Monitoring wildfires from satellite, integration in Copernicus services and characterising atmospheric impacts from the regional to the global scales

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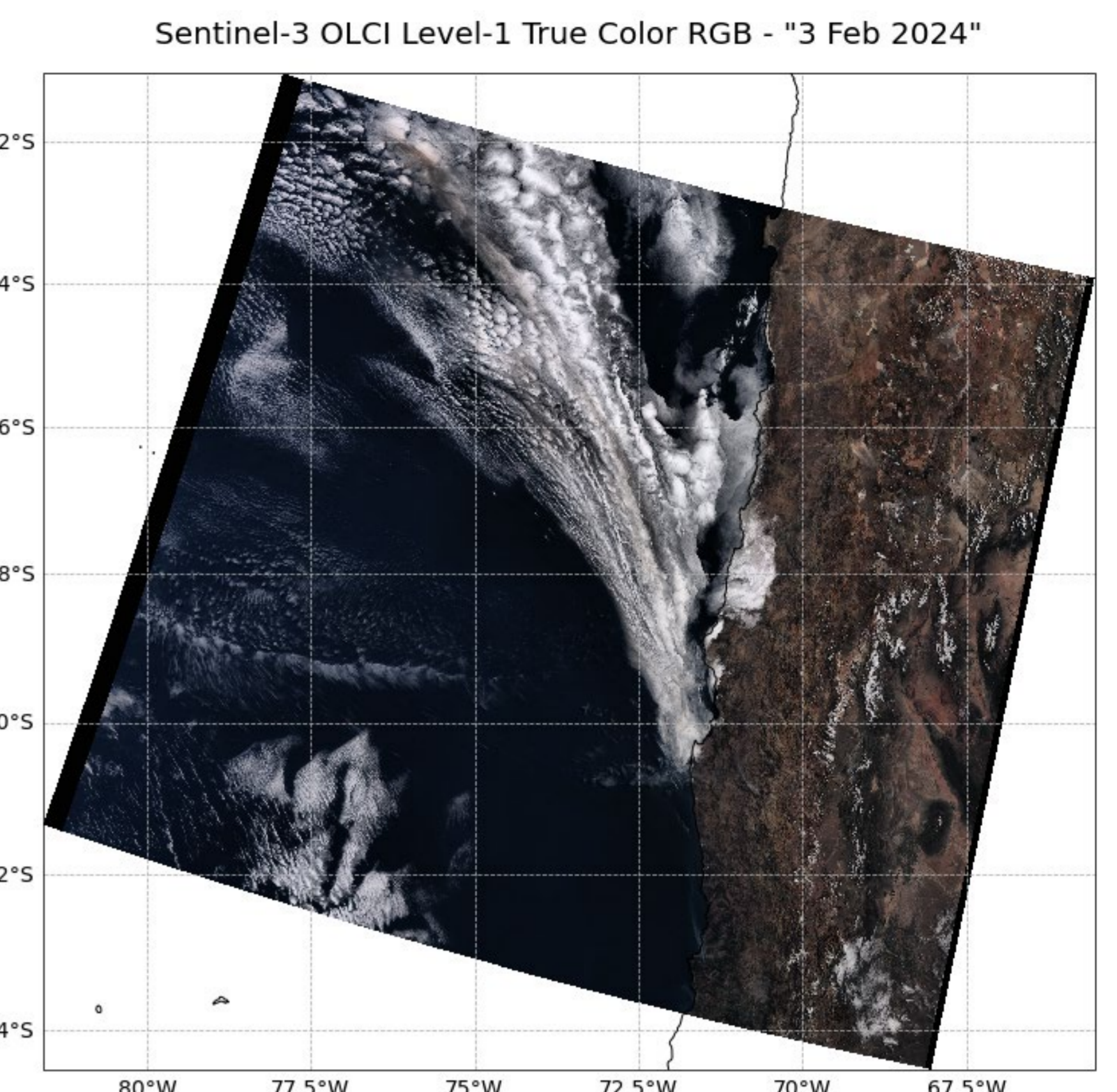
Fig. 1. True Color RGB from the Ocean and Land Colour Instrument onboard Sentinel-3 on 3 Feb 2024 over Chile close to Santiago with a clearly visible smoke plume from wildfires.

