ESoWC 2020: deepGEFF

Deep Learning for Wildfire Modelling

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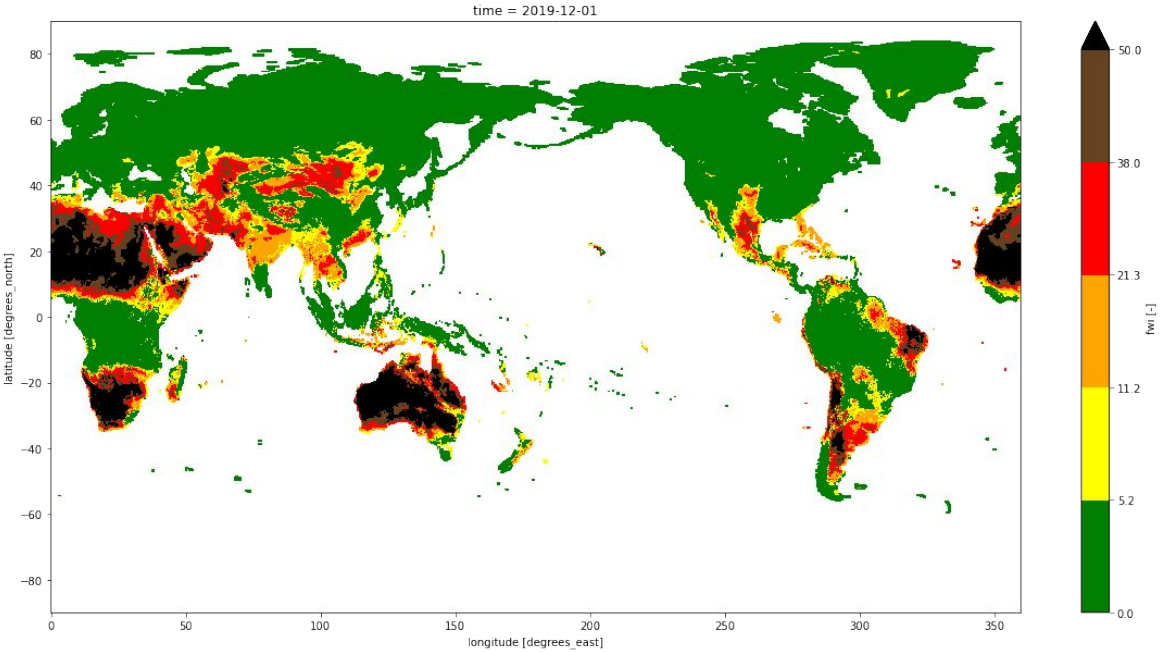
How is Wildfire Danger measured?

Fire Weather Index (FWI) is a meteorologically based index used worldwide to estimate fire danger.

It is calculated using:

1. Air Temperature (in the shade)
2. Relative Humidity (in the shade)
3. Wind speed (at 33 ft above ground level for an average over 10 minutes)
4. Rainfall (for the previous 24 hours)

