

Fire and drought forecasting in the western US



Ronnie Abolafia-Rosenzweig (NCAR/RAL)

with contributions from
Dr. Cenlin He, Dr. Fei Chen and Jacob Ho

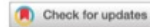


The western U.S. is experiencing severe drought and fire relative to 1000+ year paleorecords

nature
climate change

BRIEF COMMUNICATION

<https://doi.org/10.1038/s41558-022-01290-z>



Rapid intensification of the emerging southwestern North American megadrought in 2020–2021

A. Park Williams^{1,2}✉, Benjamin I. Cook^{2,3} and Jason E. Smerdon^{1,2}

A previous reconstruction back to 800 CE indicated that the 2000–2018 soil moisture deficit in southwestern North America was exceeded during one megadrought in the late-1500s. Here, we show that after exceptional drought severity in 2021, ~19% of which is attributable to anthropogenic climate trends, 2000–2021 was the driest 22-yr period since at least 800. This drought will very likely persist through 2022, matching the duration of the late-1500s megadrought.

due to abundant precipitation that year. Dry conditions returned in 2020 and intensified substantially in 2021, however, indicating that the turn-of-the-twenty-first-century drought is not over.

To understand the longer-term context of the turn-of-the-twenty-first-century drought in SWNA, Williams et al.⁵ extended the SWNA summer soil moisture record back to 800 CE using a tree-ring reconstruction and compared the observed drought of 2000–2018 to the infamous megadroughts that occurred



Rocky Mountain subalpine forests now burning more than any time in recent millennia

Philip E. Higuera^{a,1}✉, Bryan N. Shuman^b✉, and Kyra D. Wolf^a

^aDepartment of Ecosystem and Conservation Sciences, University of Montana, Missoula, MT 59812; and ^bDepartment of Geology and Geophysics, University of Wyoming, Laramie, WY 82071

Edited by Michael E. Mann, Pennsylvania State University, University Park, PA, and approved April 28, 2021 (received for review February 24, 2021)

The 2020 fire season punctuated a decades-long trend of increased fire activity across the western United States, nearly doubling the total area burned in the central Rocky Mountains since 1984. Understanding the causes and implications of such extreme fire seasons, particularly in subalpine forests that have historically burned infrequently, requires a long-term perspective not afforded by observational records. We place 21st century fire activity in subalpine

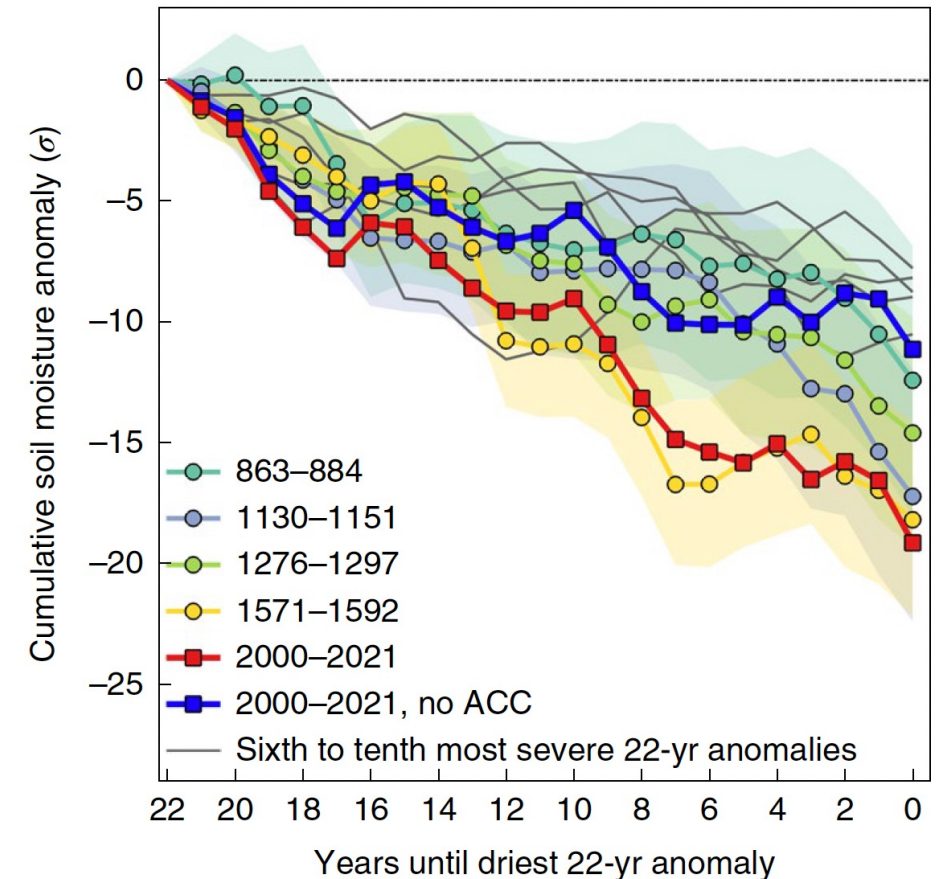
and Wyoming (Fig. 14), similar in size to the Greater Yellowstone Ecosystem.

