# Forecasting floods and wildfires – overview of Copernicus Emergency Management Service (CEMS) activities at ECMWF

Fredrik Wetterhall, ECMWF
fredrik.wetterhall@ecmwf.int
@fredolax

UEF, 4 June 2020

# Copernicus Emergency Management Service


## Provides information for

emergency response in relation to different types of disasters as well as prevention, preparedness, response and recovery activities.

## Composed of

- Mapping
  - Rapid mapping
  - Risk and recovery
- Early warning and monitoring
  - floods (EFAS and GloFAS)
  - forest fires (EFFIS and GFAS)
  - droughts (EDO)

# European Flood Awareness System and the Forest Fire Information System

## Added value

- Probabilistic information
- 10 days lead time for warnings
- Transboundary
- Knowledge exchange platform

## Novel information

- State-of-the-art science
- Comparable information across Europe
- Tool for international aid assistance during crisis

# EFAS and partners

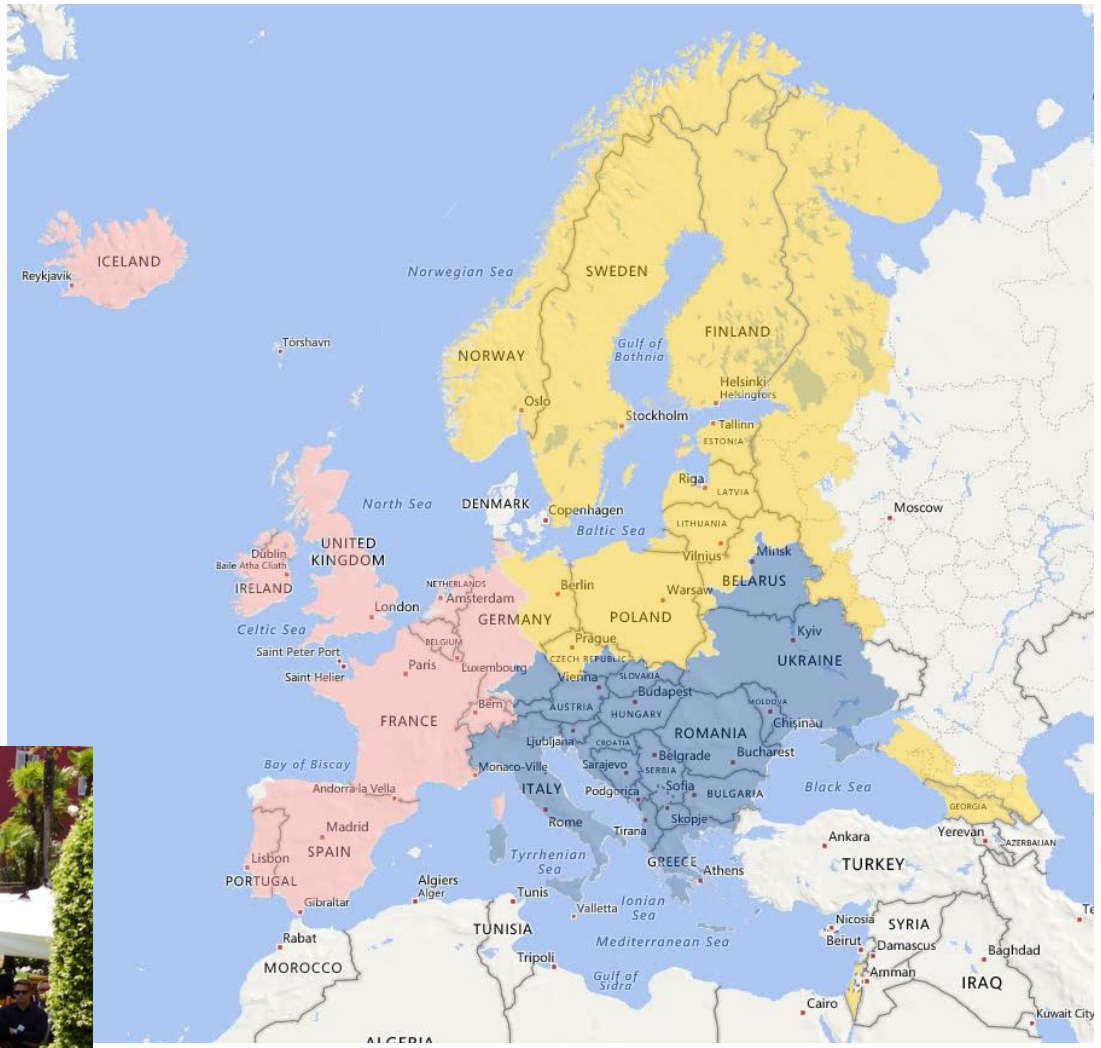
**Free and accessible** for EU & non-EU countries

