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MAPP Webinar - Fire: Modeling and Prediction Issues (part 1)
April 19
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EXCELENCIA SEVERO OCHOA

An observational study of the extreme wildfire events of California in 2017 : quantifying the relative importance of climate and weather

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and

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Motivation

- Wildfires are the largest source of biomass burning (approximately 70% of global annual sources) and a great source of pollutants and atmospheric CO_2
- In tropical areas such as the Amazon basin and Indonesia, wildfires are greatly affected by inter-annual fluctuations in tropical Sea Surface Temperatures (SSTs)
- 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

Part 1 - SPFireSD

- Seasonal Prediction of Fire danger using Statistical and Dynamical models SPFireSD) is a MARIE SkŁodowska-CURIE ACTIONS Individual Fellowship (MSCA-IF)
- SPFireSD proposes to develop and assess seasonal fire prediction capability through a variety of complementary and innovative methods using statistical and dynamical models, with a focus on Europe, the Amazonian basin and Indonesia.
- This project will develop and assess seasonal prediction capability of wildfire danger using three complementary approaches:
  - 1) **Fire danger indices approach**: simple fire danger indices computed from seasonal dynamical climate prediction systems
  - 2) Statistical approach: statistical fire danger models using a combination of past observational data and seasonal dynamical climate forecasts
  - 3) Dynamical approach: ensemble dynamical predictions using state-of-the-art fire models within Earth System Models (LPJ-Guess part of the EC-Earth Earth System Model)

Part 1 - SPFireSD

- WP1 Fire danger indices computed from seasonal dynamical climate prediction systems
  - This work package will rely on fire danger indices typically used for early warning in other countries and their computation requires climate variables which are available globally.
  - **Task 1.1 Validation of fire danger indices: Relationship between observationally-derived fire danger indices and fire danger**
  - Task 1.2 Fire danger indices obtained from dynamical seasonal climate prediction systems
- the European Forest Fire Information System (EFFIS) and Global Wildfire Information System (GWIS) produce 10-day forecasts of fire danger in Europe and globally using the Canadian Fire Weather Index and operational weather forecasts.
- This project aims to study the extension of the EFFIS/GWIS systems to seasonal timescales using predictions of FWI from multi-member operational seasonal prediction products .
- Visit to ECMWF in June to kick-start the work and foster collaboration.

Canadian Fire Weather Index

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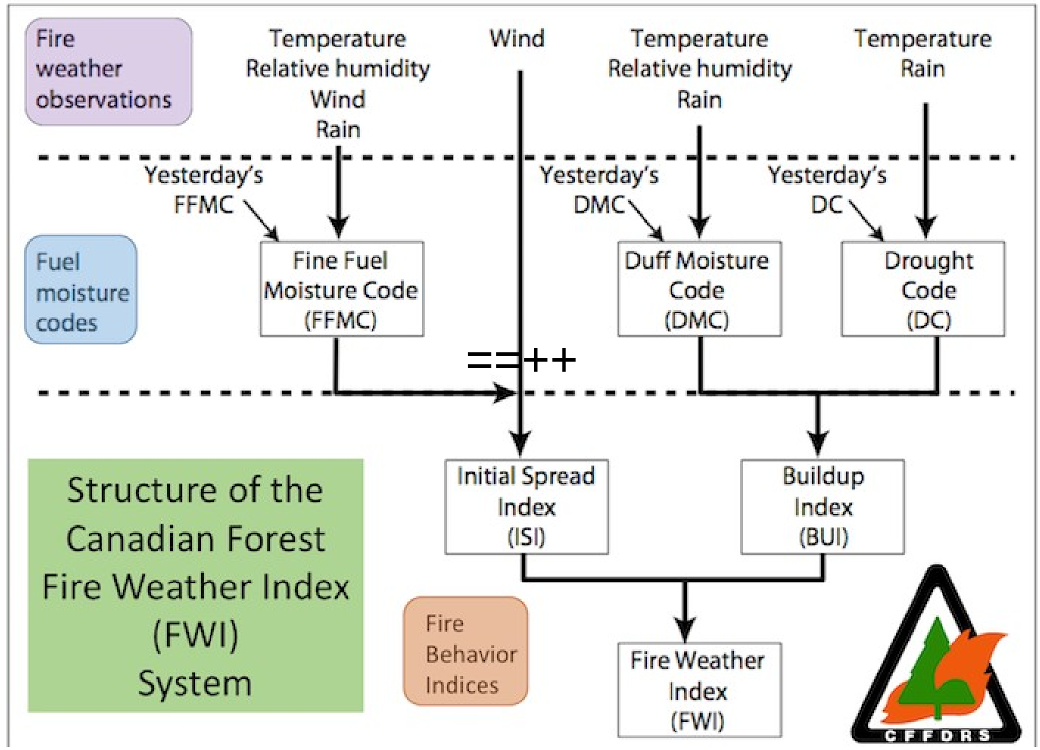
The Canadian Fire Weather Index (FWI) is used operationally for short- and medium- term forecasting of fire danger in Canada.

It relies on daily observations of precipitation, temperature, wind and relative humidity at 12h local time.

