Wildfire weather, intensity and smoke emissions of large-scale fire events in 2019

Atmosphere Monitoring

EGU General Assembly 2020

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Overview

- Copernicus program and services
  - Relevant information for monitoring and understanding global wildfire activity
- Arctic wildfires in summer 2019
  - Surface conditions
  - Fire emissions
- Australian bushfires in spring-summer 2019-20
  - Surface conditions
  - Fire emissions and smoke transport
- Summary

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COPERNICUS AND ECMWF

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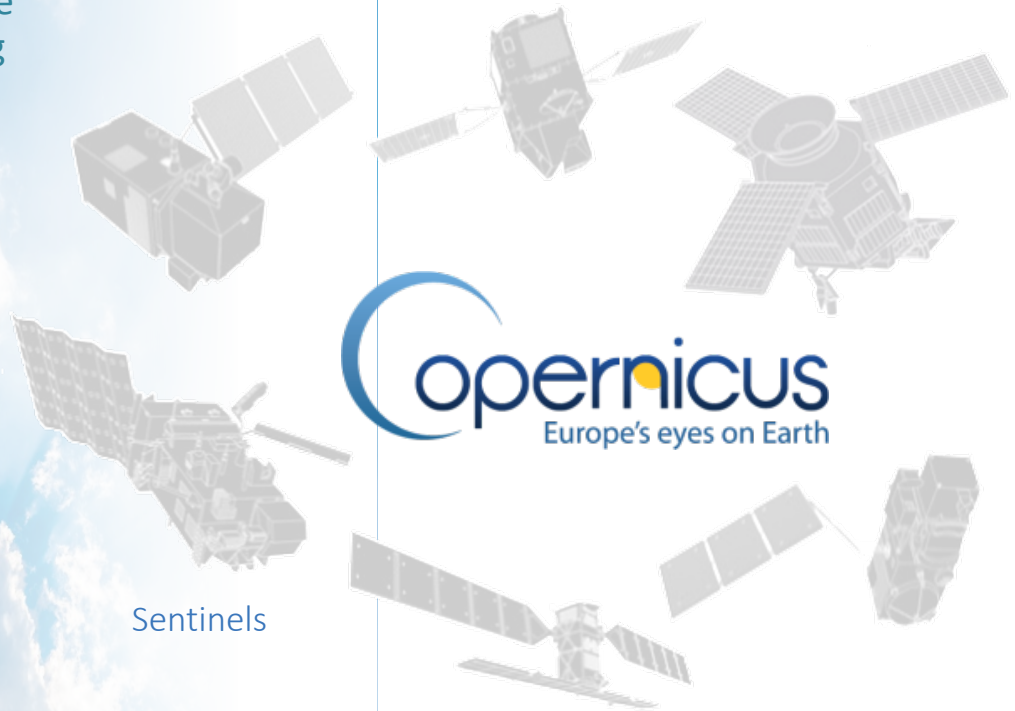

Sentinels

Observations feeding into value-added Services

- Atmosphere
- Climate
- Land
- Marine
- Emergency
- Security

Copernicus is the European Union's operational Earth Observation and Monitoring programme, looking at our planet and its environment for the ultimate benefit of all citizens.

User-driven with free and unrestricted data access

Service is implemented by ECMWF

ECWMF is contributing to the Service

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CAMS: COPERNICUS ATMOSPHERE MONITORING SERVICE

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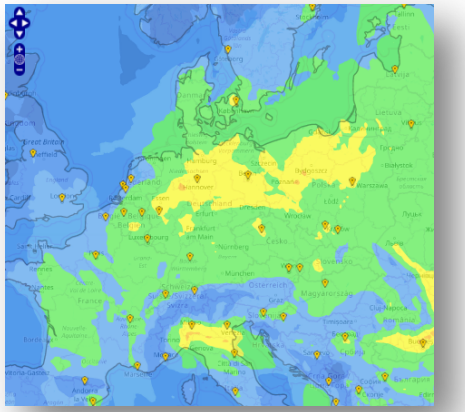
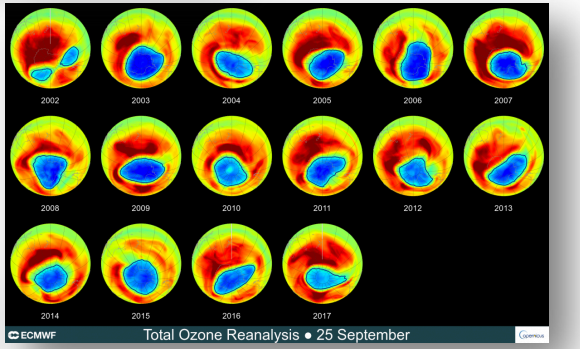
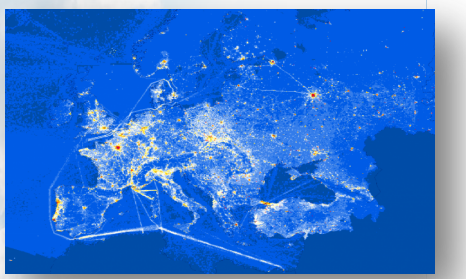


European Air Quality

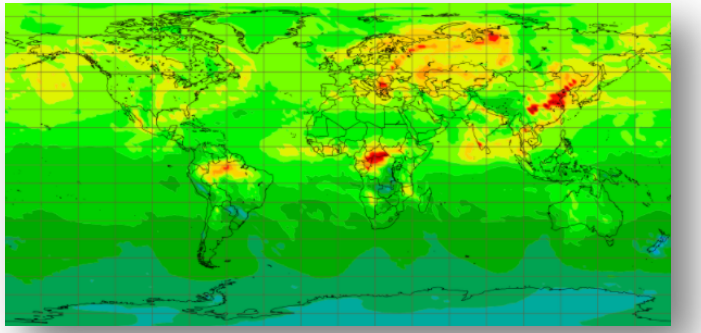
LBCs for regional models



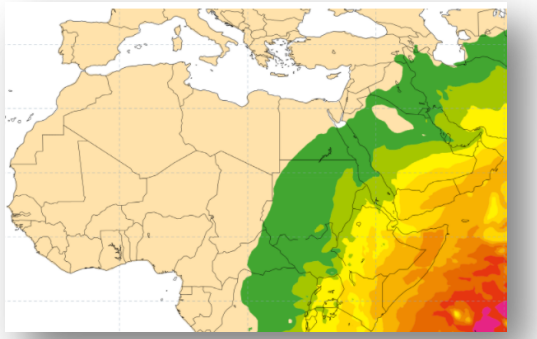
Ozone layer



Emissions and surface fluxes



Global analyses, forecasts and reanalyses



Solar radiation and UV index

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Linking Copernicus Services: From fire monitoring to fire forecasts

