CAP Implementation Workshop 2017

CAP and satellite-based fire detection

Roma 20/09/2017

- Giovanni Laneve, Lorenzo Fusilli & Pablo Marzialetti – SIA Università di Roma "La Sapienza"

SIA remote sensing applications

Landsat/TM.
Simulation of one year of acquisition (upper left) and a week of Landsat images that can be acquired at BSC.

- *Coastal erosion*
- *Sea color and sea/land temperature*
- *Atmosphere Monitoring*
- *Oil spill detection*
- *Desertification*
- *Water quality (pollution) monitoring*
- *NRT hot spot detection and monitoring*
- *Prompt estimate of damages and population monitoring*
- *indices for border monitoring*
- *Automatic detection of objects/infrastruct.*

Training

Sun-photometer

Field campaign

Applications examples

- Monitoring of volcanoes;
- Forest fires monitoring;
- Crops classification and monitoring
- Forest status monitoring.

Management of forest fires

Prevention	Detection/Monitoring	Damage assessment/ Recovery
Vegetation fuel map	Early detection of wildfires	Burned areas estimate
Hazard map	Forest fires monitoring	Damage severity map
Vulnerability map	Estimate of Fire Radiative Power (fire intensity)	Burned biomass
Risk map	Estimate of the burned biomass and atmospheric emissions	Slope instability (landslide, debris flow)
Fuel reduction map and forecast of suitable conditions for prescribed fire paractices		

Management of forest fires

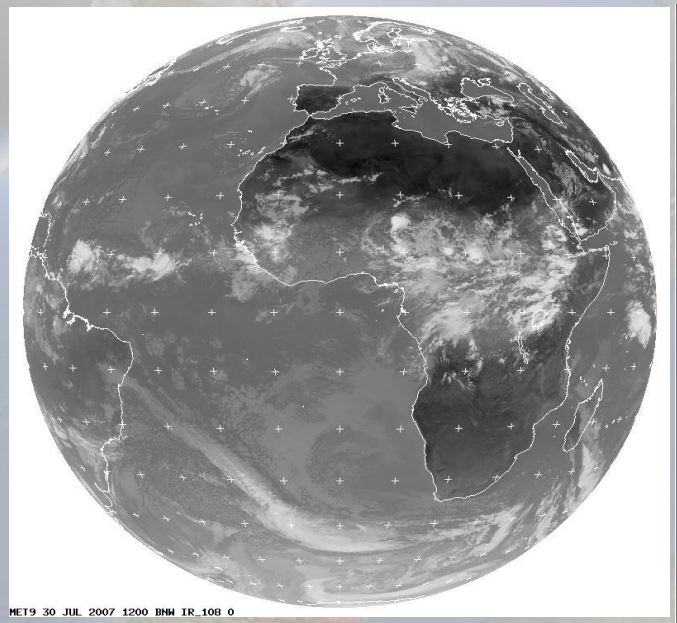
This short presentation describes the activity made in the framework of the on-going collaboration with the National Fire Corps in the field of satellite based information in support of forest fires management. In particular:

- Products devoted to support fire detection and monitoring based on gestationary (MSG) and polar orbit (MODIS, Sentinel-3) satellites.

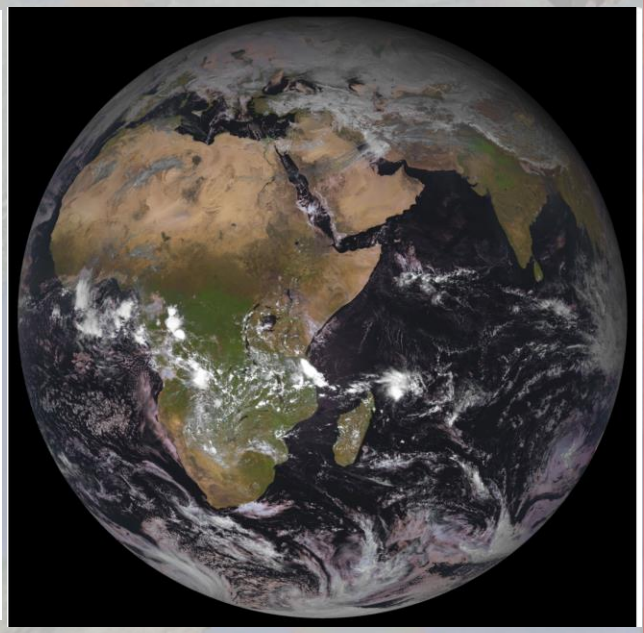
Fire detection and monitoring:

Every 15 min (geostationary MSG/SEVIRI) or 4 times per day (Terra and Aqua MODIS)

SEVIRI sensor on board of Meteosat Second Generation geostationary satellite provides every 15 min a view of one third of the Earth's surface (MSG-10 or MSG-3).
It offers the possibility to **promptly observe and locate** phenomena causing a sudden increase of the temperature in a wide area of the world.
It result very useful to locate phenomena in remote areas and in an independent way or when wide areas are involved.



MSG - 10



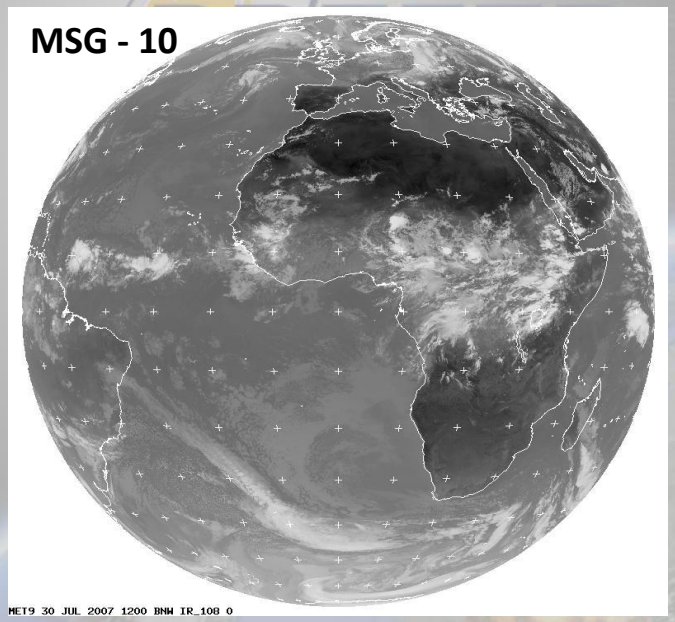
MSG – 8 (IODC)

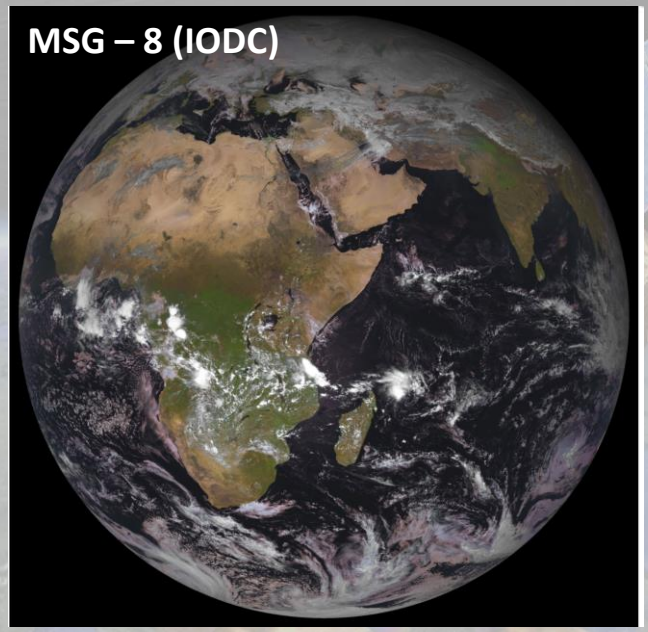
The images are acquired always in the same observation geometry but the solar illumination conditions are changing:

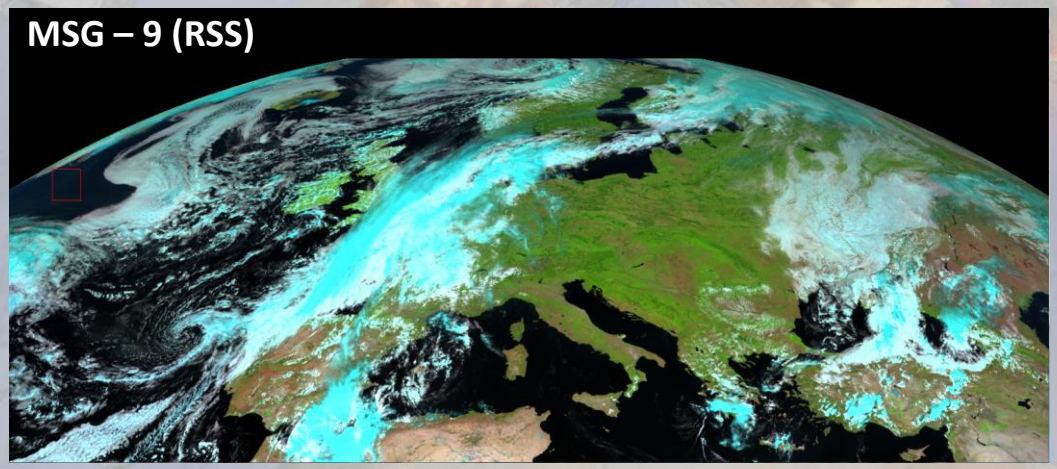
1. Geo-referencing and images registration is not a problem.
2. The change of the illumination conditions must be taken into account during the phase of event monitoring.

Fire detection and monitoring:

Data from 3 MSG satellites from 5 to 15 min (EUMETCAST)







All SEVIRI/MSG sensors data are acquired and processed:

MSG 10: Lat=0°, Lon=0°, 15 min refresh frequency;

MSG 9 (Rapid Scanning Service): Lat=0°, Lon=9.5°, 5 min refresh frequency;

MSG 8, Indian Ocean Data Coverage: Lat=0, Lon=41.5°, 15 min refresh frequency.

RGB image from MSG 9: Red (NIR 1.6), Green (VIS 0.8), and Blue (VIS 0.6)

Fire detection and monitoring:

EUMETSAT CAPs

```
<?xml version = "1.0" encoding= "UTF-8"?>
<alert xmlns = "urn:oasis:names:tc:emergency:cap:1.1">
   <identifier>urn:oid:2.49.0.3.1.1.57</identifier>
   <sender>urn:oid:2.49.0.2.1</sender>
   <sent>2017-08-20T00:15:00-00:00</sent>
   <status>Actual</status>
   <msgType>Alert</msgType>
   <scope>Public</scope>
    <info>
      <category>Geo</category>
      <event>FIRE</event>
          <responseType>Assess</responseType>
          <responseType>Monitor</responseType>
      <urgency>Immediate</urgency>
      <severity>Moderate</severity>
      <certainty>Likely</certainty>
    <effective>2017-08-20T00:00:00-00:00</effective>
    <expires>2017-08-20T00:30:00-00:00</expires>
      <senderName>EUMETSAT</senderName>
      <headline>Fire detection report</headline>
      <description> Fire detection. This is a computer generated report and has not been reviewed by a human.
      <web>http://oiswww.eumetsat.org/IPPS/html/MSG/PRODUCTS/FIR</web>
      <area>
         <areaDesc>List of detected fires (latitude, longitude, radius)</areaDesc>
         <circle>-24.157,28.872 1.877</circle>
         <circle>-24.156,28.835 1.877</circle>
         <circle>-24.125,28.862 1.877</circle>
         <circle>-24.124,28.825 1.876</circle>
         <circle>-12.478,-46.353 2.226</circle>
         <circle>-12.448,-46.344 2.225</circle>
         <circle>-12.449,-46.394 2.227</circle>
         <circle>-12.418,-46.336 2.225</circle>
         <circle>-12.419,-46.385 2.227</circle>
         <circle>-12.042,-48.809 2.329</circle>
         <circle>-12.043,-48.862 2.331</circle>
         <circle>-9.577,-48.852 2.312</circle>
         <circle>-6.006,-53.746 2.551</circle>
         <circle>-6.007,-53.807 2.554</circle>
         <circle>-5.976,-53.740 2.550</circle>
         <circle>-5.977,-53.802 2.554</circle>
         <circle>-5.947,-53.734 2.550</circle>
         <circle>-5.948,-53.796 2.553</circle>
         <circle>3.462,-59.614 2.971</circle>
      </area>
```

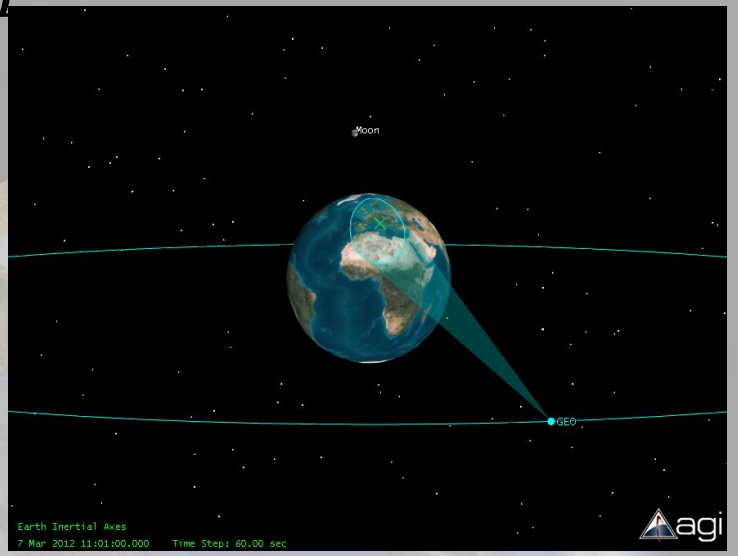
Distributed through EUMETCAST every 15 min

Information available:

- **time;**
- **Coordinates and radius (pixel size);**
- **Severity;**
- **Certainty.**

Nome	Ultima modifica	Tipo	Dimensione
201708200000-firc	29/08/2017 10:49	File XML	6 KB
201708200015-firc	29/08/2017 09:46	File XML	6 KB
201708200030-firc	29/08/2017 09:47	File XML	6 KB
201708200045-firc	20/08/2017 02:45	File XML	5 KB
201708200100-firc	20/08/2017 03:00	File XML	5 KB
201708200115-firc	29/08/2017 18:40	File XML	5 KB
201708200130-firc	20/08/2017 03:30	File XML	6 KB
201708200145-firc	20/08/2017 03:45	File XML	5 KB
201708200200-firc	20/08/2017 04:00	File XML	5 KB
201708200215-firc	20/08/2017 04:15	File XML	4 KB
201708200230-firc	20/08/2017 04:30	File XML	5 KB
201708200245-firc	20/08/2017 04:45	File XML	4 KB
201708200300-firc	20/08/2017 05:00	File XML	4 KB
201708200315-firc	20/08/2017 05:15	File XML	5 KB
201708200330-firc	20/08/2017 05:30	File XML	4 KB
201708200345-firc	20/08/2017 05:45	File XML	4 KB
201708200400-firc	20/08/2017 06:00	File XML	4 KB
201708200415-firc	20/08/2017 06:15	File XML	4 KB
201708200430-firc	20/08/2017 06:30	File XML	4 KB
201708200445-firc	20/08/2017 06:45	File XML	4 KB
201708200500-firc	20/08/2017 07:00	File XML	4 KB
201708200515-firc	20/08/2017 07:15	File XML	4 KB
201708200530-firc	20/08/2017 07:30	File XML	4 KB
201708200545-firc	20/08/2017 07:45	File XML	10 KB
201708200600-firc	20/08/2017 08:00	File XML	9 KB
201708200615-firc	20/08/2017 08:15	File XML	13 KB
201708200630-firc	20/08/2017 08:30	File XML	6 KB
201708200645-firc	20/08/2017 08:45	File XML	8 KB
201708200700-firc	20/08/2017 09:00	File XML	7 KB
201708200715-firc	20/08/2017 09:15	File XML	5 KB
201708200730-firc	20/08/2017 09:30	File XML	6 KB
201708200745-firc	20/08/2017 09:45	File XML	8 KB
201708200800-firc	20/08/2017 10:00	File XML	9 KB
201708200815-firc	20/08/2017 10:15	File XML	10 KB
201708200830-firc	20/08/2017 10:30	File XML	12 KB
201708200845-firc	20/08/2017 10:45	File XML	17 KB