Results and Discussion

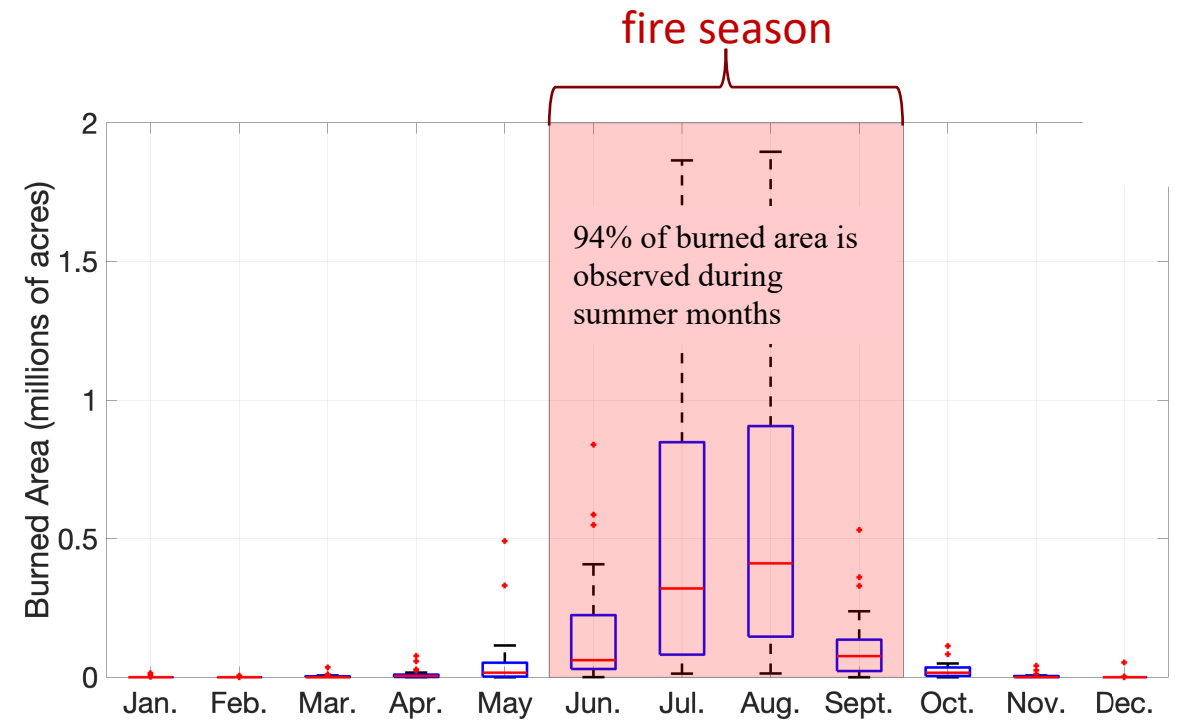
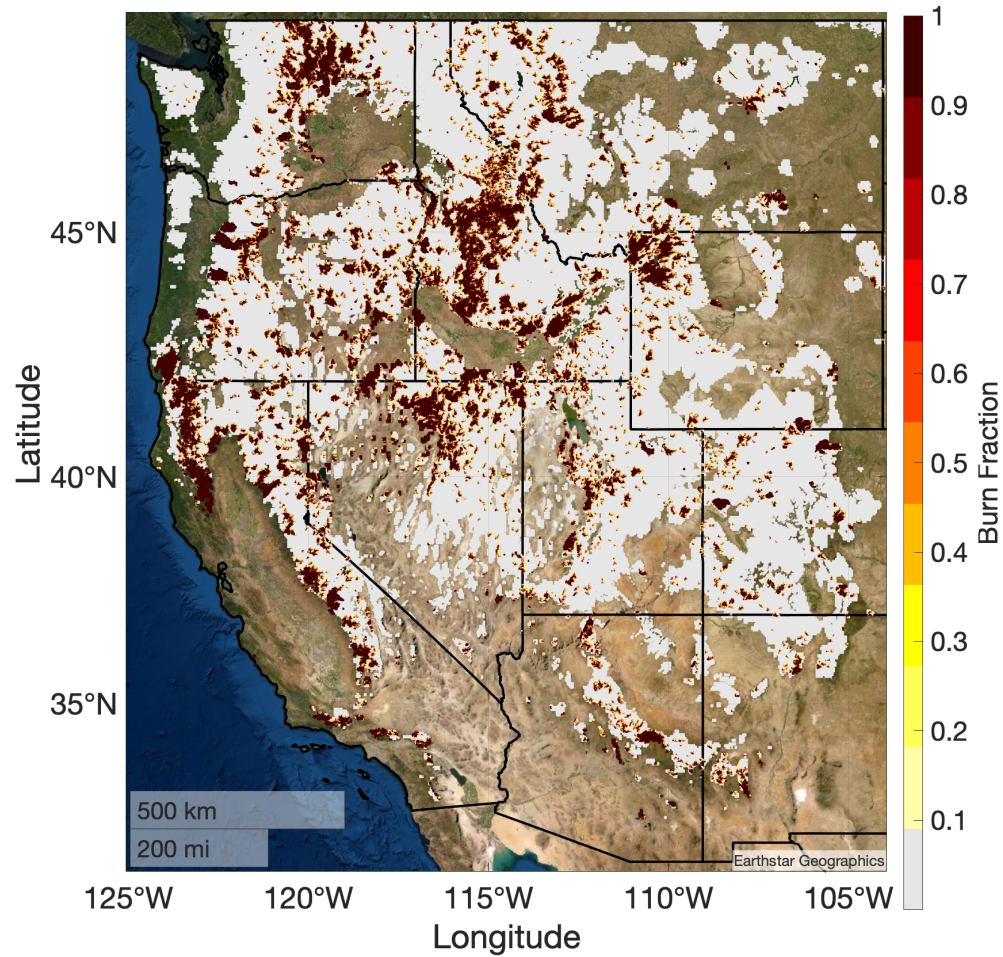
Area burned across all ecosystems in the central Rocky Mountains increased significantly since 1984 ($p = 0.40$, $P = 0.015$), a trend strongly correlated with average May to September vapor

