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Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Application of operational seasonal prediction systems for seasonal prediction of fire danger: a case study of the extreme wildfire events in California, Spain and Portugal of 2017

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Climate Prediction Group

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FWI - Introduction

The 2017 fire season in California was the costliest on record, with 18 Billion US$ in damages, and deadliest with 43 casualties on record

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Introduction

- The European countries most affected by wildfires are in the Mediterranean basin, with summer fires occurring during periods of drought.
- 2017 was a particularly extreme year for wildfires fire season with many deaths in Portugal and record-breaking wildfires in California.
- In light of this, seasonal prediction of wildfire danger appears as a priority for health, safety and economic welfare.
- While several short-term (up to 10 days in advance) fire danger systems are in place, there is currently no operational seasonal wildfire forecasting system for Europe and only a few for other continents

Introduction

- Seasonal Prediction of Fire danger using Statistical and Dynamical models (SPFireSD) is a MSCA Individual Fellowship
- Other approaches not discussed here:
  - Statistical approach: fire danger predictions using linear regression models
  - Dynamical approach: ensemble dynamical predictions using Earth System Models
- **Fire danger indices approach**: simple fire danger indices computed from seasonal dynamical climate prediction systems
  - Adapt existing ECMWF infrastructure for operational short-term wildfire predictions (GEFF model)
  - ECMWF SEAS5 forecasts (May and August start dates) used as input for FWI computations
  - FWI prediction requires daily predictions of precipitation, temperature, relative humidity and wind

Canadian Fire Weather Index

Fire Danger Ratings give you an indication of the consequences of a fire, if one was to start. The higher the fire danger, the more dangerous the conditions.

Fire Danger Ratings should be used as a trigger to take action to prevent or control a possible fire

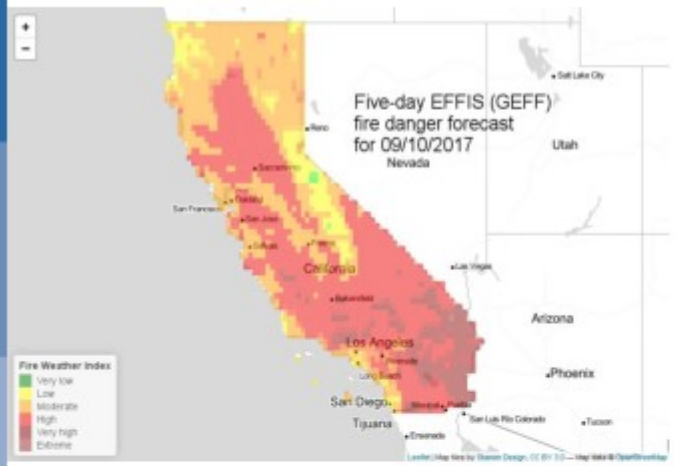
Alexander, M.E.; De Groot, W.J. 1988. Fire behavior in jack pine stands as related to the Canadian Forest Fire Weather Index System. Canadian Forest Service, Northern Forestry Centre, Edmonton, AB. Poster with text.

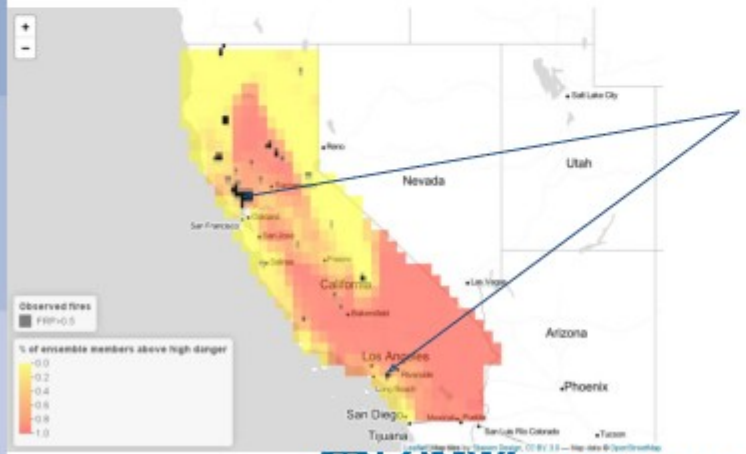
Quintilio, D.; Fahnestock, G.R.; Dubé, D.E. 1977. Fire behavior in upland jack pine: the Darwin Lake Project. Canadian Forest Service, Northern Forestry Centre, Edmonton, AB. Information Report NOR-X-174.

Source : Francesca Di Giuseppe (ECMWF)
https://cpo.noaa.gov/Portals/0/Docs/MAPP/Pdfs/DiGiuseppe.pdf

EMCWF wildfire forecast using FWI

Another example: the California fire





California fire (8-11 October 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^2), 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

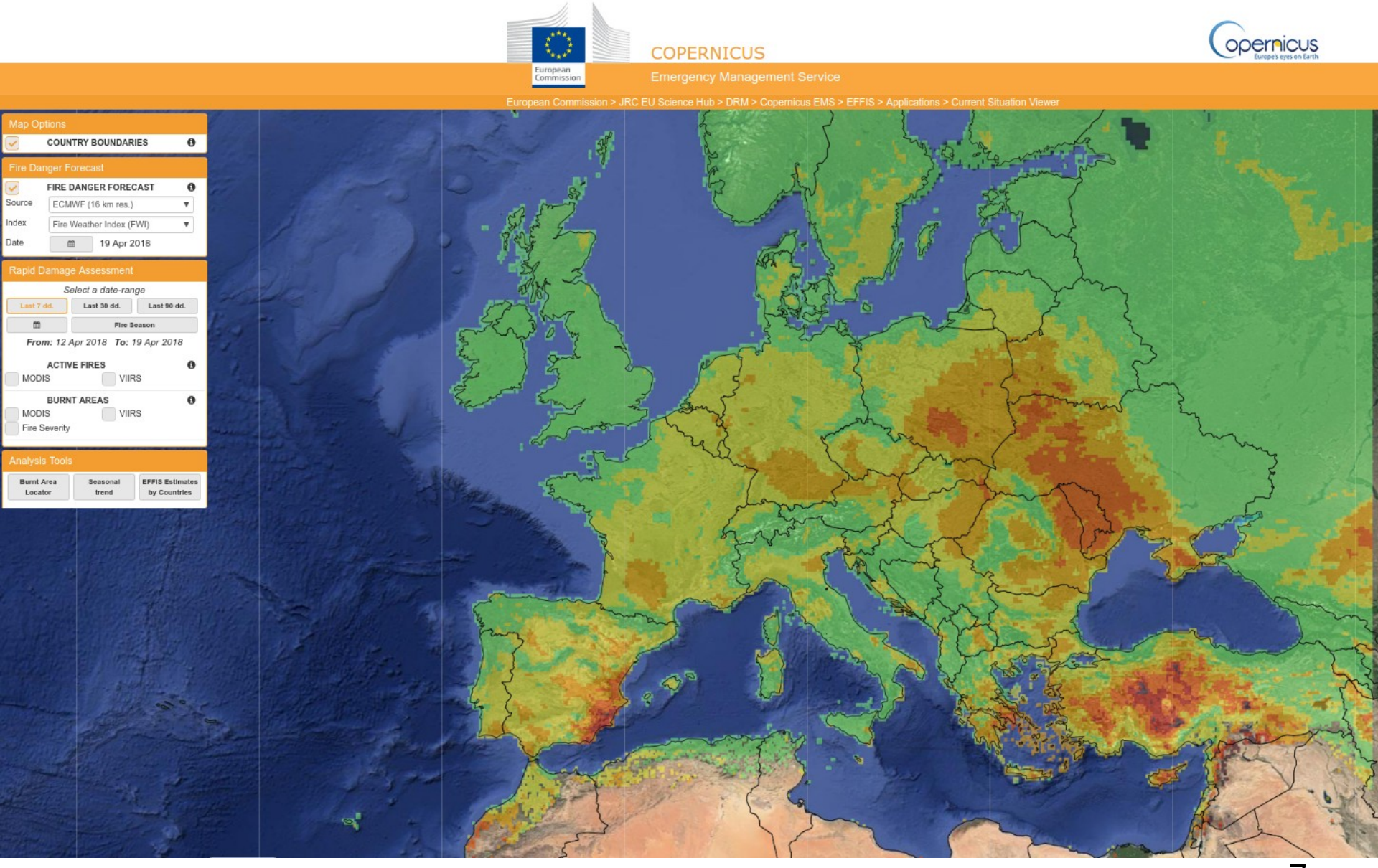
Observed fires

Probabilistic information provided by the fire forecast Ensemble prediction system