Atmosphere Monitoring

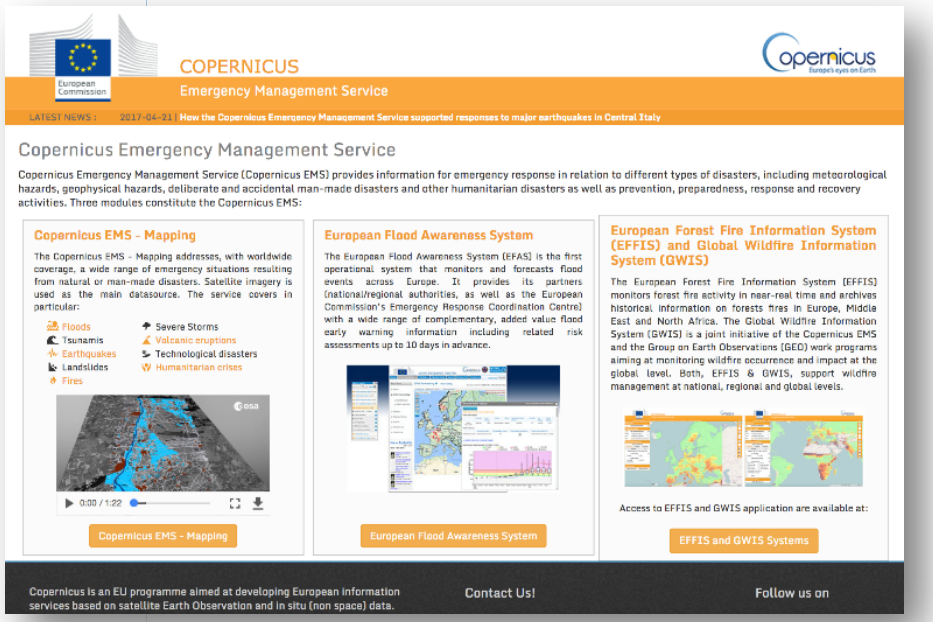
CAMS

Copernicus Emergency Management Service

Global Fire monitoring

Global fire evolution forecasting (d+5)

Global fire danger forecasting (d+10)



http://emergency.copernicus.eu/

The service is implemented by the EU Joint Research Centre

Flood and fire danger forecasts are provided by ECMWF.

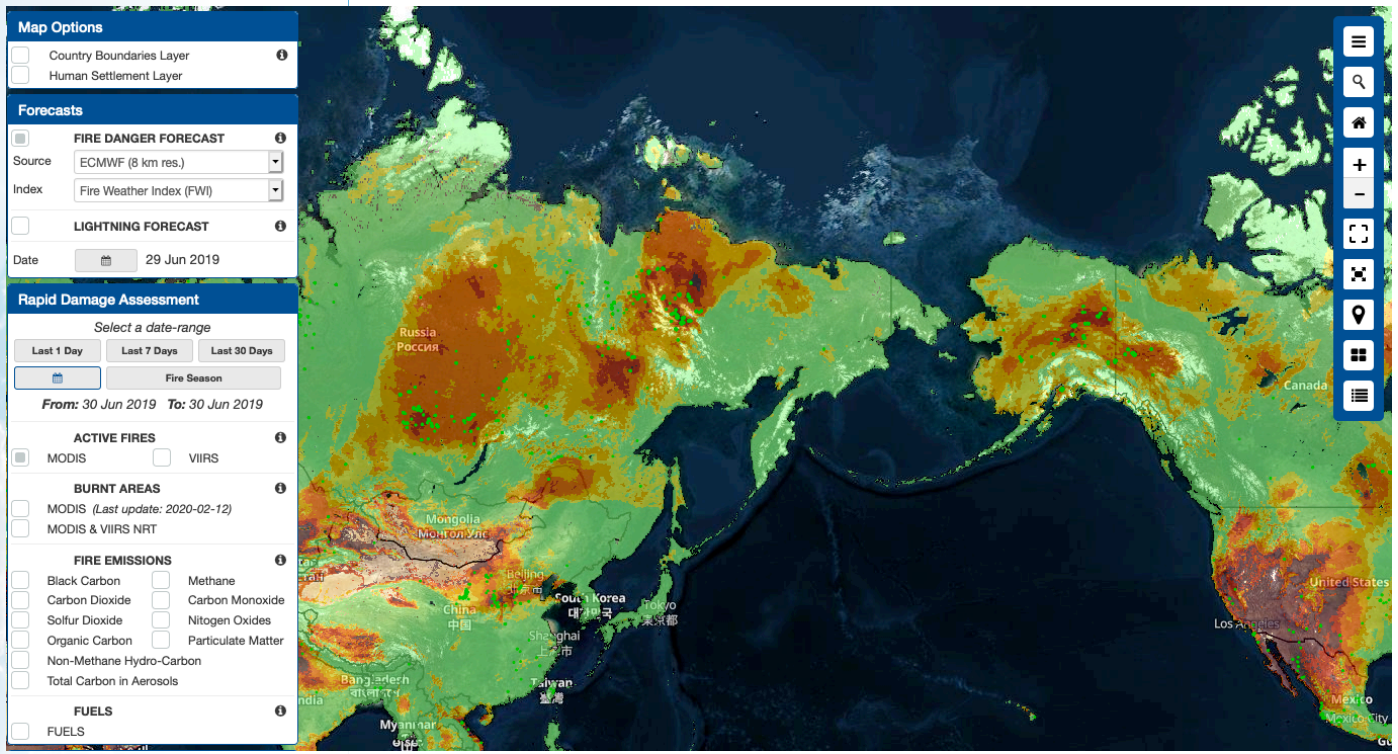
➢ Claudia Vitolo presentation D2097 | EGU2020-21781, this session