Trajectories of most severe droughts since 800 (tree-ring paleorecord)

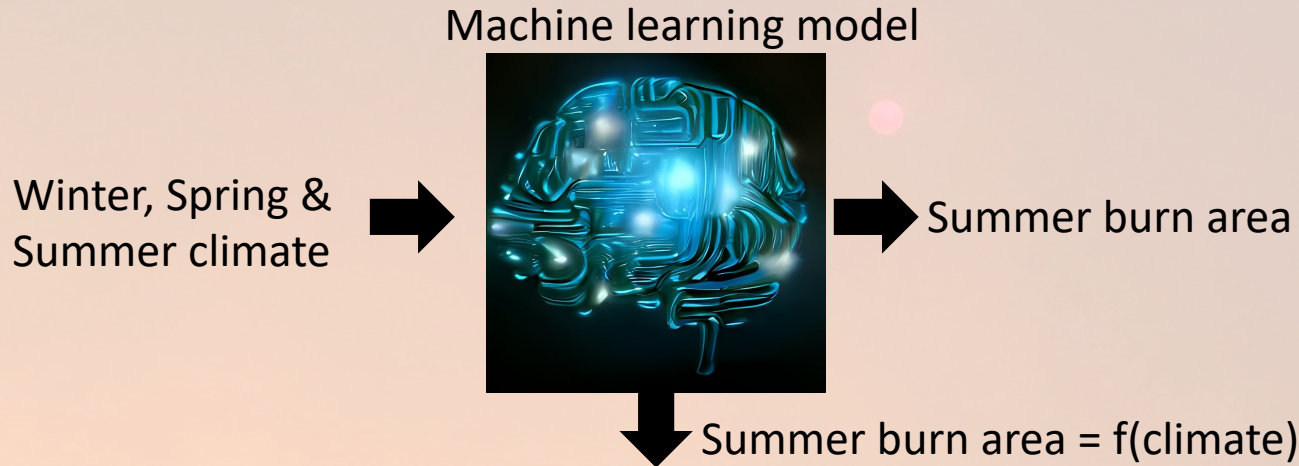
Development of driest 22-yr periods



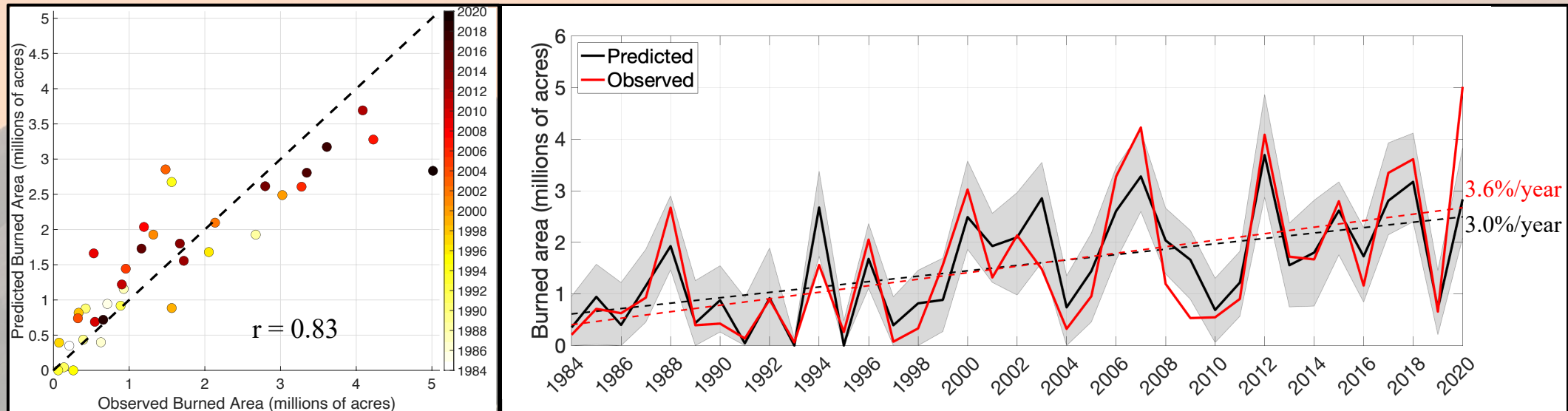
Western U.S. study domain and fire season



Coupling between summer climate conditions and fire extent in the western US



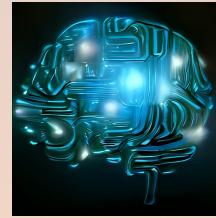
