Fire weather forecasting in Alaska on the seasonal and sub-seasonal scale

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8th Arctic Climate Forum
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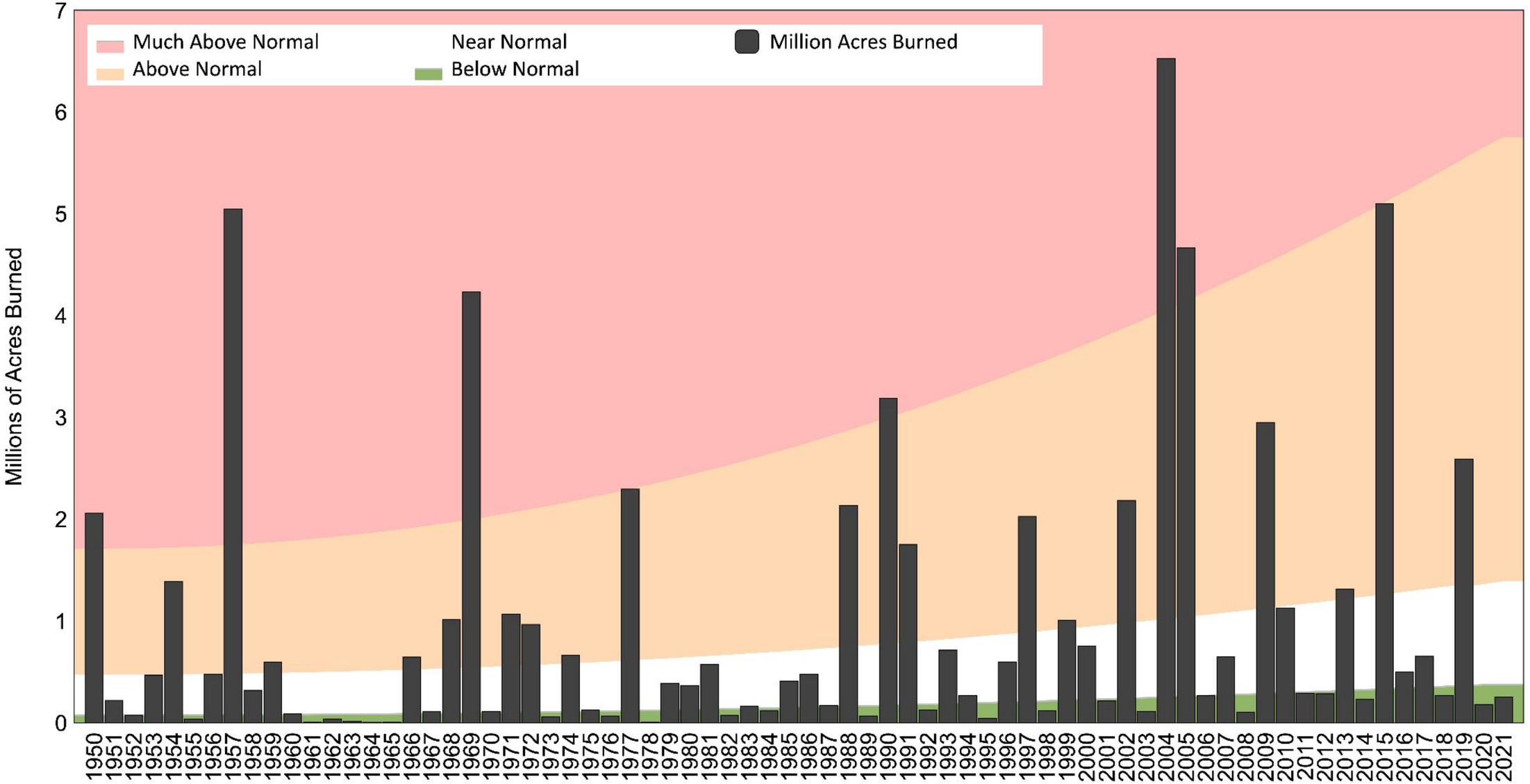
Yankovich Road Fire, credit: Alaska Fire Service

Munson Creek Fire 2021, credit: Alaska Division of Forestry

Haystack fire, evening of 6/15. credit: Casey Boespflug

Larger fire seasons becoming more common



Millions of Acres Burned in Alaska from 1950-2021 (Credit: Bhatt & Thoman)

Three items are needed for wildland fire

Weather

Ignition

Fuel

Slide from Scott Rupp

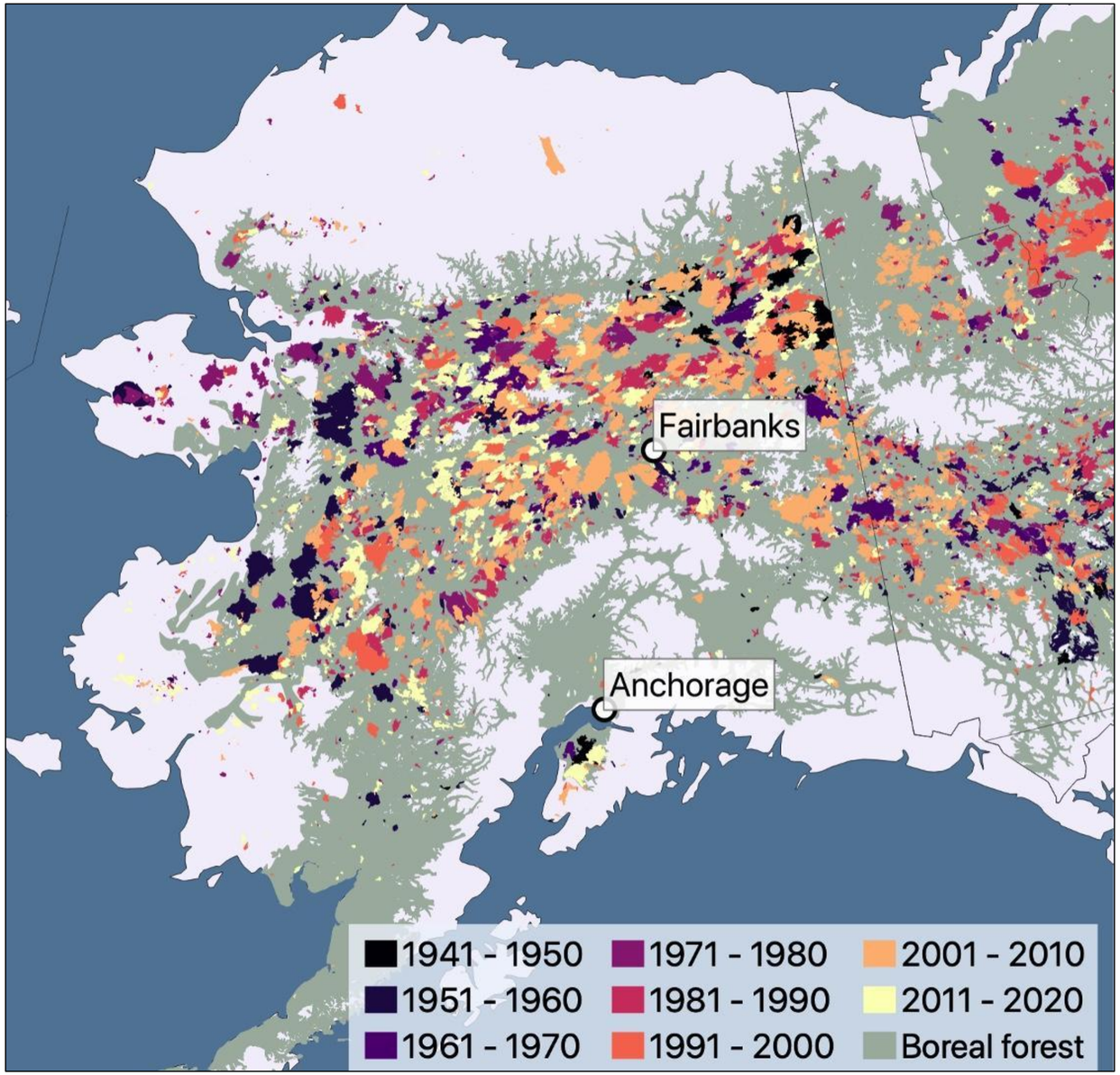
Ecological Drought: Impacts, Resistance, Recovery

The fuels are on the ground in Boreal Forest

(Credit: York & Jandt)

A "duff plug" from a black spruce stand; its accumulated dead feather mosses are key to carrying fire in boreal landscapes

Spatial Boreal Fire History



Burned land area by decade.

