ESA Sentinel-3 World Fires Atlas Prototype

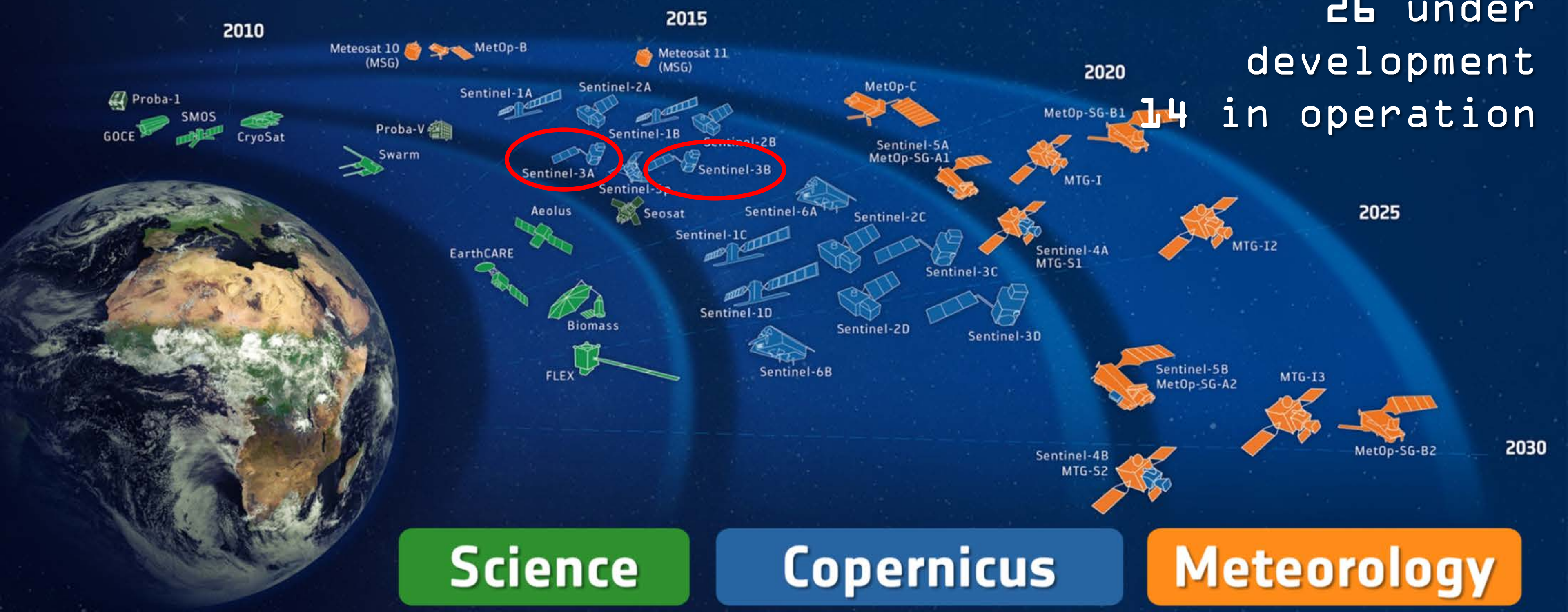
Aerial Firefighting Conference - Nimes (France)

