

Fire weakens land carbon sinks before 1.5°C

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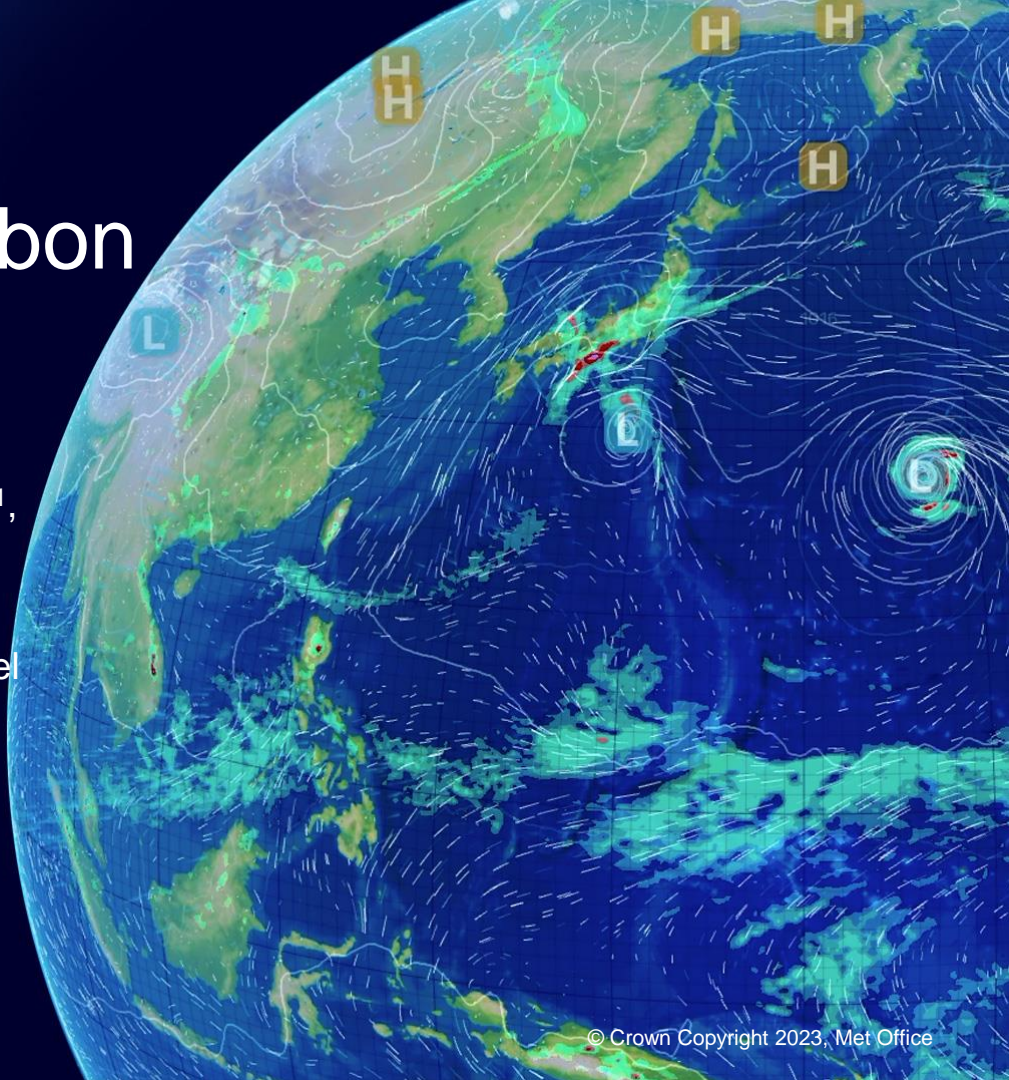
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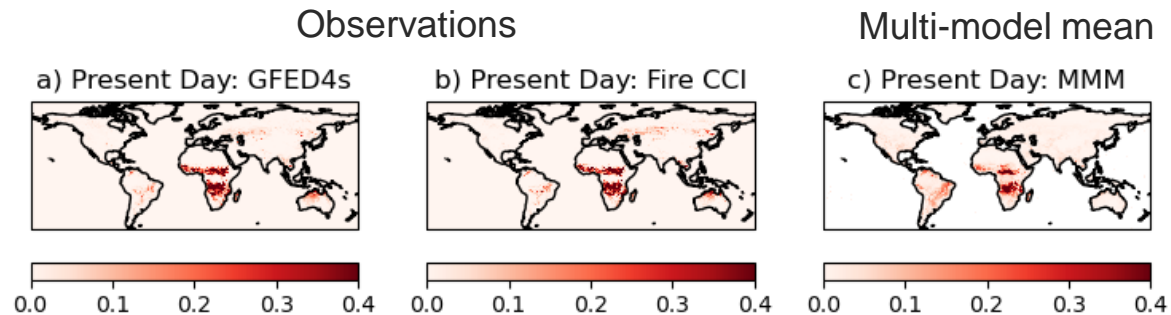


