MONITORING FIRES, FLARES AND FISHING BOATS IN S.E. ASIA USING NOCTURNAL VIIRS DATA

Christopher D. Elvidge

Earth Observation Group, National Geophysical Data Center, National Oceanic and Atmospheric Administration
325 Broadway, Boulder, Colorado 80305 USA
Tel: +1-303-497-6121; Fax. +1-303-497-6152
E-mail: chris.elvidge@noaa.gov

Kimberly Baugh, Mikhail Zhizhin, Feng-Chi Hsu

Cooperative Institute for Research in Environmental Science, University of Colorado, Boulder, Colorado 80303
kim.baugh@noaa.gov, Mikhail.zhizhin@noaa.gov,feng.c.hsu@noaa.gov

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Abstract: When compared to DMSP-OLS data, the VIIRS instrument provides substantial spatial resolution and an expanded set of spectral bands for the detection of combustion sources and heavily lit fishing boats. This paper presents a comparison of lit fishing boat detections for the two sensors and a sample of nighttime fire detection from VIIRS data using near-infrared and short-wave infrared spectral bands.

INTRODUCTION

In the 1970's the U.S. Air Force Defense Meteorological Satellite Program (DMSP) began flying low-light imaging Operational Linescan System (OLS) sensors designed to detect moonlit clouds. The OLS used photomultiplier tube to achieve a million-fold signal amplification in a panchromatic spectral band straddling the visible and near-infrared. The extreme light intensification made it possible to detect gas flares, biomass burning and lit fishing boats at night (Croft, 1973 and 1978). However, practical use of the observations outside of the U.S. military was negligible as the data were written to film and there was no distribution system. In 1992 a digital archive for the data was established at the NOAA National Geophysical Data Center (NGDC) and beginning in year 2000 NGDC began near-real time subscription services to government agencies engaged in managing fisheries and fires. In 2005 NGDC developed a method for estimating flared gas volumes from DMSP nighttime lights data (Elvidge et al., 2009).

For many years DMSP was the only source of global low light imaging data. While DMSP nighttime lights data had a number of significant shortcomings, there were no reasonable alternative products for the global mapping of lighting associated with cities and towns, gas flares and lit fishing boats. This situation changed in 2011with the launch of the Visible Infrared Imaging Radiometer Suite (VIIRS) on the NASA/NOAA Suomi NPP satellite. VIIRS offers substantial improvements over the DMSP in terms of spatial resolution, quantization, and calibration.

In this paper we compare VIIRS and OLS image data of lit fishing boats in S.E. Asia from a single night. In addition, we present results from a nocturnal combustion source detection system that relies on near-infrared and short-wave infrared spectral bands designed for daytime imaging that continue to collect data at night.

DETECTION OF LIT FISHING BOATS

In examining VIIRS DNB data of the Thailand region we identified a March 22, 2012 image with exceptionally clear and numerous boat detections. This image was geolocated into a 20 arc second grid (Figure 1). The OLS visible band image from the same date was geolocated into the same grid. Side-by-side comparison reveals that where the VIIRS detected a large number of single pixel light detections in the Gulf or Thailand and South China Sea (Figure 2). These single pixel light detections are suggestive of individual light boats arrayed so as to not interfere with each other's operations. The OLS visible band detects a diffused area of lighting in the places where VIIRS had detected clusters of single pixel lights (Figure 2).

