

# Identifying sensitivities and uncertainties in the attribution of global fire weather extremes using CMIP6 ensembles

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# Wildfires, climate change and attribution



Many large wildfire events across the globe in recent years

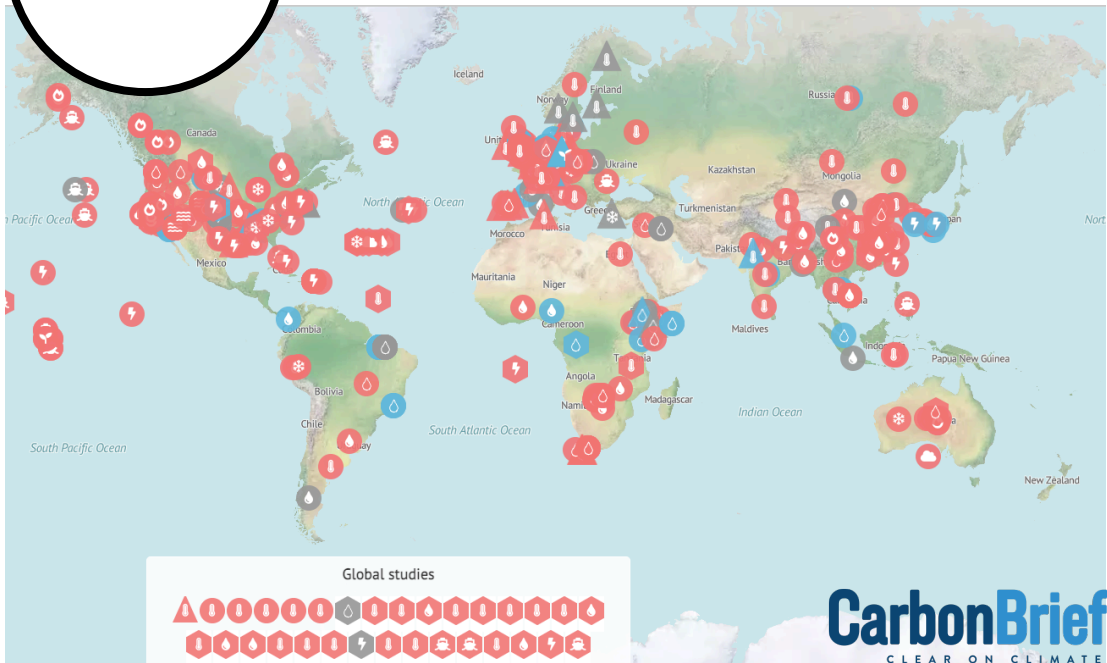
**Frequently asked question:** is climate change to blame?

**More specifically:** has climate change altered the meteorological conditions conducive to wildfire ignition and spread?

# Wildfires, climate change and attribution



404 studies



Despite progress in attribution science during the last decade...

### Attributing extreme weather to climate change

Use the filters below to explore the studies

**Finding**

☒ Human influence found ☐ No human influence found ☐ Inconclusive

**Type of study**

☒ Formal study ☐ Rapid assessment ☐ Trend

**Impact**

☒ Atmosphere ☒ Cold, snow & ice ☒ Coral bleaching ☒ Drought ☒ Ecosystem function ☒ Heat ☒ Oceans ☒ Rain & flooding ☒ River flow ☒ Storm ☒ Sunshine ☒ Wildfire

Select all  Deselect all

**Year** All **Events** 404

(Carbon Brief, 2022)

# Wildfires, climate change and attribution



only 16  
wildfires

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... focus on wildfire, or **extreme ‘fire weather’**, events is rare.



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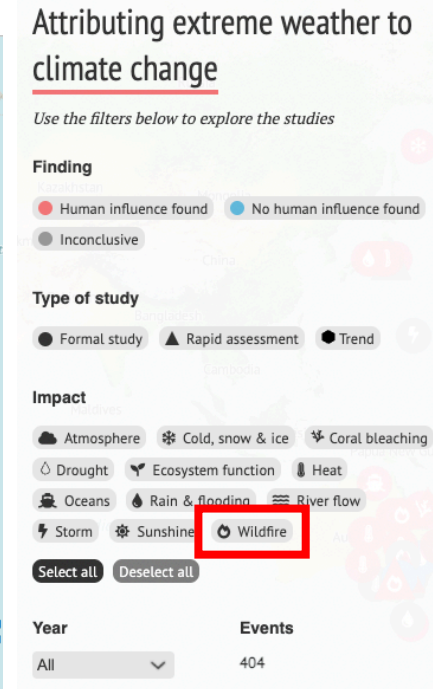
**Despite** progress in attribution science during the last decade...

