

Aerial Firefighting Conference - Nimes (France)

Olivier Arino, Fabrizio Ramoino, Fabrizio Pera

20/03/2019

ESA-DEVELOPED EARTH OBSERVATION MISSIONS

EarthCARE

2010

Proba-1

2015



Satellites
26 under
development

MetOp-SG-B1 14 in operation

MTG-I

Sentinel-3C

Sentinel-4A

MtG-I2

MtG-I3

Sentinel-4B

MetOp-SG-A2

MtG-I3

MetOp-SG-B2

MtG-I3

MetOp-SG-B2

MtG-I3

2020

Science

Copernicus

Sentinel-2C

Meteorology

The Big Data Revolution



Copernicus is the largest producer of EO data in the world



Copernicus Sentinel Status







Radar

A 3 Apr. 2014

25 Apr. 2016

c 2022/23

D > 2022/23

S-2



High Res. Optical

A 23 Jun. 2015

B 6 Mar. 2017

c 2022/23

D > 2022/23

S-3



Medium Res. Optical & Altimetry

A 16 Feb. 2016

5 25 Apr. 2018

c 2023

D > 2023

S-4



Atmospheric Chemistry (GEO)

A 2022

B 2027

S-5P



Atmospheric Chemistry (LEO)

A 13 Oct. 2017 **S-5**



Atmospheric Chemistry (LEO)

A 2021

B 2027

c > 2027

S-6



Altimetry

A 2020

B 2025

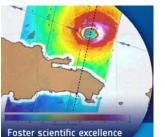
EO Science for Society

#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

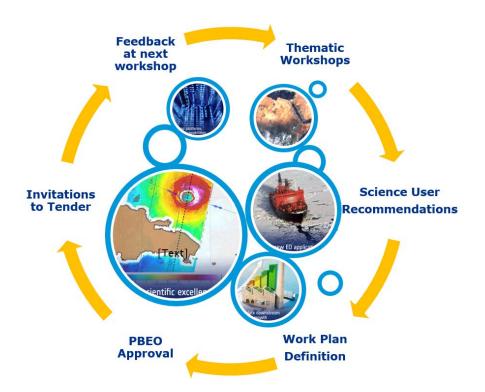












































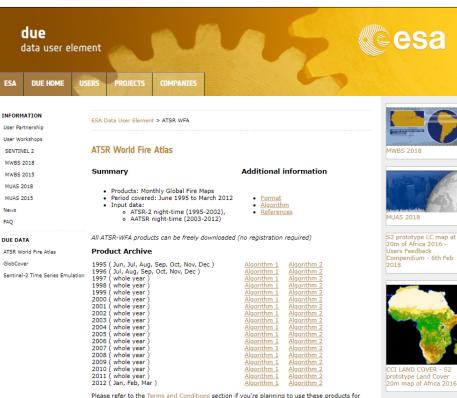




ATSR World Fire Atlas

Overview





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 μ m > 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.









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.



































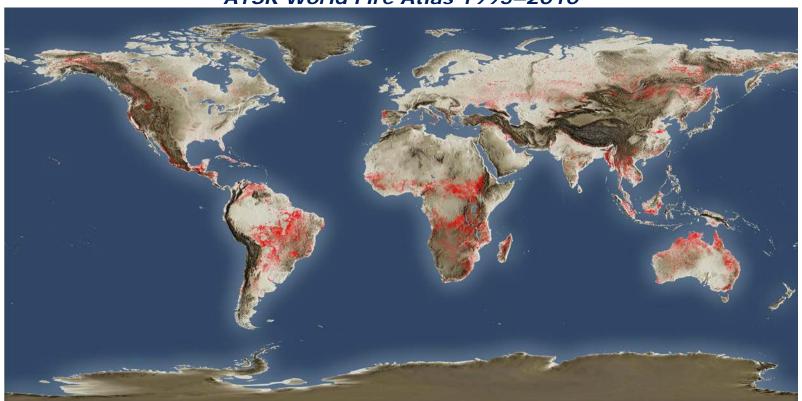


ATSR World Fire Atlas

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

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

European Space Agency, Earth Observation Directorate, ESA-ESRIN, Via Galileo Galilei, 00044, Frascati, Italy b Serco, c/o ESA-ESRIN, Via Galileo Galilei, 00044, Frascati, Italy

ARTICLE INFO

Article history Received 30 October 2009 Received in revised form 19 April 2011 Accepted 7 May 2011 Available online 16 July 2011

Keywords: Fires Satellite Global trends ARSTRACT

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.

© 2011 Elsevier Inc. All rights reserved.