Global FWI Reanalysis for 2019-12-01 in EFFIS Colour scheme



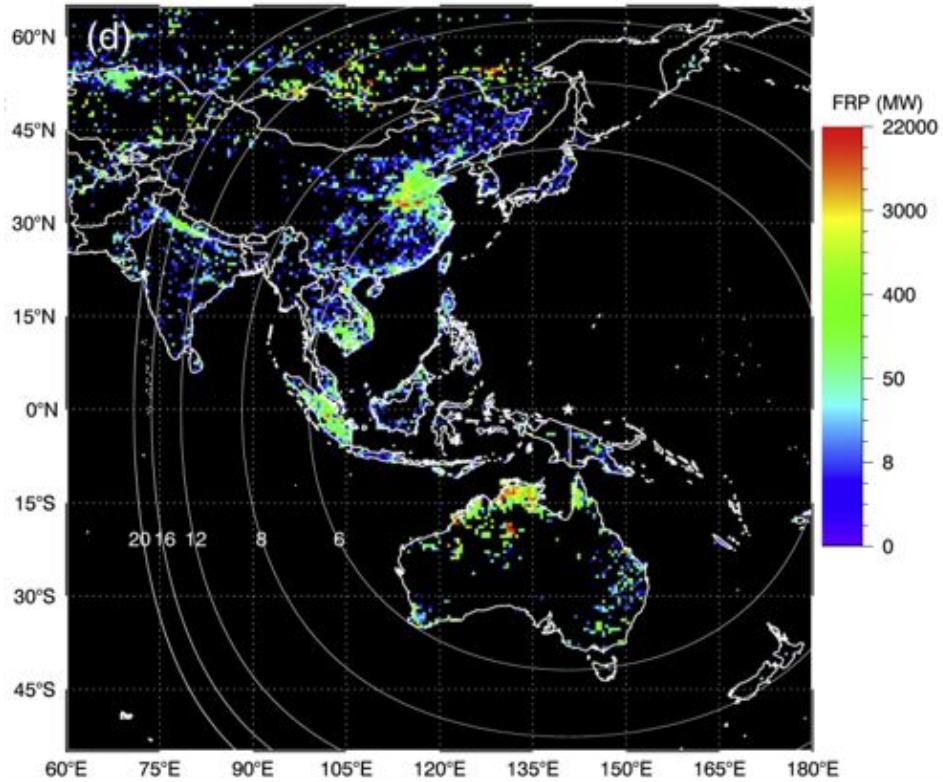
What do the FWI Numbers mean?

How do we measure an Ongoing Wildfire?

Fire Radiative Power (FRP) represents the energy emitted by fire through radiative processes.

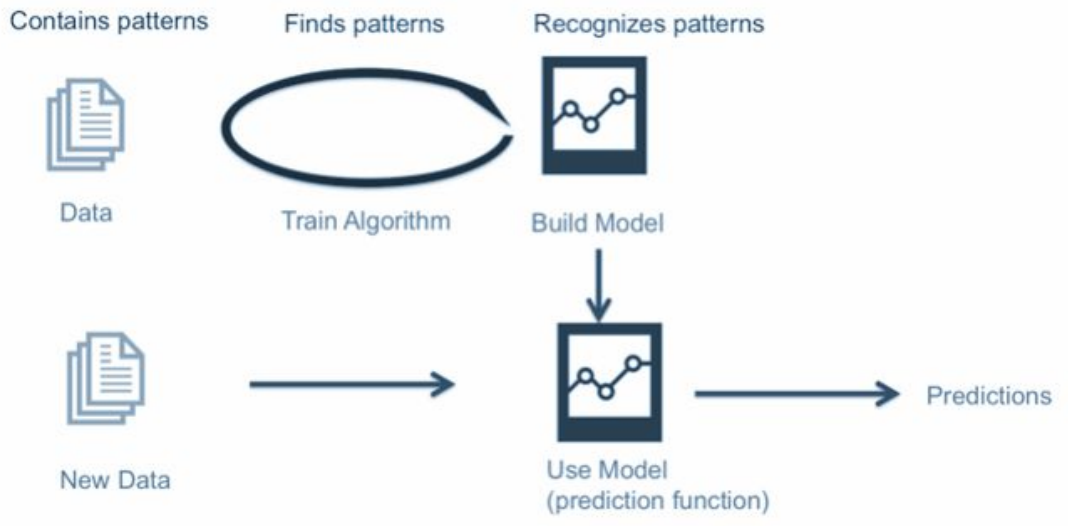
FRP is used as proxy for Fire Impact Assessment, Biomass Combustion Rates or Fire Spread Modelling.

We see here the FRP of actively burning fires detected within 0.5° grid cells in June 2015 using MODIS observation →



Numerical Modelling vs Machine Learning

The current system for **predicting Fire Weather Index** uses numerical predictions to drive empirical models and predict forest fire danger indices up to 10 days ahead.



What can be improved ?