Credit: Chris Waigl

Can We Predict Summer Fire Weather?

- **Goal:** ***Use March seasonal forecasts to provide an outlook for the summer fire season***

- 3 global seasonal forecast models:
  - NOAA CFSv2
  - ECMWF SEAS5
  - Météo France Sys 6/7

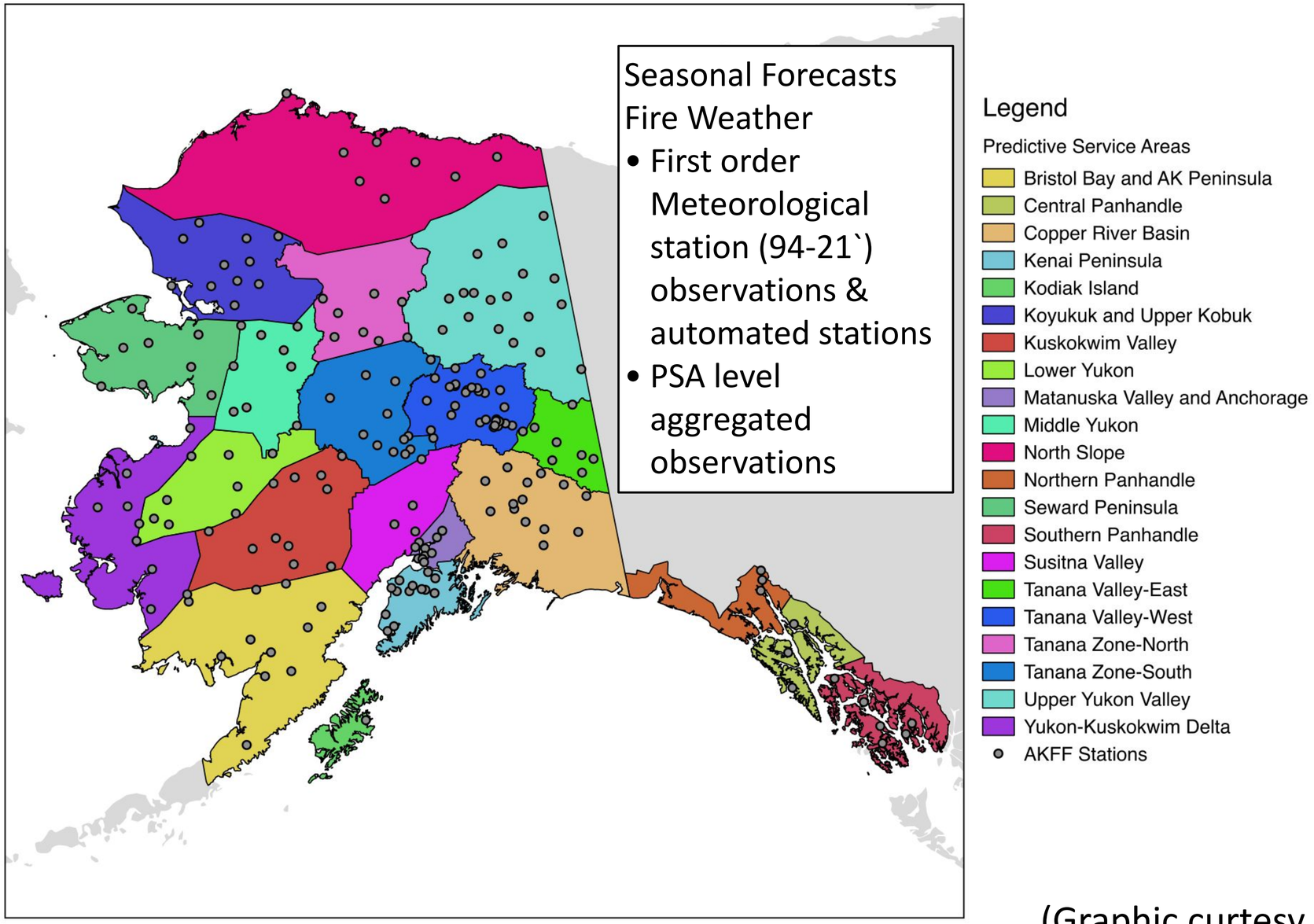
- Forecasts of:
  - Temperature
  - Precipitation
  - RH

Ensemble forecasting.

https://www.ecmwf.int/en/about/media-centre/focus/2017/fact-sheet-ensemble-weather-forecasting

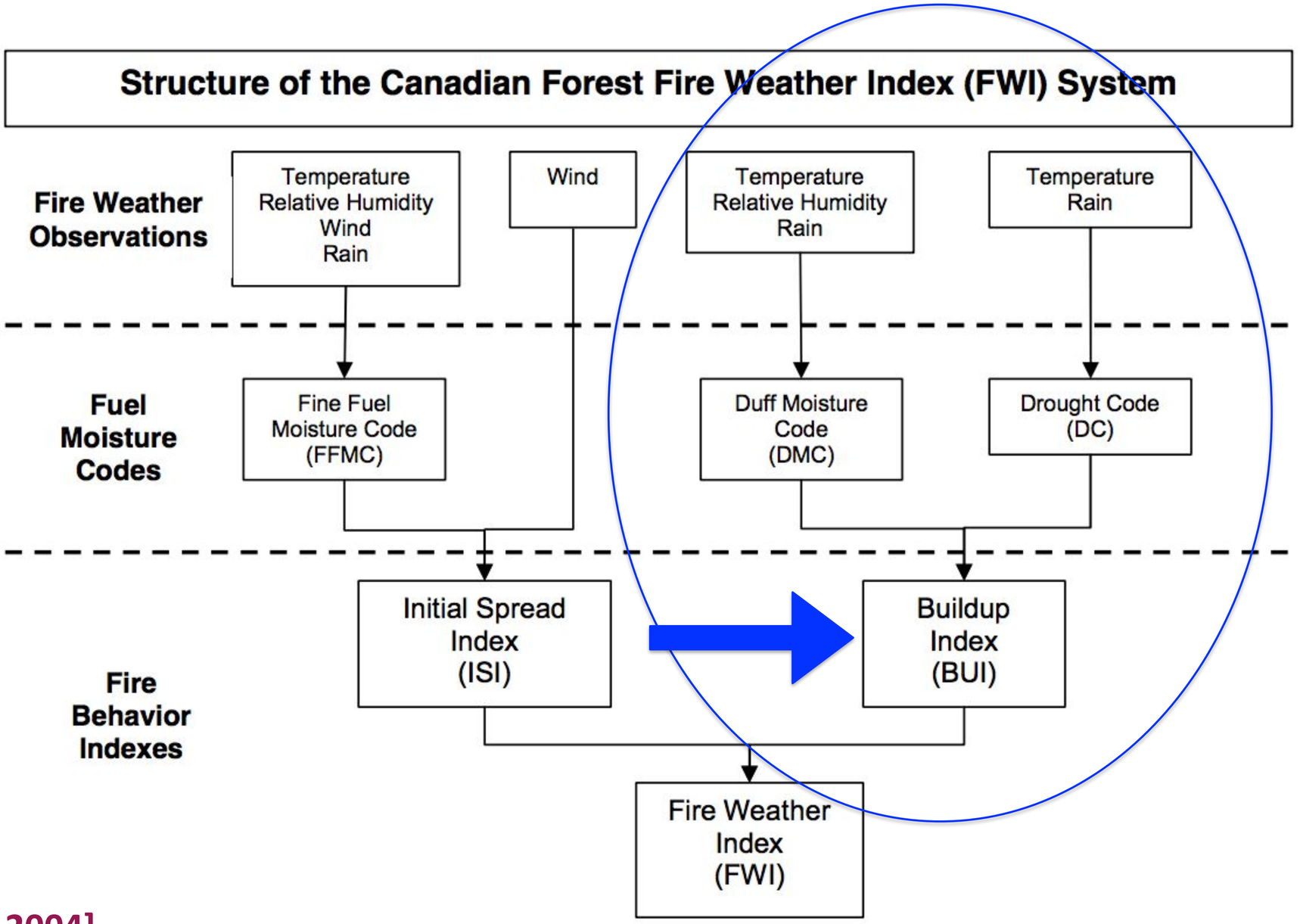
Sampath et al. 2021 - showed that skill of CFSv2 BUI forecast increased through bias corrections of T and P using quantile mapping.