~70% of summer burned area variability & ~80% of trend is explained by pre-summer and summer climate



How much variability and trend in summer burned area is explained by only preceding climate conditions?

Generalized Additive Models

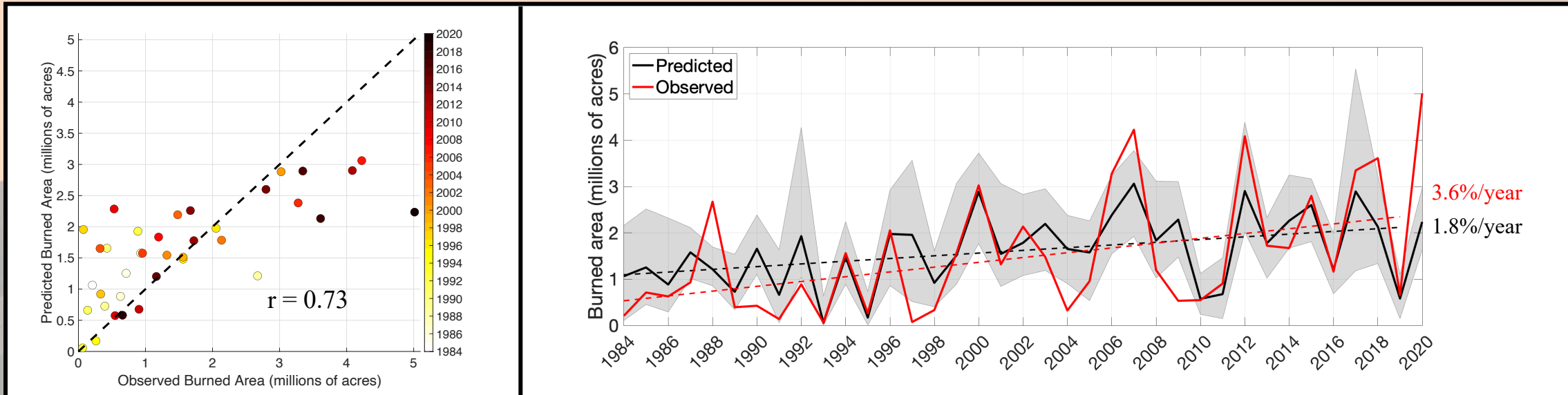
Winter & Spring
climate



Summer burn area

~ **50%** of summer burned area **variability & trend** can be explained by pre-summer climate

