Active Fire Monitoring: Product Guide

Doc.No. : EUM/TSS/MAN/15/801989
Issue : v1C
Date : 14 April 2015
WBS/DBS :

EUMETSAT
Eumetsat-Allee 1, D-64295 Darmstadt, Germany
Tel: +49 6151 807-7
Fax: +49 6151 807 555
http://www.eumetsat.int

Document Change Record

Issue / Revision	Date	DCN. No	Summary of Changes
1	06/10/2010		Initial creation of document in DM tool.
1A	08/11/2010		Initial content and graphics added.
1B	18 Nov 2014		Added content to specify product output and specifications to fit Product Guide template.
1C	14 April 2015		Subject matter expert review. Section 4 updated with algorithm specifications for numerical indicators and updated scene quality information.

Table of Contents

1 PRODUCT DESCRIPTION

The Active Fire Monitoring (FIR) product is an image-based meteorological product in full pixel resolution that displays information on the presence of fire within a pixel. It was developed primarily for detecting and quantifying biomass burning in Africa, but is generated for the complete MSG footprint. It is generated for every image and compares the brightness temperatures of the IR3.9, 8.7 and 10.8 channels over cloud-free land areas, then assigns one of three fire statuses to each pixel: fire-free, potential, or probable. The algorithm is based on threshold values but there are plans for further development.

The underlying concept of the algorithm takes advantage of the fact that SEVIRI channel IR3.9 is very sensitive to "hot spots" which are caused by fires. The algorithm distinguishes between *potential fire* and *active fire*. To classify a pixel as active fire, the algorithm uses a stricter set of classification criteria than for potential fires. Classifications of potential fires are pixels with small fires, or pixels with burned-out fires but still-hot surfaces This category can even include some false classifications possibly caused by other hot surfaces, regions with inhomogeneous surfaces, or with undetected small clouds.

In Europe, these fires occur mainly during summer and early autumn. In sub-Saharan Africa, however, fires of this magnitude occur throughout the year.

2 PRODUCT SPECIFICATIONS

Category	*Specification*
Type	Meteorological Product
Product abbreviation	FIR
Applications and users	fire detection, early warning for fire potential
Input satellite data	MSG images from the IR10.8 channel and passive microwave data from the SSM/I instrument on the US Defense Meteorological Satellite Program spacecraft.
Product Distribution	• EUMETCast • EUMETSAT Data Centre
Product Area	• Full earth scanning (FES) area • RSS Area
Product Resolution	Pixel

Category	*Specification*
Product Distribution Frequency	*Full Earth Scanning Area* • EUMETCast: every 15 minutes for the 00:00, 00:15, 00:30, …23:45 UTC products • EUMETSAT Data Centre: every 15 minutes for the 00:00, 00:15, 00:30, …23:45 UTC products *Rapid Scanning Service Area* ▪ EUMETCast: every 5 minutes for the 00:00, 00:05, 00:10, …23:55 UTC products ▪ EUMETSAT Data Centre: every 5 minutes for the 00:00, 00:05, 00:10, …23:55 UTC products
Product Format	• GRIB2 format (FIRG product) • CAP format (Common Alert Protocol)
Product Size	*Full Earth Scanning Area:* GRIB product 20 kB (variable) CAP product 5 kB (variable) *Rapid Scanning Service Area:* GRIB product 4 kB (variable) CAP product 2 kB (variable)
Resolution	3 km × 3 km pixel resolution

2.1 Product history:

Initial operational dissemination:	2007	Dissemination via EUMETCast in ASCII format.
Improvements to product after validation testing	2008	Significantly improved hot-spot detection
Changes to product inputs:	28 April 2009	• New surface emissivity maps based on MODIS observation added to product processing. • Dynamic thresholds from ECMWF used to replace static thresholds. *See Section **Error! Reference source not found.** for a detailed description.*
Replacement of ASCII text file with CAP product.	24 Mar 2011	The new CAP-formatted product was disseminated on the alert channel on EUMETCast.
Corrective maintenance	8 Feb 2012	Corrective maintenance on FIR-DU and pixel radius in the CAP-formatted product.
Substantial gaps in coverage	None	

3 PRODUCT ILLUSTRATION

Product results are shown in comparison images in Figure 1 and Figure 2 that follow. Figure 1 shows an IR3.9 image for 21 August 2005 at 02:00 UTC over Portugal and western Spain both before and after application of the product. The location of the hot spots—either active fires or potential fires—is clearly marked in the lower image when the Active Fire Monitoring product is applied. Red pixels are active fires, yellow pixels are potential fires. Figure 2 also shows the IR3.9 image before and after the Active Fire Monitoring product has been applied. The image is from south central Africa near Lake Tanganyika and Lake Malawi. Again, red pixels are active fires, yellow pixels are potential fires.