Olivier Arino, Fabrizio Ramoino, Fabrizio Pera

20/03/2019

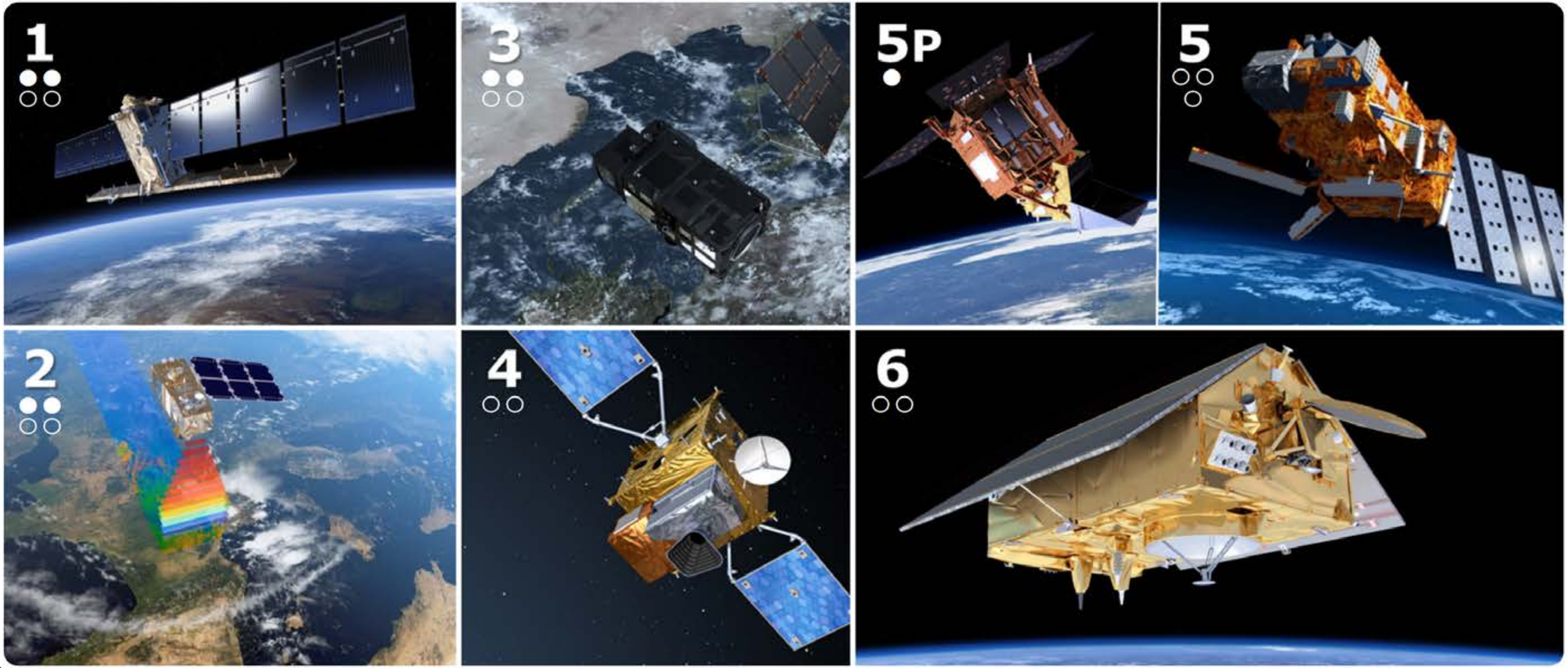
ESA-DEVELOPED
EARTH OBSERVATION MISSIONS

Satellites
26 under development
14 in operation



The Big Data Revolution

Copernicus is the largest producer of EO data in the world



Copernicus Sentinel Status

S-1	S-2	S-3	S-4	S-5P	S-5	S-6
						
Radar	High Res. Optical	Medium Res. Optical & Altimetry	Atmospheric Chemistry (GEO)	Atmospheric Chemistry (LEO)	Atmospheric Chemistry (LEO)	Altimetry
A 3 Apr. 2014	**A** 23 Jun. 2015	**A** 16 Feb. 2016	**A** 2022	**A** 13 Oct. 2017	**A** 2021	**A** 2020
B 25 Apr. 2016	**B** 6 Mar. 2017	**B** 25 Apr. 2018	**B** 2027		**B** 2027	**B** 2025
C 2022/23	**C** 2022/23	**C** 2023			**C** > 2027	
D > 2022/23	**D** > 2022/23	**D** > 2023				

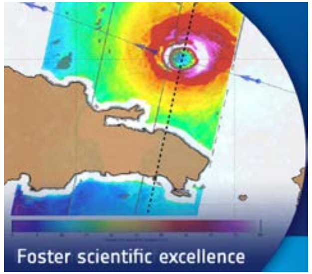
European Space Agency

EO Science for Society

#EO4society

OBJECTIVES

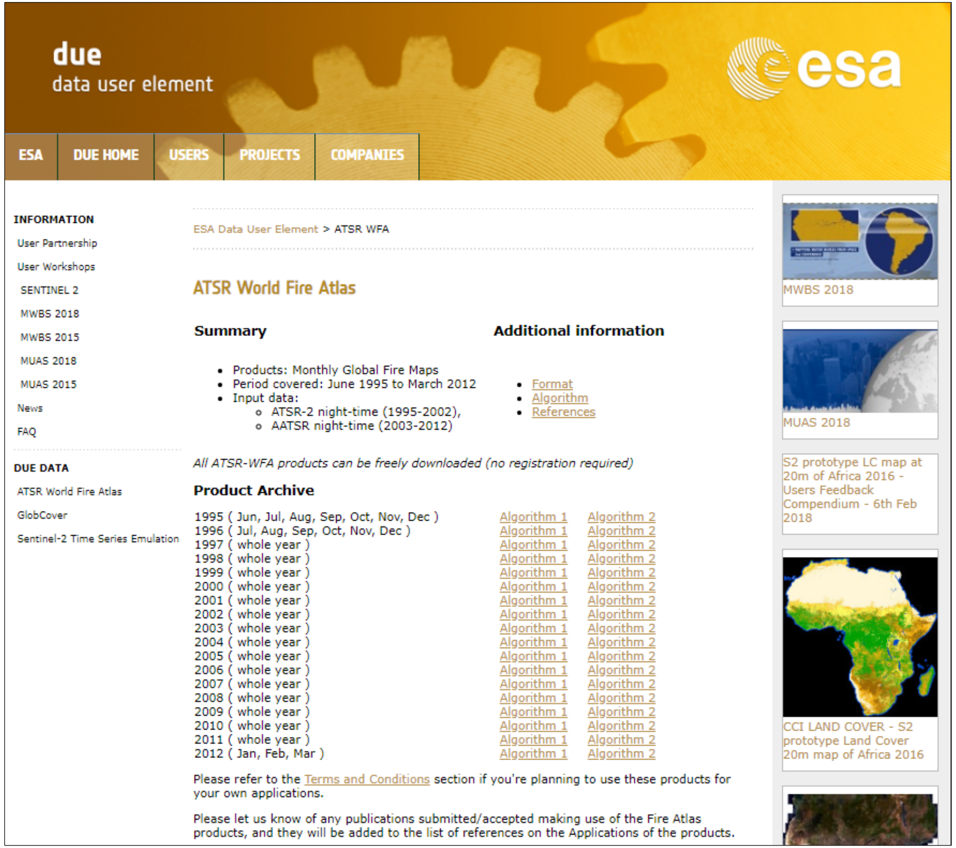
- Foster scientific excellence
- Pioneer new EO applications
- Stimulate downstream industry growth
- Support international responses to global societal challenges
- Develop platforms technical capabilities
- Build network of resources



#EO4society
Consultations

ATSR World Fire Atlas

Overview



due
data user element

ESA | DUE HOME | USERS | PROJECTS | COMPANIES

INFORMATION
- User Partnership
- User Workshops
- SENTINEL 2
- MWBS 2018
- MWBS 2015
- MUAS 2018
- MUAS 2015
- News
- FAQ

DUE DATA
- ATSR World Fire Atlas
- GlobCover
- Sentinel-2 Time Series Emulation

ESA Data User Element > ATSR WFA

ATSR World Fire Atlas

Summary

- Products: Monthly Global Fire Maps
- Period covered: June 1995 to March 2012
- Input data:
  - ATSR-2 night-time (1995-2002),
  - AATSR night-time (2003-2012)

Additional information

- Format
- Algorithm
- References

All ATSR-WFA products can be freely downloaded (no registration required)

Product Archive

1995 (Jun, Jul, Aug, Sep, Oct, Nov, Dec)	Algorithm 1	Algorithm 2
1996 (Jul, Aug, Sep, Oct, Nov, Dec)	Algorithm 1	Algorithm 2
1997 (whole year)	Algorithm 1	Algorithm 2
1998 (whole year)	Algorithm 1	Algorithm 2
1999 (whole year)	Algorithm 1	Algorithm 2
2000 (whole year)	Algorithm 1	Algorithm 2
2001 (whole year)	Algorithm 1	Algorithm 2
2002 (whole year)	Algorithm 1	Algorithm 2
2003 (whole year)	Algorithm 1	Algorithm 2
2004 (whole year)	Algorithm 1	Algorithm 2
2005 (whole year)	Algorithm 1	Algorithm 2
2006 (whole year)	Algorithm 1	Algorithm 2
2007 (whole year)	Algorithm 1	Algorithm 2
2008 (whole year)	Algorithm 1	Algorithm 2
2009 (whole year)	Algorithm 1	Algorithm 2
2010 (whole year)	Algorithm 1	Algorithm 2
2011 (whole year)	Algorithm 1	Algorithm 2
2012 (Jan, Feb, Mar)	Algorithm 1	Algorithm 2

Please refer to the Terms and Conditions section if you're planning to use these products for your own applications.

