National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

Wildfire-induced cascading geohazards and associated programming at USDA NIFA

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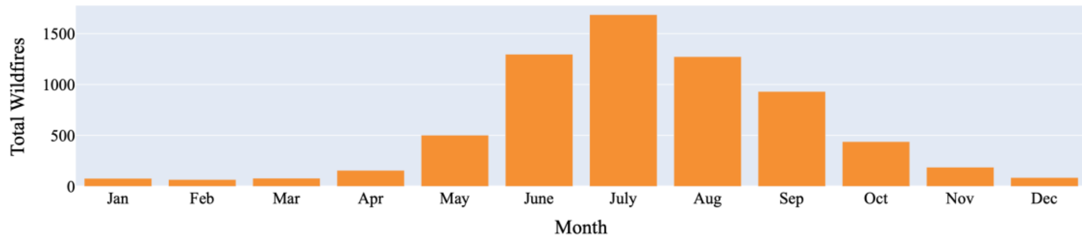
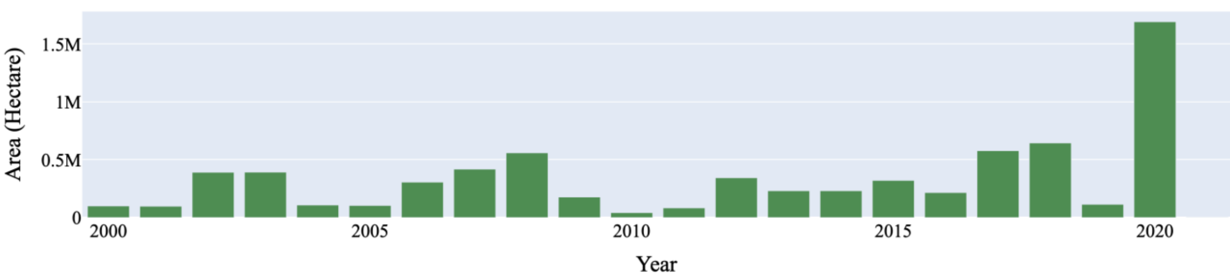
Frequency and Severity of Wildfires

Accumulated monthly wildfires in California (2000 - 2021)