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What are the key **uncertainties**?

How **sensitive** are attribution findings sensitive to:

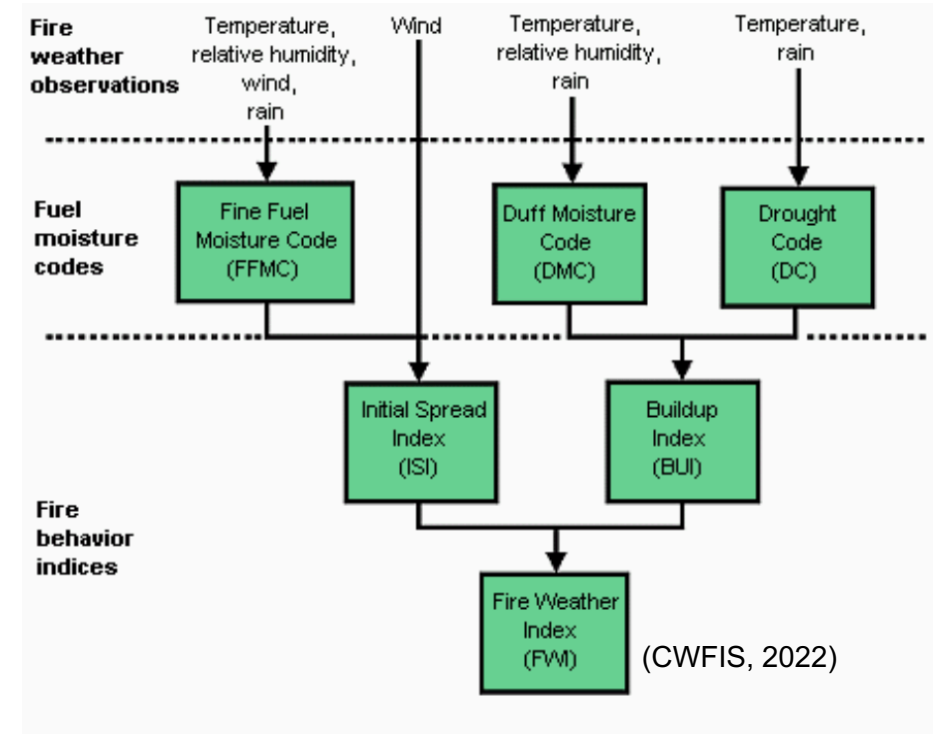
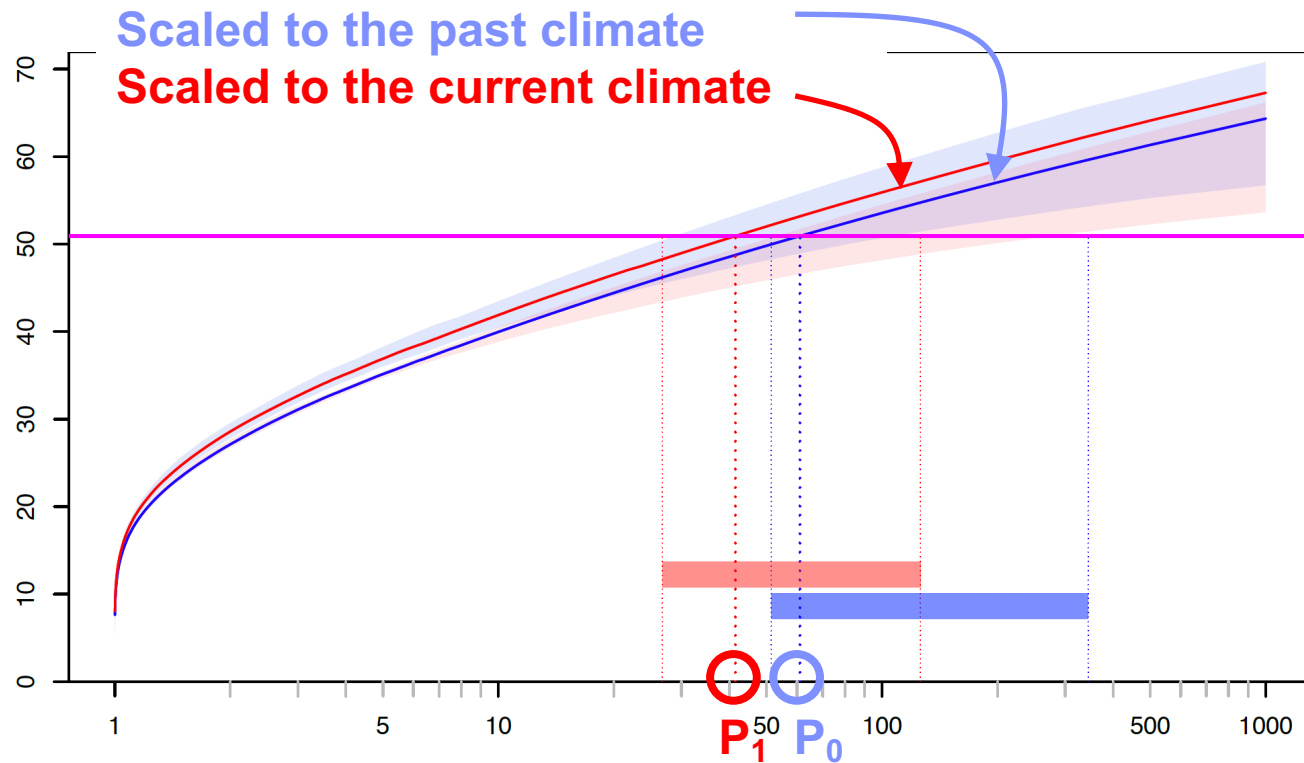
1. Fire weather indicator?
2. Event definition?
3. Choice of climate model?