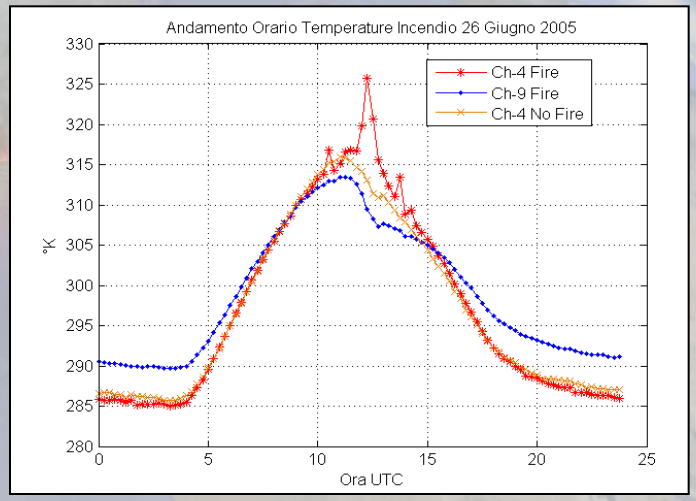
Hot Spot SEVIRI (HSS)



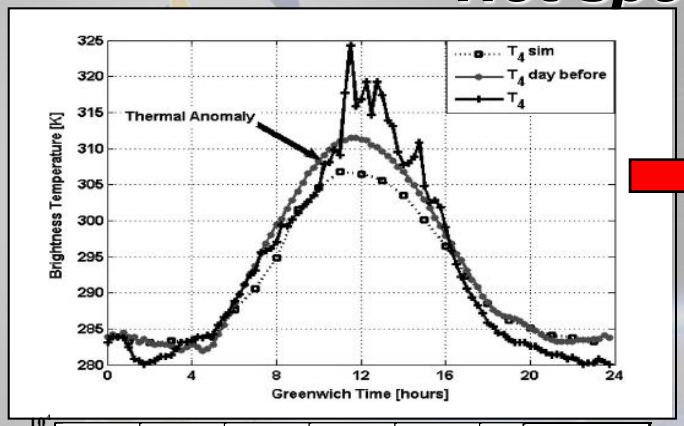
The images source is the SEVIRI geostationary sensor on board of the three MSG satellites Meteosat 8, 9 and 10. The algorithms is:

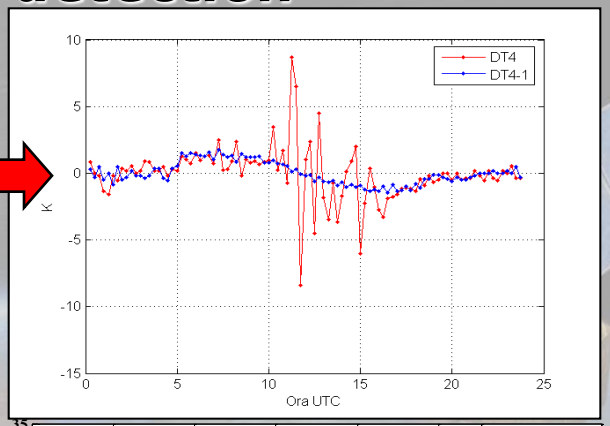
•SFIDE® (System for FIre Detection), developed by the Centro di Ricerca Progetto San Marco (CRPSM) of the University of Rome "La Sapienza", G. Laneve, M. M. Castronuovo, E. Cadau: *Continuous Monitoring of Forest Fires in Mediterranean Area Using MSG*. IEEE Trans. on Geoscience and Remote Sensing, vol. 44, N. 10, pp. 2761-2768, 2006.

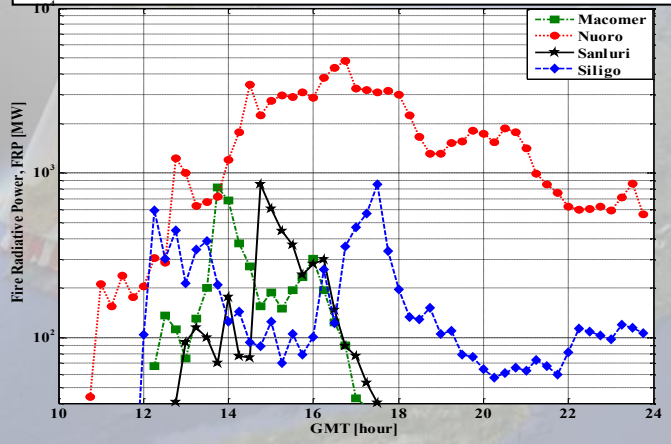
CRPSM (SFIDE®) algorithm tries to exploit the image high refreshing frequency guaranteed by the SEVIRI sensor (15 min) for minimizing the sizes of the detectable fire. This objective is achieved by comparing *temperatures variation* between two consecutive images (acquired after 15 min one to the other) with the expected value provided by a suitable model driven by local, instantaneous data.

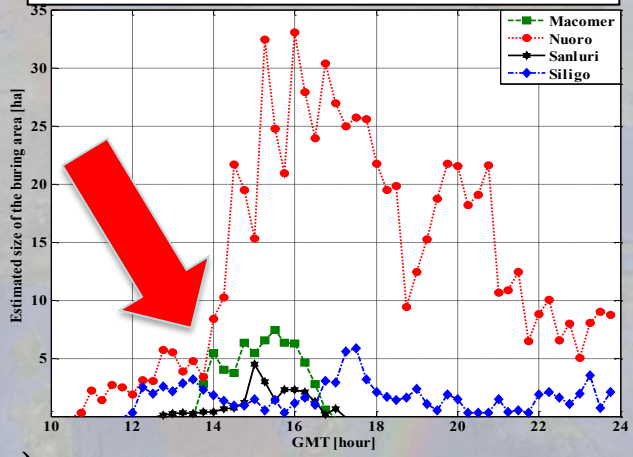


Hot spot detection









The geostationary system allows to follow the fire temporal behaviour (high refreshing frequency of SEVIRI) and estimate, objectively, its intensity by means of the **FRP (Fire Radiative Power)**.

In principle, from FRP, it is possible to compute the FRE (*Fire Radiative Energy*) and then the burned biomass (BB), if the specific heat of the burning vegetation is known.

$$FRP_{SB} = A_f \cdot \varepsilon \cdot \sigma \cdot \left(T_f^4 - T_b^4\right)$$

Stefan Boltzmann (LUT)

Assuming a combustion rate Cr = 0.368 kg/MJ, it is possible to estimate BB (Roberts et al, 2008).