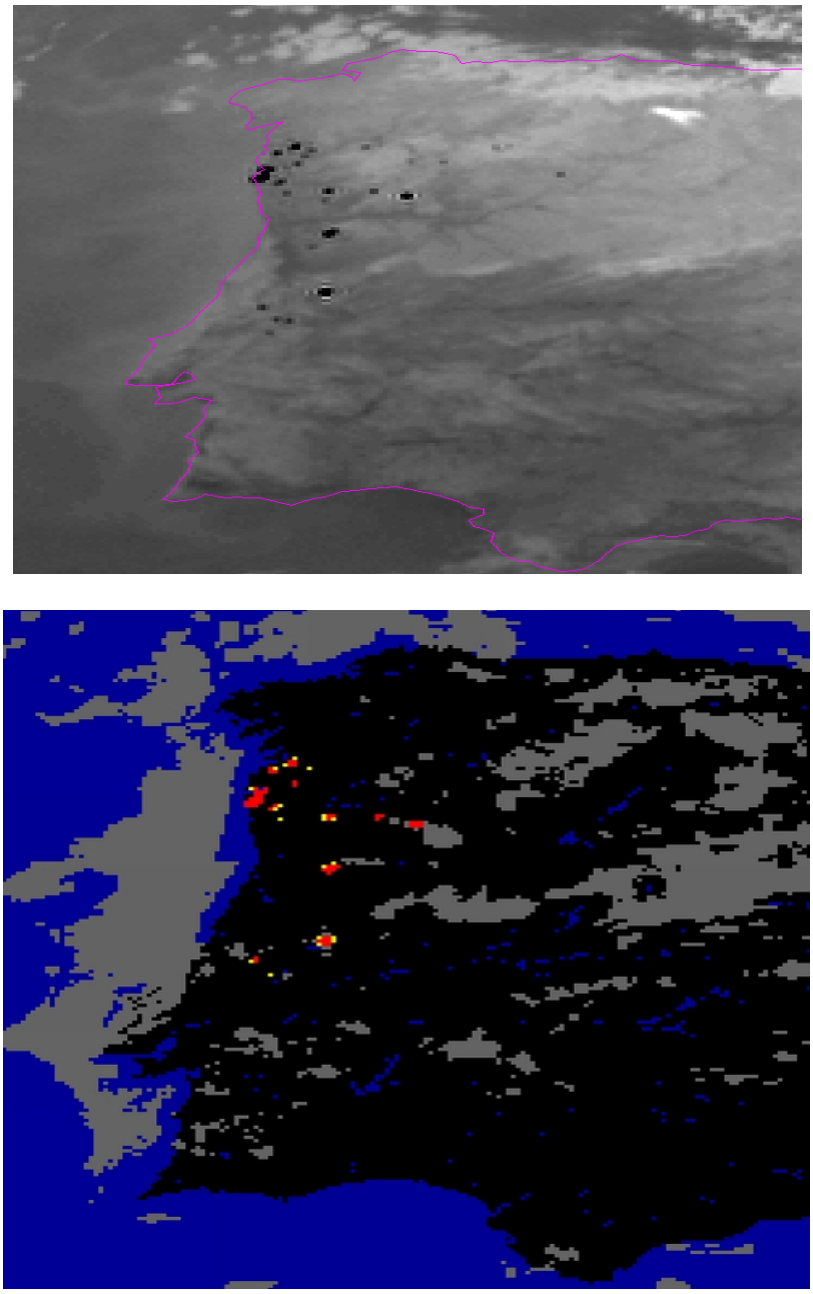

Figure 1: Top panel: Initial IR3.9 image for 21 August 2005 at 02:00 UTC. Bottom panel: Active Fire Monitoring product applied to IR3.9 image.