- Global prediction accuracy
- Increase time-scales of prediction

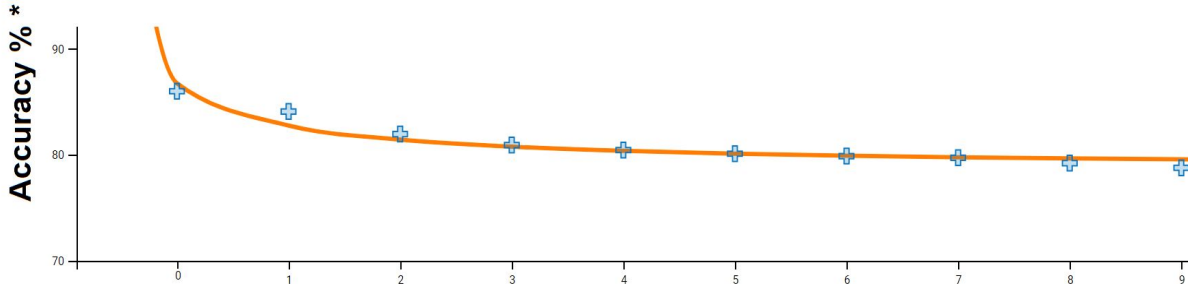
deepGEFF Project Goals

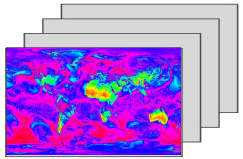
1. Reproduce Numerical Modelling using Machine Learning
2. Improve Accuracy of Predictions
3. Improve Timescale of Predictions
4. Study the Correlation of Additional Variables to Fire Danger
5. Modelling Fire Spread Dynamics

Results - The Good

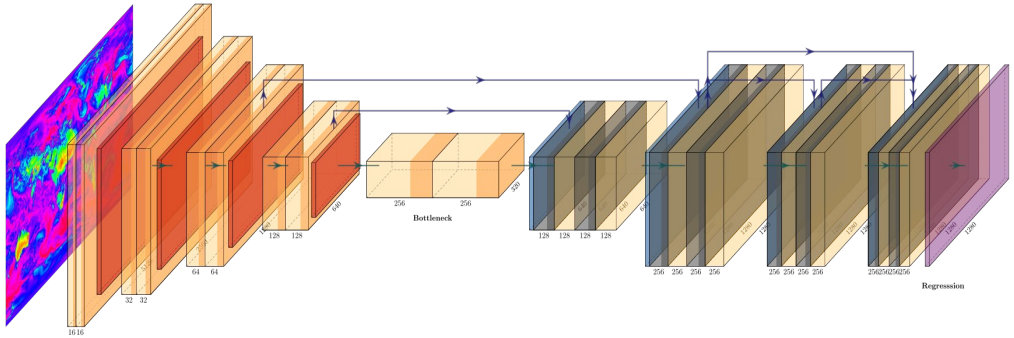
Fire Weather Index Prediction

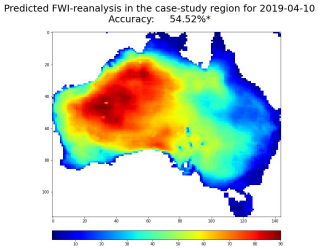
Predicting Fire Weather Index using a Deep Learning Model





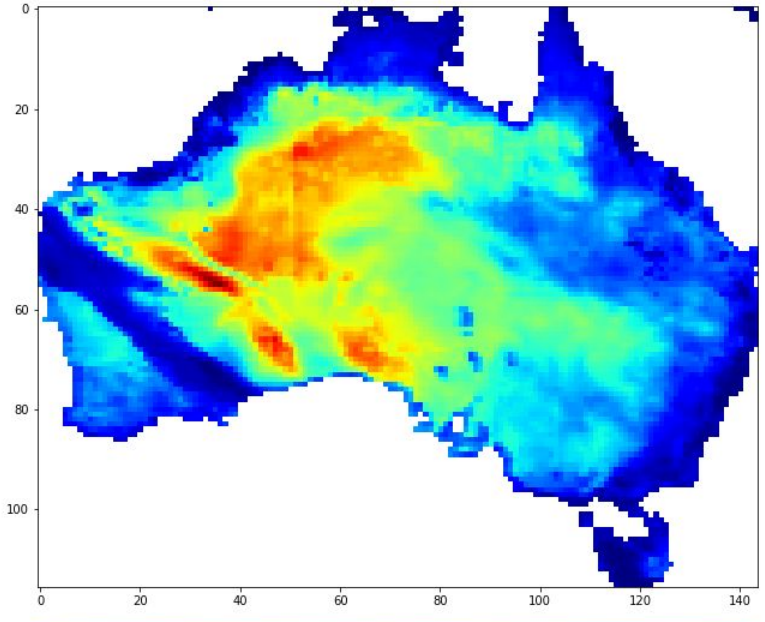
Input
(Forcings variables)



