

# Fire danger: the predictive skill provided by ECMWF Integrated forecasting System (IFS)

Francesca Di Giuseppe and the fire group at ECMWF

ECMWF, Reading, UK  
[F.DiGiuseppe@ecmwf.int](mailto:F.DiGiuseppe@ecmwf.int)

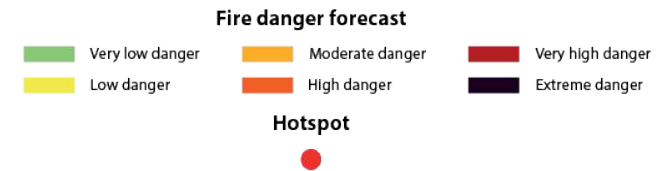
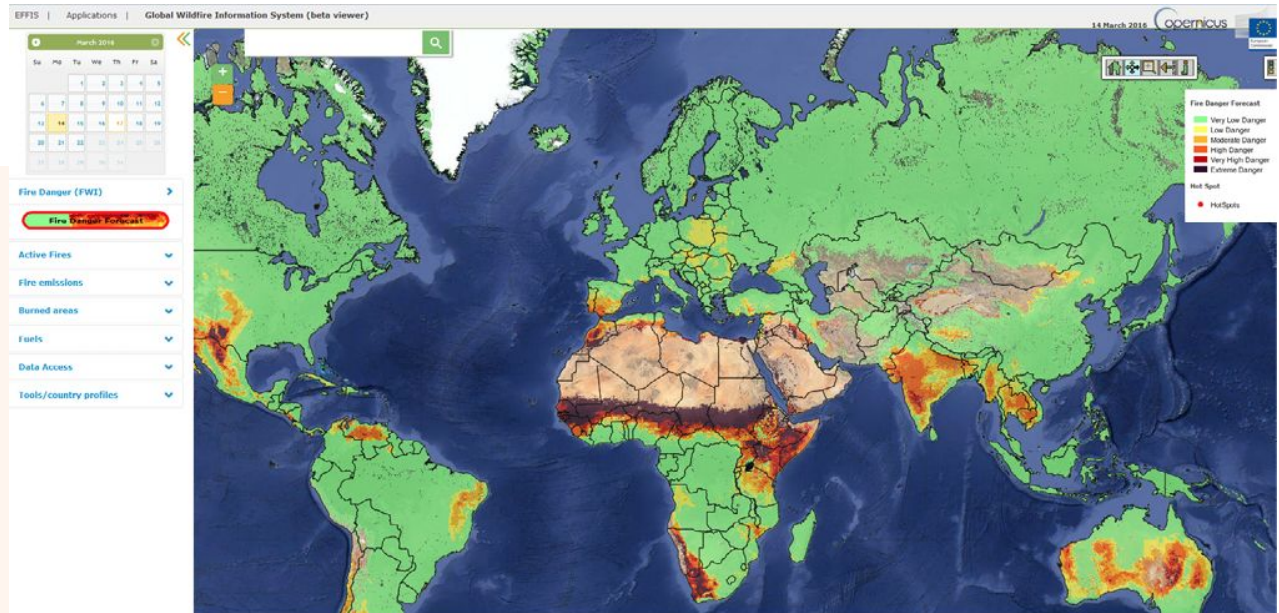


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# ECMWF involvement in fire forecast

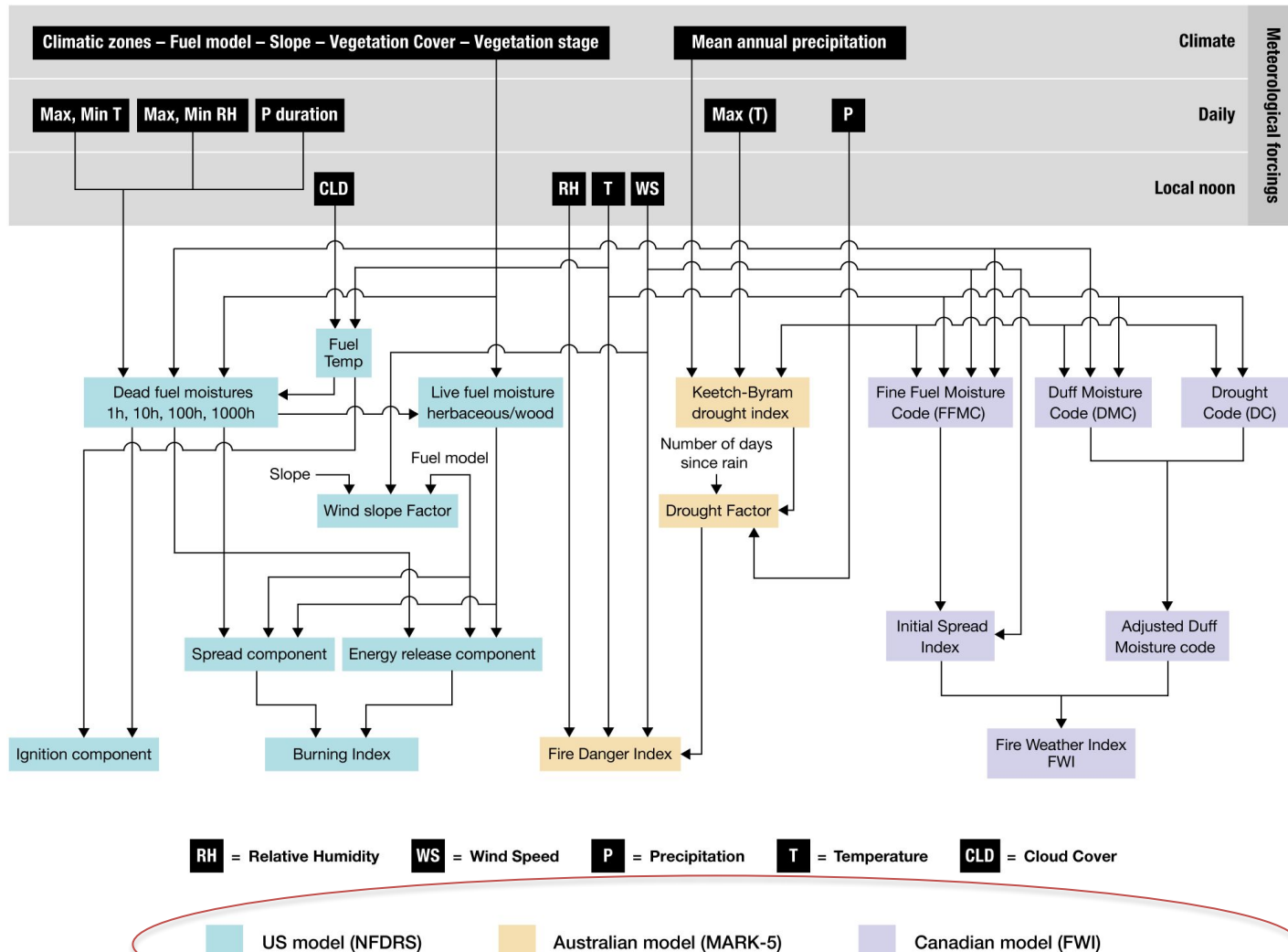
In 2000 the European Forest Fire Information System (EFFIS) became operation. It is a joint effort of the Joint Research Centre (JRC) and the Directorate General for Environment (DG ENV) of the European Commission (EC).