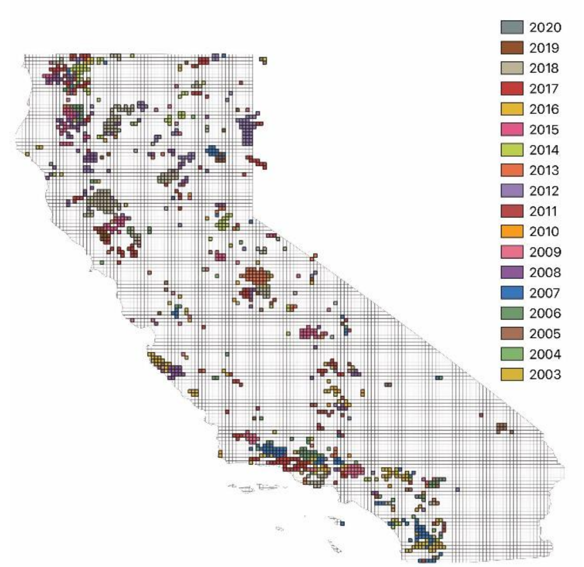


Annual total number of wildfires

Total area of annual wildfires in California State



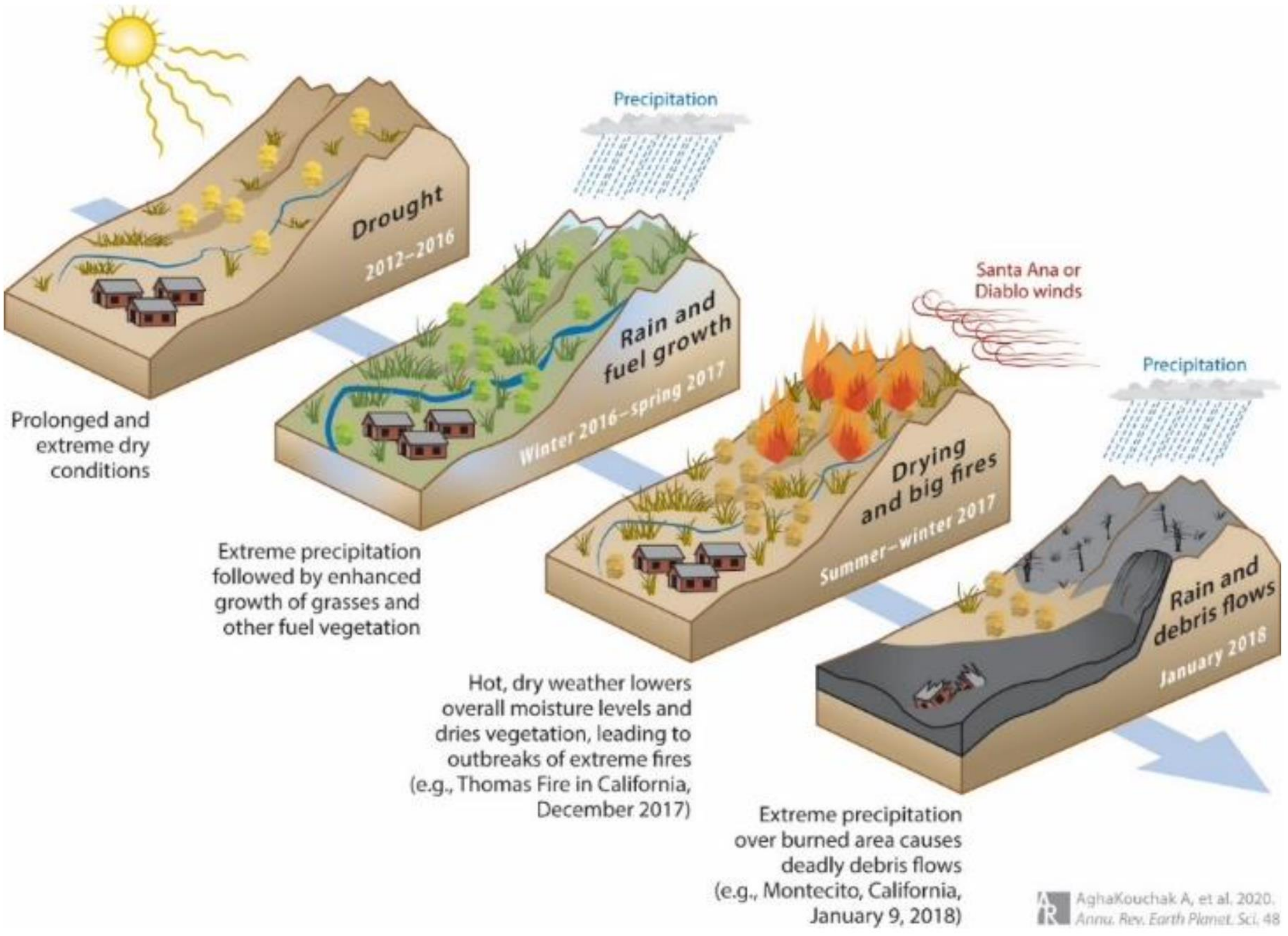
Annual Wildfires, CA



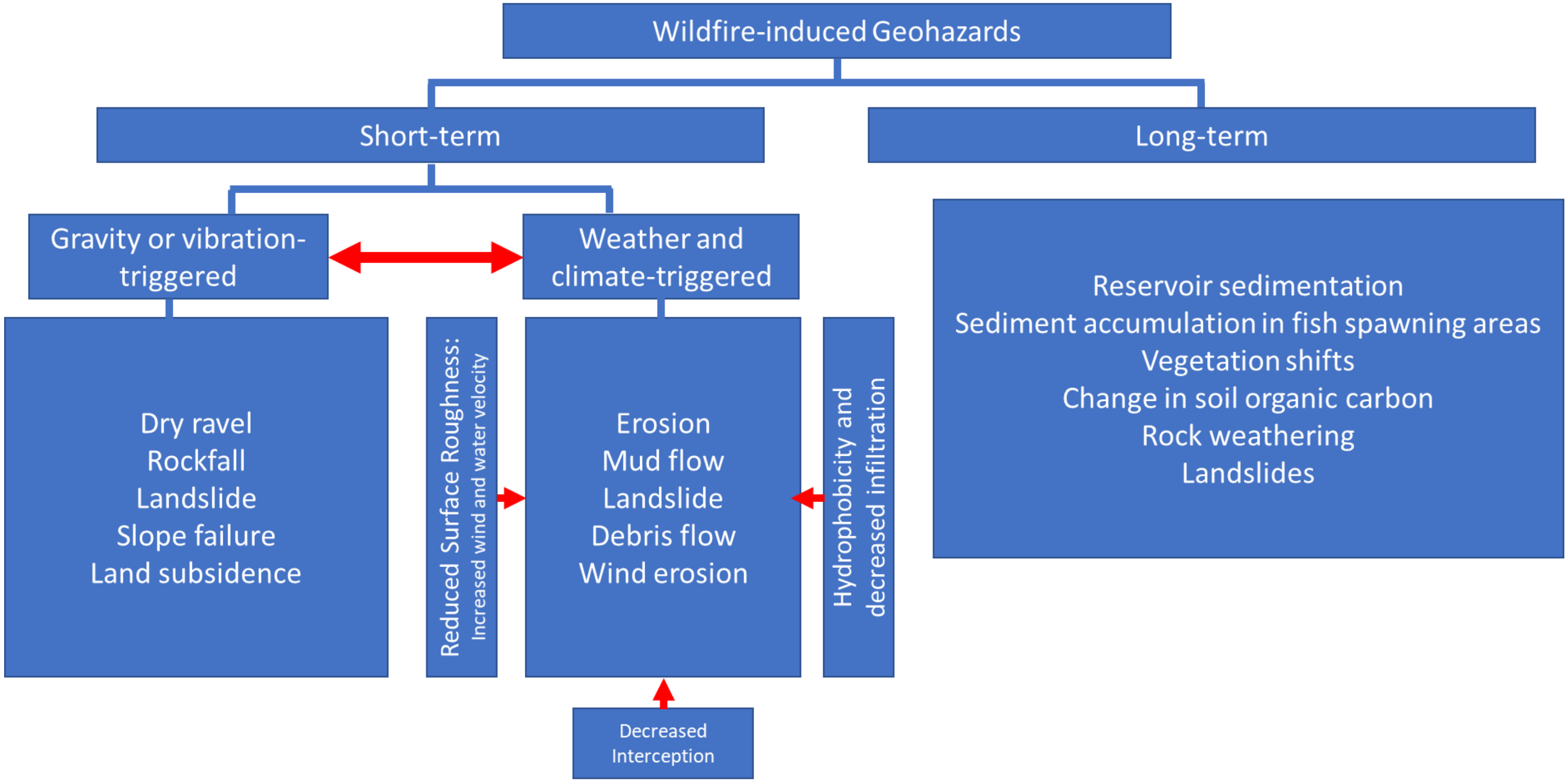
Data source: The Department of Forestry and Fire Protection, CA, U.S. https://www.fire.ca.gov

Cascading Geo-Hazards Associated with Wildfires

Cascading geohazards: catastrophic ripple effect often poses hazards deadlier and costlier than the fire itself



Cascading Geo-Hazards Associated with Wildfires



Cascading Geo-Hazards Associated with Wildfires
Cause and Effect

Type	Linkage Description
Dry Ravel	Destruction of vegetation, root structure, soil particle fracturing, increased dry ravel in wildfire impacted areas.
Erosion	Detachment of soil particles and subsequent distribution of the soil particles downslope. Accumulation of downslope soil deposits, redirection of surface water, and often times redistribution of topographic conditions.
Landslide	Occur as a result of reduced shear strength, reduced critical stress condition, or increased loading on a previously stable sloped environment.
Debris Flow	Resulting from reduced groundcover, exposed soil, disturbed soil conditions, and accumulated solids combined with sloping topography
Land Subsidence	wildfires do reduce organic material, destroy vegetation, and alter surface albedo

Cascading Geo-Hazards Associated with Wildfires
Dry Ravel

(Left) Talus cone of active ravel onto S.R. 2, LA County, during 2009 Station Fire, and (Right) accumulated ravel following the 2003 Cedar Fire in San Diego (Keaton et al. 2019)

Cascading Geo-Hazards Associated with Wildfires
Erosion

(A) (B)

(A) Sheetwash erosion with a braided pattern dominates on a hillslope burned by the Black Saturday 2009 wildfires in the Kinglake area of Victoria, Australia. Ash has accumulated in the hollow in the middle of the photograph taken in March 2009 about one month after the wildfires.

(B) Rill erosion on a hillslope burned by the 1996 Buffalo Creek wildfire in the Colorado Front Range southwest of Denver, Colorado, USA.

(Moody, et al, 2013)

Landslide

a Showing shallow landslides in the San Gabriel Mountains in Southern California, USA. Blue arrows indicate landslide scarps.