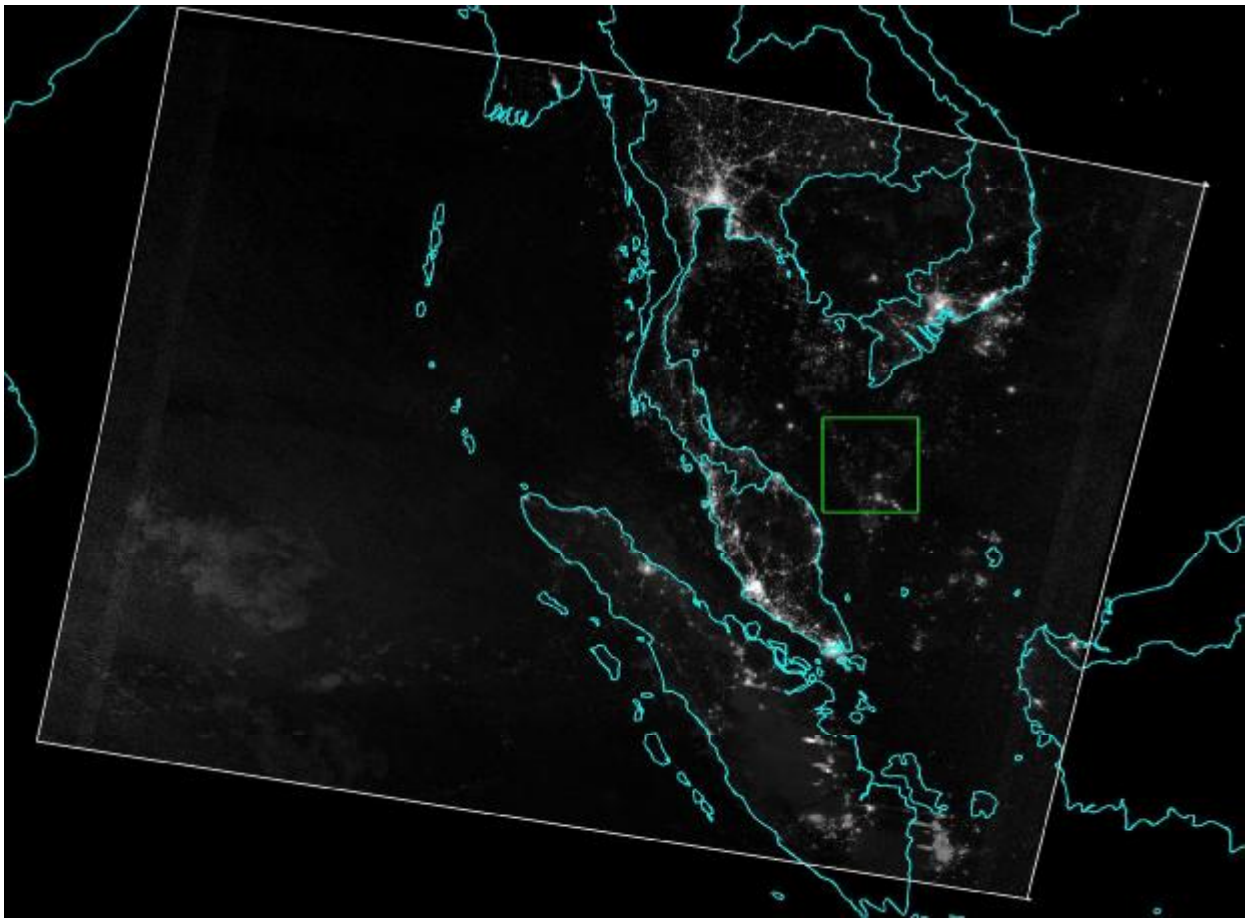

Figure 1: VIIRS day/night band (DNB) image acquired March 22, 2012.

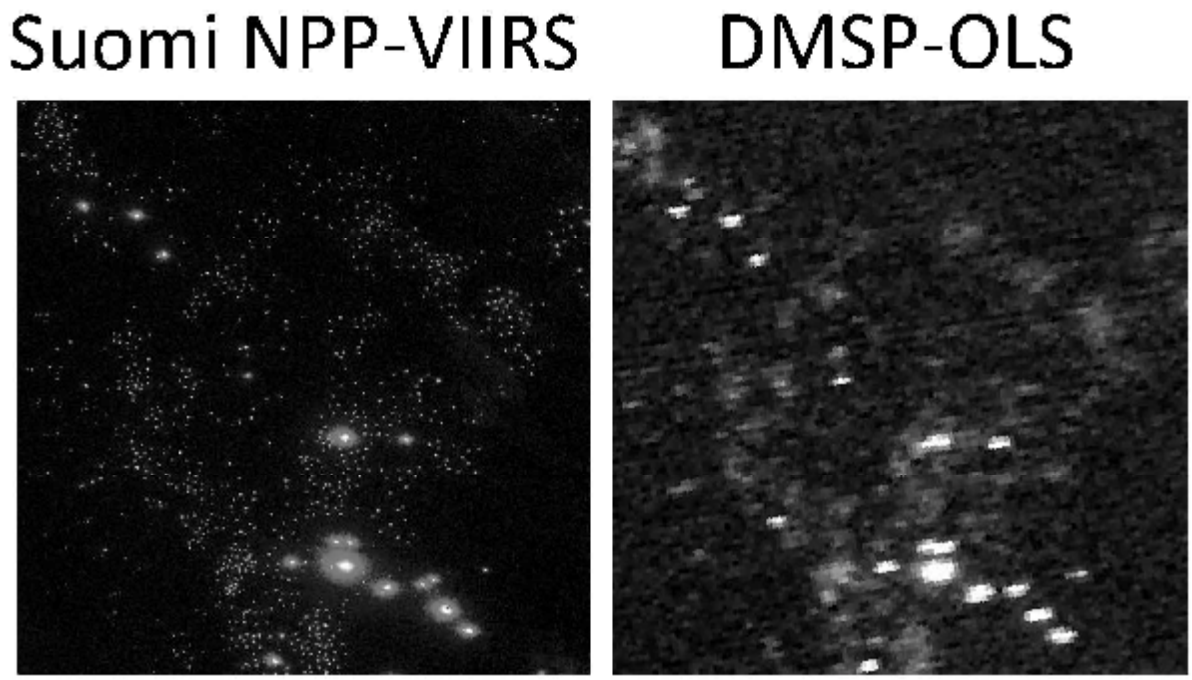

Figure 2: Full resolution VIIRS versus DMSP low light imaging data collected over the South China Sea / Gulf of Thailand on March 22, 2012.