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 (Rowman 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

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 um 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





SERCO 198, co 258 ESREI, via Galiko Galiko, 00044 Prasast, Italy European Space Agency, Earth Observation Directrosis, ESA-ESRE, Via Galiko Galiki, 00044, Prascat, Italy

ARTICLE INFO

A B E F I A C T

Graph (Born or a Characterisch III bijd interment aus der SEII) introment aus erstägen wied für
gegende gesch sich in dasser dem in der intern inner gelt der gegen gibt der das dem der Weiter
gegende gesch der der Sein der Sein internet uns der Sein der Sein der Sein der Sein der
sein der Sein der Sein der Sein der Sein für Sein der Se

Playing and venting of natural was in oil wells is a significant source of greenhouse gas emissions. Its contribution to greenhouse gases has lectined by three-quarters in absolute terms since a peak in the 1970s of approximately 110 million metric tons/year, and now accounts for 1.5% of all anthroporenic carbon dioxide emissions (Marland et al. 0.5% of all anthropogenic carbon docode emissions (Mariand et al., 2008). A gas flare is an elevated vertical stack found on oil wells, oil rigs, and in refinences, chemical plants and landfills, used for burning off unwanted gas and liquids released by pressure relief valves during. unplanned over-pressuring of plant equipment (Beychok, 2005; insurpting operations and causing the formation of large icides. In order to keep the flare system functional, a small amount of gas is ed so that the system is always ready for its primary urnose as an over-cressure safety system. Some flares have been the public. Archived products are also freely available after a simple

used to hum flammable "waste" mass or bulereducts that are m amount of energy resources that could be stocked and reused is wasted, contributing to the global carbon emission budget. In this context, during his long history, the ATSR World Fire Aclas WFA) demonstrated its usefulness, as in many other research areas This ESA projects aims at the detection of night-time hot spots usin middle-infrared (MR) and thermal infrared (TIR) radiations acquired by the Along Track Scanning Radismeter (ATSR) instruments flying onboard ESA ERS-1, ESR-2 and ENVISAT LEO satellites. The basic WFA ALCO1 and ALCO2 retrieval approaches have been recognised to b hore, 2006. On oil production rigs, in refineries and chemical plants. efficient and the related results satisfactorily accurate (Arino et a its primary purpose is to act as a safety device to protect vessels or joppes from ever-pressuring due to unplanned uppets. The released consist in the detection of the Milk 3.7 pm right-time brightness gases and/or log-special are burned as the year the flare steads. The size -100 m²) and brightness of the resulting flame depends upon how have been chosen according to instrumental characteristics (312 K i the saturation level of the ATSE 3.7 um channel). The radiometri stability of the ATSR instrument series, along with the excellent stability of the EES-1/2 and ENVISAT satellites, ensures the consistency of the detection capability for long time periods. Since 2006 ES has been maintaining a near-real-time elaboration and distribution

service through which the ATSR-WFA products are freely available to

Contents lists available at SciVerse ScienceDirect Remote Sensing of Environment

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

Remote Sensing of Environment 123 (2012) 175-186

S Casadio ** O Arino b A Minchella

Serco, cle 2551-25809, We Gallier Galliet, 00944, Prenast, Indy Surrepress Space-Agency, Starth Observation Devanages, 556-558 S.S.A.C., cle 1558-25809, Vin Gallien Gallyc, 00044, Frescott, Britis -PSROE STANGESTON CORES, DROME, Francisco, India

ARTICLE INFO

A B T I A C T

A model of the resolution of regist time gas forcing of off clear only an ordination delices a major recommendation and a contract of the contr

ells, oil rigs, and in refineries, chemical plants and landfills, used for huming off unwanted cas and liquids released by pressure relief to outing ou timentee gas and uptoo tendered by prosoure road waves during implanted over-pressuring of plant equipment (Beychok, 2005; Shine, 2006). On oil production rigs, in refineries and chemical plants, its primary purpose is to act as a safety device to protect wascils or pipes from over-pressuring due to unplanted upsets. The released gases and/or liquids are burned as they exit the flare stacks. The size (from 1 to 100 m²) and brightness of the resultducts that are not economical to retain. Although safety considerations are indeed an issue, a vast amount of energy resources that

(Farina, 2010), in fact, the commercial extraction of oil on the Nort Sea dates back to 1851 while natural gas was found near Hambur in 1910. In England, the British Petroleum company (BP) discovere eas in 1938 and in 1939 commercial oil was found in Nottingham shire. From 1953 to 1961 the Gainstocough field and other smalle fields were discovered. The Netherlands' first oil extractions took place at De Minnt in 1938. The first exploration in the prevince of Gro-ningen was carried out in 1952 and in 1959 gas was found in the Redlegendes. The seismic exploration started in 1965 and large gas finds followed in 1966. The discovery of the Forties oilfield in October 1970 and Shell Expro discovered the Brent oilfield in the northern North Soa in 1971. Oil production from the Argyll field started in 1975. The Donish explorations of Cennosic stratigraphy, undertaken in the 1990s, showed petroleum rich reserves in the north

onitoring dates back to the latest wars of the past or



















































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.

