Increasing Synchronicity of Global Extreme Fire Weather

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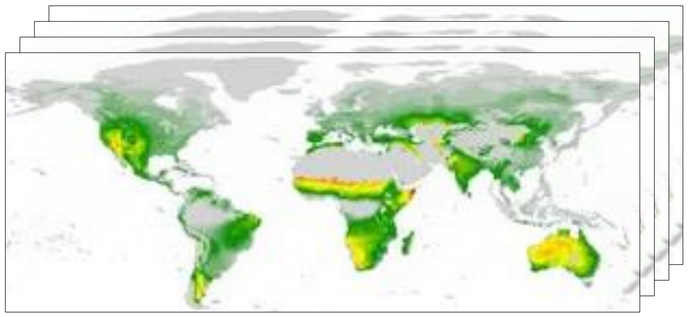
INTRODUCTION

- The rising trend in extreme fire weather and concurrent heat extremes underscores the growing threat of not only localized but also **synchronous fire weather (SFW)**.
- Combined with the expansion of the wildland–urban interface and the accumulation of fuels in some regions, SFW can amplify the risk of **widespread fire activity** compared to localized fire weather.
- This heightened risk intensifies the demands on **fire suppression** efforts, worsens **air pollution**, adversely impacts **human health**, and further complicates the **coordination of firefighting resources**.

METHODOLOGY

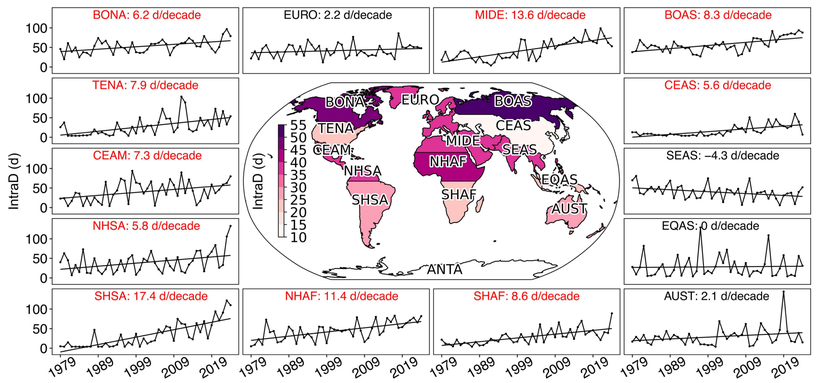
- **Data**: ERA5-drived daily gridded fire weather index (FWI) during 1979-2024. The FWI is the most widely used fire danger index globally, integrating fuel dryness and potential fire spread driven by meteorological conditions.



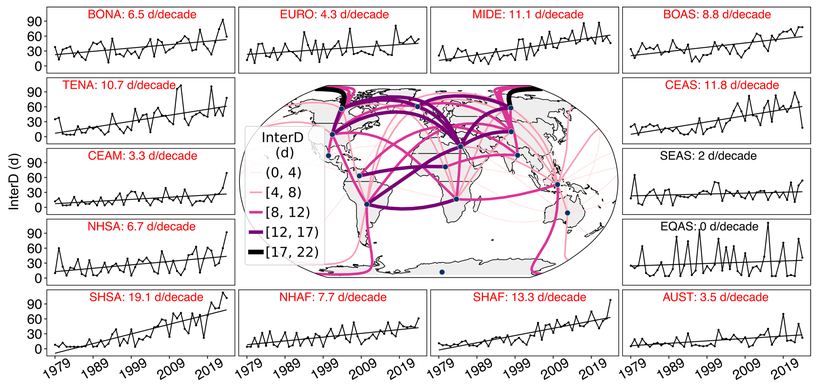
- **IntraD**: days when FWI exceeds the 90th percentile (FWI90) across at least 30% of the burnable area within a GFED region.
- **InterD**: days when the regional average FWI exceeds FWI90 in at least two GFED regions on the same day.