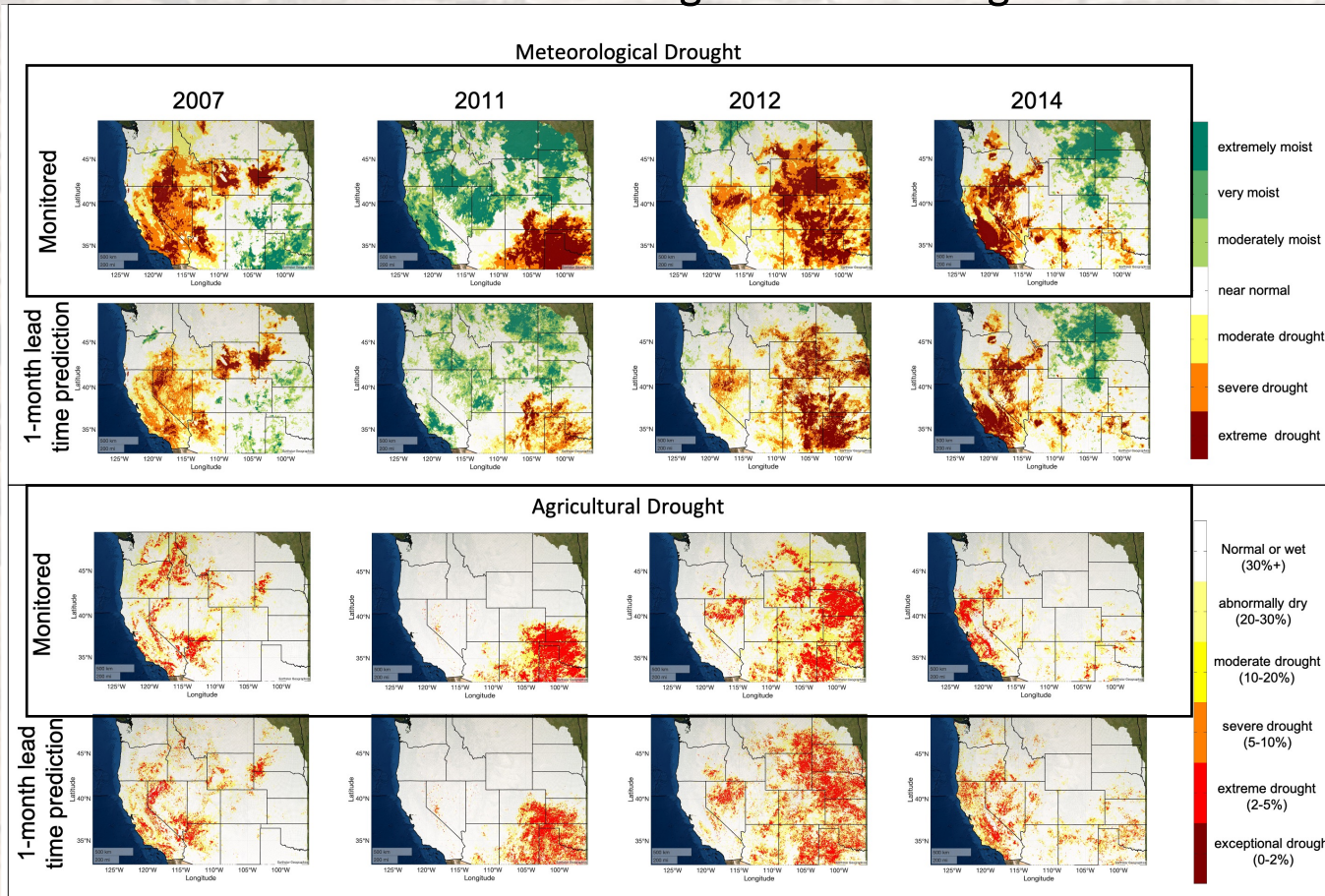
Predicting fire with pre-summer climate



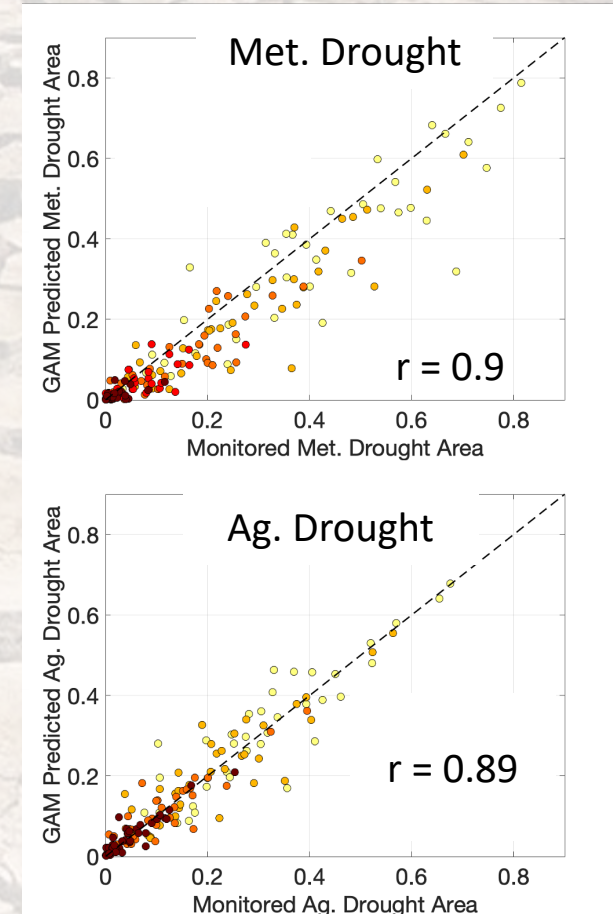
Results of cross validation from Abolafia-Rosenzweig et al. (2022, *ERL*)