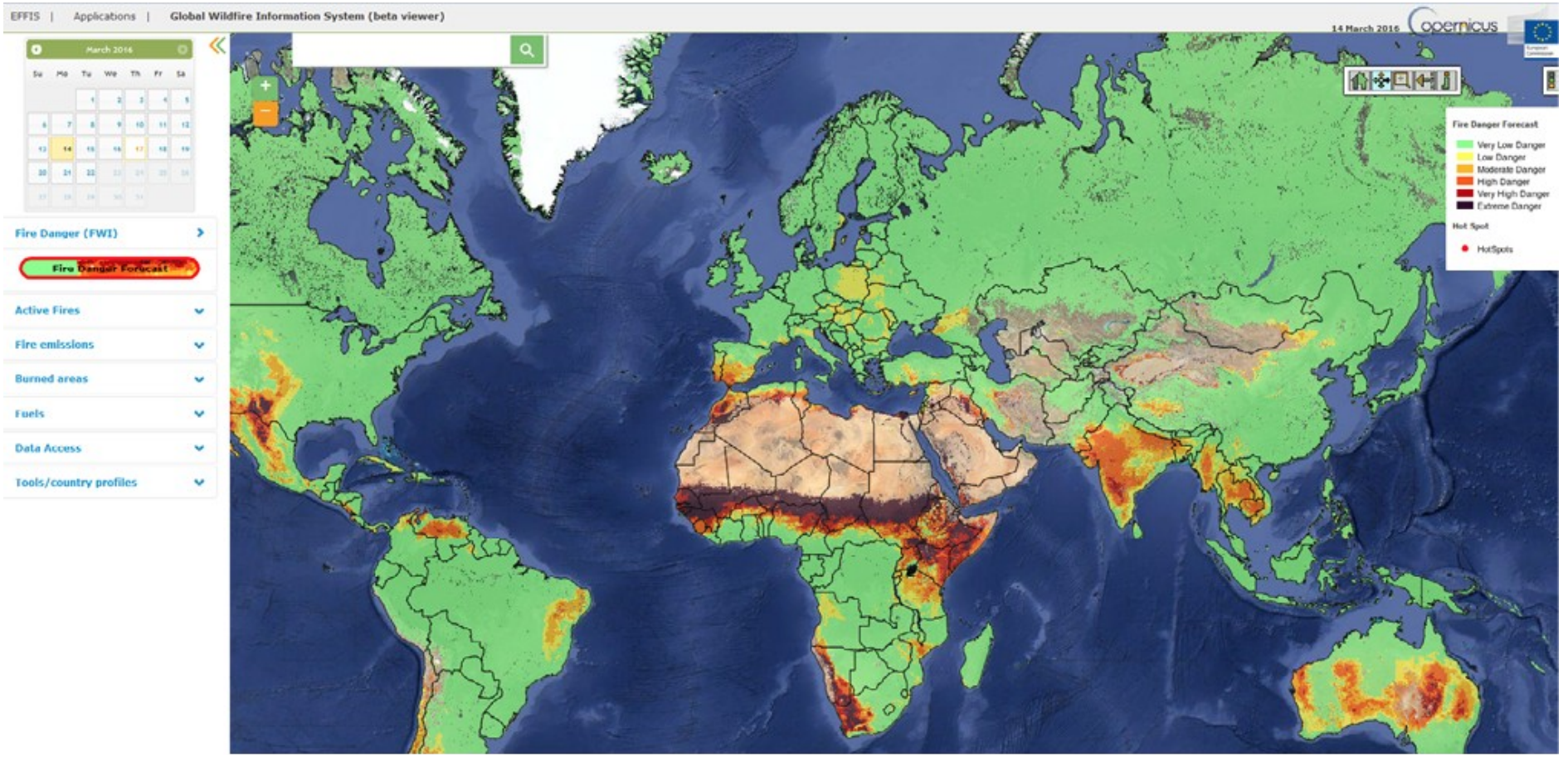
ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS 15

Source : Francesca Di Giuseppe (ECMWF)
https://cpo.noaa.gov/Portals/0/Docs/MAPP/Pdfs/DiGiuseppe.pdf

EFFIS 10-day FWI forecast



GWIS 10-day FWI forecast



Fire danger forecast

Very low danger | Low danger | Moderate danger | High danger | Very high danger | Extreme danger

Hotspot

EFFIS “seasonal prediction”

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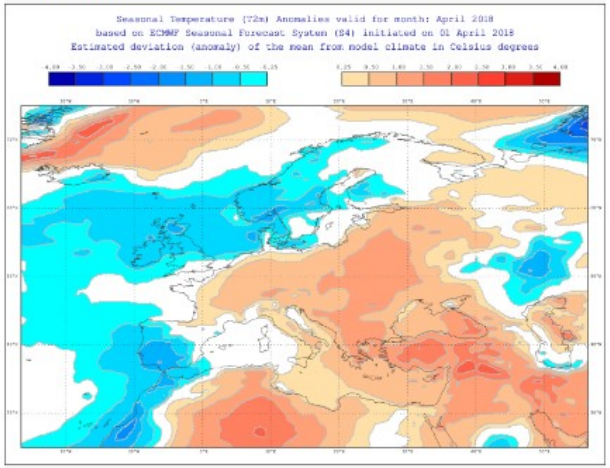
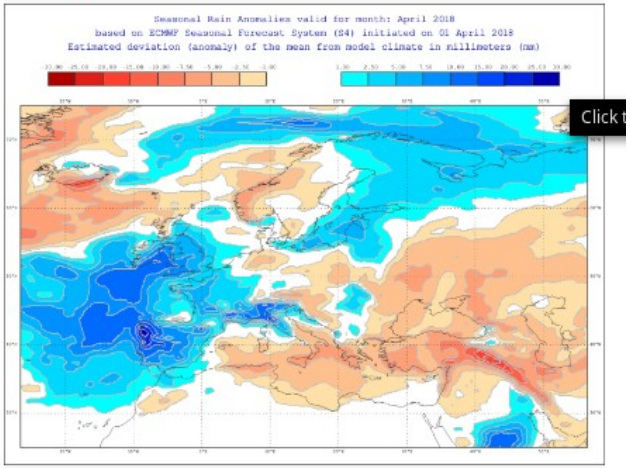
Temperature anomalies

APRIL 2018



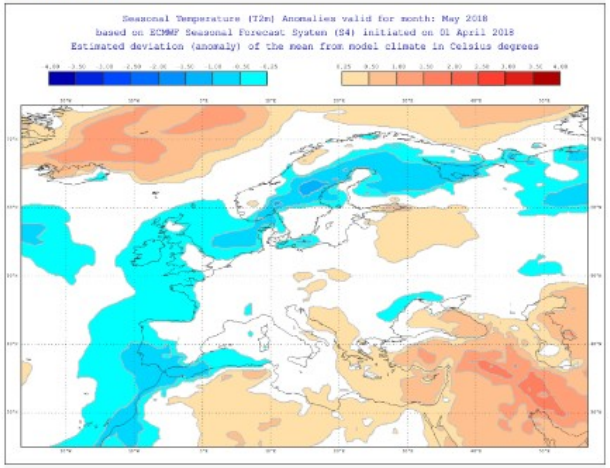
Rain anomalies

APRIL 2018



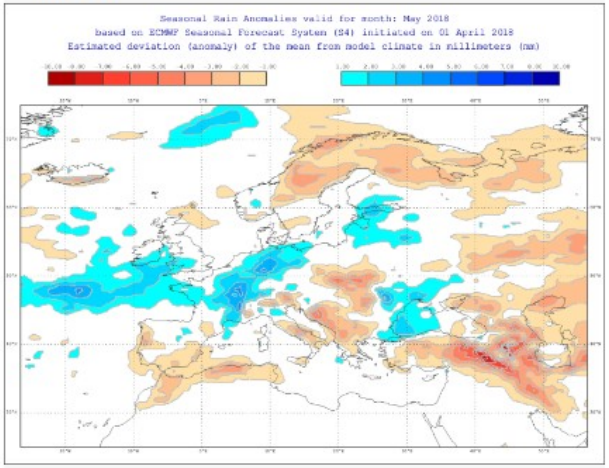
Temperature anomalies

MAY 2018



Rain anomalies

MAY 2018

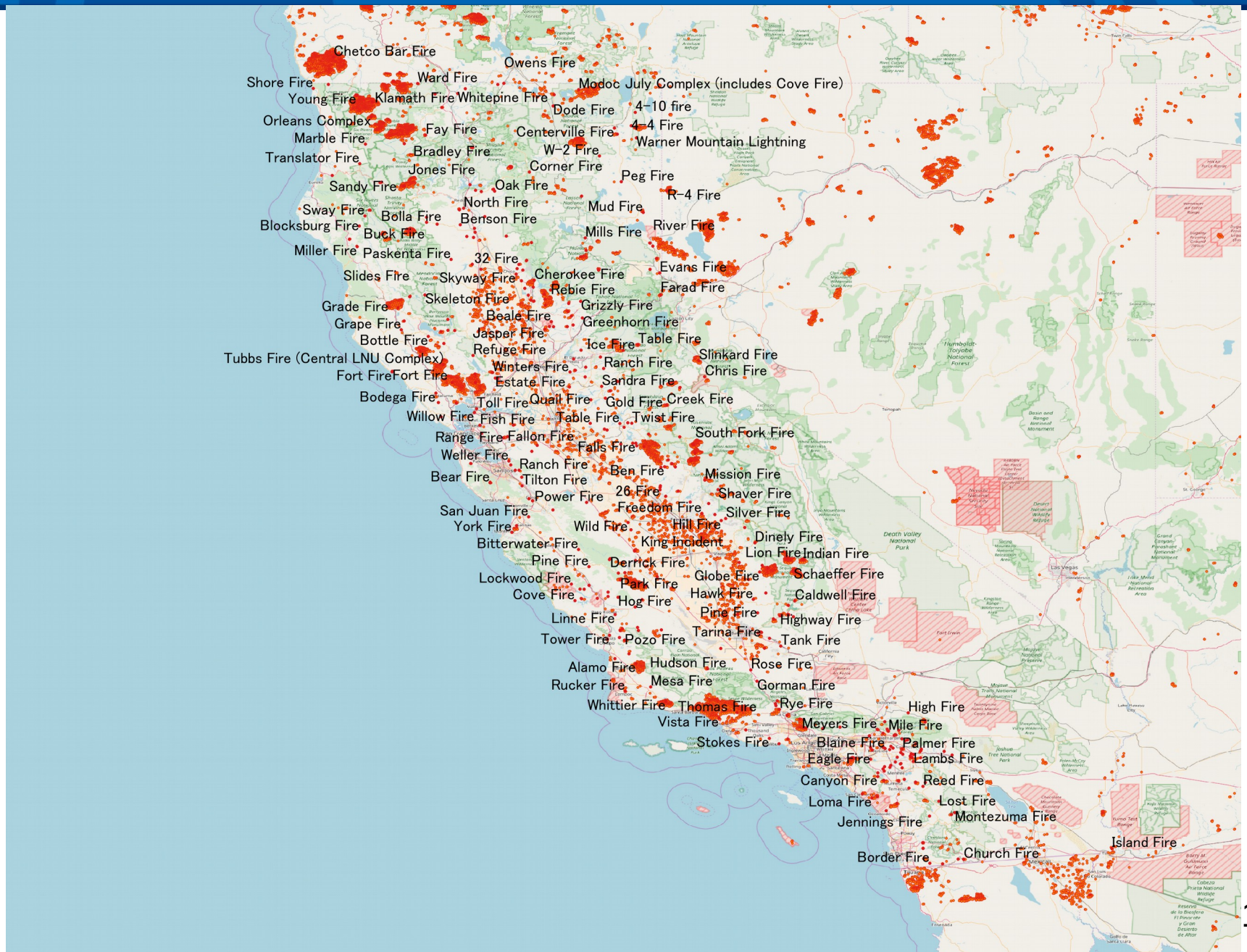


California 2017 wildfires

In October, around the Napa valley in Northern California, the Tubbs fire was the most destructive in US history. Warm temperatures and strong winds are thought to be responsible for the severity of these wildfires.