Sentinel-3 OLCI Level-1 True Color RGB - "3 Feb 2024"

INTRODUCTION

With the progressing climate change most regions in the world will face longer and more intense fire weather. An increase in exposure to fire risk and impact in the future is also projected (IPCC, IR6). Therefore, we need to monitor fires at the possibly earliest stage for emergency response. We should also assess impacts on the atmospheric composition for the air quality and climate. EUMETSAT data is helping to achieve both.

BEFORE THE FIRE: satellite-informed modelling

Fire weather: weather conditions conducive to the ignition and spread of wildfires; the Canadian Forest Fire Weather Index is based on the weather forecast.
Fire Risk Map: adjusted to the Mediterranean conditions, basing on the satellite observations from SEVIRI onboard MSG.

LSA SAF

Advantages:
- Based also on actual measurements: better adjusted to regional conditions
- Near-Real Time product: possible operational use

Limitations:
- Statistical modelling: might not predict anomalies
- Fire Risk only over Mediterranean
- Available daily: no diurnal cycle

Fig. 2. Land Surface Analysis Satellite Application Facility (LSA SAF) product (LSA-504.2) related to wildfires on 5 August 2021. (a) Fire Weather Index is estimated for the whole MSG disk. (b) Fire Risk Map v2 for the Mediterranean region. Source: LSA SAF.

DURING THE FIRE: intensity observations

LSA SAF

Advantages:
- Measurement every 15 min
- Over the whole geostationary disk.

Limitations:
- Spatial resolution of 3 km

Fig. 3. Fire Radiative Power from SEVIRI/MSG on 5 August 2021 over Southern Italy. Source: LSA SAF.

Advantages:
- Spatial resolution of 1 km
- Over the whole globe.

Limitations:
- Only once a day and once a night.

Fig. 4. Fire Radiative Power from the Sea and Land Surface Temperature Radiometer onboard Sentinel-3 on 5 Aug 2021

AFTER THE FIRE: tracking the plume

AC SAF ATMOSPHERIC COMPOSITION MONITORING

In the summer 2023, many wildfires in Canada broke out. Aerosol particles and gases were transported far from the original sources. At the end of June, the smoke plume reached Europe. It could have affected air quality and weather.

Data from IASI: CO & HCOOH
+ available at night & for high latitudes
- cloud filtering needed
- vertically sensitive only from ~3 km or higher

Data from GOME-2, AAI
+ Important for aviation
- Low spatial resolution
- Strict filtering needed

Data from GOME-2, HCHO
- High noise, needs averaging.

Data from STLSTR/Sentinel-3: AOD
+ many improvements to the algorithm over last years
+ reliable also over ocean
- strict filtering needed, especially over land

Fig. 5. Aerosol Optical Depth at 550 nm from SLSTR onboard Sentinel-3 on 26 Jun 2023.

Fig. 6. Atmospheric composition products from Metop on 26 Jun 2023, depicting a plume from Canadian wildfires reaching Europe. (a) Carbon monoxide from IASI. (b) Formic acid from IASI. (c) Aerosol Absorbing Index from GOME-2. (d) Formaldehyde from GOME-2. Source: AC SAF.

INTEGRATION INTO ASSIMILATION SYSTEM: understanding the fire extent

The satellite data is used in the Copernicus Atmospheric Monitoring System (CAMS) Global Fire Assimilation System (GFAS), which serve later as online sources of atmospheric pollution, leading to better air quality forecasts.

According to CAMS estimates, global wildfires generated approximately 2,170 megatons of carbon emissions in 2023, of which the Canadian wildfires accounted for 22%.

Fig. 7. GFASv1.2 daily total cumulative carbon emissions in 2023 for Canada with respect to the previous years. Source: CAMS.

The wildfires in Greece were the largest in the EU since 2000, when the European Forest Fire Information System (EFFIS) began recording data. They have resulted in a cumulative burned area since the start of the year of almost 175,000 hectares – over 4 times Vienna area.

Fig. 8. Burnt area yearly composite from Sentinel-3 for 2023. Source: DLR.

Fig. 9. GFASv1.2 results for fires in Greece in 2023. (a) Daily total wildfire radiative power; (b) wildfire carbon emissions. Source: CAMS.

WHAT WILL THE FUTURE BRING?

