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Global Gas Flare Survey by Infrared Imaging, VIIRS Nightfire, 2012-2019

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Dataset Version: 1

Summary

This dataset contains annual global flare site surveys from 2012-2019 derived from Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar Partnership (SNPP) satellite. Gas flaring sites were identified from heat anomalies first estimated by the VIIRS Nightfire (VNF) algorithm from which high-temperature biomass burning and low-temperature gas flaring were separated based on temperature and persistence. Nightly observations for each flare site were drawn to determine their activity in the given calendar year. Data include flare location, temperature, and estimated flared gas volume; flaring data summarized by country; and KMZ files for viewing flaring locations in Google Earth. This dataset is valuable for measuring the current status of global gas flaring, which can have significant environmental impacts.

There are 24 data files included in this dataset; 16 files in comma-separated values (*.csv) format and 8 files in compressed Keyhole Markup Language (*.kmz) format.

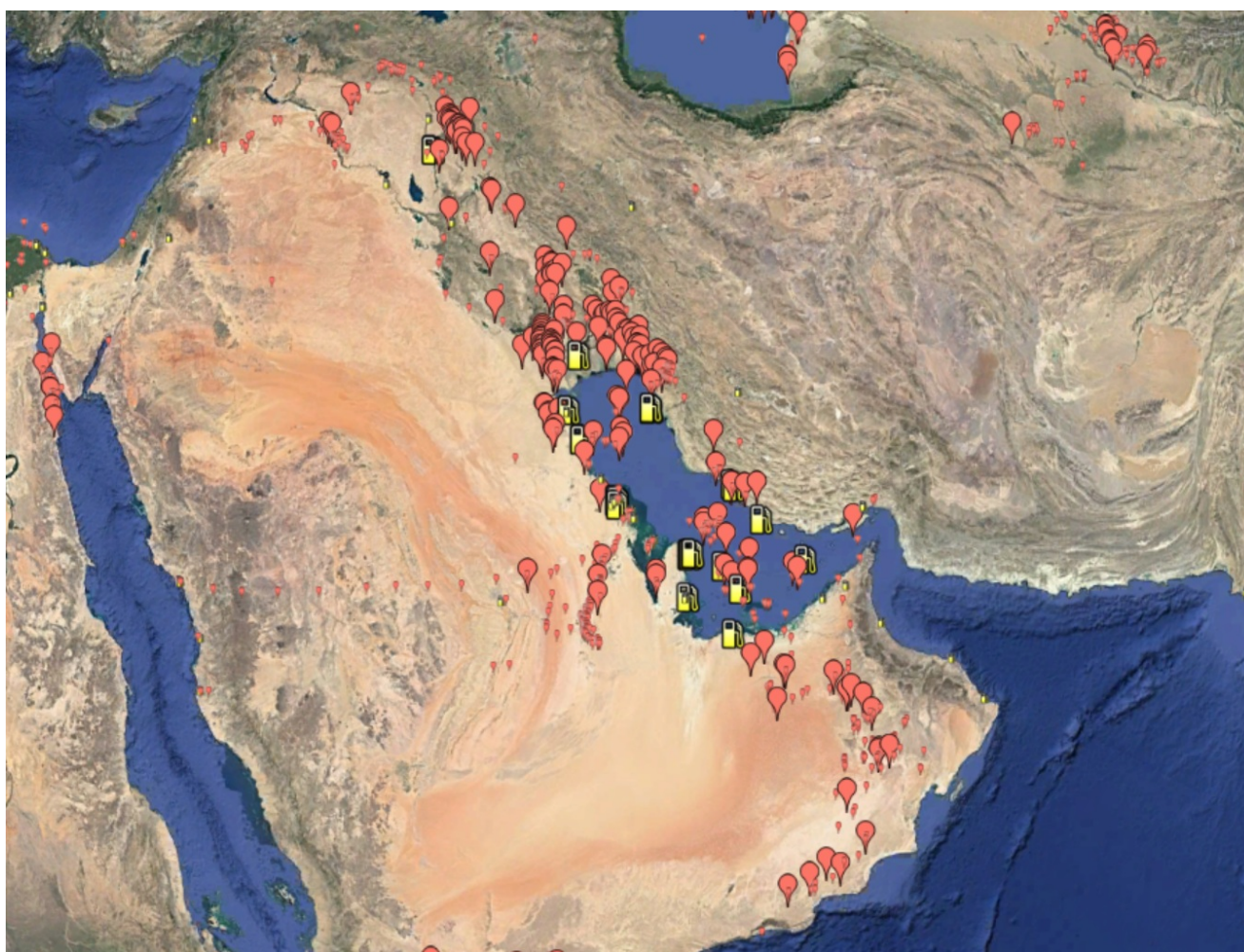


Figure 1. Representation of gas flares recorded over the Persian Gulf in 2019 by Earth Observation Group's Global Gas Flare Survey. Source: Authors

Citation

Elvidge, C.D., and M. Zhizhin. 2021. Global Gas Flare Survey by Infrared Imaging, VIIRS Nightfire, 2012-2019. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1874>

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1. Dataset Overview

This dataset contains annual global flare site surveys from 2012–2019 derived from Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar Partnership (SNPP) satellite. Gas flaring sites were identified from heat anomalies first estimated by the VIIRS Nightfire (VNF) algorithm from which high-temperature biomass burning and low-temperature gas flaring were separated based on temperature and persistence. Nightly observations for each flare site were drawn to determine their activity in the given calendar year. Data include flare location, temperature, and estimated flared gas volume; flaring data summarized by country; and KMZ files for viewing flaring locations in Google Earth. This dataset is valuable for measuring the current status of global gas flaring, which can have significant environmental impacts.