RESULTS

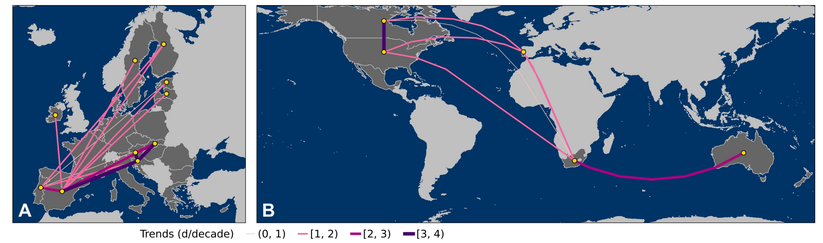
- The boreal regions experience the highest levels of intra-regional SFW due to strong flammability constraints outside the summer months. In contrast, Central and East Asia exhibit the lowest levels of synchronicity due to the diverse seasonality in temperature and precipitation patterns within the region.
- Intra-regional SFW significantly increased in 10 of the 14 GFED regions from 1979 to 2024 ($p < 0.05$), with South America exhibiting the largest increase in synchronicity, a trend associated with significant warming and drying.



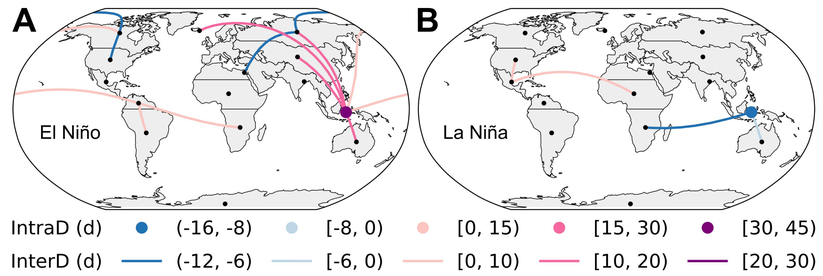
- North America and the Middle East, along with South America and Africa, exhibit relatively high inter-regional SFW. In contrast, extreme fire weather in Australia rarely coincides with that of other regions, reflecting its geographic isolation and distinct fire seasonality.
- Inter-regional SFW significantly increased in 12 of the 14 GFED regions from 1979 to 2024 ($p < 0.05$).



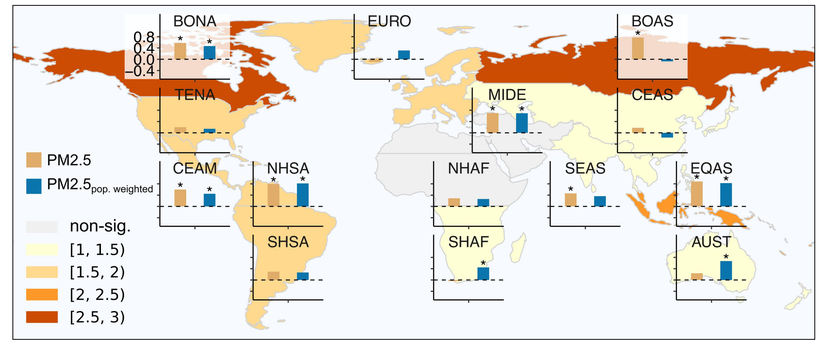
- The increase in SFW poses challenges for firefighting cooperation networks across the European Union (EU), and fire-prone countries such as the US, Canada, and Australia.



- During El Niño years, intra-regional synchronous days in Equatorial Asia increase by 43 days, while inter-regional synchronous days between Equatorial Asia and adjacent regions increase by 10–20 days compared to ENSO neutral years, exhibiting significant links between SFW and ENSO.



- Intra-regional SFW significantly degrades air quality in multiple regions ($p < 0.05$) due to elevated burned area during SFW compared with conditions immediately prior to SFW. In Boreal North America, the daily average burned area on SFW days is 2.7 times that of the five days preceding SFW.



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