(Carbon Brief, 2022)

# Statistical methodology

Annual Fire Weather Index (FWI) maxima fitted to GEV scaled to global mean surface temperature.



$$F(x) = \exp \left[ - \left( 1 + \xi \frac{x - \mu}{\sigma} \right)^{\frac{1}{\xi}} \right]$$

$$\mu = \mu_0 \cdot \exp \frac{\alpha T}{\mu}$$

$$\sigma = \sigma_0 \cdot \exp \frac{\alpha T}{\mu}$$

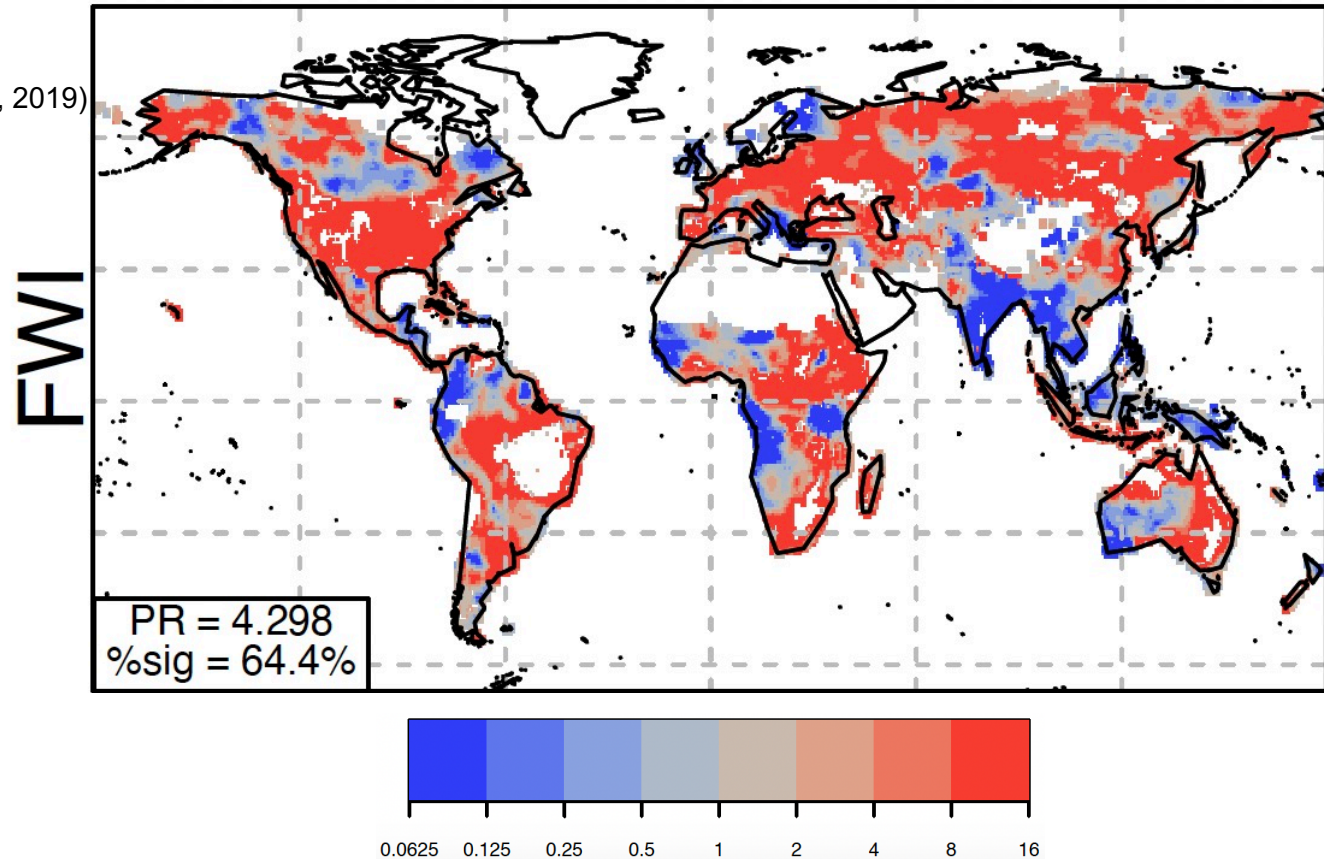
## Applications

### 1: Global Fire Danger Reanalysis (Vitolo et al., 2019)

Event definition: 5-day FWI annual maxima (**FWI<sub>5day</sub>**)

