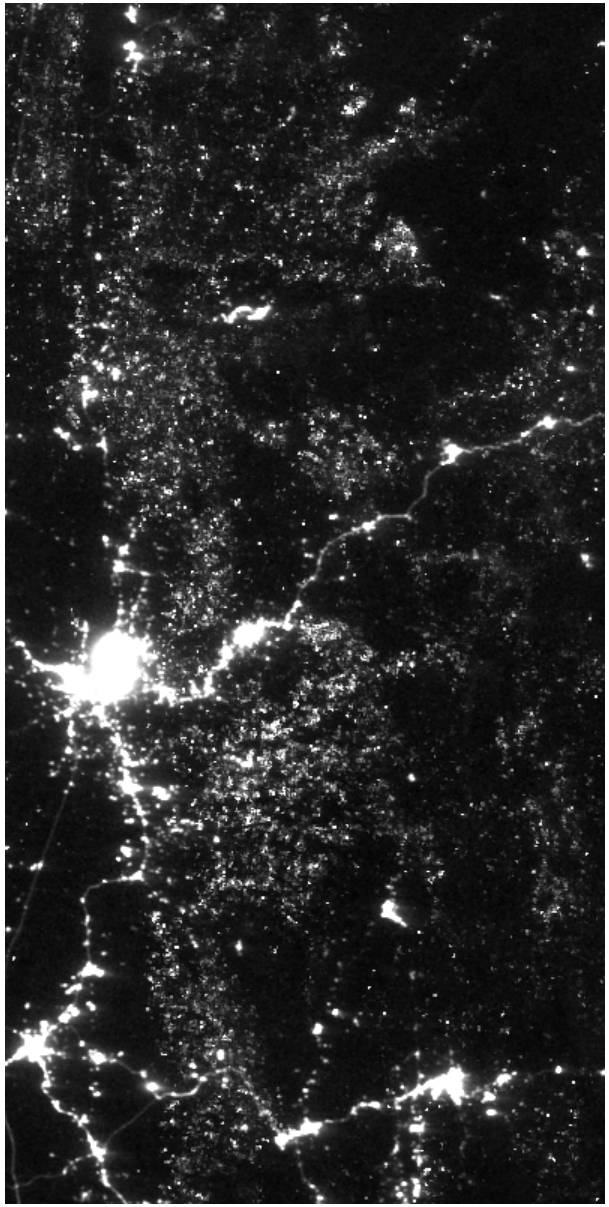

Flaring in billions of cubic meters (BCM)
Flaring BCM
30
25
20
15
10
5
0
2012
2013
2014
2015
2016
Russia
Iraq
Iran
USA
Venezuela
Nigeria
Algeria
Mexico
Kazakhstan
Angola
Libya
Malaysia
Indonesia
Egypt
Oman
Saudi Arabia
Turkmenistan
China
India
Canada

VIIRS Nighttime Lights (VNL)

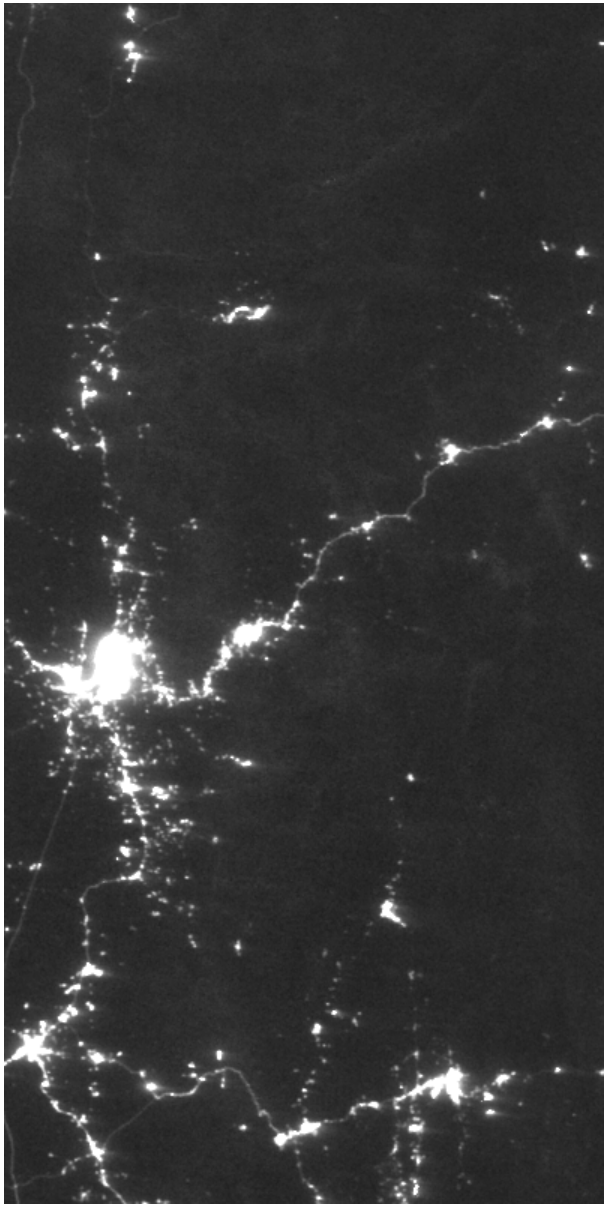
- Raw cloud-free composite: Average DNB radiance filtered to remove sunlit, moonlit, cloudy, and lightning.
- Outlier removal to filter out the biomass burning and most of the aurora contamination.
- VIIRS nighttime lights: Filtered to remove background noise and manual editing to removed remaining aurora features.