Project: [Carbon Monitoring System](#)

The NASA Carbon Monitoring System (CMS) is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System will use the full range of NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS will maintain a global emphasis while providing finer scale regional information, utilizing space-based and surface-based data and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

Related Publications

Elvidge, C.D., M. Zhizhin, K. Baugh, F-C. Hsu, and T. Ghosh. 2016. Methods for global survey of natural gas flaring from visible infrared imaging radiometer suite data. *Energies* 9:14. <https://doi.org/10.3390/en9010014>

Elvidge, C.D., M. Zhizhin, F-E. Hsu, and K. Baugh. 2013. VIIRS nightfire: Satellite pyrometry at night. *Remote Sensing* 5:4423-4449. <https://doi.org/10.3390/rs5094423>

Acknowledgments

This dataset was supported by funding from NASA's Carbon Monitoring System (grant NNH16AD04I).

2. Data Characteristics

Spatial Coverage: Global

Spatial Resolution: Point locations

Temporal Coverage: 2012-04-01 to 2019-12-31

Temporal Resolution: Annual

Data File Information

There are 24 data files included in this dataset; 16 files in in comma-separated values (*.csv) format and 8 files in compressed Keyhole Markup Language (*.kmz) format. The files are named eog_global_flare_survey_<year>_<type>.<ext> (e.g., eog_global_flare_survey_2012_flare_list.csv), where

- <year> is the four-digit year of data collection (2012–2019),
- <type> is the type of data ("country_summary" or "flare_list"), and
- <ext> is the file extension ("csv" or "kmz").

Table 1. File names and descriptions.

File Name	Number of Files	Description
eog_global_flare_survey_<year>_country_summary.csv	8	Country-wide summary of the flare survey
eog_global_flare_survey_<year>_flare_list.csv	8	Annual global gas flare survey
eog_global_flare_survey_<year>_flare_list.kmz	8	Annual global gas flare survey locations for viewing in Google Earth.

Data File Details

For each file,

- Coordinates are in longitude-latitude, "WGS 84" (EPSG:4326).
- Missing values are coded as -9999.

Table 2. Variable names and descriptions for files named eog_global_flare_survey_<year>_country_summary.csv.