Arctic wildfires 2019: Environmental conditions

Atmosphere Monitoring

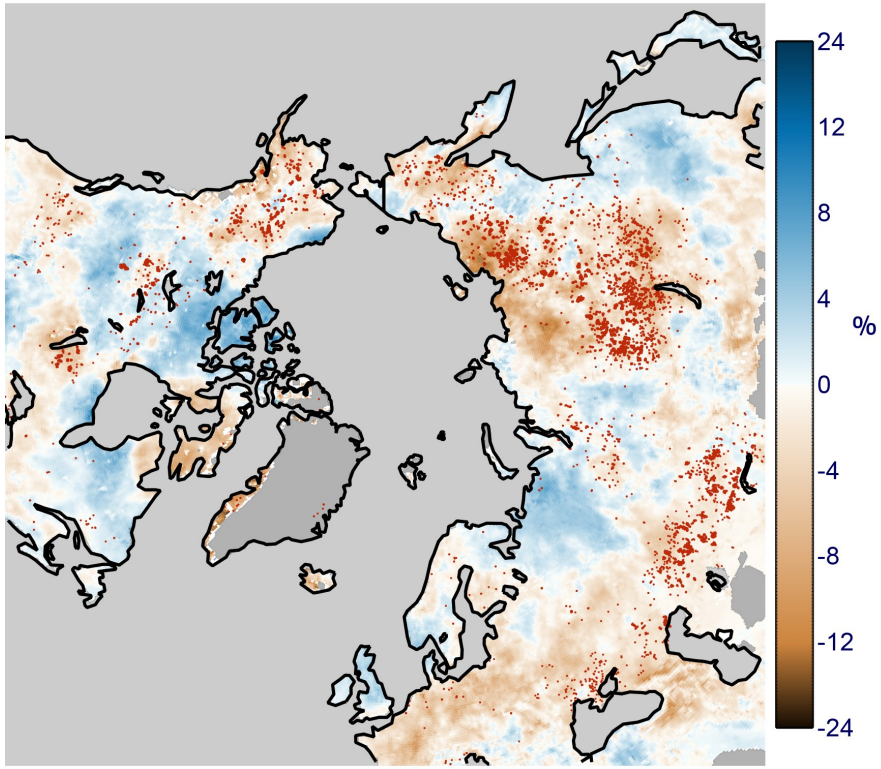
30 June 2019 fire danger forecast & active fires[1]

MODIS active fire observations (green dots) showed good correspondence with areas of very high to extreme to extreme fire danger forecasts at high northern latitudes in Yakutia, Siberia and Alaska throughout June-August indicating the environmental conditions were ideal for wildfires following ignition (possibly by lightning). ECMWF FWI forecast in the Global Wildfire Information System (GWIS).



June-August 2019 soil moisture anomaly & fire locations[2]

Active fire observations throughout the summer corresponded with areas of negative (drier) soil moisture anomalies (relative to 1981-2010) from the Copernicus Climate Change Service.



[1]https://gwis.jrc.ec.europa.eu/static/gwis_current_situation/public/index.html

[2]https://www.copernicus.eu/en/news/news/observer-copernicus-services-enable-civil-authorities-anticipate-spread-wildfires-and

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Arctic wildfires 2019: Environmental conditions

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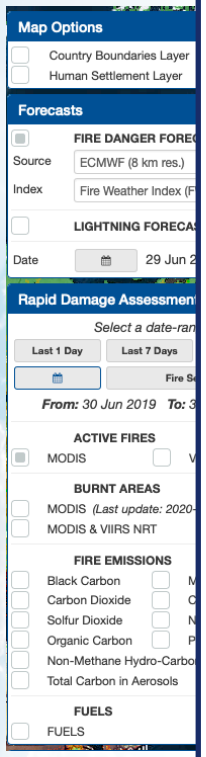
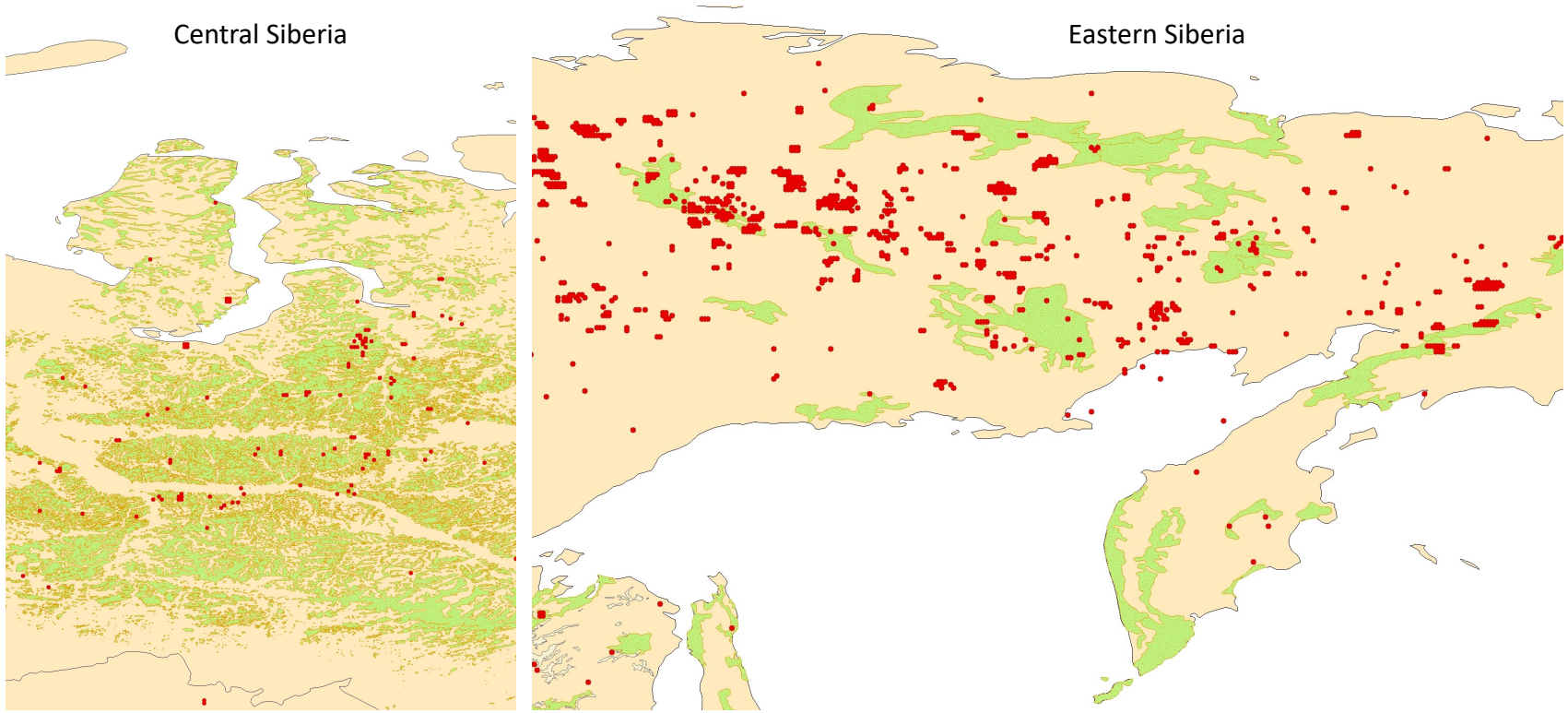


[1]https://gwis
[2]https://www

Peat and Arctic Fires

Central Siberia

Eastern Siberia



- Many active fire observations (red dots) were located in known peatlands (green shaded areas) across Siberia, and other parts of the Arctic.
- Potential source of uncertainty in estimating emissions, e.g.: undetected smouldering fires; unknown emission factors.
- Possible climate implications for release of carbon which has been stored for >10,000 years.