**Respects** the one voice principle

**Currently** >70 partners (national and regional authorities & the ERCC)

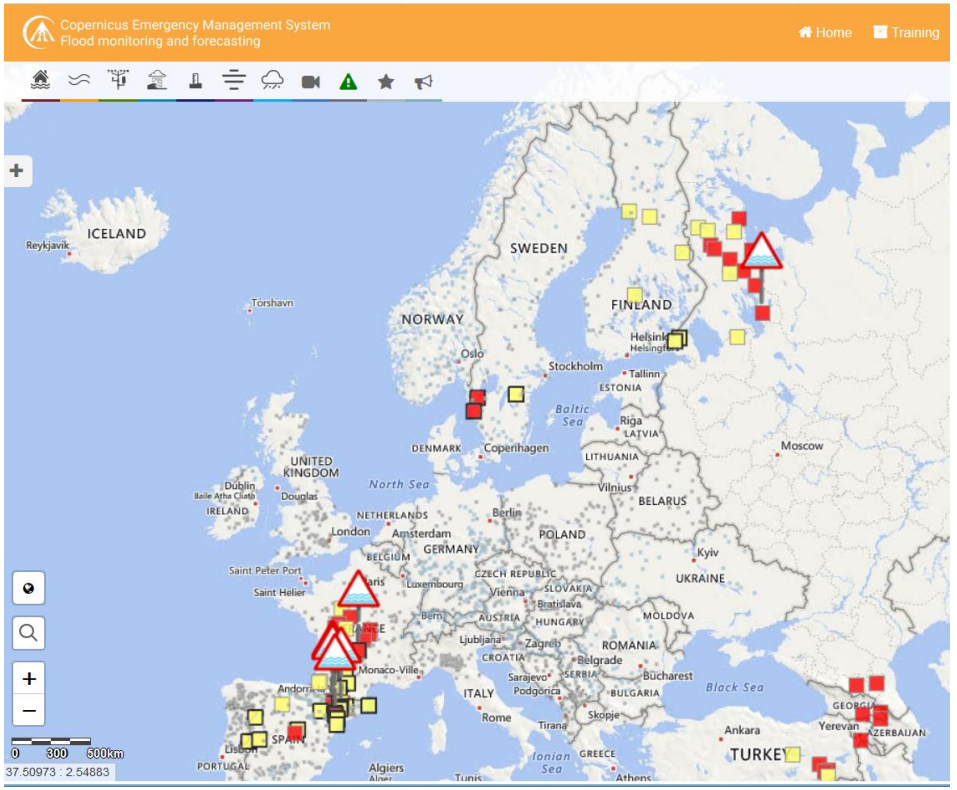
**Annual** partner meetings


EFAS Annual Meeting, Stresa (Italy), 2019



# EFAS system

**A hydrological model forced with NWP output to produce flood forecasts**




Easy access to operational flood forecasts

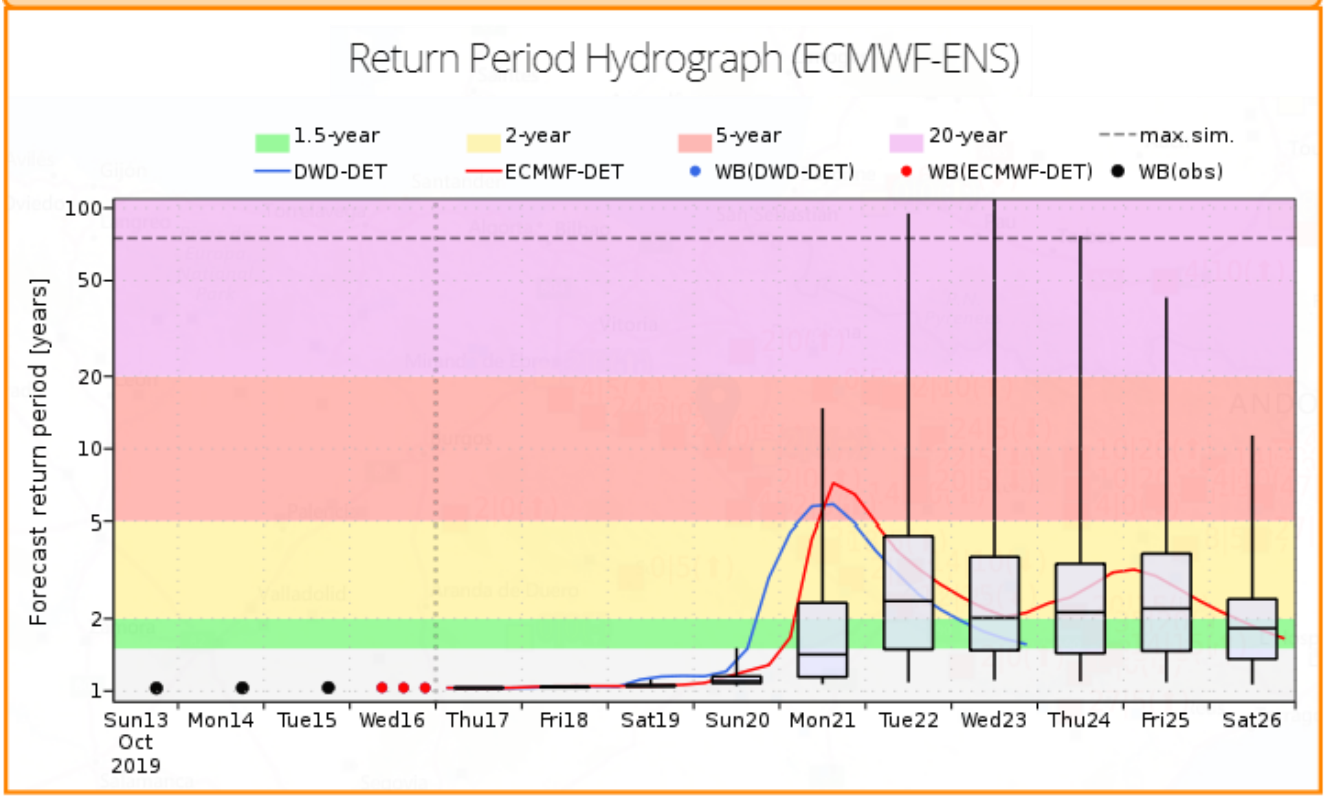
Real-time information for partners only

Overview maps and plots

Hydrological and meteorological information as well as static maps

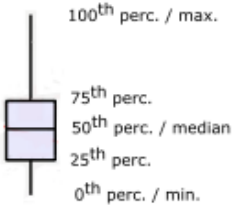
# EFAS medium-range hydrographs

**Return period hydrograph.** Time series plot of the (6-hourly deterministic and daily probabilistic) discharge forecasts over the next 10 days. Compared