Forests and Trees as Tools for Wildfire Power Modeling

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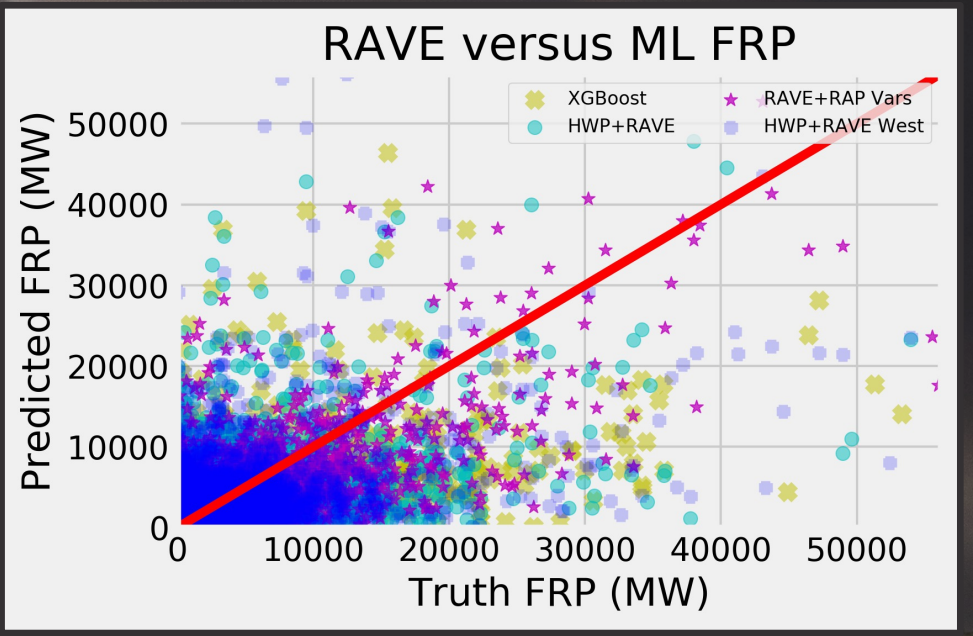
Modeling future hourly Fire Radiative Power (FRP) helps improve aerosol modeling and can have valuable impacts on understanding wildfire behavior. FRP is derived from satellite, although there are often many factors that can contaminate or block FRP extraction such as smoke, clouds, and false-detections from solar flaring. Different types of satellites have different advantages and disadvantages to FRP derivation, but with the RAVE [1] FRP dataset, there is now a merged polar and geostationary satellite FRP product.

The following experiments are conducted using different input variables, from RAVE and the rapid refresh (RAP) model, for training random forest (RF) and gradient boosted (XGBoost) machine learning (ML) models. Some use Eric James' formula to calculate an hourly wildfire potential (HWP) variable[2] and analyze the performance of using HWP.

ML models are trained under the assumption that there was rolling 24-hour FRP mean greater than zero for that grid cell (up to hour-before) and are trained/tested from July 2019 – December 2021, with case study periods excluded. This dataset does include controlled burns.

[1]https://doi.org/10.1å016/j.rse.2022.113237
[2]https://github.com/NOAA-GSL/pygraf/blob/main/adb_graphics/datahandler/gribdata.py

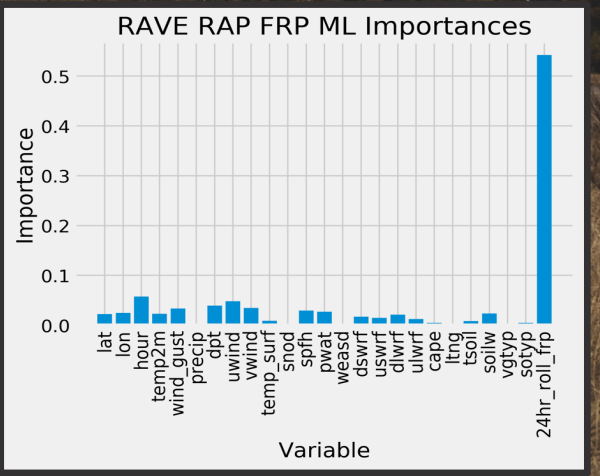
Model Type	Inputs	MAE	MSE	Size of Datasets
RF	HWP	518.9	2427335.894	Train size: 188993 Test size: 80998
RF	HWP + RAVE	322.73	1678572.204	Train size: 188993 Test size: 80998
RF	HWP variables	419.64	1938811.936	Train size: 188993 Test size: 80998
RF	*HWP variables + RAVE*	*239.41*	*929547.1606*	*Train size: 188993 Test size: 80998*
RF	*RAVE + all variables*	*212.04*	*779852.9637*	*Train size: 188993 Test size: 80998*
RF	HWP variables + RAVE (west of -105)	588.02	3199412.284	Train size: 312090 Test size: 39495
XGBOOST	*HWP variables + RAVE*	*270.84*	*1313135.947*	*Train size: 188993 Test size: 80998*
RF	All variables NO RAVE	312.56	1241393.717	Train size: 188993 Test size: 80998



RAVE data from July 2019 through December 2021 were used in testing/training. August 13 – October 2 2020 were kept out for validation case studies.

The HWP variable calculated on RAP data is actually much lower in value than for HRRR, ranging from [0,65]. This might be due to HRRR's low soil moisture and humidity bias and/or RAP's inability to solve for as high resolution convective storm winds.

Interesting Note: With experiments just using HWP variable and rolling 24-hour mean FRP from RAVE, the importance analysis scored all importance on the FRP input.



Conclusions and Future work: Right now, it looks like there is potential to explore both XGBoost and RF. Using the HWP variable on RAP alone as well as with RAVE information isn't as good as using additional variables in combination with the 24-hour mean RAVE information. Future tests will be done on wildfires in excluded time range, some which include snow/precipitation, to see if the models trained using those variables perform better or worse in those cases. Further evolution will also examine higher FRP values and the errors associated with modeling those specifically.