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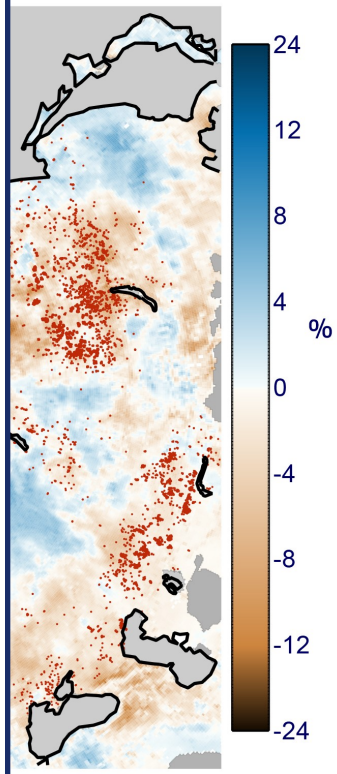

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Arctic wildfires 2019: Emissions

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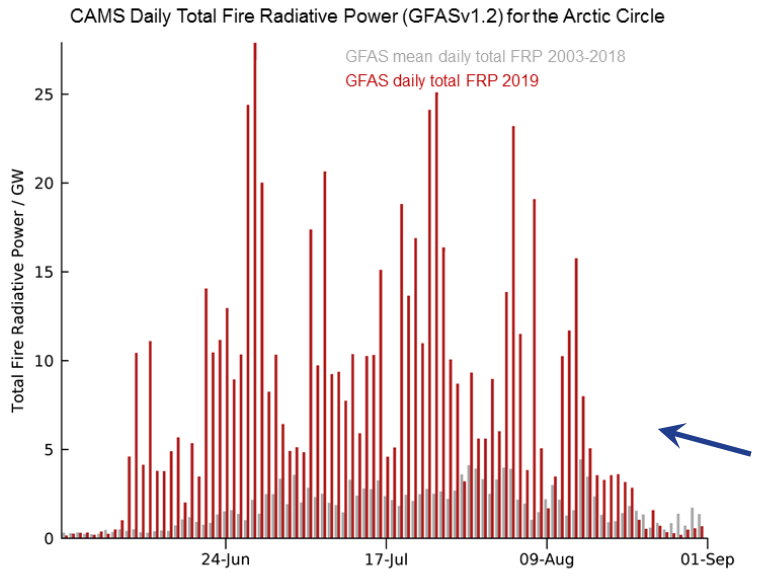
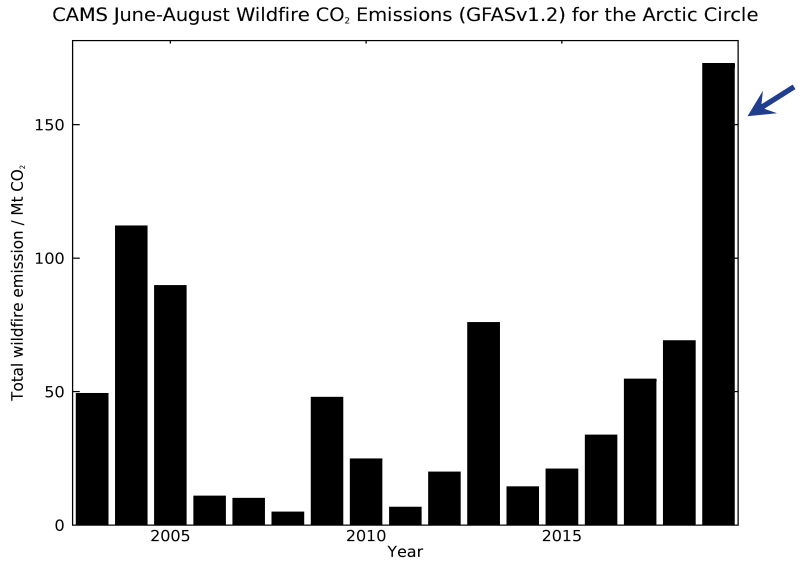




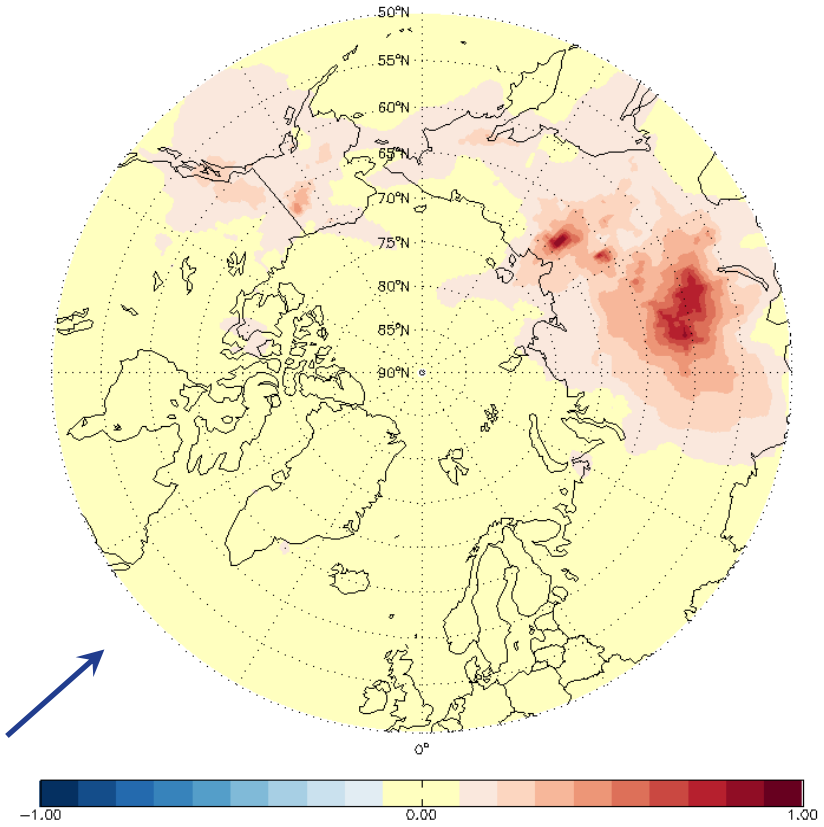
Daily total fire radiative power (FRP) and June-August total estimated CO_2 emissions from the CAMS Global Fire Assimilation System (GFASv1.2), based on MODIS observations

FRP for 2019 (red bars) was significantly above the 2003-2018 mean (grey bars) for the Arctic Circle (latitudes > 66º N) from mid-June to mid-August.