against the flood severity thresholds (coloured return periods on the y-axis), the forecast indicates potential upcoming floods over the forecast window.




**Severity thresholds.** Return periods (green to purple colours) and simulation maximum (dotted horizontal line) derived from the model climatology.

**Ensemble forecast boxplot**

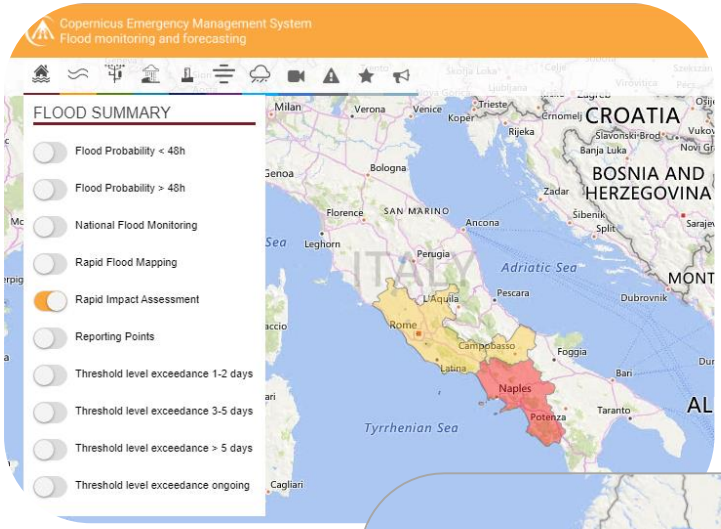



**Initial conditions period.** Shows the simulations from observations (black dots; daily) and the fill-up (coloured dots; 6-hourly).

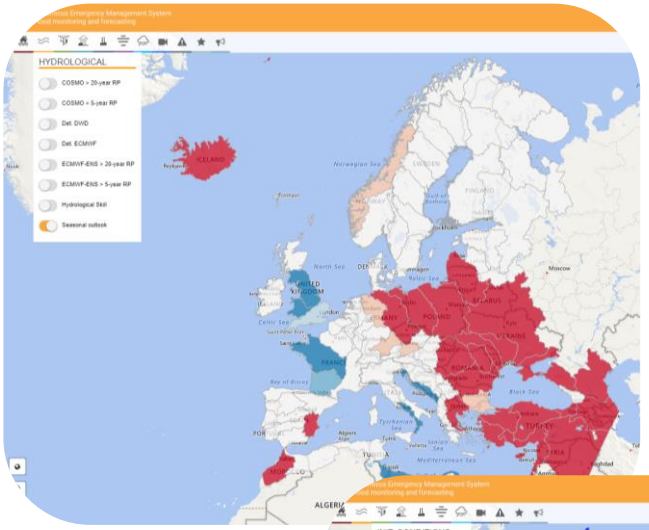
**Forecast period.** Starts at the vertical dotted line. Shows the two deterministic forecasts (single lines; 6-hourly) and ensemble forecast (daily boxplots; in this case ECMWF-ENS, as shown by the plot title).