The machine learning methodology is also able to forecast summer drought area and severity at a high-resolution (4km)

Monitored & Predicting Summer Drought Events

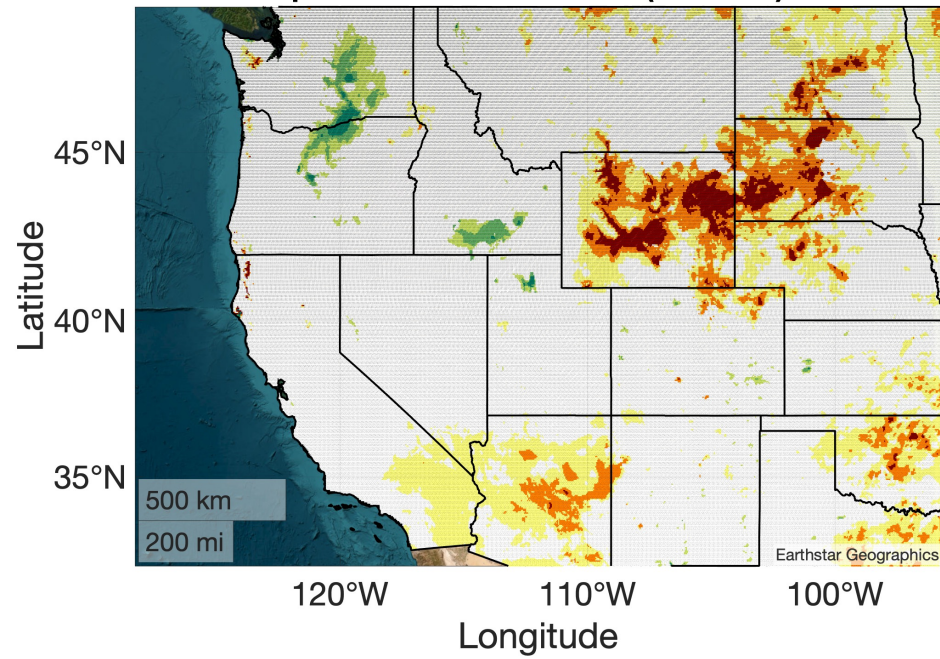


Predicting vs . Monitored Summer Drought Area (1982-2020)