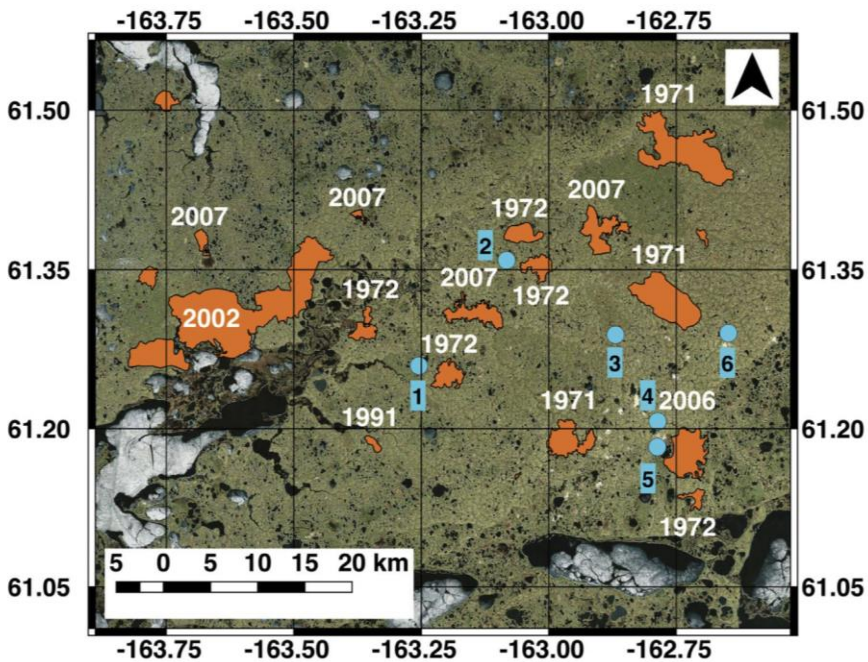
b View near the scarp of one landslide with the depth of the landslide release zone indicated

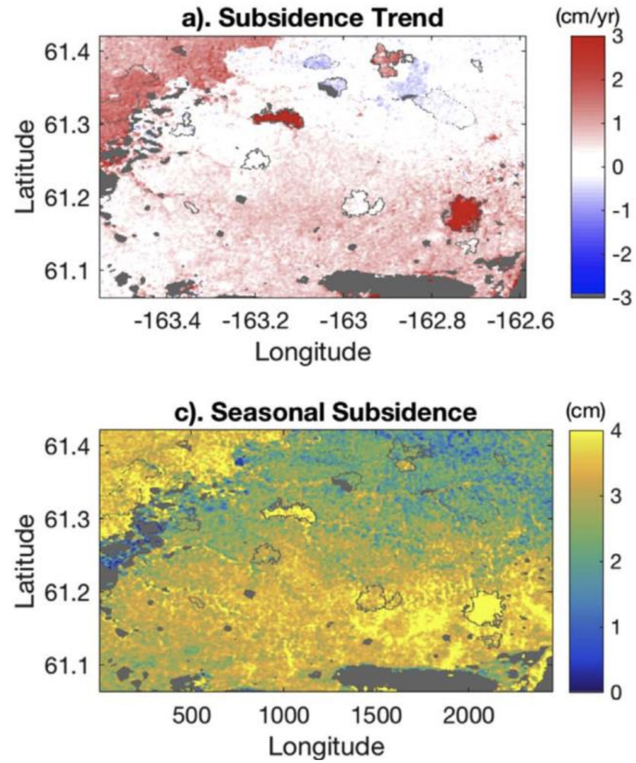
(Rengers, et al. 2020)

Cascading Geo-Hazards Associated with Wildfires
Debris Flow

Incision produced by debris flow following a wildfire near Sula, Montana, USA (Parise et al. 2012)

Land Subsidence



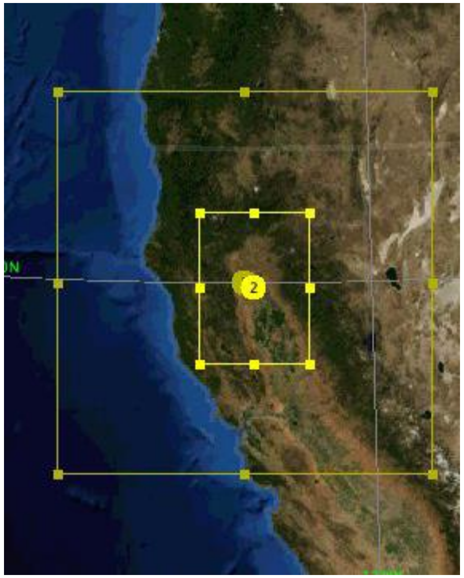


(Left) The YK Delta field study area. Wildfire burn zones are shown in orange and labeled by year of burn. (Right) Results from application of the ReSALT algorithm to the YK study region. (a) ReSALT-derived long-term subsidence trend, positive values correspond to an increase in thaw depth (cm yr−1). (b) Uncertainties in long-term trends (Michaelides et al. 2019)

