Improving seasonal forecasting of Alaska wildfires

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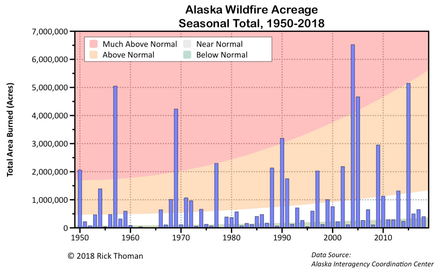
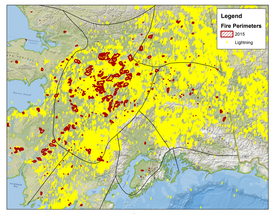
Main Results

- Fire managers need seasonal outlooks for the upcoming summer by March
- CFSv2 requires bias correction to produce reasonable forecasts of the Canadian Fire Weather Index
- Seasonal lightning can be estimated by regression from reanalysis but is challenging for CFSv2

Motivation

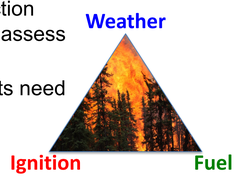
- Summer wildfires can burn large areas and most of Alaska area burned is due to lightning-ignited fires
- Few seasons have large area burned (> 1 million acres)
- Seasonal predictions of wildfire risk need to account for lightning ignitions





Large numbers of lightning strikes (yellow) on June 19-22, 2015 initiated 207 fires resulting in the burned areas shown in red. Data from G. Branson, AICC.

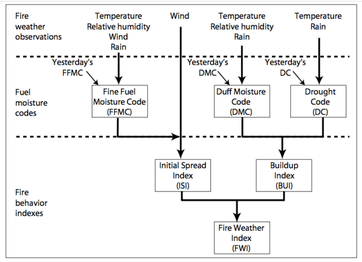
- Seasonal predictions of wildfire activity are needed in March for fire managers to plan
- NMME seasonal prediction models can be used to assess fire danger
- CFS ensemble forecasts need to be analyzed



Data and Methods

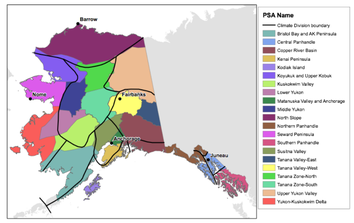
- CFSv2 6-hr hindcast/prediction data employed 1982-2017
- Lightning observations
- Dynamically downscaled ERA-Interim reanalysis (Bieniek et al. 2016)

Components of the Canadian Forest Fire Weather Index System (CFFWIS)



- CFFWIS driven by daily afternoon temperature, wind speed, humidity and 24-hr precipitation
- Calibrated in the boreal forest so it was easily applied in Alaska
- Need to develop outlooks for May-August CFFWIS using forecasts in late winter
- Lightning is a key ignition source for large wildfires and outlooks of ignition risk are also critical

Alaska PSAs and Climate Divisions

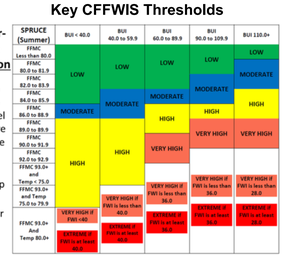


- Analysis conducted by predictive service area (PSA) and climate division
- Alaska fire managers use PSAs to predict wildfire danger
- Alaska fire danger is measured by the Canadian Forest Fire Weather Index System (CFFWIS)
- Compute CFFWIS using the CFS/reanalysis and assess predictability

Key CFFWIS Thresholds

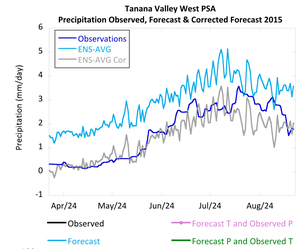
Summer-Spruce Calibration

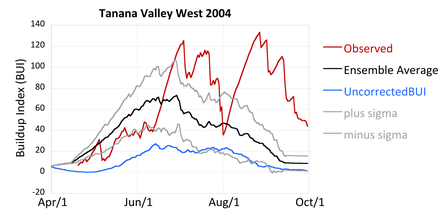
- Buildup Index & Fine Fuel Moisture Code are first factors
- Air Temp
- Fire Weather Index

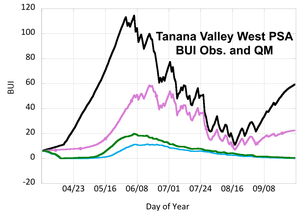


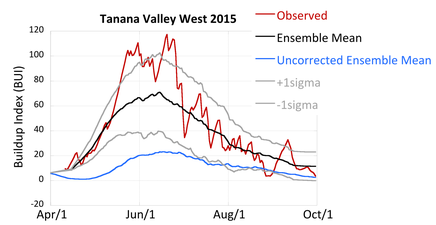
CFSv2 bias corrections needed for wildfire danger thresholds