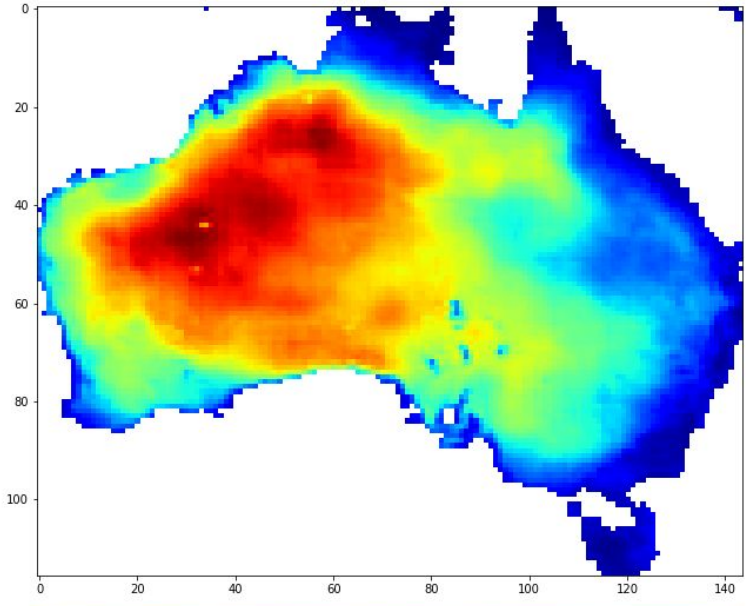


FWI Prediction - A Visual Demonstration

Observed FWI

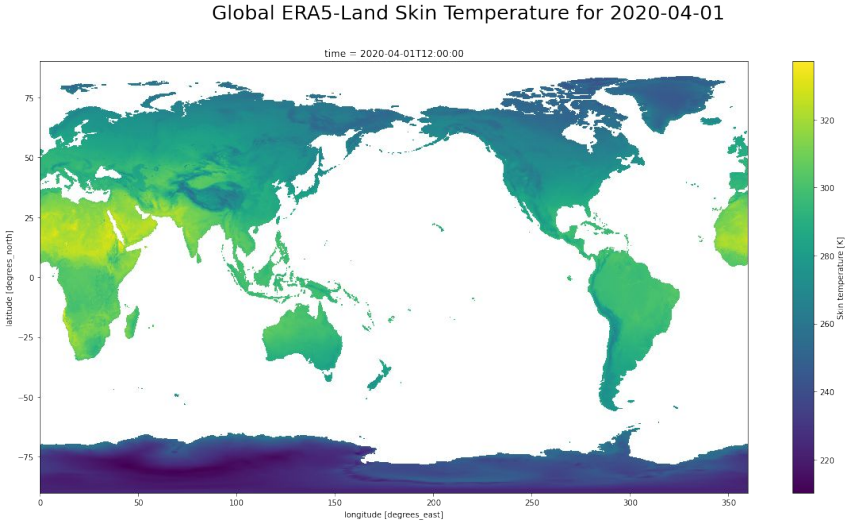


Predicted FWI



Australia, 2019 Wildfire season

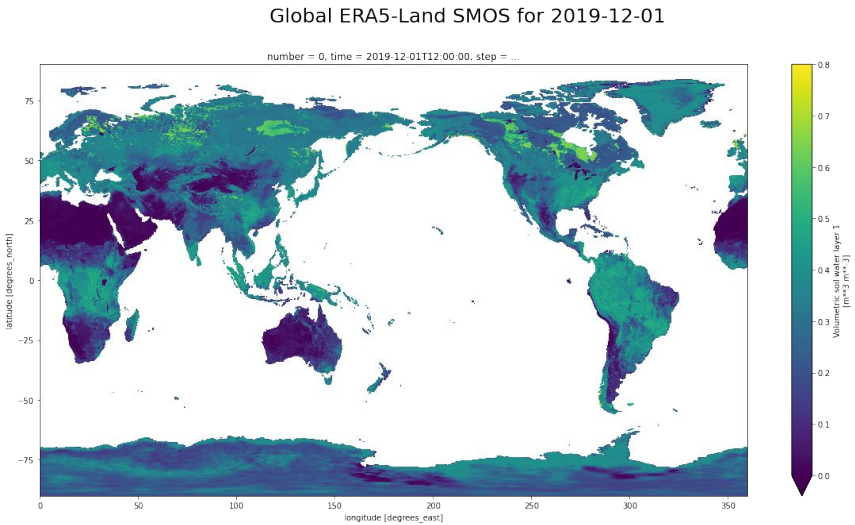
FWI Prediction - Effects of Skin Temperature



Land Skin Temperature - The temperature of the Earth Surface

68% Global Accuracy in FWI Prediction when used along with standard inputs with just 30 epochs of training on 4 months of data.

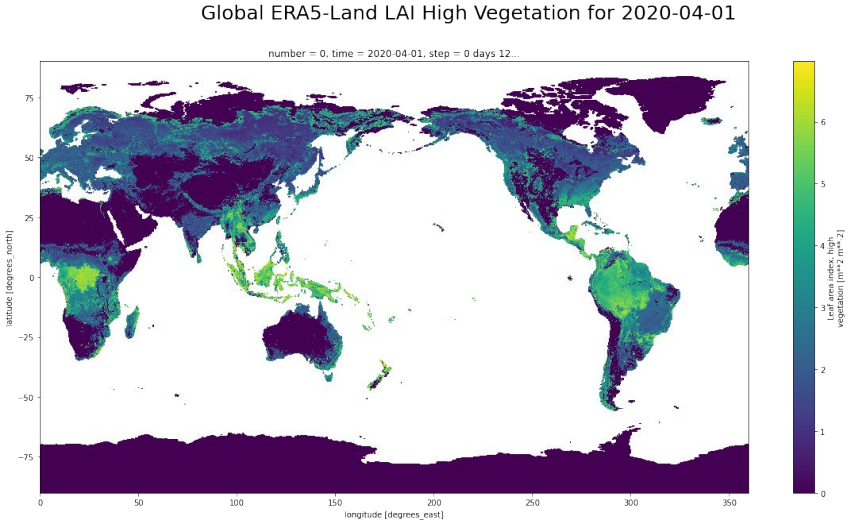
FWI Prediction - Effects of Soil Moisture



