State of Wildfires Report 2023/2024

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Douglas Hamilton, Stijn Hantson, Sarah Harris, Piyush Jain,
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Natasha Ribeiro, Bambang Saharjo, Jesus San-Miguel-Ayanz,
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International science for net zero plus

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International Partnership

What's useful?

What are we missing?

What information do you need about recent events?

What projections will help you prepare for the future?

Feedback:
https://shorturl.at/Mo50S

Report:
https://essd.copernicus.org/articles/16/3601/2024/

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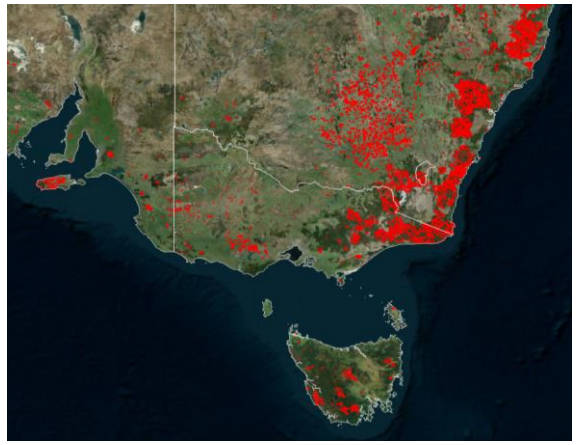
Extreme Fires are on the Rise

SE Australia, 2019-20

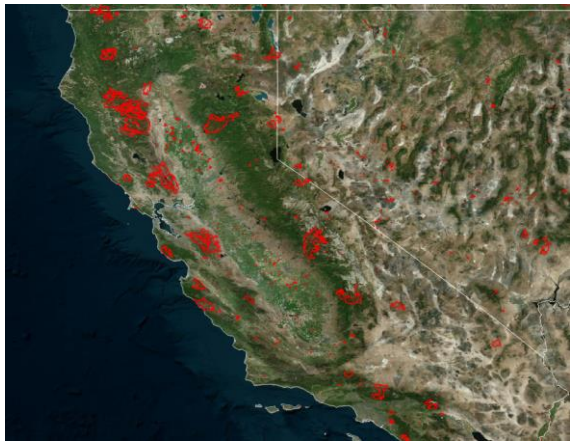

AFP



- 20m hectares burned – double the prior record.
- 33 deaths, 65,000 evacuations.
- >3,000 structures lost.
- 70 endemic species lost >30% of their habitat.

Western US, 2020

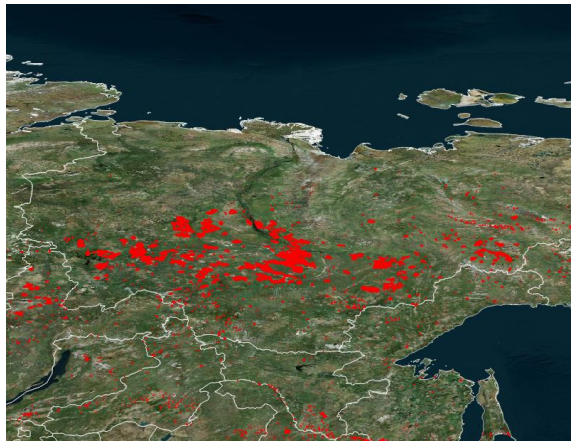

DigitalGlobe/ScapeWare3d/Getty Images



- 2m hectares burned – double prior record.
- 5 of the Top-20 largest. wildfires on record in US.
- 37 deaths, 80,000 evacuations.
- >10,000 structures lost.

Siberia, 2021


Getty



- 20m hectares burned.
- Regional fire emissions record - 5 times average (similar to UK fossil fuels).
- 21 deaths, 1,000 evacuations.

Mediterranean, 2022


REUTERS/Rodrigo Antunes

- ~1m hectares burned – 2nd highest on record.
- Large number of 'critical' high-severity fires synchronously burning in France, Spain, Portugal, Slovenia and Czechia.
- 41 deaths, 45,000 evacuations.

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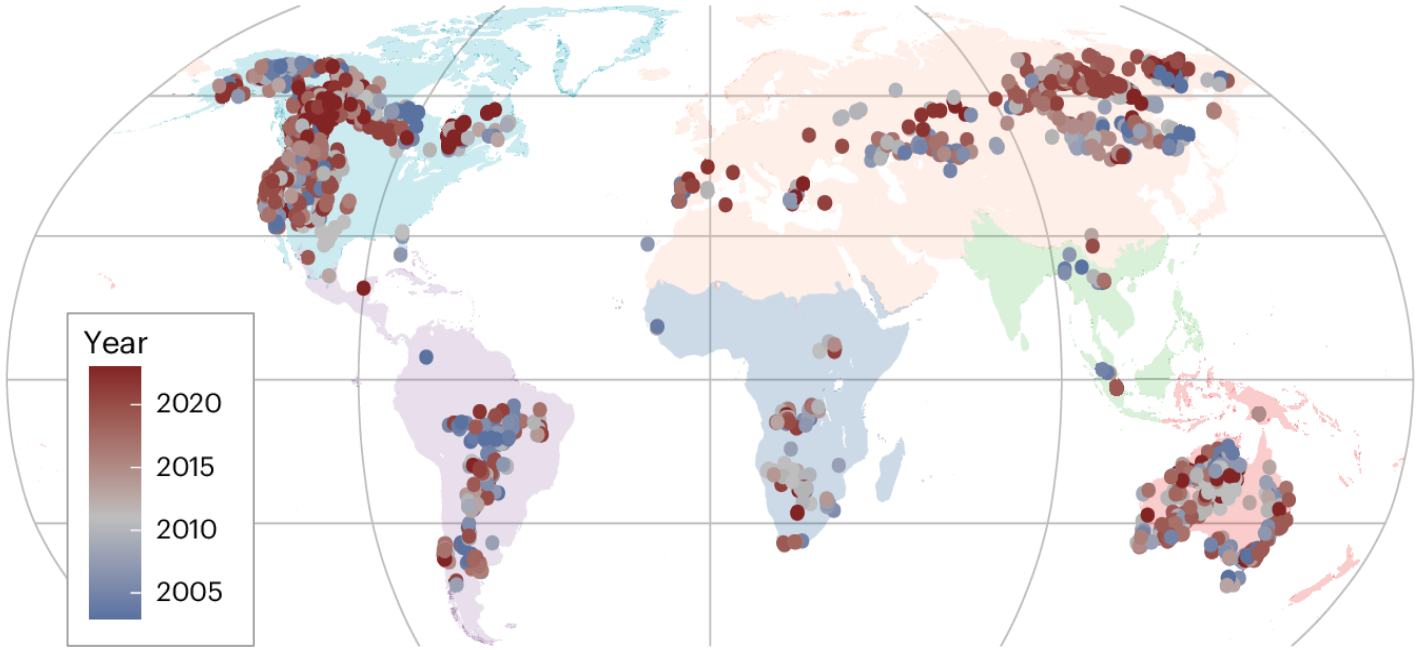

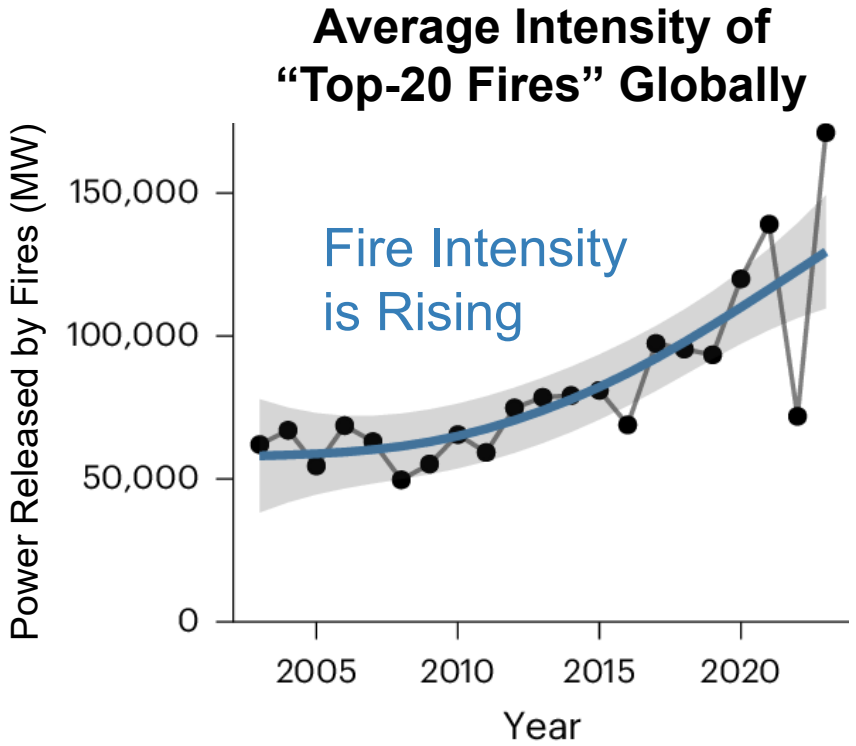

Cunningham et al. (June 2024) Nature Earth & Env., doi: 10.1038/s41559-024-02452-2

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Key Extremes of the 2023-24 Fire Season

Canada


Eyevine / Xinhua News Agency

Almost a decade's worth of fire emissions in one fire season. 230,000 evacuations.

Amazonas, Brazil


REUTERS/Bruno Kelly

Manaus temporarily had among the worst air quality on the planet.

Greece


Maxar Technologies

Largest wildfire ever recorded in Europe.

Chile


JAVIER TORRES / AFP

Valparaíso wildfire leaves 131 dead.

Hawaii


AP

Lahaina wildfire leaves 100 dead.

Venezuela, Bolivia, Peru, Pantanal


Henry González/Mongabay

Continued drought brings high fire counts and emissions extending into 2024.

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Society's Questions to Scientists

Was this the worse fire season?

Is climate change to blame?

Did land management factors contribute?

Was this predictable?

Is this the "new normal"? Will it get worse?

Will delivering on climate commitments help to avoid a repeat?

How can land use or land management policy help?

Can firefighters be better prepared and resourced?

How should governments invest to tackle the problem?

The State of Wildfires Report

Identify the Extremes → Assess the Causes → Attribute to Climate Change → Predict Future Likelihood

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The State of Wildfires Report

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Earth Observations (Satellite Images)

Regional Expert Panel

Meteorological Reanalysis (Weather Datasets)

Probabilistic Fire Models (Simulations using Observations)

Hadley Centre Climate Model (UK's Flagship Atmosphere Model)

UK Land Model 'JULES' (UK's Flagship Land Model)

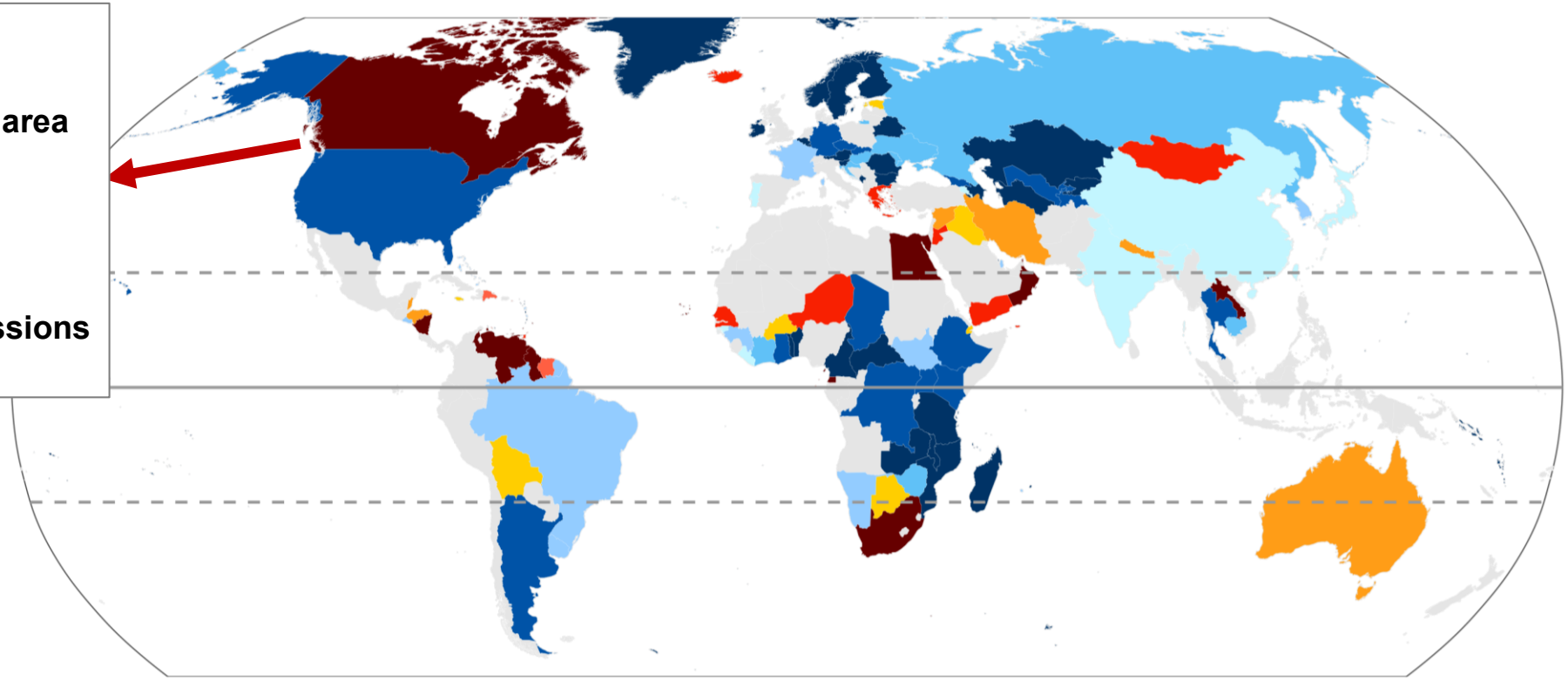
2023-24 was a Year of Extremes

>6x

greater **burned area** than usual.