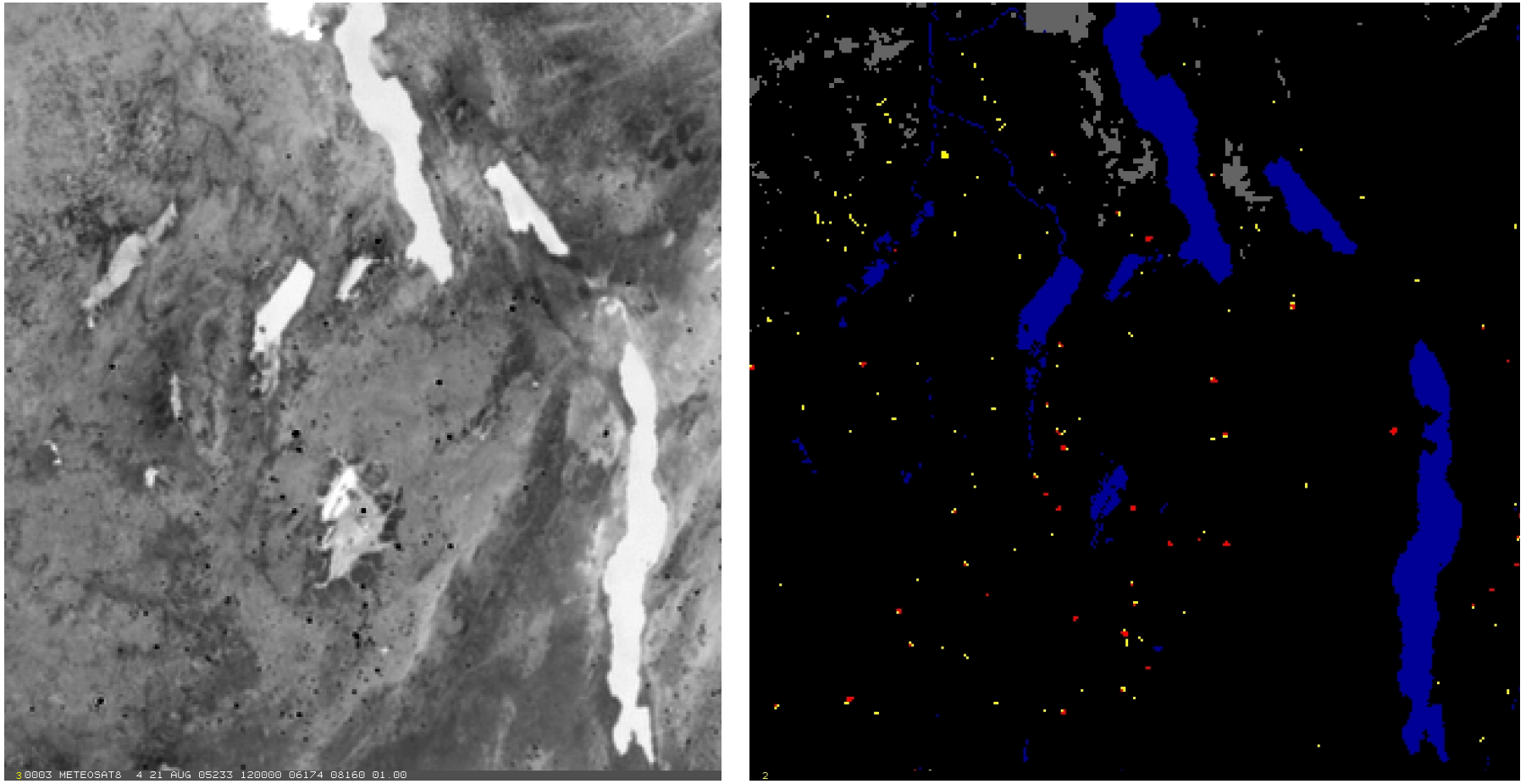

Figure 2: Initial IR3.9 image for 21 August 2005 at 12:00 UTC over central Africa is at left. Active Fire Monitoring product is applied to the image at right.

3.1 Analysis of results after algorithm improvements in 2008

The first analysis was the inspection of individual products to demonstrate the expected improvement in the hot spot detection. The example presented here is from 18 August 2008 11:30 UTC using Meteosat-9 full Earth scan (FES) products. Figure 3 shows the underlying IR3.9 μm channel image over the west coast of Africa. Figure 4 shows the image after application of the FIR product. On the left is the operational algorithm. The new FIR algorithm is on the right. Red pixels indicate probable fires, yellow indicates possible fires.