- CFSv2 March forecasts for May-August used to calculate CFFWIS.
- Model is too wet and cool and results in much lower values of BUI than observed
- Temperature and precipitation were corrected by Quantile Mapping (QM)
- QM of the model increases BUI to expected range of values
- Improved forecast BUI magnitude for 2015 extreme season but missed late-season BUI peak in 2004









Sampath et al. (2018)

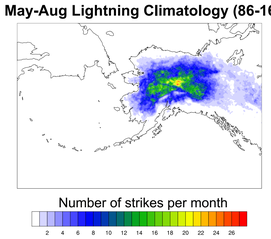
Observed lightning linked to reanalysis predictor variables

- Lightning observed at a ground station network 1986-present
- Homogenization of data needed through time due to changes in the network
- Most lightning strikes occur in Interior Alaska

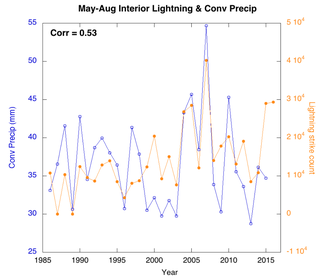
Alaska Lightning Sensors

Interior areas highlighted

May-Aug Lightning Climatology (86-16)



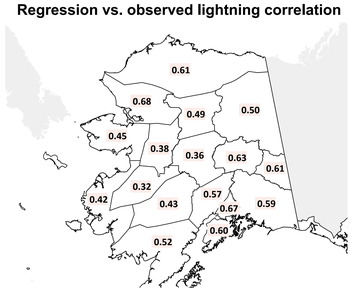
May-Aug Interior Lightning & Conv Precip



- Regression predictor set chosen by AIC for each PSA
- Predictors: Convective Precipitation, 2m Temperature, Dewpoint, 850-500hPa dT, and 500hPa heights
- Good correlation between regressions and observed lightning

- May-Aug Interior average convective precipitation from reanalysis is correlated with seasonal lightning totals
- Regressions are developed to diagnose weekly lightning with predictor variables from reanalysis
- Reanalysis normalized first to remove bias
- Regressions conducted on PSA-scale

Regression vs. observed lightning correlation



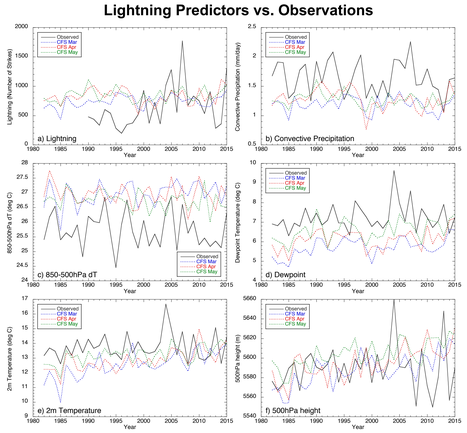
Seasonal lightning prediction is challenging

- Normalized CFSv2 variables applied to PSA regressions for March, April and May to produce predictions of June-July lightning
- Low correlation between observed lightning and ensemble mean regression output

Interior Alaska Jun-Jul CFSv2 Ensemble Mean Predictors vs. Observations Correlations

CFS Forecast	Lightning	Conv Precip	850-500 dT	Dewpoint	2m Temp	500h
March	-0.08	0.14	0.18	0.13	0.19	0.01
April	0.06	0.33	0.32	0.17	0.12	0.01
May	0.15	0.10	0.13	0.06	0.21	-0.12

Interior Alaska Jun-Jul CFSv2 Ensemble Mean Lightning Predictors vs. Observations



- Correlations between CFSv2 ensemble mean and reanalysis predictor variables by PSA and averaged over Interior Alaska show positive correlation between convective precipitation and 850-500hPa dT with lower values for dewpoint and temperature
- Lowest correlation for 500hPa heights
- Low model skill makes producing lightning outlooks difficult

Summary

- Bias corrections required for CFSv2 to reproduce CFFWIS observed magnitudes
- Quantile mapping of daily temperature and precipitation used for correction
- Weekly lightning prediction regressions produced for each PSA using reanalysis
- Low predictability with CFSv2 is a barrier for seasonal lightning and CFFWIS outlooks
- CFSv2 predictions of Jun-Jul 500hPa height have the lowest skill of all lightning predictors evaluated

Next Steps:

- CFSv2 hindcast evaluation by PSA to assess forecast skill
- Spatial evaluation of CFSv2 lightning predictor variables vs. reanalysis
- Fire managers want gridded outlooks: how can we provide those?

References

- Bieniek, P. A., U. S. Bhatt, J. E. Walsh, T. S. Rupp, J. Zhang, J. R. Krieger, and R. Lader, 2016: Dynamical downscaling of ERA-Interim temperature and precipitation for Alaska. *J Appl Meteor Climatol*, 55:635-654.
- Sampath, A., U. S. Bhatt, P. A. Bieniek, A. York, R Ziel, R. Thoman, and H. Strader, 2018: Seasonal forecasting for fire weather in Alaska. In prep.

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