Background

- **Changes to fire regimes** are already occurring due to climate change
- **Fire impacts ecosystems and carbon stores**, and may determine alternate stable states of ecosystems (forest / savanna)
- Fire-vegetation feedbacks may **reduce the capacity of the global sink to store carbon**, as fire regimes change in the future with climate change
- **Many models** used for 1.5°C (CMIP5) **didn't include fire**
- Is 1.5°C still consistent with avoiding **significant ecosystem changes** when considering shifts in fire regimes?



Methods



- **JULES-INFERNO** - nitrogen limitation, dynamic vegetation, fire
- ISIMIP2b – 4 driving climate models (**HadGEM2-ES**, **GFDL-ESM2M**, **IPSL-CM5A-LR**, **MIROC5**)
- **Future scenarios** (RCP2.6), RCP6.0
- Fire at **Global Warming Levels** 1.5°C and 2.0°C (21 year rolling mean)
- Looking for **GWs where impacts become significant**
- Lots of **evaluation** of models for burnt area, tree cover, carbon stores

Results: Change in Burnt Area

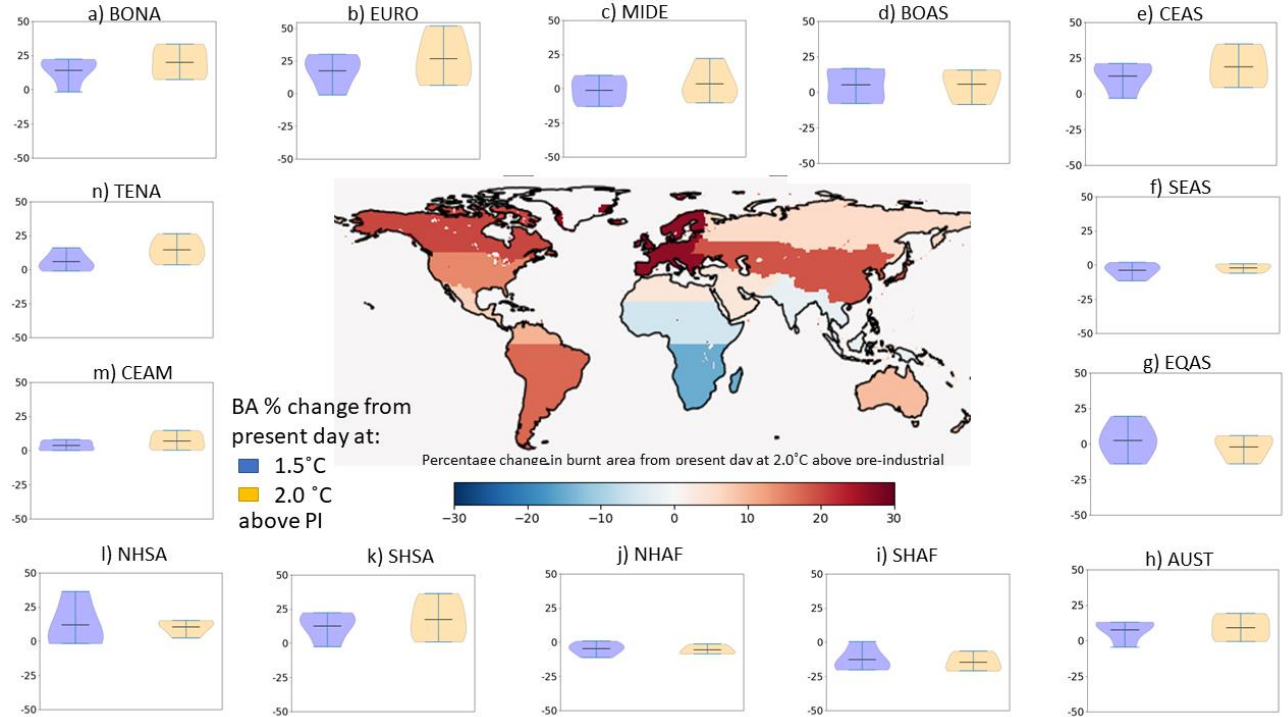
➤ **Burnt area mostly projected to increase from Present Day (PD)**