Seasonal total estimated CO2 emissions for 2019 in the Arctic Circle was the highest in the 17-year GFAS dataset.

Wildfire emissions in the Alaska, Arctic Siberia and Central Siberia caused widespread atmospheric pollution, with strong positive anomalies (relative to 2003-2018)

June-August 2019 anomaly in organic matter aerosol optical depth at 550nm relative to 2003-2018 mean from the CAMS global reanalysis of atmospheric composition



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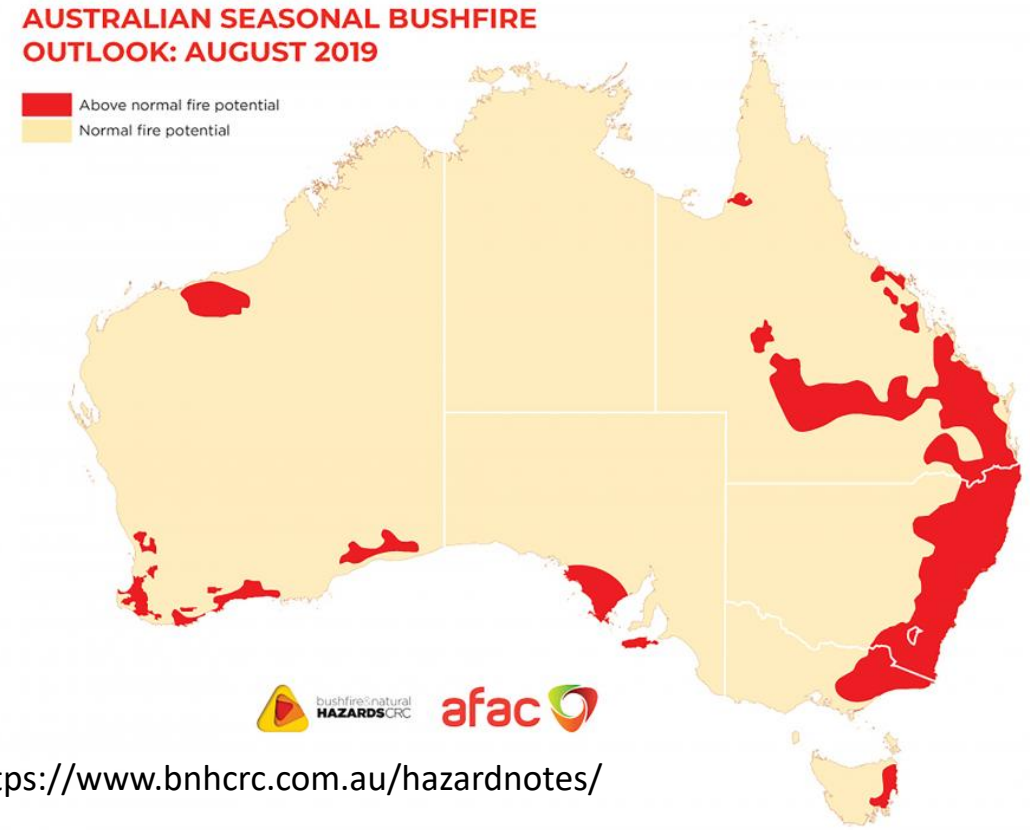
Bushfire conditions in Australian spring

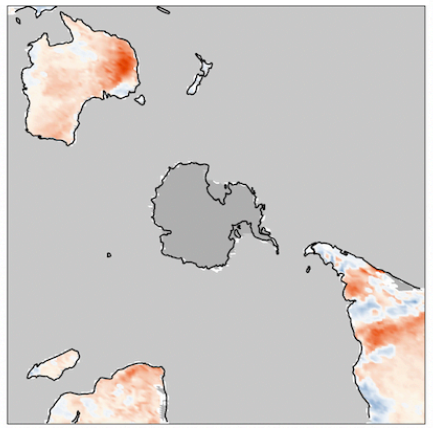


https://www.bnhcrc.com.au/hazardnotes/

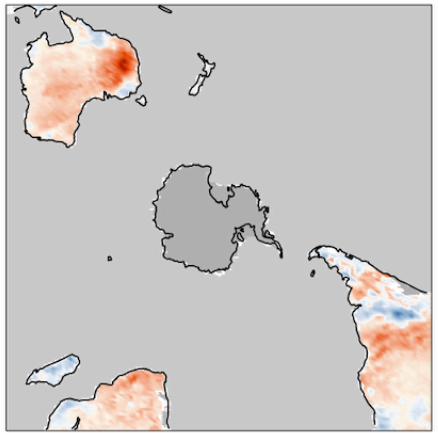
Australian Bushfire and Natural Hazards CRC seasonal outlook for August 2019 showed above normal fire potential for NSW, QL & VI

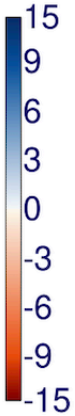
Climate anomalies: 0-7cm volumetric soil moisture (%)

August 2019

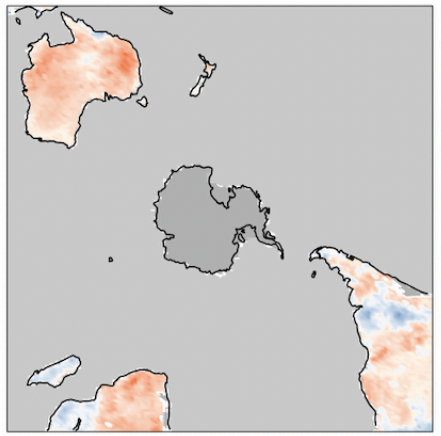


June-August 2019





September 2018 – August 2019



Climate anomalies calculated relative to 1981-2010 average.

