

# Monitoring Wildfire Recovery Using Solar-induced Chlorophyll Fluorescence

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## Motivation

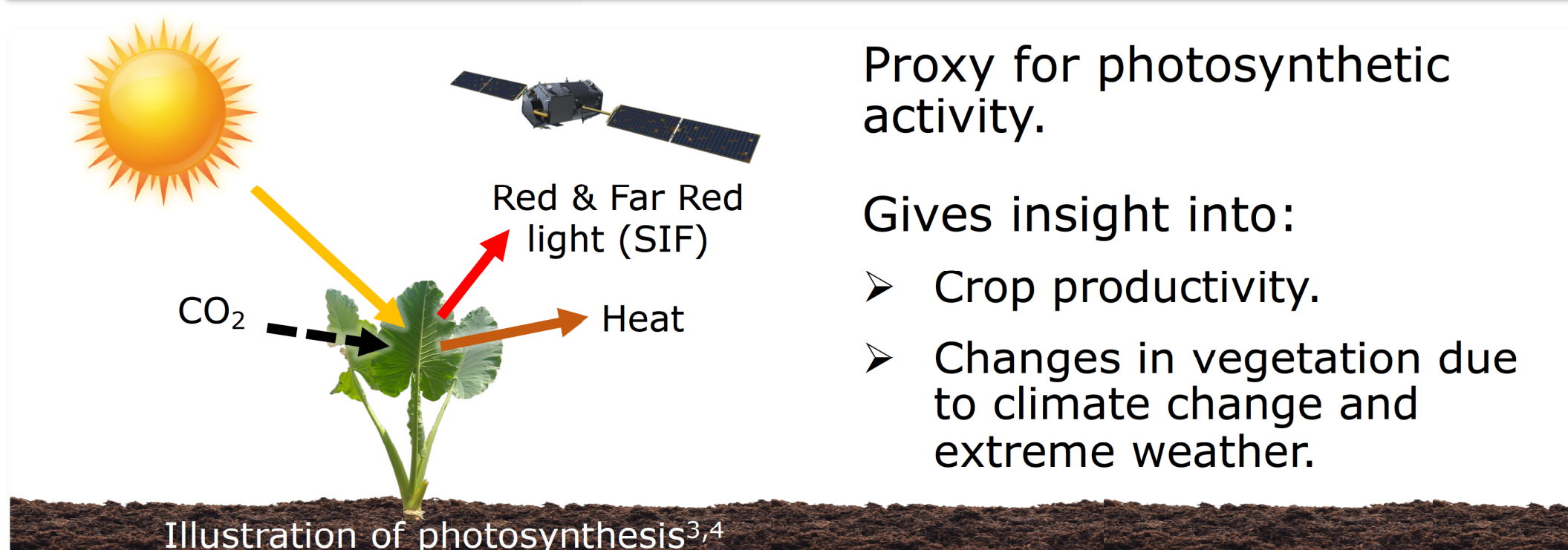
- Increase in frequency and severity of wildfires due to climate change.
- July 27, 2018: Mendocino complex fire burned approx. 410,000 acres (NW California).
- Important consequences:
  - Conservation
  - Carbon cycle



(Left) Satellite and (Right) On-ground images of the Mendocino complex fire.