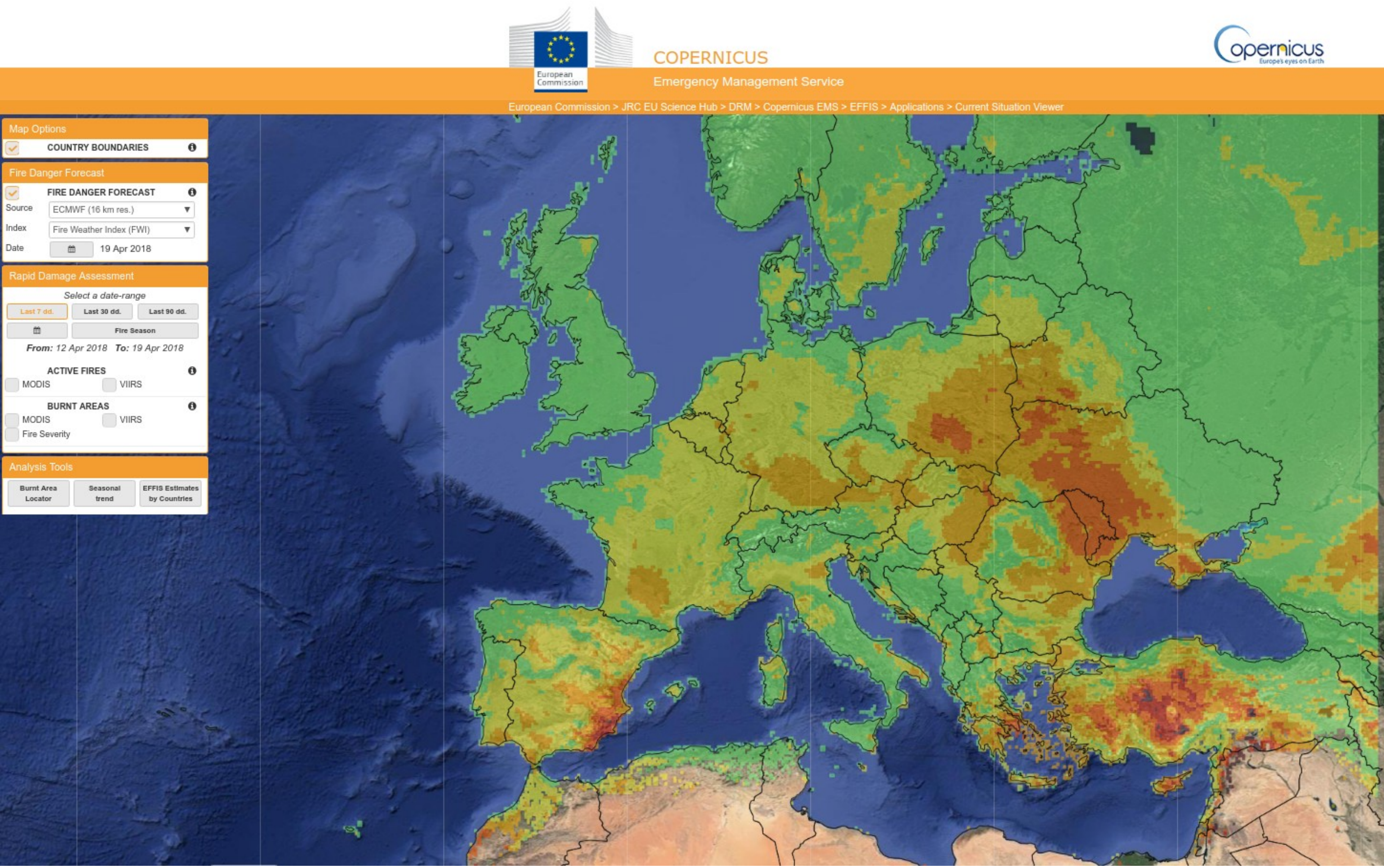
It has been adopted by the (European Forest Fire Information System) EFFIS and Global Wildfire Information System (GWIS) for producing 10-day forecasts of fire danger in Europe.

However, these systems do not go beyond the 10-day short term forecast fimeframe.



(source: http://www.fbfrg.org/cffdrs/fire-weather-index-fwi-system)

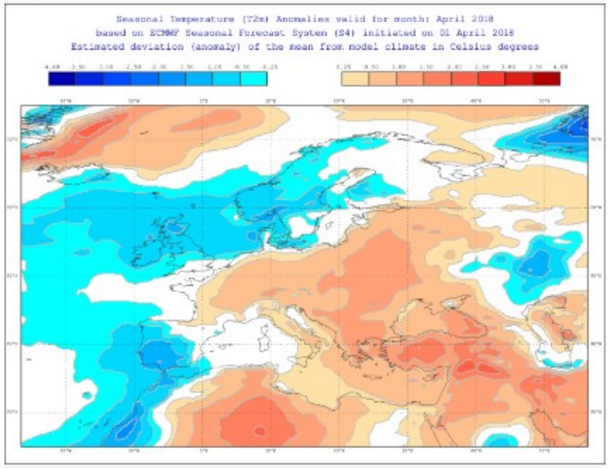
EFFIS 10-day FWI forecast



EFFIS seasonal prediction

Temperature anomalies

APRIL 2018



Rain anomalies

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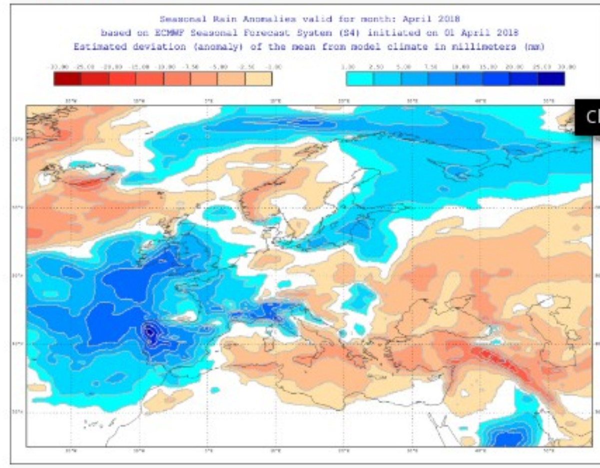
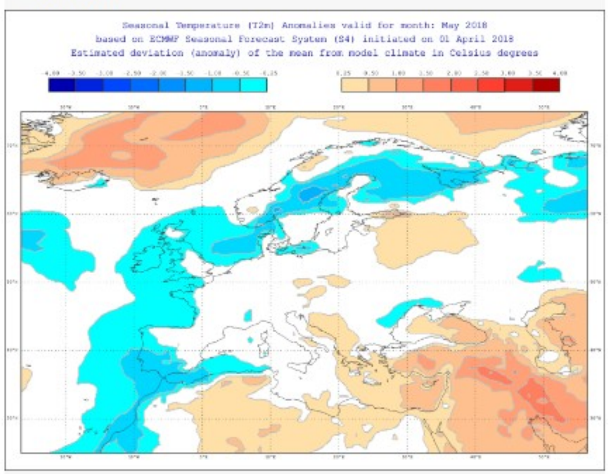


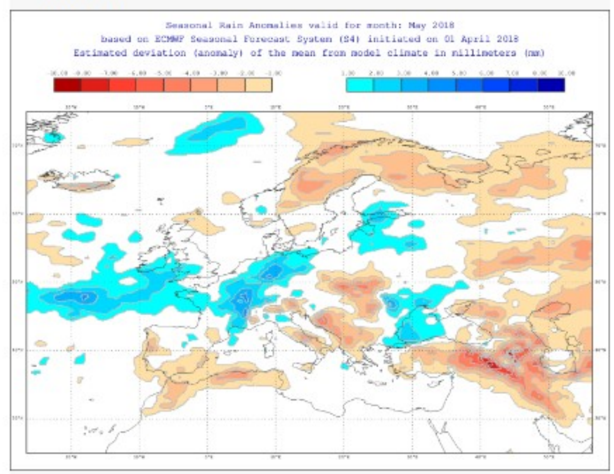
Temperature anomalies

MAY 2018



Rain anomalies

MAY 2018



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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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Part 2 - Introduction

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.