Lately it has been incorporated into the **Copernicus Emergency Management Service**



Since the end of 2017 ECMWF is the Computational centre for the Copernicus Emergency Management Service-fire and provides the meteorological input and the forest danger indices for EFFIS and GWIS on a daily base.

# ECMWF Fire Forecast system



# Datasets (not-) available from ECMWF fire forecasting system

## Climatological dataset

38 years of Re-analysis (Available and downloadable)

- 80 Km resolution
- Daily data
- FWI indices only

<https://zenodo.org/communities/wildfire>

SCIENTIFIC  
DATA

38 years of global fire danger calculation using the ECMWF Re-Analysis (ERA)-Interim database

Claudia Vitolo<sup>1\*</sup>, Francesca Di Giuseppe<sup>1\*</sup>, Blazej Krzeminski<sup>1</sup>,  
Jesus San-Miguel-Ayanz<sup>2</sup>

datasets

## Realtime - up to 15 days ahead (Available but not openly distributed)

Daily outputs using latest version of IFS model cycle

1. High resolution ~9km globally
2. ENS prediction (51 ensemble members at 18km).

Only available through ECMWF dissemination service/not publically open. A selection downloadable through the EFFIS website.

## Extended range forecast - up to 7 months ahead (Not available)

Plan is to develop a system using latest version of ECMWF seasonal forecast S5

# ECMWF Fire Forecast model - Open Source

CEMS-fire / geff

Source

master | geff

Source	Description	Last Modified
data		
docs		
src		
tests		
.gitignore	integrated geff repositories into one	02 Nov 2017
CONDUCT.md	GEFF original repo was split into two: geff (contains model only) and ecgeff (containing scripts and suits only). Also added README< LIC	27 Jul 2018
LICENSE	GEFF original repo was split into two: geff (contains model only) and ecgeff (containing scripts and suits only). Also added README< LIC	27 Jul 2018
NEWS.md	Updated README and added a NEWS file for documenting releases	41 mins ago
NOTICE	Changed notice to mention geff	21 mins ago
README.md	Removed redundant text	6 mins ago

README.md

## Global ECMWF Fire Forecasting (GEFF) model

Maintainer: [Francesca Di Giuseppe](mailto:francesca.digiuseppe@ecmwf.int), please report any issues or bugs to [francesca.digiuseppe@ecmwf.int](mailto:francesca.digiuseppe@ecmwf.int).

The Global ECMWF Fire Forecasting (GEFF) model is a Fortran-95 program to calculate fire danger indices from atmospheric inputs. It implements the Fire Weather Index, the National Fire Danger Rating System and the Mc-Arthur ratings in one single infrastructure. While it was principally designed for gridded data, it can operate with any kind of inputs.

**Content:**

- docs/ documentation
- src/ source code
- tests/ script for launching an example run
- data/ sample input data (please note, ERA-Interim and other inputs will need to be locally available)

**Meta:**

- This software and functions herein are part of an experimental open-source project. They are provided as is, without any guarantee.
- Please note that this project is released with a [Contributor Code of Conduct](#). By participating in this project you agree to abide by its terms.
- License: [APACHE-2](#)
- If you use this software, please cite the following paper:  
 Di Giuseppe, F., Pappenberger, F., Wetterhall, F., Krzeminski, B., Camia, A., Libertà, G. and San Miguel, J., 2016. **The potential predictability of fire danger provided by numerical weather prediction.**  
[Journal of Applied Meteorology and Climatology, 55\(11\), pp. 2450-2463. \[https://journals.ametsoc.org/doi/10.1175/JAPM-D-15-0007.1\]\(#\)](#)