A first look at the images in Figure 4 reveals that the operational algorithm misses many of the fires that exist, whereas the new algorithm (at right) manages to capture the hot spots in the IR3.9 μm imagery very well. In the non-cloudy area in the eastern part of the image, the operational FIR product misses a large number of hot spots. Even where the signal is weaker (as in the southern part of the area) the detection rate has improved. However, it should be noted that, occasionally, the improved algorithm does not detect a fire that has been detected by the old operational algorithm, as shown in the south-western corner of the plot. Nevertheless, the detection rate has clearly improved. The detection of fires in the cloudy area has also improved, but only slightly. The latter analysis was supported by several case studies performed on some of the undetected hot spots in the previous operational product. These studies showed that often these fires were not detected because the IR10.8 μm standard deviation test has a strict threshold of *less than* 1 K. This means that the standard deviation of IR10.8 μm brightness temperature needs to be lower than 1 K within a 3 x 3 pixel image segment in order to allow fire detection. The purpose of these studies was to remove false alarms for fires that were sometimes detected along coastlines, rivers and around cloud edges due to these parameters.

3.2 Major product improvement made after product validation

During operations product validation, two major changes were made to the Active Fire Monitoring (FIR) product.

- The first change concerns the use of new surface emissivity maps. In the previous product release, the emissivity was set to 1.0 over land. The algorithm was changed to use monthly averages of surface emissivity data derived from MODIS observations instead.
- The second change concerns the thresholding technique used. In the previous version, static thresholds were used, whereas in the improved version dynamic thresholds derived from ECMWF forecast data are used. With this improved functionality, the product can better cope with area differences in both time and space.

3.3 GRIB-2 Encoded profuct number assignments

The GRIB-2 encoded product produces these values for each pixel. Values are in accordance with WMO FM 92-XIII GRIB Code Table 4.223 – Fire detection indicator.

Number	***...means***
0	No fire detected.
1	Possible fire detected
2	Probable fire detected
3	Missing