➤ **Europe: 15% (1.5°C) and 25% (2.0°C) increase**

➤ **Boreal North America 12% (1.5°C) and 20% (2.0°C) increase**

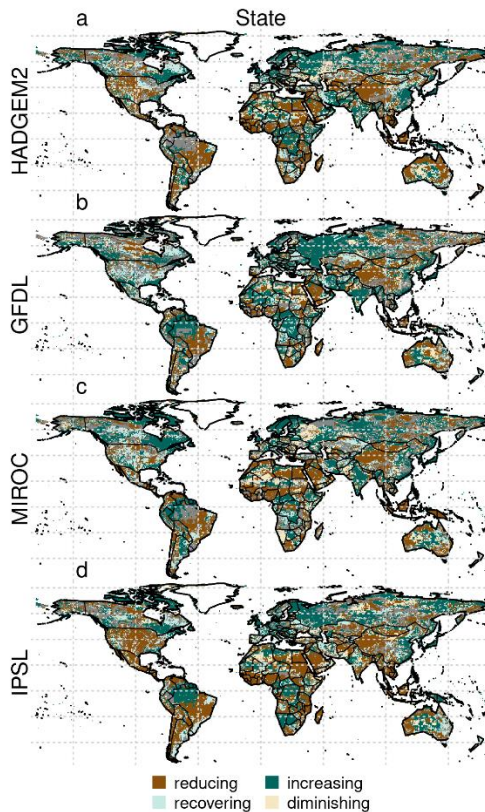
➤ **Decline in Africa**

➤ **High model spread in Equatorial Asia**



Results:

Change in Tree Cover

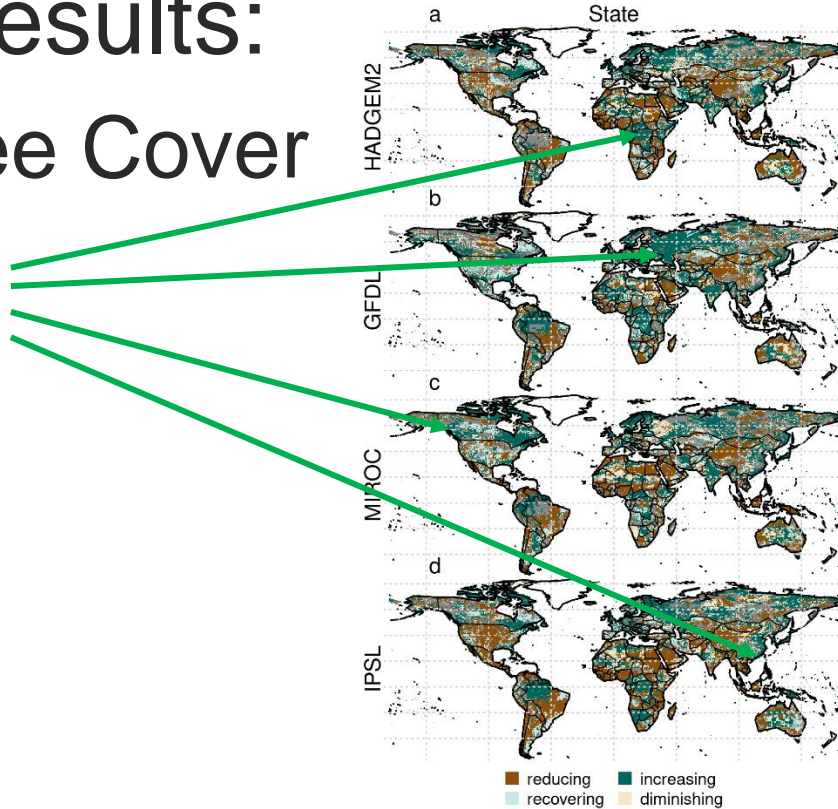


Change in tree cover at 1.5°C above PI

Results:

Change in Tree Cover

Increasing tree cover



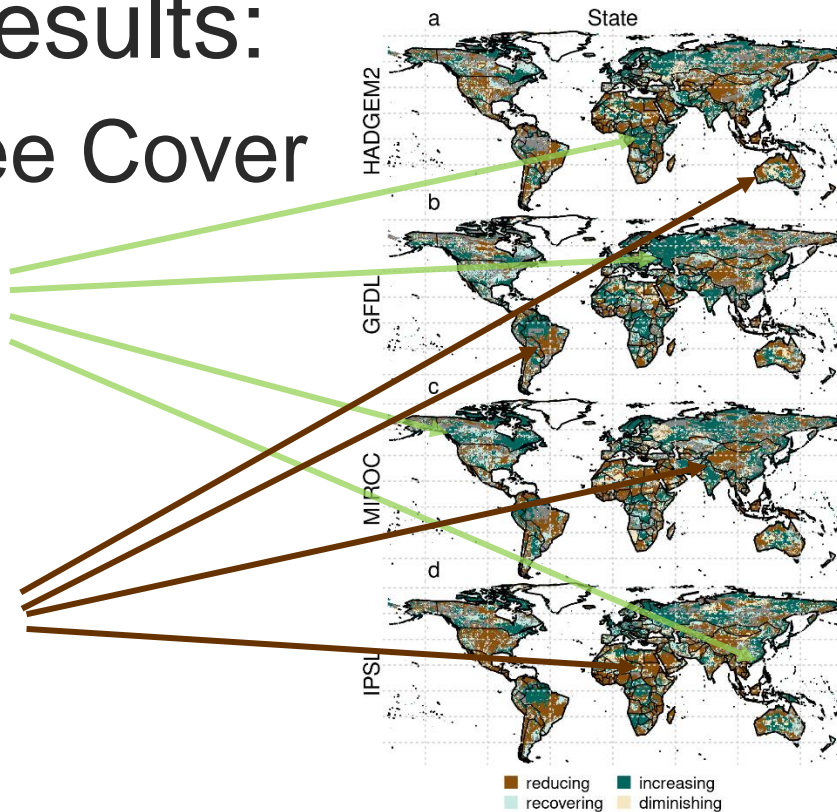
Change in tree cover at 1.5°C above PI

Results:

Change in Tree Cover

Increasing tree cover

Decreasing tree cover

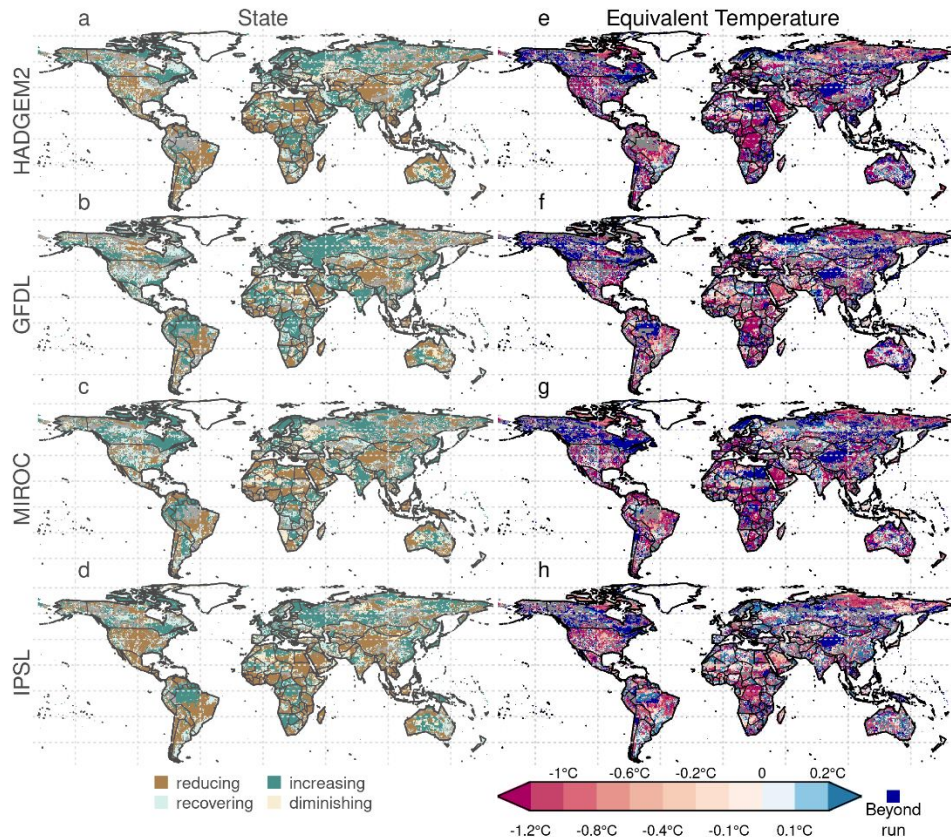


Change in tree cover at 1.5°C above PI

Results:

Change in Tree Cover

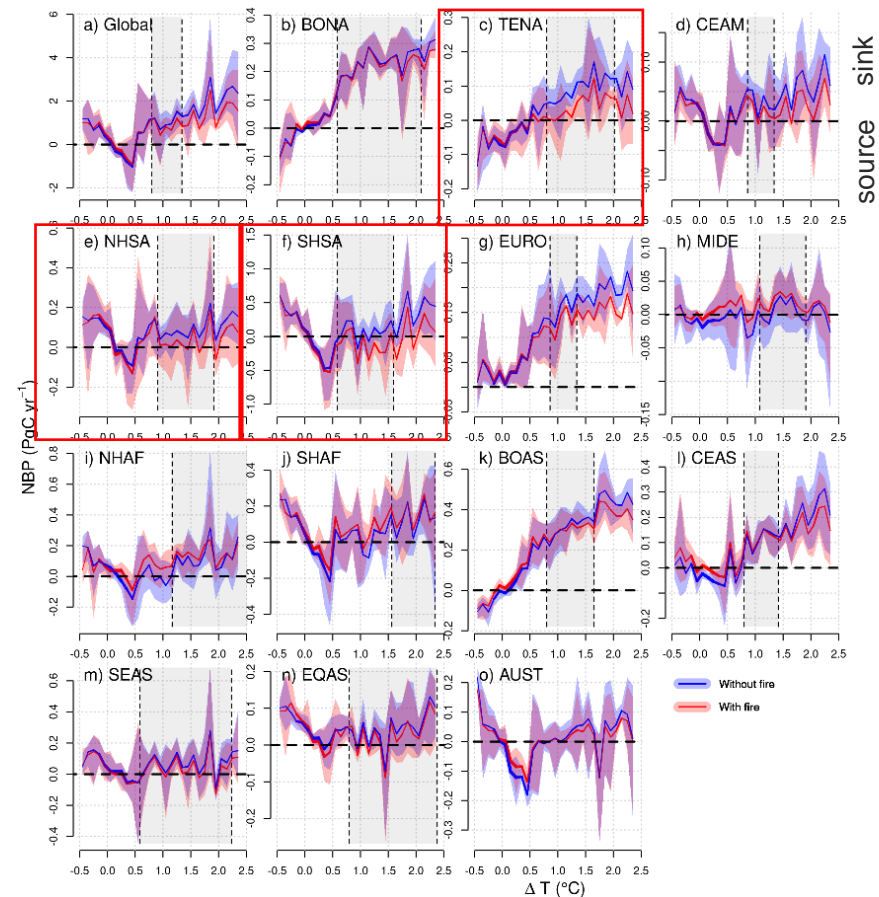
- **‘Equivalent impact of change in tree cover’** = the point at which tree cover is at the same level with fire, as without fire at 1.5°C above PI
- Equivalent change in tree cover happens at **lower temperatures (red)** with fire
- **Impacts may happen earlier** than we thought



