Predicting Summer Wildfire Activity in Alaska Using Seasonal Forecasts at a 3-month Lead

C Borries-Strigle[1], US Bhatt[1], PA Bieniek[2], R Ziel[2], H Strader[3], E Stevens[3], AS York[2], R Thoman[4]

[1]Geophysical Institute, U Alaska Fairbanks (UAF), [2]International Arctic Research Center, UAF, [3]Predictive Services, Fairbanks AK, [4]Alaska Center for Climate Assessment and Policy, UAF

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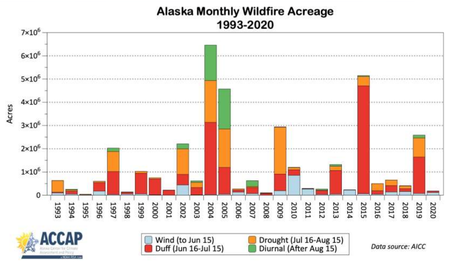
Main Results

- *Fire managers identified the need for information in late March for upcoming fire season to motivate this work*
- *Seasonal forecasts using CFSv2, ECMWF, and MétéoFrance show skill for fire weather indices*
- *Model skill varies within the fire season with greatest skill during drought, diurnal seasons and in MétéoFrance model*

Motivation

Provide fire managers with skillful information about the upcoming fire season to aid in management decisions and allocate resources efficiently

- Peak of Alaskan fire season (1 Apr. – 30 Sep.) usually in June-late July
- Summer 2019 had two anomalous and costly late season fires in August
- With an increase in temperatures, fire season is expected to be longer with enhanced fire activity and rising fire suppression costs
- Canadian Fire Indices (Buildup Index) used by fire management community to evaluate fire likelihood and related to largest acres burnt (Partain et al. 2016, Ziel et al. 2020)



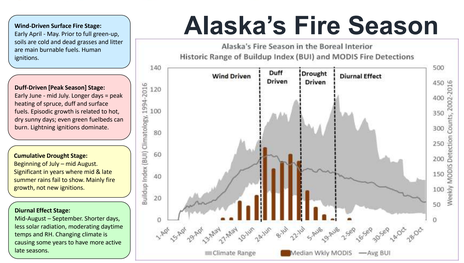


Figure 1. top: Alaska wildfire acreage burned by year and by fire subseason (Credit: R. Thoman). bottom: Definition of subseason, MODIS counts, & Buildup Index (Adapted from D. Burrows).

Data and Methods

Studying three seasonal forecast models: NOAA CFSv2, ECMWF SEAS5, and MétéoFrance Sys. 6/7

- Use March forecasts from seasonal forecast models to prepare fire season outlook
- Calculate daily forecast Buildup Index (BUI) as given by Canadian Forest Fire Weather Index System at Predictive Service Area (PSA) level for each model
  - Fire behavior index calculated from Duff Moisture Code (DMC) and Drought Code (DC) -> temperature, precipitation, and relative humidity
  - Metric of how much fuel is available to burn
- Compare to daily observations from station data aggregated over PSAs in Alaska for fire season from 1994 to 2019

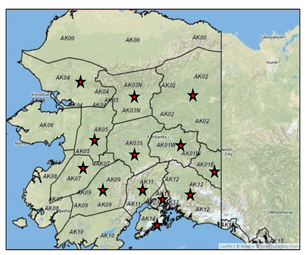
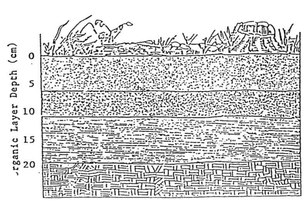


Figure 2. Map of Alaska Predictive Service Areas (PSAs). PSAs marked with a red star are included in this study. www.akff.mesowest.org



	Weight	Fuel Moisture Code
Duff Layer	5 t/ha	FFMC
Upper		
Middle	50 t/ha	DMC
Lower	440 t/ha	DC
Mineral Soil		

Figure 3. Forest floor fuels by Fuel Moisture Codes of the FWI System. From De Groot, 2004.

Seasonal Forecasts

- Models tend to overestimate precipitation and underestimate temperature for Alaska

Apply Delta Method to fix model biases of temperature and precipitation

$$T_{model} - T_{model\ clim.} = T_{anomaly}$$
$$T_{anomaly} + T_{obs\ PSA\ clim} = T_{reconstructed}$$

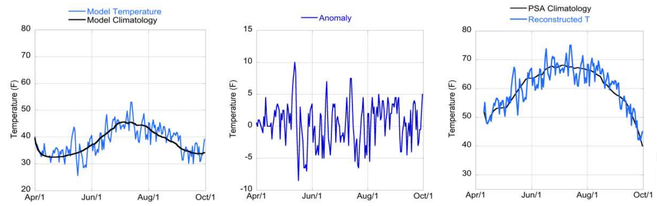


Figure 4. Schematic of Delta Method approach.