Cascading Geo-Hazards Associated with Wildfires

Effect of Land Use and Land Cover Change

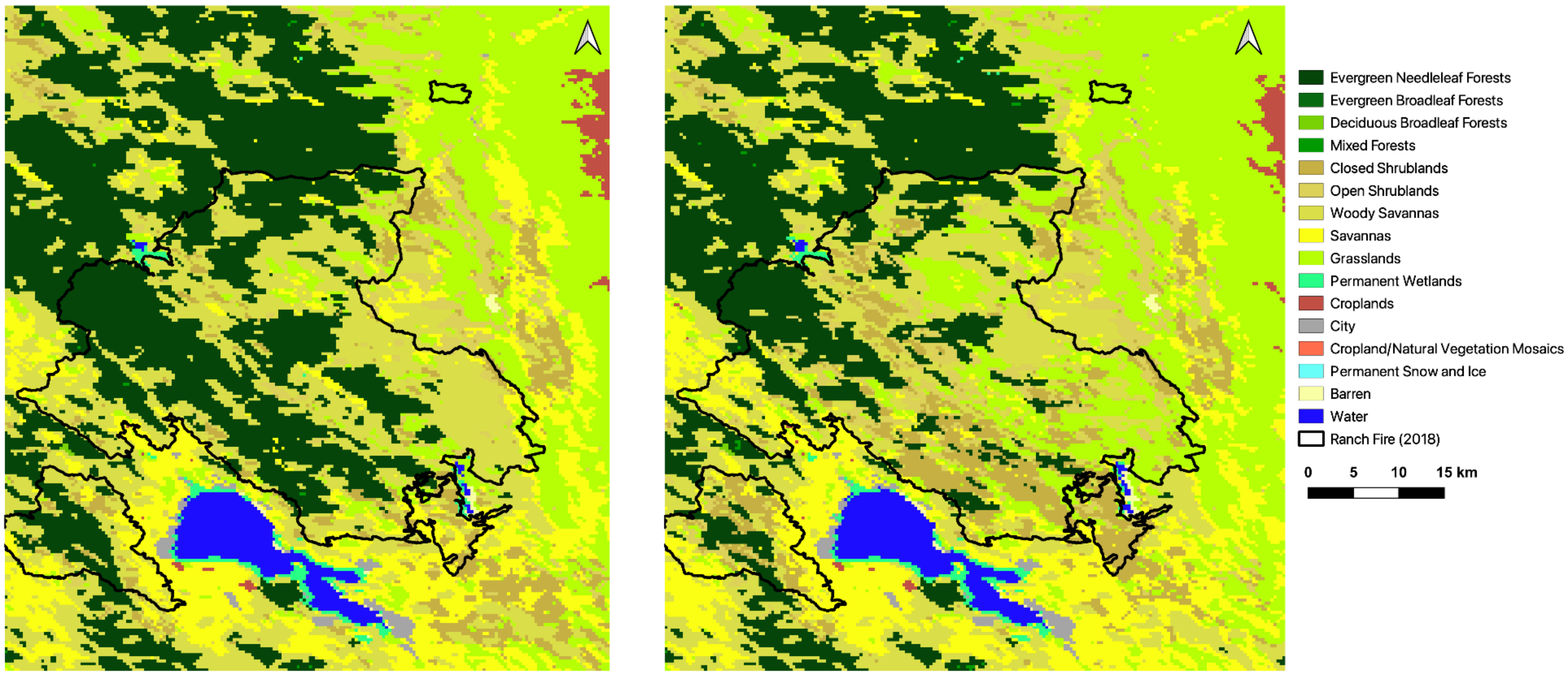
- Wildfire changes the land use and land cover (LULC)
- LULC modification impacts on the local and regional climate
- Accurate representation of land surface parameters in land surface models (LSMs) is essential to accurately predict these LULC-induced climate signals
- We use MODIS LULC data to update the land use data within the Weather Research and Forecasting (WRF) model
- We run the WRF model before and after wildfire events to simulate the sensitivity of the regional weather to LULC changes due to wildfire events



