

Environmental KING'S Monitoring & Modelling LONDON Research Group University of London

The LSA_SAF FRP Pixel Product : Details and Comparison to MODIS

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Active Fire Detection

Fire Spectral Emission





- Fires have very high temperatures compared to ambient surroundings
- Intense radiant emissions $\,$ particularly in 3-5 μm atmos. window
- Fires of $10^{-3} \rightarrow 10^{-4}$ pixel maybe detectable.

Fire Spectral Emission







infrared composite

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Fire Spectral Emission



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Meteosat Active Fire Detection

Meteosat Active Fire Detection in the FRP Pixel Product of the EUMETSAT LSA SAF



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Meteosat SEVIRI



15 min imaging freq.



SEVIRI is a 12 channel imager







Detected Fire Pixels



Meteosat Active Fire Detection in the FRP Pixel Product of the EUMETSAT LSA SAF



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Meteosat SEVIRI



15 min imaging freq.



SEVIRI is a 12 channel imager



Rapid Scan Data (every 5 min)

Early Application of MODIS-like Active Fire Detection Algorithm to Meteosat SEVIRI



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6000 Unrealistic spikes resulting from use of FRP freg – magnitude 5000 Underestimation Active Fire 4000 Frequencyy Count vs or weaker burning fires Time 3000 2000 0

'MODIS' type algorithm over full diurnal cycle due to 3000 non-detection of smaller Number of fire pixels 2000 1000 (\$\$\$±+±/ 100014 Jul 14 Jul 14 Jul 14 Jul 14 Jul 14 Jul 14 Jul 100 MV 2 am 7 am 12 pm 4 pm 9 pm 0 GMT 200 0 400600 800 1000 One full day of active fire detections FRP bin mid point (MW)

Detailed in Roberts, Wooster et al. (2005) Journal of Geophysical Research-Atmospheres

Example Improvements Used for Geostationary Active Fire Detection



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Solar zenith angle

Vis channel reflectance MIR

MIR channel Radiance

• Active fire detection thresholds set as fn of solar zenith angle (not slot time as in most LEO active fire algs).

• Also use "edge detection" spatial filter to enable "spectral filter" thresholds of BT_{MIR} -BT_{LWIR} to be made more sensitive without much increase in "false alarms" or computational time .

Geostationary Active Fire Detection Algorithm in the LSA SAF FRP_Pixel Product



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Detailed in Roberts and Wooster (2008) IEEE Geoscience and Remote Sensing

Enhanced Geostationary Active Fire Detection Algorithm Performance



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Prior Alg ~ 100 – 500 MW Enhanced Alg. ~ 40 – 500 MW

Calculations assume mid-latitude summer atmosphere (rural aerosol, 23 km vis), and fixed surface reflectance of 0.15 and emissivity 0.85. Surface temperature of 300 K and 20° solar zenith angle.

Enhanced Geostationary Active Fire Detection Algorithm Performance





- Fire pixel time-series now smoothly varying / realistic.
- In excess of 300% more fire pixels detected around the diurnal peak.

• Total number of active fire pixels increased by more than 100% over 24 hrs.

• False detects remain low ~ 6% compared to MODIS.

Enhanced Geostationary Active Fire Detection Algorithm Performance





- FRP trend now more smoother / more realistic.
- S. African FRP ~ 100% increased at diurnal peak.
- Total FRE increased by ~ 80% over 24 hr period.
- Differences lower than for fire pixel detects as 'extra' detections have mostly low FRP (i.e. smaller fires).



Active Fire Detection Map



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SEVIRI 2004 Fire Detections GLC2000 Landcover A1 Landcover Class 2 4 6 8 10 12 14 16 18 20 22 24 26 1 Closed lowland forest 18 Croplands (>50%) 2 Lowland forest 19 Crops/woody veg 20 Irrigated croplands 3 Submontane forest 4 Montane forest 21 Tree crops 22 Sandy desert/dunes 5 Swamp forest 6 Mangrove 23 Stony desert 7 Forest/Croplands 24 Bare rock 8 Forest/Savanna 25 Salt hardpans 26 Waterbodies 9 Deciduous forest 10 Deciduous woodland 27 Cities 11 Deciduous shrubland 12 Open deciduous shrubland 13 Closed grassland 14 Open grassland / shrubs Date of Actve Fire Detection 15 Open grassland 16 Sparse grassland 17 Swamp bushland/grassland FMAMJJASONDJ A3



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LSA SAF FRP_PIXEL PRODUCT



- Strong agreement between LSA_SAF FTA & KCL code results.
- Small local peak in FTA results at sun-rise due to cloud problems (LSA SAF v1 used EUMETSAT only cloud mask not HRV).

Operational Deployment of the FTA Algorithm in the LSA SAF



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Small differences found to be mainly due to cloud mask.

Nowcasting SAF Cloud Mask



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Some Tests set to "OFF"

- Not detect fire as cloud.
- Not detect smoke as cloud.

• Recent work indicates the mask may still be a little too strict compared to what it need be for the FRP_Pixel product... examine further.