DETECTION AND CHARACTERIZATION OF COMBUSTION SOURCES AT NIGHT

VIIRS is unique in recording near-infrared and short-wave infrared data at night. This includes the M7, M8, and M10 spectral bands. These spectral bands are designed for daytime imaging. A decision was made to collect data at night for use in detecting and characterizing combustion sources. With sunlight eliminated, combustion sources are readily detected, particularly in the M10 band. The recorded signal can be fully attributed to the combustion source. In our analysis we use data from all of the VIIRS bands collecting data at night. The M10 band data are used to detect combustion sources. To eliminate noise, confirmation is sought in the Day/Night Band (DNB), M7, M8 and M12. Plank curve fitting is performed to estimate the temperature of background and heat source. Results are distributed in form of CSV files and KMZ files. The KMZ has data from the local maxima detected in the M10 band. Filtering is used to eliminate the bow tie effects from the identification of local maxima. The CSV has data from all of the pixels with radiances above background noise in the M10 band. Atmospheric correction is performed with MODTRAN parameterized with temperature and moisture profiles processed from the simultaneously acquired CrIS and ATMS sensors. Figure 3 shows an example of the kmz data for S.E. Asia from September 23, 2012. The placemarks are color coded with red being the hottest and purple being the coolest. There are three size categories for the placemarks, indicating three ranges in total radiant output. Note that gas flares are detected offshore from Malaysia while biomass burning is detected on Borneo. In general gas flares are burning hotter than biomass burning. Figure 4 is a chart showing the original radiances, atmospherically corrected radiances, blackbody curves, and estimated temperature and total radiant output for a gas flare detection. The processing runs daily with products available at:
http://www.ngdc.noaa.gov/dmsp/data/viirs_fire/viirs_html/download_viirs_fire.html.