WRF domains
10km parent and
2km nested domain

Effect of Land Use/Land Cover Change Due to Wildfires

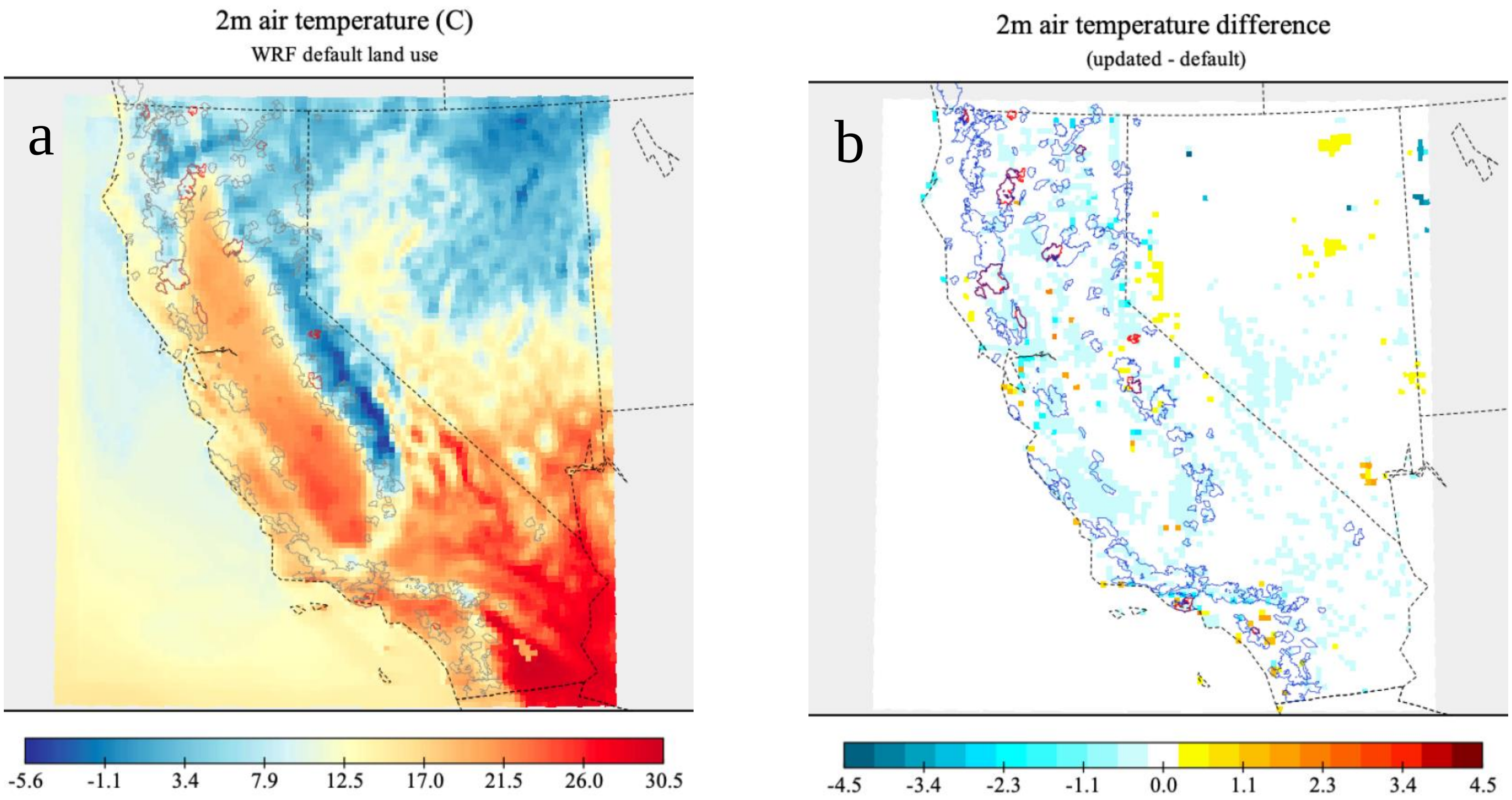
MODIS land use land cover



2017
Before fire

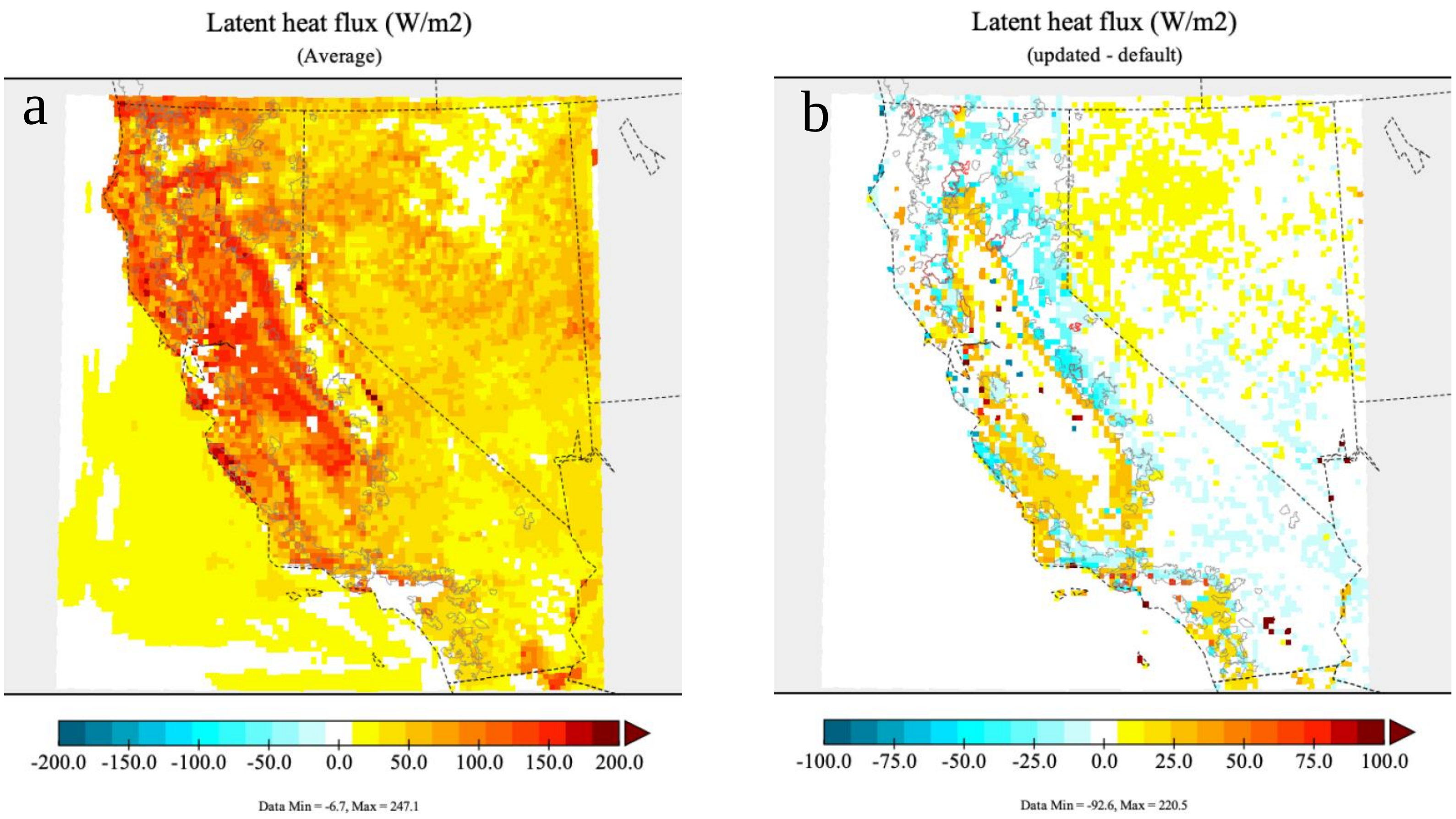
2019
Before fire

Effect of Land Use and Land Cover Change Due to Wildfires



Average of 2m air temperature from Mar 10th through April 30th (a), and mean differences between WRF updated and default land use simulations (b)

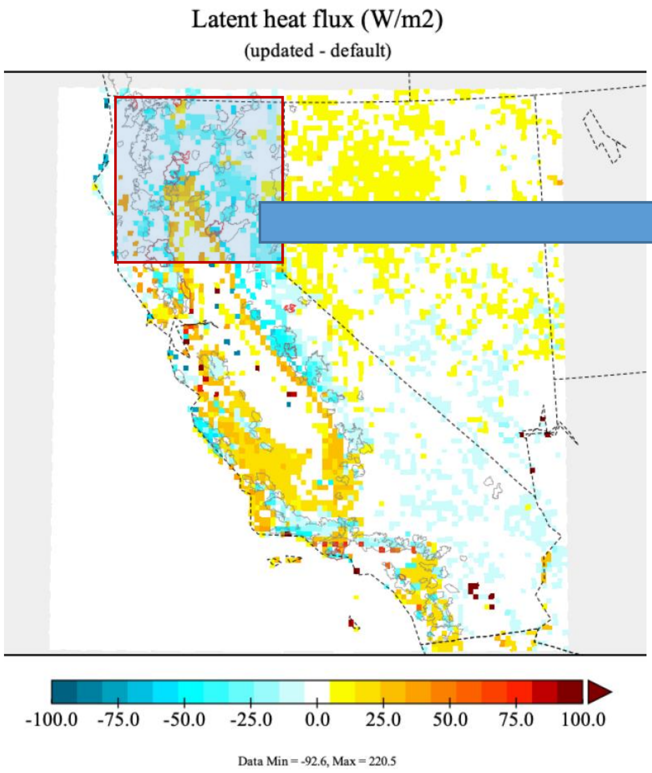
Effect of Land Use/Land Cover Change Due to Wildfires