>9x

greater **CO_2 emissions** than usual.



Burned Area

Rank of the 2023-24 Fire Season versus all since 2002

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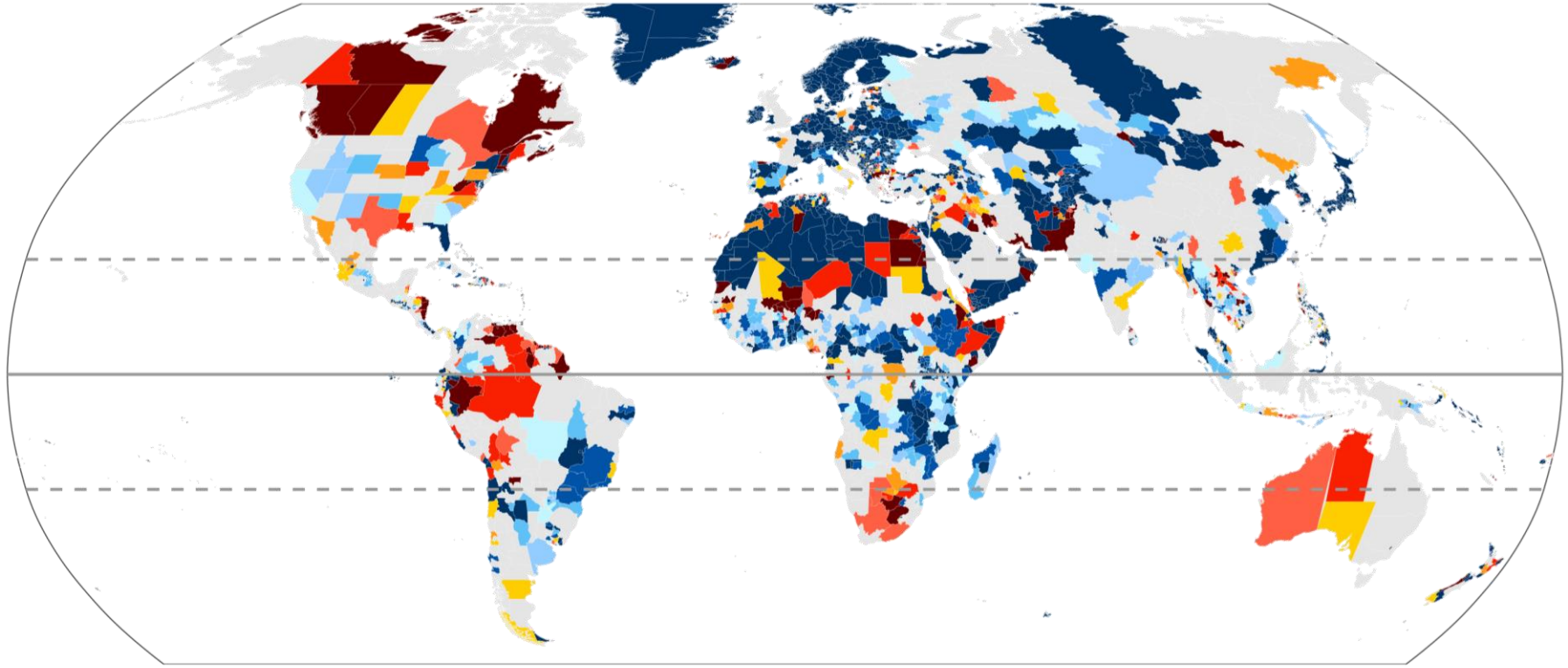
2023-24 was a Year of Extremes



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Rank of the 2023-24 Fire Season versus all since 2002

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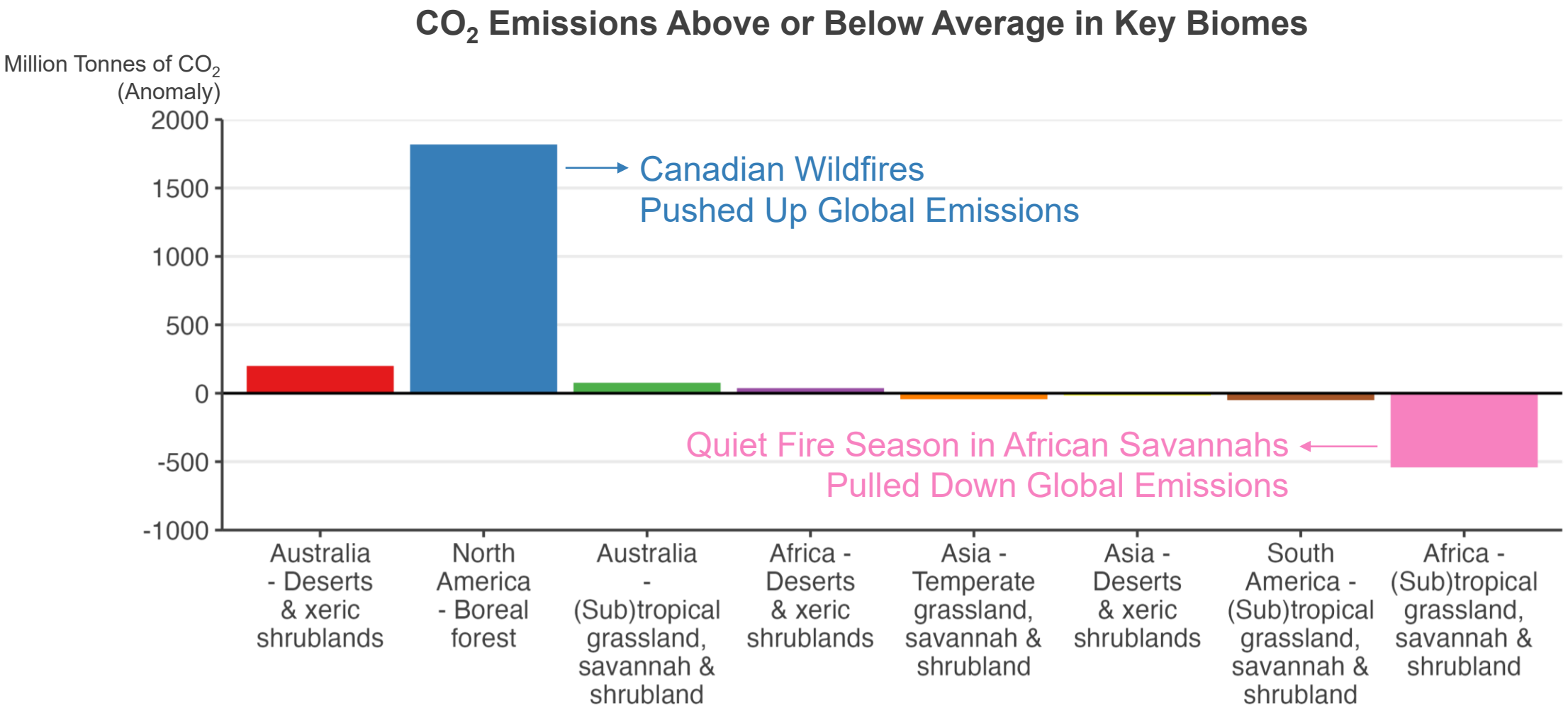
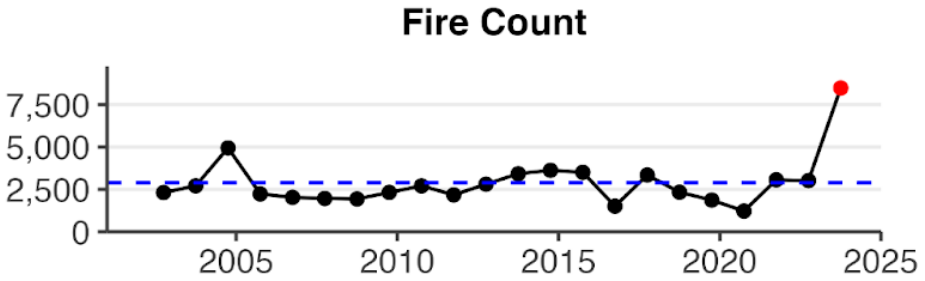
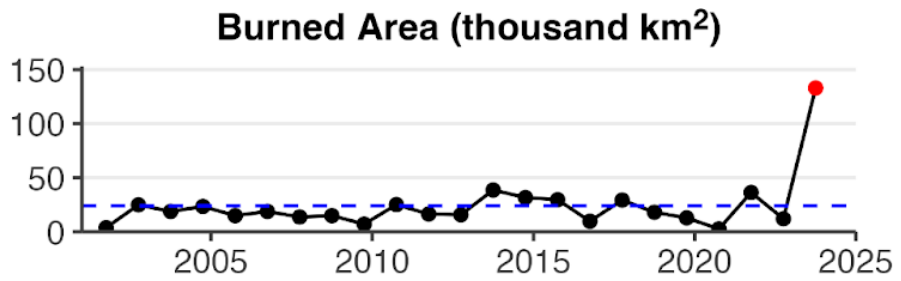
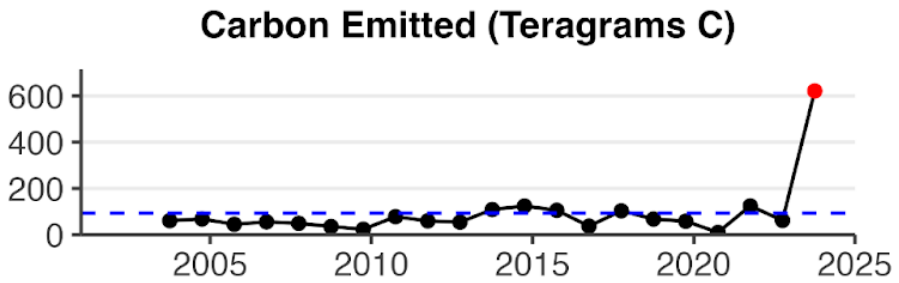
2023-24 was a Year of Extremes