Part 2 - Introduction

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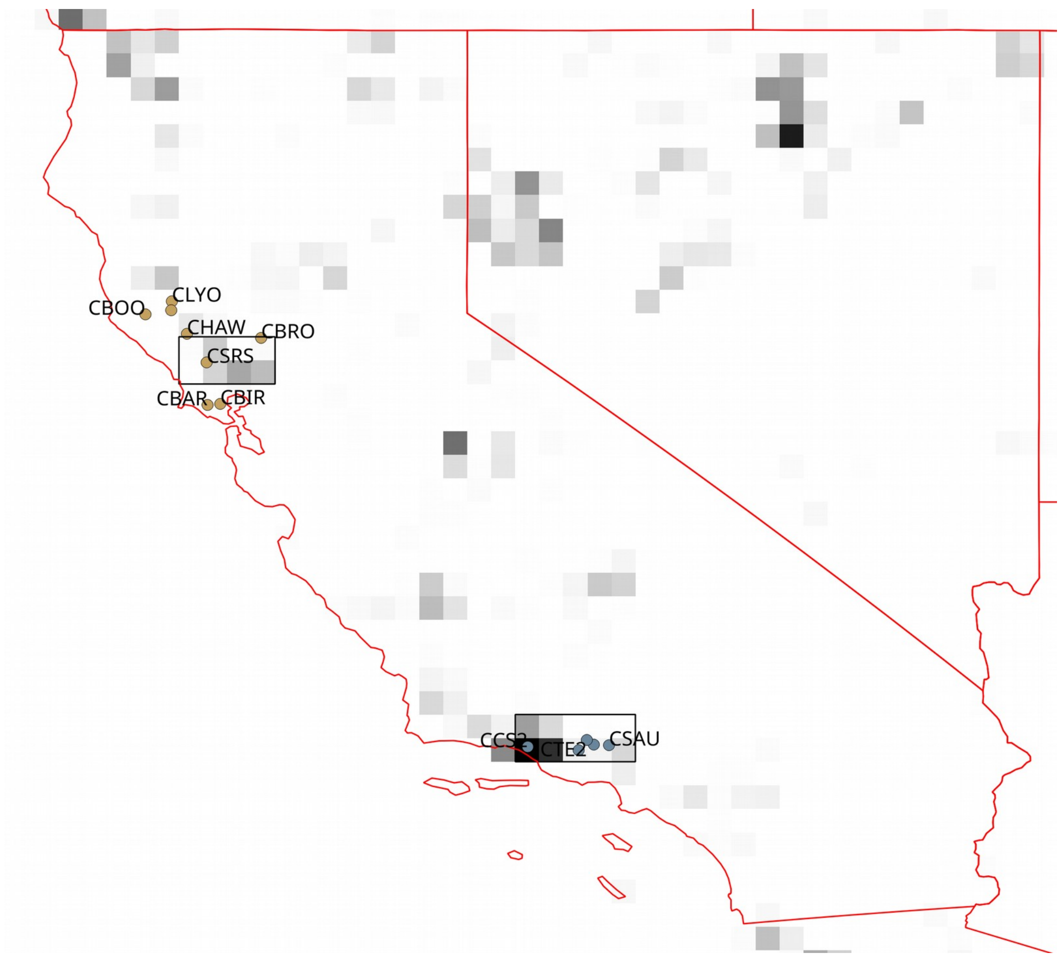
- What are the relative importance of climate (drought/heat waves) vs. weather events (dry spells, strong winds)?
- We use the Canadian Fire Weather Index to compute daily fire risk from daily observations of temperature, precipitation, wind speed and relative humidity.
- We study in which way the conditions of fall of 2017 were conductive to these extreme conditions, and if human-caused climate change could have contributed.

Data sources

- Burned Area data from the MCD64A1 global burned area product, aggregated at monthly 0.25deg grid.

- daily weather data from Remote Automated Weather Stations (RAWS) located in the vicinity of the Tubbs fire (Northern California) e.g. CSRS - Santa Rosa California and Thomas fire (Southern California) e.g. CCS2 - Casitas California

- daily data from the ERA-Interim Reanalysis at native resolution (approx. 80 km) and North American Regional Reanalysis (NARR) interpolated to 0.25 degrees (approx. 30 km).



Overview of the study area showing Burned Area fraction during 2017 from the MCD64A1 burned area product and the RAWS stations used.