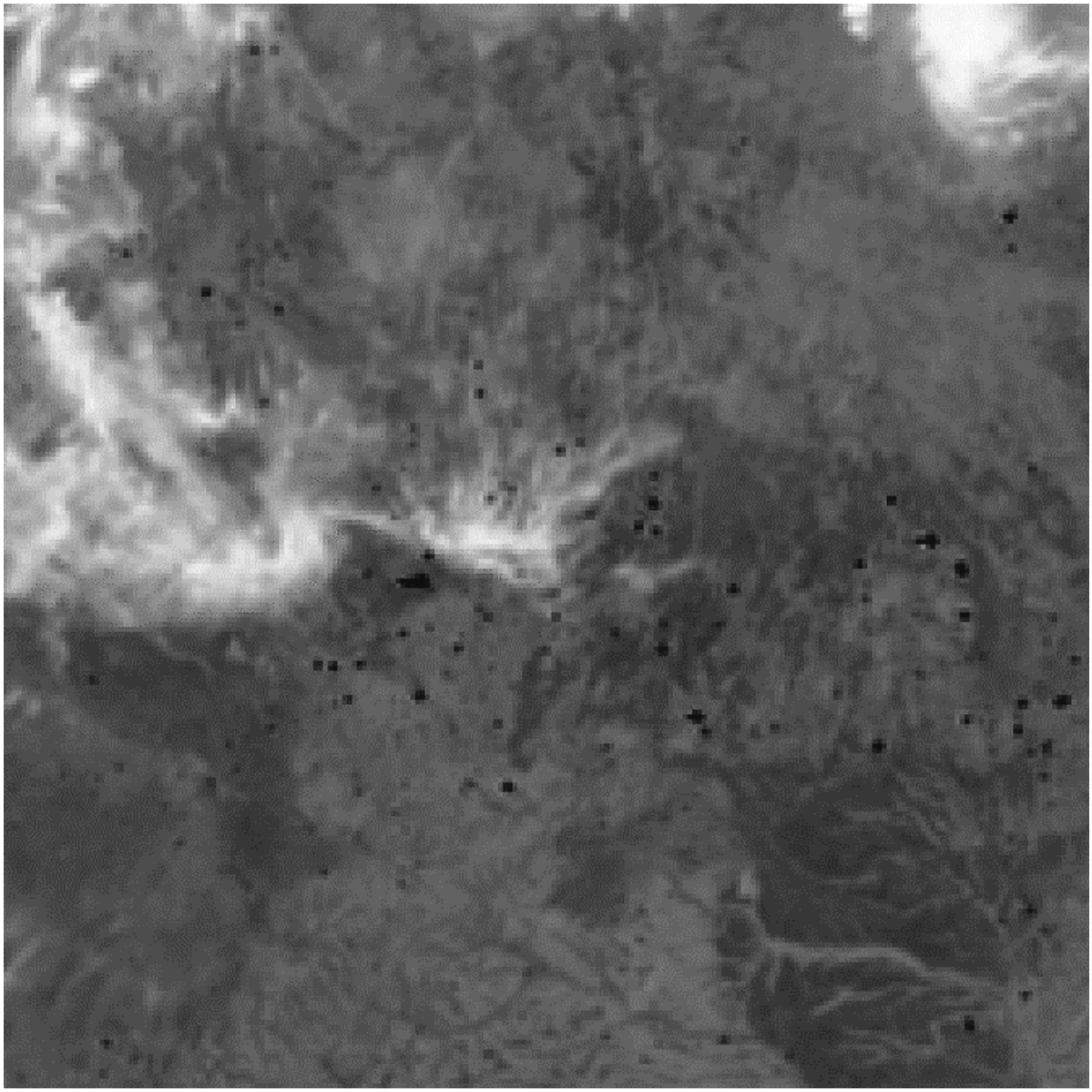

Figure 3: Basic IR3.9 channel image corresponding to FIR images in Figure 4.