Please let us know of any publications submitted/accepted making use of the Fire Atlas products, and they will be added to the list of references on the Applications of the products.

MWBS 2018

MUAS 2018

S2 prototype LC map at 20m of Africa 2016 - Users Feedback Compendium - 6th Feb 2018

CCI LAND COVER - S2 prototype Land Cover 20m map of Africa 2016

http://due.esrin.esa.int/page_wfa.php

Products: *Monthly Global Fire Maps*

Period covered: *June 1995 to March 2012*

Input data:
ATSR-2 night-time (1995-2002)
AATSR night-time (2003-2012)

The pixel resolution of ATSR data is 1km.

Two straightforward algorithms have been tested in this project:

Algorithm 1: *Hot spot if: 3.7 μm > 312 Kelvins (Saturation)*

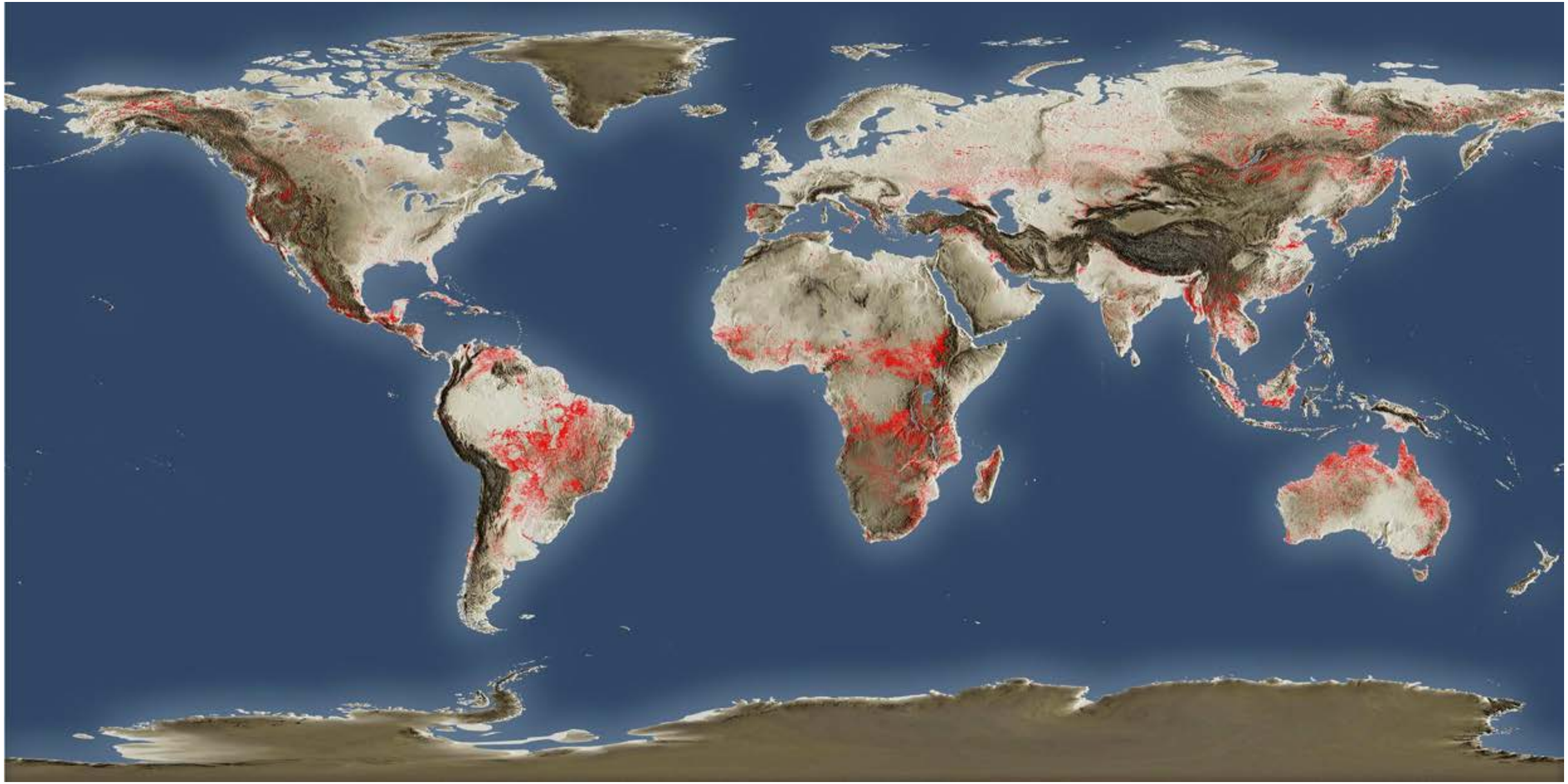
Algorithm 2: *Hot spot if: 3.7 μm > 308 Kelvins*

The user of the Fire product must take into account the algorithm limitations due to cloud presence, atmospheric effects, bidirectionality of emissivity. Fire temperature and extension are not taken into account in the processing.

ATSR World Fire Atlas

Results & Achievements

ATSR World Fire Atlas 1995–2010



ATSR World Fire Atlas

Results & Achievements

Remote Sensing of Environment 116 (2012) 226–238

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Global night-time fire season timing and fire count trends using the ATSR instrument series

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ABSTRACT

Global night-time fire counts for the years from 1995 to 2009 have been obtained by using the latest version of Along Track Scanning Radiometer Top of Atmosphere radiance products (level 1B), and related trends have been estimated. Possible biases due to cloud coverage variations have been assumed to be negligible. The sampling number (acquisition frequency) has also been analysed in detail and proved not to influence our results. The new ATSR World Fire Atlas (WFA) product continuity has been tested by comparing the partially overlapping fire counts time series from the ATSR-2 (on board ERS-2) and the AATSR (on board ENVISAT) missions which showed negligible offsets. The ATSR-WFA products show very good correlation with the TRMM-VIRS and MODIS-Aqua/Terra monthly night-time fire counts. Global night-time fire trends have been evaluated by inspecting the time series of hot spots aggregated a) at 2°×2° scale; b) at district/country/region/continent scales, and c) globally. The statistical significance of the estimated trend parameters has been verified by means of the Mann–Kendall test. Results indicate that no trends in the absolute number of fire counts can be identified at the global scale, that there has been no appreciable shift in the fire season during the last 14 years, and that statistically significant positive and negative trends are only found when data are aggregated at smaller scales.