**Question:** how much more likely have recent FWI<sub>5day</sub> maxima become in the last 60 years?

**Probability ratio (PR) > 4** is found in approximately over 40% of the burnable world.



$$\text{Probability ratio (PR)} = \frac{P_0}{P_1}$$



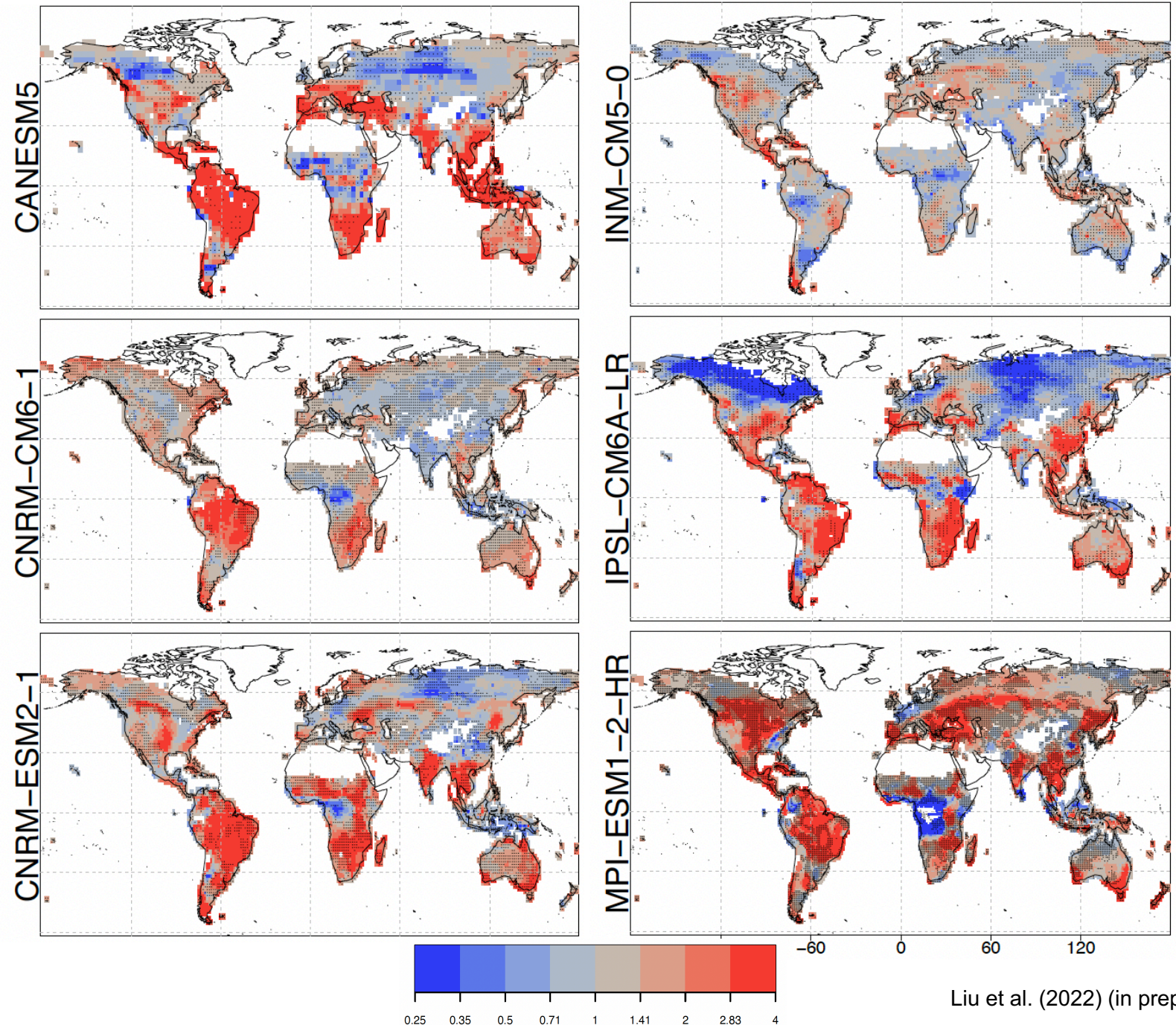
## Applications

### 2: CMIP6 [fire weather intensity]

Six large (>10-member) CMIP6 model ensembles targeted.

In many places, **more intense** extreme fire weather is **twice as likely** as a result of climate change.

Regional results are highly **sensitive** to the chosen climate models.