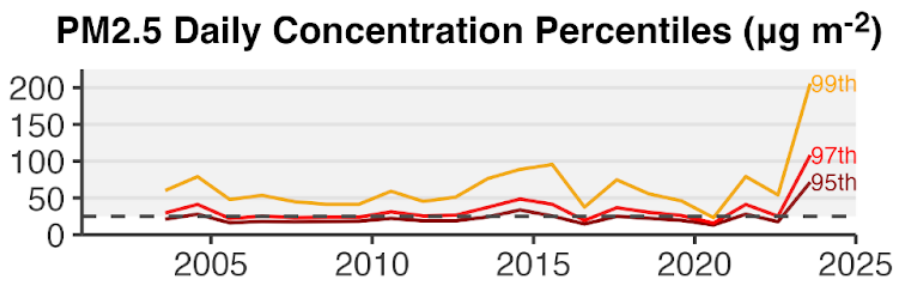


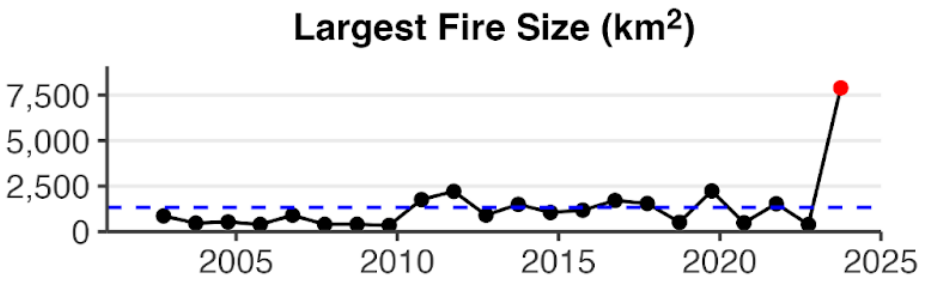
Canada 2023 was Record-Breaking

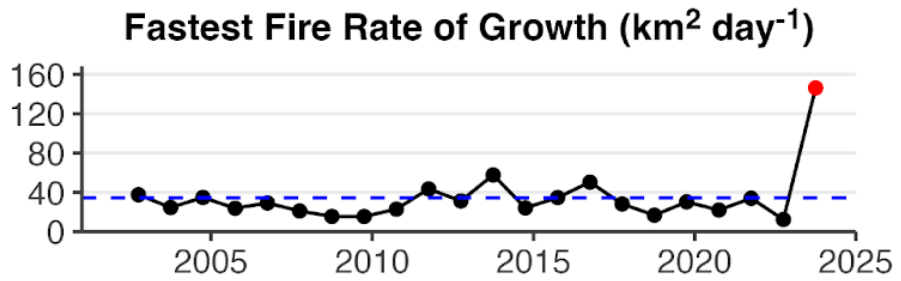












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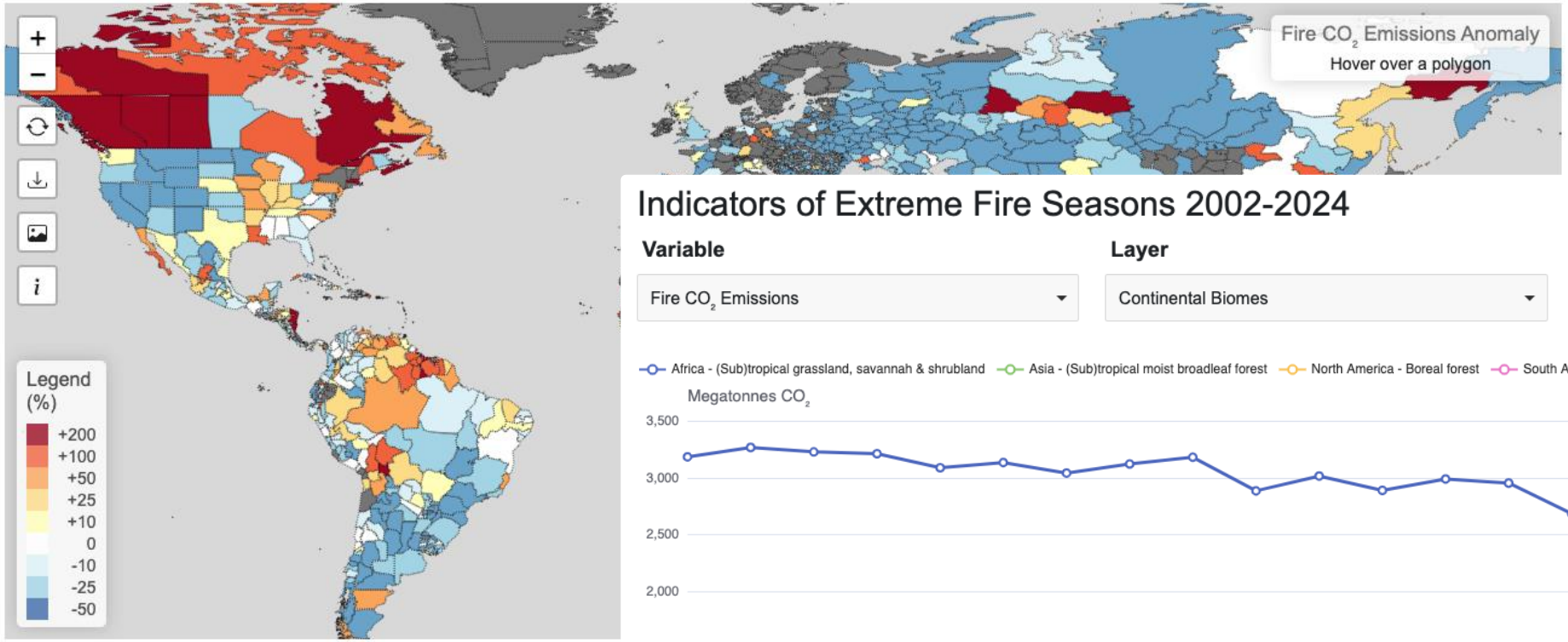
Extremes of the 2023-2024 Fire Season

Variable

Fire CO_2 Emissions Anomaly

Layer

States and Provinces



Indicators of Extreme Fire Seasons 2002-2024

Variable

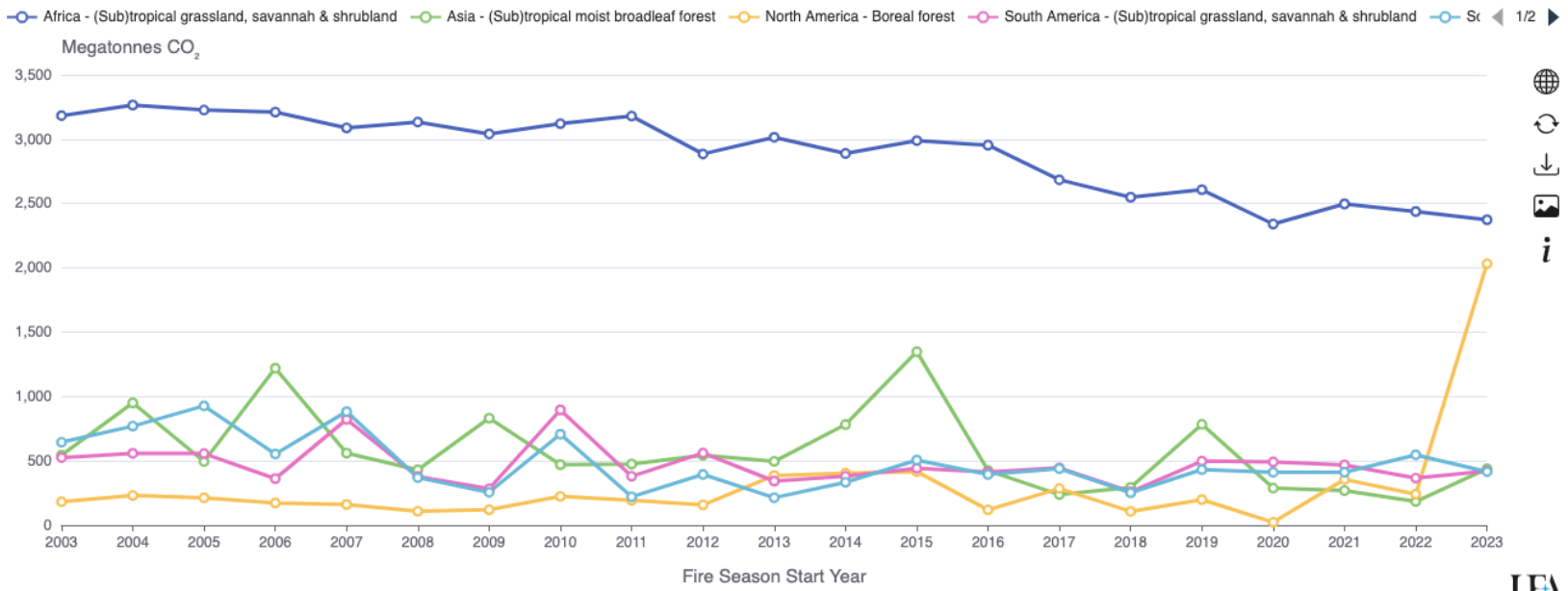
Fire CO_2 Emissions

Layer

Continental Biomes

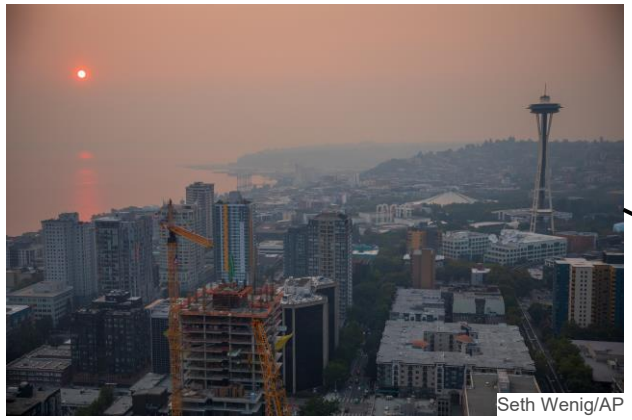
Region

Select Region

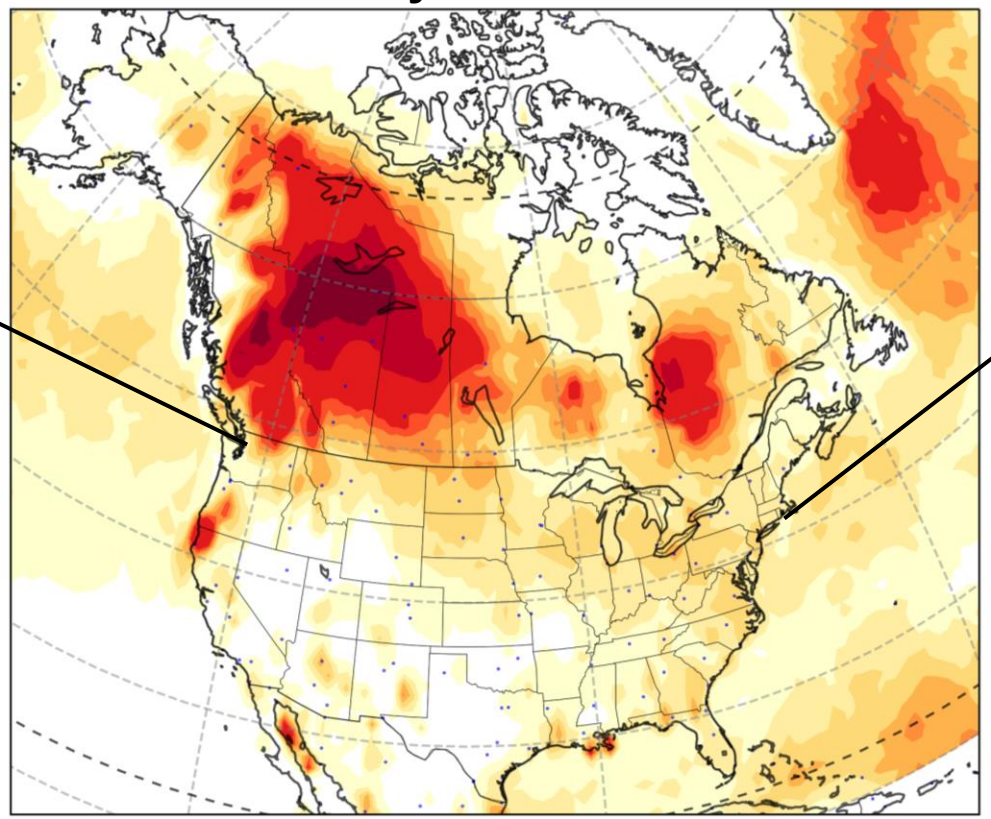


Full Consequences Yet to Unfold

Number of Days in 2023 with Air Quality Worse than WHO Guideline (35 µg PM2.5/m³)



Seth Wenig/AP



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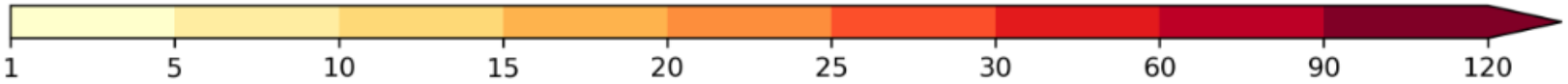

Number of Days

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Identify the Extremes → Assess the Causes → Attribute to Climate Change → Predict Future Likelihood