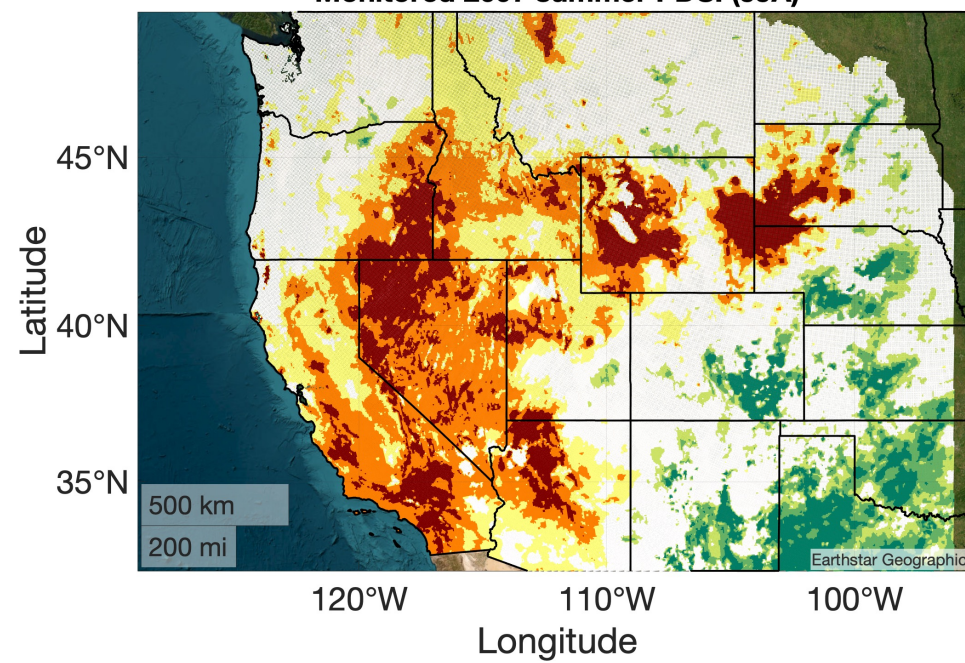


Dots colored by drought severity

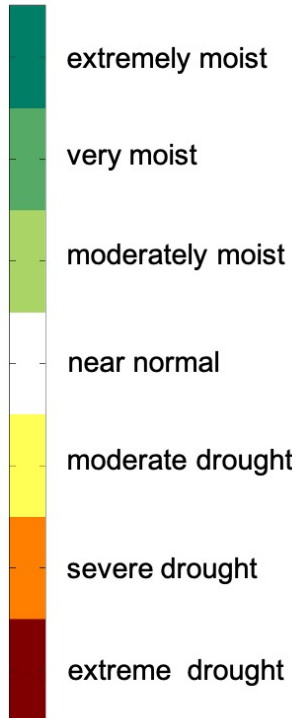
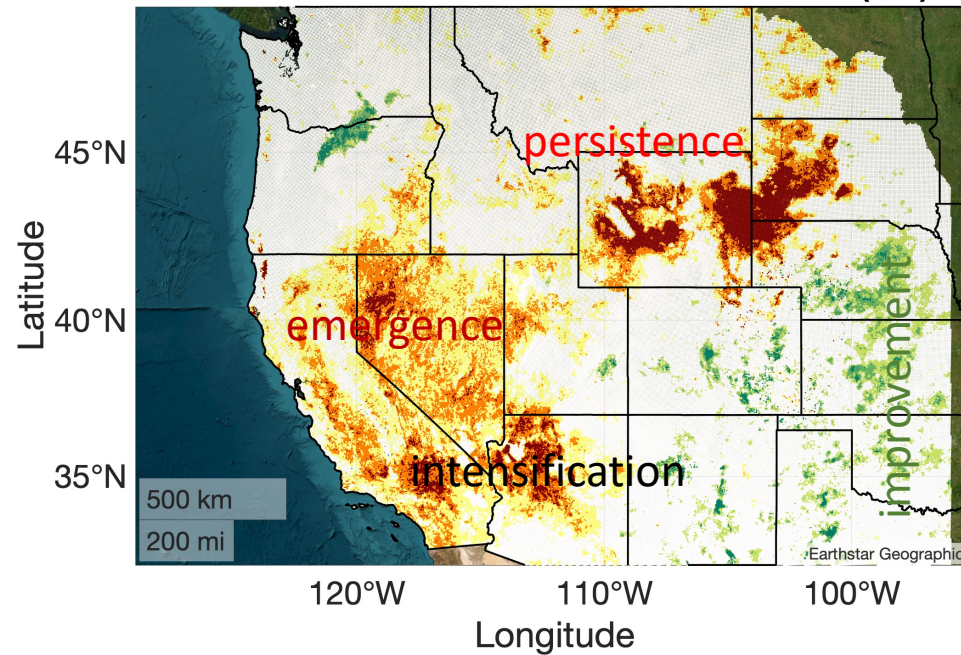
pre-summer PRISM PDSI (Feb 2007)