## Applications

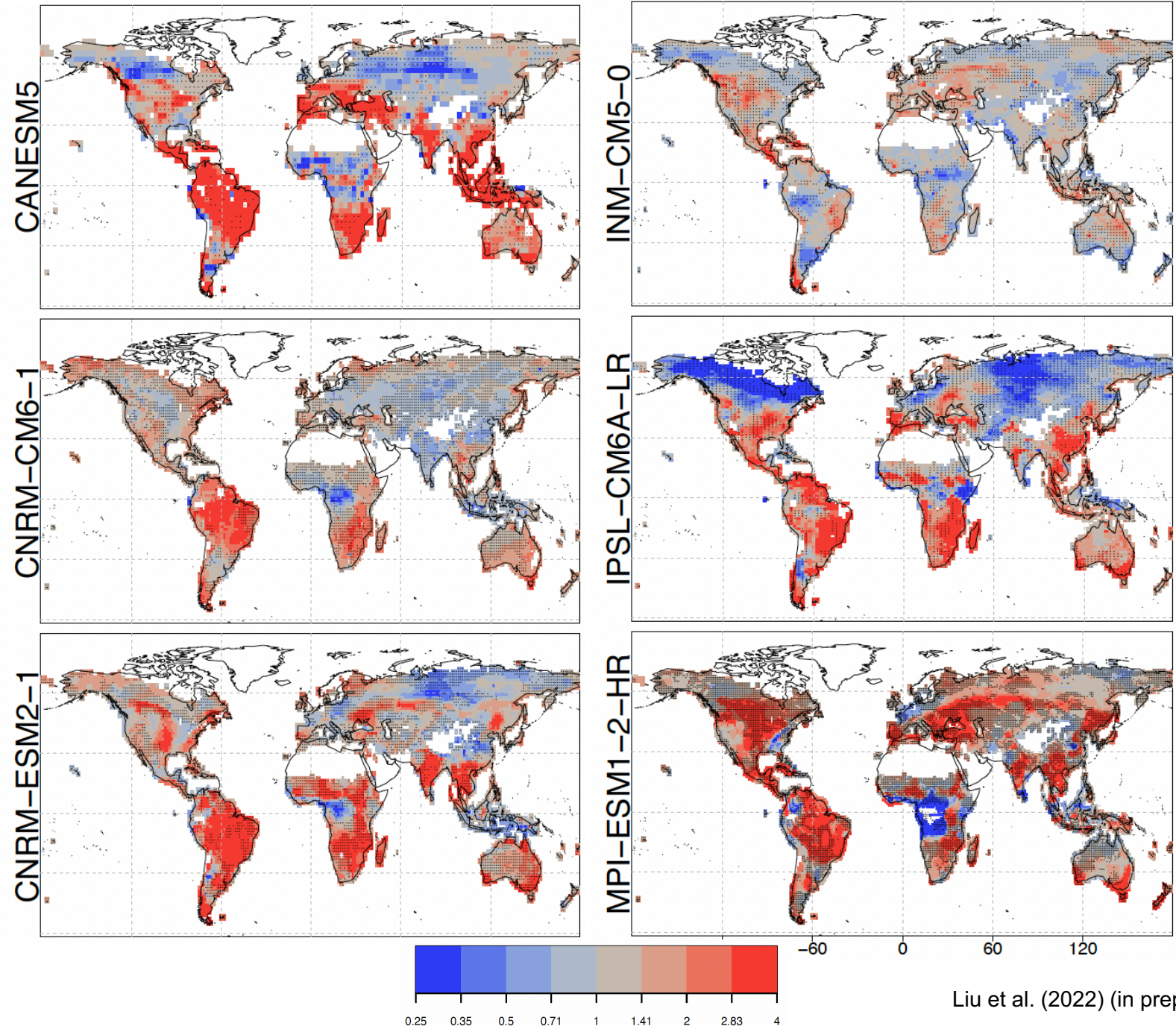
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