2017 California wildfires

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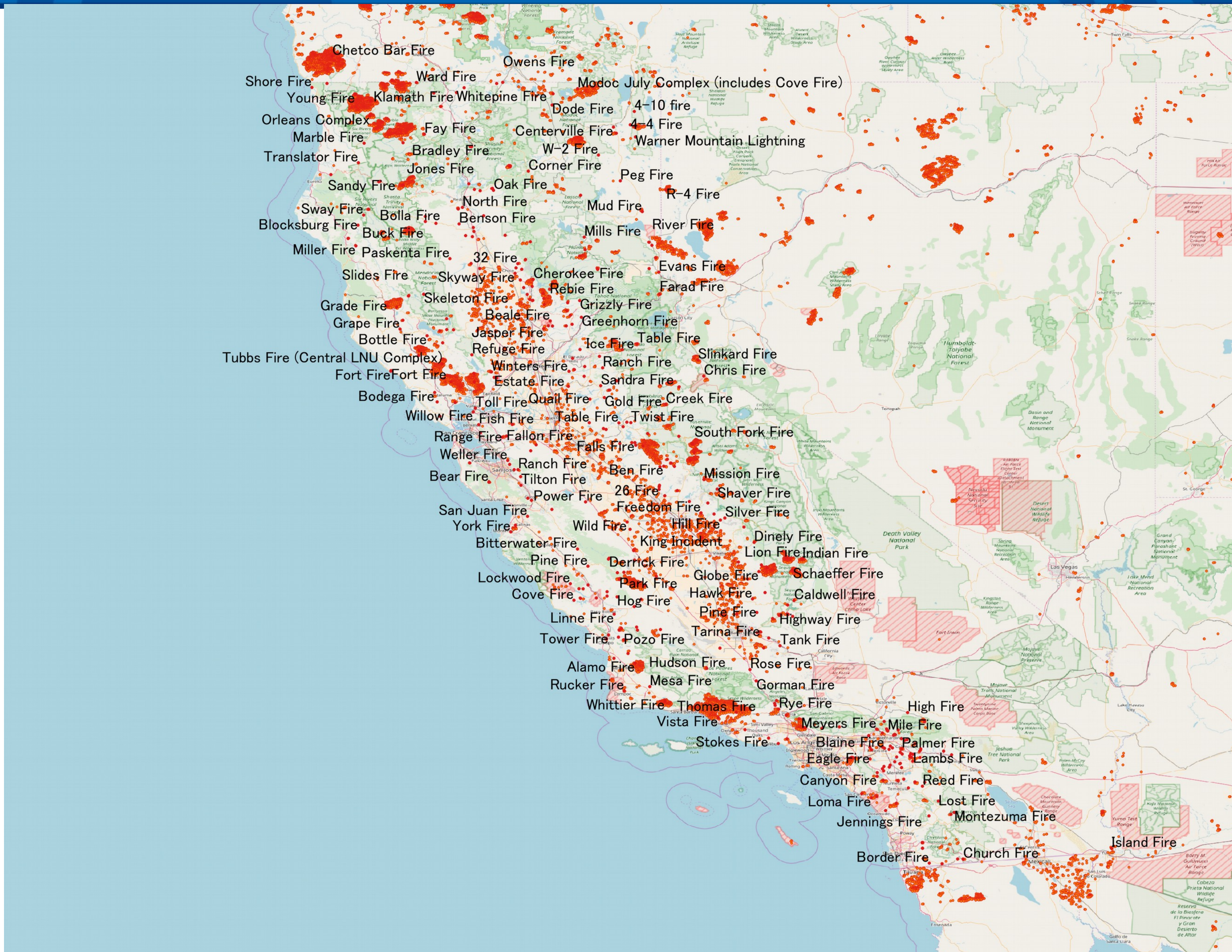
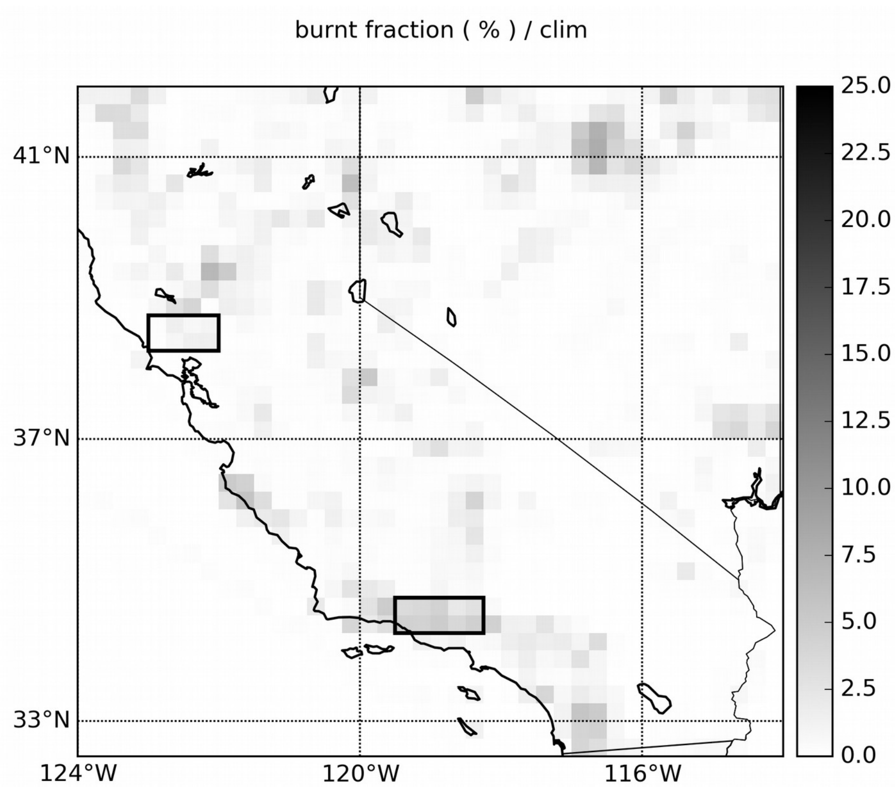
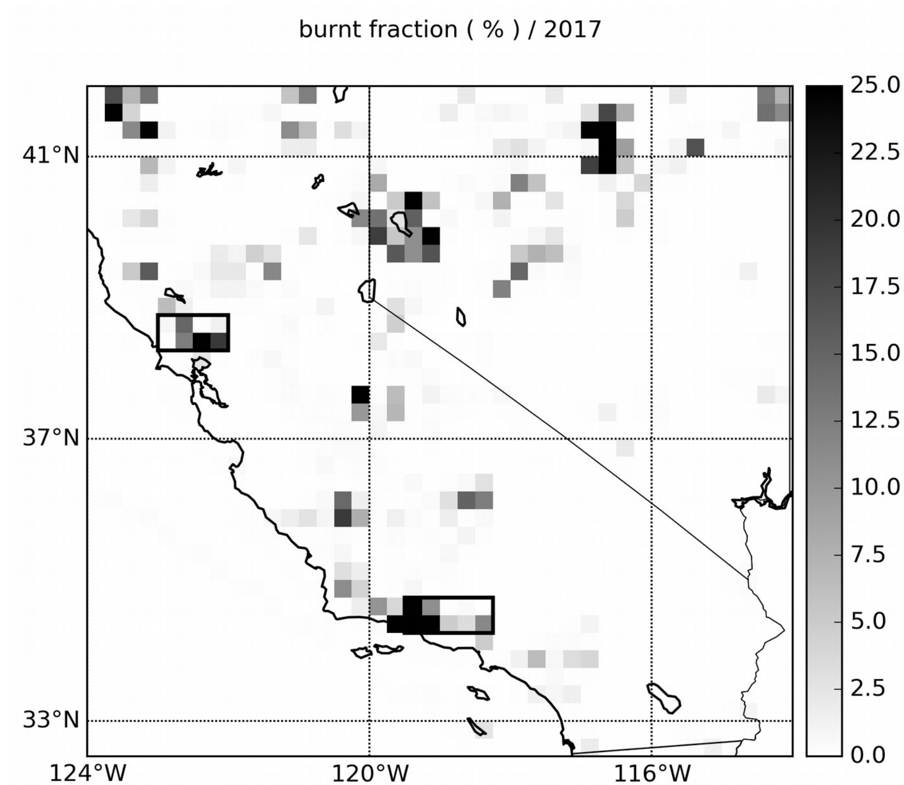


Results- was 2017 extreme?