1. Introduction

Biomass burning has been recognised to play an important role in regional and global climate change (Harden et al., 2000; Hoffmann et al., 2003; Kasischke et al., 1995), and also to affect weather on much shorter scales (Andreae, 1991; Rosenfeld, 1999). Investigation of the impact of climate change on wild fire activity at the regional scale has been recently attempted, showing that by the year 2050 the expected increases in surface temperature might cause a drastic increase in the annual mean burned area (Spracklen et al., 2009). However, our capability of assessing risks related to possible changes in fire regimes at the global scale is impaired by the poor representations of fires in global models (Bowman et al., 2009).

Globally fires can be of different nature, but in general three main categories can be identified: forest fires, agricultural fires and industrial fires. Forest fires are mainly attributed to human behaviour, e.g. in the Mediterranean region, while an ignition factor of natural origin (e.g. lightning) is relevant in the Boreal region. In agriculture fire has been used for thousands of years (Clement & Horn, 2001; Delcourt et al., 1998; Goldammer, 1988). As to the industrial component, gas flaring activity related to oil-gas extraction appears to be the dominant factor (Marland et al., 2008).

The most effective tools for global fire analysis are space-borne instruments, as they are capable of detecting flames at relatively high space and time resolution, even in remote areas not accessible with other means. Rigorous processing of such measurements allows the construction of a statistically significant data set that shows no sampling bias.

Global fire time series derived from different space-borne sensors are by now long enough (i.e. more than 14 years) to allow the analysis of long term trends at the global scale with adequate accuracy. The long history of fire detection from space started with the pioneering works of Dozier (1981) and Matson and Dozier (1981), in which the thermal response of the Advanced Very High Resolution Radiometer (AVHRR) sensor (on board the NOAA satellites) was analysed. In particular, Dozier theoretically approached the study of the sub-pixel temperature fields by using the 3.7 and 10.6 µm channels of AVHRR. For more than twenty years space-borne detection of active fires has been conducted making use of sensors operating at visible to infrared wavelengths, with a 1–3 km nadir spatial resolution and a spectral channel in the middle infrared atmospheric window, i.e. 3.4 to 4.2 µm. The most effective sensors in this class have been NOAA-AVHRR

Remote Sensing of Environment 116 (2012) 239–249

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Gas flaring monitoring from space using the ATSR instrument series

Stefano Casadio [a,*], Olivier Arino [b], Danilo Serpe [a]

Remote Sensing of Environment 123 (2012) 175–186

Contents lists available at SciVerse ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Use of ATSR and SAR measurements for the monitoring and characterisation of night-time gas flaring from off-shore platforms: The North Sea test case

S. Casadio [a,*], O. Arino [b], A. Minchella [c]

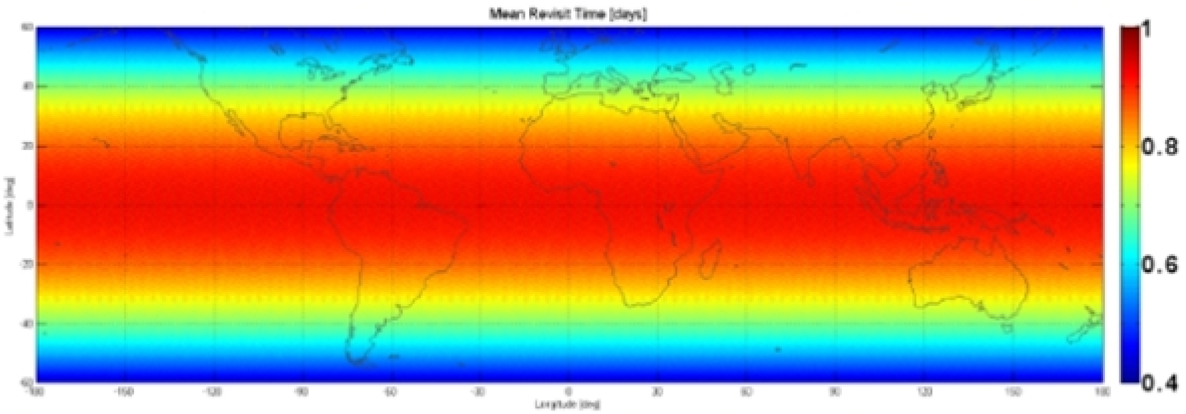
Sentinel-3

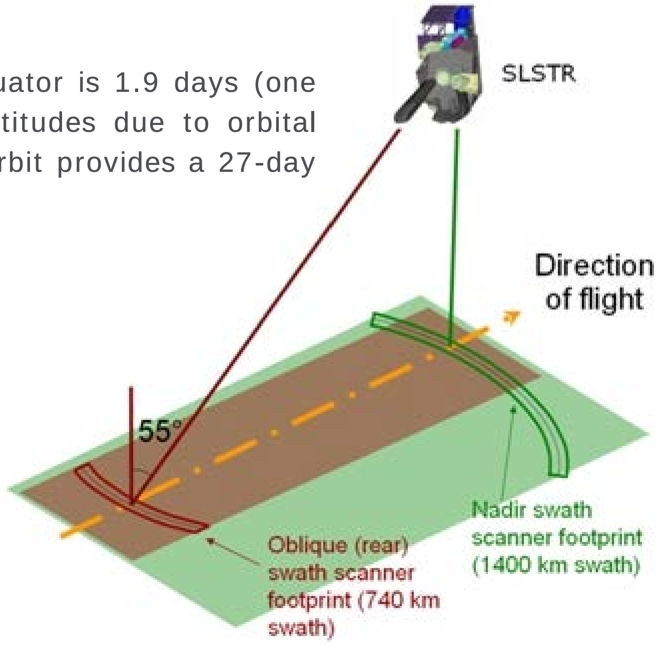
SLSTR Overview

The **SLSTR** (Sea & Land Surface Temperature Radiometer) uses two independent scan chains each including a separate scan mirror. While more complex than the single scan system employed by the ATSR instrument, this configuration especially increases instrument swath coverage.

- Oblique view swath: ~ 740 km
- Nadir view swath: ~ 1400 km.