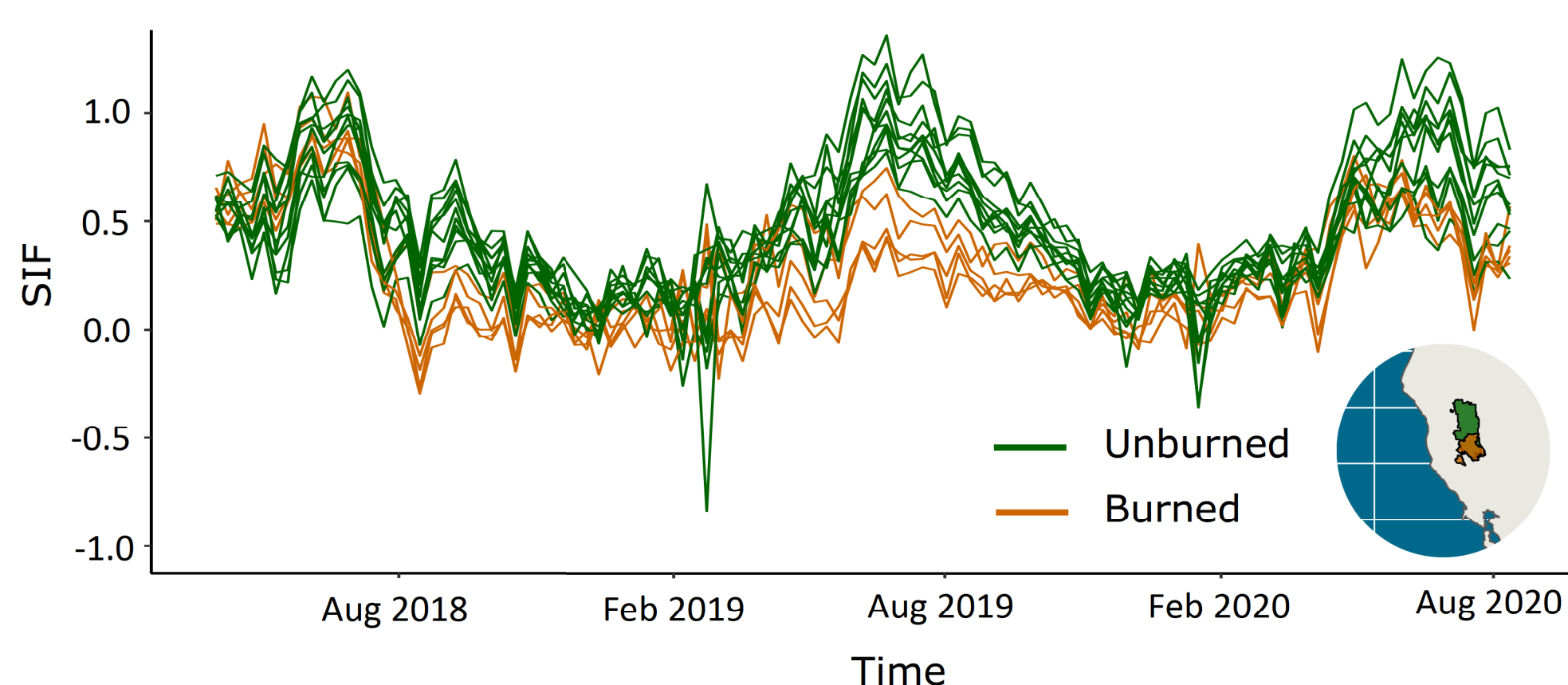
**Objective: Study the impact of the Mendocino fire and monitor post-fire vegetation recovery.**

## Solar-induced Fluorescence (SIF)



## Data

TROPOspheric Monitoring Instrument (TROPOMI) on board the Copernicus Sentinel-5 Precursor satellite<sup>3</sup> (0.2° x 0.2° gridded, weekly SIF).



TROPOMI SIF measurements obtained over the Mendocino forest in California.