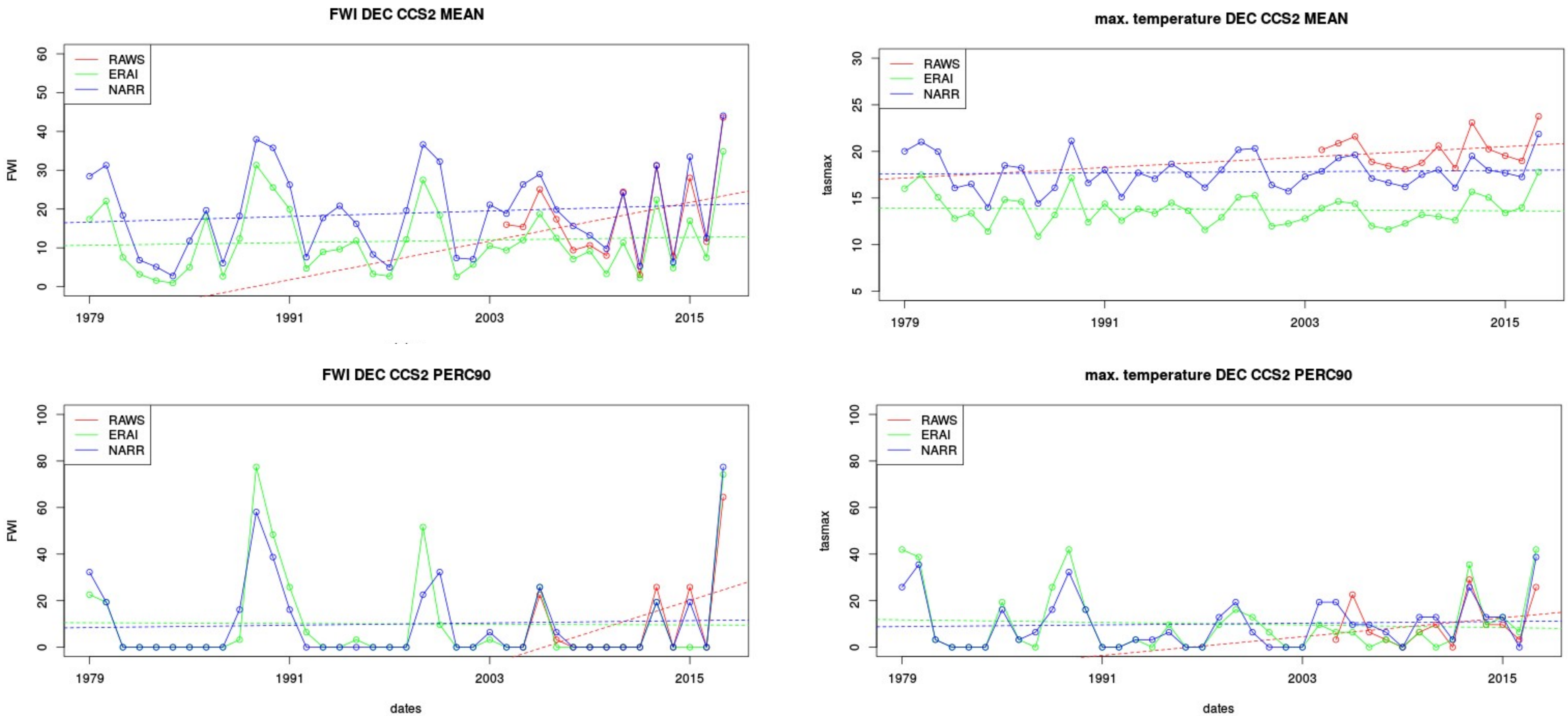
Observed burned areas in 2017 were indeed much higher than climatological averages.

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





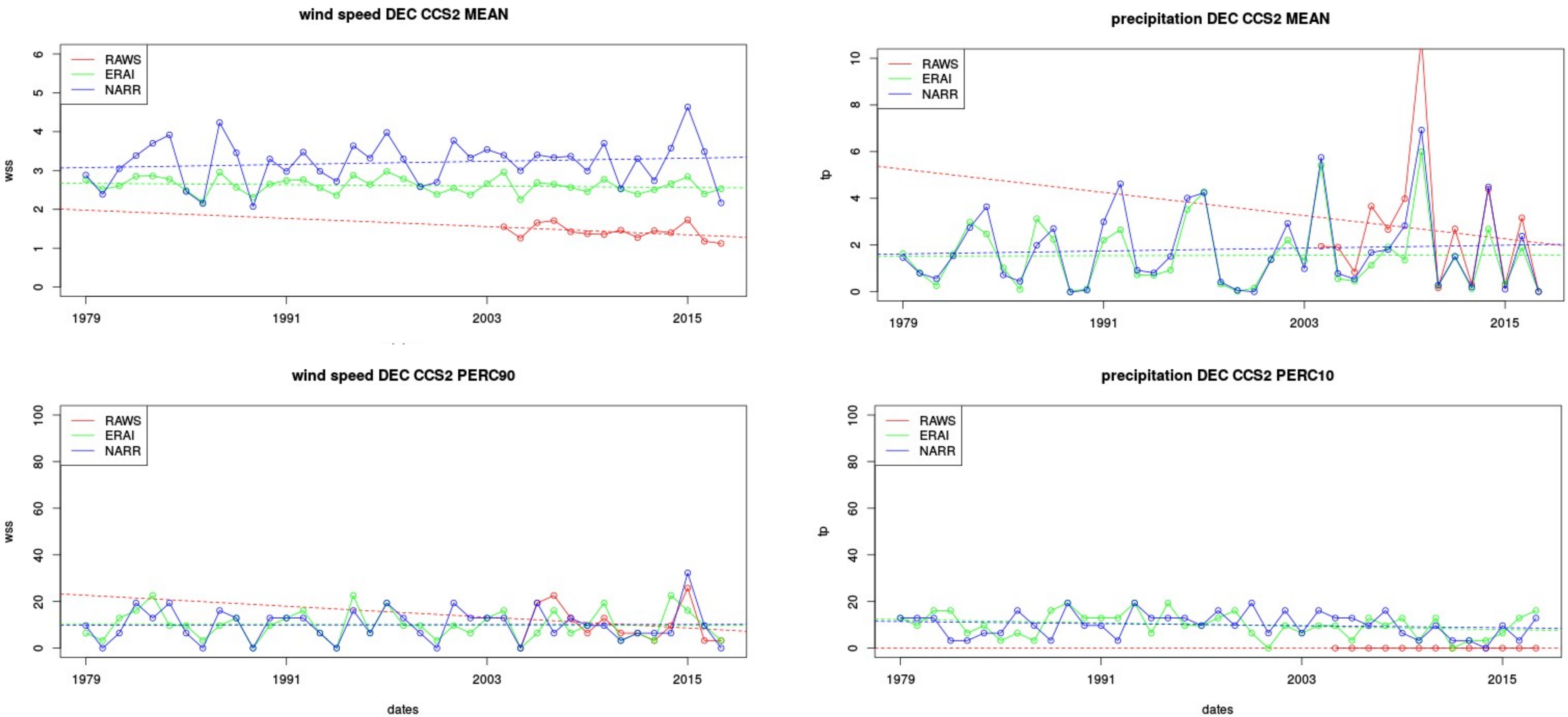
Results- was 2017 extreme?