Forecast prepared based on Fire manager needs: March initialized and Regionally



(Graphic curtesy of P. Bieniek)

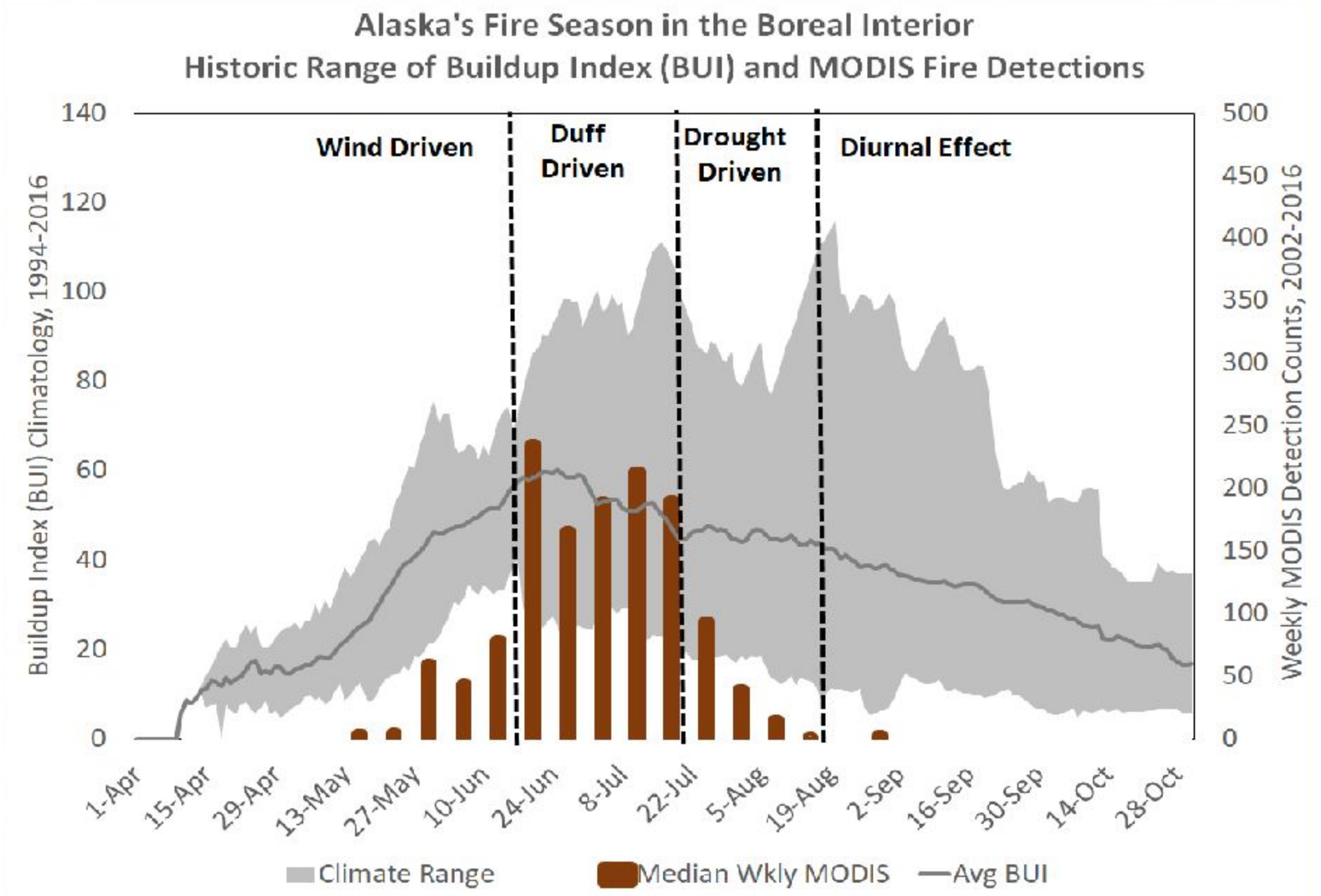
Canadian Forest Fire Weather Index System



[De Groot 2004]

Evolution of Alaska Fire Season

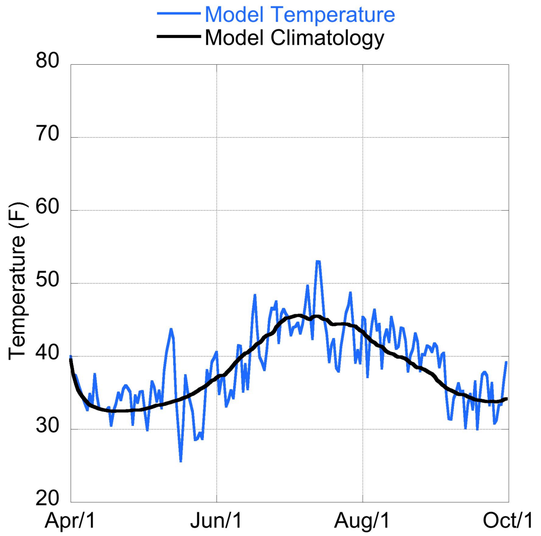
Buildup Index (grey) seasonal cycle

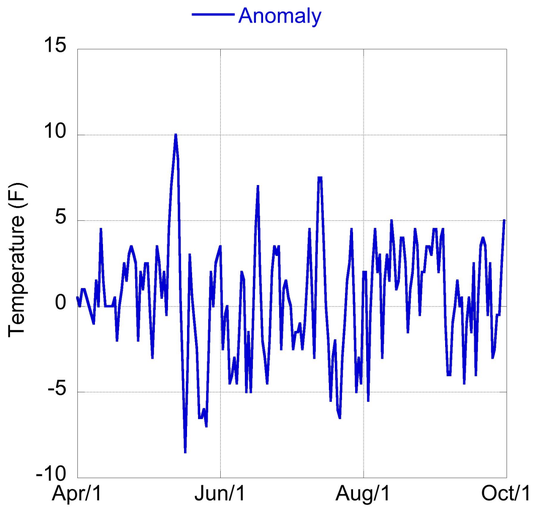


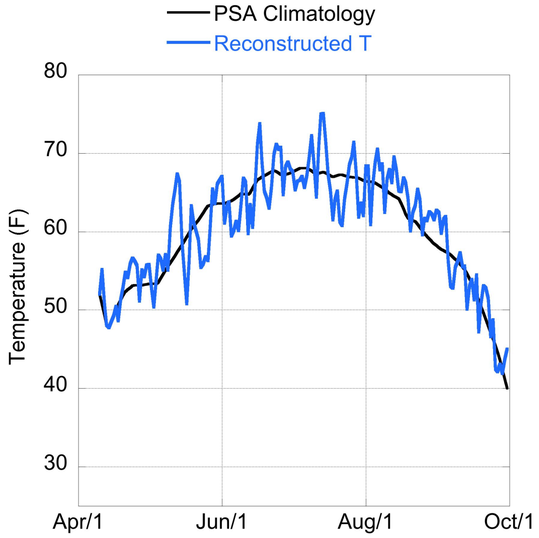
Adapted from Dan Burrows.