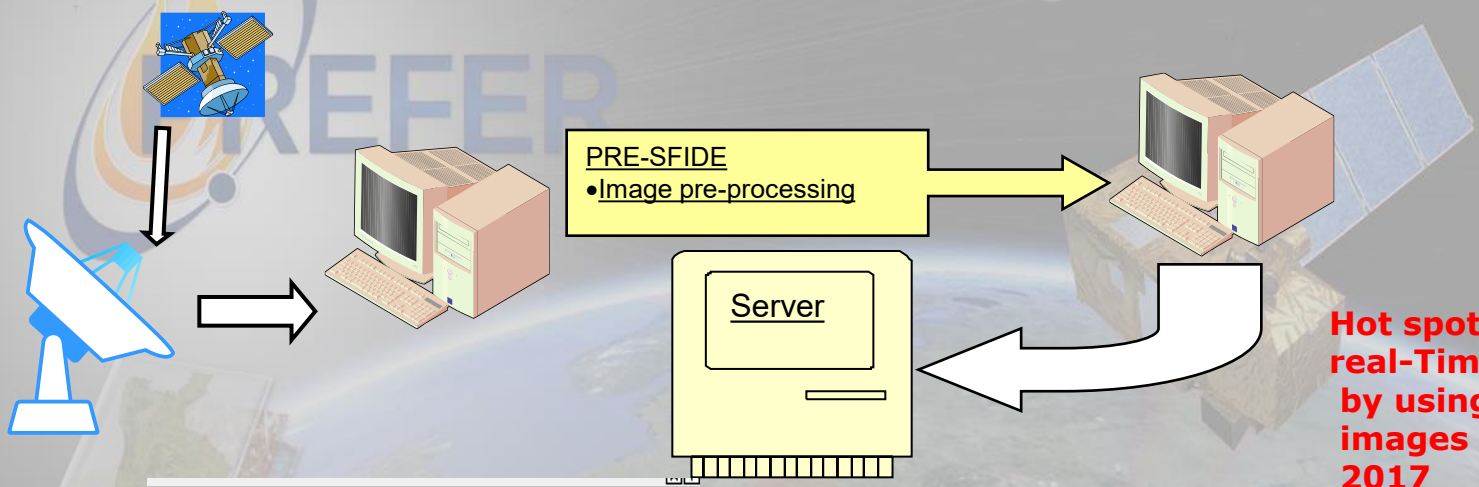
$$\begin{cases} FRP_W = \dfrac{A_p \cdot \sigma \cdot \varepsilon_{MIR}}{a \cdot \varepsilon} L_{MIR} \cong \dfrac{A_p \cdot \sigma}{a} L_{MIR} \\ B(\lambda_{MIR}, T_f) \cong a \cdot T_f^4 \end{cases}$$

Wooster

$$BB \cong 0.368 \cdot FRE \quad [MJ] \quad [kg]$$

$$\rho_B \cong BB / area_B \quad [Kg / m^2]$$

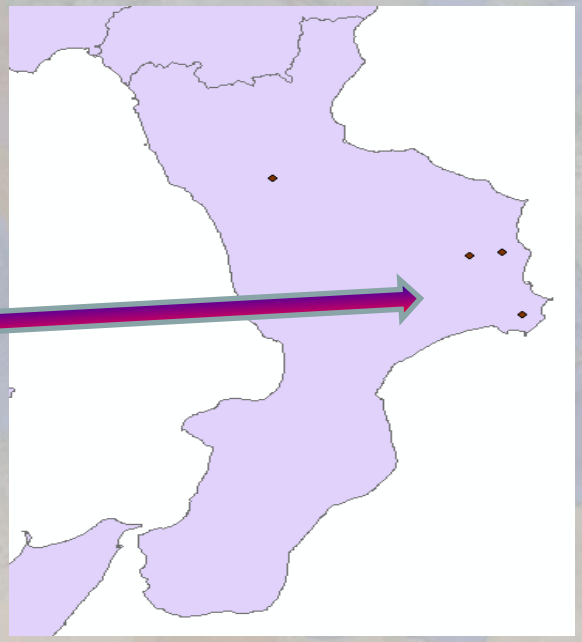
Forest fires monitoring



Hot spot detected in Near real-Time (NRT) by SFIDE by using the MSG/SEVIRI images of the 13th August 2017

Location: 16,229260 38,214452 Decimal Degrees

Field	Value
FID	0
Shape	Point
ID	1
XMAP	16,222503
YMAP	38,211803
DATE	20170813
ORA	1755
RADIOMETRO	SEV
AREA_M2	1749
TEMPERATUREN	303
Tfuoco	801
FRP_MW	45
QC	100
DATE_1st_deC	20170813
ORA_1st_detC	1755



Fire detection and monitoring:

EOSIAL CAPs

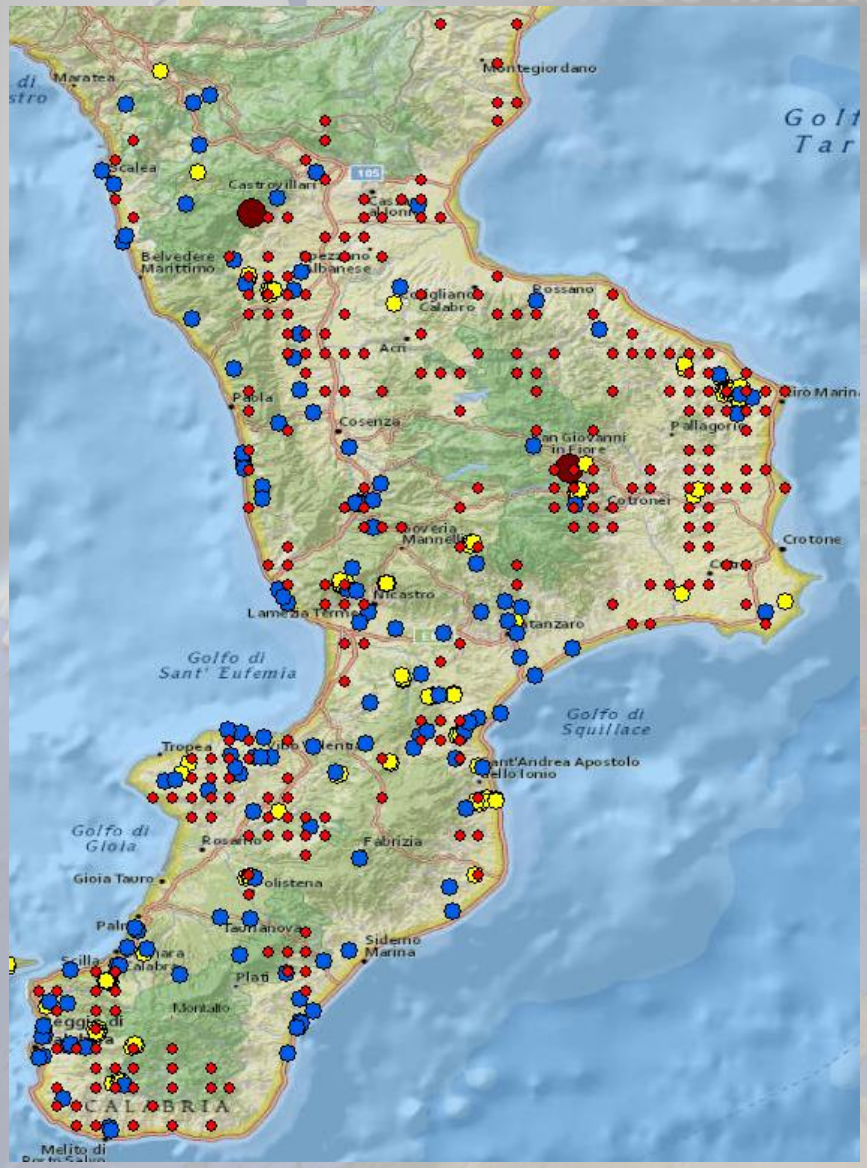
Distributed every 5 min or 15 min

Information available:

- **time;**
- **Coordinates and radius (pixel size);**
- **Municipality;**
- **Severity (based on FRP);**
- **Certainty**
- **etc.**

```
<?xml version="1.0" encoding="UTF-8"?>
<alert xmlns = "urn:oasis:names:tc:emergency:cap:1.1">
    <identifier>urn:oid:2.49.0.0.380.X EOSIAL_hotSpot_39.20048916.14653201708221055</identifier>
    <sender>urn:oid:EOSIAL_SapienzaUniversityOfRome</sender>
    <sent>2017-08-22T11:55:00-00:00</sent>
    <status>Actual</status>
    <msgType>Alert</msgType>
    <scope>Private</scope>
    <info>
        <category>Geo</category>
        <event>FIRE</event>
        <responseType>Assess</responseType>
        <urgency>Unknown</urgency>
        <severity>Severe</severity>
        <certainty>Likely</certainty>
        <effective>2017-08-22T11:55:00-00:00</effective>
        <expires>2017-08-22T12:25:00-00:00</expires>
        <senderName>EOSIAL Lab. School of Aerospace Engineering. Sapienza University of Rome</senderName>
        <headline>Fire detection report</headline>
        <description>Fire detection. This is a computer generated report
        <web>http://eosial.psm.uniroma1.it/SFIDE</web>
        <parameter>
            <valueName>Country</valueName>
            <value>Italy</value>
        </parameter>
        <parameter>
            <valueName>Region</valueName>
            <value>Calabria</value>
        </parameter>
        <parameter>
            <valueName>Province</valueName>
            <value>Provincia di Cosenza</value>
        </parameter>
        <parameter>
            <valueName>Municipality</valueName>
            <value>Lago</value>
        </parameter>
        <parameter>
            <valueName>Route</valueName>
            <value>Unnamed Road</value>
        </parameter>
        <parameter>
            <valueName>PostalCode</valueName>
            <value>87035</value>
        </parameter>
        <parameter>
            <valueName>FRP</valueName>
            <value>60</value>
        </parameter>
        <parameter>
            <valueName>Area</valueName>
            <value>1204</value>
        </parameter>
        <parameter>
            <valueName>TFire</valueName>
            <value>1023</value>
        </parameter>
        <parameter>
            <valueName>Temp</valueName>
            <value>297</value>
        </parameter>
        <parameter>
            <valueName>QC</valueName>
            <value>54</value>
        </parameter>
        <area>
            <areaDesc>List of detected fires: latitude, longitude, radius(km)</areaDesc>
                <circle>39.200489,16.14653 2</circle>
        </area>
    </info>
</alert>
```

Forest fires monitoring



Hot spots detected in Near-Real-Time (NRT) by SFIDE by using the MSG-2 (or 9)/SEVIRI images (5 min revisit frequency) of the 20th August 2017

20° of August 2017

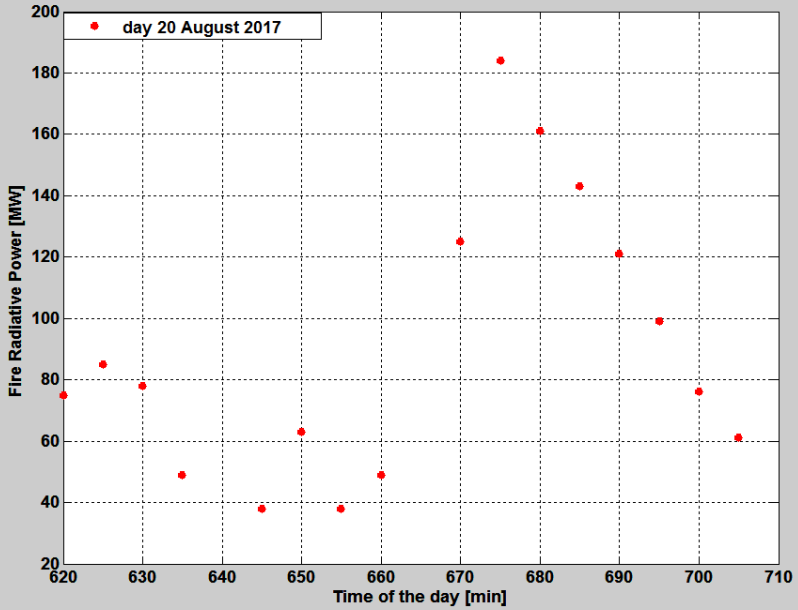
Yallow circle = VVFF fire events

Blue circle = MODIS/VIIRS hot-spots

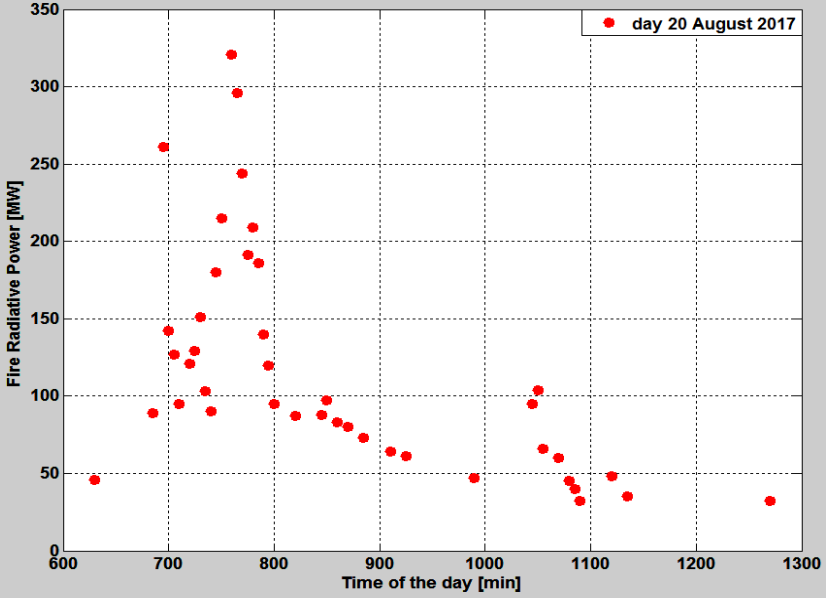
Red circle = = MSG 5 min

Marron circle = CAP EUMETSAT (only 2 events available for the that day)