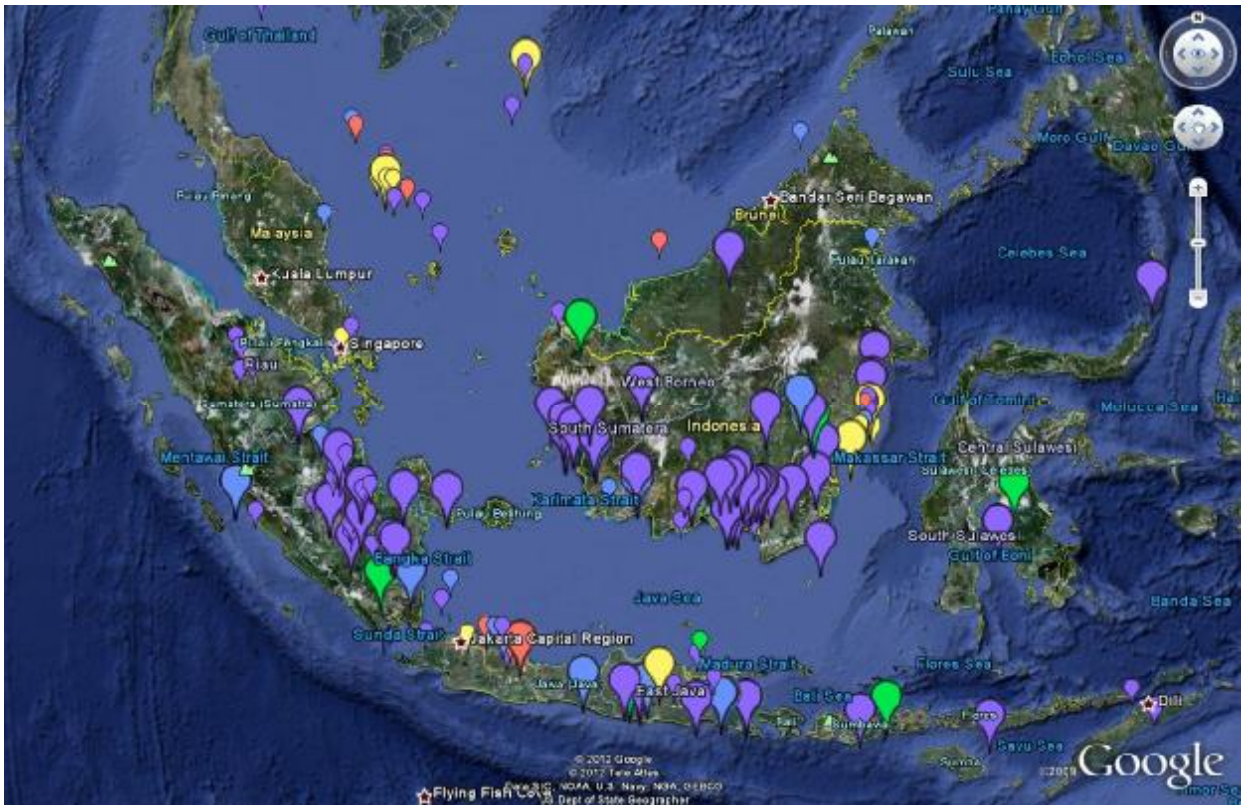

Figure 3: Display of VIIRS nighttime detection of combustion sources from September 23, 2012.

CONCLUSIONS

VIIRS low light imaging data exhibit a remarkable improvement over DMSP. It appears possible to count individual fishing boats with VIIRS. Further research will be required to confirm this possibility. The VIIRS is unique in its collection of near-infrared and short-wave infrared observations at night, recording peak radiant emissions that are missed in the traditional 3-5 um "fire-band" data. By modeling the blackbody curves of combustion sources it is possible to make independent estimates of temperature and total radiant output. The combustion source data should provide useful data for improved fire management and information on flared gas volumes.

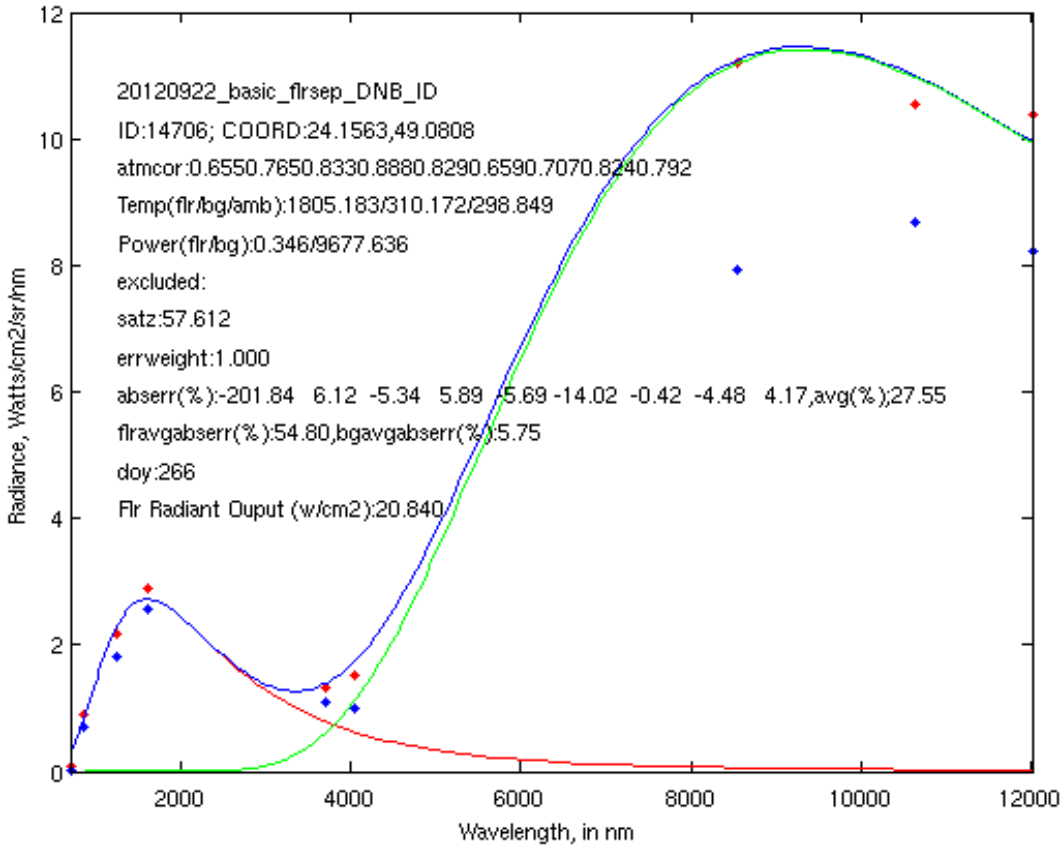

Figure 4: Tapping on the kmz placemarks brings up chart displaying the radiances and analysis results from a gas flare. The background thermal emission is high in the 8-12 um range. The gas flare's radiant emissions peak in the 1.6 um region.

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