In December, Southern California was plagued by severe wildfires and the Thomas fire near Los Angeles became the largest in California history. It was thought to be fueled by sever Santa Ana winds and warmer than average temperatures.

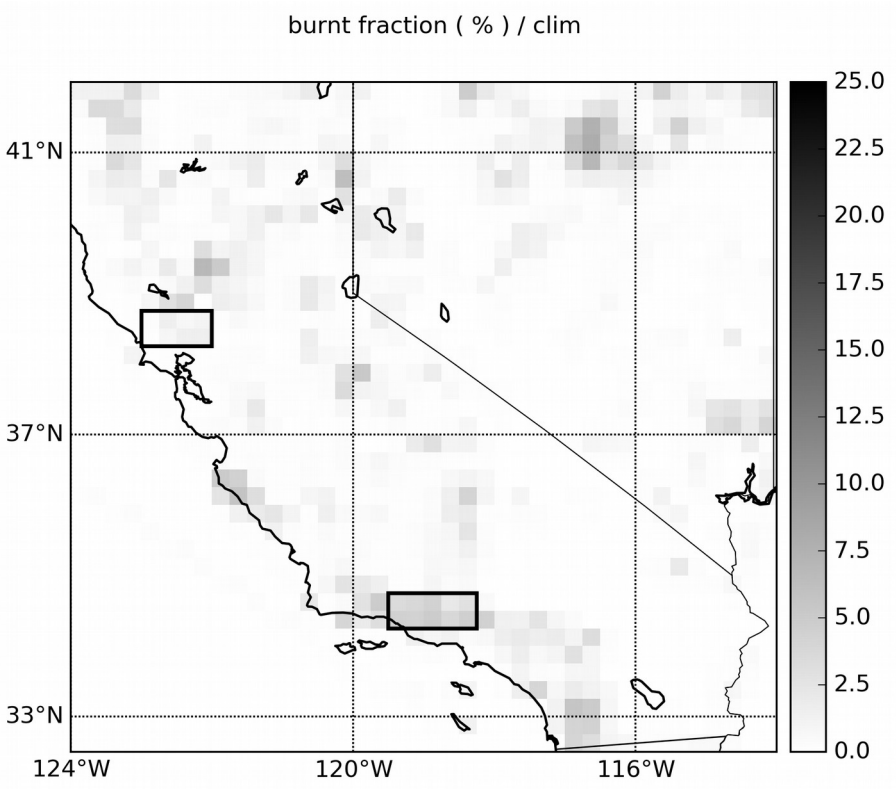
Case study -2017 California wildfires

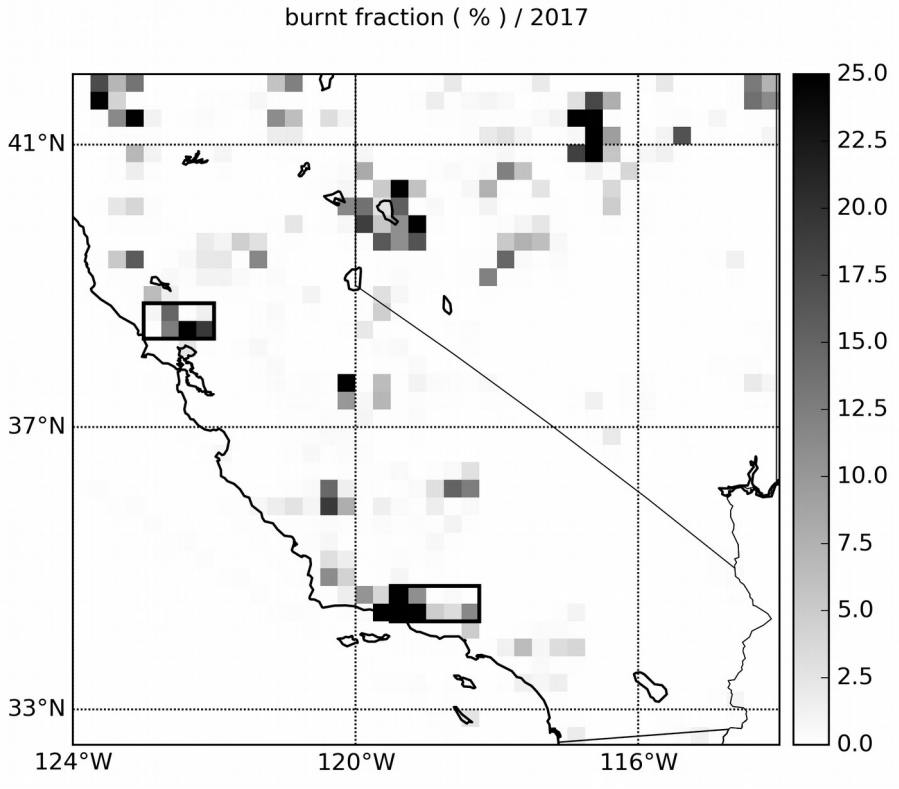


was 2017 extreme?

Observed burned areas in 2017 were indeed much higher than climatological averages.

In fact many areas had not been previously burned in the entire MODIS observation period (2000-2017).





FWI in October-December 2017

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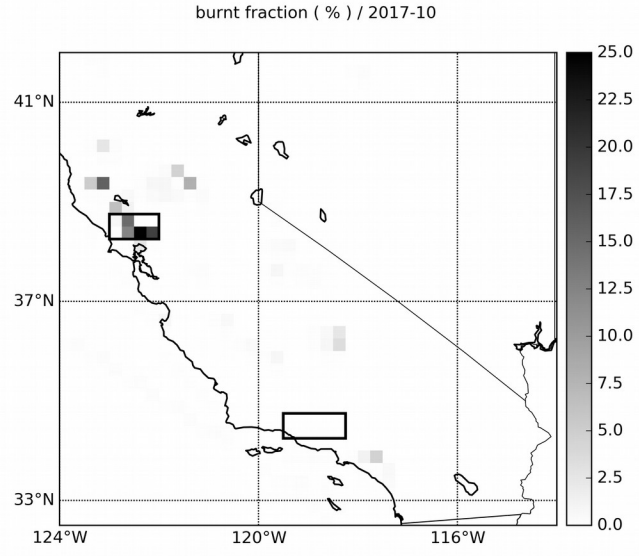
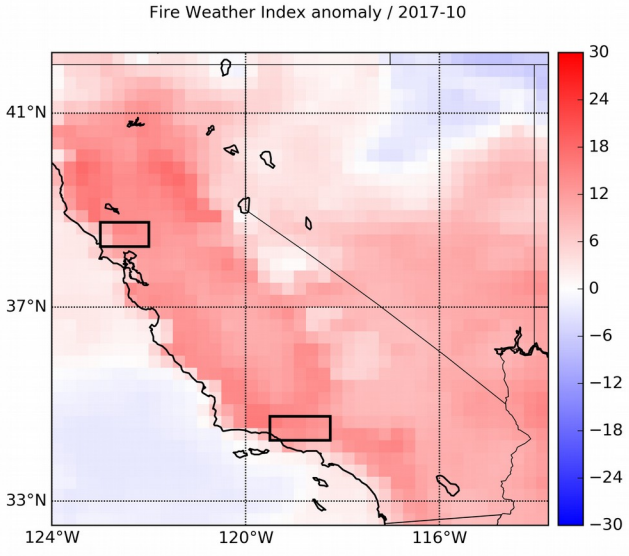
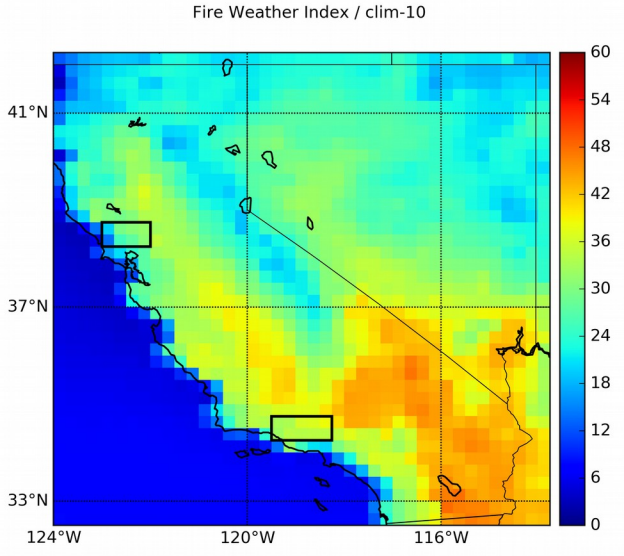
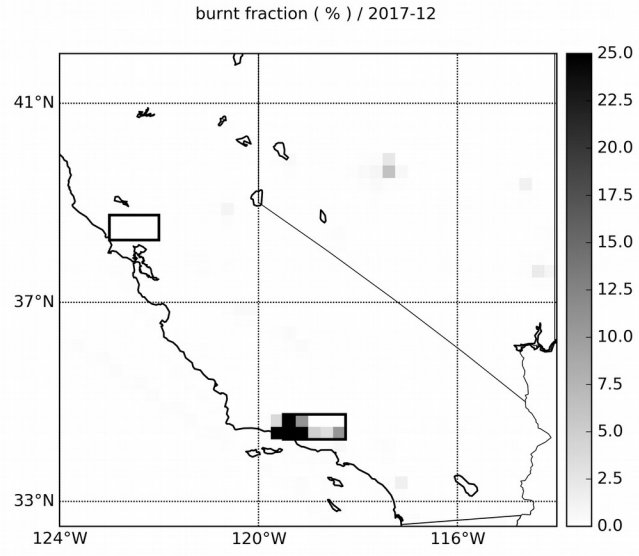
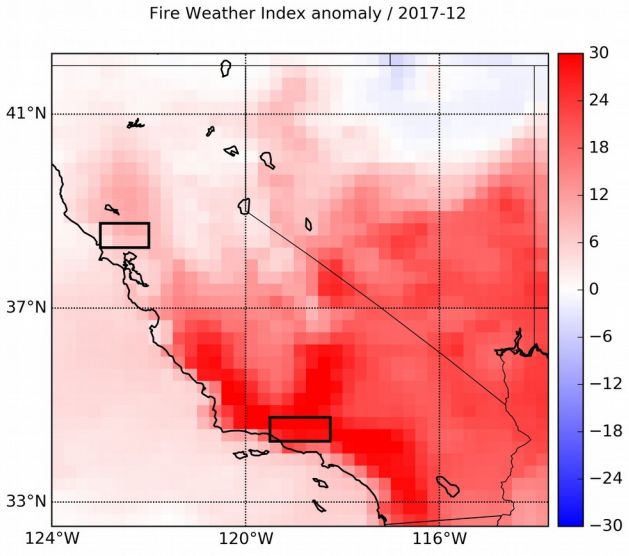
Widespread positive FWI anomalies in Oct and Dec created conditions which favoured the extreme wildfires in northern and southern California.