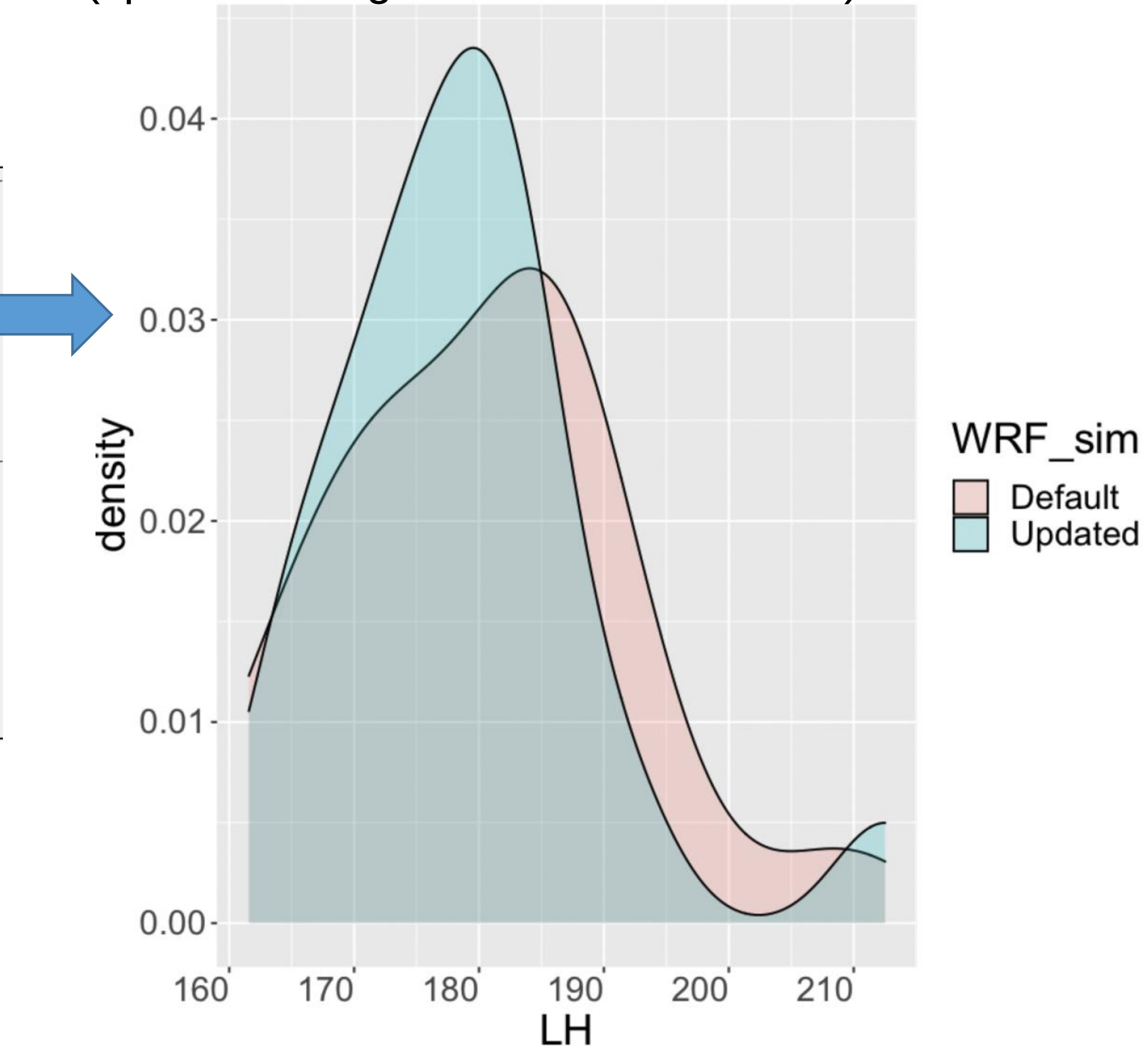


Average of latent heat flux (W/m^2) from Mar 10th through April 30th (a), and mean differences between WRF updated and default land use simulations (b)

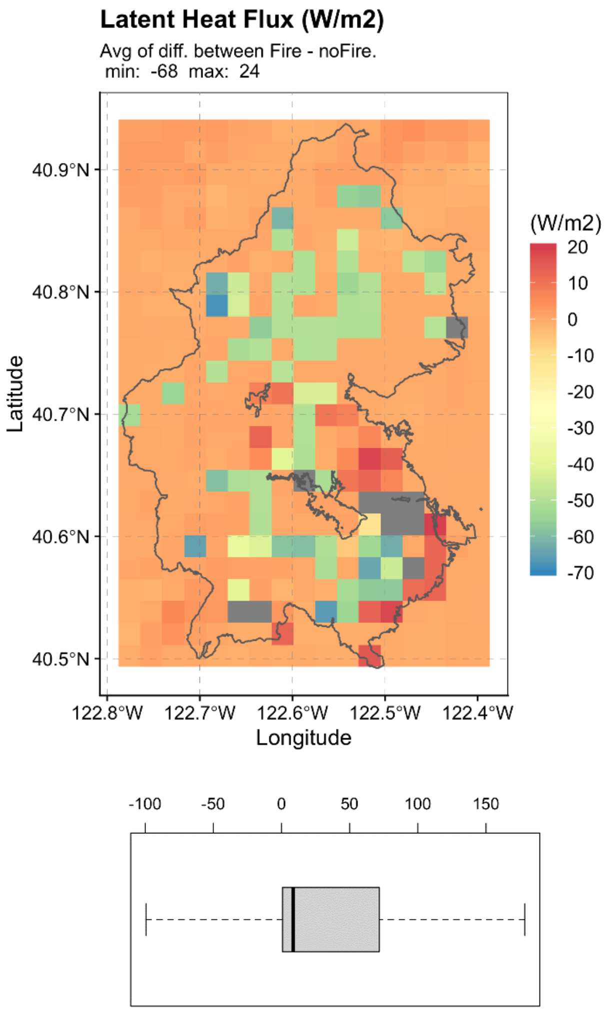
Effect of Land Use/Land Cover Change Due to Wildfires

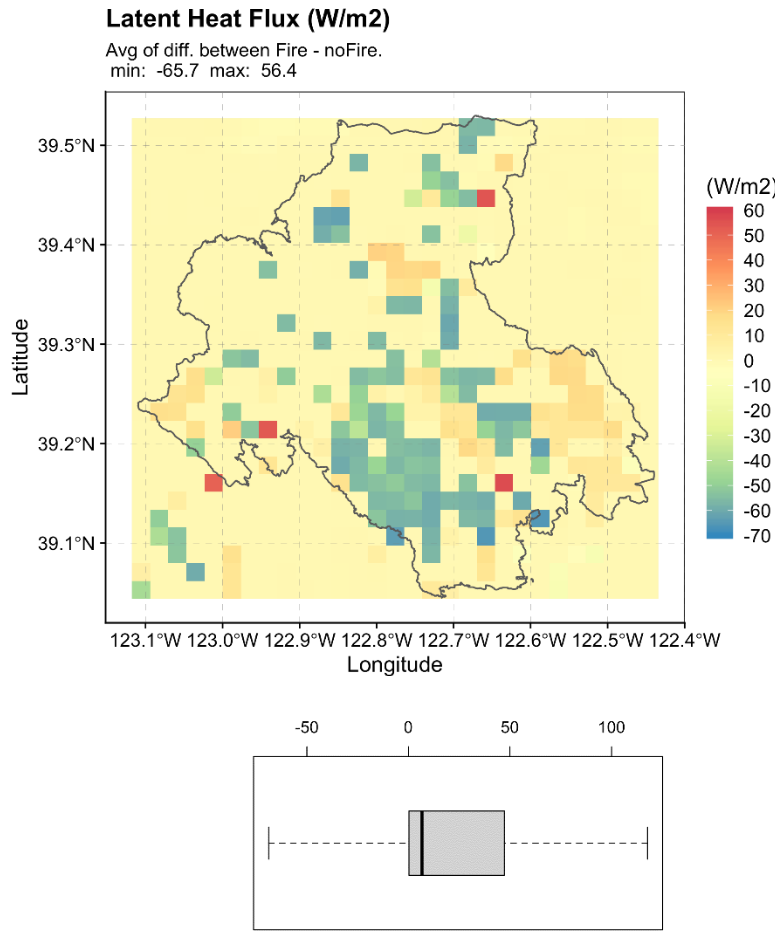
Density plots of extreme latent heat flux time series for default and update land use in WRF simulations (spatial average of the selected area)