Models Do Not Capture Alaska Temp., Precip. Well

- Models tend to be too cold, too wet over Alaska - apply Delta Method
  - Model T - Model Clim. = Anomaly
  - Anomaly + PSA Clim. = Reconstructed T
- Use reconstructed data to calculate rel. hum., BUI

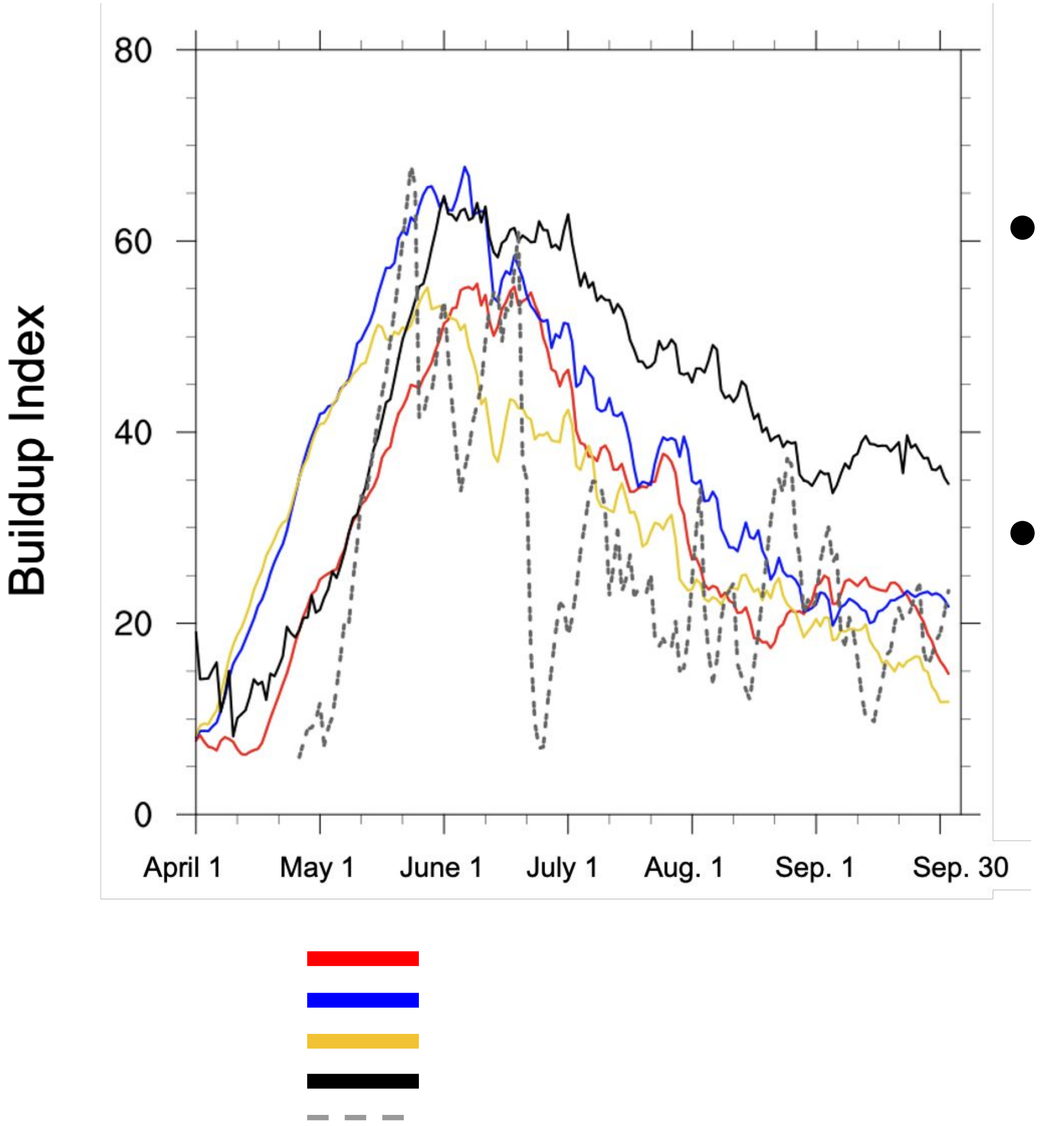






NOAA CFSv2
ECMWF SEAS5
MF Sys. 7
PSA climatology
PSA observed

2020 Outlook for Tanana Valley West PSA



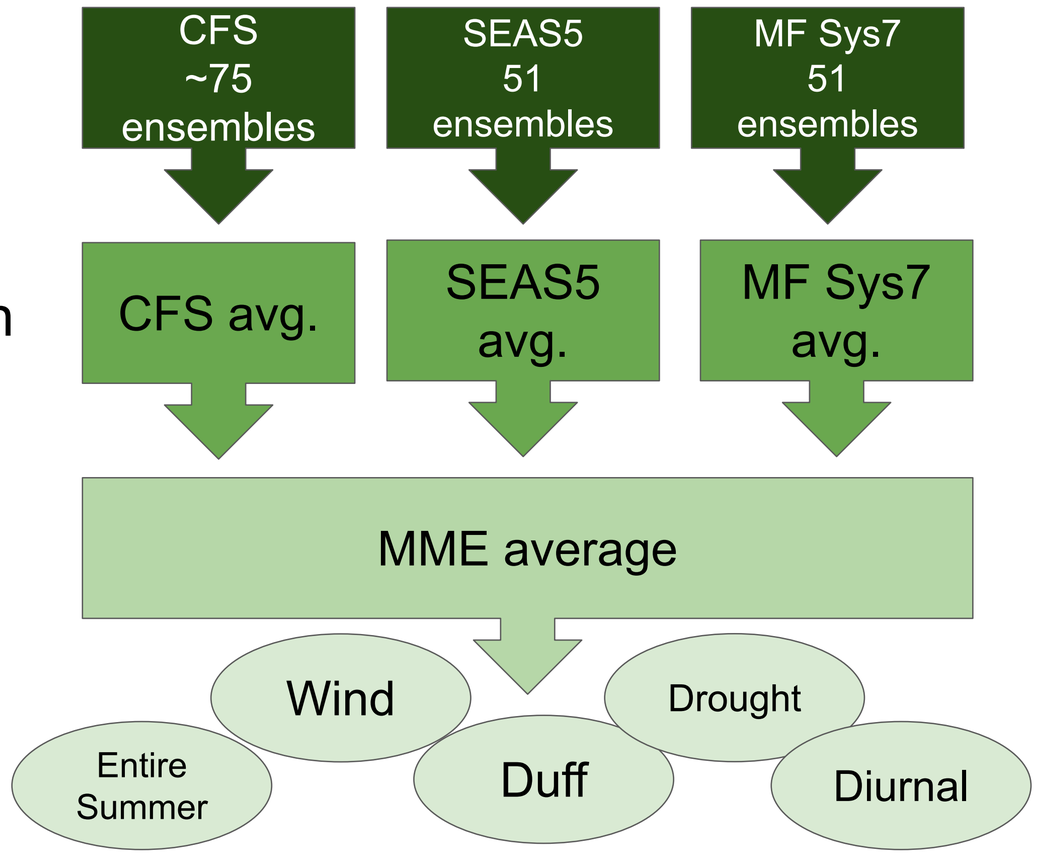
- 2020 models forecasted BUI values below climatology, but were higher than actual observations
- Did capture the early peak in BUI in May and small peaks in June and August

Borries-Strigle et al. 2021, *in prep*

Multi-model Ensemble Forecasting Process

To create forecasts:

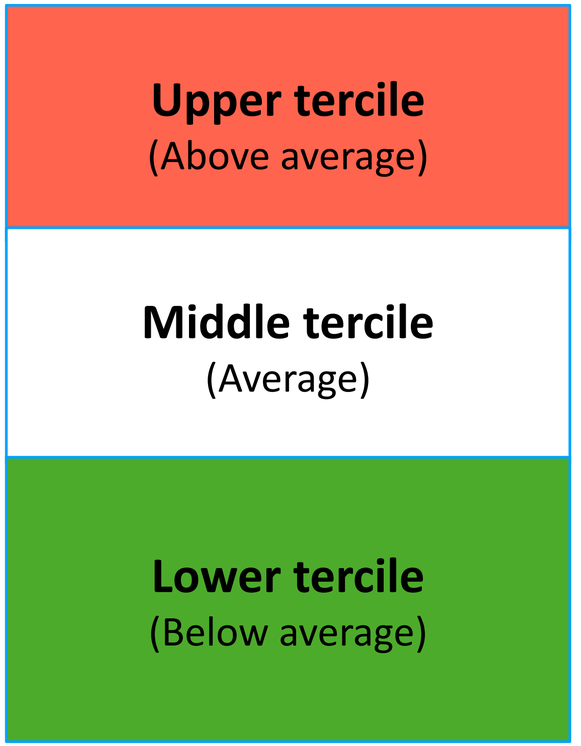
1. Calculated daily BUI from each model for April 1 - September 30
2. Averaged ensembles in each model
3. Averaged three models together for MME average
4. Averaged daily BUI for each time period of interest



Borries-Strigle et al. 2021, *in prep*

Forecast 3 Categories and Evaluate Forecast Skill

- Separate model BUI and observed BUI into terciles
- ***If the models forecast BUI in the upper tercile, in what tercile did the observed BUI fall?***
- ROC skill score - hit rate vs. false alarm rate, score > 0.5 shows skill
- Calculate skill for entire fire season as well as the four sub-seasons



Bottom line on forecast skill:

- Skill depends on fire sub-season and PSA
- Summer as a whole and cumulative drought season performed best
- Combining average of each model into MME increases forecast skill