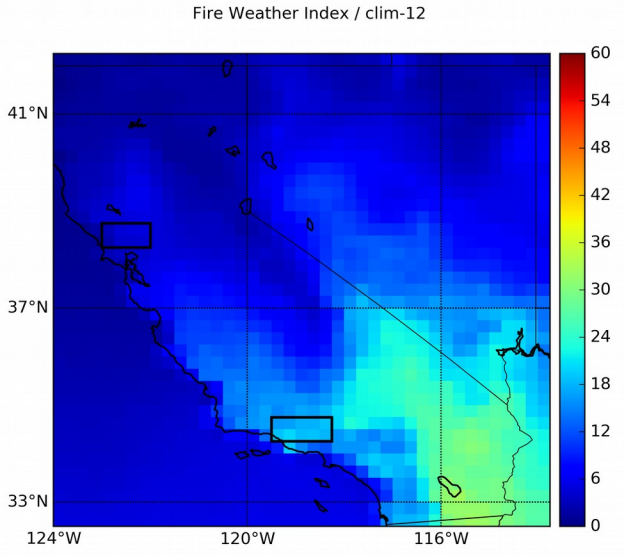




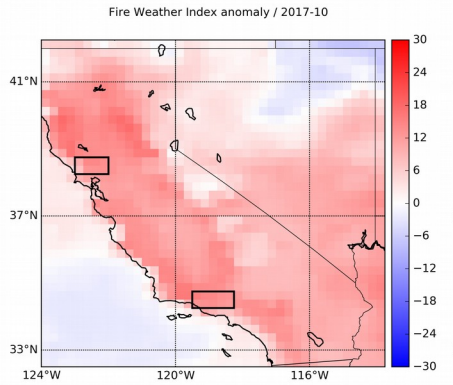
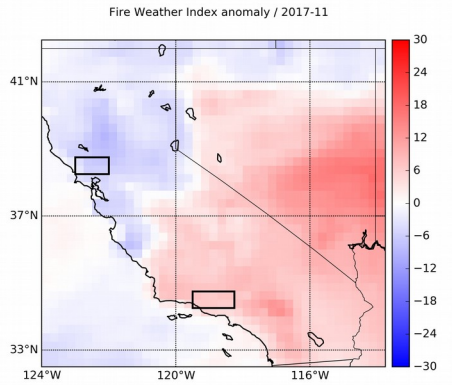
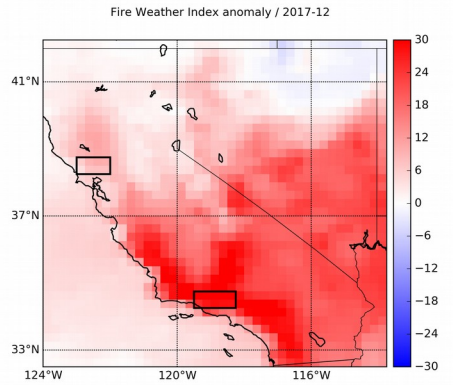
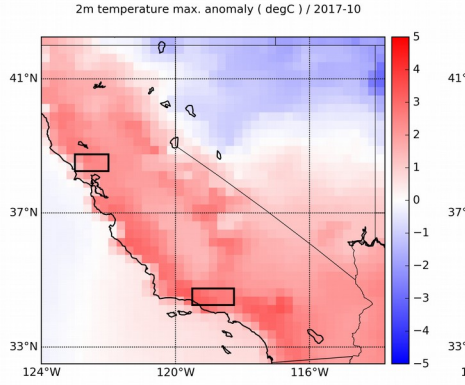
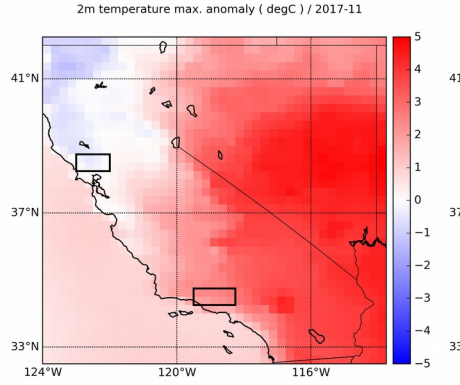
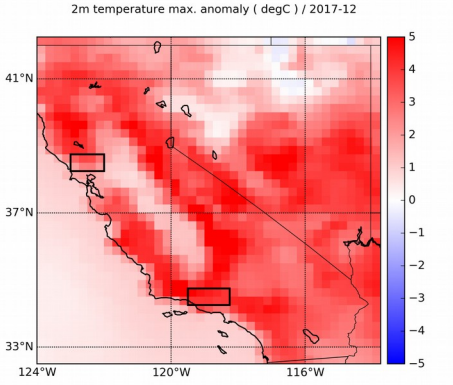
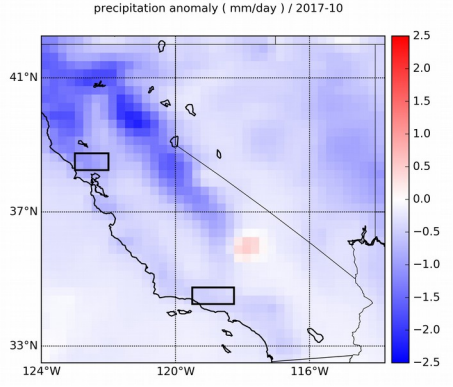
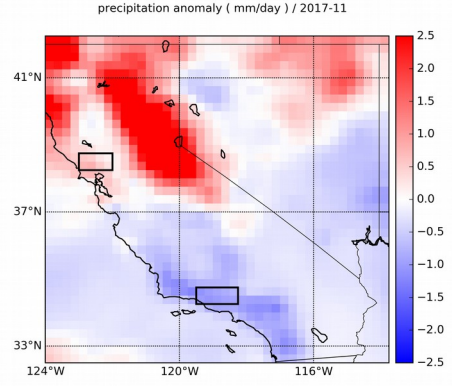
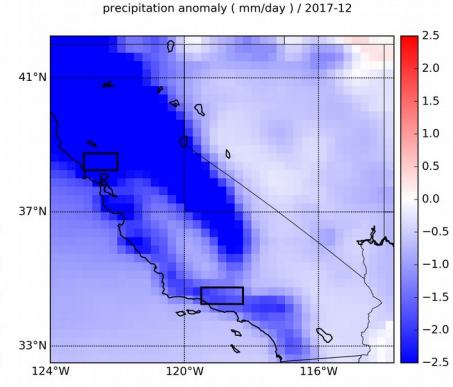








FWI in OCT-DEC 2017

	October	November	December
FWI			
Temperature			
Precipitation			

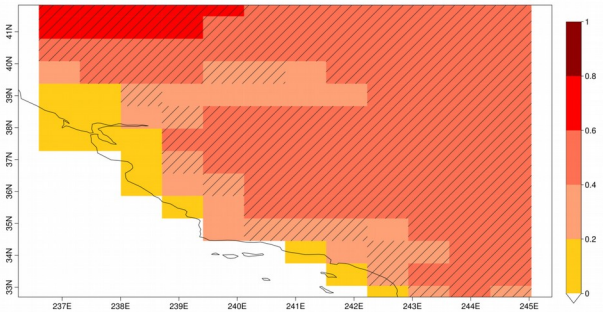
Seasonal prediction skill – August init

Anomaly Correlation Coefficient (ACC) of SEAS5 FWI predictions over California, initialized in August.