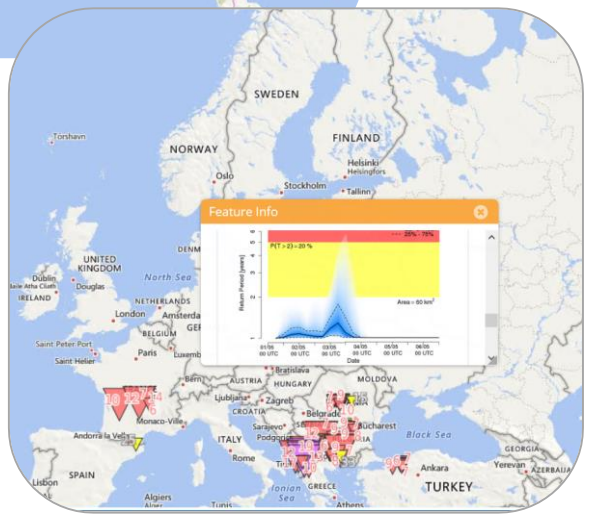
# Other products

## Rapid Impact Assessment

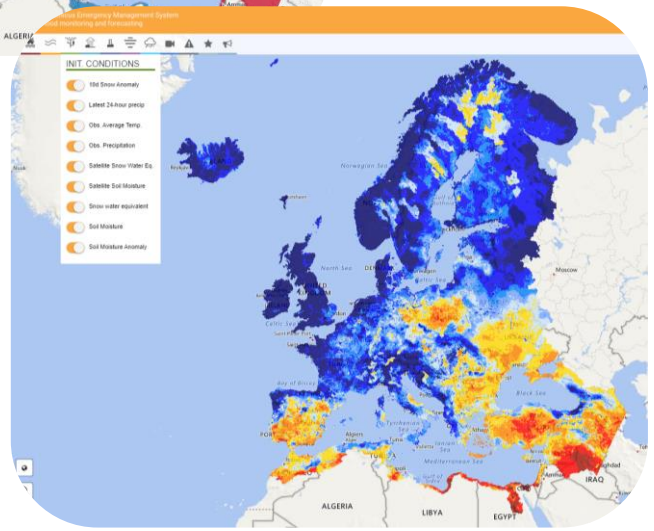



## Seasonal and sub-seasonal outlook




## Flash flood forecasts



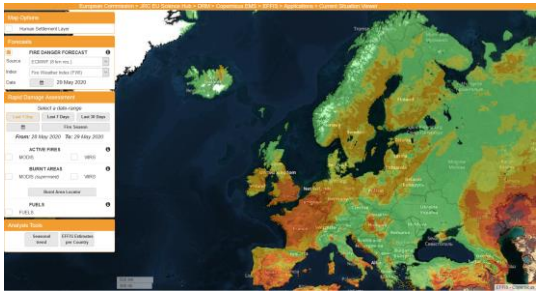

## Initial Conditions

# EFFIS at a glance

Early probabilistic fire danger warning system and fire monitoring (active fires and burned areas)

In Europe (EFFIS), ~ 40 partners:

- EFFIS is supported by a network of experts from the countries in what is called the Expert Group on Forest Fires
- Service delivered by the JRC. ECMWF with the aid of MeteoFrance is the computational centre for fire forecasting



# Example EFFIS products

**Three models**

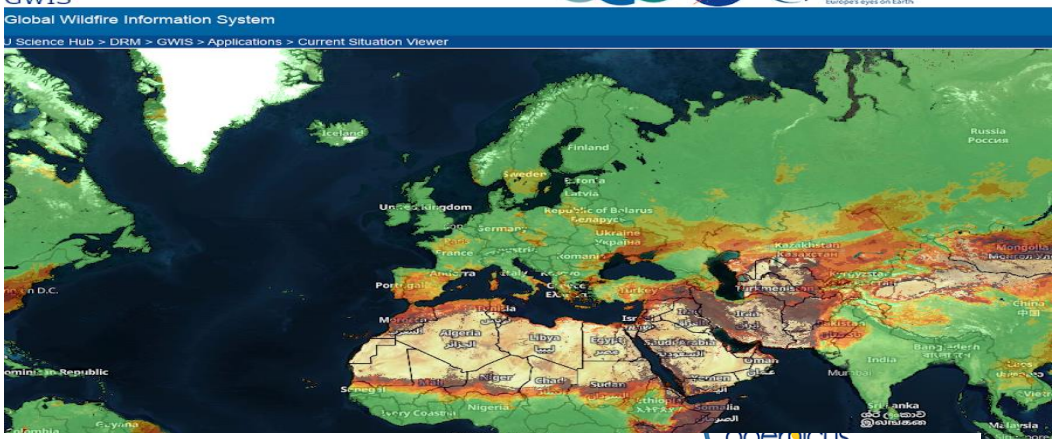
1. Canadian Fire Weather index
2. Australian Mc Arthur
3. US National Fire Danger Rating system

**Updates** daily

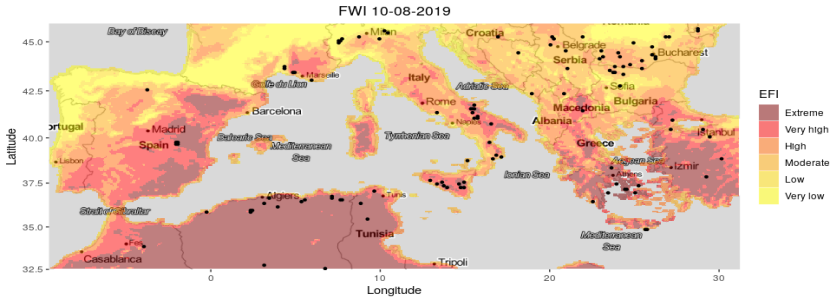
**Easily understandable**

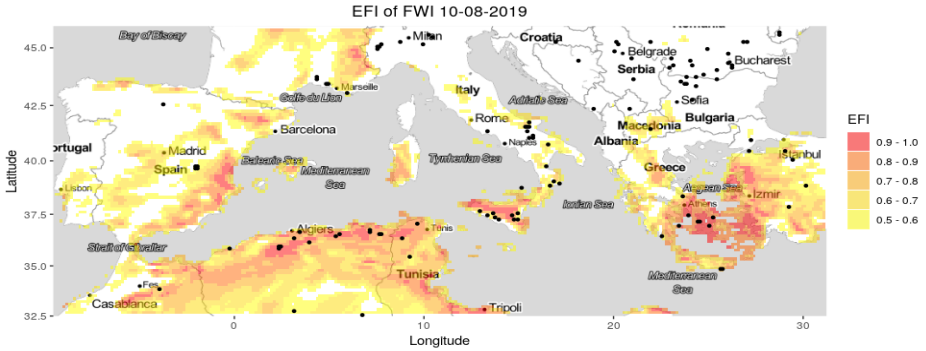
overview maps and plots

**Fire danger**




# New products




**New:** Probabilistic EFI
Climate = 20 years of reforecast of FWI
Forecast = Distribution from ENS

FWI is not a "sharp" index and extreme conditions might be "usual" in some regions (e.g. Greece, Spain in August)