Borries-Strigle et al. 2021, *in prep*

2021 Results: Full Season (April 1 - Sep. 30)

2021 MME BUI Forecast

Below average BUI

Average BUI

Above average BUI

PSA not in study

Forecast skill for PSA

2021 forecast matches observations

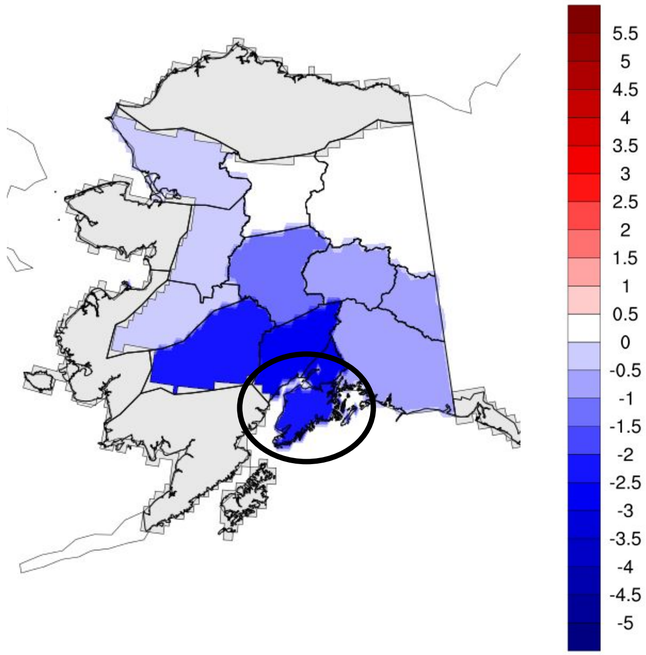
2021 Observed BUI

Borries-Strigle et al. 2021, *in prep*

2021 Results: Full Season (April 1 - Sep. 30)

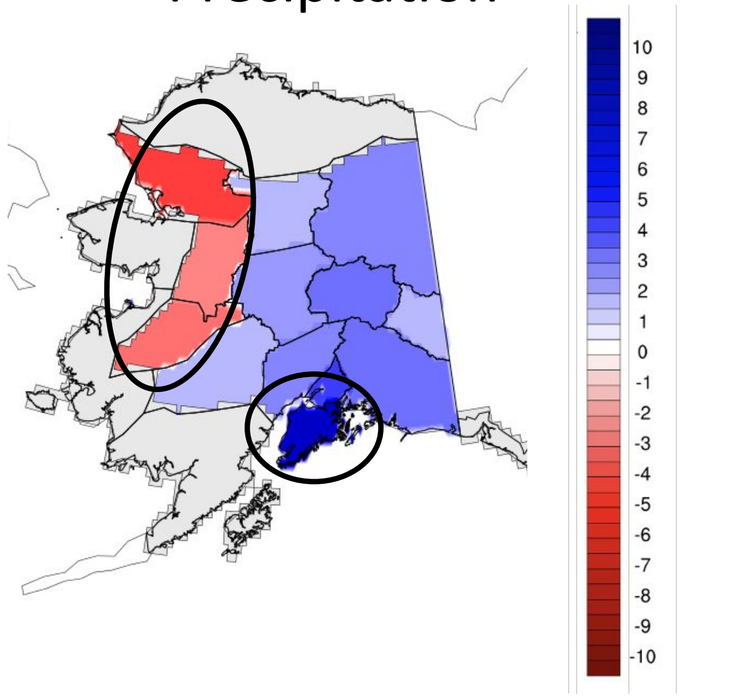
MME Forecast Minus Observations

Temperature



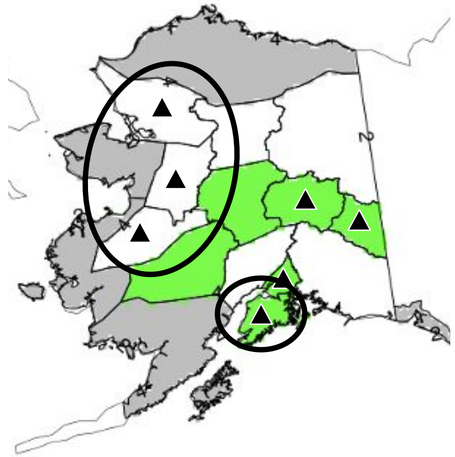
°F

Precipitation

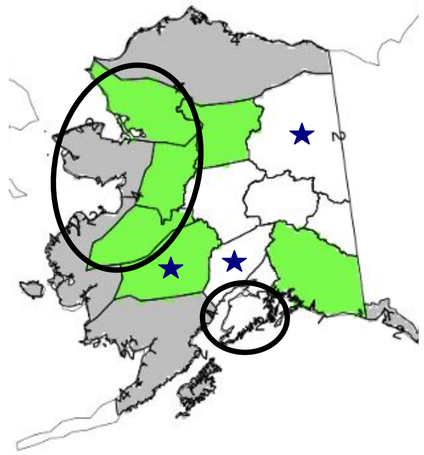


0.01” per day

Forecast



Observed



Blue - Models too cold, too wet compared to observations

Red - Models too hot, too dry compared to observations

Borries-Strigle et al. 2021, *in prep*

2021 Results: Duff-Driven Season (June 11 - July 20)

Below average BUI

Average BUI

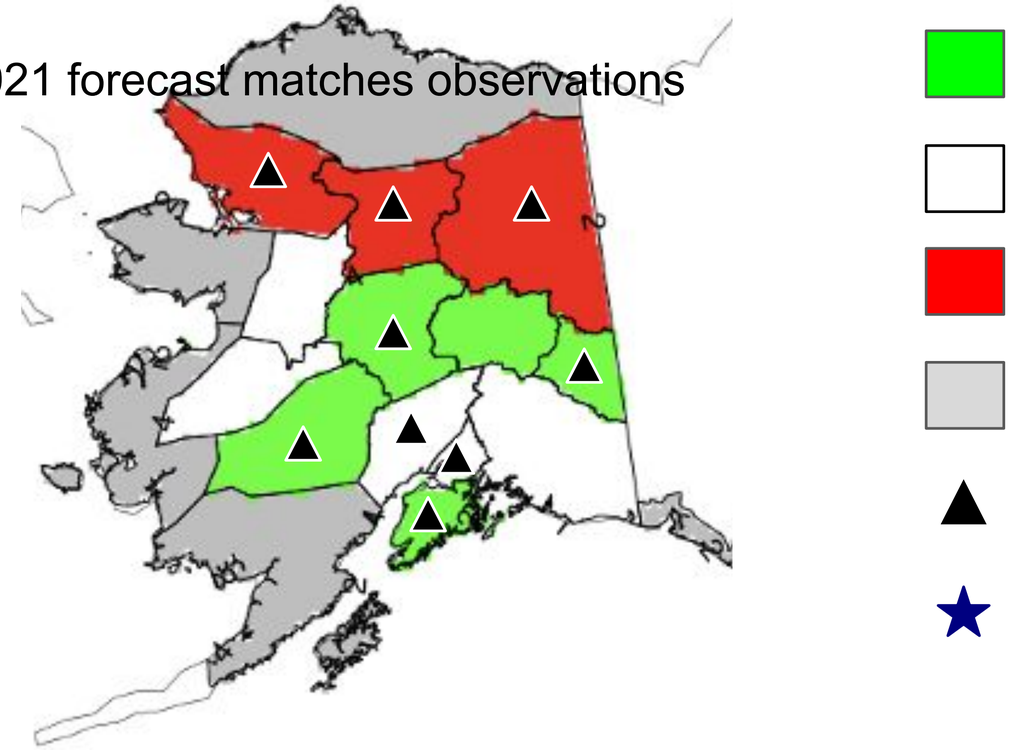
Above average BUI

PSA not in study

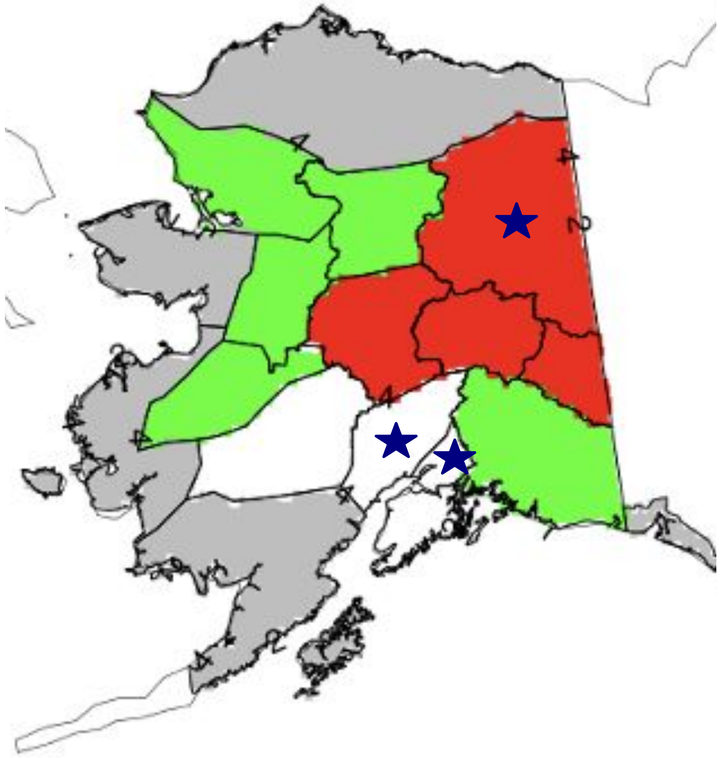
Forecast skill for PSA

2021 forecast matches observations

2021 MME BUI Forecast



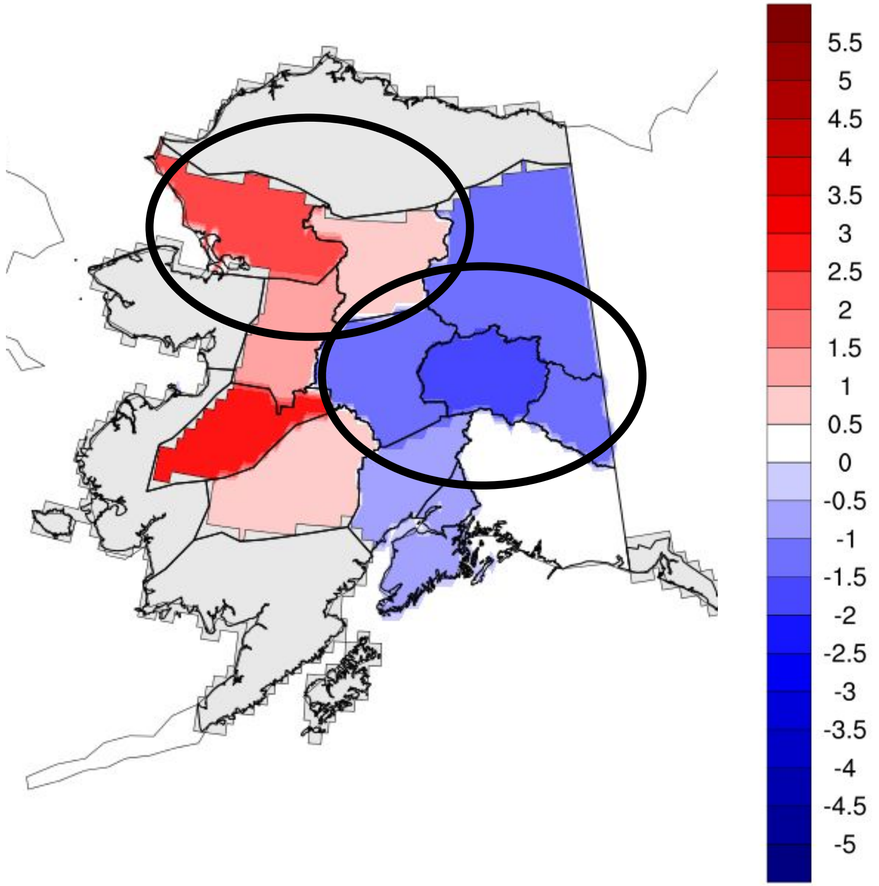
2021 Observed BUI



2021 Results: Duff-Driven Season (June 11 - July 20)

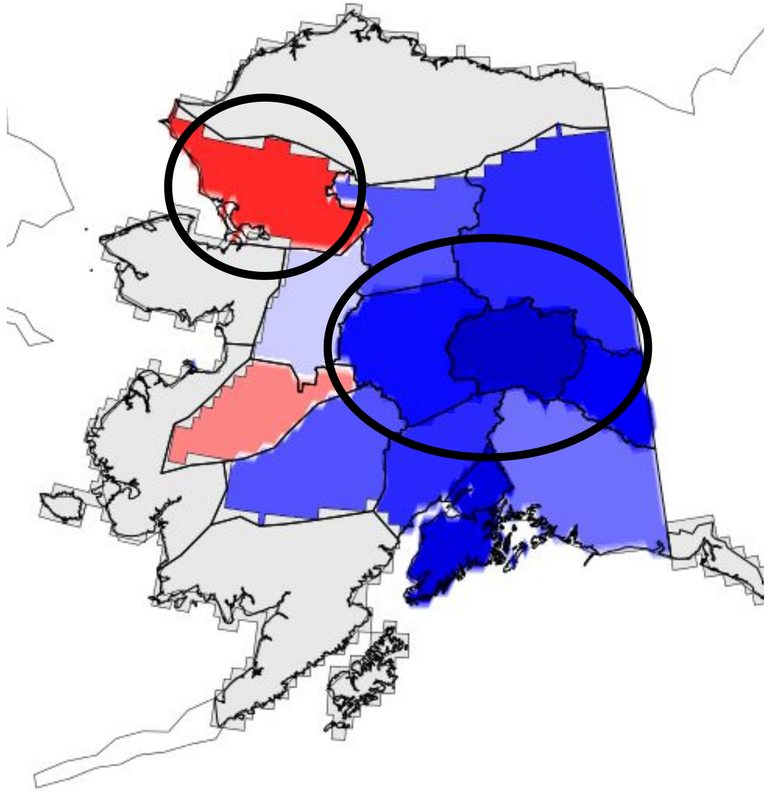
MME Forecast Minus Observations

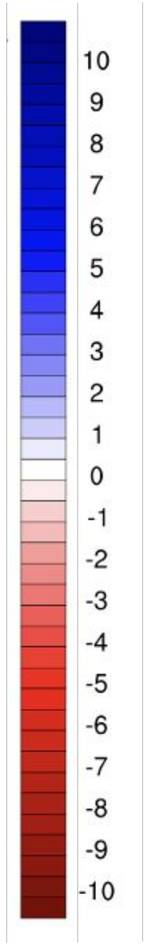
Temperature



°F

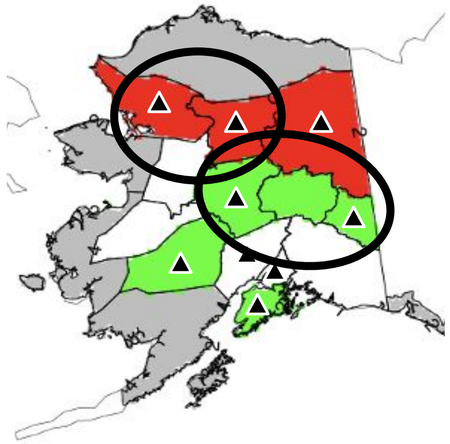
Precipitation



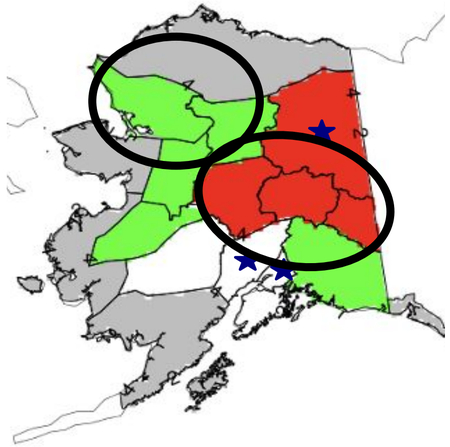


0.01” per day

Forecast



Observed



Multimodel Forecast Increases Skill => Higher ROC scores for MME

	NOAA CFSv2				ECMWF SEAS5				MeteoFrance Sys 6				MME			