<https://software.ecmwf.int/stash/projects/CEMSF/repos/geff/browse>

# calive-R package

Calibration and verification package for gridded fire danger input

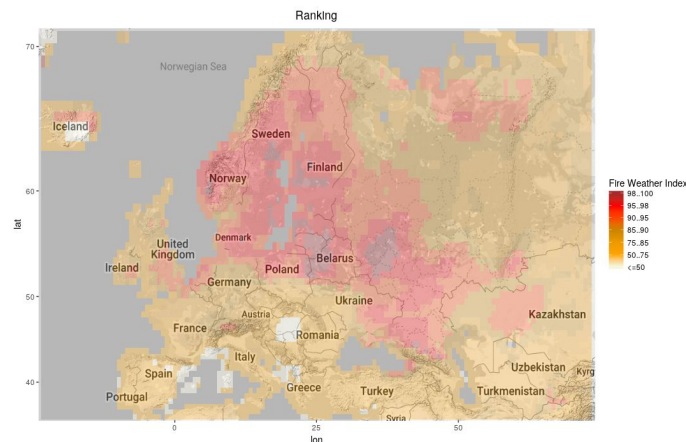
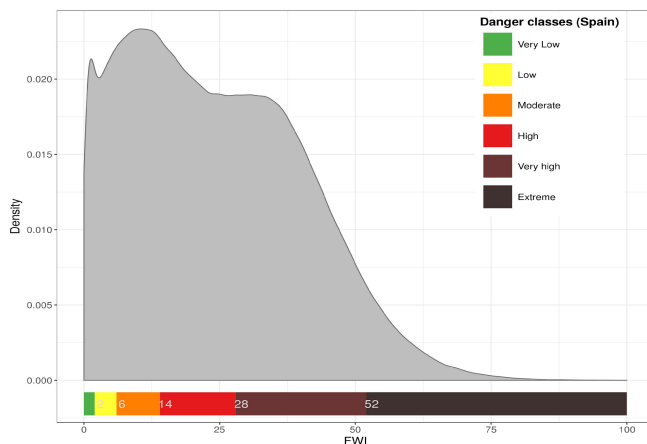


Table 7. Fire danger levels for selected areas.

Area of interest	Very low	Low	Moderate	High	Very high	Extreme
Europe	<= 2	3 – 4	5 – 9	10 – 16	17 – 28	> 28
United Kingdom	<= 1	2 – 3	4 – 6	7 – 11	12 – 18	> 18
Spain	<= 2	3 – 6	7 – 14	15 – 28	29 – 52	> 52
Italy	<= 2	3 – 5	6 – 11	12 – 21	22 – 38	> 38
Calabria Region (IT)	<= 2	3 – 5	6 – 12	13 – 22	23 – 40	> 40
Sicily (IT)	<= 2	3 – 6	7 – 13	14 – 26	27 – 48	> 48
Liguria Region (IT)	<= 1	2 – 4	5 – 8	9 – 15	16 – 25	> 25
Province of Genoa, part of Liguria Region	<= 2	3 – 4	5 – 9	10 – 16	17 – 27	> 27

Journal paper:

Vitolo, C., Di Giuseppe, F., & D'Andrea, M. (2018, January).

**Caliver: an R package for calibration and verification of forest fire gridded model outputs.** PLOS ONE, 13(1), 1–18.

Doi:10.1371/journal.pone.0189419

Repository on GitHub:

<https://github.com/ecmwf/caliver>



# Where FWI approach is likely to be more accurate to detect fire danger: reanalysis 2000-2015

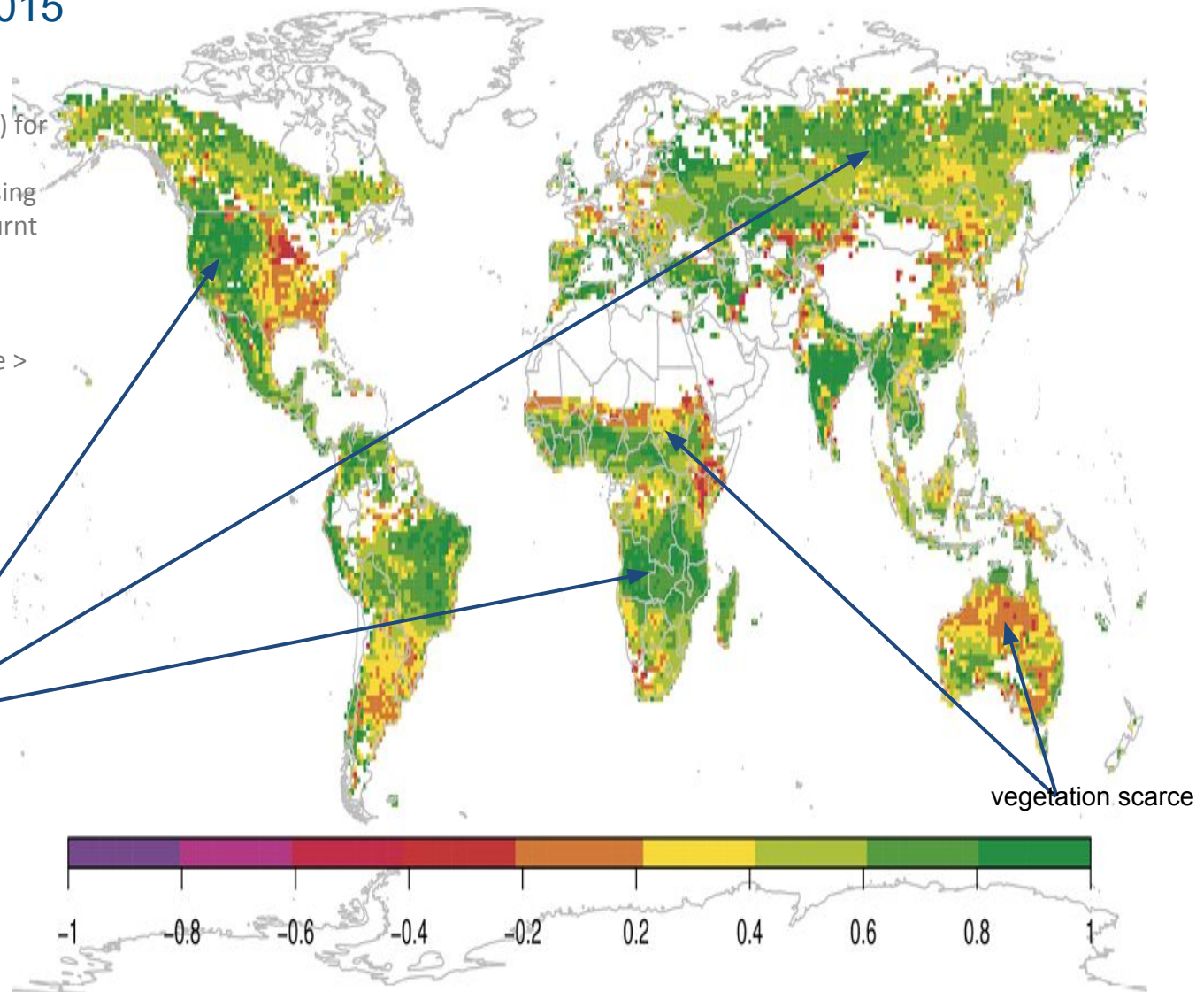
Extremal Dependence Index (EDI) for the Fire Weather Index (FWI). The EDI skill score is calculated using the fire mask derived from the burnt areas of the GFED4 dataset.