The extreme forecast Index helps identifying conditions that are also statistically **unusual** compared to the model climate

# CEMS Data access

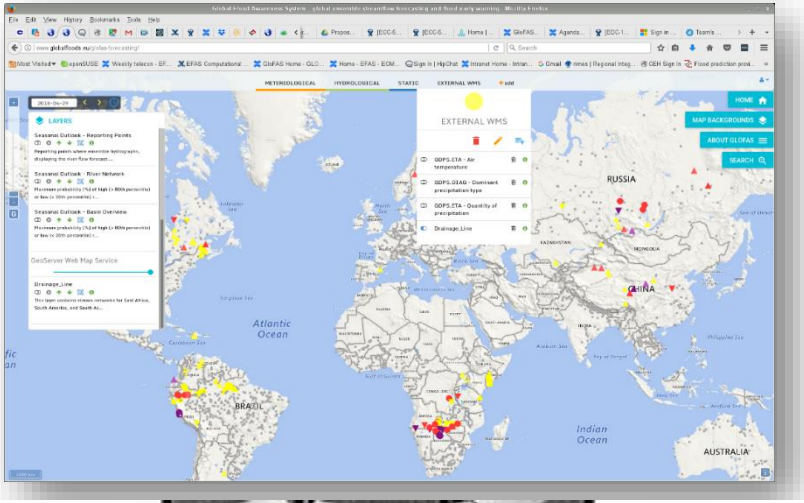
## Web Services

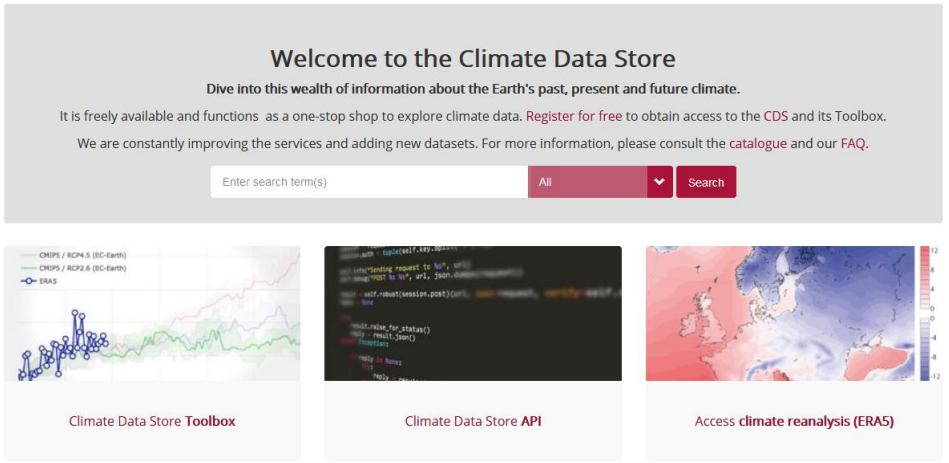
WMS service for CEMS-Flood

## Data Access

Copernicus Climate Data Store

cds.climate.copernicus.eu



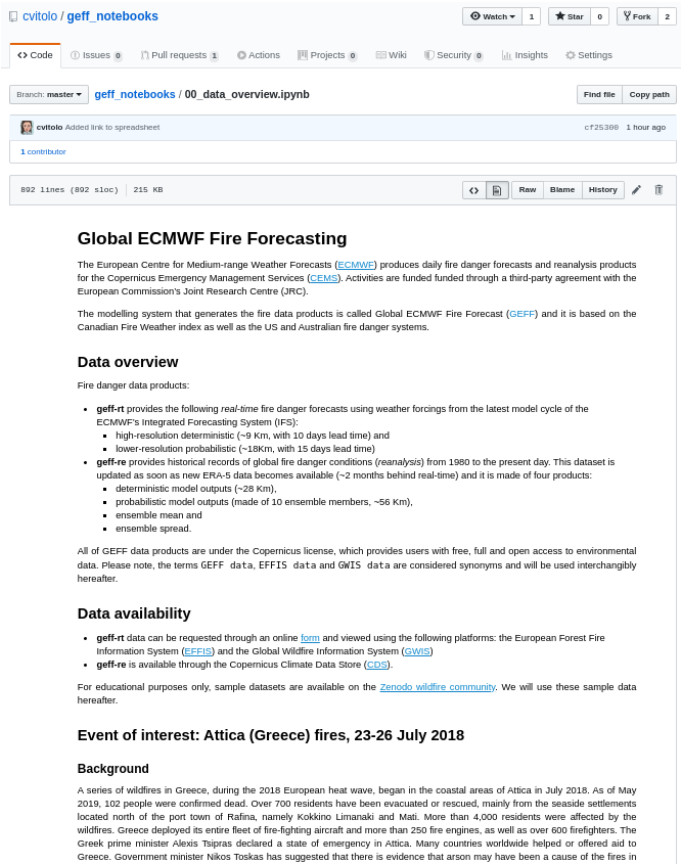




# Training

## Webinars


In this video, you will learn more about EFAS - the European Flood Awareness System.