In December/2017 station and reanalysis data show that monthly-mean FWI was much higher than average and 80% of days were above the 90th percentile.

Maximum temperature was also above-average, and a linear trend of 0.05 C/year was detected, which is equivalent to 5C/century. The warming trend could be partially responsible for these extreme conditions (more work is needed).

Results- was 2017 extreme?



Despite news reports and statements that Santa Ana winds were exceptionally strong in Decembre/2017 we did not find such evidence in the station data.
In fact there were fewer strong wind events, but timing may be a factor.

Precipitation was below-average and which helped create dryer than average conditions.

Results – FWI in December 2017

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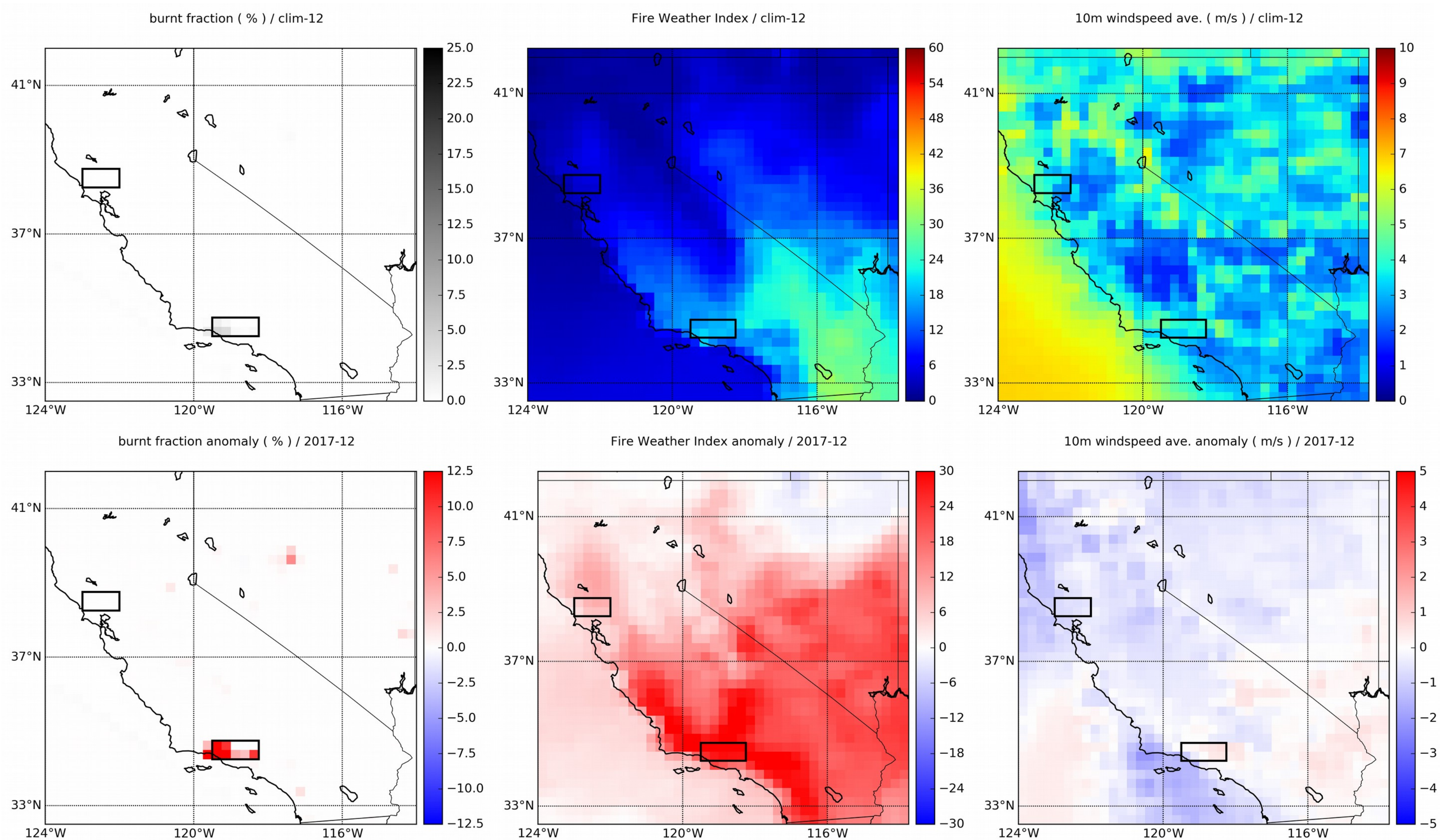
Anomalous burned area in Southern California associated with widespread anomalous FWI, but wind anomalies were not important.