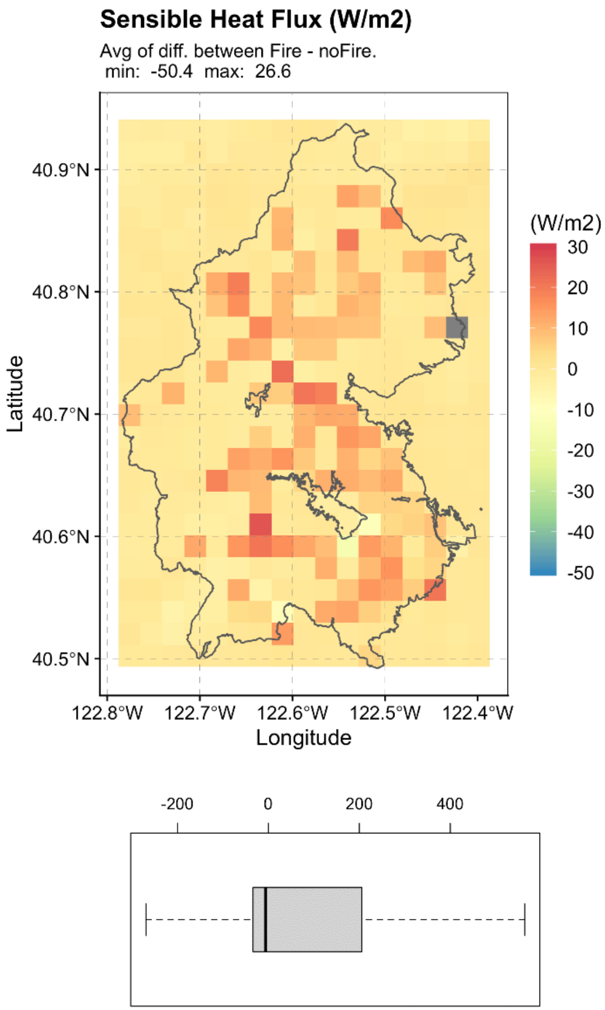
Effect of Land Use/Land Cover Change Due to Wildfires

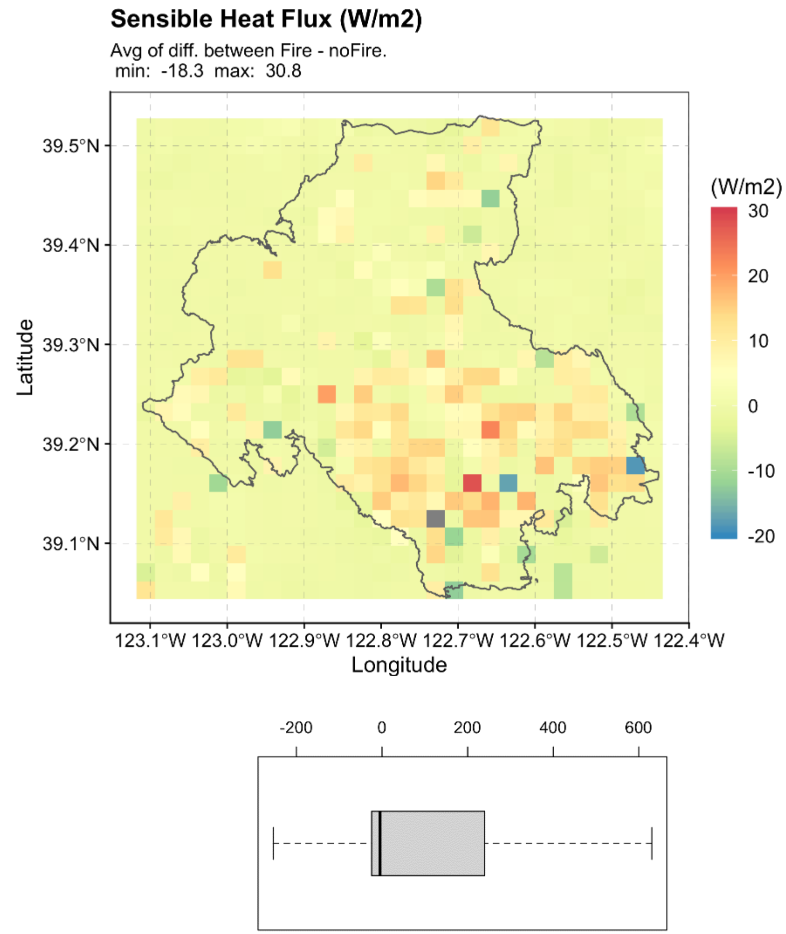




Map of latent heat flux changes due to land cover change over the CARR (Left) and RANCH (Right) wildfires (2018). The boxplots show the summary statistics of spatiotemporal time series of the variable for no-fire simulations.

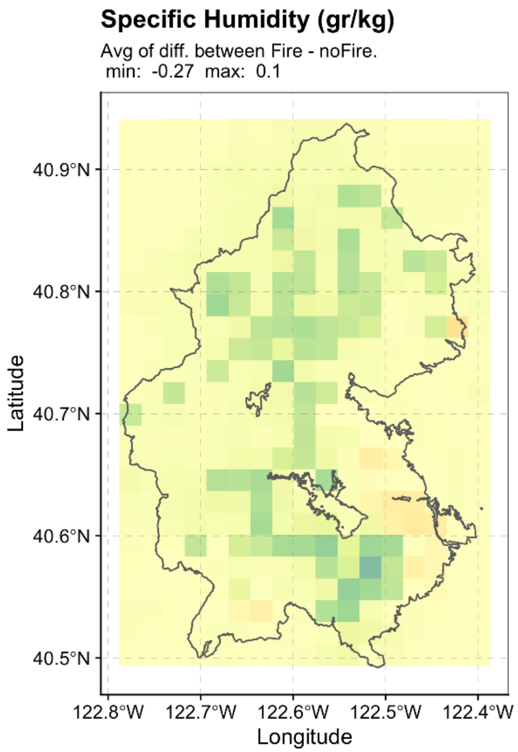
Effect of Land Use/Land Cover Change Due to Wildfires