## Jupyter Notebook



cvitolo / geff_notebooks

Watch 1 | Star 0 | Fork 2

Code | Issues 0 | Pull requests 1 | Actions | Projects 0 | Wiki | Security 0 | Insights | Settings

Branch: master | geff_notebooks / 00_data_overview.ipynb | Find file | Copy path

cvitolo Added link to spreadsheet — cf25300 — 1 hour ago

1 contributor

892 lines (892 sloc) | 215 KB | Raw | Blame | History

### Global ECMWF Fire Forecasting

The European Centre for Medium-range Weather Forecasts (ECMWF) produces daily fire danger forecasts and reanalysis products for the Copernicus Emergency Management Services (CEMS). Activities are funded funded through a third-party agreement with the European Commission's Joint Research Centre (JRC).

The modelling system that generates the fire data products is called Global ECMWF Fire Forecast (GEFF) and it is based on the Canadian Fire Weather index as well as the US and Australian fire danger systems.

### Data overview

Fire danger data products:

- **geff-rt** provides the following *real-time* fire danger forecasts using weather forcings from the latest model cycle of the ECMWF's Integrated Forecasting System (IFS):
  - high-resolution deterministic (~9 Km, with 10 days lead time) and
  - lower-resolution probabilistic (~18Km, with 15 days lead time)
- **geff-re** provides historical records of global fire danger conditions (*reanalysis*) from 1980 to the present day. This dataset is updated as soon as new ERA-5 data becomes available (~2 months behind real-time) and it is made of four products:
  - deterministic model outputs (~28 Km),
  - probabilistic model outputs (made of 10 ensemble members, ~56 Km),
  - ensemble mean and
  - ensemble spread.

All of GEFF data products are under the Copernicus license, which provides users with free, full and open access to environmental data. Please note, the terms `GEFF data`, `EFFIS data` and `GWIS data` are considered synonyms and will be used interchangibly hereafter.

### Data availability

- **geff-rt** data can be requested through an online form and viewed using the following platforms: the European Forest Fire Information System (EFFIS) and the Global Wildfire Information System (GWIS)
- **geff-re** is available through the Copernicus Climate Data Store (CDS).

For educational purposes only, sample datasets are available on the Zenodo wildfire community. We will use these sample data hereafter.

### Event of interest: Attica (Greece) fires, 23-26 July 2018

#### Background

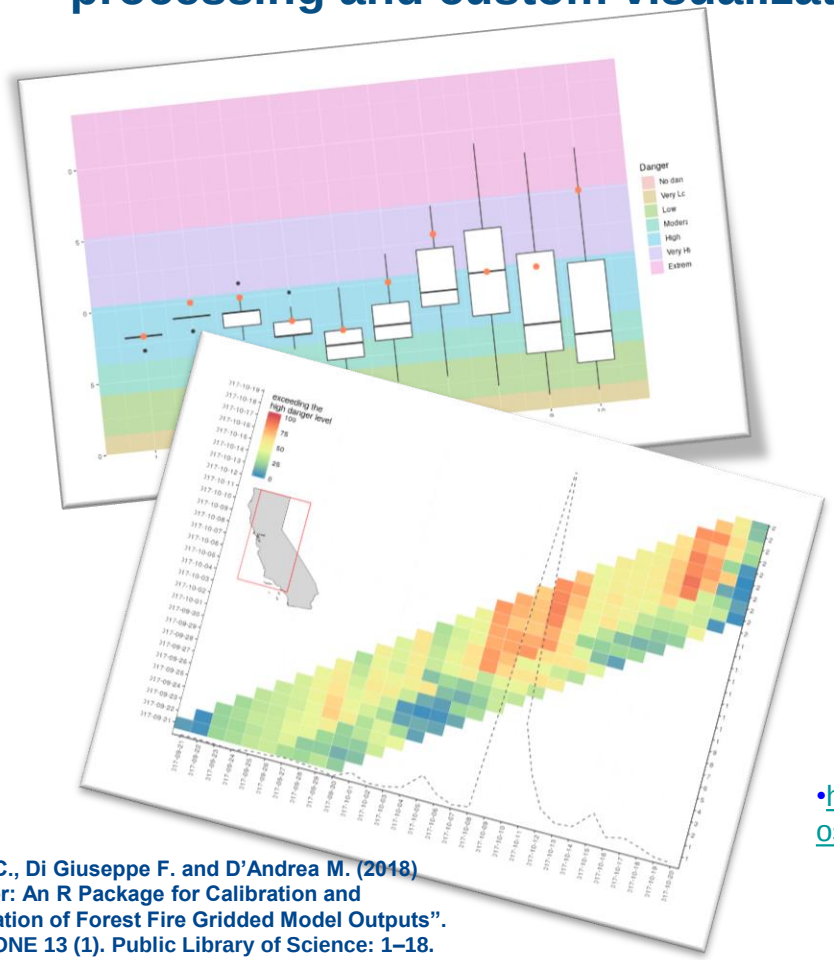
A series of wildfires in Greece, during the 2018 European heat wave, began in the coastal areas of Attica in July 2018. As of May 2019, 102 people were confirmed dead. Over 700 residents have been evacuated or rescued, mainly from the seaside settlements located north of the port town of Rafina, namely Kokkino Limanaki and Mati. More than 4,000 residents were affected by the wildfires. Greece deployed its entire fleet of fire-fighting aircraft and more than 250 fire engines, as well as over 600 firefighters. The Greek prime minister Alexis Tsipras declared a state of emergency in Attica. Many countries worldwide helped or offered aid to Greece. Government minister Nikos Toskas has suggested that there is evidence that arson may have been a cause of the fires in