Negative soil moisture anomalies across SE Australia show drier than average conditions by up to -15%

https://climate.copernicus.eu/precipitation-relative-humidity-and-soil-moisture-august-2019

Australia fire danger forecasting

➢ Francesca Di Giuseppe presentation D2076 | EGU2020-18654, this session

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Australia bushfires: Emissions

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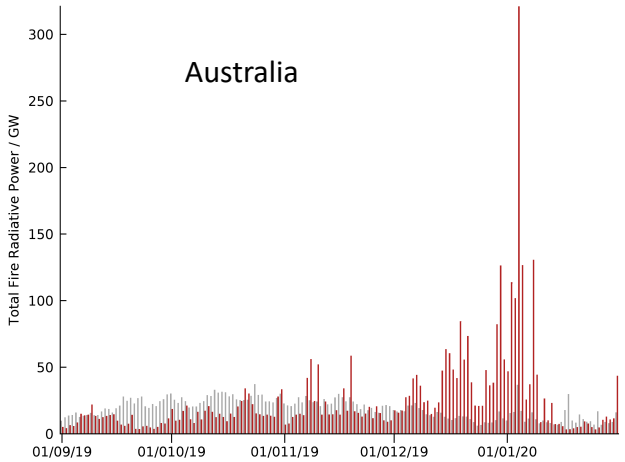
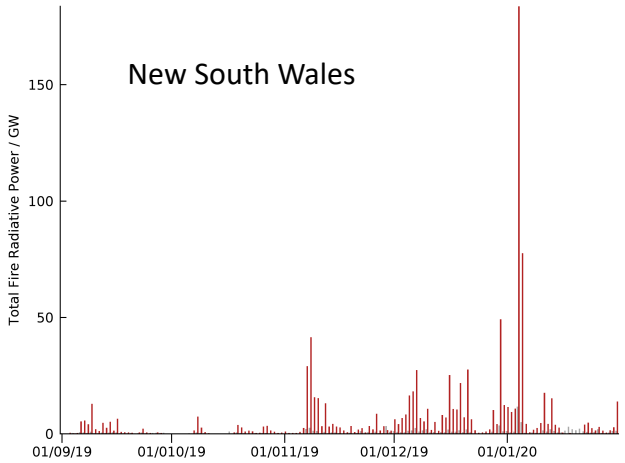
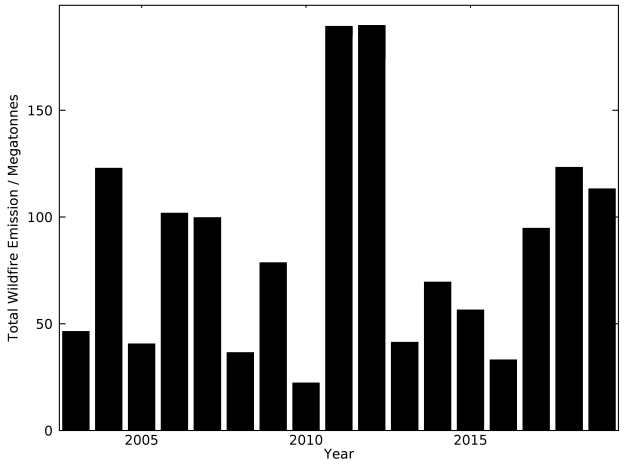
- Sept-Dec bushfires generally below average for Australia except for NSW which emitted large amounts of smoke through Nov (examples shown for 8th & 11th).
- Significant increase in bushfire activity from late December with activity in NSW, Victoria & South Australia resulting in long-range transport of smoke across New Zealand and the South Pacific Ocean (next slide).

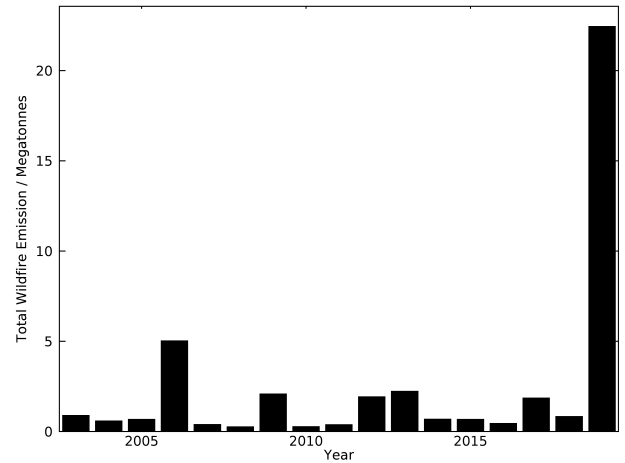
Daily Total Fire Radiative Power

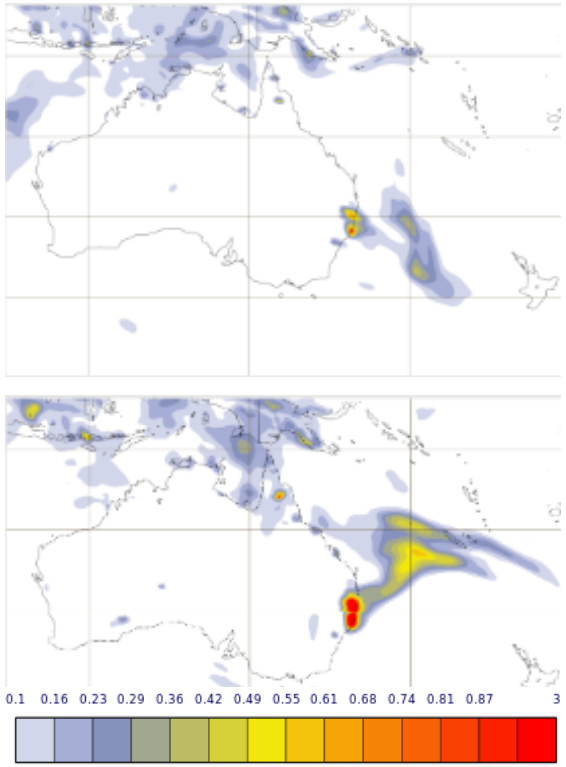




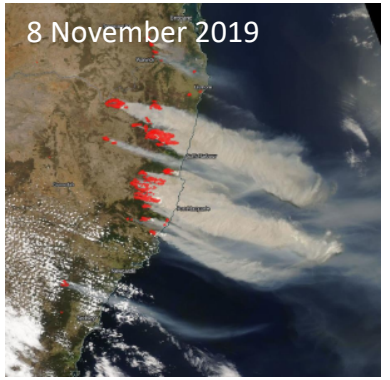
1 September – 31 January total carbon emissions

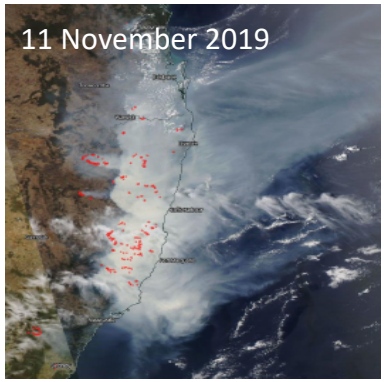






CAMS organic matter AOD forecasts (valid 03Z, 3h lead time)