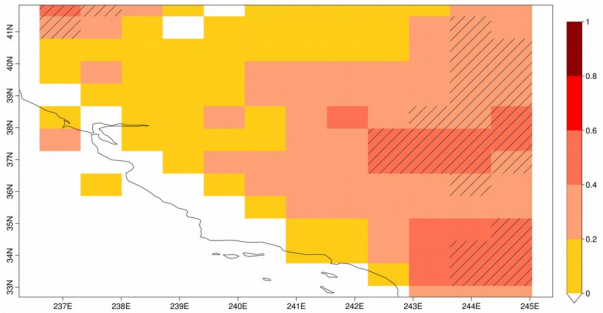
Shows potential skill in Lead month 0 (August) and 2 (October).

After 3 months skill drops rapidly.

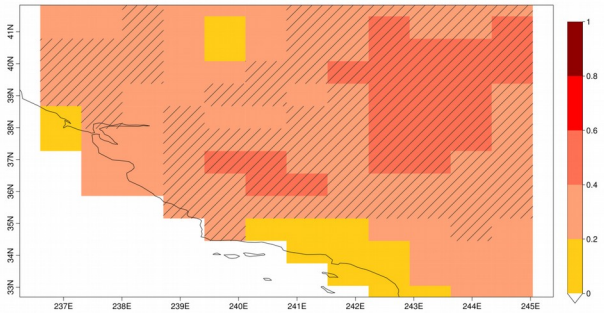
August



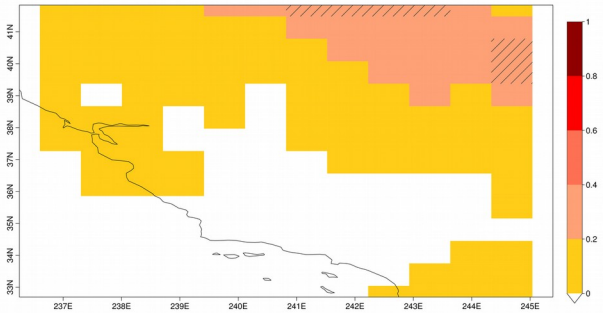
September



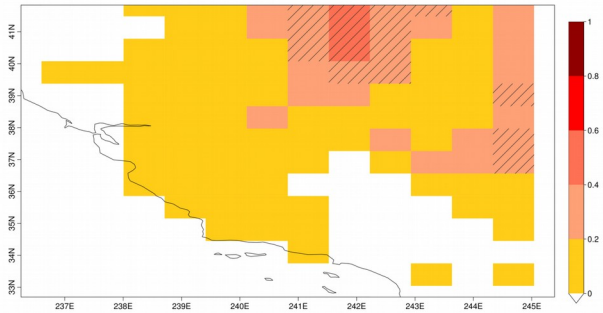
October



November



December



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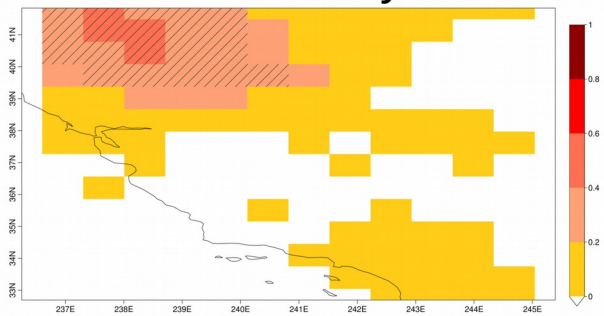


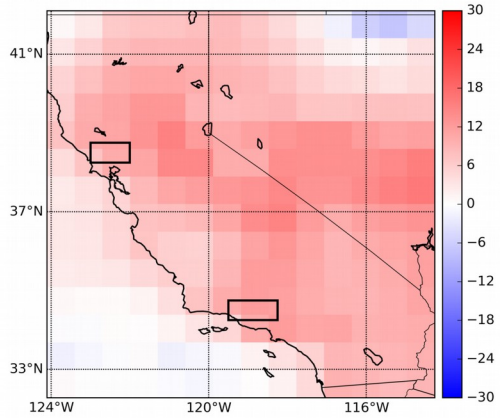
Seasonal prediction – August 2017

FWI computed from August predictions – results are quite dissapointing…

Need to understand which variable(s) are not well predicted

Must run hin

ERA-Interim



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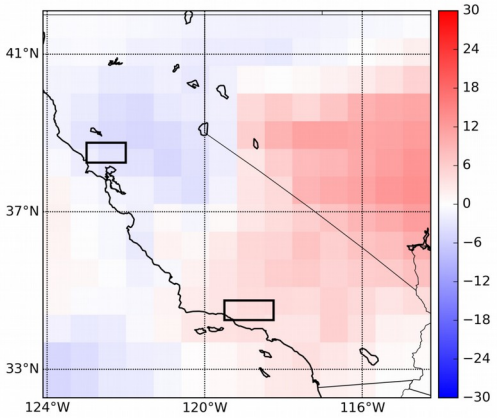

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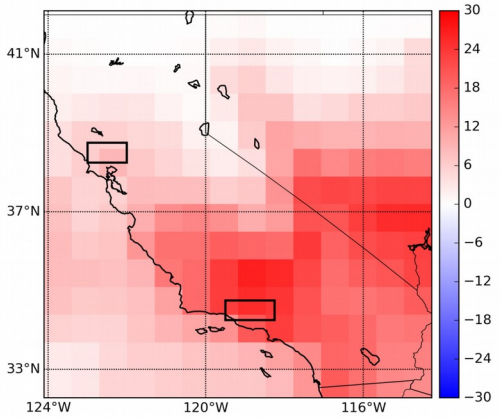
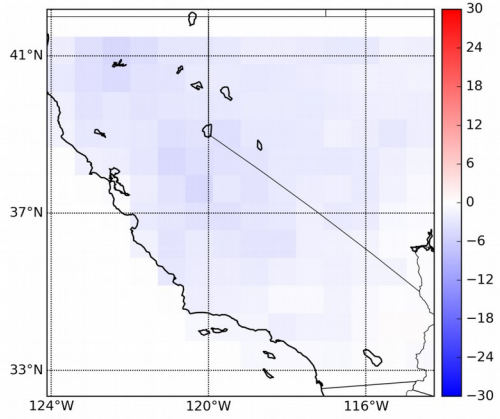
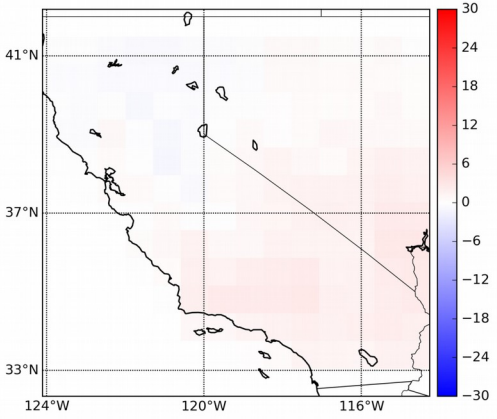
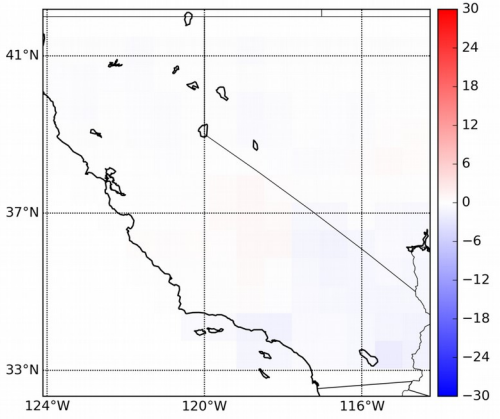


December

SEAS5 FWI







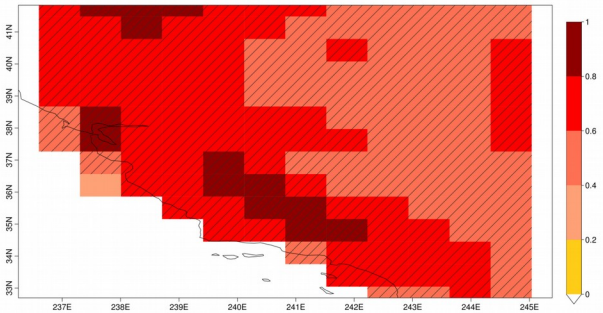
Seasonal prediction skill – May init

Anomaly Correlation Coefficient (ACC) of SEAS5 FWI predictions over California, initialized in May.

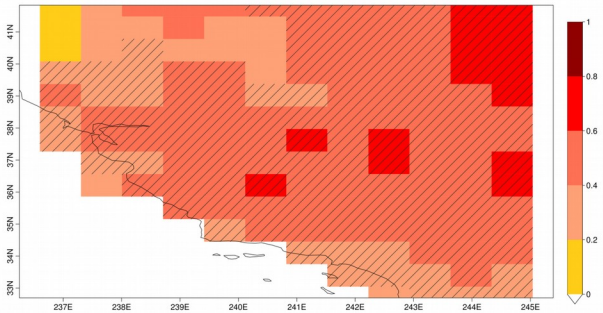
Shows potential skill in Lead months 0 (May) and 1 (June), small regions of skill later.

After 3 months skill drops rapidly.