Volumetric Soil Water - the volume of water in soil layer 1, a measure of its moisture content

65% Global Accuracy in FWI Prediction when used along with standard inputs with just 12 epochs of training on 4 months of data.

FWI Prediction - Effects of Vegetation



Leaf Area Index (High Vegetation) - projected area of leaves over a unit of land, typically green and thus not a direct indicator

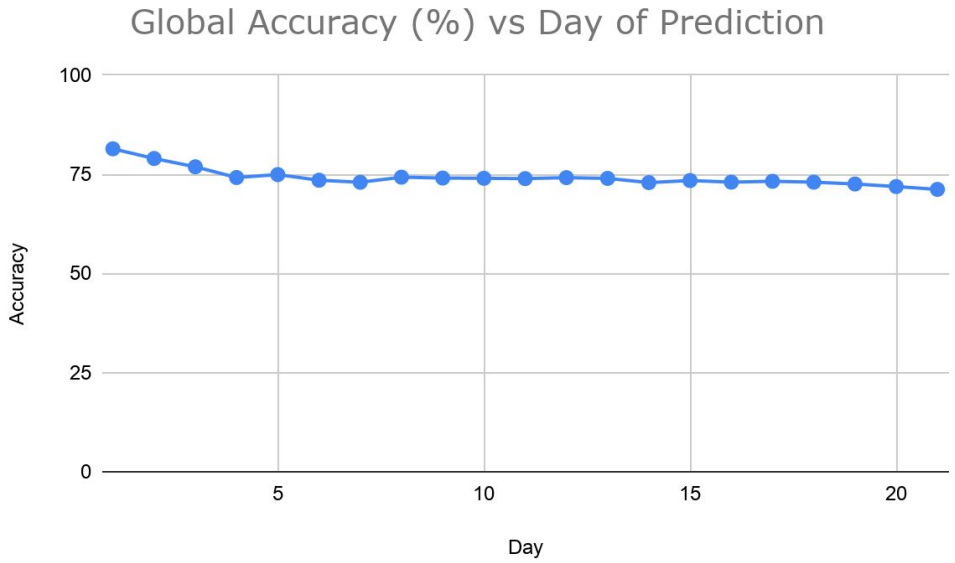
No significant improvements in accuracy, possibly due to lag in green vegetation getting cured into burnable biomass matter.