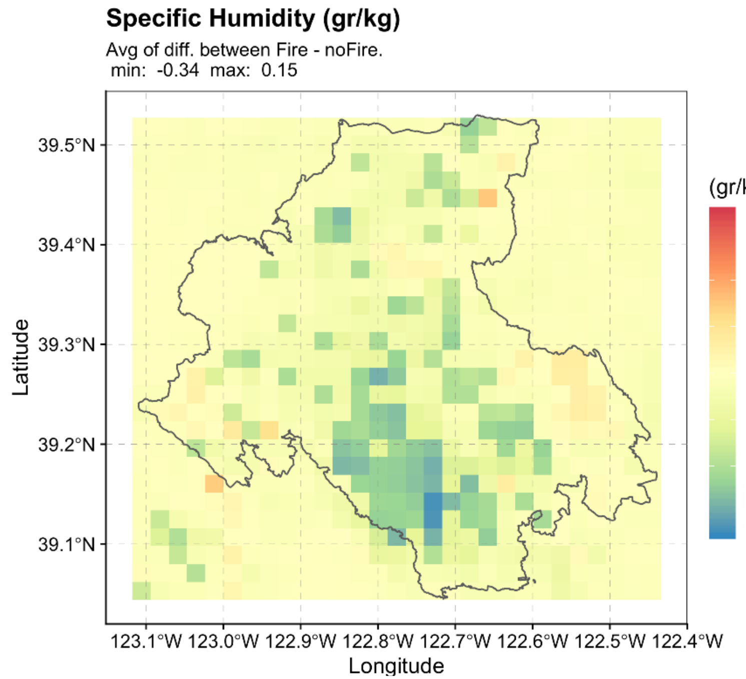


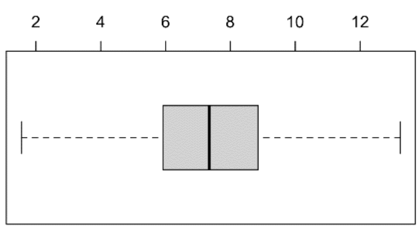


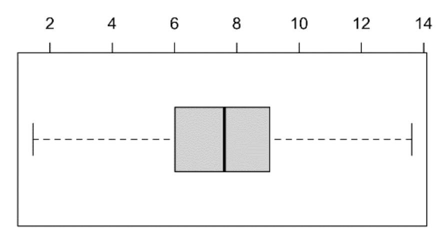
Map of sensible heat flux changes due to land cover change over the CARR (Left) and RANCH (Right) wildfires (2018). The boxplots show the summary statistics of spatiotemporal time series of the variable for no-fire simulations.

Effect of Land Use/Land Cover Change Due to Wildfires









Map of specific humidity changes due to land cover change over the CARR (Left) and RANCH (Right) wildfires (2018). The boxplots show the summary statistics of spatiotemporal time series of the variable for no-fire simulations.

Effect of Land Use/Land Cover Change Due to Wildfires

Summary statistics of difference between two WRF simulations (Fire - noFire) over two large wildfires in California State, 2018

			Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
WildFire	CARR	Sensible Heat Flux (W/m2)	-460.56	-2.87	-0.05	2.11	2.82	522.51
		Latent Heat Flux (W/m2)	-433.42	-1.18	-0.05	-7.14	0.53	446.05
		2m Air temperature (C)	-9.73	-0.16	0.00	-0.02	0.16	6.29
		Specific humidity (kg/kg_air)	-8.628	-0.149	-0.020	-0.050	0.064	11.249
	RANCH	Sensible Heat Flux (W/m2)	-504.83	-2.13	0.02	1.85	2.30	517.87
		Latent Heat Flux (W/m2)	-370.05	-0.46	-0.01	-5.71	0.26	631.90
		2m Air temperature (C)	-8.43	-0.14	0.00	-0.02	0.15	7.74
		Specific humidity (kg/kg_air)	-9.30	-0.16	-0.02	-0.05	0.08	6.77

Conclusions

- Frequency and severity of destructive wildfires have increased in many regions
- Cascading geohazards associated with wildfires are one of the most prominent long-ranging and far-reaching post-fire effects.
- Catastrophic ripple effect often poses hazards deadlier and costlier than the fire itself
- LULC modification due to wildfire impacts on the local and regional climate
- WRF simulations show substantial differences in weather parameters due to land cover changes after wildfire events

Programming at USDA-NIFA

- The following appropriate programs are within the AFRI (Agriculture and Food Research Initiative)

- **Developing core science and engineering of complex CPS technologies**
  - ➢ NIFA/NSF Cyber-Physical Systems for Agriculture (CPS) NO DEADLINE
    - Encourages projects that advance science and technology applied to:
      - **Smart & Connected Communities (both rural and urban)**
      - Real-time agricultural data analytics and control
    - 5M/year
    - 500K (small),1.2M per grant (medium).
    - NIFA does not fund Frontier level (7M) unless split with NSF
    - ~ 12-20% funding rate
    - Program allows collaborative proposals, Extension collaborators encouraged
- **Broad engineering-centered program for agriculture**
  - ➢ NIFA Engineering for Agricultural Systems (A1521) October 6, 2022
    - Broad program
    - 4-5M/year
    - 650K/grant
    - ~ 10% funding rate
    - **Allows Integrated proposals (Research, Extension, Education – at least 2 out of 3) as do other AFRI programs**

Smart and Connected Communities

- It's an NSF program
- Is also a subtopic within the USDA NIFA-NSF collaboration in CPS
- All applications specifying NIFA as the funding agency have been under the real-time agricultural data analytics and control area
- NIFA can fund S&CC proposals on a selective basis as brought to us by NSF for consideration
  - already paneled but just missed the funding line
  - require budget reduction if funded by NIFA

- **Data Science for Agriculture**
  - NIFA Data Science for Food and Agricultural Systems (DSFAS) October 20, 2022
    - 7.5M, typically
    - 650K (Standard) or 1M (CIN) per grant
    - Approx. 14% funding rate
    - Majority of funded proposals involve **data analytics and decision support**.

- **Applied Research and Extension - Critical Needs**
  - Critical Agricultural Research and Extension (CARE) September 15, 2022
    - Funded projects are expected to produce results that lead to practices, tools, and technologies that are rapidly adopted by end-users.
    - 300K, one to three years duration
    - Does not accept SEED applications

- **Enable novel applications of autonomy**
  - NIFA/NSF National Robotics Initiative (NRI)
    - Encourages robotics research, applications, and education to enhance agricultural production, processing, and distribution systems that benefit consumers and rural communities
    - 5M/ year
    - Approximately 15% funding rate
    - Allows collaborative proposals
    - Labor saving technologies are also major focus areas for NIFA

For NIFA-only AFRI programs...

- Strengthening Seed grants are available for almost all programs: 300K
- New Investigator Seed are now available
  - New Investigator FAQ FASE New Investigator FAQ (usda.gov)
- There is now an incentive for an added 150K for certain partnerships (International Collaborations, MSI, etc).

THANK YOU!

Questions?