FOR ATMOSPHERIC COMPOSITION
Sentinel-4
- onboard Meteosat Third Generation Sounder Platform
- Geostationary, over Europe
- Every 1 hour

Sentinel-5
- onboard Metop Second Generation A
- polar –> global coverage
- on average once a day

FOR FIRE DETECTION
Sentinel-3
- new Format of Fire Radiative Power –> CSVs available in Q2 2024!

Flexible Combined Imager
- onboard Meteosat Third Generation Imager Platform
- 2 km spatial resolution
- every 15 min(!)

PRODUCTS related to wildfires

Simulated data.

AEROSOLS
- UV Aerosol Index
- Aerosol Optical Depth
- Aerosol Layer Height

TRACE GASES
- Nitrogen Dioxide
- Formaldehyde
- Sulphur Dioxide
- Carbon Monoxide — Only Sentinel-5

Fig. 10. Fires in the Rhodes island, Greece on 22 July 2023, seen from FCI onboard MTG-I1, launched on 13 Dec 2023. Note: this is preliminary commissioning data.

STAY TUNED FOR THE NEXT USER EVENTS!

Julien's solicited oral on Thu, 18 Apr, 10:45–11:05 on S3 & MTG

Joint Training in Atmospheric Composition, Norway, Sep 2024

16-20 September 2024 Kjeller, Norway

Joint Training in Atmospheric Composition

Copernicus ECMWF EUMETSAT esa
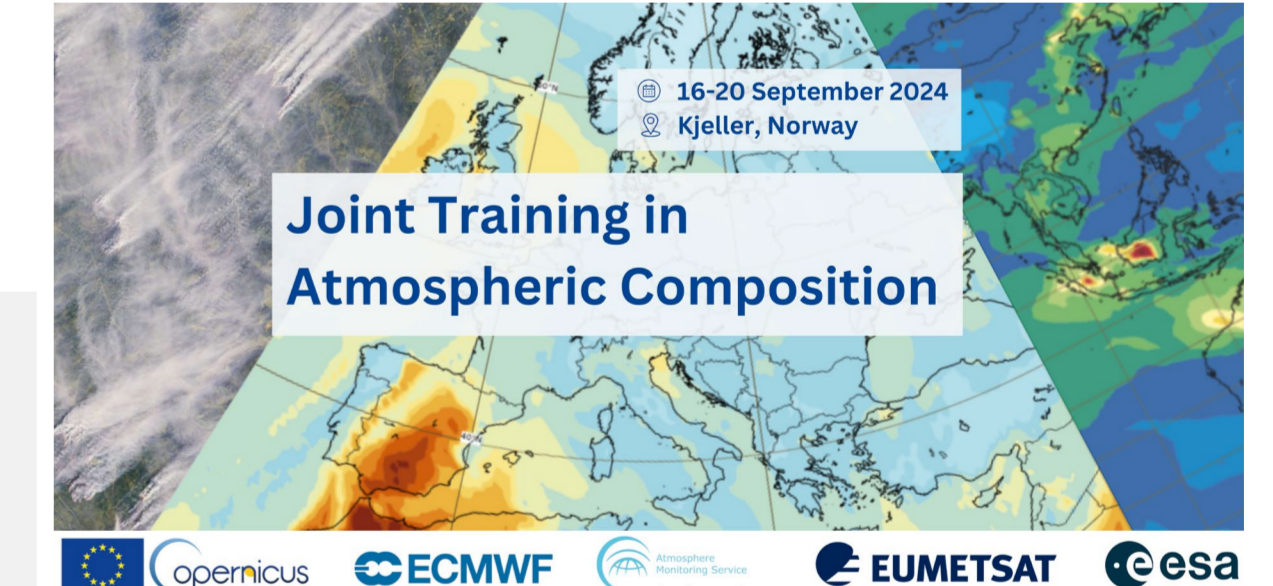
CONCLUSIONS

EUMETSAT with its Satellite Application Facilities provide a wealth of satellite data related to wildfires. It can be used for the risk management, early warnings, tracking the fire development, as well as the analysis of air pollution and finally assessment of big-scale impact on carbon global emissions. As a result, it contributes to saving lives and livelihoods, and climate studies. EUMETSAT is committed to listen to the users' needs – if you have any feedback, please contact us!

Affiliations

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Links for data & training

user.eumetsat.int, landsaf.ipma.pt, acsaf.org, atmosphere.copernicus.eu, classroom.eumetsat.int