LSA SAF Products

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ESAC-ME-VII
(5-16 February 2011)
Outline

- The LSA SAF
- LSA SAF PRODUCTS
- COMPONENTS OF THE SURFACE RADIATION BUDGET
- VEGETATION
- EVAPOTRANSPIRATION & REFERENCE EVAPOTRANSPIRATION
- FIRE RADIATIVE POWER
- PRACTICAL ISSUES
LSA SAF – Satellite Application Facility on Land Surface Analysis

LSA SAF is dedicated to:

✓ Development of **algorithms**:
  ✓ Land Surface Parameters from MSG & Metop observations

✓ Scientific validation

✓ Operational production (IM)

✓ Distribution (IM)

✓ User support (IM)

**SAFs** - Specialised development and processing centres that complement the product-oriented activities of EUMETSAT Central Facility in Darmstadt.
Surface Radiation Budget

- LST
- Albedo
- LongWave Flux
- ShortWave Flux

Surface Water Balance

- Snow Cover
- Evapotranspiration

Vegetation

- Fraction Veg Cover
- LAI
- FAPAR

Wild Fires

- Fire Risk Mapping (Europe)
- Fire Detection & Monitoring
- Fire Radiative Power

Increased level of maturity

Development | Pre. Operat. | Operational
• Components of the **Surface Radiation Budget**:

\[
F_{net} = F_{\text{sw} \downarrow} - F_{\text{sw} \uparrow} + F_{\text{lw} \downarrow} - F_{\text{lw} \uparrow}
\]

**Shortwave radiation budget**
- Downward shortwave radiation
- Reflected shortwave radiation
- Albedo \( \times F_{\text{sw} \downarrow} \)

**Longwave radiation budget**
- Downward longwave radiation
- Upward longwave radiation
- Reflected + Emitted
- \((1-\varepsilon) \times F_{\text{lw} \downarrow} + \varepsilon \sigma T^{4}\)
Components of the **Surface Radiation Budget**:

\[
F_{\text{net}} = F_{\text{sw} \downarrow} - \text{ALBEDO} \times F_{\text{sw} \downarrow} + \varepsilon F_{\text{lw} \downarrow} - \varepsilon \sigma LST^4
\]
Components of the Surface Radiation Budget:

- **Shortwave radiation budget**
  \[
  F_{net} = F_{sw \downarrow} - F_{sw \uparrow}
  \]
  - Downward shortwave radiation
  - Reflected shortwave radiation

- **Longwave radiation budget**
  \[
  F_{LW \downarrow} - F_{LW \uparrow}
  \]
  - Downward longwave radiation
  - Upward longwave radiation

Re-writing...

\[
F_{net} = F_{sw \downarrow} - \text{ALBEDO} \times F_{sw \downarrow} + \varepsilon \times F_{Lw \downarrow} - \varepsilon \times \sigma \times LST^4
\]
\[\text{(DSSF)} \quad \text{(DLSF)}\]
Land Surface Temperature

LST in the LSA SAF estimated from MSG/SEVIRI data

- **Spatial Resolution:**
  SEVIRI resolution, i.e.,
  3 x 3 km at sub-satellite point

- **Temporal Resolution:**
  15 minutes

- **Geographical Coverage:**
  Earth disk within SEVIRI field of view,
  divided in 4 areas: Europe, North Africa,
  South Africa & South America.

- **Available Since:**
  Europe – February 2005
  All disk – July 2005
LST in the LSA SAF estimated from MSG/SEVIRI data

201008 @ 0900UTC

201001 @ 0300UTC
**Surface Fluxes**

**Donwelling surface radiation fluxes in the Land-SAF - MSG/SEVIRI**

- **Shortwave- DSSF**
  - ✓ SEVIRI resolution
    - (3 x 3 km at sub-satellite point)
  - ✓ 30 minutes & daily
  - ✓ Land Pixels within SEVIRI field of view, divided in 4 areas: Europe, North Africa, South Africa & South America.
  - ✓ Available since 2005

- **Longwave- DSLF**
Downwelling Surface Solar Radiation

F_{sw\downarrow} in the LSA-SAF - MSG/SEVIRI

27 Jan 2011 @04:00UTC
06:00UTC
12:00UTC
14:00UTC
16:00UTC
17:00UTC

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Tel.: (351) 21 844 7000     Fax: (351) 21 840 2370     e-mail: informacaoes@meteo.pt     URL: http://www.meteo.pt
Monthly variation of daily accumulated Solar Radiation

⇒ variation of Sun's apparent position through the year

15 Jan 2009  
15 March 2009  
15 May 2009  
15 July 2009  
15 Sep 2009  
15 Nov 2009
Downwelling Surface Longwave Radiation

$F_{Lw\downarrow}$ in the LSA-SAF - MSG/ SEVIRI

Zonal band of High DSLF values!

JULY 2010

Zonal band of High DSLF values!

JAN 2010
The variation of longwave radiation through the year allows to know/follow the Intertropical Convergence Zone (ITCZ)
Albedo in the LSA-SAF - MSG/SEVIRI

- **Spatial Resolution:**
  SEVIRI resolution, i.e., 3 x 3 km at sub-satellite point

- **Temporal Resolution:**
  Daily & 10-days

- **Geographical Coverage:**
  Earth disk within SEVIRI field of view, divided in 4 areas: Europe, North Africa, South Africa & South America.