Variable	Description
cntry_name	Country name
cntry_iso	Country ISO-3166 Alpha3 code
bcm_sum_up	Sum of annual flared volume for upstream gas flares in billion of cubic meters (BCM)
flr_cnt_up	Count of upstream gas flares
bcm_sum_dn	Sum of annual flared volume for downstream gas flares in BCM

flr_cnt_dn	Count of downstream gas flares
bcm_sum_al	Sum of annual flared volume for all gas flare in BCM
flr_cnt_al	Count of all gas flares

Table 3. Variable names and descriptions for files named eog_global_flare_survey_<year>_flare_list.csv.

Variable	Description
cntry_name	Country name
cntry_iso	Country ISO-3166 Alpha3 code
catalog_id	Catalogue ID for the flare site
id_number	ID number for the flare site
latitude	Latitude for the flare site (decimal degrees)
longitude	Longitude for the flare site (decimal degrees)
flr_volume	Annual flared volume for the flare site in billions on cubic meters (BCM)
avg_temp	Average flare temperature for the flare site in Kelvin (K)
ellip	Ellipsoid geometry correction factor for the flare site
dtc_freq	Detection frequency for the flare site
clr_obs	Number of clear (cloud-free) observations for the flare site
flr_type	Type designation for the flare site

3. Application and Derivation

This dataset is valuable for measuring the current status of global gas flaring. It avoids potential biases present in other similar datasets, which are often produced or funded by entities with ties to industry members. This dataset was produced by unbiased reporting entity of Earth Observation Group (EGO) under the Payne Institute for Public Policy in the Colorado School of Mines.

4. Quality Assessment

The data for 2012–2016 were combined, hence the resolved flare locations do not change over these years. The years 2017–2019 are processed separately; therefore, the resolved flare locations change between years based on the observations collected during each calendar year. Thus, the catalog ID is commutable from 2012–2016, but not from 2017–2019. The accuracy of the flared gas volume estimates is rated at $\pm 9.5\%$ (Elvidge et al., 2016).

5. Data Acquisition, Materials, and Methods

These data were derived using data from Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar Partnership (SNPP) satellite. VIIRS is operated in an unusual way that offers a substantial advantage for the observation of gas flaring. At night, the VIIRS continues to record data in three near- to short-wave infrared channels designed for daytime imaging. At night, the only features detected in these channels are combustion sources. These data from gas flaring sites were identified from a year's worth of heat anomalies observed by VIIRS Nightfire product.

The VIIRS Nightfire (VNF) algorithm (Elvidge et al., 2013) was applied to all of the usable nighttime VIIRS data to convert radiance observations to temperature. Gas flaring sites could not be determined solely on temperature due to the overlap between high-temperature biomass burning and low-temperature gas flaring. To separate gas flares from fires, both temperature and persistence were used. The vast majority of biomass burning events could be filtered out by excluding single and double detections. Manual editing was used to mask out the few remaining biomass burning events. The remaining events were sorted based on temperature. Those $>1,400$ K were classified as gas flares and those $\leq 1,400$ K were classified as industrial sites. Flaring measurements were then corrected for view angle differences. Gas flaring volumes were derived from radiant heat and calculated from temperature and source size using the Stefan-Boltzmann Law.

Detailed methodology can be found in Elvidge et al. (2016).

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

[Global Gas Flare Survey by Infrared Imaging, VIIRS Nightfire, 2012-2019](#)

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

- Berk, A., G.P. Anderson, P.K. Acharya, and E.P. Shettle. MODTRAN 5.2.1 User's Manual; Spectral Sciences Inc: Burlington, MA, USA; Air Force Research Laboratory: Hanscom Air Force Base, MA, USA, 2011. <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.458.1743&rep=rep1&type=pdf>
- Elvidge, C.D., M. Zhizhin, K. Baugh, F-C. Hsu, and T. Ghosh. 2016. Methods for global survey of natural gas flaring from visible infrared imaging radiometer suite data. *Energies* 9:14. <https://doi.org/10.3390/en9010014>
- Elvidge, C.D., M. Zhizhin, F-E. Hsu, and K. Baugh. 2013. VIIRS nightfire: Satellite pyrometry at night. *Remote Sensing* 5:4423-4449. <https://doi.org/10.3390/rs5094423>

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