FWI - Increased Prediction Timescale

Input - Weather Forcings for the preceding 7 days

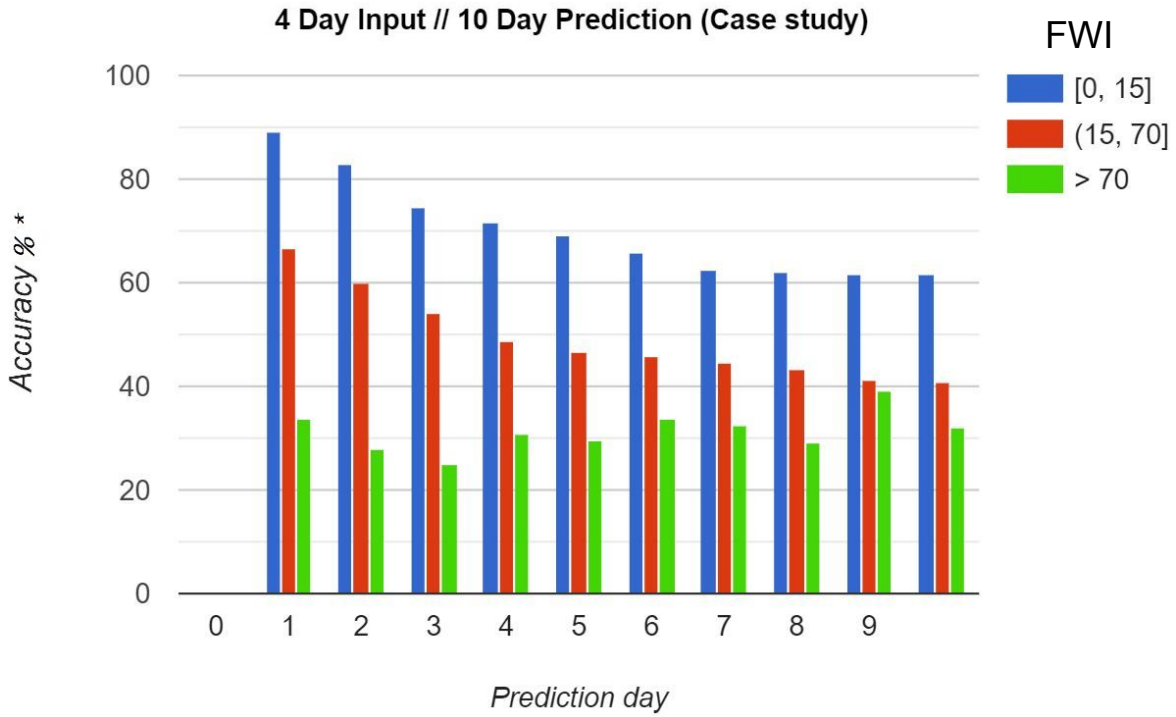
Prediction - Fire Weather Index (FWI) values for the next 21 days