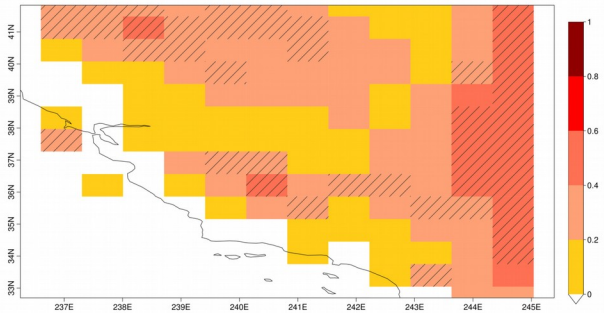
May



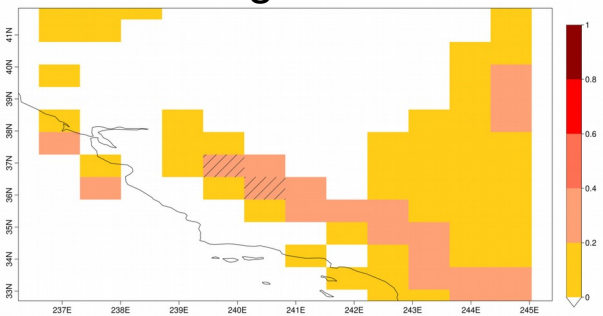
June



July



August



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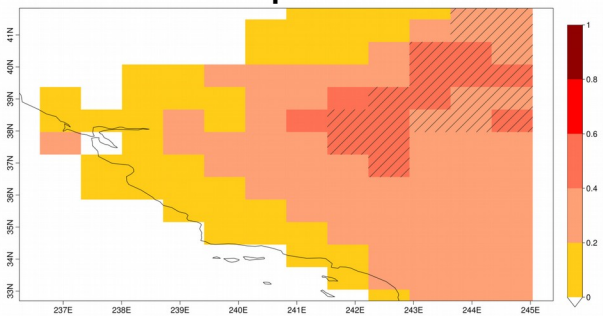
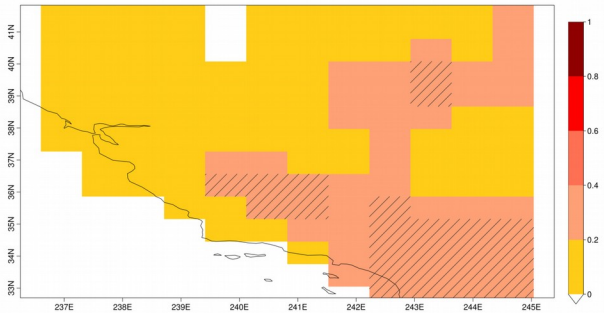


October



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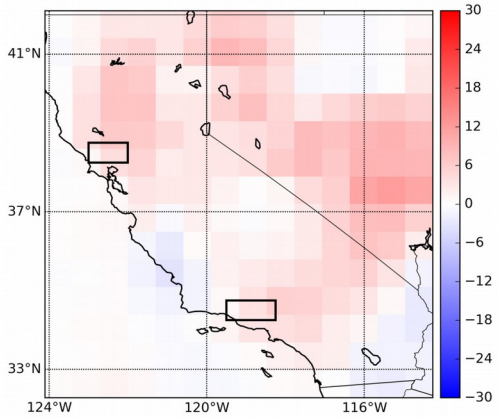
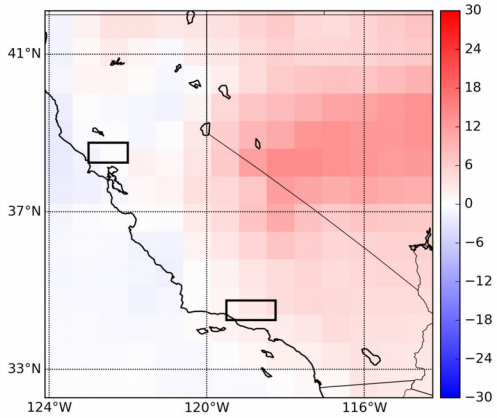
ERA-Interim



May



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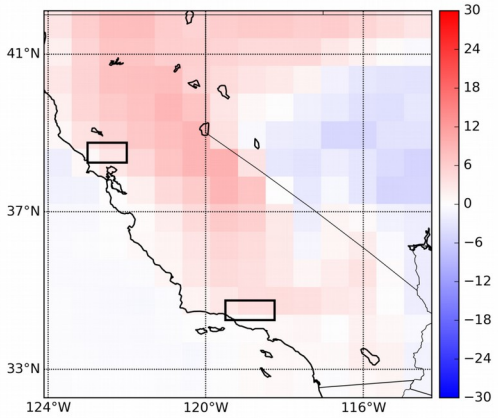
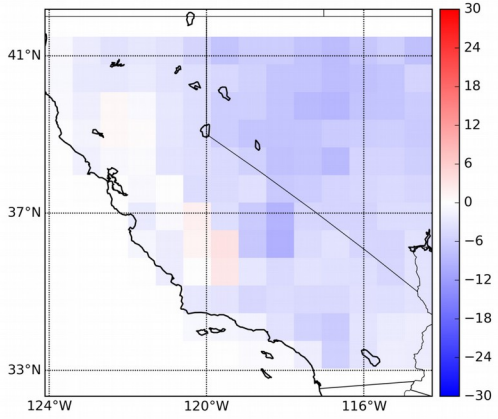
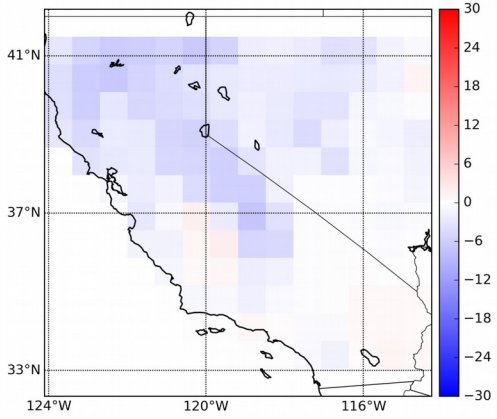
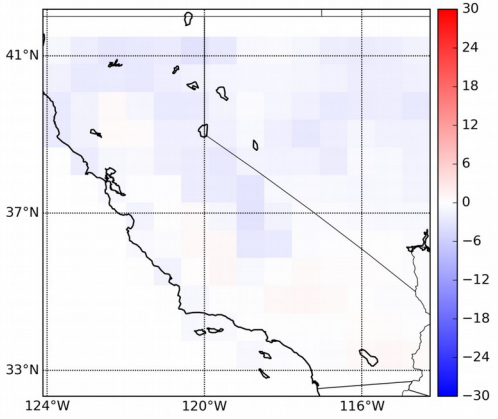


July

SEAS5 FWI







Iberia 2017 wildfires

In June 2017, the infamous “Pedrogão Grande” wildfires (in central Portugal) killed 62 people trapped in their cars are they fled the intense wildfires.

https://www.cnn.com/2017/06/18/europe/portugal-fire/index.html

Iberia 2017 wildfires

In October 2017, wildfires raged across northern Portugal and Galicia (Spain). The wildfires were made possible due to an intense drought and fueled by intense winds from Hurricane Ophelia. Arson is believed to be responsible for igniting many fires.

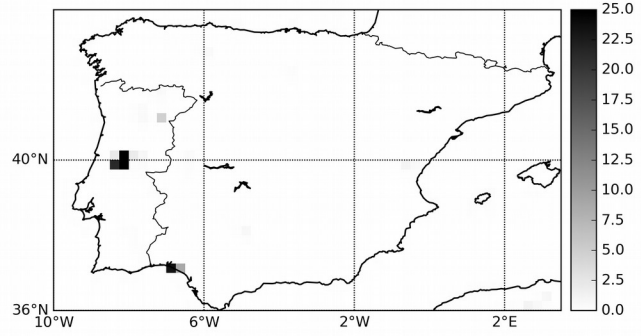
https://www.nytimes.com/2017/10/16/world/europe/portugal-spain-fires.html

Iberia 2017 wildfires

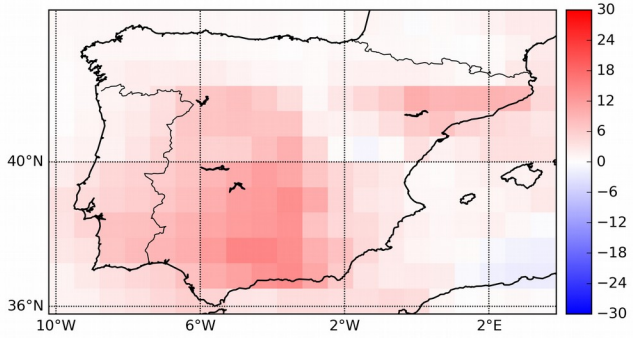
During the “Pedrogão Grande” wildfires in Portugal in June 2017, positive FWI anomalies were observed, but not so strong over the area of interest.

During the Galicia/Portugal wildfires in October 2017, widespread FWI anomalies were observed over most of the peninsula.