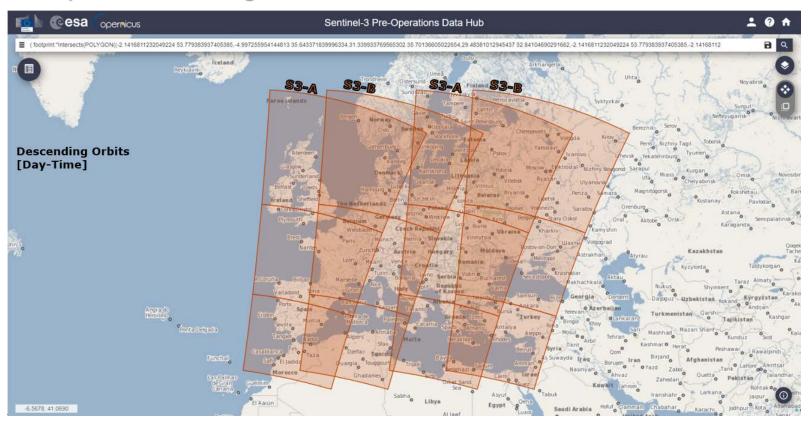
SLSTR The mean global coverage revisit time for dual view SLSTR observations ate the equator is 1.9 days (one spacecraft) or 0.9 days (two spacecraft) with these values increasing at higher latitudes due to orbital convergence, with a local equatorial crossing time of 10:00 am/pm. This satellite orbit provides a 27-day repeat. Mean Revisit Time (days) Direction of flight 0.8 Nadir swath scanner footprint Oblique (rear) (1400 km swath) swath scanner footprint (740 km swath)

Largitude idegl

Sentinel-3

SLSTR Day-Time Coverage over the Area of Interest





























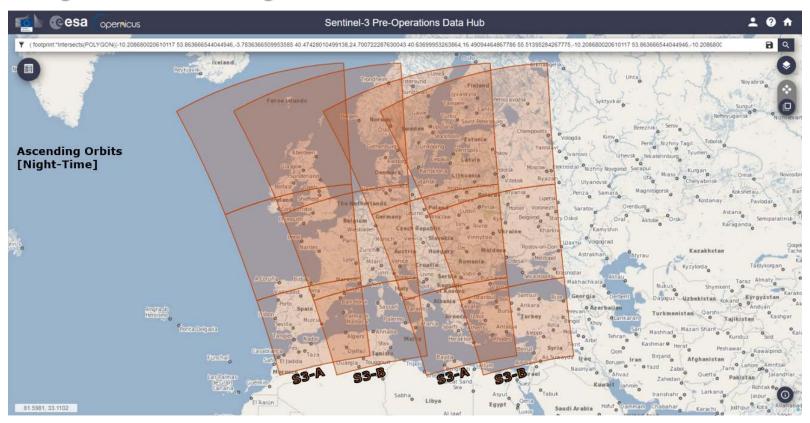




Sentinel-3

SLSTR Night-Time Coverage over the Area of Interest

































Sentinel-3 SLSTR Spectral Bands

DEDTIK DPECTAL Dallas						
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		1000
S8	10854.00	776.00	SST, LST, Active fire	bands	bands (200 K -320 K)	
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	em		

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 μ m and 1.375 μ m) 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 μ m channel and including dedicated detectors at 10.8 μ m that are capable of detecting fires up to ~650 K without saturation).











































Responding time







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

- ✓ **Near Real-Time (NRT)** products, delivered to the users in <u>less than 3 hours after acquisition</u> 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)

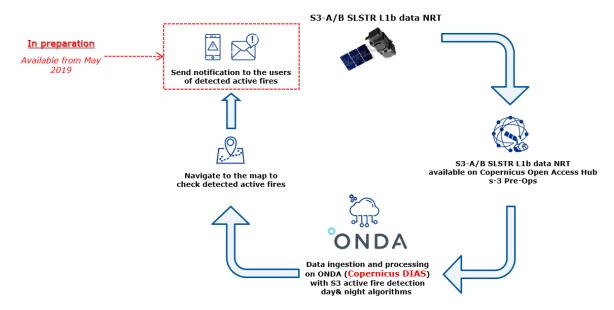


The Sentinel-3 World Fires Atlas Prototype product has been developed by ESA over the southern countries of the ESA member states (Latitude from 34°N to 60°N; Longitude from 12°W to 31°E) using both Fire channels of the S3A and S3B SLSTR sensors.

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.





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 SentineI-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



