VIIRS Nighttime Lights (VNL)

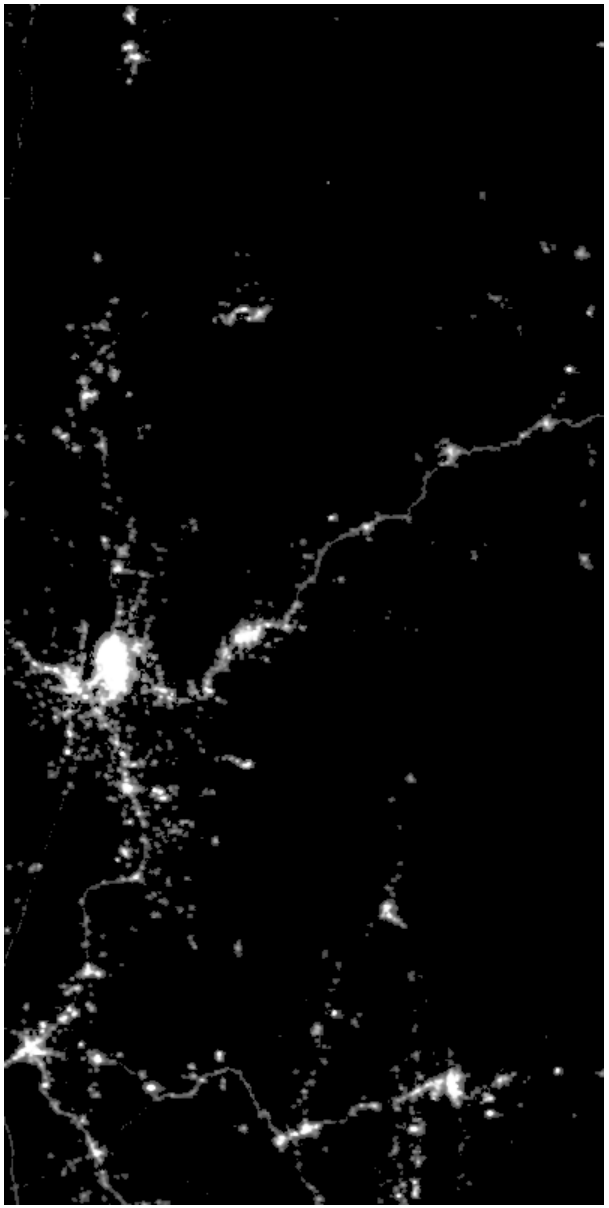
Raw cloud-free composite

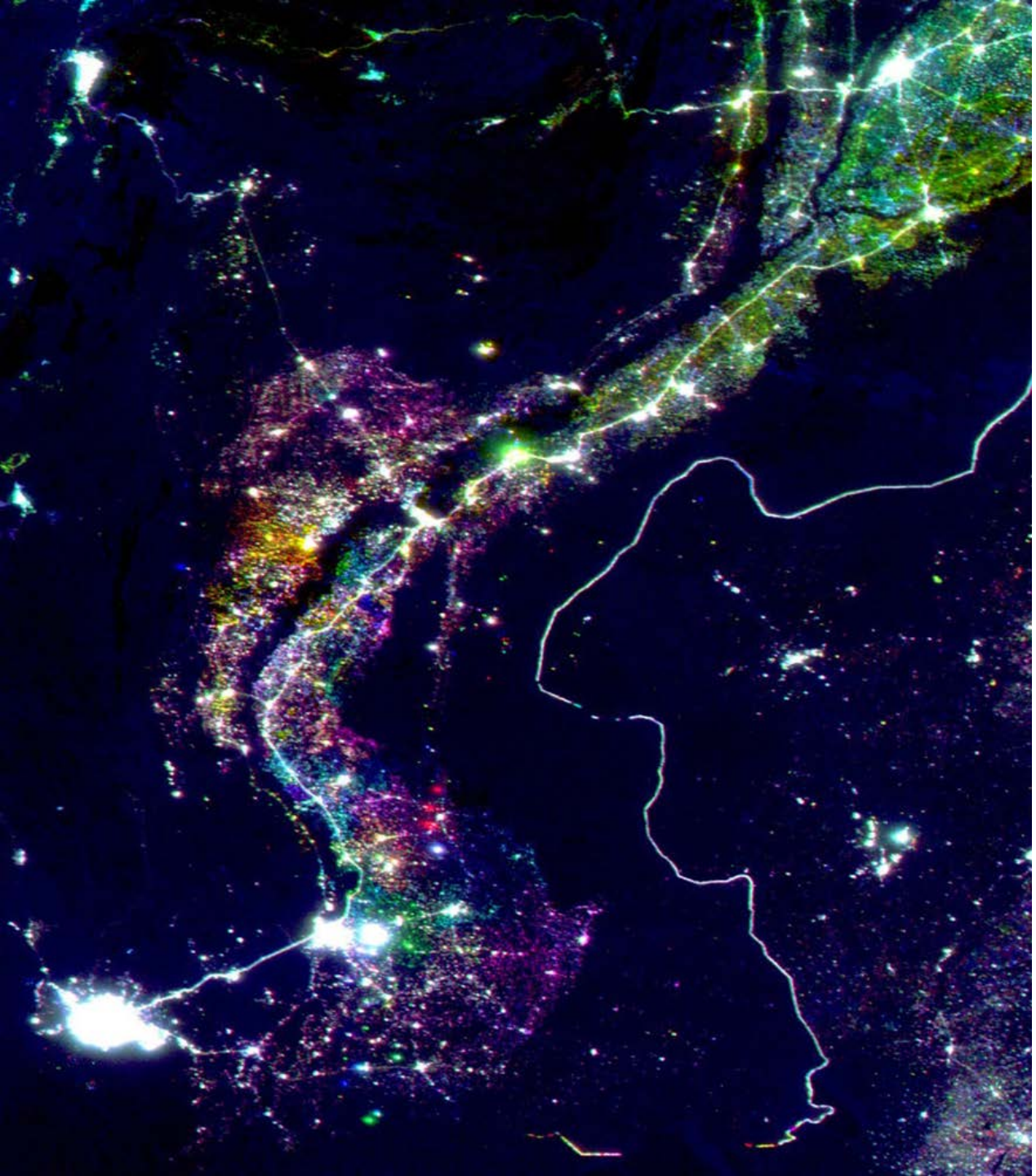


Outlier removed



Nighttime lights





Power grid behaviors uncovered by VIIRS in Pakistan. Three months as RGB (Jan. 2013 red, Oct. 2012 green, April 2012 blue).

Summary: Three global products

- VBD: Nightly VIIRS boat detection (VBD) data produced with 4 hour latency. Alerts for closures and protected areas. ID of boats lacking tracking records from VMS or AIS. Monthly and annual summary grids. Data access:
  - https://ngdc.noaa.gov/eog/viirs/download_boat.html
- VIIRS nightfire.
  - Nightly data: https://ngdc.noaa.gov/eog/viirs/download_viirs_fire.html
  - Annual gas flaring data: https://ngdc.noaa.gov/eog/viirs/download_global_flare.html
- VIIRS nighttime lights – monthly and annual cloud-free composites.
  - https://ngdc.noaa.gov/eog/viirs/download_dnb_composites.html

Publications

- 2017: VIIRS nighttime lights:. IJRS doi:10.1080/01431161.2017.1342050
- 2017: Potential Role of Gas Flaring Reductions in Meeting Paris Climate Agreement Targets. Submitted to Energy Strategy Reviews, May 2017.
- 2016: Methods for Global Survey of Natural Gas Flaring from Visible Infrared Imaging Radiometer Suite Data Energies doi:10.3390/en9010014
- 2015: Automatic Boat Identification System for VIIRS Low Light Imaging Data . Remote Sensing doi:10.3390/rs70303020
- 2013: VIIRS Nightfire: Satellite pyrometry at night . Remote Sensing doi:10.3390/rs5094423
- 2013: What is so great about nighttime VIIRS data for the detection and characterization of combustion sources? doi: 10.7125/APAN.35.5
- 2013: Using the short-wave infrared used for nocturnal detection of combustion sources in VIIRS data. doi: 0.7125/APAN.35.6
- 2013: Why VIIRS data are superior to DMSP for mapping nighttime lights. doi:10.7125/APAN.35.7
- 2013: Nighttime lights compositing using the VIIRS day-night band: Preliminary results . doi: 0.7125/APAN.35.8
- 2013: Steve Miller's Illuminating the capabilities of the Suomi NPP VIIRS Day/Night Band. doi: 0.3390/rs5126717