A fire is considered to have been forecasted when the FWI is above > 75% of its distribution.

**EDI =1 perfect forecasts**  
**EDI =0 random forecasts.**

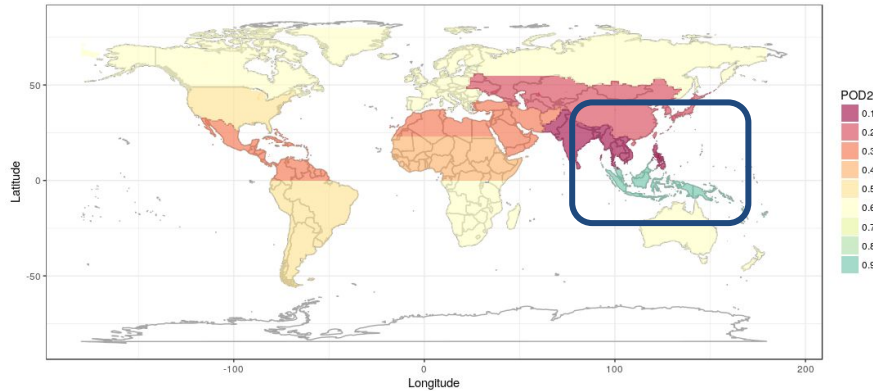
vegetation is abundant

vegetation scarce



# Probability of detection 2 -6 days forecast in 2017

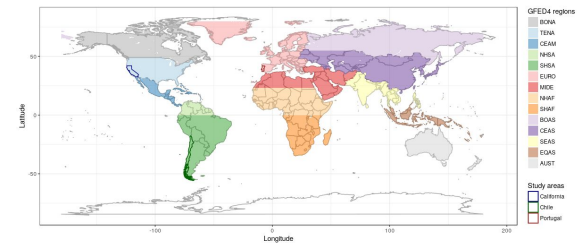
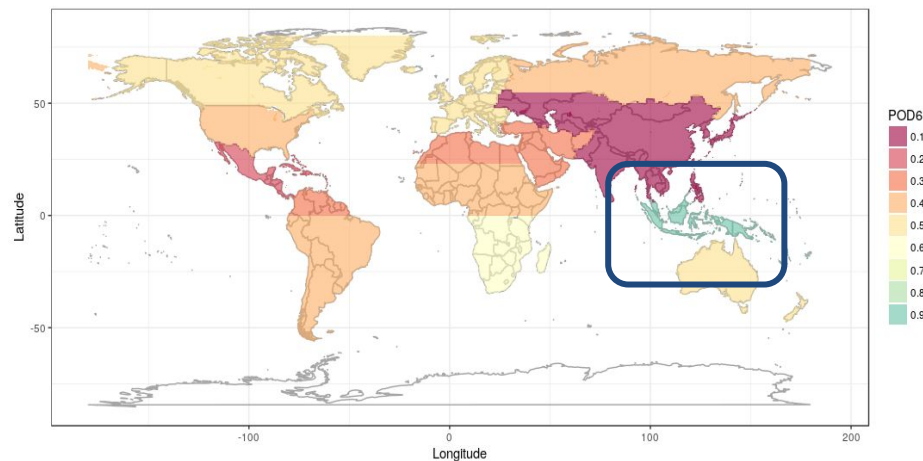
DAY-2



$POD = \text{hits} / (\text{hits} + \text{misses})$

Very rough overview of potential usability of weather forecast for fire danger detection