Results – FWI in December 2017

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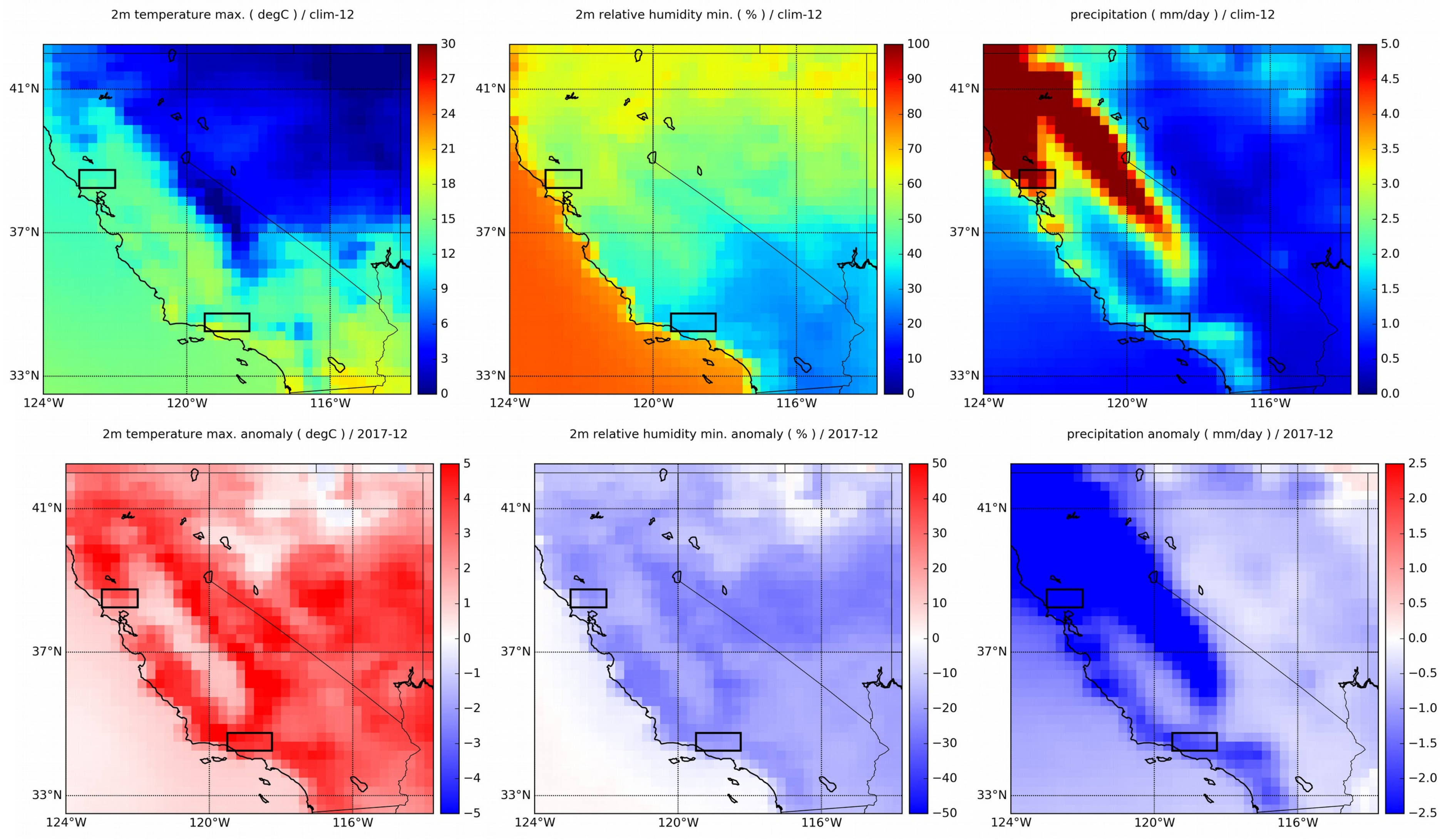
However, extreme anomalies in temperature, relative humidity and precipitation were widespread. These long-lasting anomalies are identified as playing a key role.



Results – FWI in OCT-DEC 2017

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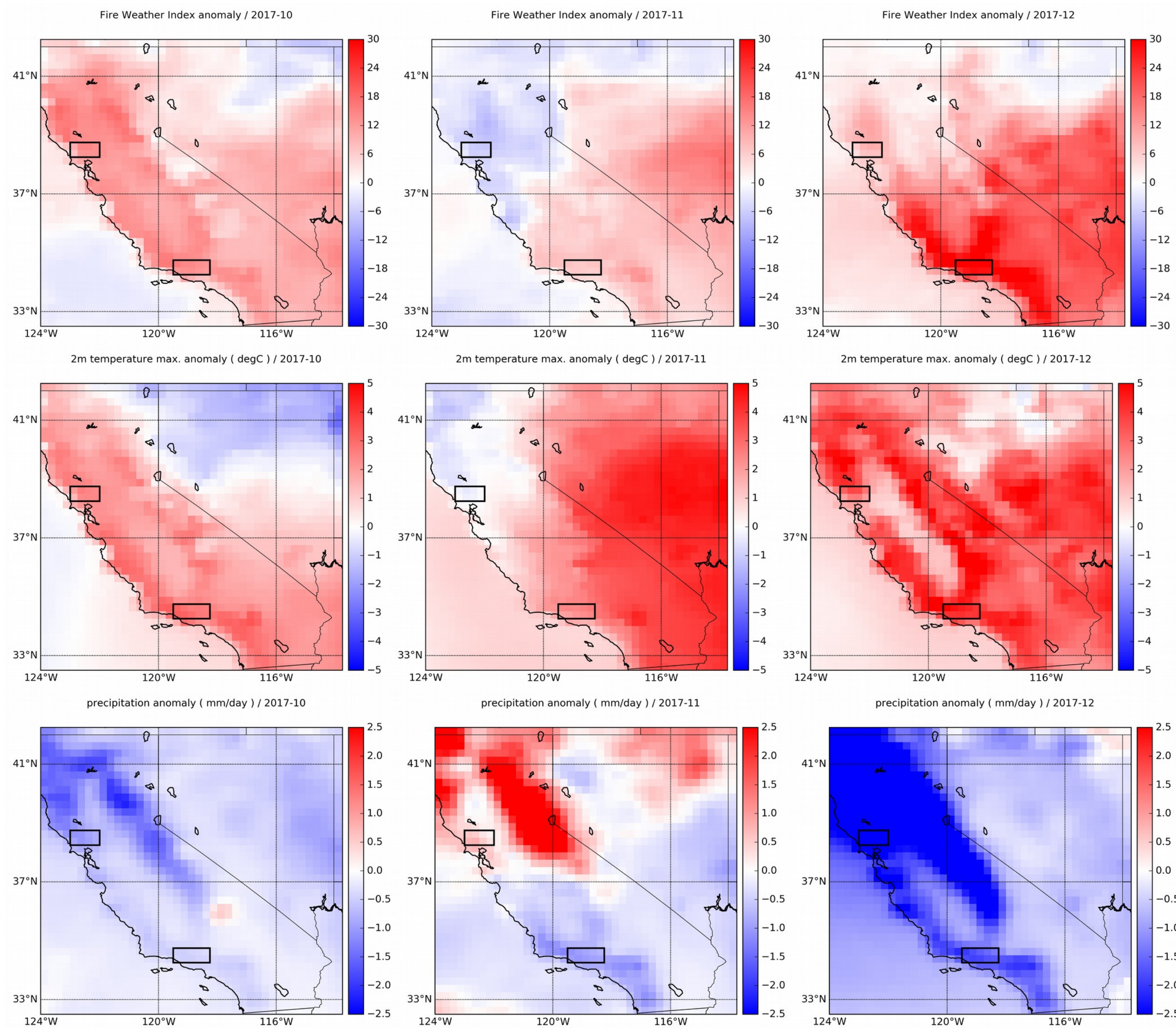
October | November | December