## Statistical Testing

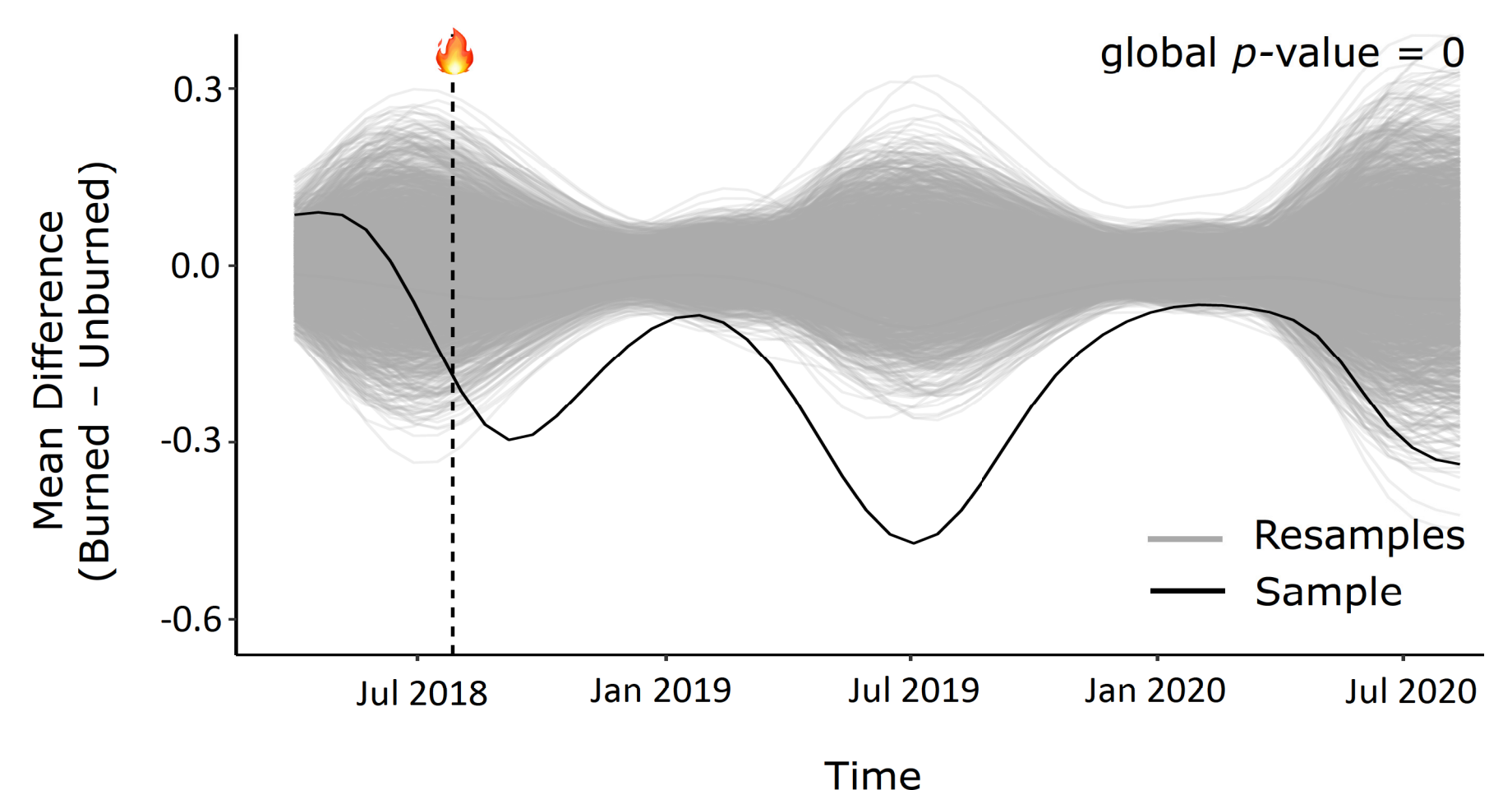
Is there a difference in SIF between burned & unburned areas?  
A hypothesis test helps determine whether observed differences are due to random chance or fundamental differences.

$$H_0 : \mu_1(t) = \mu_2(t) \quad H_A : \mu_1(t) \neq \mu_2(t)$$

## Methods

**Functional Analysis of Variance (fANOVA)** tests whether groups are significantly different using a parametric bootstrap<sup>2</sup>.

- Pre-processing: Convert each SIF time series into functional data (functions) using b-spline smoothing.
- Black: Observed mean difference in SIF (Burned – Unburned).
- Gray: 'Resample' mean difference in SIF generated under  $H_0$  (if both groups are equal) retaining spatio-temporal dependence.



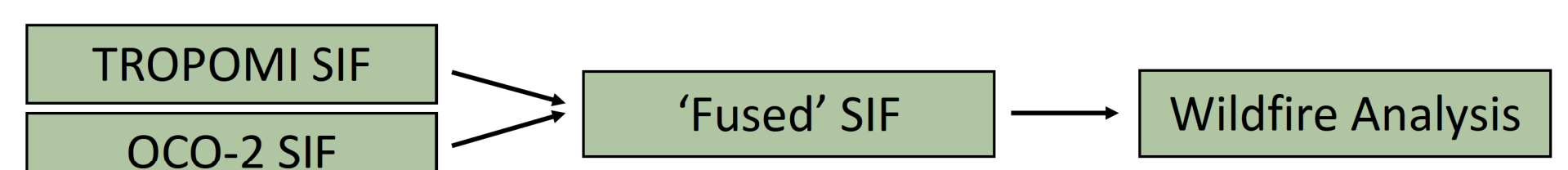
Functional ANOVA visualization shows significant and prolonged decrease in SIF in the burned areas of the Mendocino forest.

## Conclusion

- Significant decrease in SIF after the fire.
- Photosynthetic activity has not recovered to pre-fire levels 2 years after the fire, although recovery has started.

## Next Steps

Data fusion of SIF from multiple instruments.



Study vegetation recovery, and joint behavior of SIF and atmospheric CO<sub>2</sub>.

- Different types of vegetation.
- Other extreme weather events (drought, flood, etc.)
- Different fire intensities.

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