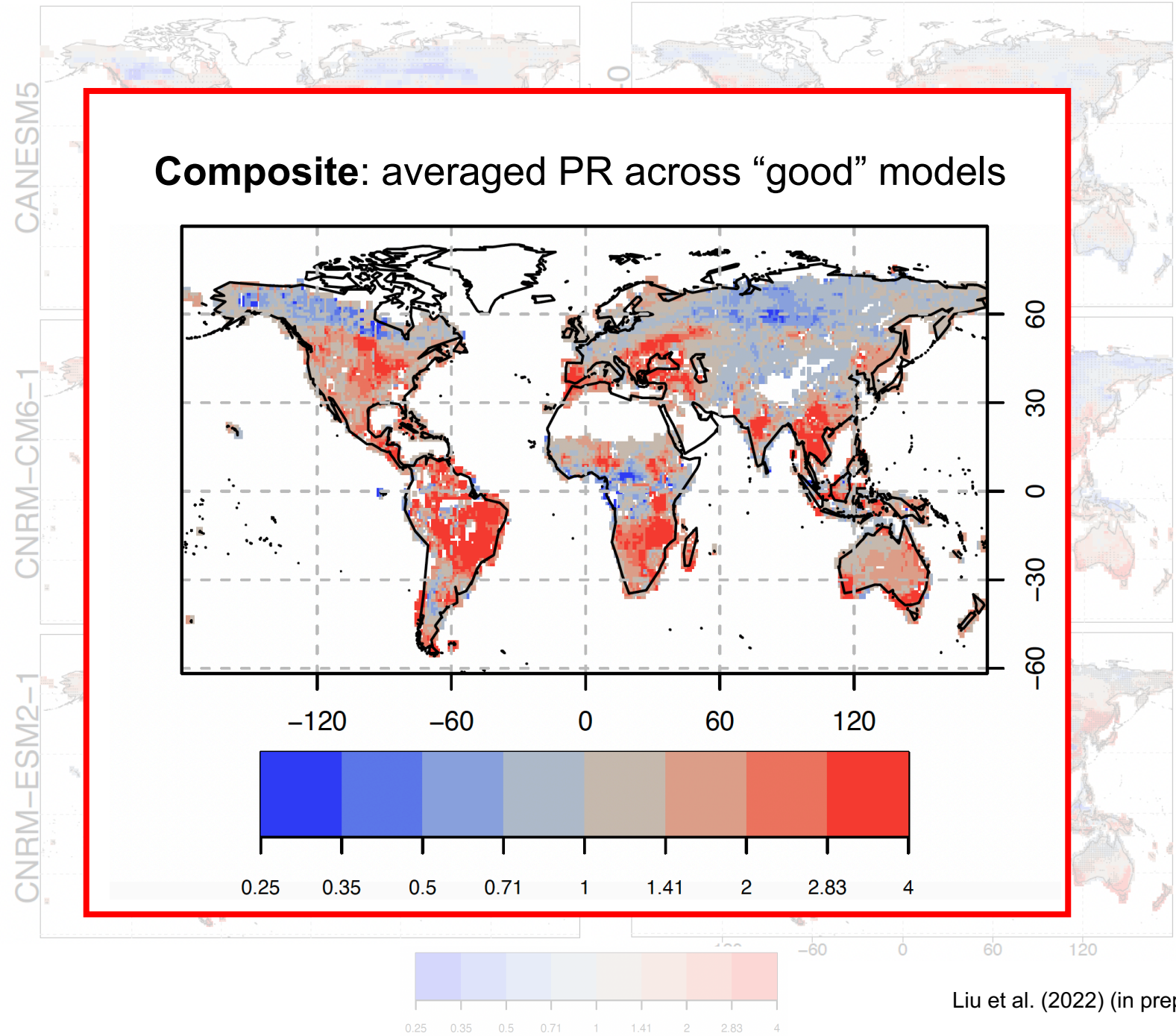