LSA SAF Meteosat FRP_Pixel Product



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Available via FTP/EUMETCast from the EUMETSAT Land Surface Analysis Satellite Application Facility (LSA SAF)

http://landsaf.meteo.pt/ - for data, ATBD, Product User Manual & Validation Report

- FRP Pixel Product (native spatial/temporal resolution) available within 30 mins
- FRP Gridded product inc. adjustments for "small fires" and "clouds" also available.



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LSA SAF Meteosat FRP_Pixel "Quality Product"



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Two HDF files for each slot

• "List Product"- Fire Data only

• Matching "Quality Product" reports the processing status of each pixel – Fire Detected & FRP measured, cloud-covered, etc.

VALUE	MEANING
0	NOT POT FIRE
1	FRP OK
2	FRP SAT
3	CLOUDY
4	SUN GLINT
5	SUN GLINT RATIO
6	NO BCK
7	BAD BCK
8	CLOUD EDGE
254	NOT PROCESSED



LSA SAF "FRP_Grid" Spatio-Temporal Gridded Product King's London FRP GLOBAL PRODUCT 20080122133000 ty of London -4050 NGE Prod Strud Form Size Spati Temp FRP is t 1001 Cell acc missed ន 0.901 FRP Grid 80,180] 22 about th found. Tl data miss FRP (MW) grid cell: 50 100 400 650 800 900 1000 ŝ Input D • No fire 50 -70 20 30 -60 -50 -40 -30-20-1010 40

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Comparisons to MODIS

MODIS vs. SEVIRI Active Fire Detection

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R: Detected fire pixels G: MIR spectral radiance B: TIR spectral radiance

Central African Repulic Evaluation Site





Initial Detection Comparison with MODIS



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All MODIS detections 01 – 14 Feb 2004

SEVIRI detections at MODIS overpass times only (± 6 minutes) 01 – 14 Feb 2004

All SEVIRI detections for all SEVIRI timeslots 01 – 14 Feb 2004

Most fires detectable by MODIS are detected in the Meteosat FRP_Pixel prouduct at some point in their life.



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MODIS



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SEVIRI



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MODIS



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MODIS



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MODIS



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MODIS



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MODIS











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MODIS = 3089 fire pixels ^o SEVIRI = 11747 fire pixels over 96 timeslots SEVIRI = 3674 unique fire pixel locations



All fire pixels detected by MODIS (red) and SEVIRI (green) on 02 Feb 2004 MODIS fire pixels with a SEVIRI fire pixel within 4km are shown in blue 15°N $10^{\circ}N$ $5^{\circ}N$

MODIS = 3089 fire pixels, of which 1520 have SEVIRI fire pixel within 4km SEVIRI = 11747 fire pixels over 96 timeslots SEVIRI = 3674 unique fire pixel locations



All fire pixels detected by MODIS (red) and SEVIRI (green) on 02 Feb 2004 SEVIRI fire pixels within 4km of a MODIS fire pixel are shown in purple 15°N $10^{\circ}N$ $5^{\circ}N$

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FRP_PIXEL FRP Comparison with MODIS MOD14

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FRP_PIXEL FRP Comparison with MODIS MOD14

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At this time, most fires are in Eastern Europe and have have SEVIRI view zenith angle > 60°

FRP_PIXEL FRP Comparison with MODIS MOD14





	Image Dates (2008)	Fire Detects Omission Error (%)	Fire Detects Comission Error (%)	Slope of linear best fit between SEVIRI-to- MODIS per-fire FRP
North Africa	1 - 8 Dec	62%	8%	0.96
South Africa	19 - 24 Aug	71%	6%	0.97
South America	14 - 24 Aug	85%	9%	0.97
Europe	9 - 17 Aug	95%	1%	0.88

SEVIRI Fire Detection Confidence



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 Most fires have high 1.0 July-October (all data) February May August confidence parameter. (False alarms) Normalised Frequency 0.8 Most false alarms are low confidence pixels. 0.6 **SEVIRI FTA Fire** 0.4 **Pixel Detection** 6% 8% 6% **False Alarm Rate** 3% 3% 6% Equivalent of total 0.2 FRP in scene (%) Feb May Aug 0.0 0.75 0.00 0.25 0.50 1.00

Fire Pixel Confidence Parameter

FRP_PIXEL FRP Comparison with MODIS MOD14

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North Africa LSA SAF Region 1 – 8 Dec 08



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South America	14 - 24 Aug	85%	9%	0.97	0.30
Europe	9 - 17 Aug	95%	1%	0.88	0.13



- FRP_Pixel Product available since 2008 (versions improve to 2010.)
- List Product contains fire detections, confidence values, FRP values and error budget estimates for each detected fire pixel.
- Quality Product contains a "map" showing pixel processing status.
- Product has been "validated" in all four LSA_SAF regions via comparison to MODIS MOD14 product (higher spatial resolution).
- FPR_Pixel Product has low(ish) false alarm rate ~ 6% and good detection and FRP comparison to MODIS for FRP > ~ 50 MW
- SEVIRI FRP_Pixel Product fails to detect many fires < 50 MW
- Gridded Product adjust for mean bias, and for cloud cover.