- **Available Since:**
  2005
Monthly Albedo variation:

- High Albedo values: Desert regions
- Low Albedo values: Vegetated regions

Seasonal Vegetation change

Snow
Vegetation Products

Fractional Vegetation Cover - FVC

Leaf Area Index - LAI

Fraction of Absorbed Photosynthetically Active Radiation - fAPAR

TEMPORAL RESOLUTION:

Daily

• Surface models inputs
• Crop yield forecasts
Effects of the *khareef* in vegetation

The south east monsoon affects the Dhofar region from about June to early September.
Evapotranspiration

Temporal Frequency: 30 min & daily

15 July 2010 @10:00UTC  15 Sep 2010 @10:00UTC  15 Nov 2010 @10:00UTC

Evapotranspiration - quantification of the flux of water vapour from the ground surface (soil and canopy) into the atmosphere.
Reference evapotranspiration (equivalent to the evapotranspiration from a well defined surface (FAO))

\[ \text{ET}_c = K_c \text{ET}_0 \]

Crop evaporation or crop water need

\[ \text{ET}_0 \] is essentially determined by solar irradiance:

\[ \text{ET}_0 \approx a_M f(T) DSSF_{Daily} \]

Important in irrigation management, allowing an effective use of soil water reserves on agricultural production.

\[ K_c \quad \text{FAO Coefficient:} \]

- Pineapple
- Grass reference
- Apple
- cherries
- Peaches
- Citrus
- Large Vegetables
- Small Vegetables
- Sugar cane
- Maize
- Cotton

\[ K_c \text{ at mid-season} \]
Water requirements for irrigation crops are higher in July and then diminishes towards November.
FIRE RADIATIVE POWER (FRP) - The Fire Radiative Power (FRP) is the amount of radiant energy emitted per unit time during a vegetation fire.
By integrating FRP during the lifetime of a vegetation fire we get the total combusted biomass (M(Kg))

\[
\text{Emission of Trace Gas Species (g)} \quad = \quad M \text{ (kg)} \times \text{Species Emissions Factor (EF, g/ kg)}
\]
FRP product allows to:

- Detect an active vegetation fire
- Compute the radiant energy per unit time for the detected fire
- Estimate trace gas emissions from the fire
FRP from LSA SAF (MSG-SEVIRI) is derived every 15min (characterization of the diurnal cycle)
Example of FRP product application:

Monitoring of gas flares with MSG active fire data

LSA SAF 4th User Workshop
Toulouse, France
15-17 November, 2010

Keith Peterson, Peter Navratil
What is a gas flare?

- Gas flares, or flare stacks, are associated with oil wells, gas wells, rigs, refineries, natural gas plants and landfills.

- Commonly used practice for the disposal of waste gas in oil rich regions lacking distributive infrastructure.

- In 2008 estimated emissions from gas flaring amounted to 9% of the total CO2 emissions of the European Union (EU-15).

- An estimated 150 – 170 billion m$^3$ of gas has been flared annually over the past 14 years (GGFR, Worldbank).

- To date, reliable and accurate data on gas flaring is hard to find and mostly based on self-reporting, independent assessments of flared gas volumes are not being carried out.
The **LSA SAF FRP** Product suitability for **gas flare monitoring** in comparison to other satellite fire products (from MODIS & ESA World Fire Atlas) was assessed, over an extended period of time (2008-2010).
Persian Gulf

- Includes the oil rich Al Basrah region in southern Iraq and the productive oil fields of Kuwait

73 Flare Sites:
68 onshore
5 offshore
MSG FRP Product limitations

- **Spatial Resolution**
  - impossible to distinguish different flare sites within small areas (size of an MSG pixel in the Persian Gulf area ~ 5 x 6 Km);
  - Difficult to get exact location of flare sites – the temperature anomaly detected is given for the center of the pixel which doesn’t always correspond to the position of the features.
MSG FRP Product limitations:

- **MSG seasonal detection trends:**
  - Decrease in both day- and nighttime detections during summer months
  - BT of the fire pixel is not sufficiently above the background BT

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**Persian Gulf: MSG FRP PIXEL Product Daytime Detection Count 2009**

![Graph showing daytime detection count](image1)

**Persian Gulf: MSG FRP PIXEL Product Nighttime Detection Count 2009**

![Graph showing nighttime detection count](image2)

**Decrease in detections!!**
Conclusions

- Despite limitations:
  - Low spatial resolution
  - Landwater mask (not offshore detections possible)
  - Limited sensor coverage

- MSG shows excellent potential for gas flare monitoring:
  - Good performance (on par with MODIS);
  - Very high temporal resolution advantageous in areas with cloud cover and provides detailed monitoring capabilities (15 min. temporal resolution);
  - FRP value

Contact: info@rssgmbh.de
ACCESS

The LSA SAF products are available:

- ftp (https://landsaf.meteo.pt/)
  - Download from the LSA SAF website
  - Products sent to the server specified by the user
  - In both cases the user must first register on the web page

- EUMETCAST
Files Format: HDF5

HDF5 file attributes
Version, Dimensions, Projection: GEOS (0°)
Pixel size=3.1 km at equator
Aquisition Time
Region Name
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Future Perspectives

- LSA SAF will enter a new phase (2012-2017)
- Continuity of products/services in NRT
- Plans:
  - a toolbox developed by LSA SAF will be available
  - Re-processing of some of the products (LST, Albedo, Vegetation products, FRP, Solar radiation, Evapotranspiration, ...)
  - new products will be developed (adaptation to MTG)
More on LSA SAF:

http://landsaf.meteo.pt