Tercile	Upper		Lower		Upper		Lower		Upper		Lower		Upper		Lower	
Season	Duff	Drought	Duff	Drought	Duff	Drought	Duff	Drought	Duff	Drought	Duff	Drought	Duff	Drought	Duff	Drought
AK01W	0.37	0.46	0.36	0.58	0.48	0.51	0.51	0.52	0.53	0.48	0.41	0.53	0.39	0.28	0.44	0.66
AK01E	0.57	0.49	0.49	0.49	0.46	0.53	0.52	0.54	0.53	0.47	0.50	0.43	0.44	0.61	0.83	0.41
AK02	0.64	0.46	0.37	0.51	0.49	0.53	0.47	0.51	0.52	0.53	0.59	0.56	0.59	0.62	0.47	0.42
AK03N	0.49	0.45		0.49	0.52	0.51	0.51	0.53	0.43	0.45	0.50	0.38	0.61	0.43	0.59	0.38
AK03S	0.40	0.58	0.37	0.53	0.46	0.48	0.35	0.59	0.38	0.38	0.48	0.52	0.38	0.32	0.57	0.63
AK04	0.72	0.43	0.27	0.51	0.46	0.44	0.49	0.57	0.43	0.53	0.47	0.51	0.61	0.55	0.42	0.40
AK05	0.33	0.58	0.42	0.50	0.51	0.48	0.50	0.55	0.34	0.52	0.51	0.50	0.31	0.54	0.50	0.69
AK07	0.33	0.46	0.29	0.45	0.47	0.48	0.47	0.50	0.44	0.53	0.60	0.43	0.46	0.49	0.68	0.54
AK09	0.53	0.54	0.09	0.49	0.39	0.42	0.46	0.57	0.45	0.43	0.53	0.46	0.33	0.52	0.60	0.53
AK11	0.66	0.51	0.40	0.50	0.40	0.50	0.63	0.51	0.47	0.51	0.52	0.51	0.60	0.62	0.59	0.60
AK12	0.44	0.56	0.44	0.51	0.44	0.44	0.49	0.56	0.46	0.48	0.51	0.47	0.36	0.74	0.27	0.75
AK13	0.48	0.51	0.46	0.44	0.54	0.41	0.46	0.56	0.48	0.50	0.43	0.40	0.66	0.43	0.57	0.66
AK14	0.49	0.43	0.43	0.48	0.44	0.52	0.57	0.45	0.56	0.51	0.52	0.47	0.6	0.45	0.53	0.73

Table 1. ROC Skill scores for the duff-driven and cumulative drought fire seasons for Predictive Service Areas (PSAs) in Alaska in the upper and lower BUI terciles and by model. Highlighted skill scores show scores greater than 0.50 (green 0.51-0.54, yellow 0.55-0.64, light orange 0.65-0.74, dark orange >0.75).