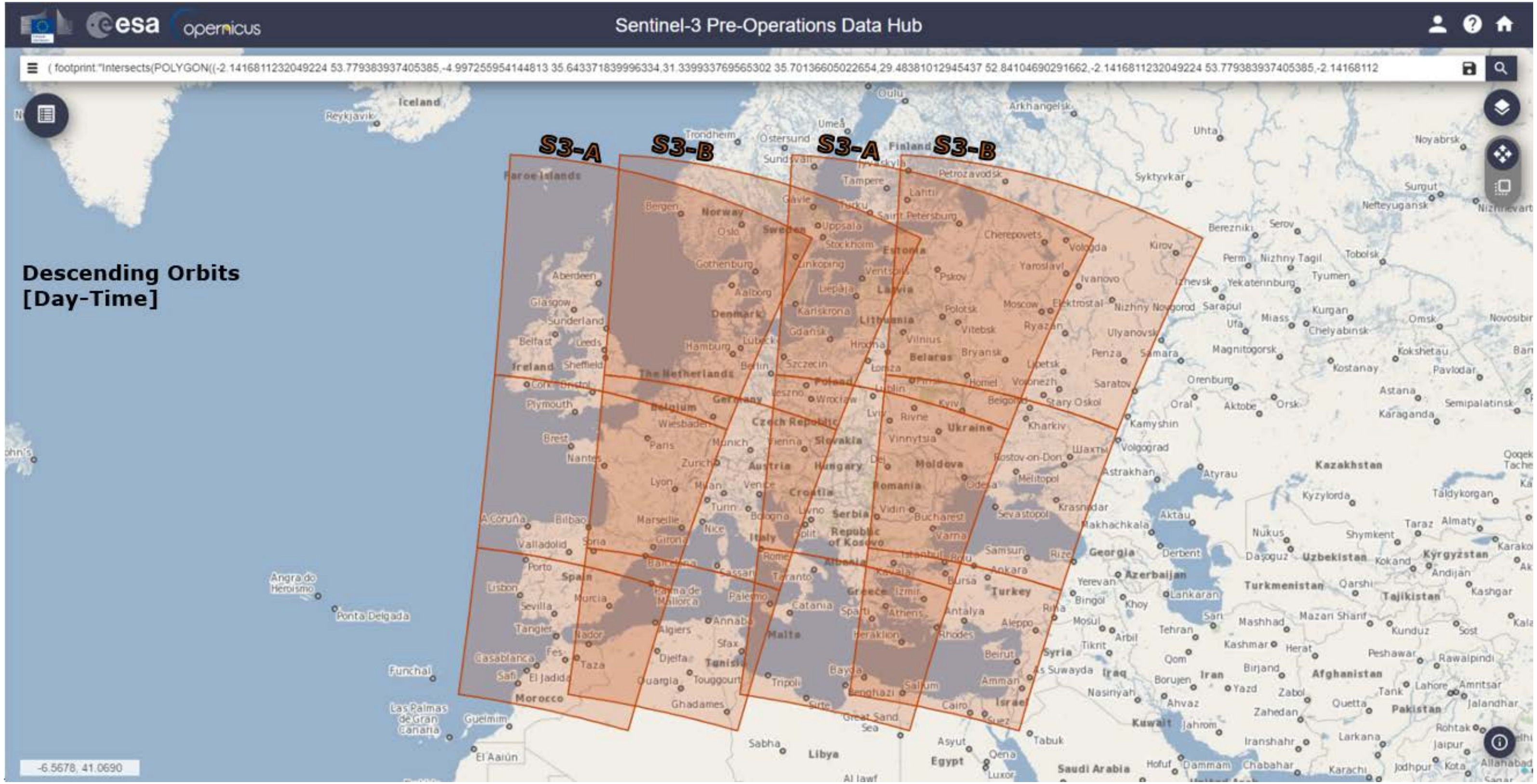
The mean global coverage revisit time for dual view SLSTR observations ate the equator is 1.9 days (one spacecraft) or 0.9 days (two spacecraft) with these values increasing at higher latitudes due to orbital convergence, with a local equatorial crossing time of **10:00 am/pm**. This satellite orbit provides a 27-day repeat.