3 selected events

Canada

Eyevine / Xinhua News Agency

Western Amazonia

REUTERS/Bruno Kelly

Greece

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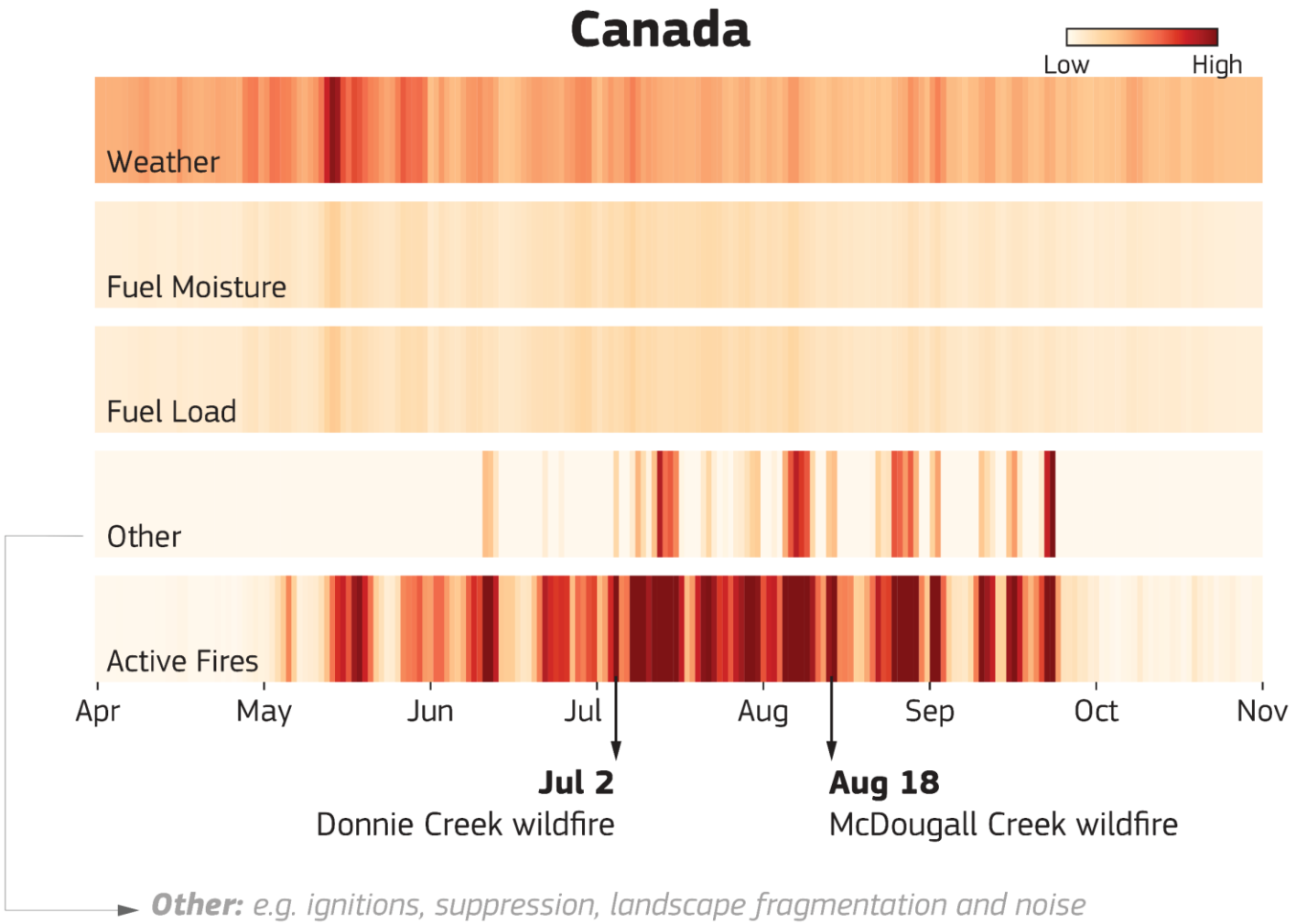
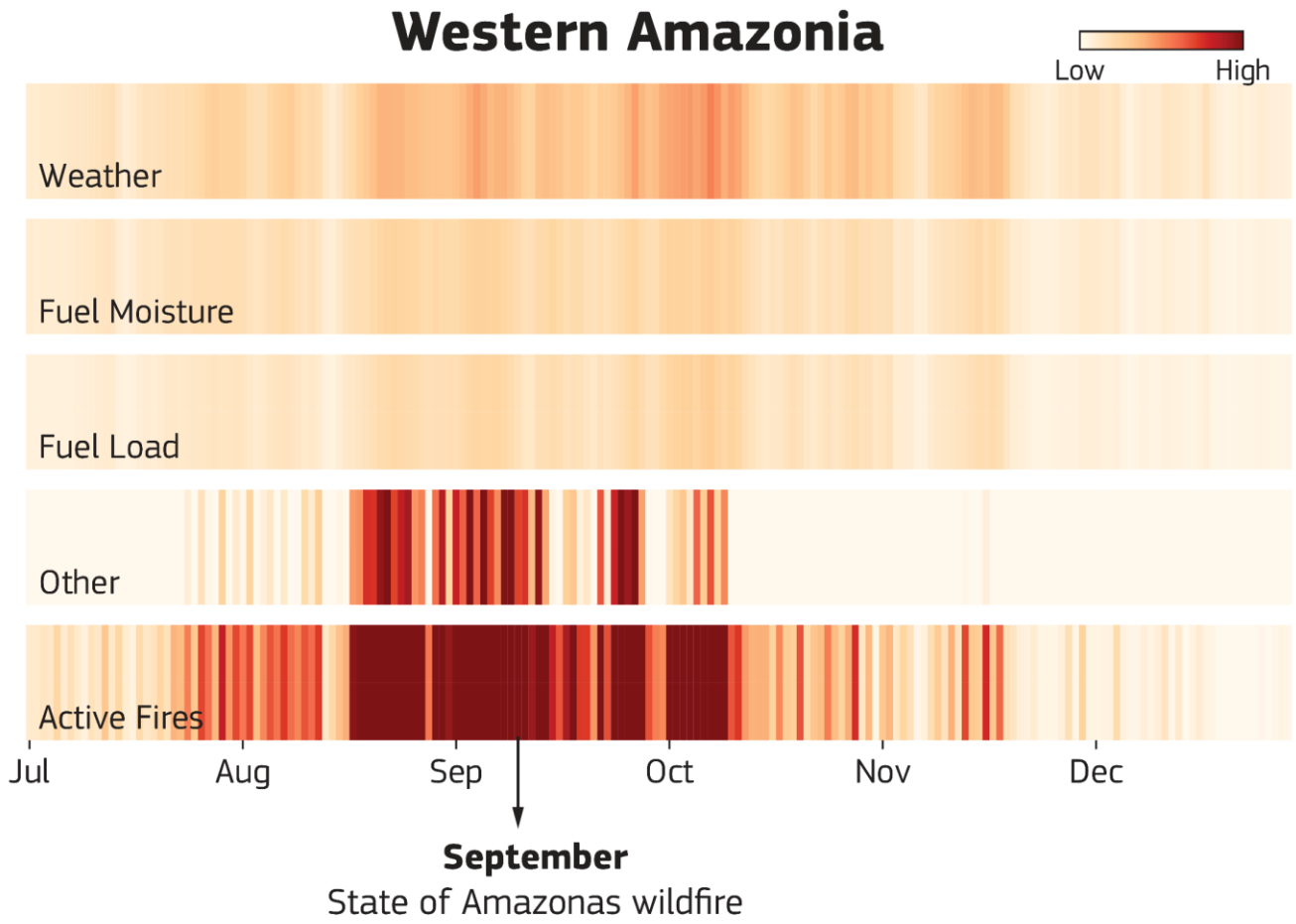
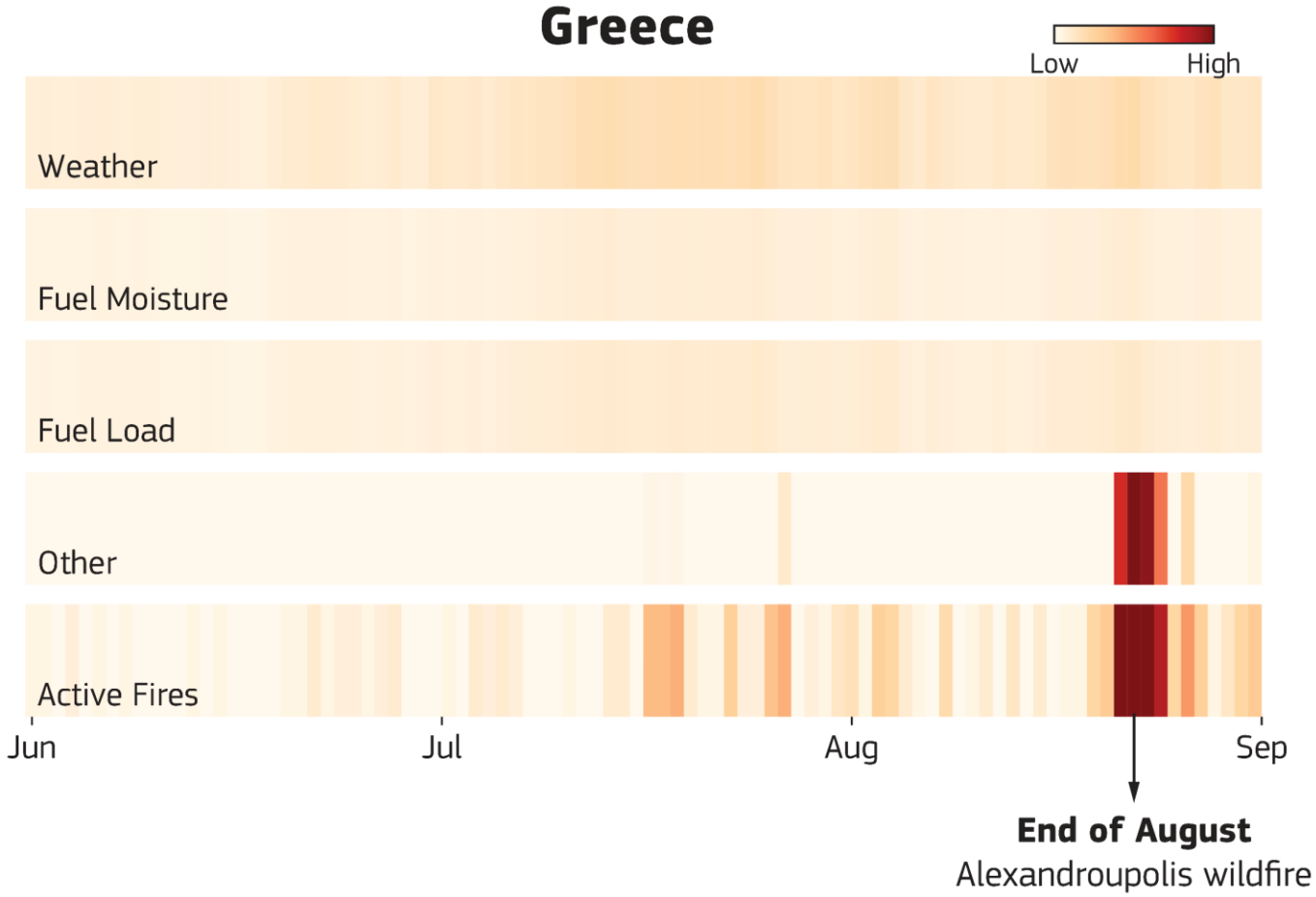
Controls on Canada's Extreme Fire Season



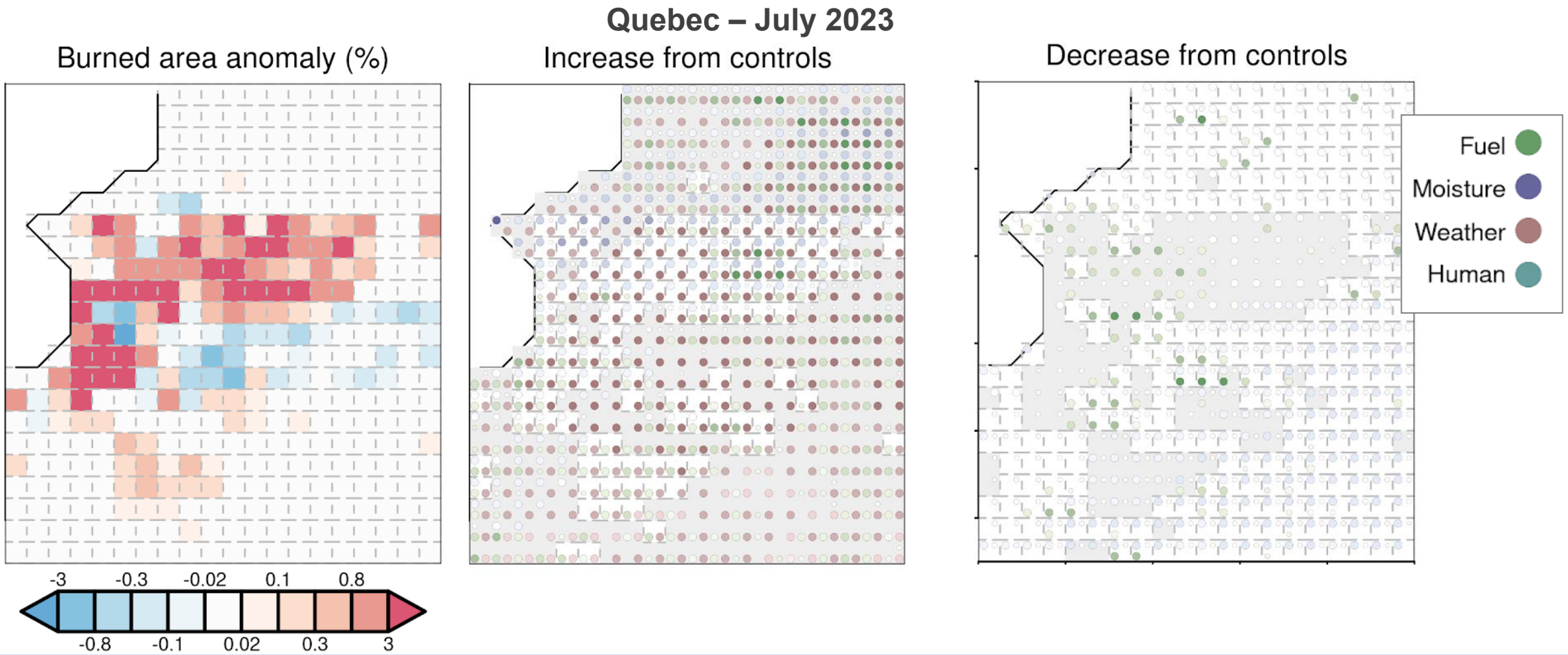
Controls on Amazonia's Extreme Fire Season