- Use reconstructed data sets in daily BUI calculations
- Compare to observed BUI values for each year, PSA
- Ex: Models did not capture the second peak in 2019 season for Kenai Peninsula (Fig. 5)

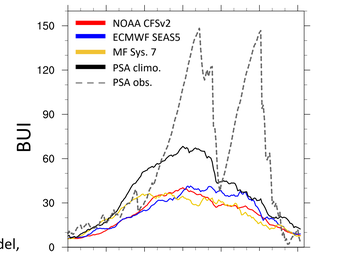


Figure 5. 2019 BUI forecasts for each seasonal forecast model, observed BUI, and PSA climatology for PSA AK14 (Kenai Peninsula).

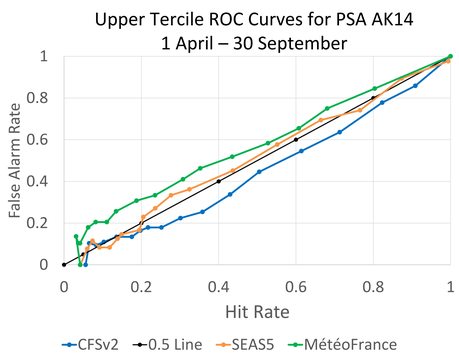
Forecast Skill

- Separate model BUI and observed BUI into terciles: upper, middle, lower
- Evaluate forecast skill with ROC curves and skill score
  - ROC curve: hit rate (HR) vs. false alarm rate (FAR) at different thresholds

$$HR = \frac{N_{hit}}{N_{hit} + N_{miss}} \qquad FAR = \frac{N_{false\ alarm}}{N_{false\ alarm} + N_{correct\ negative}}$$

  - ROC skill score = area under ROC Curve
  - Skillful if score > 0.5, high skill at 0.7 or greater
- Determine skill for each model, PSA, and fire subseason

Upper tercile BUI had most skill across all models



ROC Skill Scores	
CFSv2	0.45
SEAS5	0.51
MétéoFrance	0.57

Figure 6. ROC curves and corresponding ROC skill scores for the upper tercile BUI values for PSA AK14 (Kenai Peninsula) for the entire fire season (1 April – 30 September) for each seasonal forecast model.

Application: 2020 Outlook Example

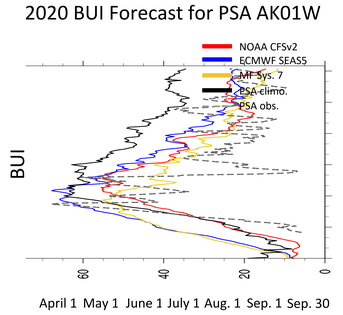


Figure 7. 2020 BUI forecasts for each seasonal forecast model, observed BUI, and PSA climatology for PSA AK01W (Tanana Valley West).

Provide outlook for 2020 summer fire season in April 2020 from March seasonal forecasts

- All models predicted below average BUI for most of fire season, but still in middle tercile
- Based on observations:
  - 2020 was a very low fire season
  - Peak occurred end of May
  - Observed BUI were in lower tercile for all subseasons except wind-driven

Models did not capture below avg. T for 2020, but did capture above avg. precipitation

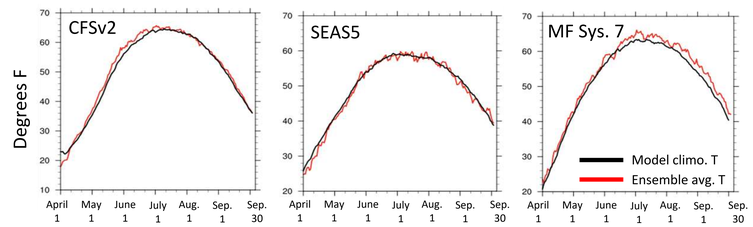


Figure 8. 2020 ensemble average temperature forecast for each model and model climatology for PSA AK01W.

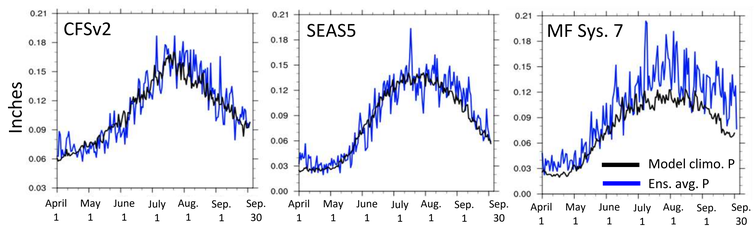


Figure 9. 2020 ensemble average precipitation forecast for each model and model climatology for PSA AK01W.

Summary & Next Steps

- Seasonal forecasts have potential to provide outlook for Alaska boreal wildfire season
- Combine models into MME and evaluate forecast skill
- Continue working with fire managers to determine best practices to communicate information and what information is useful

References

- De Groot, W, 2004: Interpreting the Canadian forest fire weather index (FWI) system, technical reference paper.
- JL Partain and coauthors, 2016: An assessment of the role of anthropogenic climate change in the Alaska fire season of 2015, Bulletin of the American Meteorological Society Special Report Explaining Extreme Events of 2015 from a Climate Perspective, S14-S18 pp.
- Ziel, R.H.; Bieniek, P.A.; Bhatt, U.S.; Strader, H.; Rupp, T.S.; York, A., 2020: *A Comparison of Fire Weather Indices with MODIS Fire Days for the Natural Regions of Alaska*. Forests 2020, 11, 516.

Acknowledgements

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