Training on 6 months of Data for 30 epochs

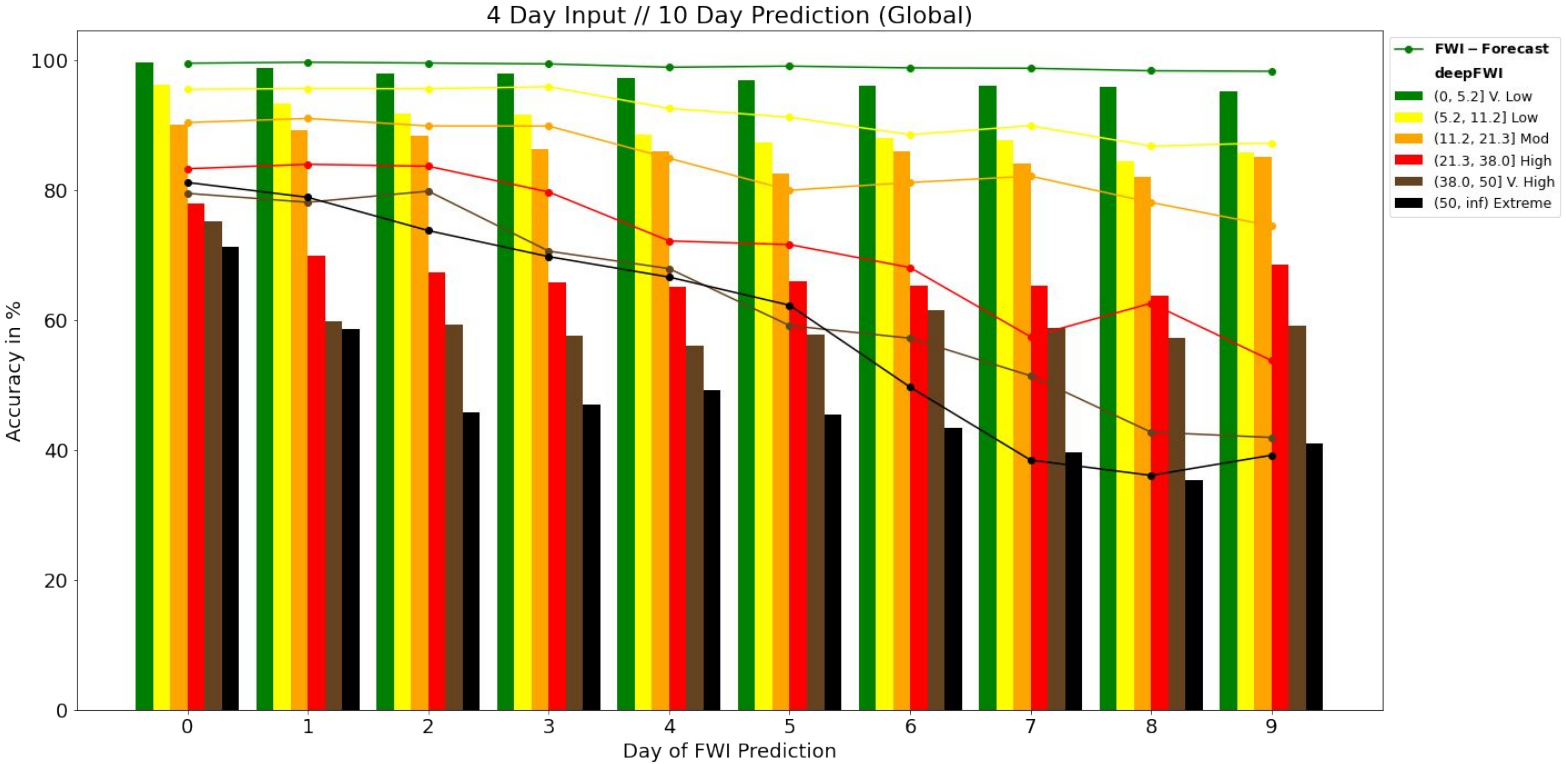


Results - The Not So Good

Accuracy of Predictions at the Higher end

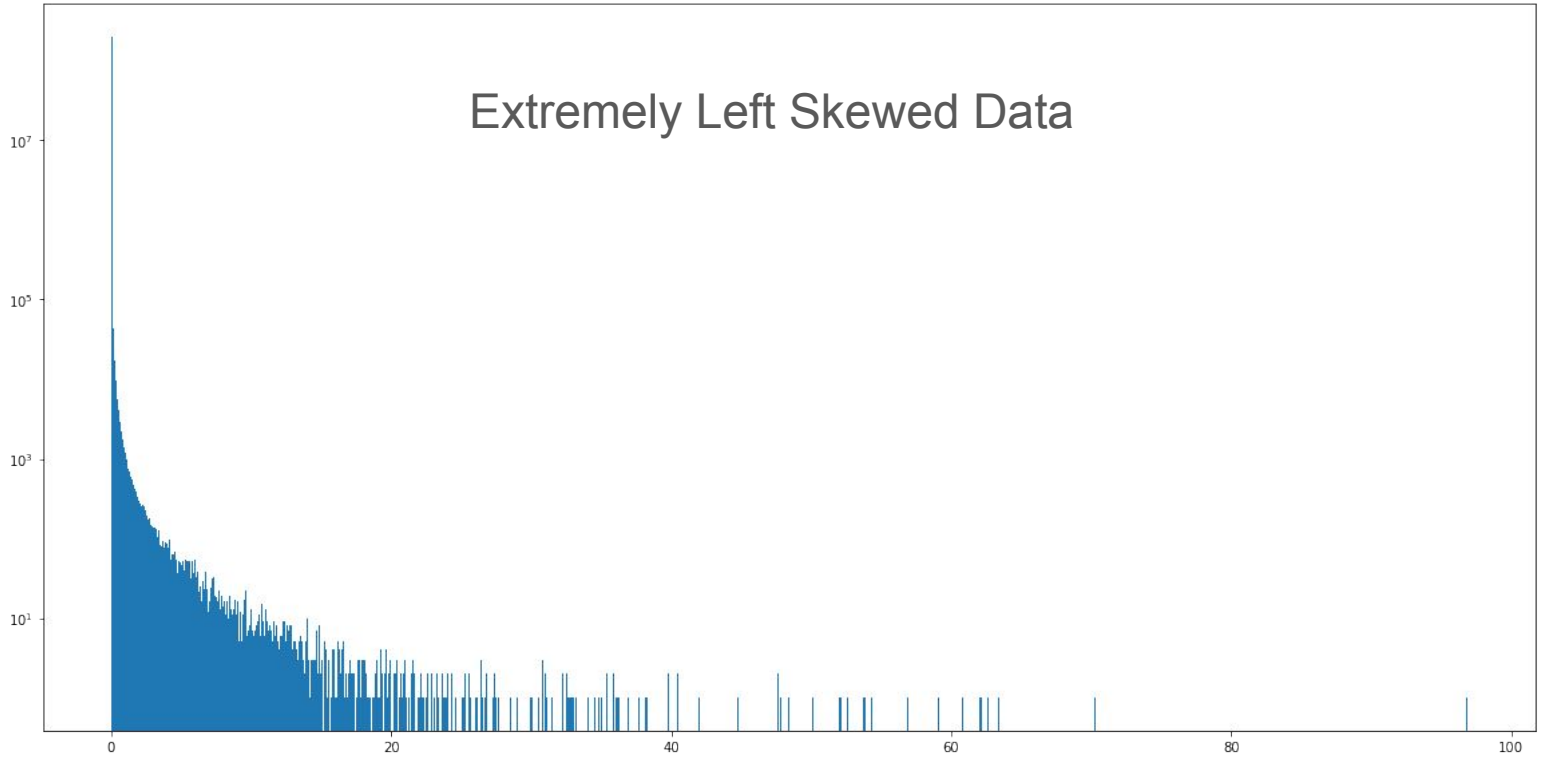


Benchmarking with Numerical Predictions



Results - The somewhat Bad (and work in progress)

Predictions of Fire Radiative Power



Fire Ignition and Fire Spread

Predicting Fire Ignition:

- Human Activity
- Lightning

Modelling Fire Dynamics:

- Presence of burnable biomass
- Presence of Fire in Adjacent Grids
- Presence of Control Measures
- Weather Factors

Currently exploring datasets or products that help integrate these factors into FRP Prediction

Currently exploring Reinforcement Learning based approaches

Key Takeaways

- Data Cleaning & Preprocessing is more important and more time consuming than ML Engineering
- Metrics have nuances and it is easy to get carried away by top level numbers and results
- Writing good code is as (or probably more) important when compared to producing quick research outputs
- Have fun even when the results might not look promising

https://github.com/esowc/wildfire-forecasting