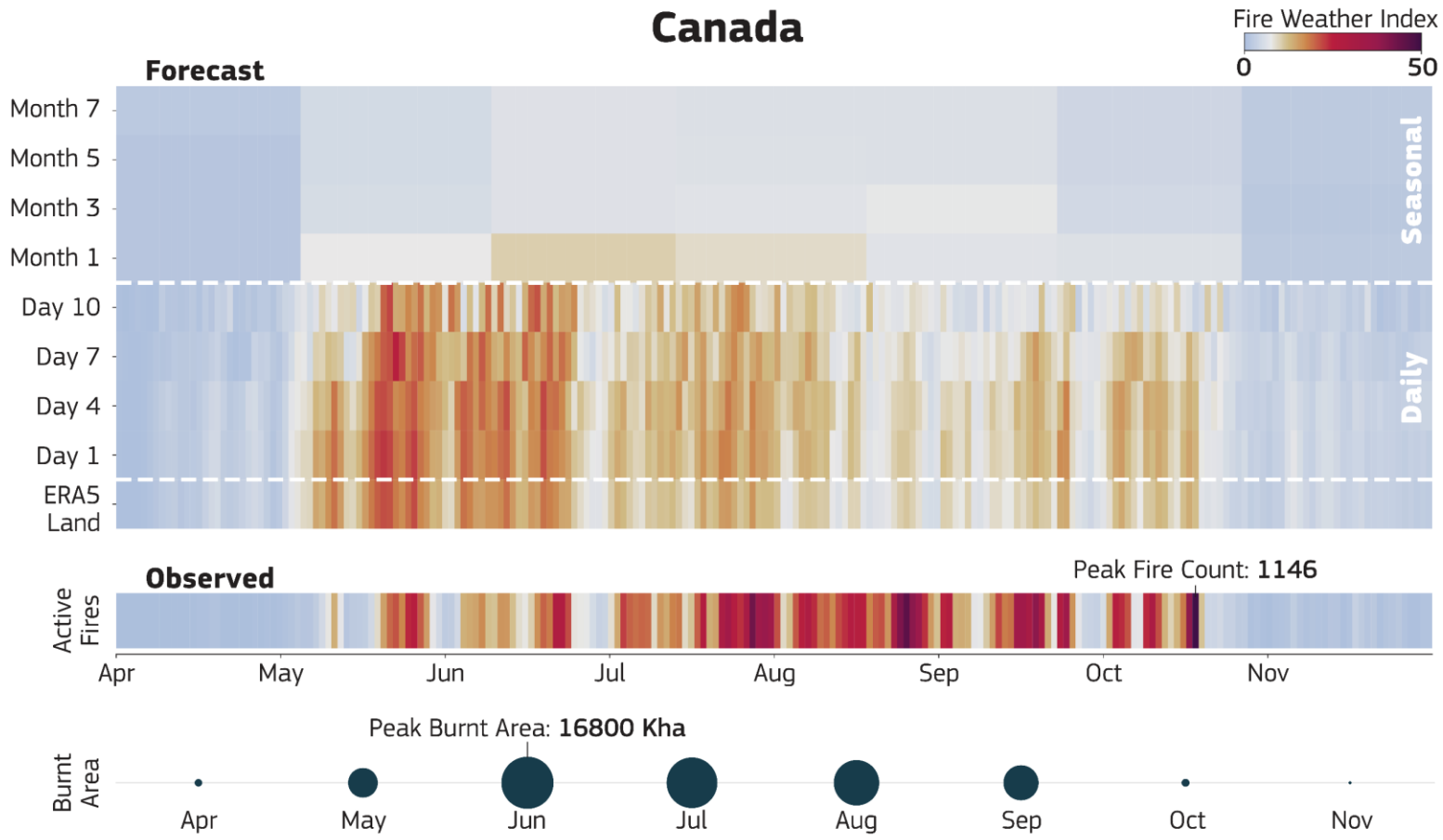
Controls on Greece's Extreme Fire Season



Not Just Weather: No Fire without Fuel, Ignitions



Extreme Fires were Predictable in Canada



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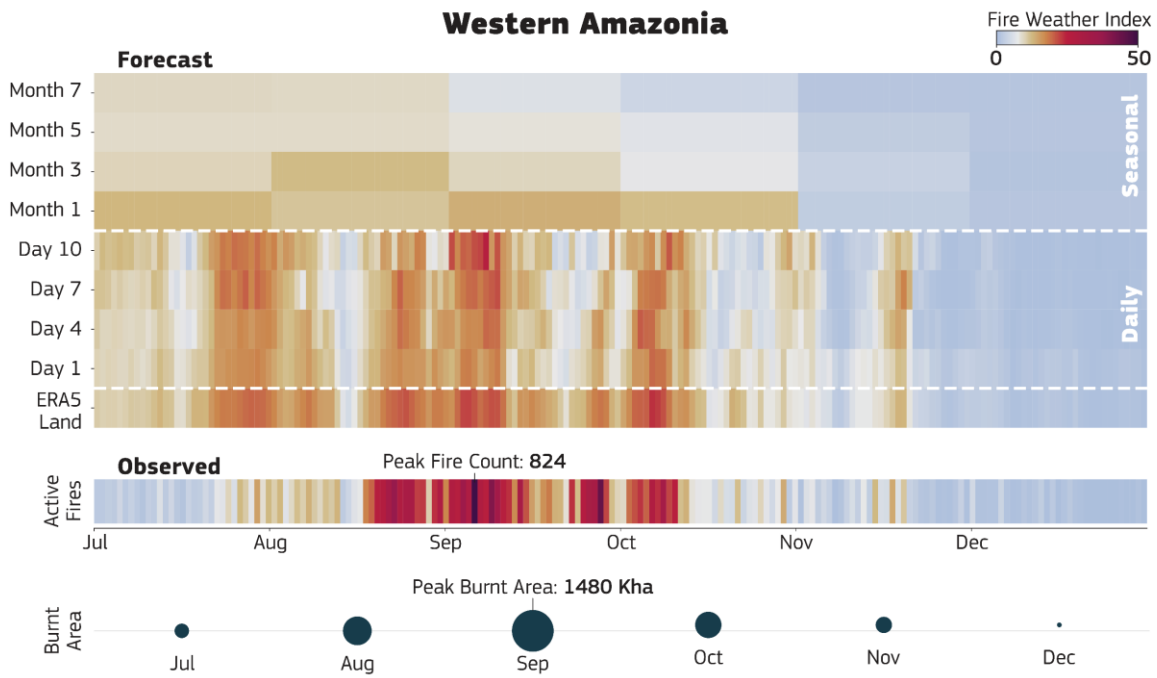
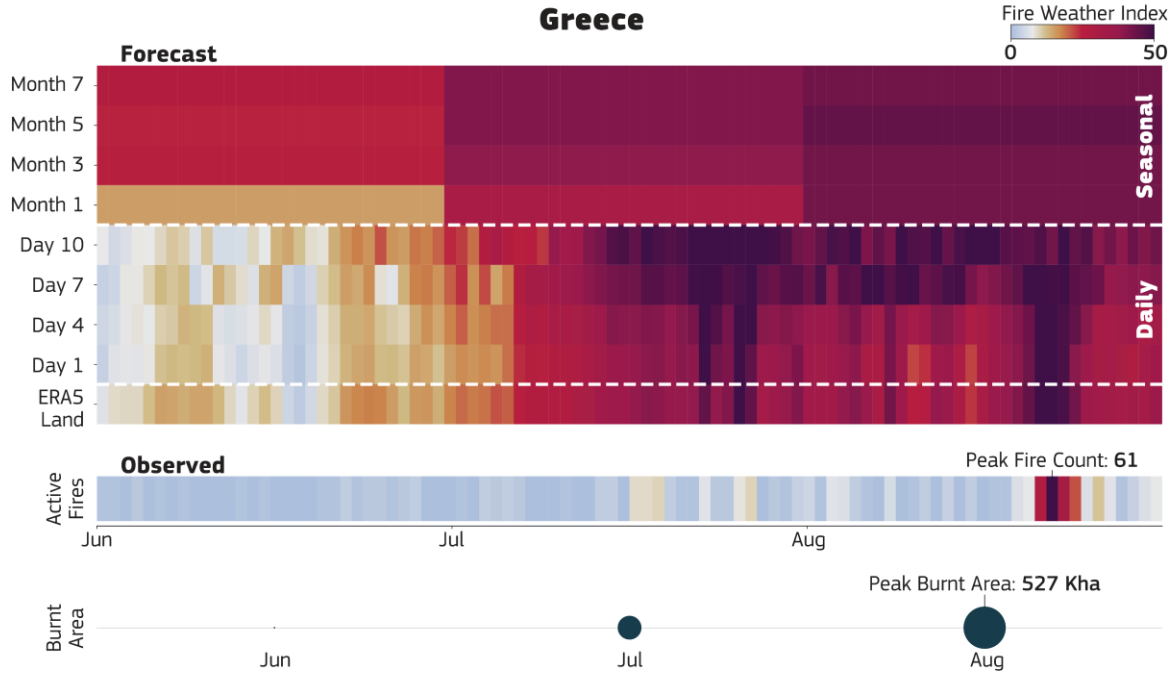
But not in other regions





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3 selected events

Canada	Western Amazonia	Greece
 Eyevine / Xinhua News Agency	 REUTERS/Bruno Kelly	 Maxar Technologies

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How we Attribute to Climate Change

Different approaches to answer the question:

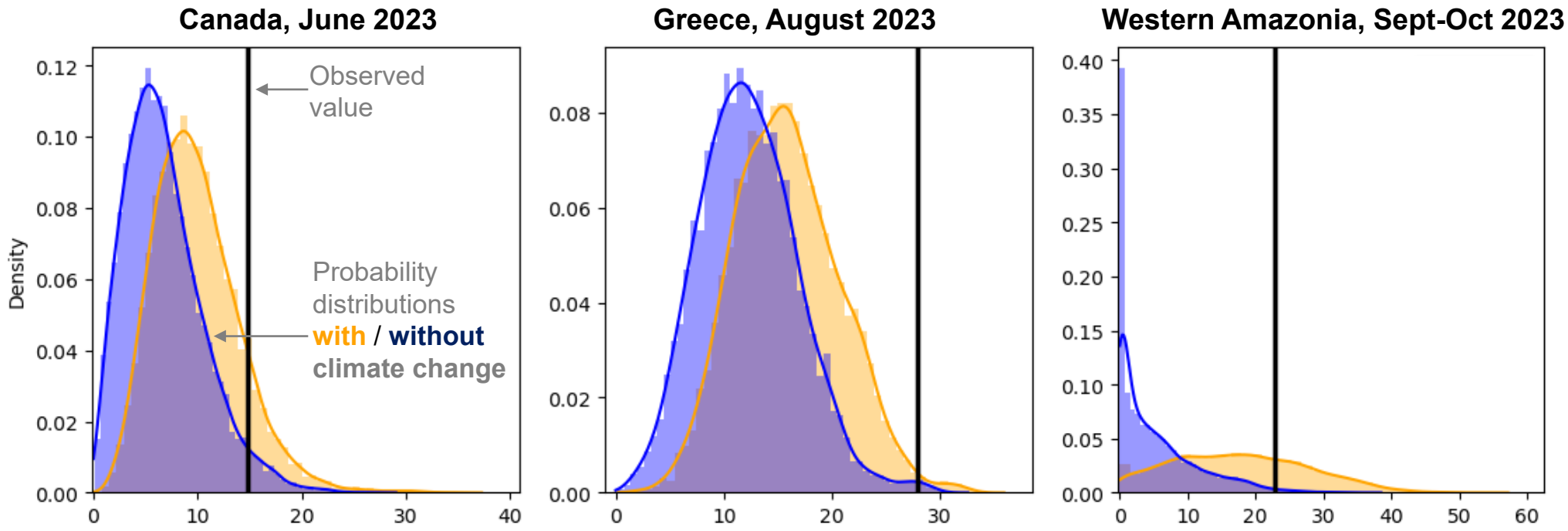
How much has climate change increased the probability of the 2023 fires?