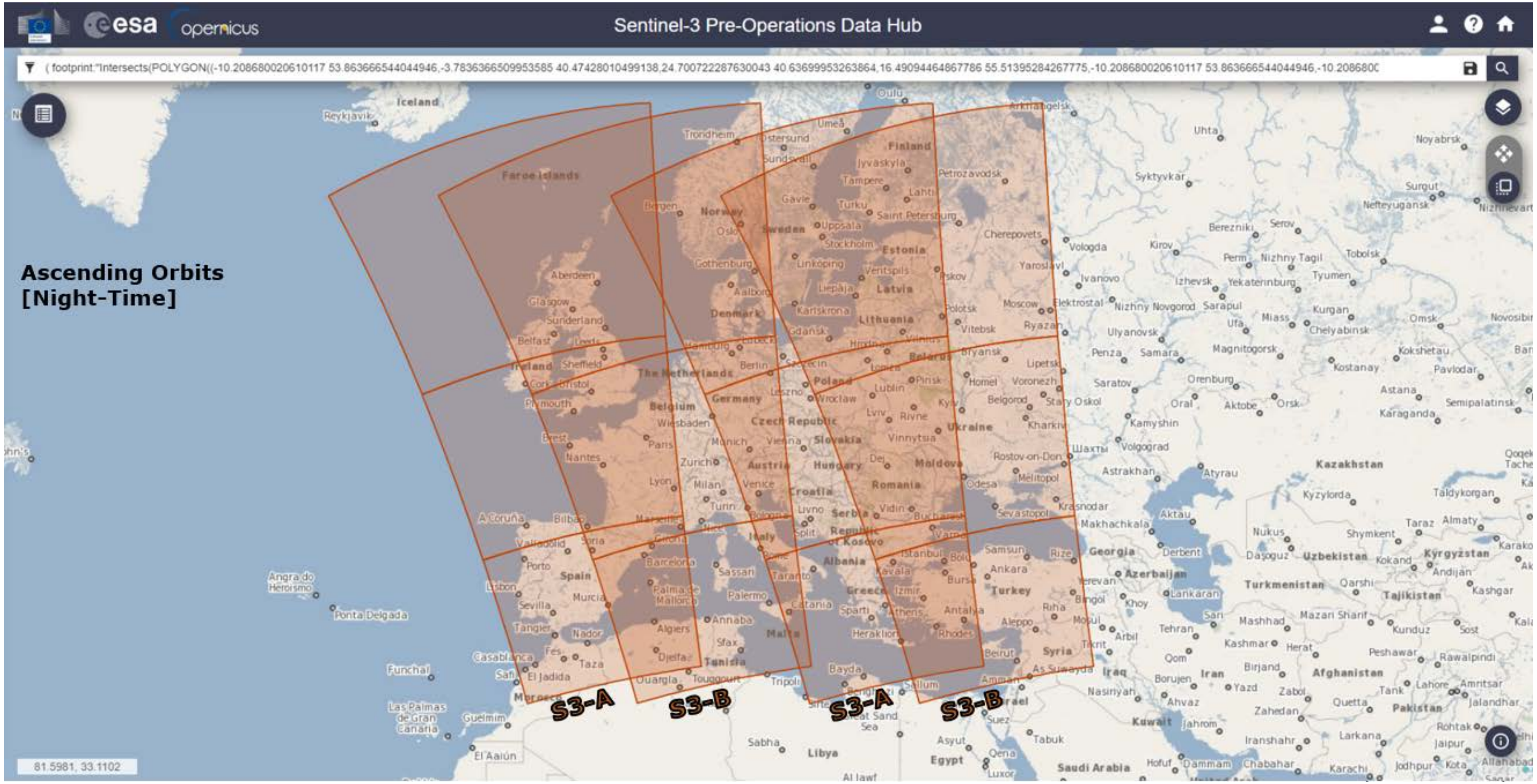
Sentinel-3

SLSTR Day-Time Coverage over the Area of Interest



Sentinel-3

SLSTR Night-Time Coverage over the Area of Interest



Sentinel-3

SLSTR Spectral Bands

Band	Central Wavelength (nm)	Bandwidth (nm)	Function	Comments		Resolution (metres)
S1	554.27	19.26	Cloud screening, vegetation monitoring, aerosol	**VNIR**	**Solar Reflectance Bands**	**500**
S2	659.47	19.25	NDVI, vegetation monitoring, aerosol			
S3	868.00	20.60	NDVI, cloud flagging,Pixel co-registration			
S4	1374.80	20.80	Cirrus detection over land	**SWIR**		
S5	1613.40	60.68	loud clearing, ice, snow,vegetation monitoring			
S6	2255.70	50.15	Vegetation state and cloud clearing			
S7	3742.00	398.00	SST, LST, Active fire	**Thermal IR Ambient bands (200 K -320 K)**		**1000**
S8	10854.00	776.00	SST, LST, Active fire			
S9	12022.50	905.00	SST, LST			
F1	3742.00	398.00	Active fire	**Thermal IR fire emission bands**		
F2	10854.00	776.00	Active fire			

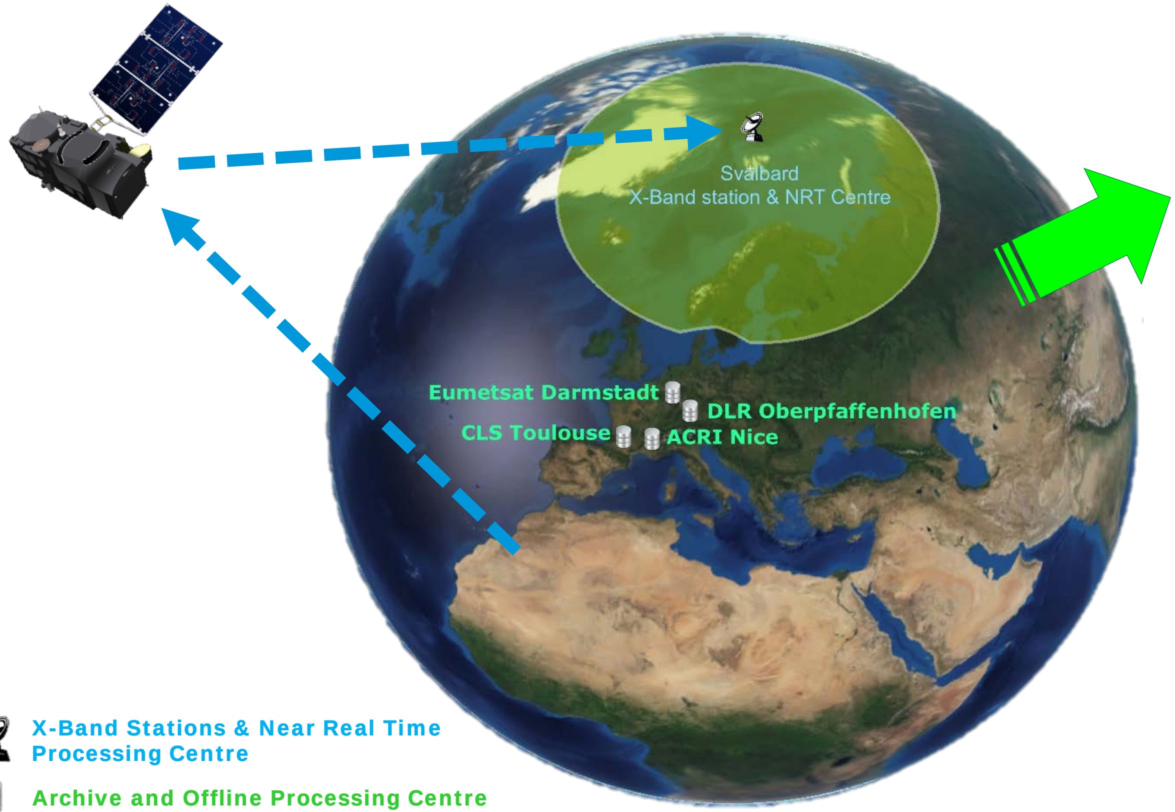
An on-ground resolution of 0.5 km at nadir for all VIS and SWIR channels. Radiance measurements from these channels are used for both land and clouds daytime observations.

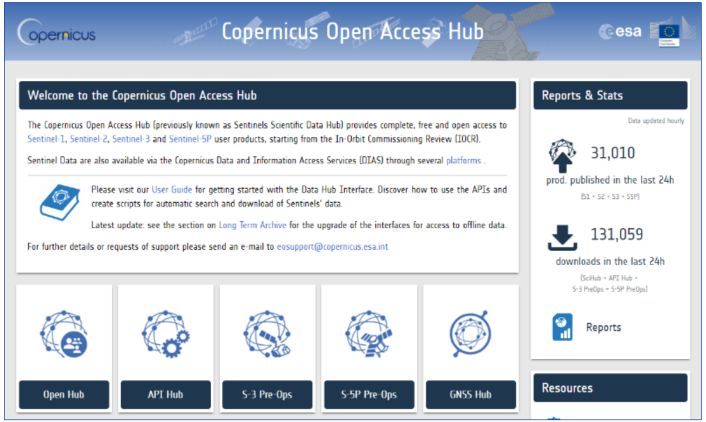
Two SWIR channels (at wavelengths of 2.25 μm and 1.375 μm) to allow improved cloud and aerosol detection to give more accurate SST/LST retrievals.

Two dedicated channels (F1 and F2) for fire and high temperature event monitoring at 1 km resolution (by extending the dynamic range of the 3.7 μm channel and including dedicated detectors at 10.8 μm that are capable of detecting fires up to ~650 K without saturation).

