Combining seasonal forecasts into multi-model ensemble to increase forecast skill of Alaska summer fire weather

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Main Results

- Skill scores increase in MME (model average of 0.54 to MME average of 0.60)
- Number of Predictive Service Areas and time periods with skill increase in MME for upper and lower BUI terciles, but decrease in middle tercile
- Cumulative drought subseason (21 July – 9 August) performed best

Motivation

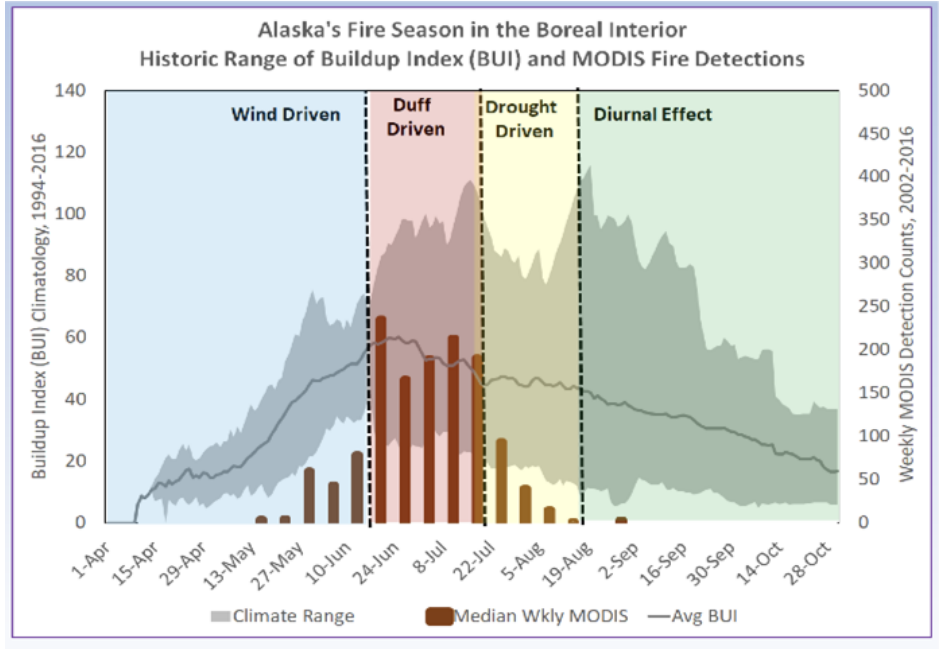

Figure 1. Seasonal cycle of Alaska Buildup Index climatology (1994-2016) with fire seasons delineated and MODIS weekly count climatology (2002-2012). Figure credit: Dan Burrows.

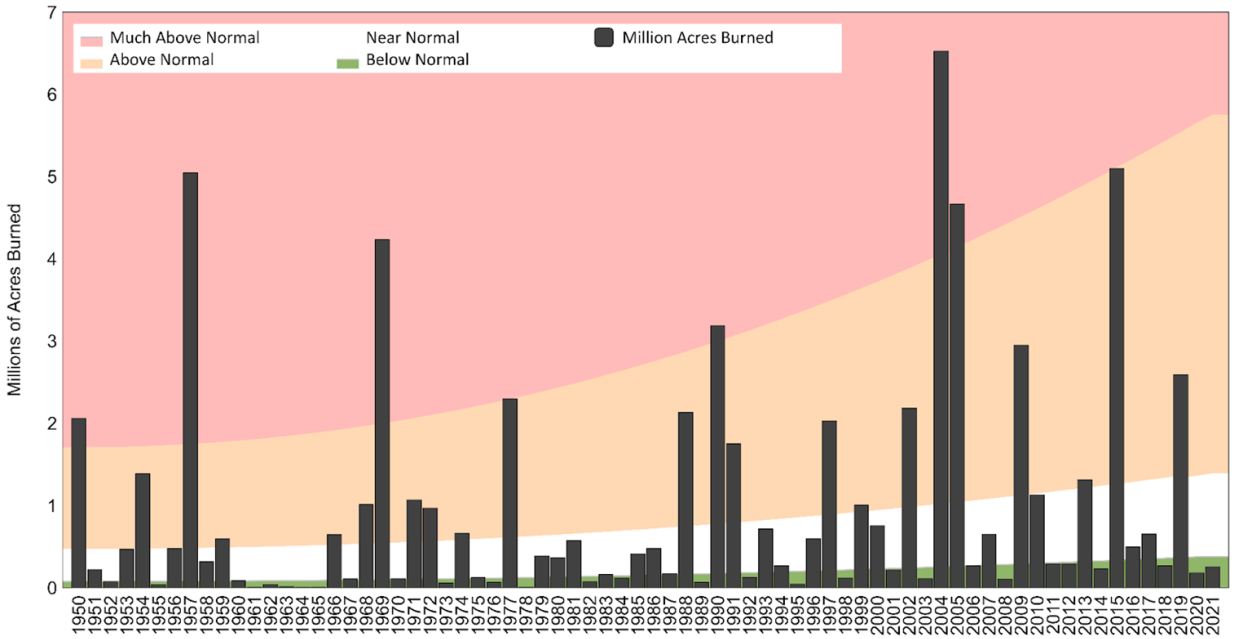

Figure 2. Annual millions of acres burned in Alaska from 1950-2021. Shaded areas show the 33rd (green), 66th (orange), and 90th (red) percentiles of acres burned. Figure credit: U. Bhatt and R. Thoman.