Fire Weather

Peak burned area

We use modelling to look at simulations with vs without climate change

Climate Change Raised the Odds of Fire-prone Weather



Fire Weather Index (Rating Fire Danger)

3x	>2x	>20x
more likely due to climate change	more likely due to climate change	more likely due to climate change

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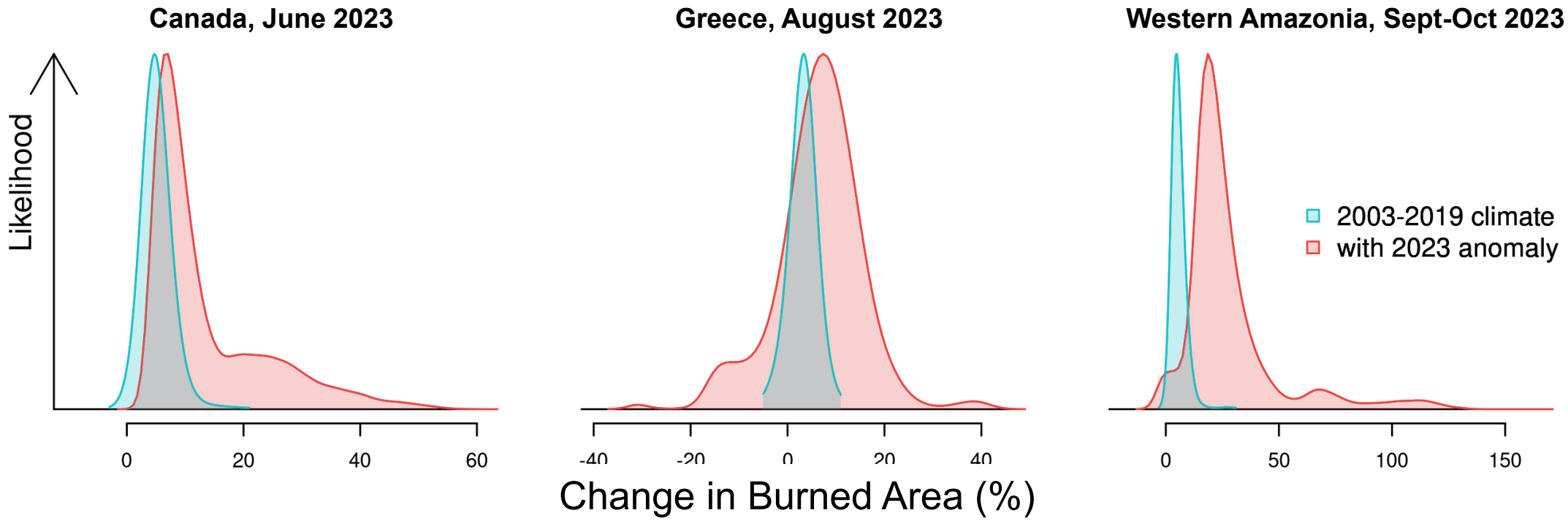
Climate Change Caused Larger Area Burned



Up to 40%
more land area burned due to climate change

Up to 18%
more land area burned due to climate change

Up to 50%
more land area burned due to climate change

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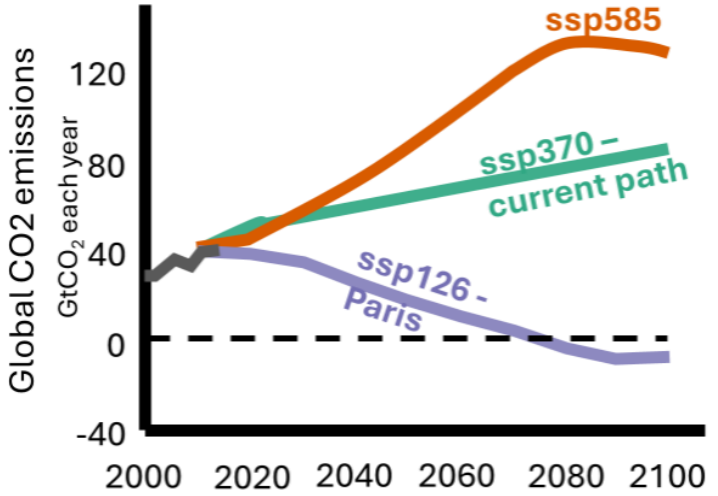
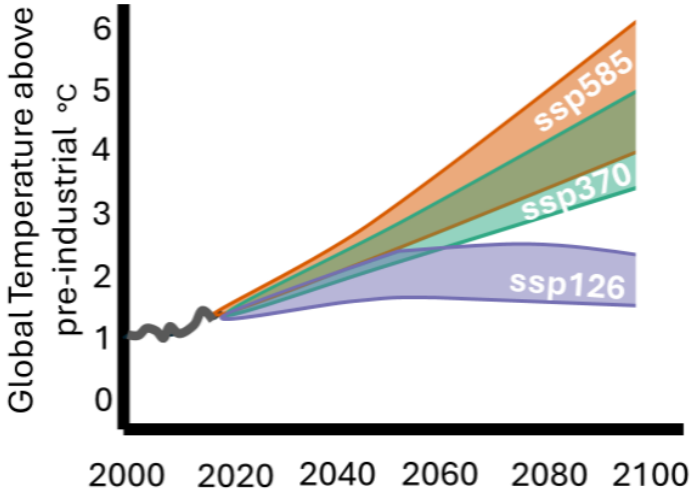
 Eyevine / Xinhua News Agency	 REUTERS/Bruno Kelly	 Maxar Technologies

Future Climate Scenarios

We tested three future emission scenarios:

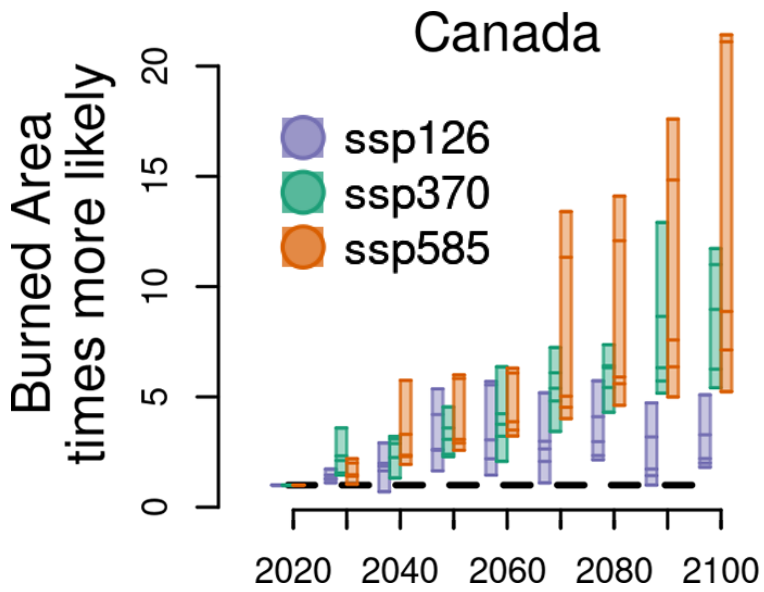
1. ‘No mitigation’ – Economy based on fossil fuel dependence (SSP585).
2. **‘Current path’** – A high-end emissions future aligned with current global trends in emissions and policies **(SSP370).**
3. **‘Low-carbon future’** – Reduce emissions and reach Net Zero, targetting Paris Agreement **(SSP126).**

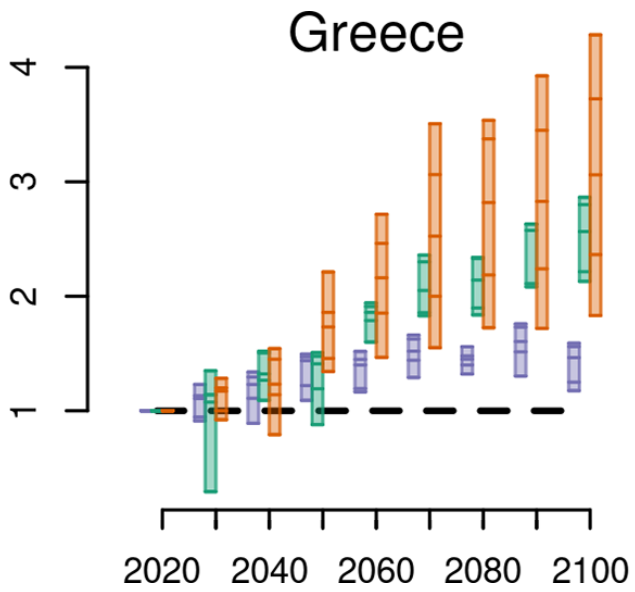


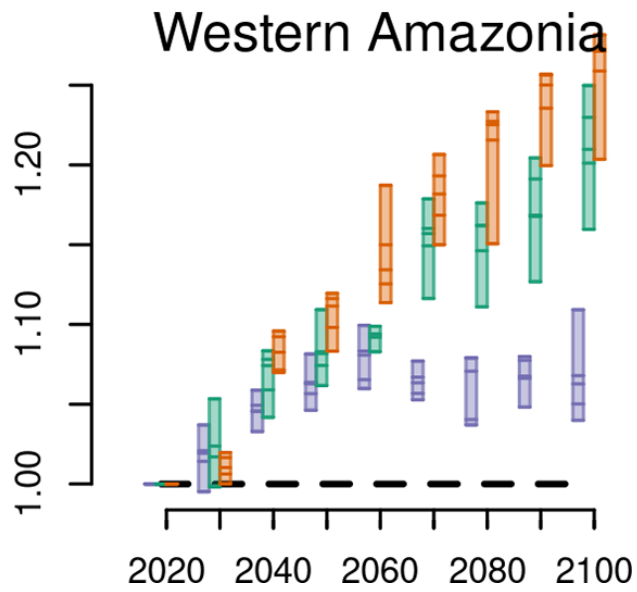


For more, see: https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/

Fire Risks Rising in Future, but can be Avoided







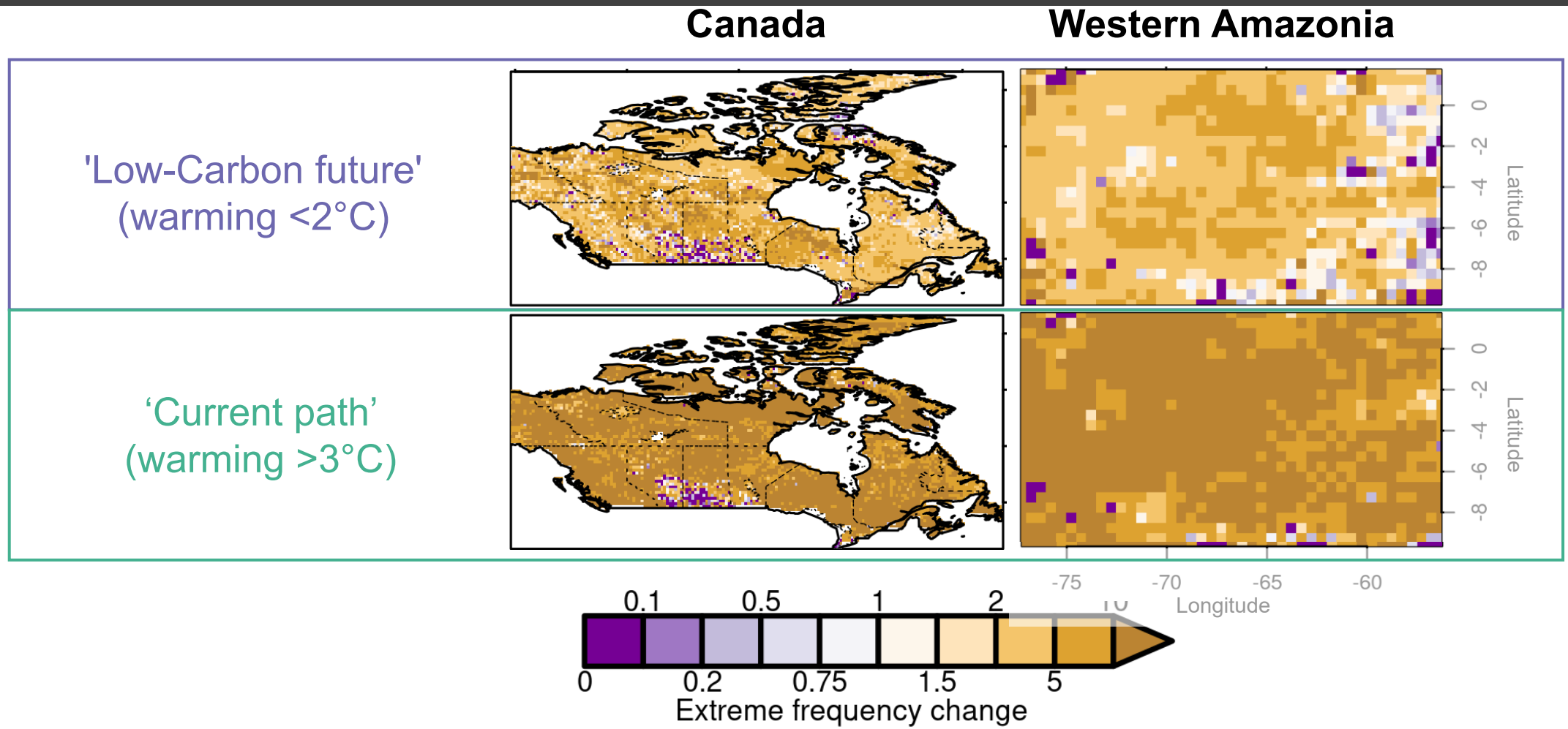
SSP370 ➡
>3°C warming

6-11x more likely by 2100 under 'current path'	**2-3x** more likely by 2100 under 'current path'	**1.2-1.3x** more likely by 2100 under 'current path'

SSP126 ➡
<2°C warming

2-3x more likely if Paris targets are hit	**NO** more likely if Paris targets are hit	**NO** more likely if Paris targets are hit

World's Forests Face Growing Wildfire Risk



Change in Likelihood of a 1-in-100 Year Event in 2090s (vs. 2010s)

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Unless global greenhouse gas emissions fall, Canadians born today face a **48-84% likelihood of witnessing an event like 2023** in their lifetime.

This is significantly greater than the **12% likelihood** faced by someone born in the 1940s.

Take-homes

- The State of Wildfires report will provide **timely, policy-relevant science** explaining extremes of the past fire season.
- Wildfires in Canada, western Amazonia, and Greece were among the stand-out features of the 2023-24 fire season, and they were **several times more likely due to climate change**.
- Fire's needed **multiple drivers** to become extreme
- Future climate change could bring further increases in the likelihood of events like 2023-24, however increases in **risk are minimised or avoided completely in a low-carbon future**.