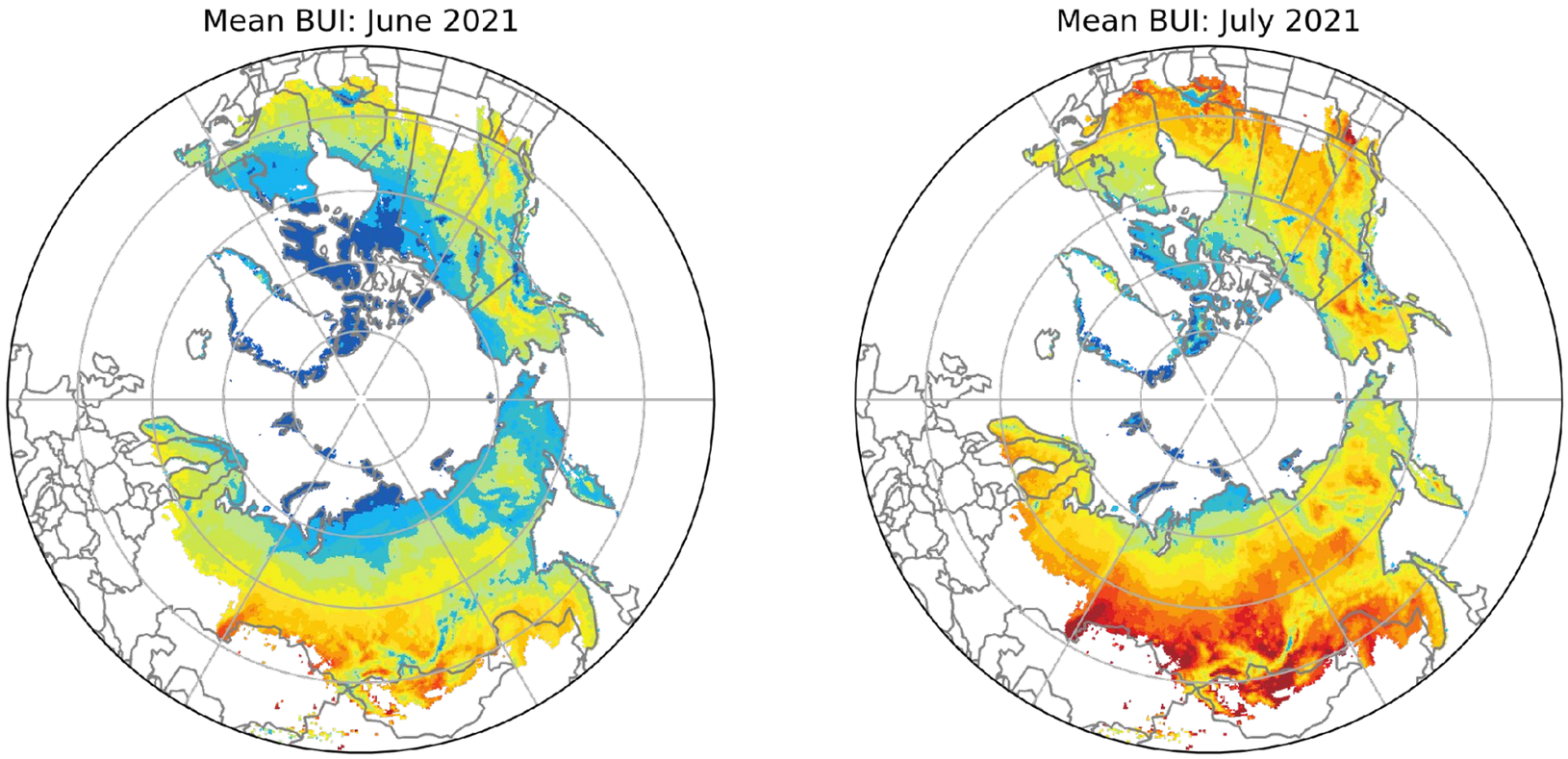
Take home points

- Skill varies by PSA/subseason (best: drought)
- Skill primarily in upper and lower BUI terciles

- Skill scores increase in MME for all terciles
- Increase in number of PSAs/time periods with skill in upper and lower terciles

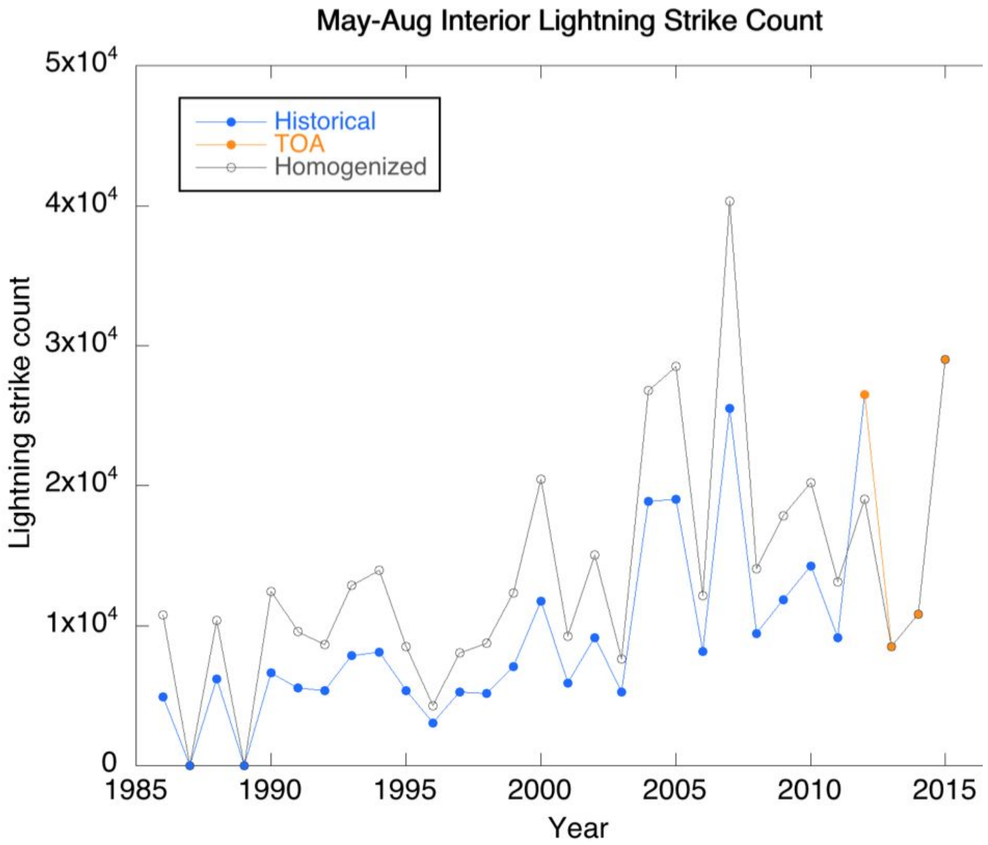
Borries-Strigle et al. 2021, *in prep*

Observational analysis to understand predictability of summer weather in Alaska

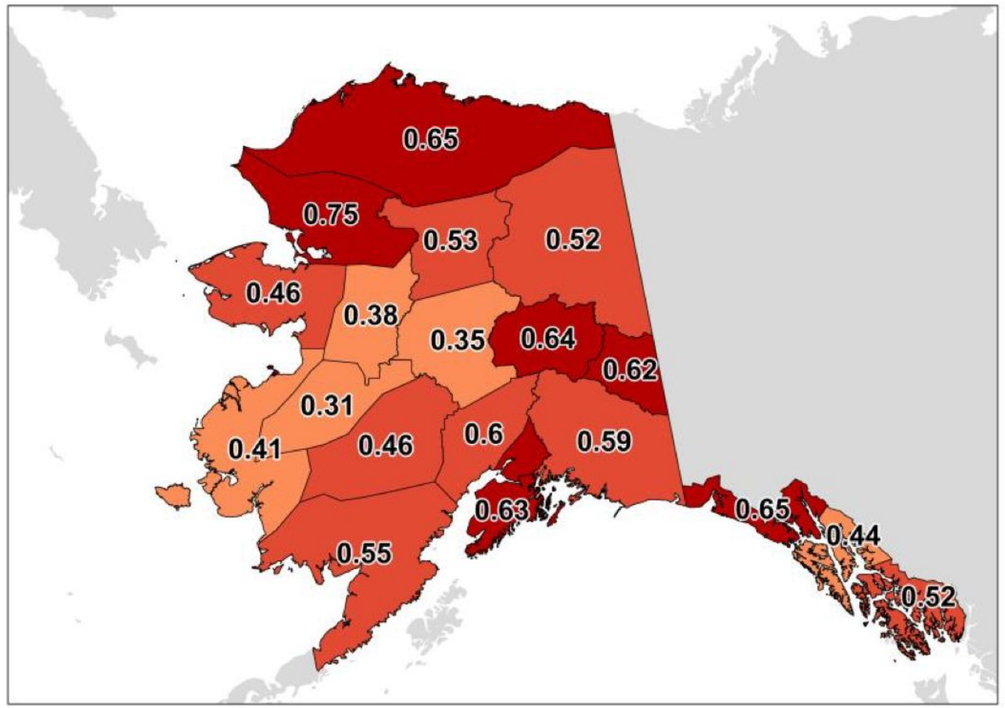


E. Fischer & Frankenstein postdoc

At seasonal scale regression model built for lightning strike count using reanalysis convective precipitation, 850-500hPa delta T, 2m dew point, T2m and 500hPa Z



Homogenization of Lightning Data



Correlation between regression-based and observed lightning strike count

[Bieniek et al 2020]

Conclusions and Takeaway Points

- Co-production requires time but makes outcomes relevant. (Request for May initialized forecasts & subseasonal 3d-3w)
- Identify the predictability in system for AK summer weather to increase skill. Extend to sub-season 3 days - 3 weeks
- Lightning likelihood has links to meteorology in observations, need to associated with synoptic patterns and need to explore within the context of forecasts
- Ultimate goal is to produce a seasonal outlook that includes information on climate, lightning risk and fuel conditions.

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