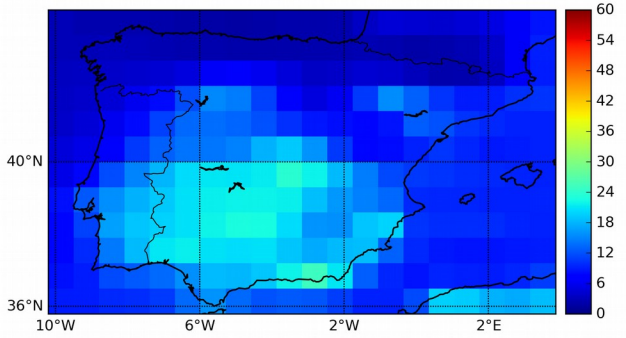
monthly burnt fraction (%) / 2017-06



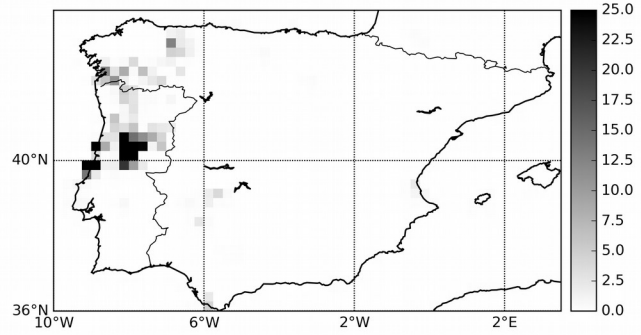
Fire Weather Index anomaly / 2017-06



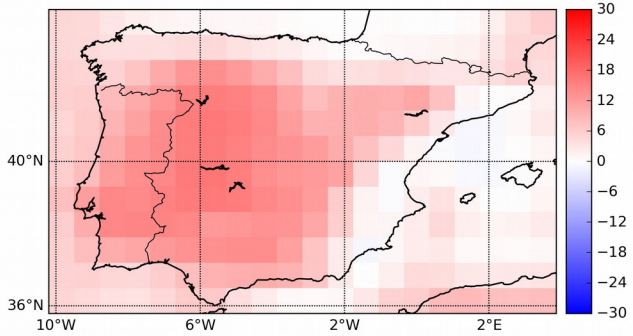
Fire Weather Index / clim-06



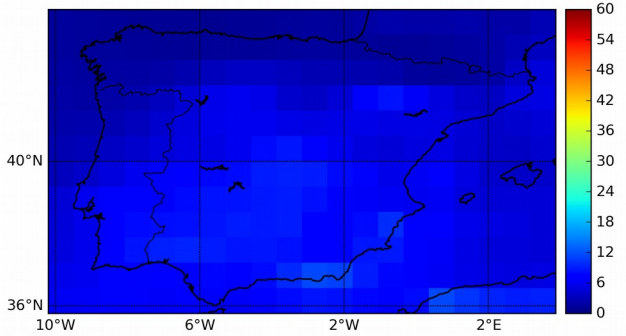
monthly burnt fraction (%) / 2017-10



Fire Weather Index anomaly / 2017-10



Fire Weather Index / clim-10



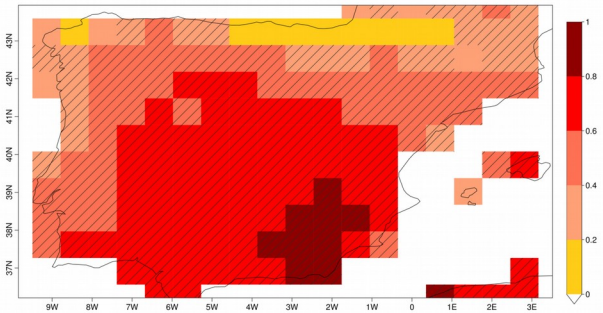
Seasonal prediction skill – May init

Barcelona Supercomputing Center
Centro Nacional de Supercomputación
EXCELENCIA SEVERO OCHOA

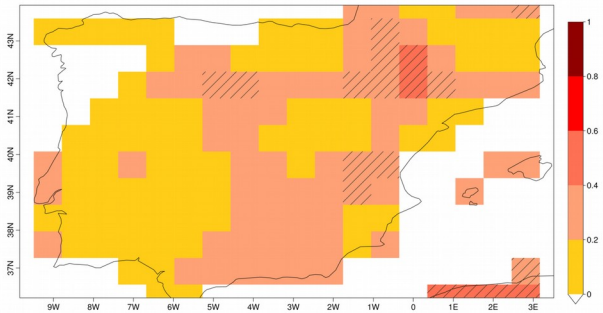
Anomaly Correlation Coefficient (ACC) of SEAS5 FWI predictions over Iberia, initialized in May.

Shows potential skill in Lead month 0 (May), patchy skill later.

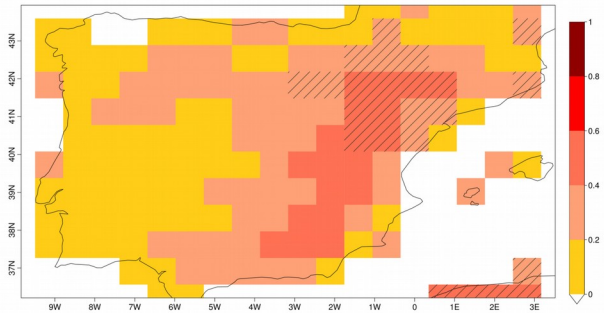
May



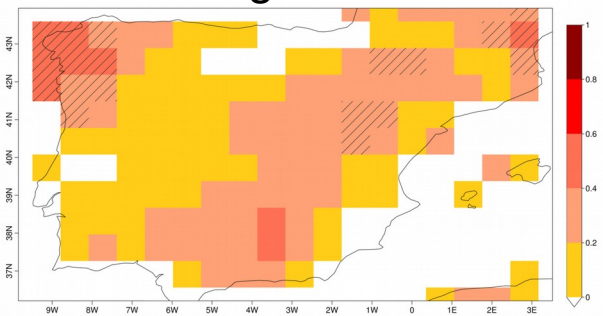
June



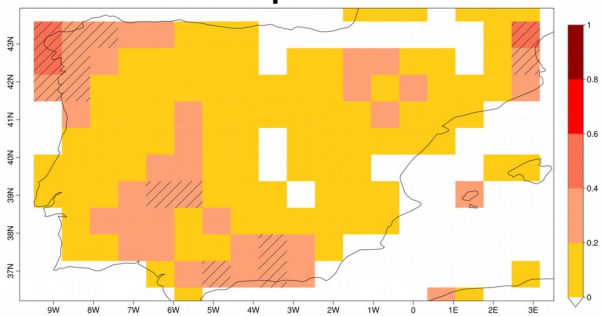
July



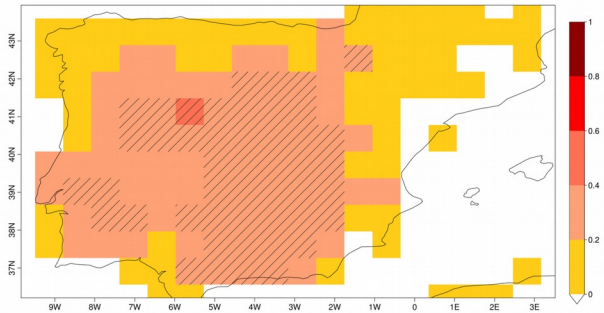
August



September



October

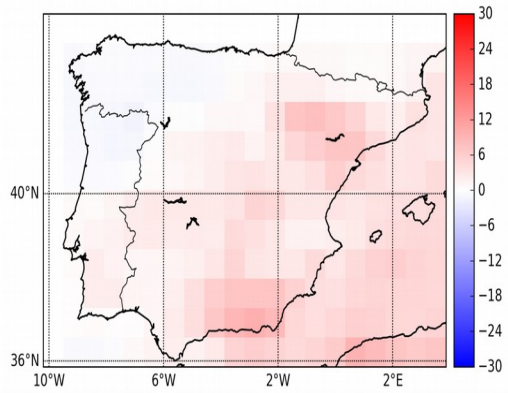


Seasonal prediction – May 2017

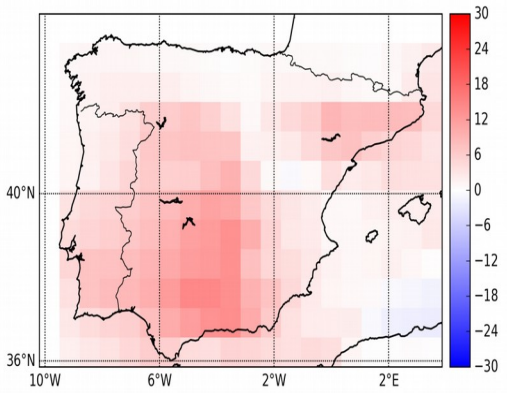
FWI computed from May predictions – results are much more encouraging!

Widespread positive FWI anomaly during the June wildfires.