ESA Sentinel-3 World Fires Atlas Prototype

Responding time





X-Band Stations & Near Real Time Processing Centre

Archive and Offline Processing Centre

The timeframe for delivery of SLSTR products is dependent on the specific application:

- ✓ **Near Real-Time (NRT)** *products, delivered to the users in less than 3 hours after acquisition of data by the sensor worldwide.*
- ✓ **Non-Time Critical (NTC)** *products delivered not later than 1 month after acquisition or from long-term archives. Typically, the product should be available within 24 or 48 hours (but this is not guaranteed).*

ESA Sentinel-3 World Fires Atlas Prototype

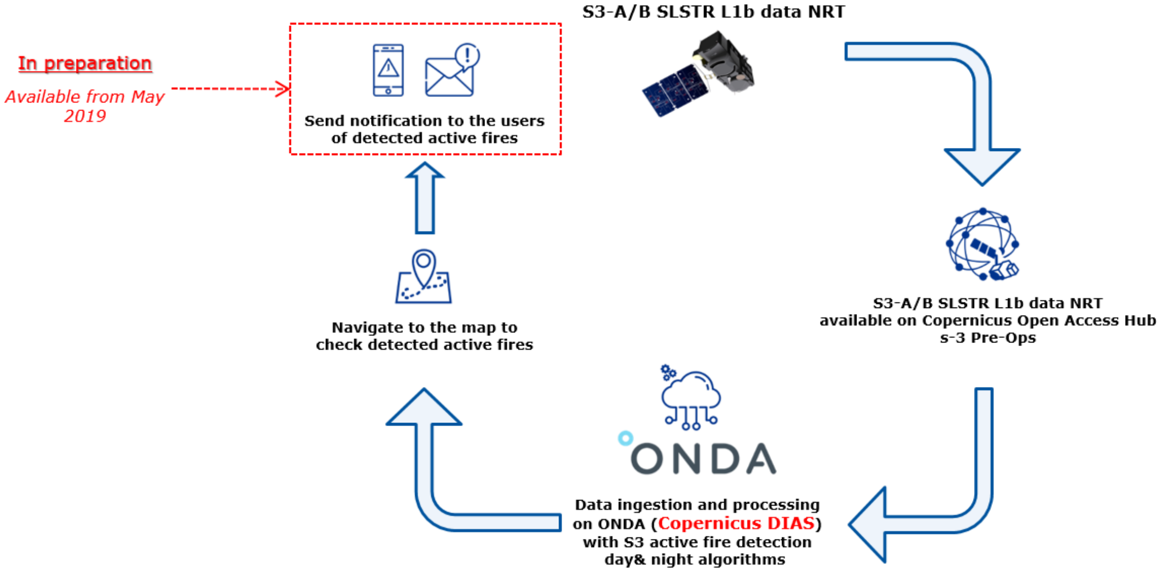
System Overview (Daily routine)

The Sentinel-3 World Fires Atlas Prototype product has been developed by ESA over the southern countries of the ESA member states (Latitude from 34°N to 60°N; Longitude from 12°W to 31°E) using both Fire channels of the S3A and S3B SLSTR sensors.

The algorithm is derived from a simplification of the work of Wooster et al., 2012 adapted to NRT processing constraints.

ESA intends to process systematically all acquired Sentinel-3A and Sentinel-3B data from April 2019 onward over this region and operate the prototype service up to end of summer.

In order to improve the ESA Sentinel-3 World Fires Atlas Prototype product and service, feedback from users are welcome by email at due@esa.int.



ESA Sentinel-3 World Fires Atlas Prototype

Algorithms Description

S3-Fire_DT [Day-Time]

For all valid pixels over land is applied an algorithm based on:

- ✓ Brightness Temperature of Sentinel-3 Fire channels acquired at nadir (*F1_BT_in* and *F2_BT_in*)
- ✓ *Skin Temperature – auxiliary data provided by ECMWF [it is defined as the temperature of the surface at radiative equilibrium. It forms the interface between soil, snow or ice and the atmosphere]*
- ✓ Contextual filters*, mean & standard deviation on 5x5 window, are applied in order to prevent false alarms

S3-Fire_NT [Night-Time]

For all valid pixels over land is applied an algorithm based on:

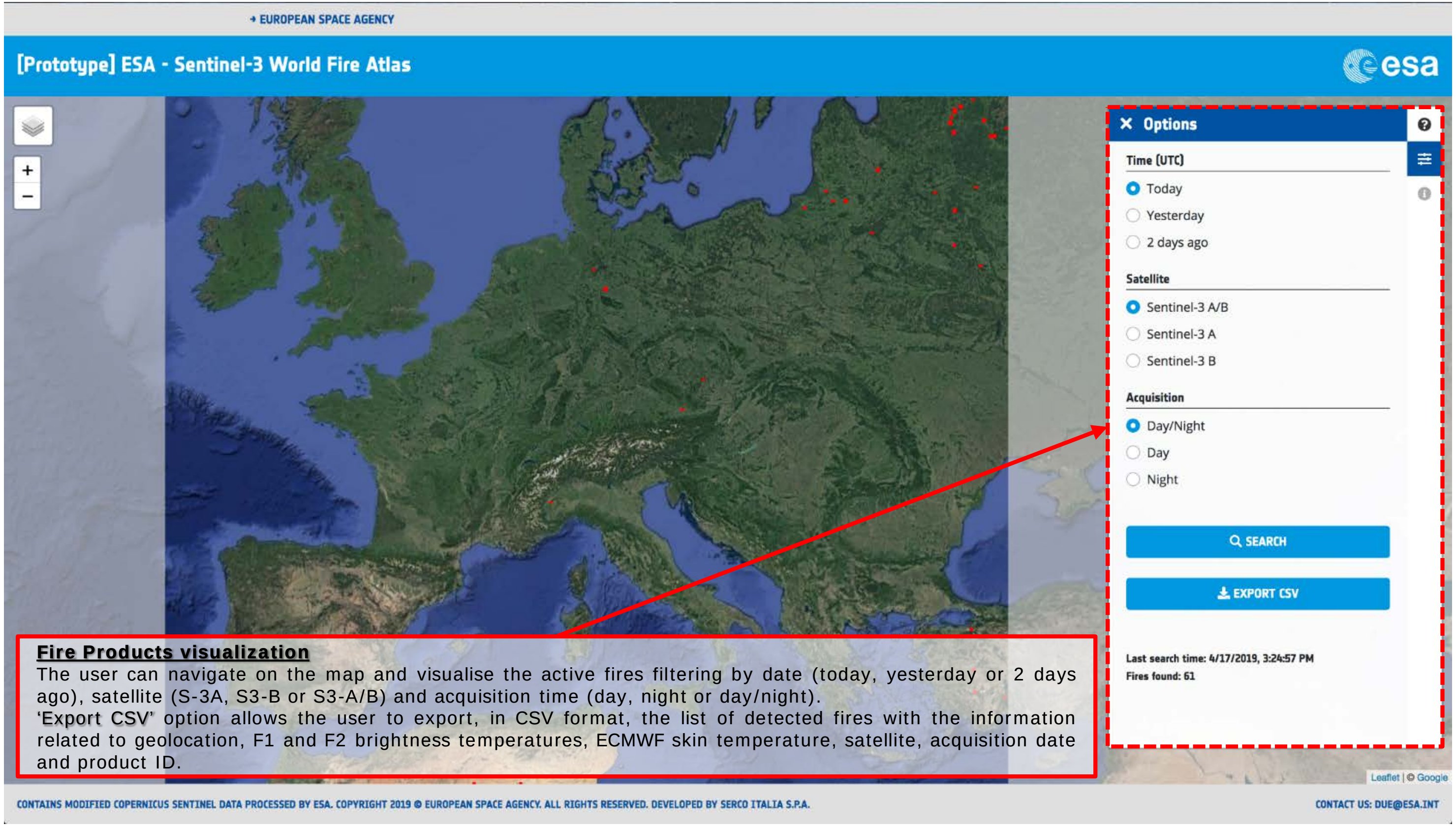
- ✓ Brightness Temperature of Sentinel-3 Fire channels acquired at nadir (*F1_BT_in* and *F2_BT_in*)
- ✓ Contextual filters* (mean & standard deviation on 5x5 window) are applied in order to prevent false alarms