Copernicus | Europe's eyes on Earth

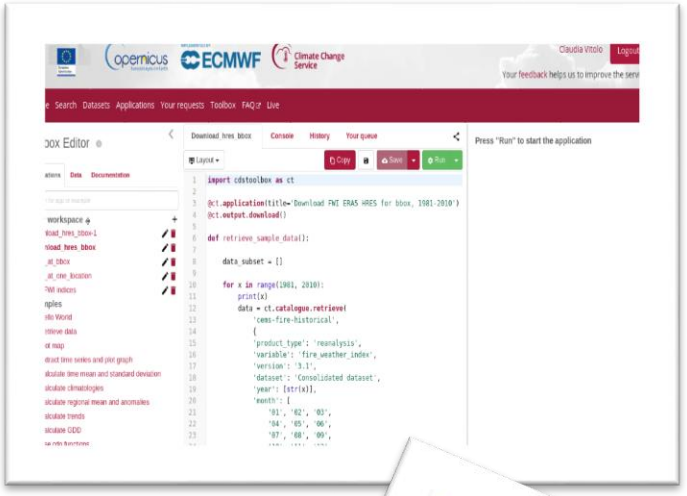
# Software availability

## R resources for advanced statistical processing and custom visualizations




Vitolo C., Di Giuseppe F. and D'Andrea M. (2018) "Caliver: An R Package for Calibration and Verification of Forest Fire Gridded Model Outputs". PLOS ONE 13 (1). Public Library of Science: 1–18. doi:10.1371/journal.pone.0189419

## Demo of Copernicus Climate Data Store and Toolbox




## GEFFv4 available

## LISFLOOD open source


•https://git.ecmwf.int/projects/CEMSF/repos/geff/browse

# Upcoming developments

## CEMS-Flood

- Release of EFAS 4.0
  - 6-hourly model
  - New products
- Release of GloFAS 3.0
  - New LISLOOD model

## CEMS-Fire

- Seasonal forecast
  - Outlook up to 4 months
- Sub-daily fire indices
  - Maximum hourly FWI

- More functionality on CDS

# More information

**Visit our websites or email us**

efas.eu
globalfloods.eu
effis.jrc.ec.europa.eu
gwis.jrc.ec.europa.eu

efas@ecmwf.int

**Data Access**

Copernicus Climate Data Store
cds.climate.copernicus.eu

# LISFLOOD

**Surface runoff** routing

**Subsurface and groundwater** flow

**River channel** routing

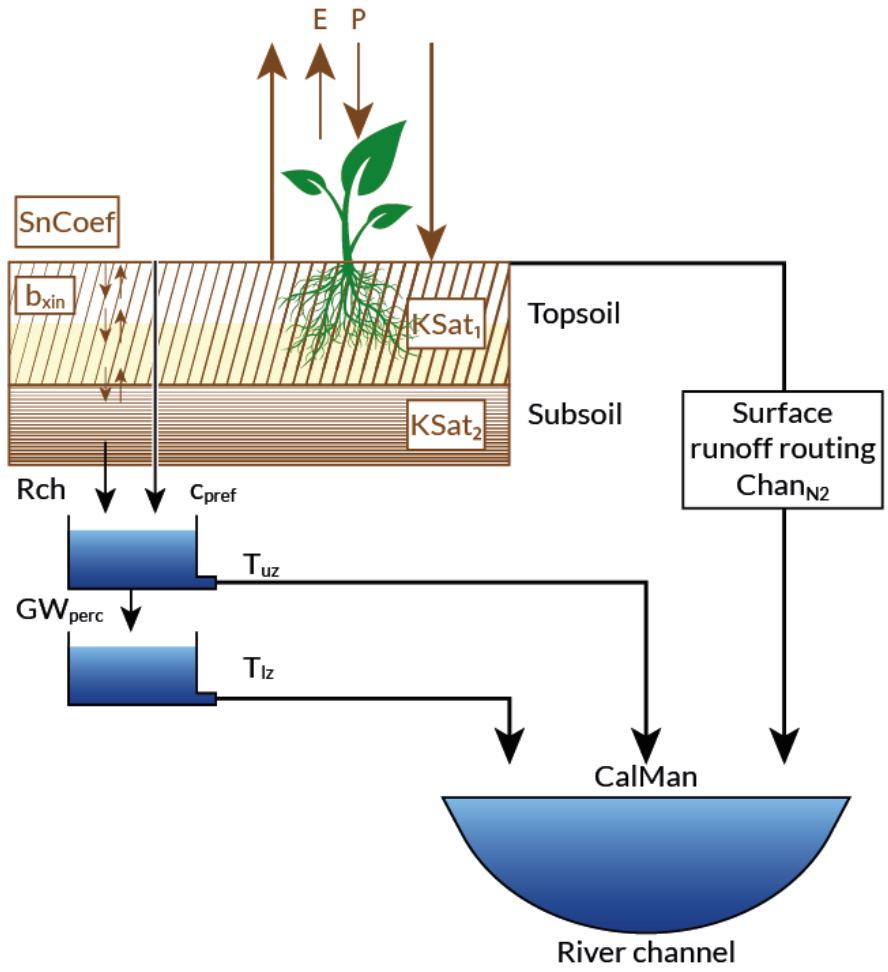
**Snow** accumulation and melt

**Lakes and reservoirs** included

**Not simulated:** upward vertical soil moisture, deep groundwater systems

Performance issue in groundwater-driven or arid regions (e.g. S. England, C. Spain)

