SEVIRI Fire Radiative Power (FRP) Dataset

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Background

The Fire Radiative Power (FRP) is a measure of the rate of radiant heat output from a fire. It has been demonstrated in small-scale experimental fires that the FRP of a fire is related to the rate at which fuel is being consumed (Wooster *et al.,* 2005) and smoke emissions released (Freeborn *et al.,* 2008). This is a direct result of the combustion process, whereby carbon-based fuel is oxidised to CO_2 (and other compounds) with the release of a certain "heat yield". Therefore, measuring this FRP and integrating it over the lifetime of the fire provides an estimate of the total Fire Radiative Energy (FRE), which for wildfires should be approximately proportional to the total mass of fuel biomass consumed.

Data Format

The original SEVIRI FRP (in units of MegaWatts; MW) data are produced at the native spatial resolution of 3 km (at the Meteosat sub-satellite point, decreasing away from this) and a temporal resolution of 15 minutes. See the Section on SEVIRI LSA SAF FRP Product for details of how to access these data. The gridded product provided here are spatially degraded to a 1° x 1° grid-cell resolution, but keep the 15 minute temporal resolution. The gridded data are netCDF format files, each file containing 4 parameters. Each of the parameters comprise of an FRP dataset consisting of 71 columns, 73 rows and 96 frames, covering the African continent only (not Europe or South America) on a daily basis. The data cover a 12 month time period between February (2004) and January (2005)…which is the first full year of SEVIRI post-commissioning phase data. The spatial coverage of these gridded data are:

Upper left Lat	=	+36.5°
Upper Left Lon	=	-19.5°
Bottom Right Lat	=	-35.5°
Bottom Right Lon	=	+50.5°

The naming convention for the gridded files is:

SEVIRI_FRP_[year]-[month]-[day].nc

for example SEVIRI_FRP_2004-02-16.nc corresponds to data from 16th February 2004.

Each netCDF file contains 96 frames (15 minute frequency) between 00:12 – 23:57. These acquisition times correspond to the end of the SEVIRI image scan where each scan takes ~12minutes to complete. The times are in UTC.

Atmospheric Correction Procedure

The FRP data have been atmospherically corrected. Atmospheric correction was carried out using MODTRAN (v4), GTOPO30 elevation data and 3-hourly total column water vapour (TCWV) data supplied by European Centre for Medium-Range Weather Forecasts (ECMWF). The TCWV and GTOPO30 data were resampled to the 1° grid cell spatial resolution and subset to cover the same spatial extent as the FRP dataset. An atmospheric transmittance look-up-table (LUT) was developed from the MODTRAN runs, using variations in TCWV, view zenith angle and surface height. The number and magnitude of these parameters is given in the table below along with some of the other model parameters which were held constant.

MODTRAN PARAMETER	**Value**	**Description**
MODEL	3	Tropical Atmosphere
TPTEMP	300K	Surface temperature
IHAZE	1	Rural 23km aerosol extinction
Wavelength Range (cm^{-1})	2070 - 3200	Wavenumber range that encompasses the entire SEVIRI 3.9 µm channel spectral response. Analysis was conducted at a resolution of 5 cm^{-1}.
View Zenith Angle	0° - 65°	View zenith angle variation in increments of 5°.
Solar Zenith Angle	0°	Held constant
Surface Height	0 – 4.8km	The range of surface height, carried out in increments of 0.2km and covers the range of heights in the resampled 1° GTOPO30 product.
Total Column Water Vapour	0 – 8.2 $g.cm^{-2}$	The TCWV per gridcell, carried out in increments of 0.082g-cm^2. Analysis of the annual TCWV data indicates a maximum of 6-8g-cm^2 per month with a mean around 2-3g-cm^2

The range of values over which the LUT was developed were derived from inspection of the respective datasets. Inspection of a number of months of TCWV data indicated that the range of values typically fall between 0 and 8 $g.cm^{-2}$. The retrieved spectral transmittance values, at a spectral resolution of 5cm^{-1}, were then convolved with the SEVIRI 3.9um Spectral Response Function. In the LUT retrieval process, the TCWV for a given grid-cell is interpolated to a temporal resolution of 15 minutes (from the original ECMWF 3 hourly values). The associated surface height, interpolated TCWV and the mean view zenith angle for each the grid-cell then form the basis for retrieving the transmittance of the condition with the closest matching parameter set stored within the LUT.

NetCDF file parameters

Each daily netCDF file contains a 4 output parameters. These are :

1) **Total Fire radiative Power (FRP)**
Name : 'Total_fire_radiative_power'
Long name : 'Total Fire Radiative Power (FRP) in grid cell'

Units : ‘MegaWatts (MW)’
Fill value : -1

This is the sum of the SEVIRI observed FRP within the 1° grid cell, corrected for atmospheric effects.

2) **Total Observed FRP corrected for cloud cover**
Name : 'Adjusted total Fire Radiative Power'
Long name : 'Total Fire Radiative Power (FRP) in grid cell adjusted for cloud cover fraction in grid cell'
Units : ‘MegaWatts (MW)’
Fill value : -1

This is the SEVIRI observed FRP at 1° resolution weighted by the cloud fraction within each 1° gridcell to potentially account for fires obscured by cloud cover. Giglio *et al.* (2006) reports the same methodology is used in the MODIS CMG Fire Products. Schroeder *et al.,* (2008) present an analysis of the impact of such cloud weighting on active fire observations.

3) **Total Number of Fire Pixels**
Name : Number of fire pixels’
Long name : ‘Number of fire pixel detections in grid cell’
Units : ‘Count’
Fill value : -1

This is the total number of active fire pixel detections in each grid cell.

4) **Mean observed FRP**
Name : ‘Mean Fire Radiative Power'
Long name : ‘Mean per-pixel Fire Radiative Power in grid cell'
Units : ‘MegaWatts (MW)’
Fill value : -1

This is the mean atmospherically corrected per-pixel FRP of the grid cell

Additional notes

Zero values indicate cases where there were no fires observed but SEVIRI data was available for processing. Negative values (-1) indicate cases where no SEVIRI data were available for 15 minute period, or areas where fire detection is not carried out. The latter only concerns grid cells that don’t contain any land (i.e. oceans)

SEVIRI LSA SAF FRP Product

A version of the fire detection and characterization algorithm (Roberts and Wooster, 2008) that was used in developing this dataset is now being used to operational produce FRP products at the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Land Surface Analysis Satellite Applications Facility (LSA SAF) (http://landsaf.meteo.pt/algorithms.jsp?seltab=10&starttab=10). The operational SEVIRI FRP product is available in two forms. A full spatio-temporal resolution (pixel level) FRP dataset that is produced every 15 minutes for 4 regions (southern hemisphere Africa, northern hemisphere Africa, South America and Europe). A second gridded FRP dataset available at a 1° x 1° grid-cell resolution and a 1 hourly temporal resolution. Statistical correction factors are applied to these

gridded data to adjust the FRP estimates for cloud obscuration (as with the product available here) and also for missing small fires that SEVIRI is unable to detection (due to its coarse spatial resolution; see Freeborn *et al.,* 2009 for the magnitude of this effect). The gridded dataset was developed for the climate modeling community. These products are being disseminated free to any user in near real time and are available operationally from mid-2008 onwards. Please see the LSA SAF pages for more details on how to register for product delivery, or to order archived data.

References

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