FWI

Temperature

Precipitation



Part 1 Conclusions

- Although the Santa Ana winds were important for fire spread as they fueled the flames, they were not stronger nor more frequent than other years.
- The anomalous warm and dry conditions which persisted for months were key factors in creating the extreme conditions.
- A long-term trend in temperature was detected, further work is require to quantify its relative importance and the likelihood that climate change will favor these conditions in the future.

Future Work

- Repeating same analysis for the 2017 summer fires in Portugal and fall fires in Galicia, Spain
- Seasonal prediction of fire risk
  - Using operational seasonal prediction products (e.g. ECMWF S5)
  - predicting frequency of days which extreme FWI a few months ahead
  - can make authorities aware of extreme conditions and prepare ahead of time
  - Combined with reliable short-term forecasts this could prevent loss of property and life.
  - Work focused on the 2017 wildfires which happened in California and Portugal and Spain

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Thank you!

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MARIE CURIE ACTIONS

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Daily input data

FWI

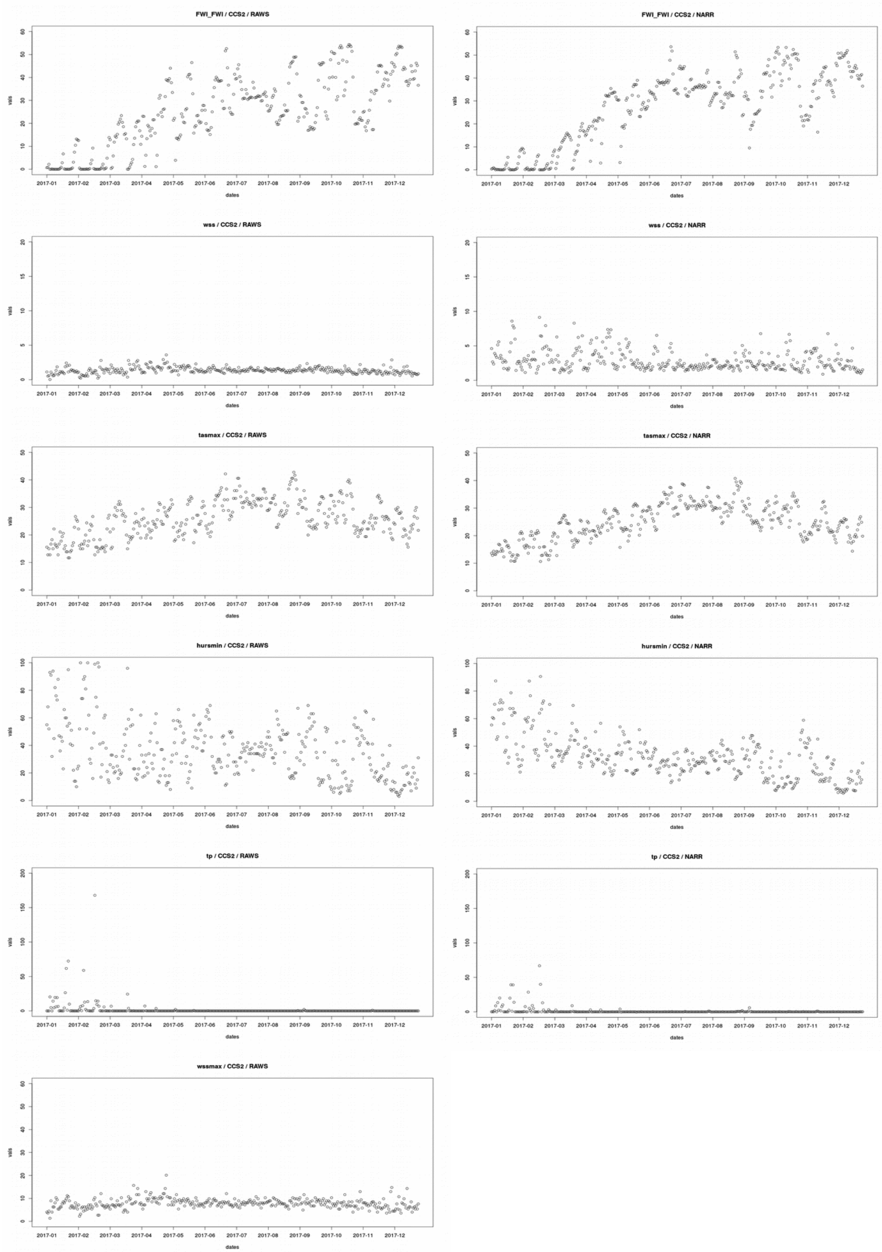
Average wind Speed (m/s)

Maximum Temperature (C)

Minimum Relative Humidity (%)

Precipitation (mm/day)

Wind speed gust (m/s)



Introduction

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- 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.

- This works aims to study the important meteorological and climactic factors responsible for the extreme widlfire season of 2017 in California, using the Canadian Fire Weather Index computed from daily values of maximum temperature, minimum relative humidity, wind speed and precipitation computed from RAWS weather stations and ERA-Interim and NARR reanalyses.