**Land classes** defined at subgrid level



# Flash floods

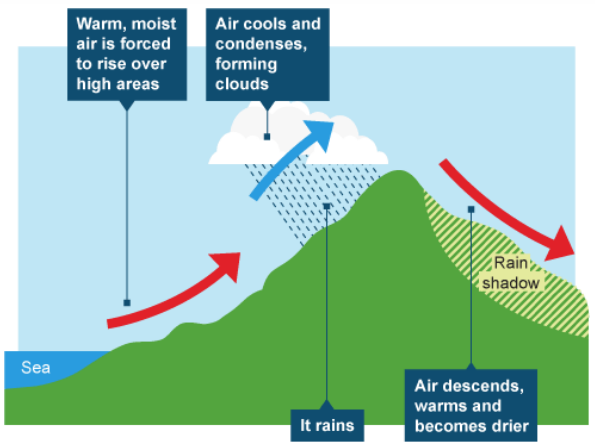
**Linked to** intense precipitation

2 types: orographic vs. convective

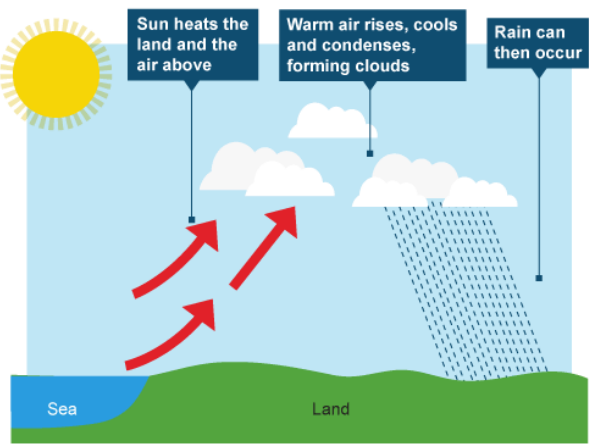
**<24h lag** to peak discharge

**Short warning time** and high mortality risk

Purcell, Oklahoma, 24 May 2015
Source: @NickBrownOKC



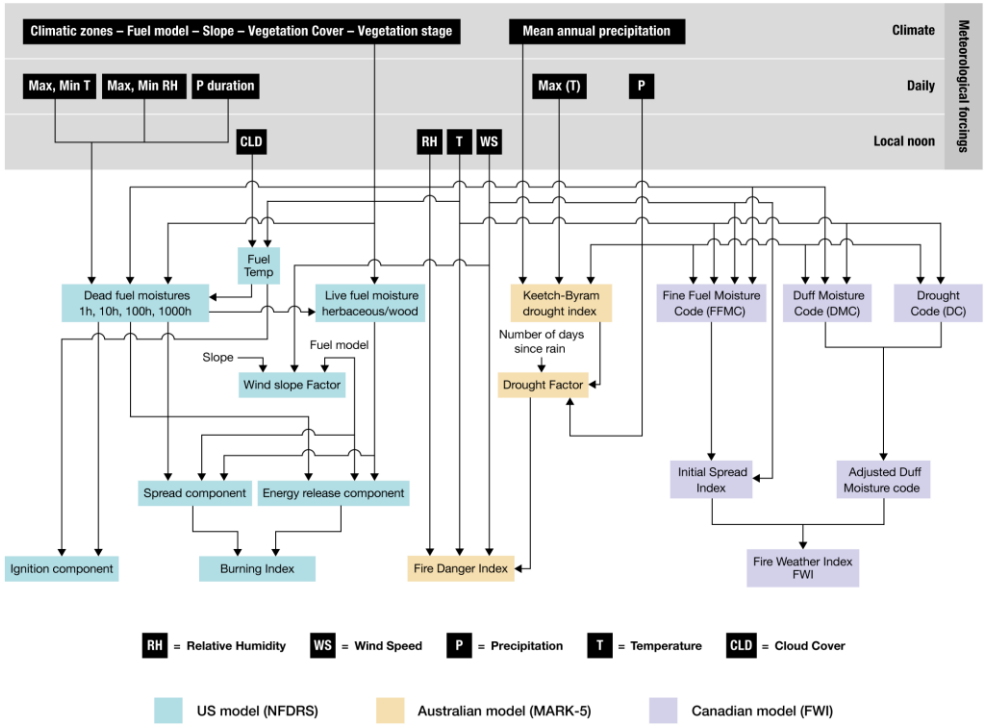

Orographic




Convective

Source: BBC

# GEFF Global Ecmwf Fire forecast Model




**Multi-model ensemble prediction system for fire danger forecast:**

- 3 fire rating models: NFDRS (US),MARK-5 (Australia), FWI (Canada)
- 51 ensemble members at 18 km resolution
- 1 high resolution run at 9km resolution
- 10 days lead time
- Daily updates
- Uses the most recent ECMWF model cycle

**Reanalysis from ERA5 available through the climate data store 1980-2017**

**Seasonal prediction coming this year**

*Di Giuseppe, Francesca, et al. "The potential predictability of fire danger provided by numerical weather prediction." Journal of Applied Meteorology and Climatology 55.11 (2016): 2469-2491.*

# Comparing the model-climate with the forecast (In terms of the whole ensemble)