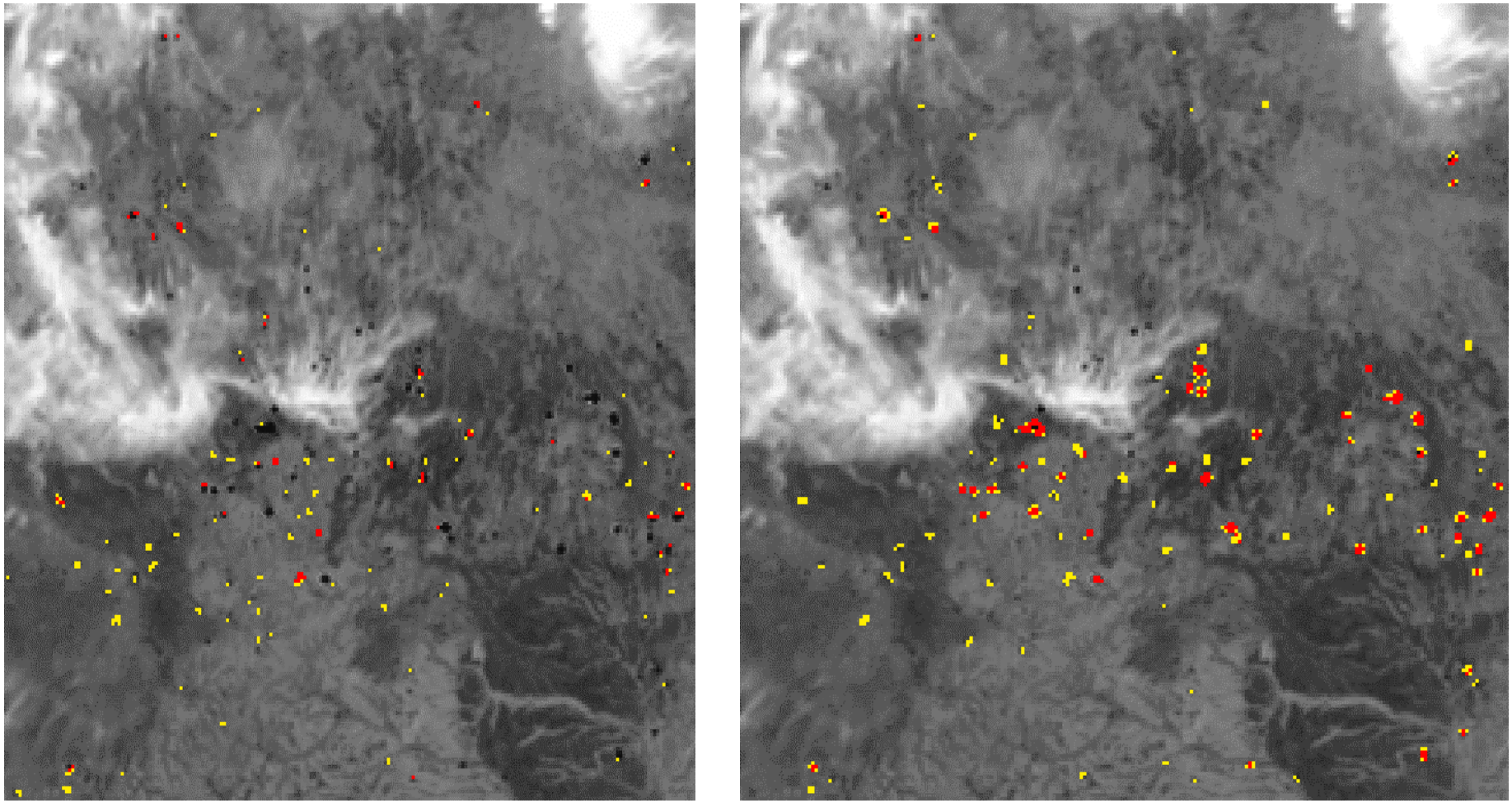

Figure 4: (Left) FIR product over western Africa for 18 August 2008 11:30 UTC, using the operational algorithm. Red indicates a probable fire, while yellow indicates a possible fire. (Right) The FIR product over western Africa for 18 August 2008 11:30 UTC, using the improved algorithm. Red is a probable fire, while yellow is a possible fire.

4 BASIC STRUCTURE OF THE ALGORITHM

4.1 Input Data Used

- MSG SEVIRI image data in the following channels:
  - VIS0.6 µm channel
  - IR3.9 µm channel
  - IR10.8 µm channel
- Forecast data from the European Centre for Medium Range Weather Forecasts (ECMWF) which are used for estimating the Equivalent Blackbody Brightness Temperature (EBBT) in the IR channels.
- Results of the pixel-based Scenes Analysis (an internal product), indicating for every pixel whether cloud has been detected
- Surface emissivity, coastline and surface type maps

4.2 Algorithm Description

The basic principles of the FIR algorithm are similar to those already in use for other instruments like GOES, AVHRR and MODIS. Scene quality is taken from the pixel-based Scenes Analysis product. The scale in this product is as follows: 100 means that the pixel is cloudy, while 0 means the pixel is clear. Given this criteria, off-shore oil fires, fires from active volcanoes on small islands, or fires hidden by thick clouds are not monitored by the algorithm. Bare-soil land surfaces (deserts) are also excluded from the processing.

During daylight hours, channel VIS0.6 is used to exclude bare soil surfaces, small clouds, and sun glint areas. For the remaining valid pixels, the FIR algorithm uses the following criteria to check for potential fire and fire pixels:

- Brightness temperature of channel IR3.9
- Standard deviation of channel IR3.9
- Brightness temperature difference of channel IR3.9 and IR10.8
- Standard deviation of channel IR10.8

4.3 Known Operational Limitations

The status of the product is *demonstration*.

5 REFERENCES AND LINKS

5.1 Reference Documents

Type	*Document Name*	*Reference*
Validation	Operations Product Validation Report: FIR Product	EUM/OPS/REP/08/3689
Detailed Algorithm	MSG Meteorological Products Extraction Facility Algorithm Specification Document	EUM/MSG/SPE/022
Science/Research	Amraoui, M., C.C. DaCamara, J.M.C. Pereira, 2010: Detection and monitoring of African vegetation fires using MSG-SEVIRI imagery	doi:10.1016/j.rse.2009.12.019
Science/Research	Giglio L., J. Descloitres, C.O. Justice, Y.J. Kaufman 2003: An Enhanced Contextual Fire Detection Algorithm for Modis.	Remote Sensing of Environment, Vol. 87, pp. 273-282

5.2 Online Resources and Assistance

All of the reference documents listed above are in the EUMETSAT Technical Documents page.

www.eumetsat.int > Satellites > Technical Documents > Meteosat Services
> 0° Meteosat Meteorological Products

A training presentation for the FIR Product is here:

http://www.eumetsat.int > home > Data
> Training > TrainingLibrary > Index
> Use of SEVIRI and AVHRR Channels for Remote Fire/Smoke Detection

To register for data delivery from this product, go to the Data Registration page on the EUMETSAT web page:

www.eumetsat.int > Data > Data Delivery > Data Registration

Information about the service status of EUMETSAT satellites and the data they deliver is this EUMETSAT web page:

www.eumetsat.int > Data > Service Status

To get answers to any questions about data delivery, registration or documentation, contact the EUMETSAT User Service Help Desk:

Telephone: +49 6151 807 3660/3770
e-mail: ops@eumetsat.int