Forest fires monitoring



Coordinates:
lon = 16.1085
lat = 39.5808

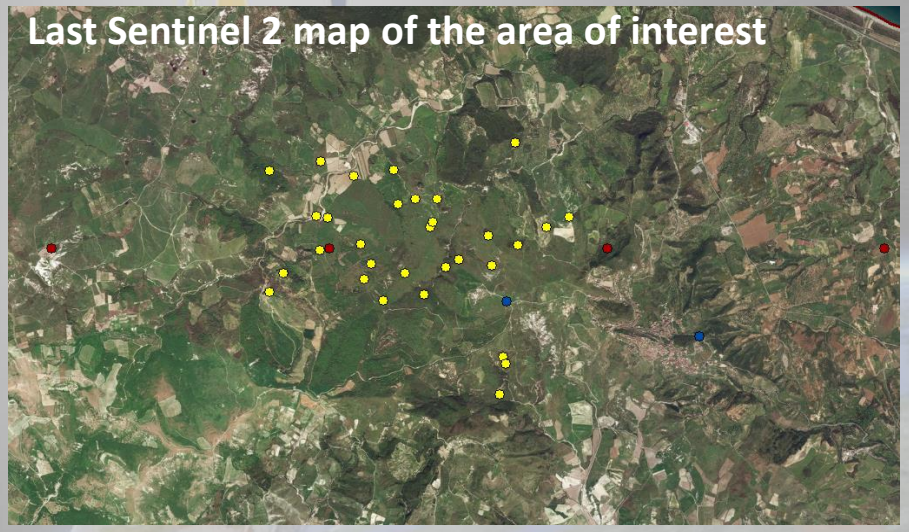


Coordinates:
lon = 17.0582
lat = 39.390

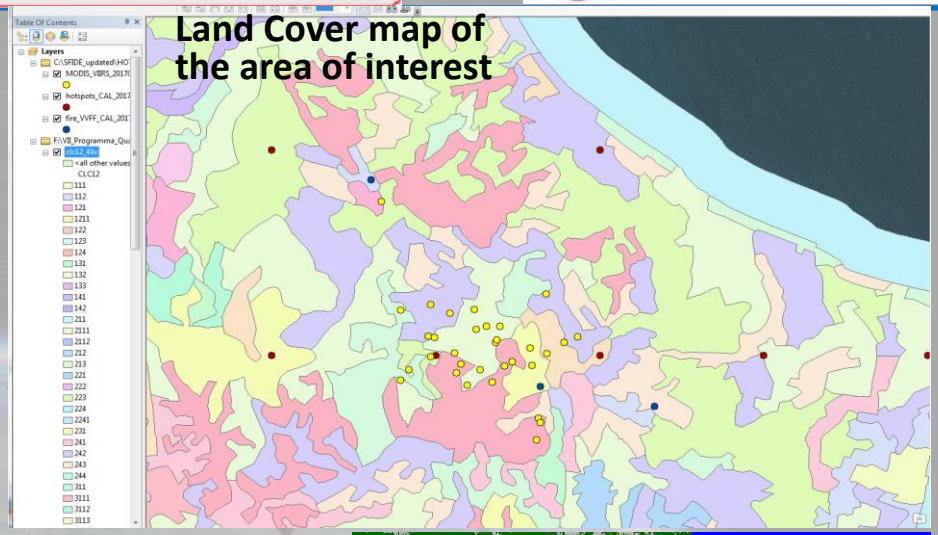
Fire Radiative Power (FRP) as function of the time as retrieved by using SFIDE algorithm and MSG-RSS images (5 min revisit frequency) of the 20th August 2017.
Two events have been considered.