- Typical Alaska fire season spans 1 April – 30 September
- Peak in fire activity during duff-driven subseason (late June/early July)
- Increasing temperatures ➡longer fire season, earlier fire starts, larger and longer-burning fires

Research Goals

- Use March seasonal forecasts to create summer fire weather outlooks and evaluate forecast skill
- Share outlooks with Alaska fire managers to inform management decisions

Methods

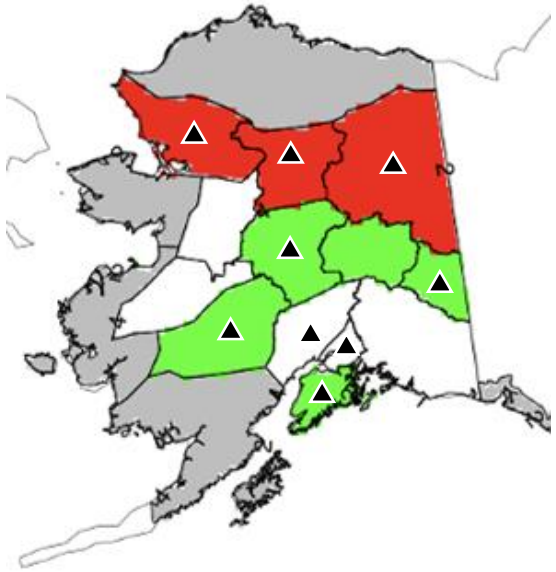

Figure 3. Map of 2021 duff-driven season MME forecast showing above average BUI (red), average BUI (white), and below average BUI (green). PSAs with triangles have skill for that tercile. PSAs in gray are not included in the study.

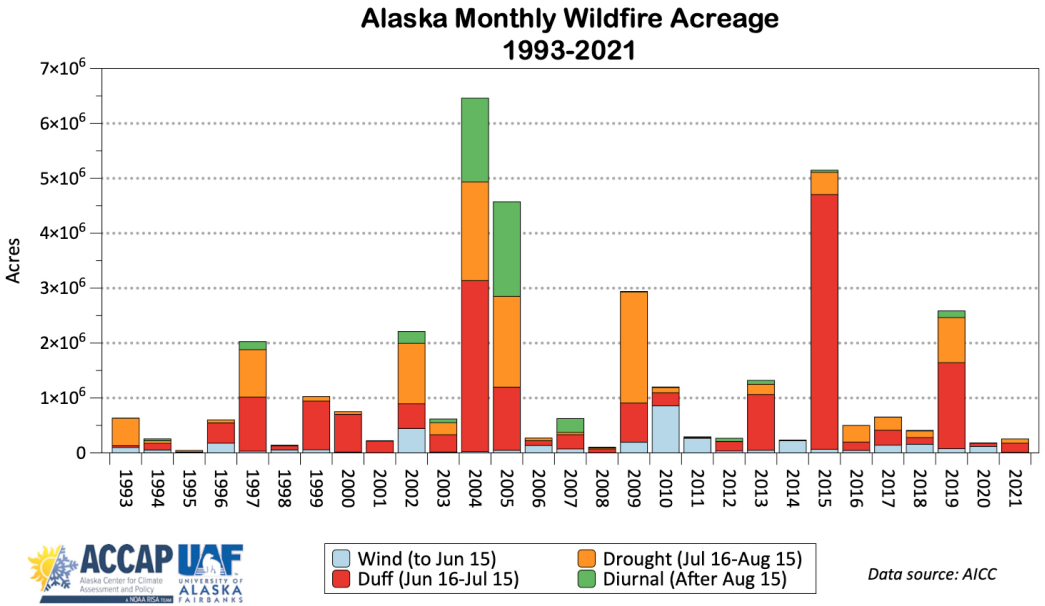

Figure 4. Number of acres burned in Alaska by fire subseason for 1993-2021. Figure credit: R. Thoman.

Time period for study: 1994-2019

Three seasonal forecast models:
- NOAA CFSv2
- ECMWF SEAS5
- MétéoFrance System 6

Temperature
Precipitation
RH

Calculate **Buildup Index (BUI)** as defined by the Canadian Forest Fire Danger Rating System

Evaluated forecast skill with ROC skill score by:
- model
- BUI tercile
- PSA
- Fire subseason

Create **multi-model ensemble (MME)** from model ensemble averages

Results

	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	0.44	0.57	0.47	0.56	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	0.54	0.53	0.44	0.54	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	0.52	0.44	0.52	0.46	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	0.48	0.46	0.47	0.45	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	0.48	0.56	0.40	0.52	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	0.38	0.47	0.39	0.47	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	0.36	0.49	0.45	0.44	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	0.49	0.46	0.39	0.57	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	0.39	0.55	0.54	0.59	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	0.46	0.51	0.45	0.56	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	0.47	0.57	0.50	0.48	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	0.49	0.49	0.54	0.54	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	0.48	0.47	0.57	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

Next Steps

- How to increase skill of forecasts?
  - Alaska climate/weather predictability
  - Drivers of skill during different subseasons
  - May-initialized forecast comparison
- Forecast analysis
  - 2020 versus 2021 fire seasons
  - Role of temperature, precipitation, and winds
- Continue working with fire management community to develop a product that is useful

Figure 5. Duff plug from a black spruce stand in Alaska.

Figure 6. Photo of the Swan Lake Fire on the Kenai Peninsula in 2019. Photo credit: Alaska Fire Service.

Acknowledgements:

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