Temperature of equivalent impact

Impact on Net Biome Productivity

- NBP increases globally and in boreal regions with temperature
- NBP mostly **decreased** with fire (red vs blue)
- Some regions are **close to a sink/source** threshold
- **Fire can shift** some regions from a net sink -> net source



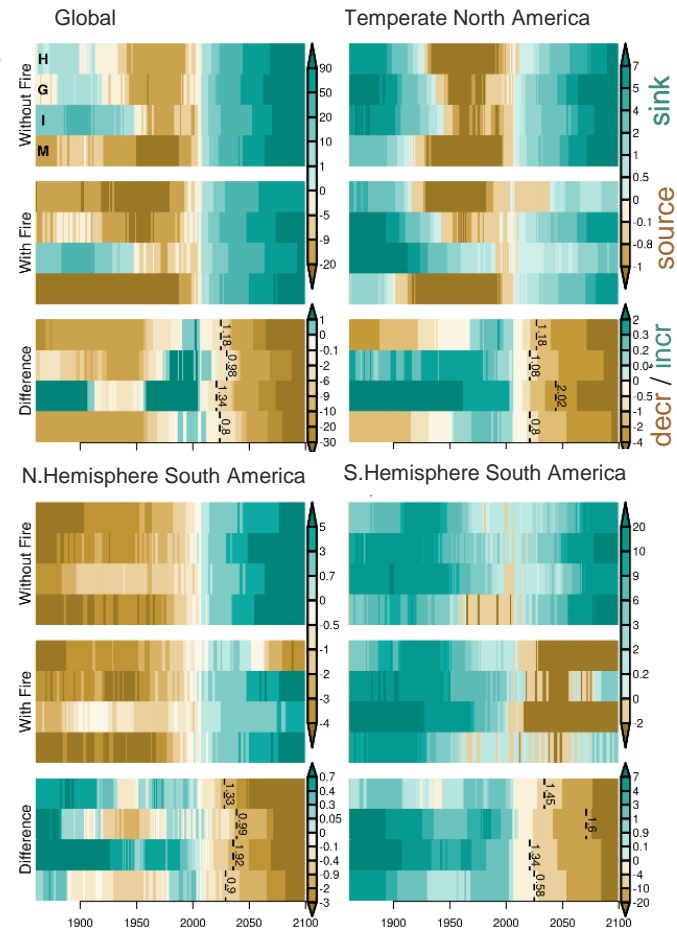
NBP with and without fire by temperature

Results:

Impact on Net Biome Productivity

- More shifts from **sink to source** (brown stripes) 'with fire'
- Fire has a **negative impact by the end of the century**, offsetting CO₂ fertilisation, weakening carbon sink
- We find that the global warming level at which **fire significantly impacts global carbon storage is 1.07°C** (0.8-1.34°C) above pre-industrial (with fire vs without fire, anomaly from PD, Wilcoxon signed-rank test)

Rows = GCMs



Stripes = Individual years

Conclusion

- **Impacts happen earlier** when we account for fire
- Fire **significantly impacts global carbon storage** at 1.07°C above PI
- Therefore, regions which were previously projected to continue as a net sink of carbon into the future may be closer to a threshold than previously understood, and those **impacts could be starting now**.
- We estimate the reduction in the **remaining carbon budget** due to fire is 15 GtCO₂ for limiting temperature rise to 1.3°C, **25 GtCO₂ for 1.5°C**, and 64 GtCO₂ for 2.0°C compared to IPCC AR6