Forest fires monitoring: ancillary data

Last Sentinel 2 map of the area of interest

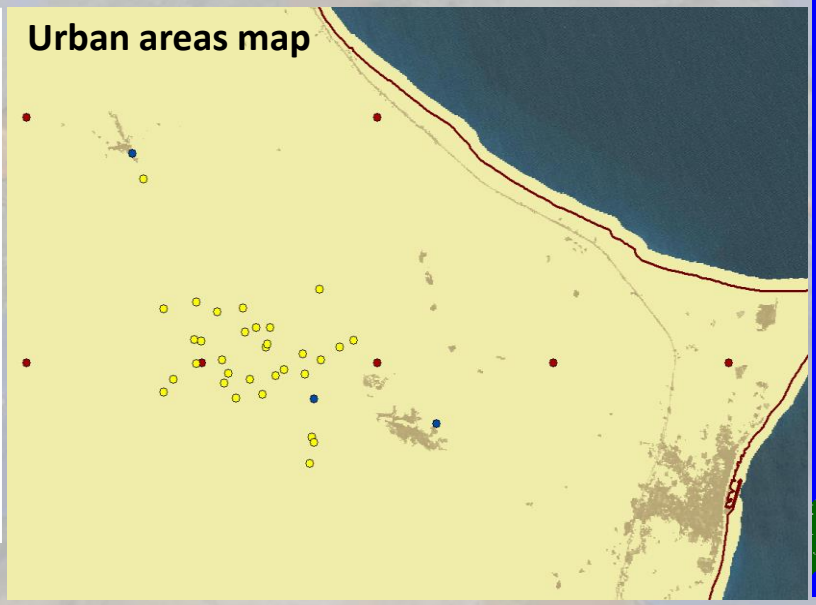


Land Cover map of the area of interest

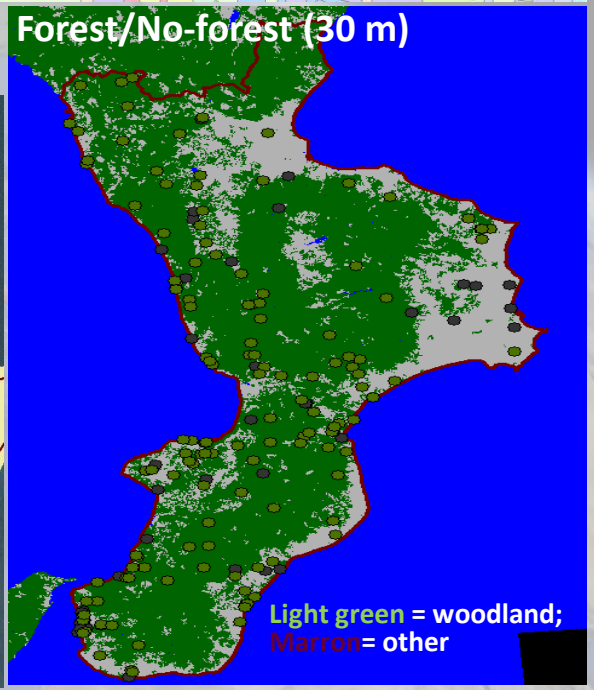


Corine land cover classes

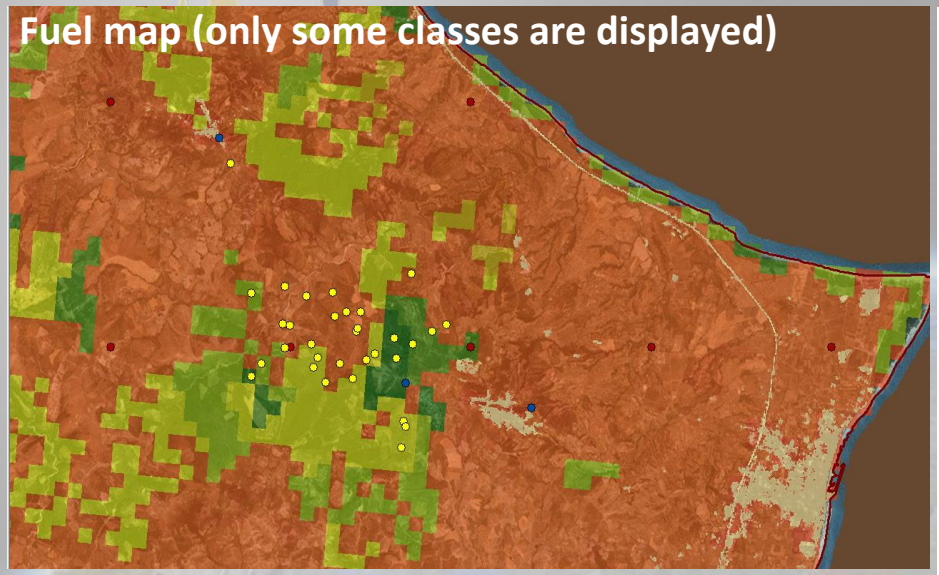
Urban areas map

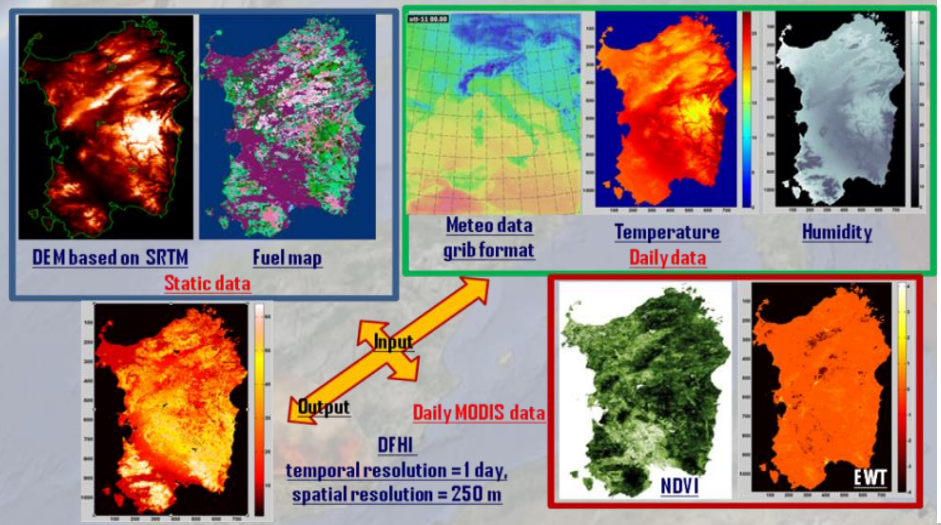


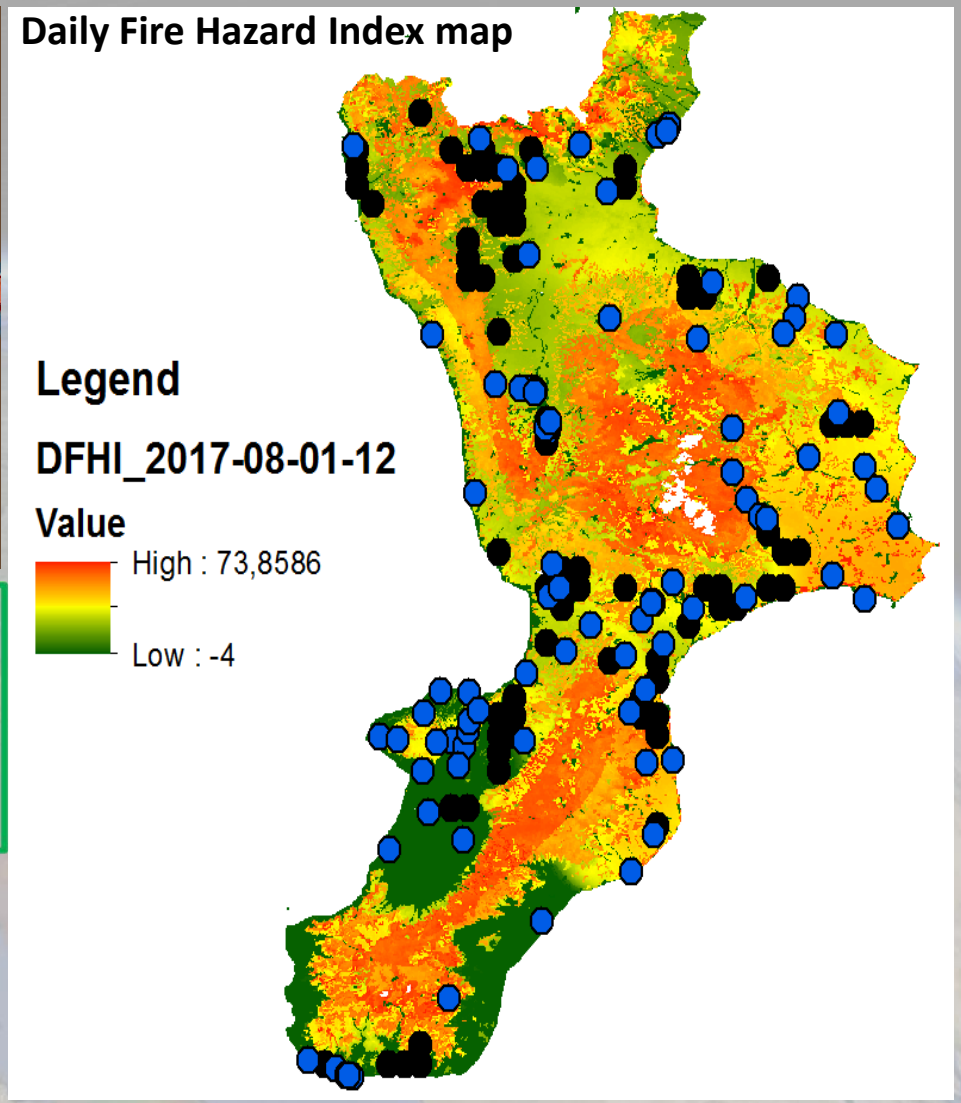
Forest/No-forest (30 m)



Forest fires monitoring: ancillary data





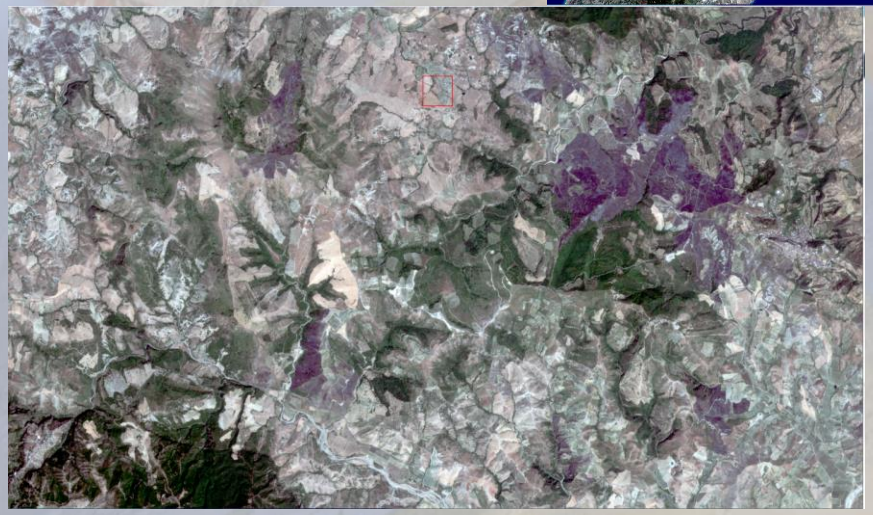


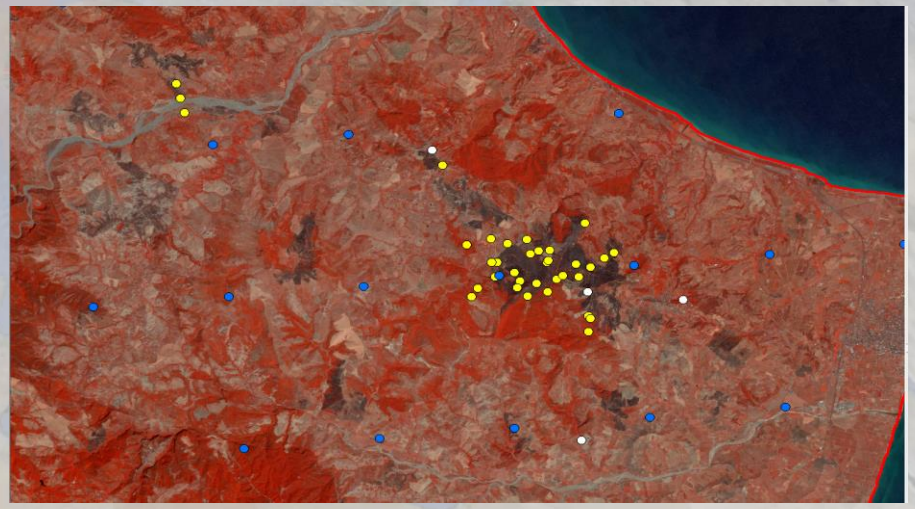
Forest fires monitoring: burned areas

Yellow circle = hot spot MODIS;