DAY-6



GFED4 Regions for averaging

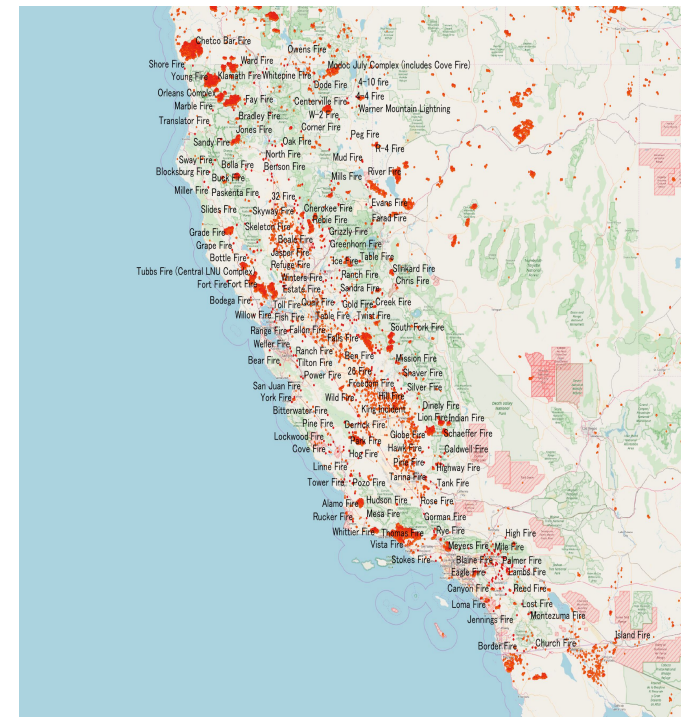
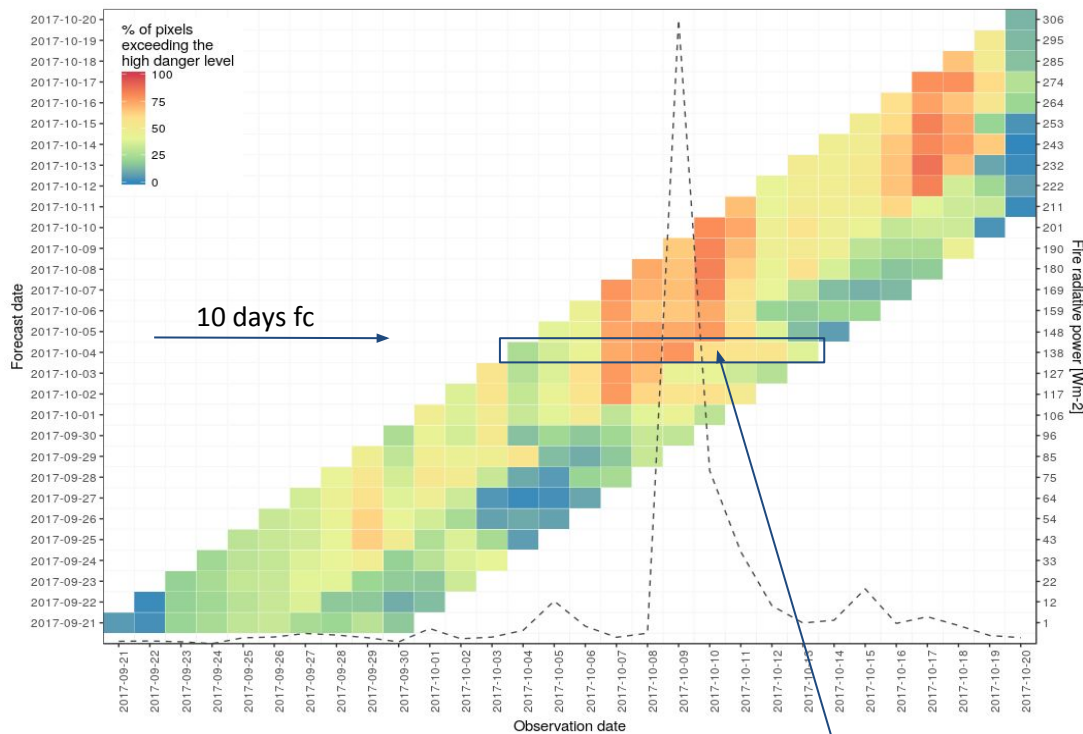
Di Giuseppe, F et al. "Fire Danger: the skill provided by ECMWF ensemble prediction system." submitted Environment international



## Looking into the fire forecasting system - California Fire 2017

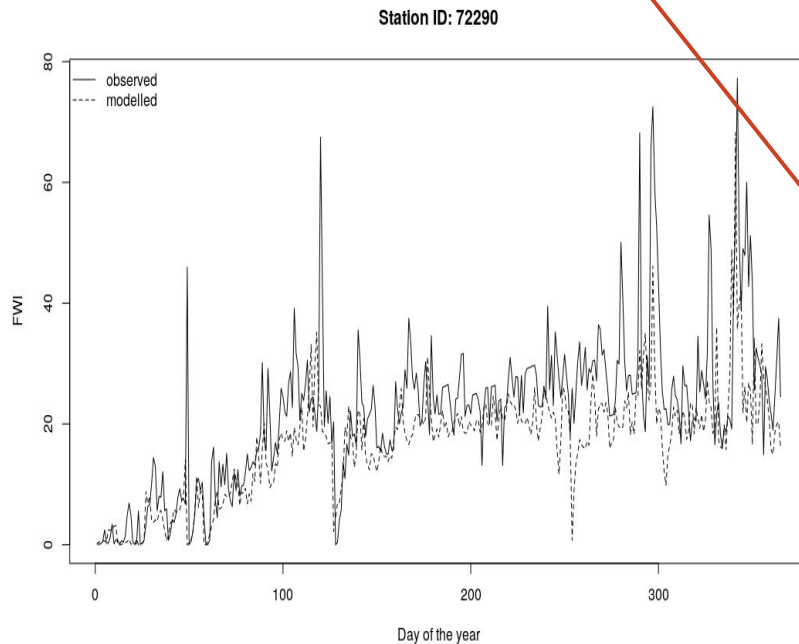
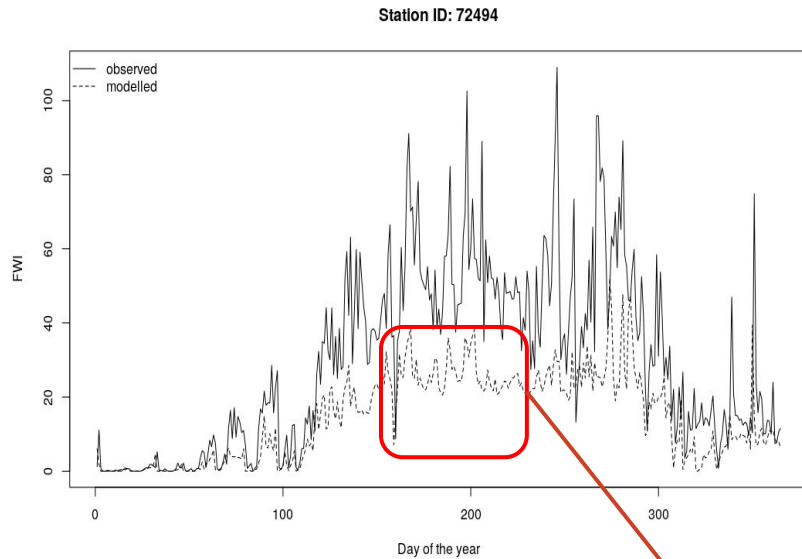
The **2017 California wildfire season** was the most destructive wildfire season on record, which saw multiple wildfires burning across California. A total of 9,133 fires burned 1,381,405 acres (5,590.35 km<sup>2</sup>), according to the California Department of Forestry and Fire Protection, including five of the 20 most destructive wildland-urban interface fires in the state's history.