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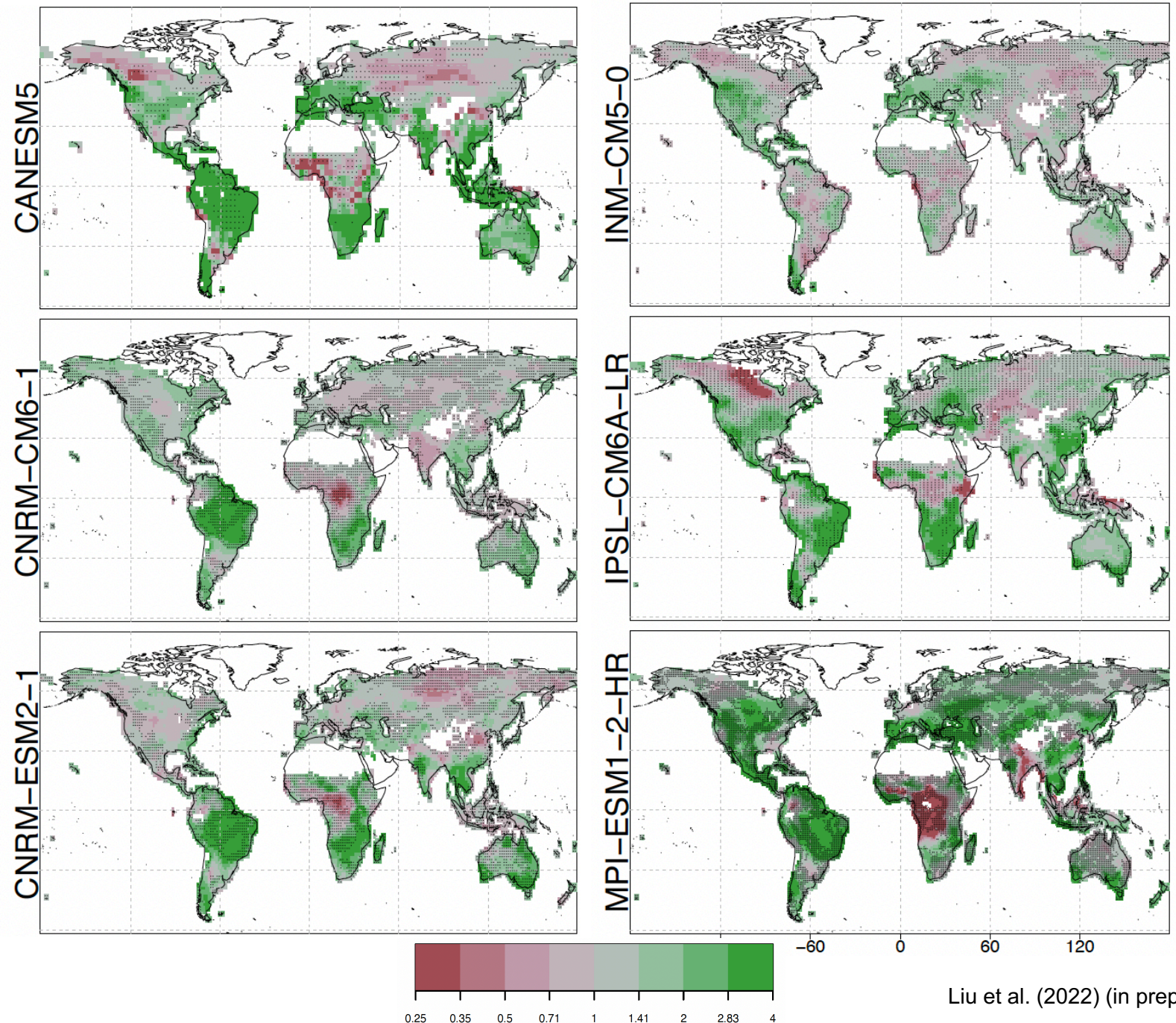
## Applications