Aqua-MODIS satellite imagery from NASA Worldview

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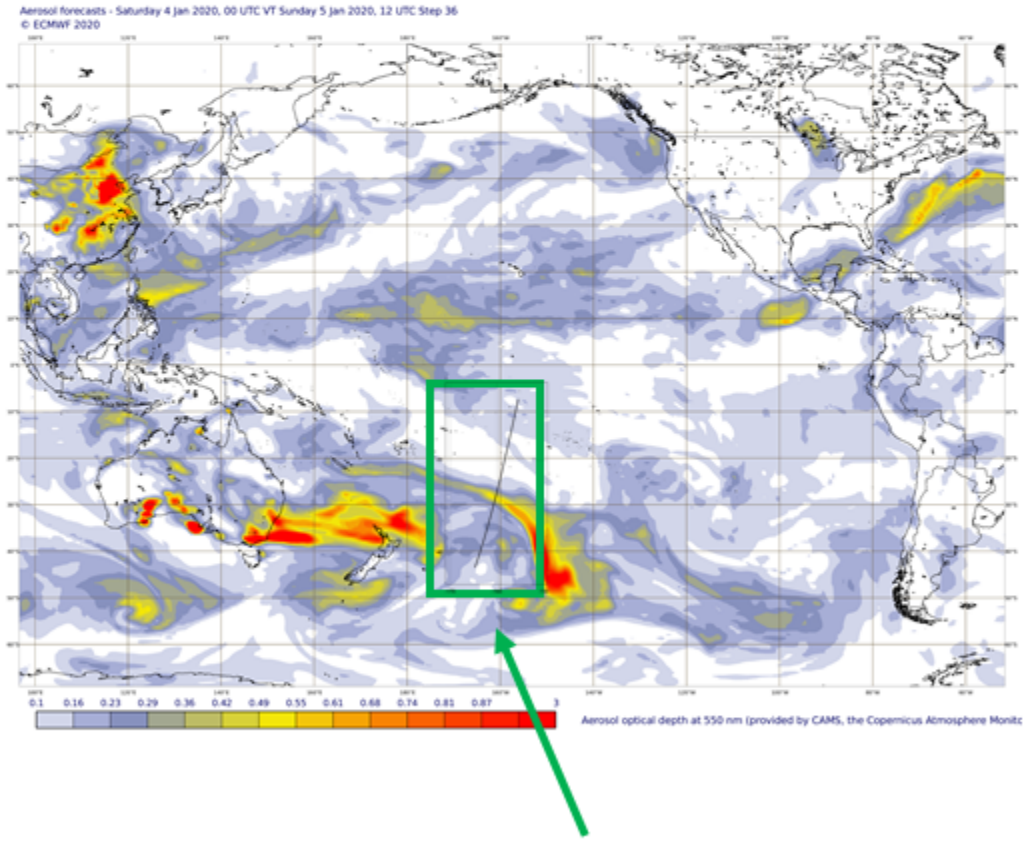
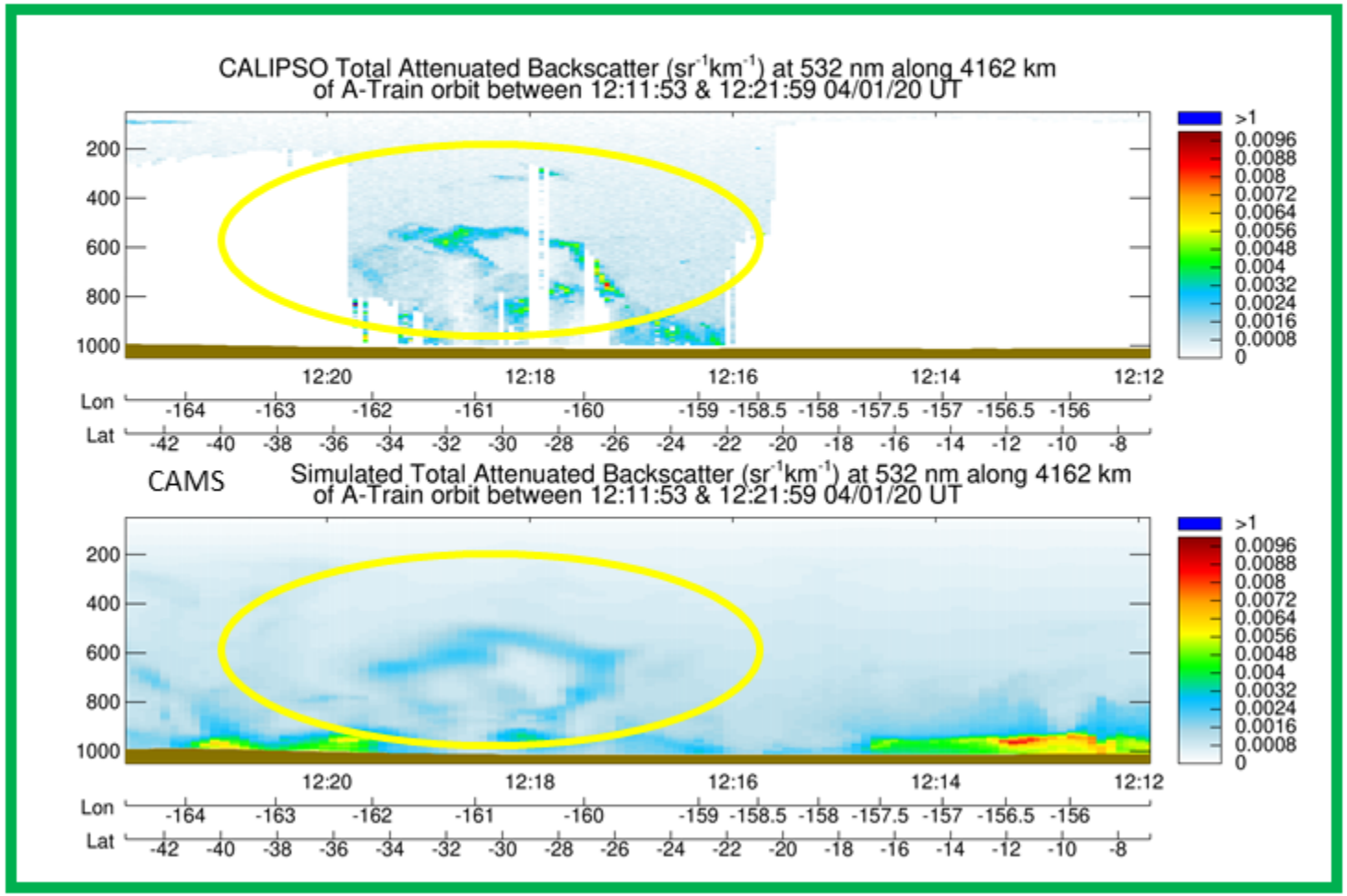
Australia bushfires: Long-range smoke transport

CAMS forecasts of Aerosol Optical Depth showed smoke transport over 1000s of kilometres around the Southern Hemisphere.
Example for 4 January 2020 at 12:00 UTC.