Monitored 2007 summer PDSI (JJA)



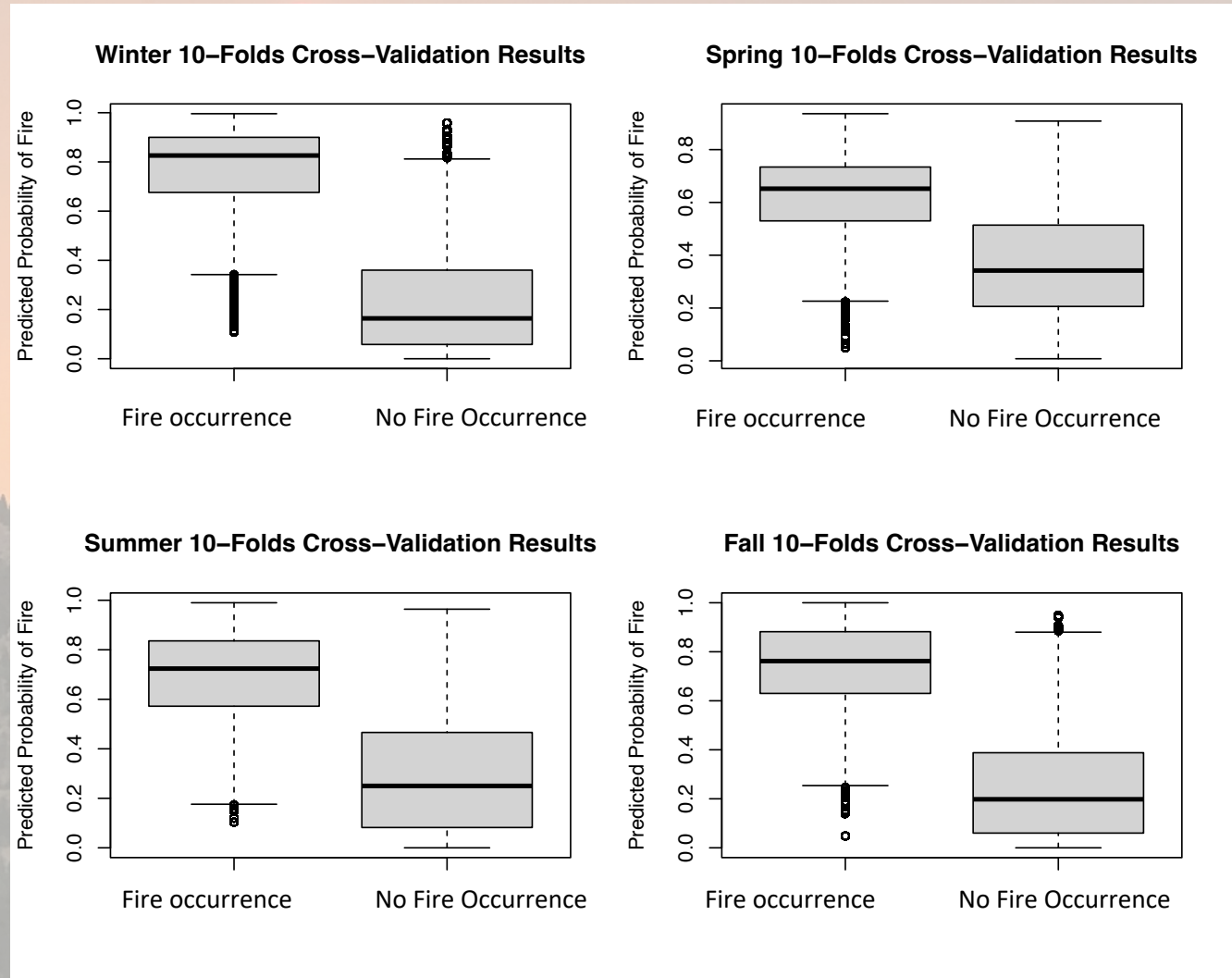
3-month lead time forecasted 2007 summer PDSI (JJA)



Machine learning for daily fire probability in Colorado's Front Range



Can fire probability be quantified at a daily time scale?



Thank you

email: abolafia@ucar.edu