Extreme fires &their impacts EDI

EGU25

Explore the world of extreme fire events - their characteristics, drivers, impacts, and strategies for mitigation and prevention.

Dive into the challenges of representing extreme fires in different models. Examine the potential of data science and machine learning in improving representation.

Contribute your case studies, modelling, data, and policy & management insights. Share your research that's preparing us for future extreme wildfire events.

To submit an abstract by 15th Jan &
Full session information

https://meetingorganizer.copernicus.org/EGU25/session/52195

Or email doukel@ceh.ac.uk, stijn.hantson@urosario.edu.co or any co-conveners for info

Thanks

Matt Jones, UEA, identifying extremes
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Francesca di Giuseppe, ECMWF, drivers
(francesca.digiuseppe@ecmwf.int)

Chantelle Burton, Met Office, attribution
(maternity leave, back for 2025/26)

Doug Kelley, UKCEH, attribution stand in, outlook
(doukel@ceh.ac.uk)

and many others

Maxar Technologies

University of East Anglia

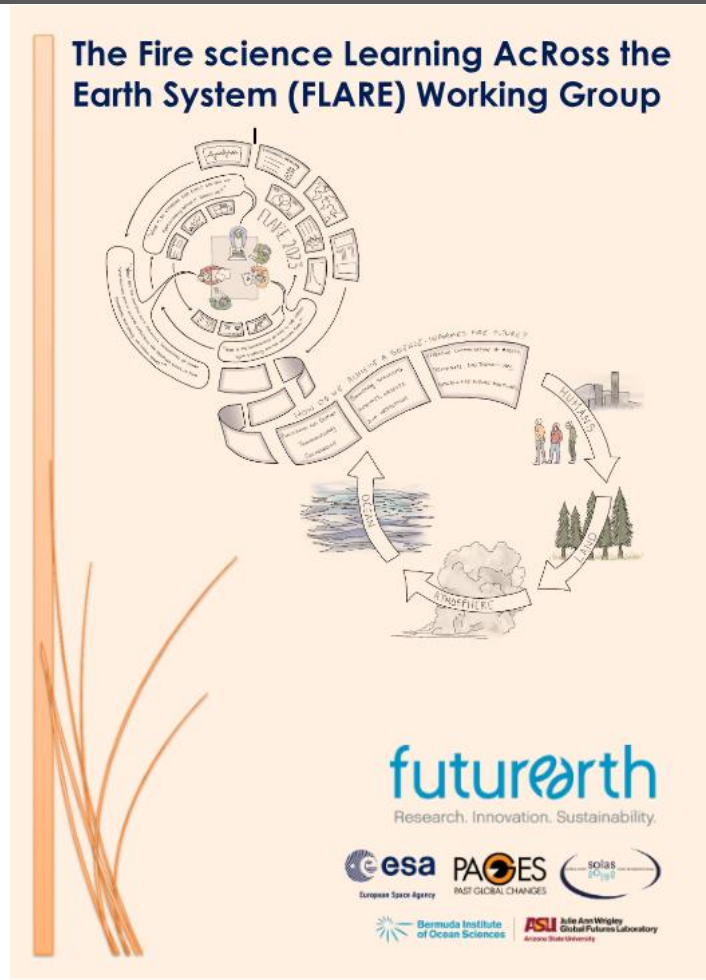
UK Centre for Ecology & Hydrology

Met Office

ECMWF

Extreme Fires are on the Rise

https://tinyurl.com/3ktw4w26



https://tinyurl.com/mpc5vk9b

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NATIONAL CAPABILITY FOR GLOBAL CHALLENGES

Tyndall Centre for Climate Change Research

Thanks

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UK Centre for Ecology & Hydrology

Met Office

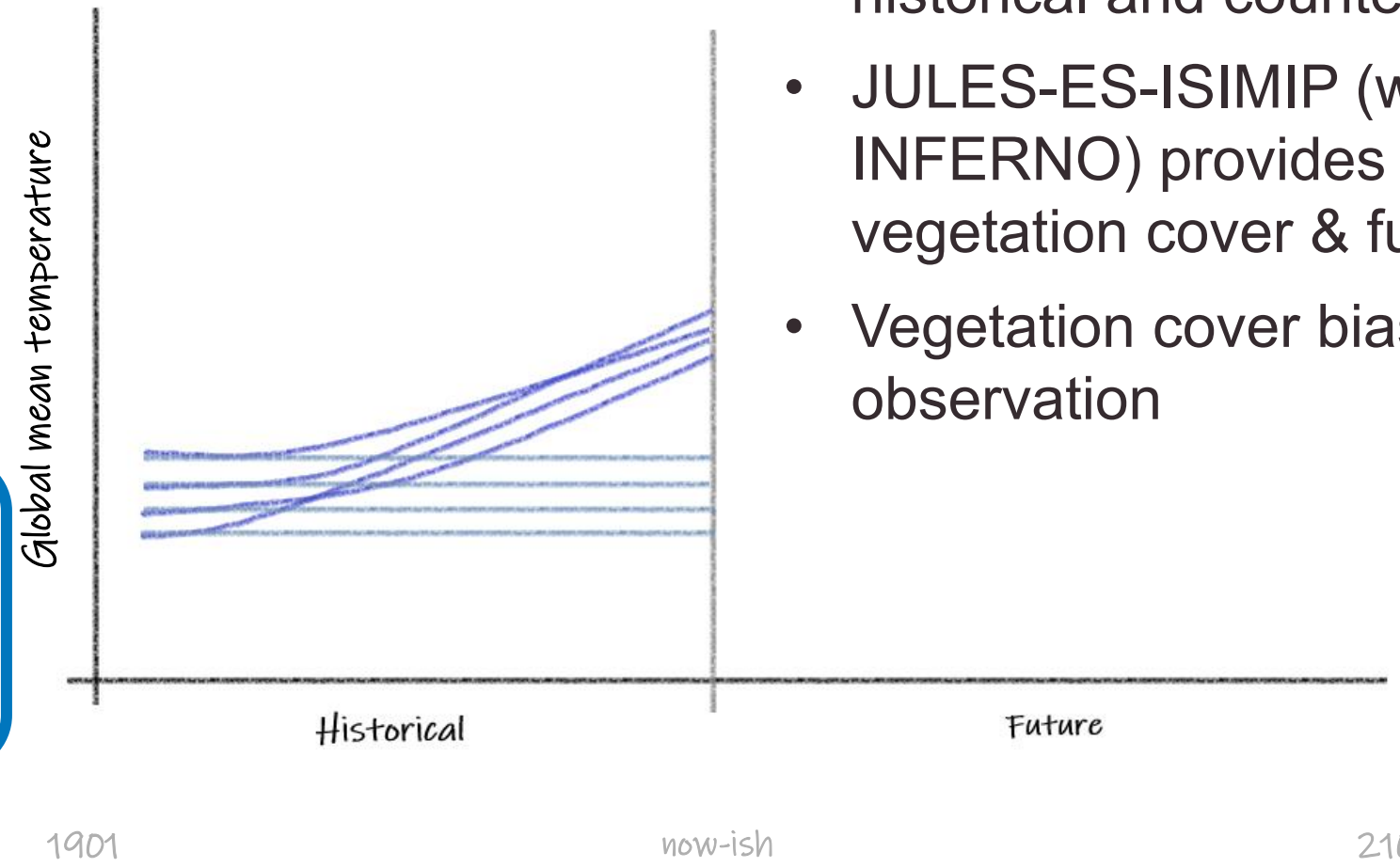
ECMWF

- Metrological data from ISIMIP3a historical and counter climate
- JULES-ES-ISIMIP (without INFERNO) provides soil moisture, vegetation cover & fuel information
- Vegetation cover bias-corrected to observation

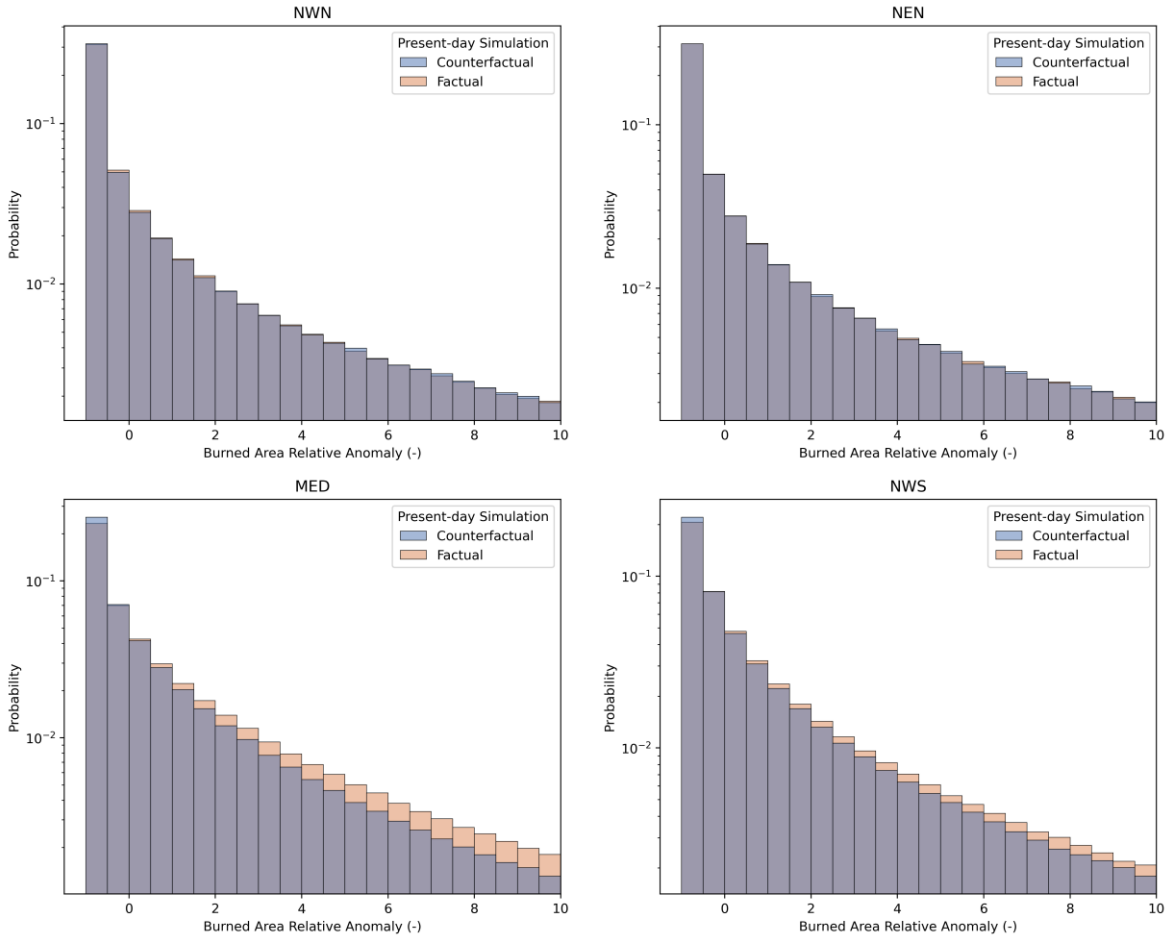
Historical climate

Counter climate

ISIMIP3a



Climate Change Causing increased overall burnt area

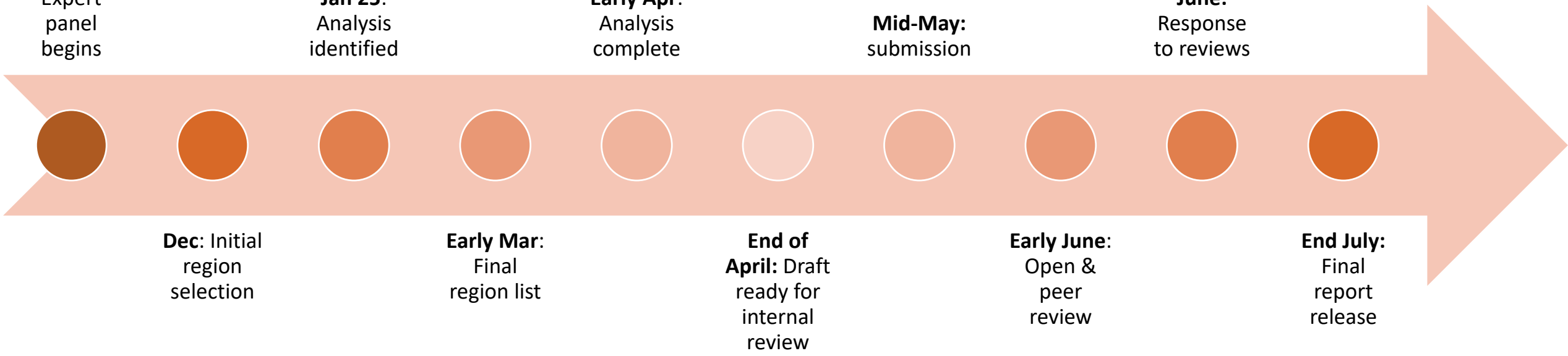


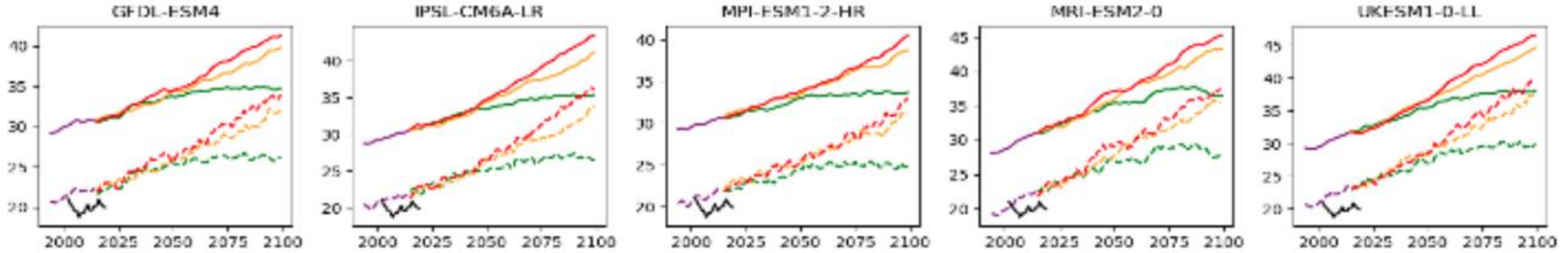
DRAFT guidance

Contributions guidelines:

- **Identify a clear research gap** (e.g., health, ecology, costs) or add new important evidence.
- **Fit within the report structure** – specify section.
- ***Timely delivery*** – *adhere to report's timeline.*
- ***Established methods*** – *peer-reviewed, published, & focused.*
- ***Use publicly available data*** – *ensure transparency.*
- ***Quantify uncertainty*** – *evidence based and including stochasticity for individual events & forcing/climate response for future projections.*
- ***Can assess driver or control interactions*** *for driver attribution.*
- **High-quality visuals** – ready for publication.
- **Policy relevance** – tie findings to real-world decisions.
- **Data sharing** – provide access to new datasets/tools.
- **Time constraints** – running on volenteer time, so we cant guarantee inclusion straight away.