CALIPSO orbit

Long-range transport of smoke pollution from SE Australia followed injection into the free troposphere.
Vertical extent of smoke in CAMS forecasts compares well with (independent) CALIOP attenuared backscatter observations.



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IMPLEMENTED BY ECMWF

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SUMMARY

- The Copernicus services provide a wide-range of complimentary information for monitoring global wildfire conditions and activity, and their impact on atmospheric composition.
  - Fire danger forecasts and climate anomalies provide broader context for observed fire activity and emissions.
  - Widespread intense fire activity in the Arctic Circle related to warmer and drier surface conditions led to to strong positive anomalies in atmospheric composition across the region.
  - Devastating bushfires in southeastern Australia between Sept 2019 and Feb 2020 due to warmer and drier conditions emitted large amounts of smoke which was monitored during its long-range transport around the Southern Hemisphere.
- All Copernicus data are free and open for everyone to access.

atmosphere.copernicus.eu | climate.copernicus.eu | emergency.copernicus.eu

@CopernicusECMWF | @CopernicusEU | @CopernicusEMS

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Extra slides

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CAMS SERVICE CHAIN

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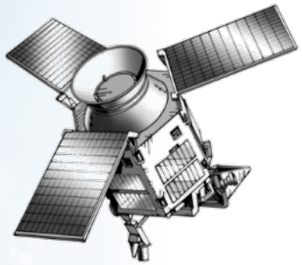
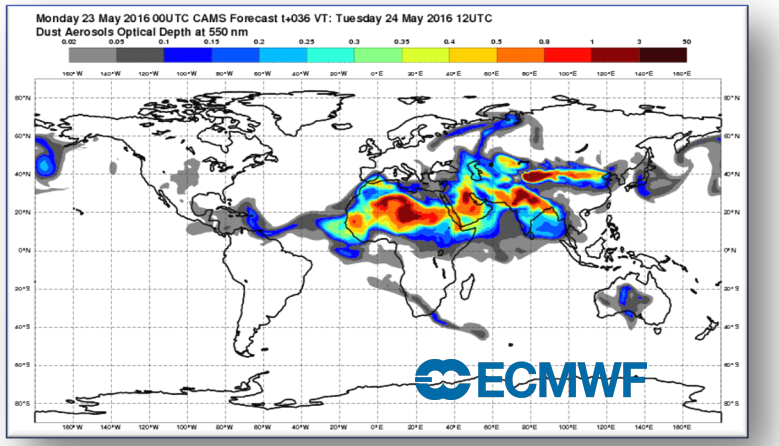
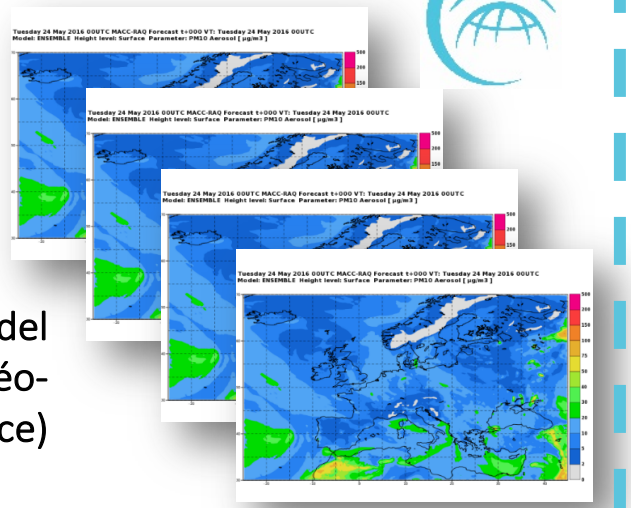
Space Agencies



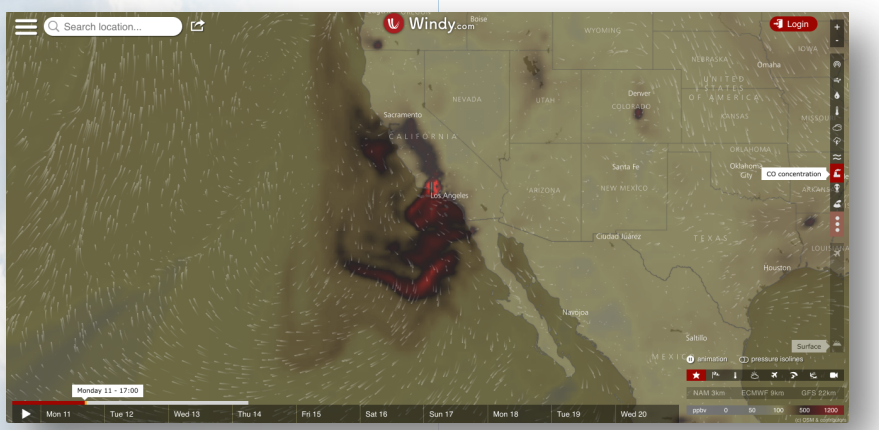


ECMWF Integrated Forecasting System (IFS)

In-situ observations



Regional multi-model ensemble (lead: Météo-France)



Users

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Near-real-time satellite data usage

Species	Instruments
Global system	
O_3	**OMI**, **SBUV-2**, **GOME-2**, **MLS**, **TROPOMI**, **OMPS**, IASI
CO	**IASI**, **MOPITT**, **TROPOMI**
NO_2	**OMI**, **GOME-2**, **TROPOMI**
SO_2	**OMI**, **GOME-2**, **TROPOMI**, IASI
Aerosol	**MODIS**, **PMAp**, VIIRS, SLSTR, SEVIRI
CO_2	**GOSAT**, **OCO-2**
CH_4	**GOSAT**, **IASI**, **TROPOMI**
GFAS fire emissions **Assimilated** **Monitored** Future	**MODIS**, **GOES-E/W***, **SEVIRI***, SLSTR, **VIIRS**, HIMAWARI-8*

*Geostationary platform

A wide-range of atmospheric composition satellite observations are assimilated in the IFS to produce daily analyses.

Control runs (with no data assimilated) and forecasts (initialised from analyses) are also produced in CAMS.

CAMS data used for field campaign planning and evaluating special events.

Composition data additional to thousands of assimilated meteorological data.