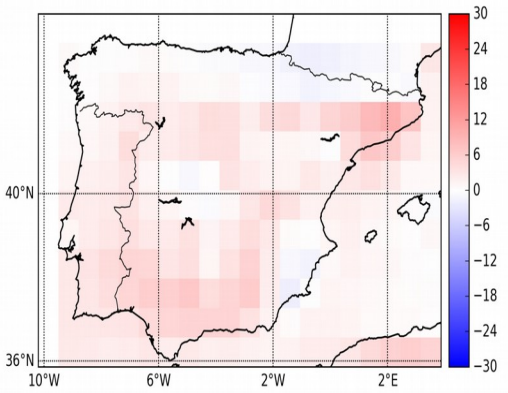
ERA-Interim



May

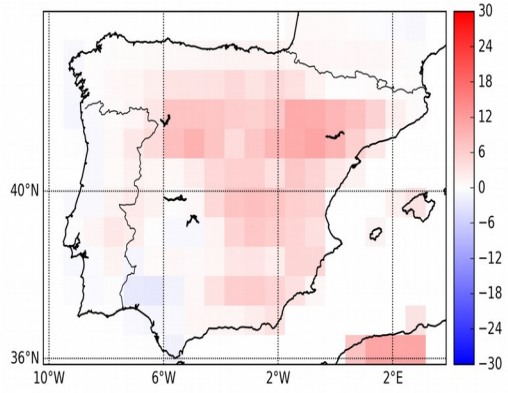


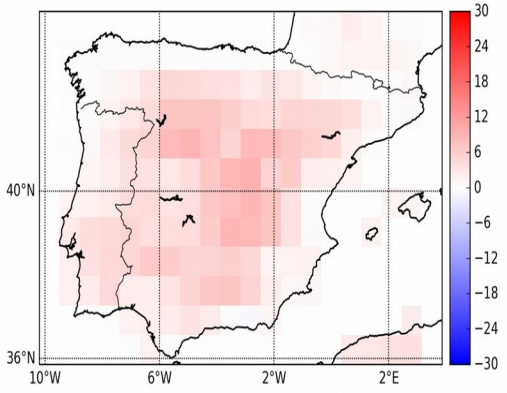
June

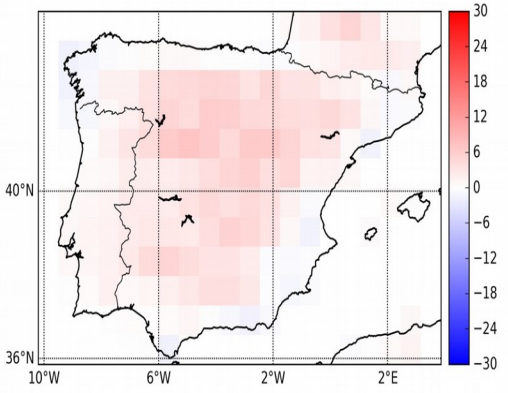


July

SEAS5 FWI







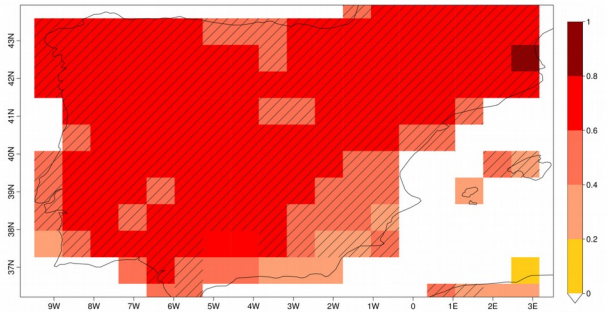
Seasonal prediction skill – August init

Anomaly Correlation Coefficient (ACC) of SEAS5 FWI predictions over Iberia, initialized in August.

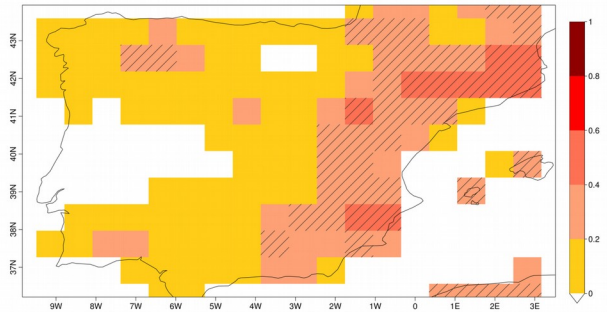
Shows potential skill in Lead month 0 (August), limited skill in Lead Month 1 (Sept.), some skill in northwest area of the peninsula in October.

After 2 months skill drops rapidly.

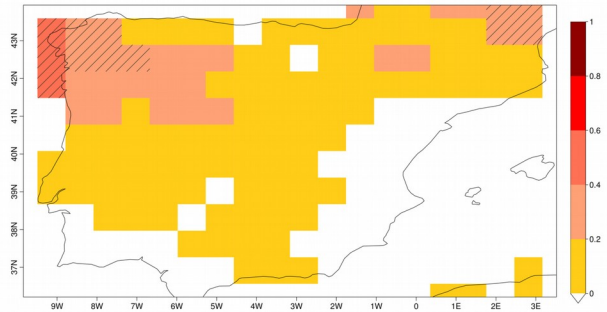
August



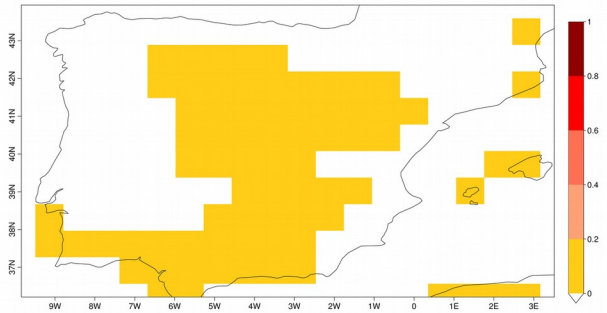
September



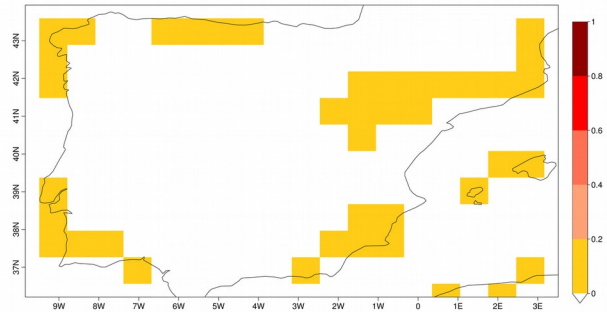
October



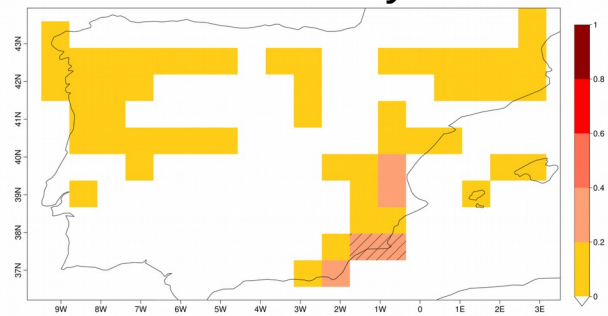
November



December



January

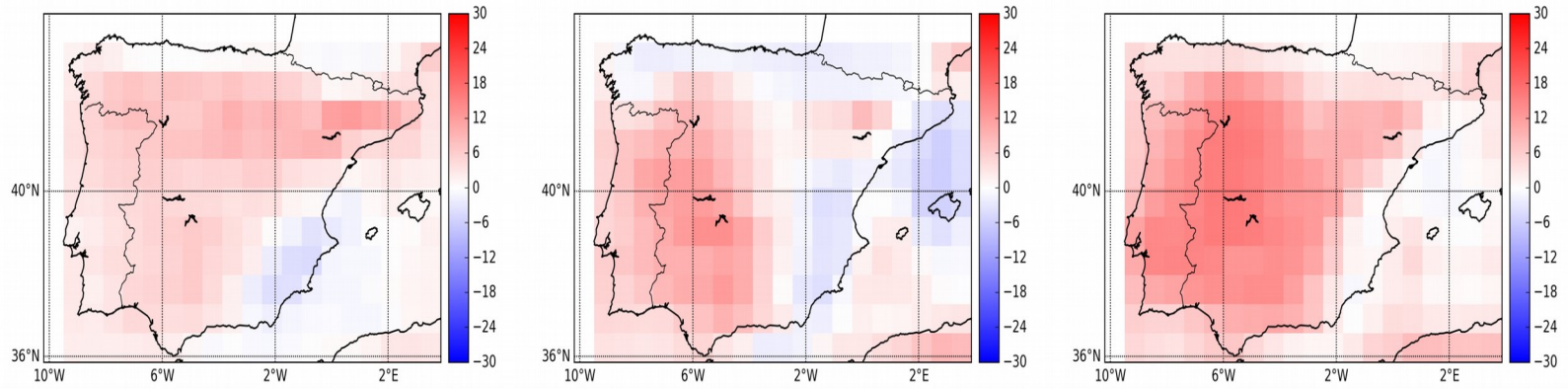


Seasonal prediction – August 2017

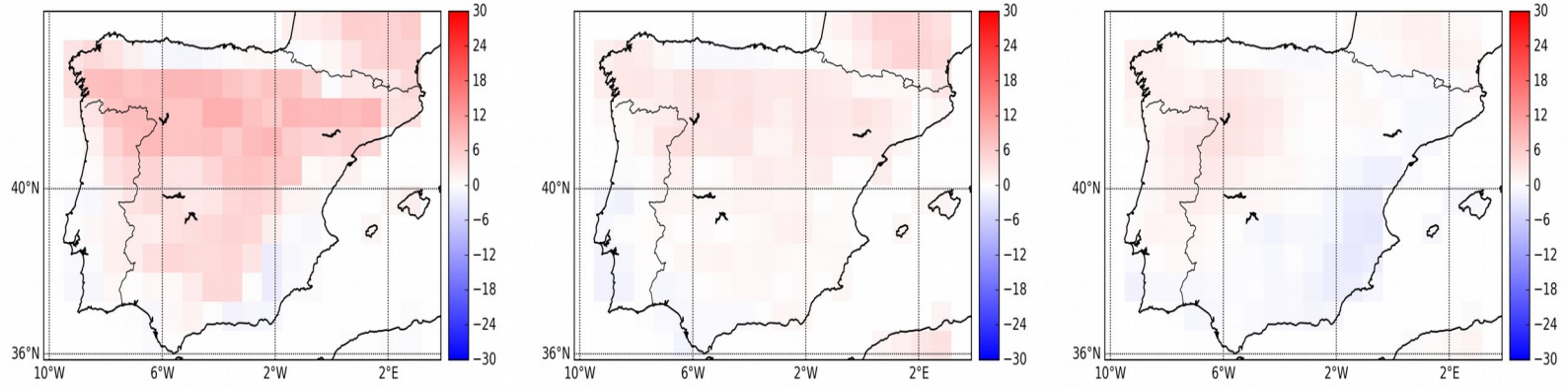
FWI computed from August predictions – results are not bad

Observed FWI anomaly during the October fires are stronger than predictions.

ERA-Interim



SEAS5 FWI



Conclusions

A wildfire seasonal prediction system using ECMWF SEAS5 predictions and wildfire forecasting infrastructure has been tested.

- Preliminary results show some skill (1-2 months lead time) over California and Iberian peninsula
- However, FWI was not well predicted over California in 2017, better result over the Iberian peninsula
- Initial state might be important and responsible for erroneous predictions, therefore testing will continue with all start dates (not only May and August)
- Future work:
  - Analyze the raw seasonal prediction outputs to understand the problems found in the FWI predictions
  - Apply bias correction techniques (e.g. QQ mapping)
  - Use thresholds / quantiles for forecasting fire danger classes instead of absolute FWI values
  - Use other seasonal prediction systems

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Thank you!

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