State data showed that the large wildfires killed 43 people – 41 civilians and 2 firefighters - higher than the previous 10 years combined

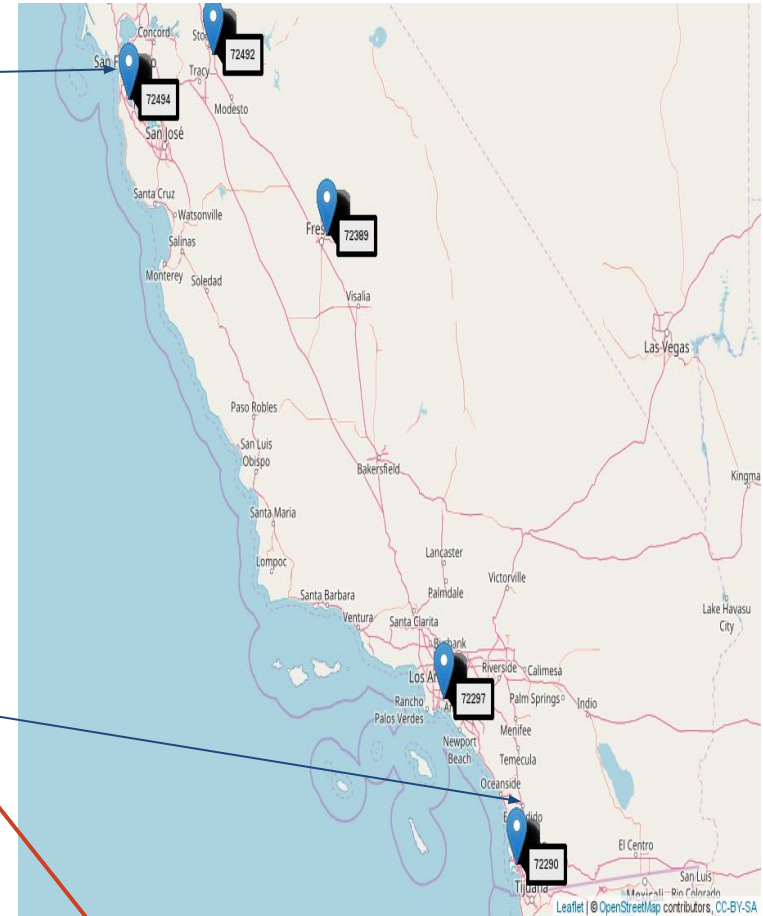


By Phoenix7777Own work [CC BY-SA 4.0  
(<https://creativecommons.org/licenses/by-sa/4.0>

# The accuracy of a global model compared to local observations



FWI comparison between ERA-I and weather stations data (2017-California )