Provisional Timeline





GCM SSP585

GCM SSP370

GCM SSP126

ISIMIP3b

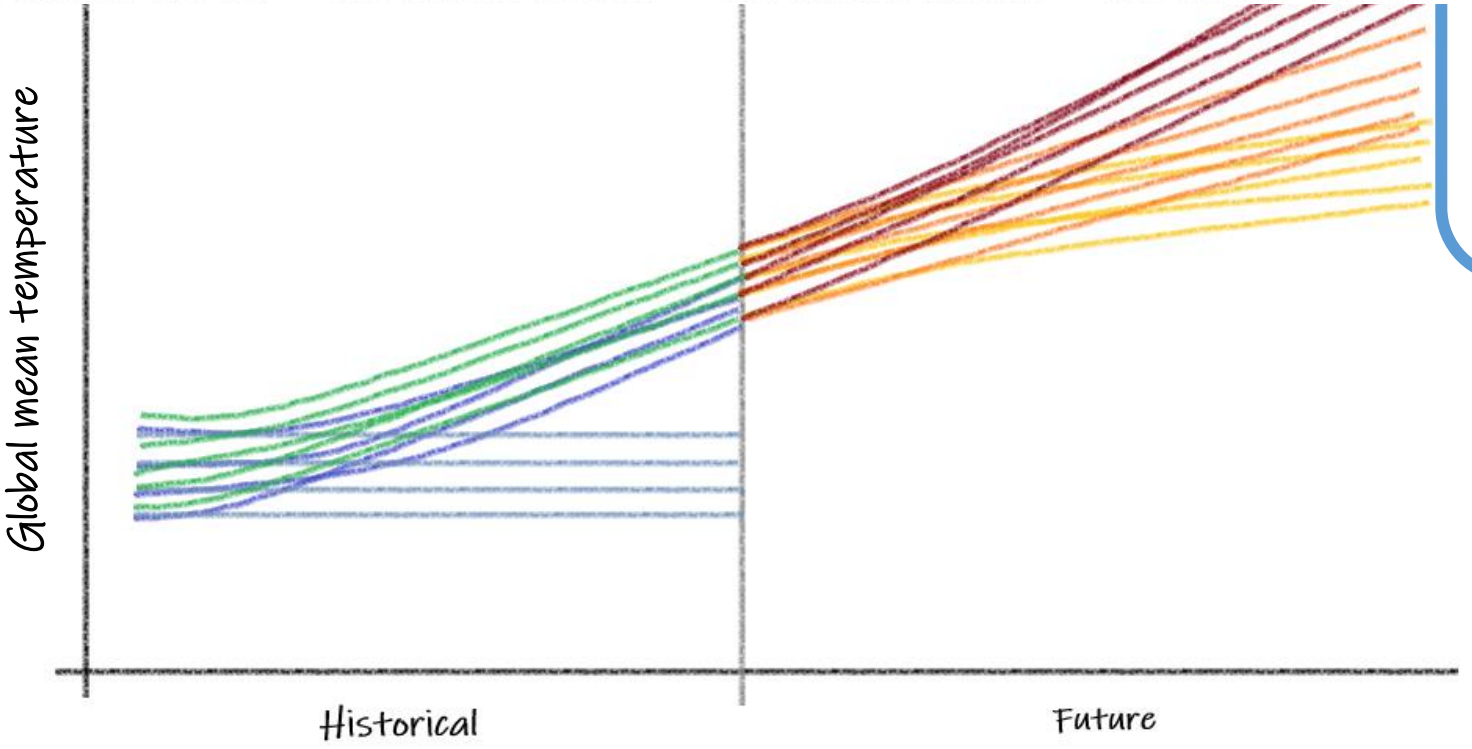
ISIMIP3b

GCM historical

Historical climate

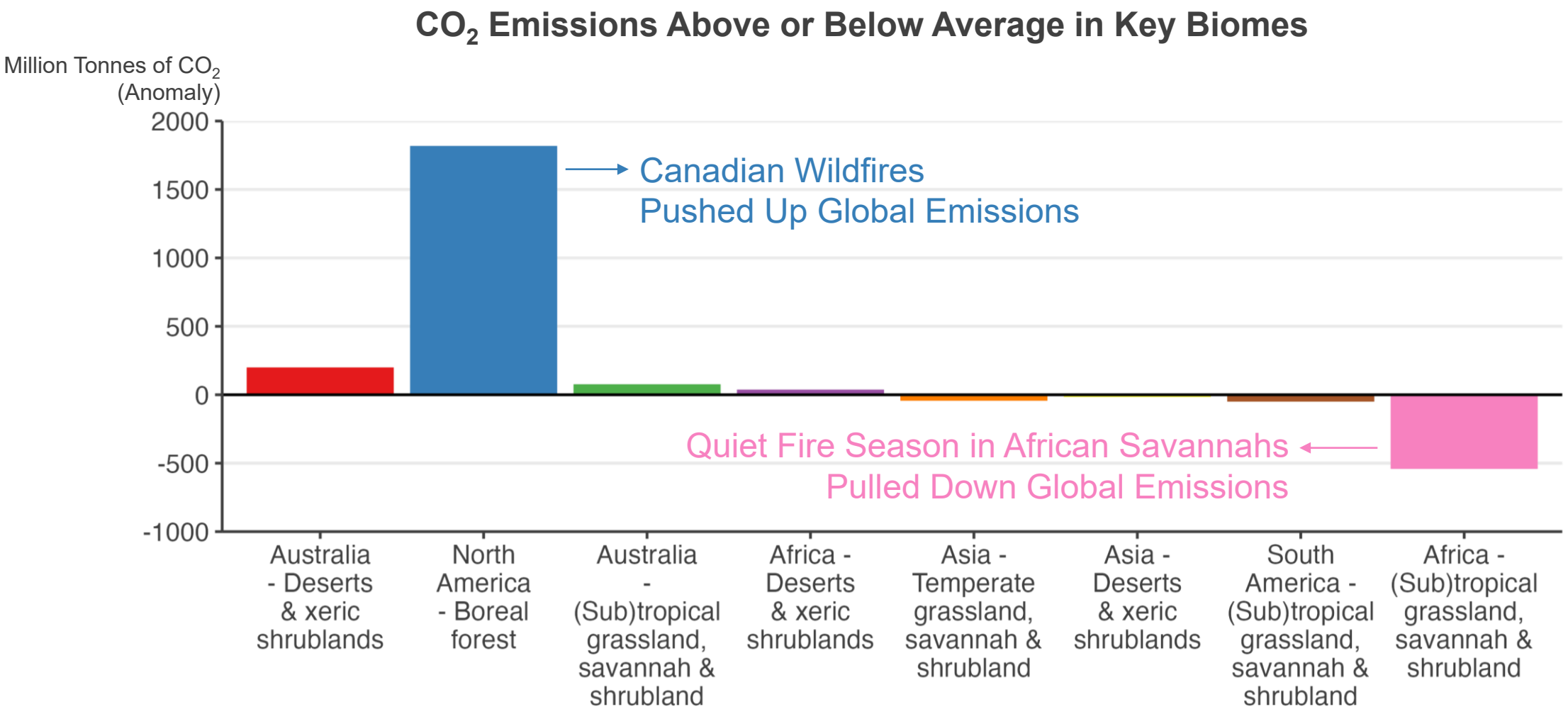
Counter climate

ISIMIP3a



1901 now-ish 2100

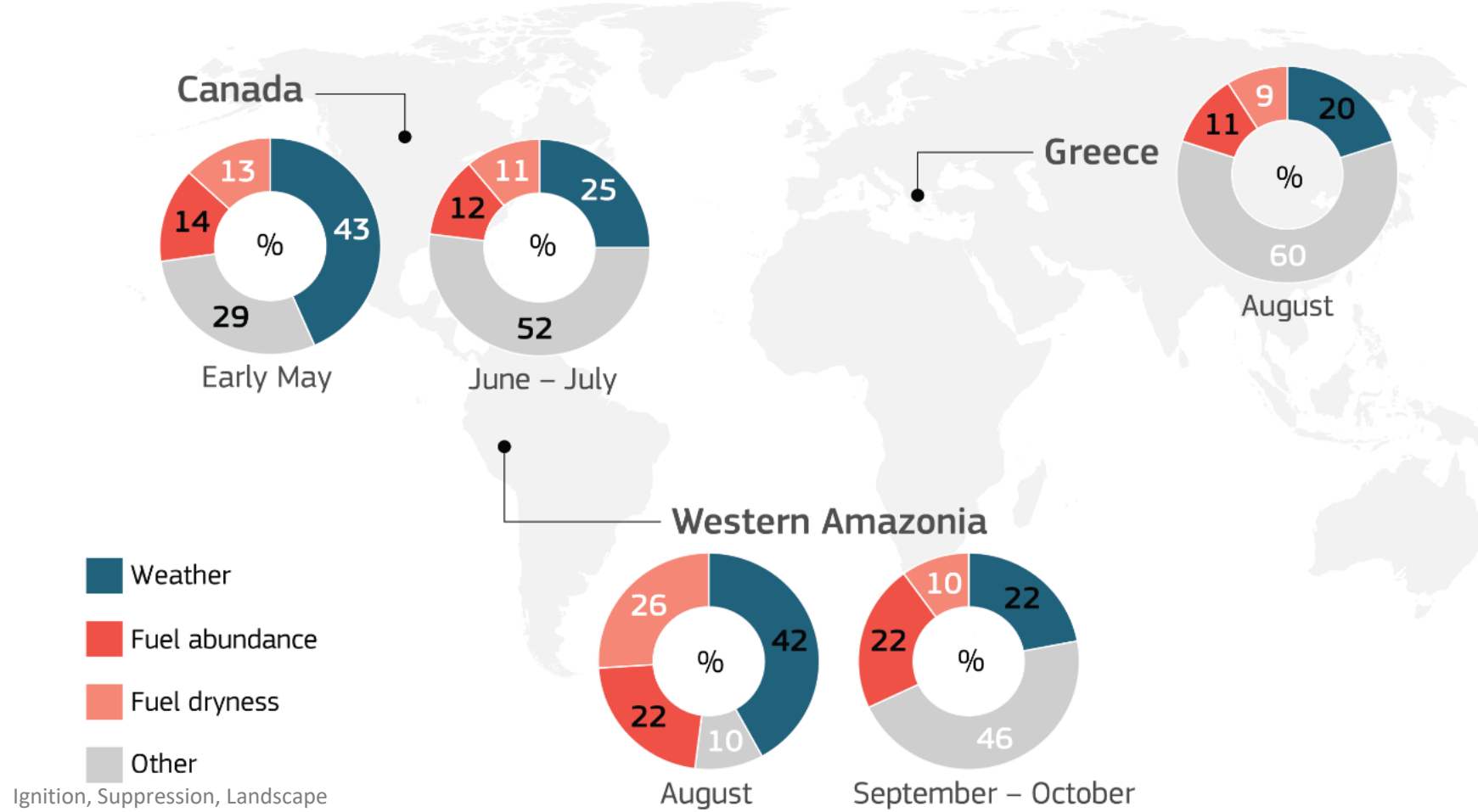
2023-24 was a Year of Extremes



What are we missing?

Do you have any relevant papers, research or tool?

Main Controls on Extreme Fires in 2023-24



Ignition, Suppression, Landscape Fragmentation and Noise