### 3: CMIP6 [fire weather duration]

Event definition: Annual maxima in consecutive days with a 7-day FWI peak above the 90th percentile.

In many places, **prolonged** extreme fire weather condition is **twice as likely** as a result of climate change.

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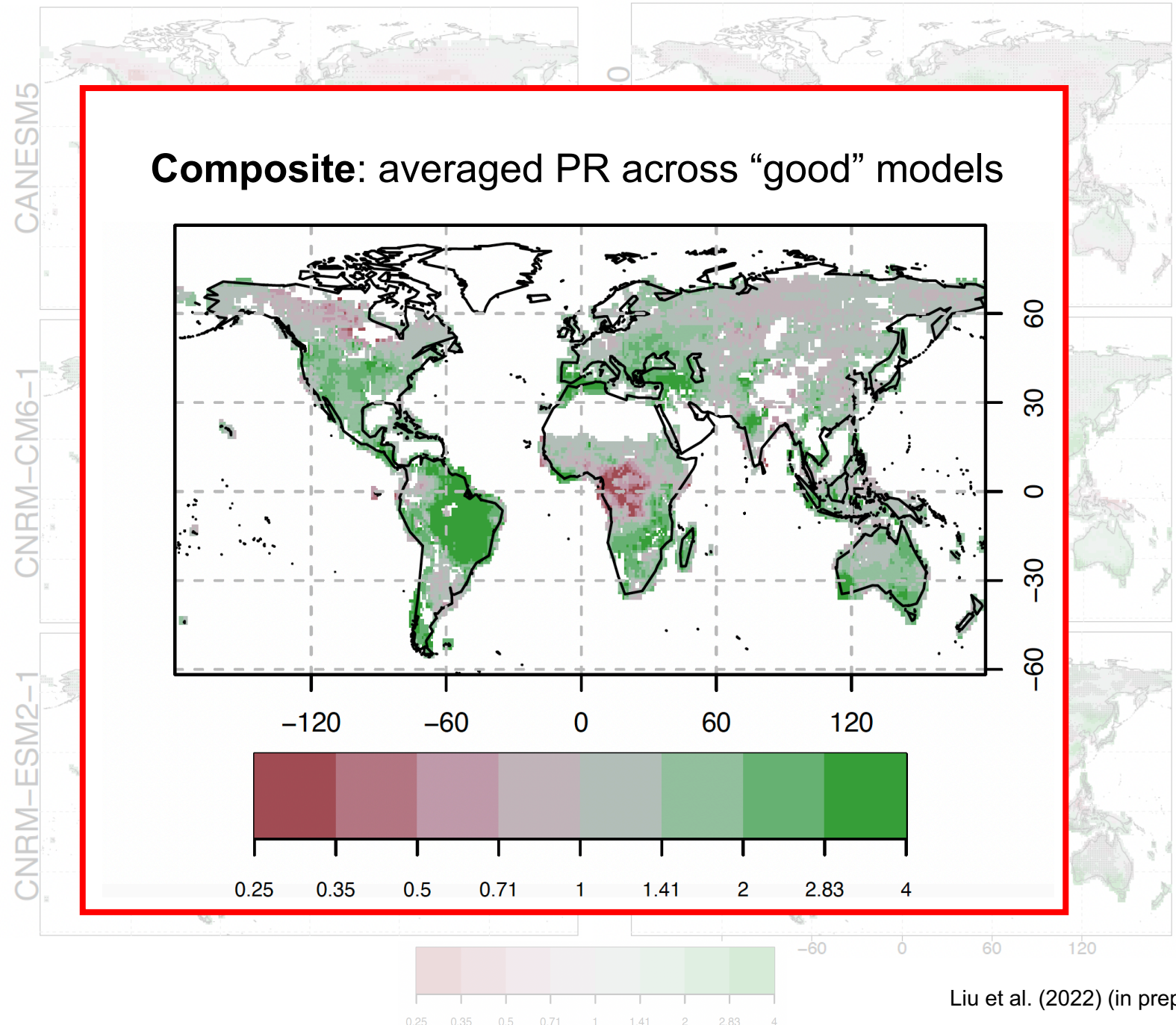
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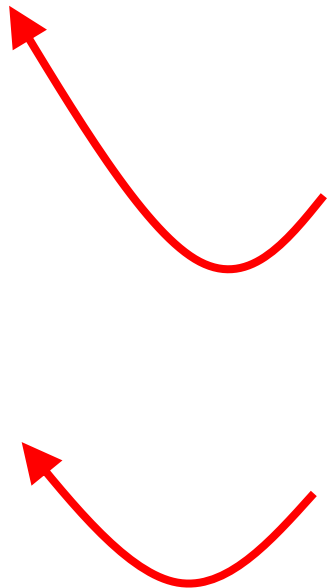




Statistical methodology

Applications

Summary



- A series of **probability ratio maps** for extremes in both the intensity and duration of fire weather from CMIP6 models is generated.
- Regional results are highly **sensitive** to the chosen climate models.
- The composition results for **intensity** and **duration** both show a significant **increases** in likelihoods ( $PR > 2$ ) in many fire-prone regions.

### Recommendations for fire weather attribution

- To use multiple model ensembles (and combine...).
- To evaluate each model's capacity to represent distribution of extremes.

### Further reading:

Global observed extreme fire weather attribution study: Liu et al. (2022). *Clim. Change* (in review).

A case study of the 2020 Siberia wildfires: Liu et al. (2022). *Bull. Am. Meteorol. Soc.*