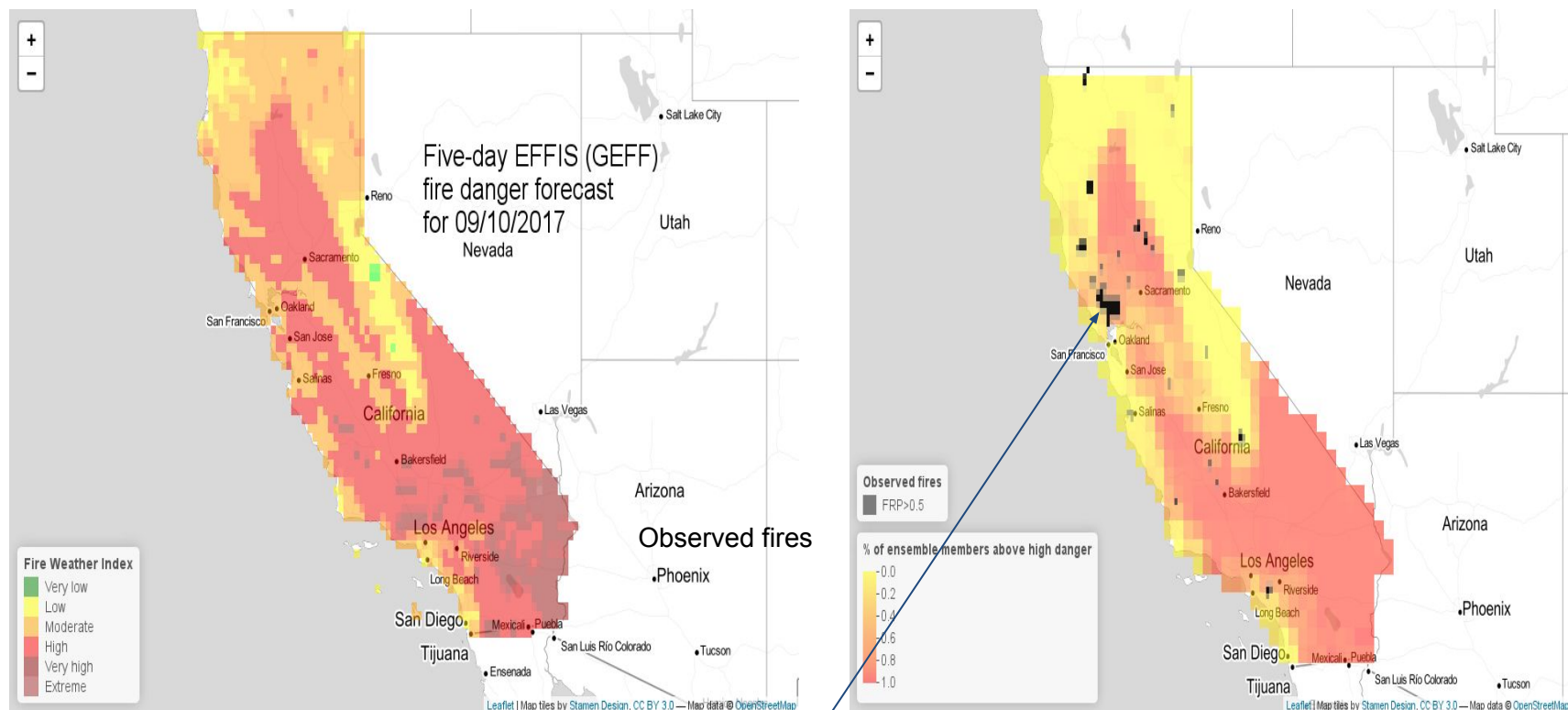


ACC >0.85 in all stations  
Calibration can correct the bias

Credits: Claudia Vitolo

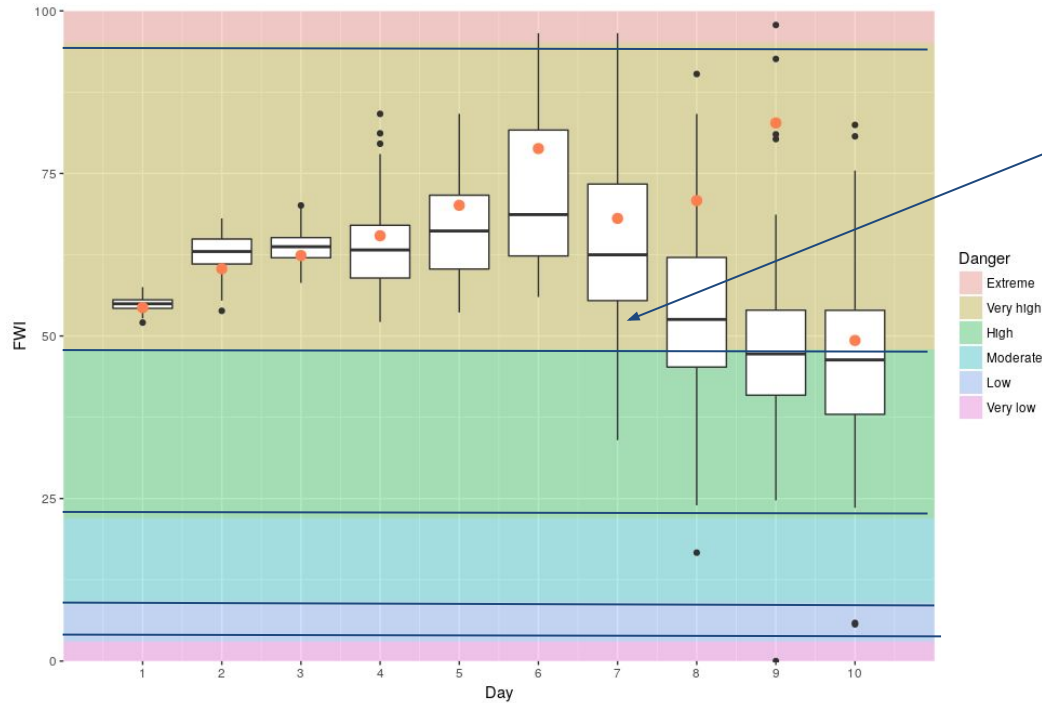
# Exploiting the information from the ensemble prediction

## California fire (8-11 October 2017)



Observed fires

# “Fire -gram”



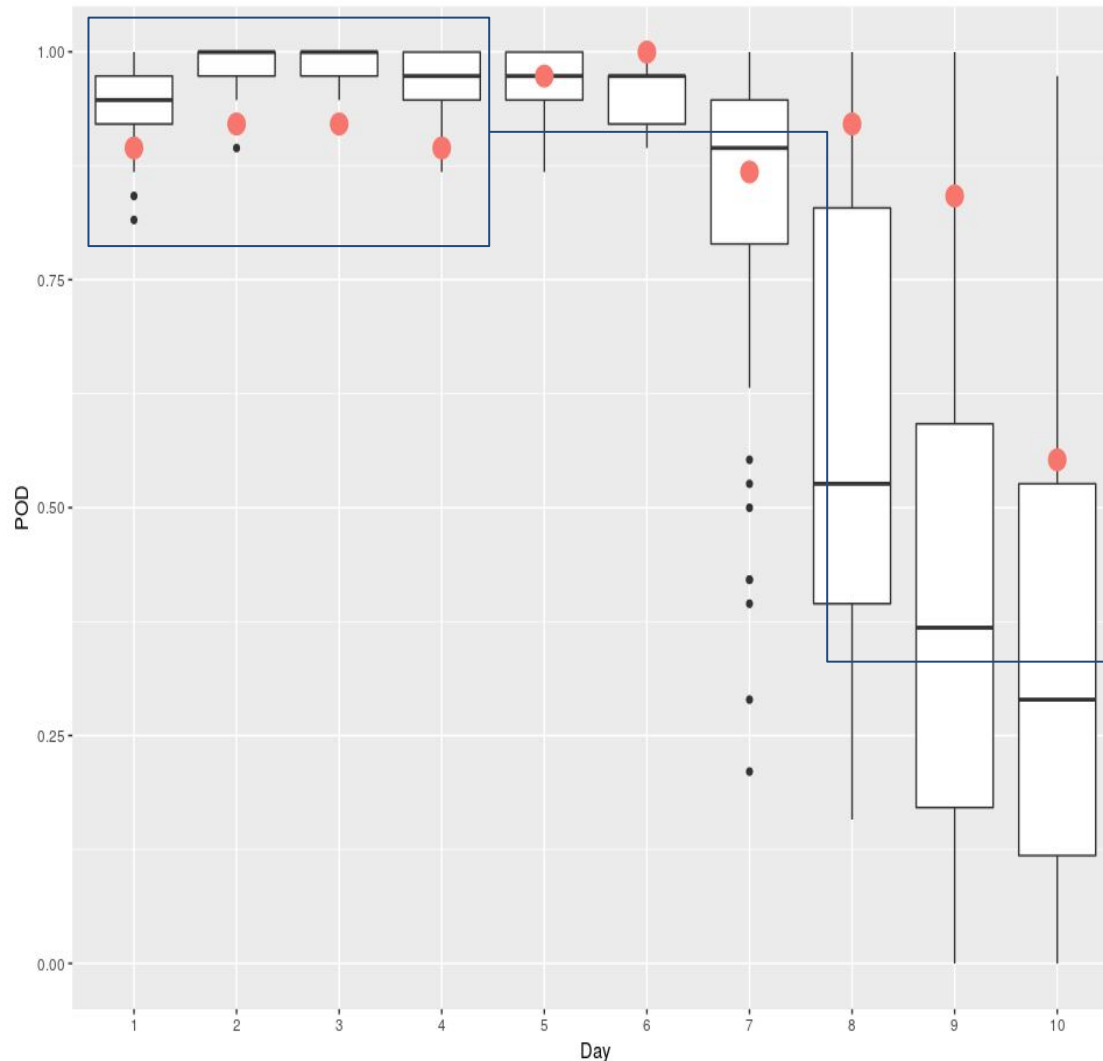
The higher resolution did not capture the “Extreme conditions”