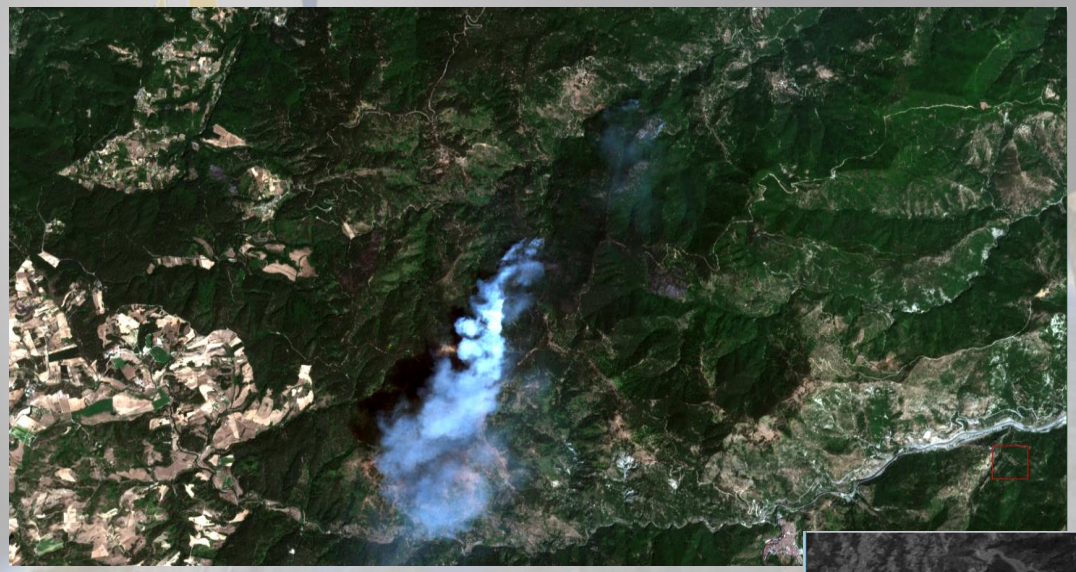
White circle = database VVFF;

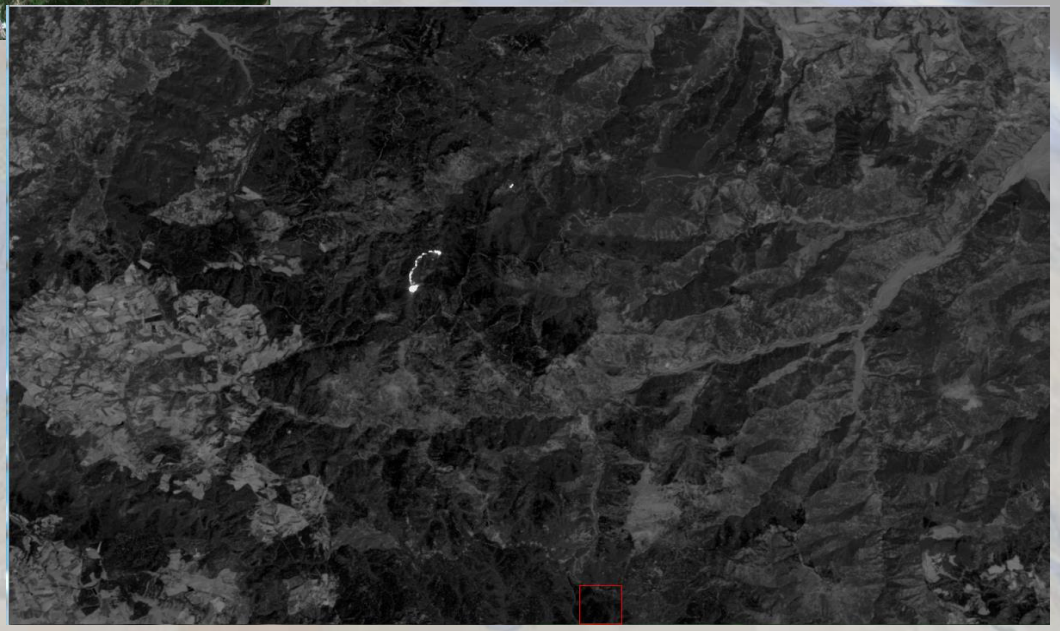
Blue circle = hot spot MSG





Forest fires monitoring: burned areas





Istituto Superiore Antincendio, 20th September 2017

CORPO NAZIONALE DEI VIGILI DEL FUOCO

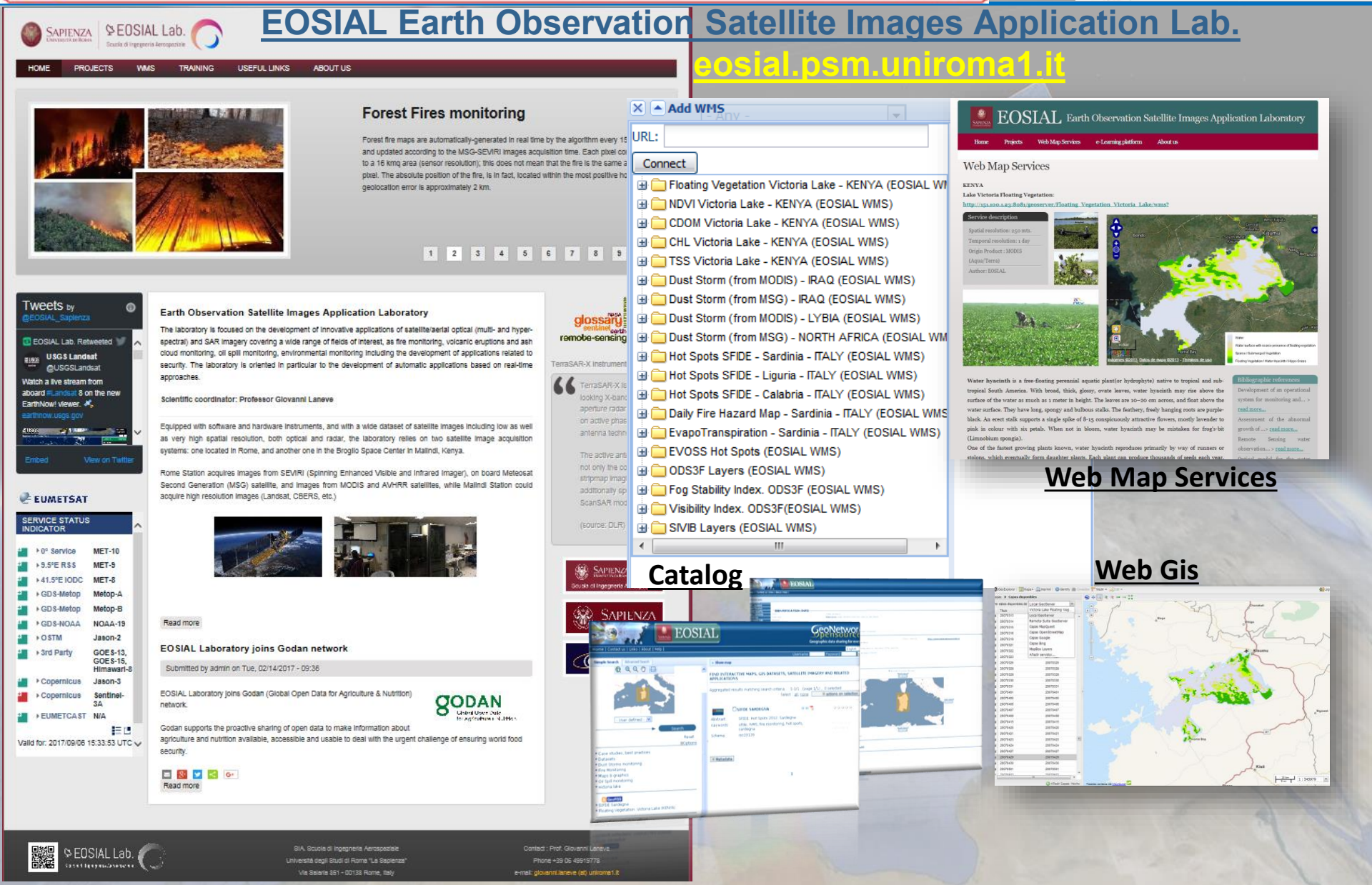
Istituto Superiore Antincendi

Dipartimento dei Vigili del Fuoco, del Soccorso Pubblico e della Difesa Civile

SAPIENZA UNIVERSITÀ DI ROMA

EOSIAL Earth Observation Satellite Images Application Lab.

eosial.psm.uniroma1.it



Web Map Services

Catalog

Web Gis

Istituto Superiore Antincendio, 20th September 2017

PREFER

THANK YOU for your attention !

giovanni.laneve@uniroma1.it

eosial.psm.uniroma1.it