**Contextual filters derived from a simplification of the work of Wooster et al. 2012*

N.B. Presence of clouds prevents the detection of fires

ESA Sentinel-3 World Fires Atlas Prototype

System Overview (Near Real Time)



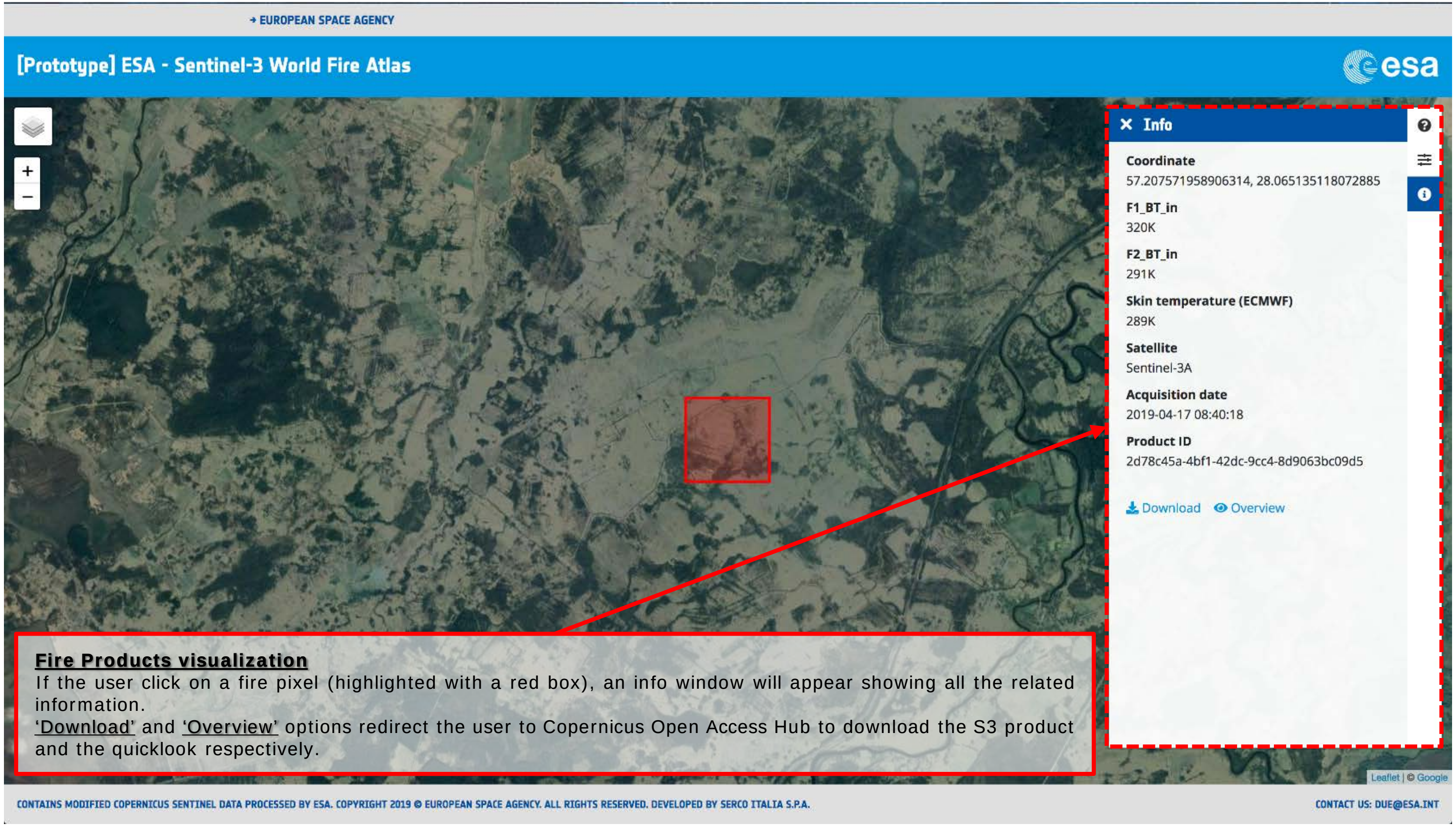
Fire Products visualization

The user can navigate on the map and visualise the active fires filtering by date (today, yesterday or 2 days ago), satellite (S-3A, S3-B or S3-A/B) and acquisition time (day, night or day/night).

'Export CSV' option allows the user to export, in CSV format, the list of detected fires with the information related to geolocation, F1 and F2 brightness temperatures, ECMWF skin temperature, satellite, acquisition date and product ID.

ESA Sentinel-3 World Fires Atlas Prototype

System Overview (Near Real Time)



Fire Products visualization

If the user click on a fire pixel (highlighted with a red box), an info window will appear showing all the related information.

'Download' and 'Overview' options redirect the user to Copernicus Open Access Hub to download the S3 product and the quicklook respectively.