Fire Weather Index distribution at one location where fire raged out of control the 8th of October.  
California Fire 8 October 2017

1 Location @ [38 34'N; 122 34' W]

Di Giuseppe, F et al. "Fire Danger: the skill provided by ECMWF ensemble prediction system." Journal of Applied Meteorology and Climatology (2018);to be submitted

# The added skill provided by the ensemble prediction



California Fire 8 October 2017

1 Location @ [38 34'N; 122 34' W]

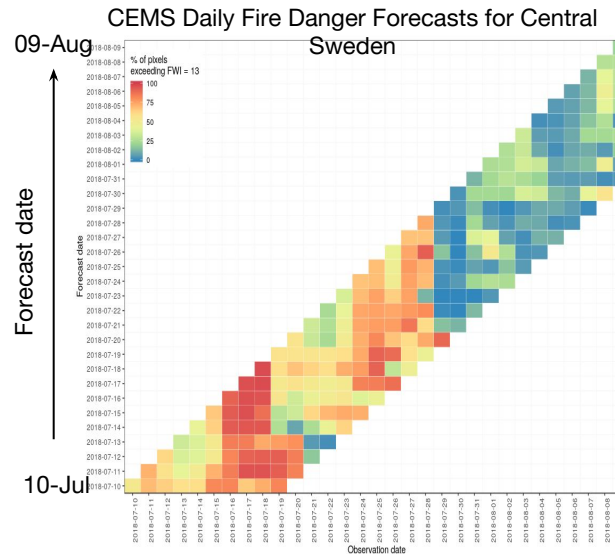
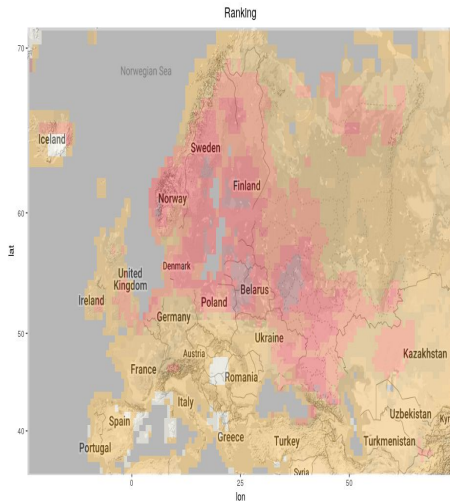
● HRES

Skills from the distribution of the ENS prediction system is, in this case, better than the HRES

Di Giuseppe, F et al. "Fire Danger: the skill provided by ECMWF ensemble prediction system." submitted to Environment International (2018)



# Links between CAMS and CEMS: from fire forecasts to emissions



10-day forecasts of fire danger, calibrated for central Sweden between 10 July and 9 August 2018.

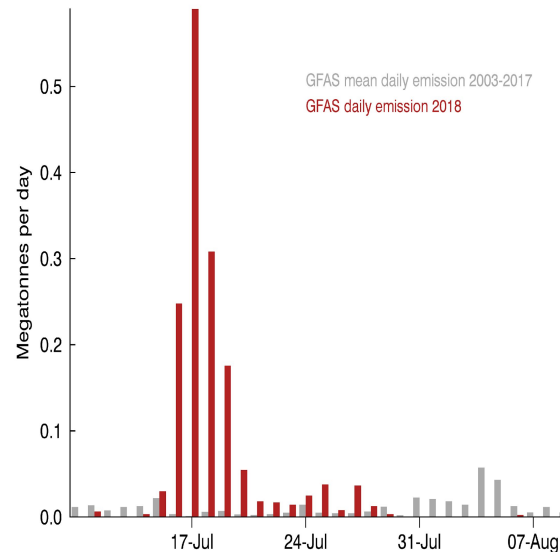
c/o C. Vitolo, F. di Giuseppe (ECMWF)

Fire danger classes calculated with ECMWF Fire Forecast (GEFF) System.

Featured in Euronews interview with C3S senior scientist Freja Vamborg.

Daily forecasts available via CEMS EFFIS (for Europe) and GWIS (globally).

CAMS Daily Fire CO<sub>2</sub> Emissions (GFASv1.2) for Sweden



CAMS GFAS daily CO<sub>2</sub> emissions from wildfires in Sweden.

# Conclusions

- ECMWF is producing fire forecast on a daily base.
- Software and datasets are available
- Fire forecasting based on weather predictions can be less accurate than using local observations
  - Mitigation through warning level calibration
  - The advantage of the Information provided by the ensemble in decision making

Improve the distribution of fire products. Best way it to get into the climate data store ?

Extended range forecast expecially for the global forecast