

Fire Weather Waves Drive Extreme Fires Globally

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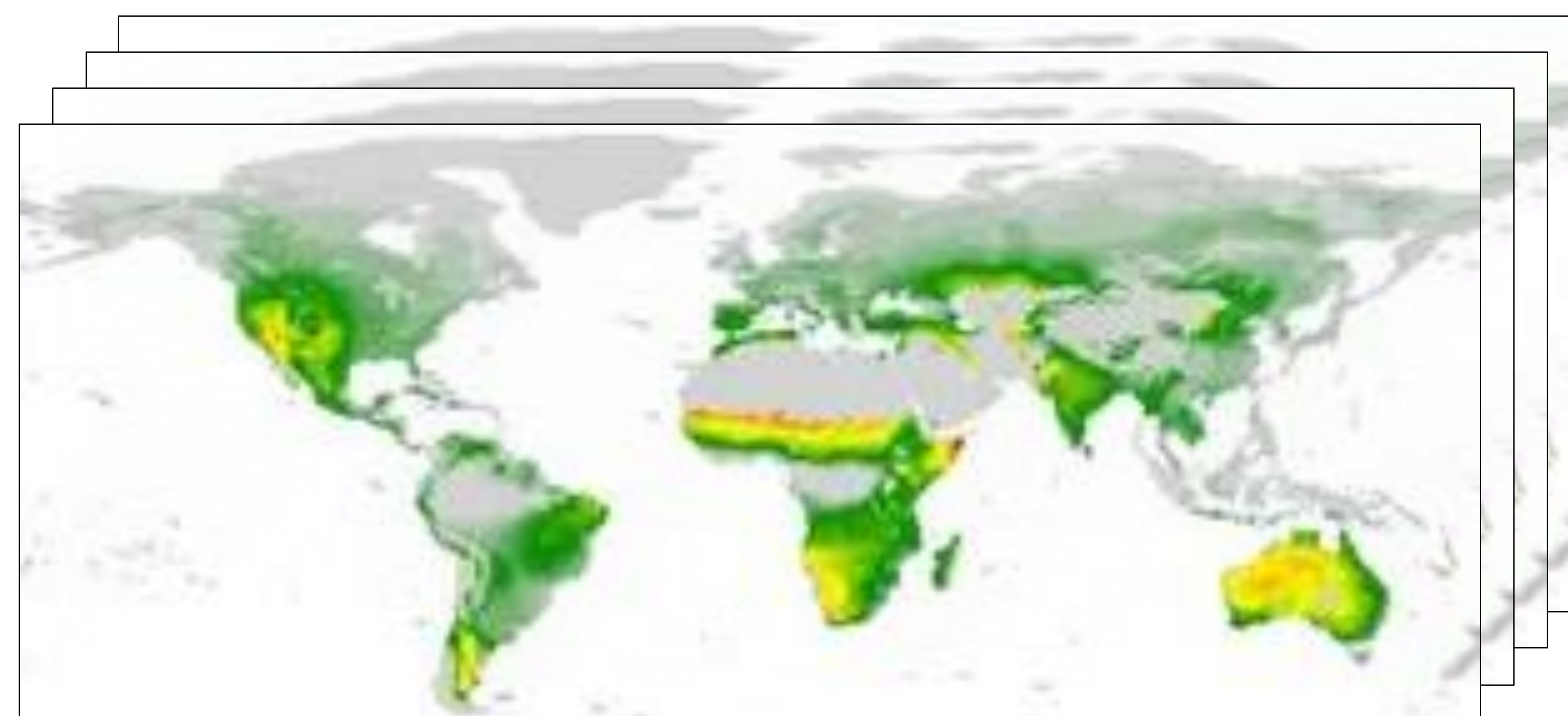
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INTRODUCTION

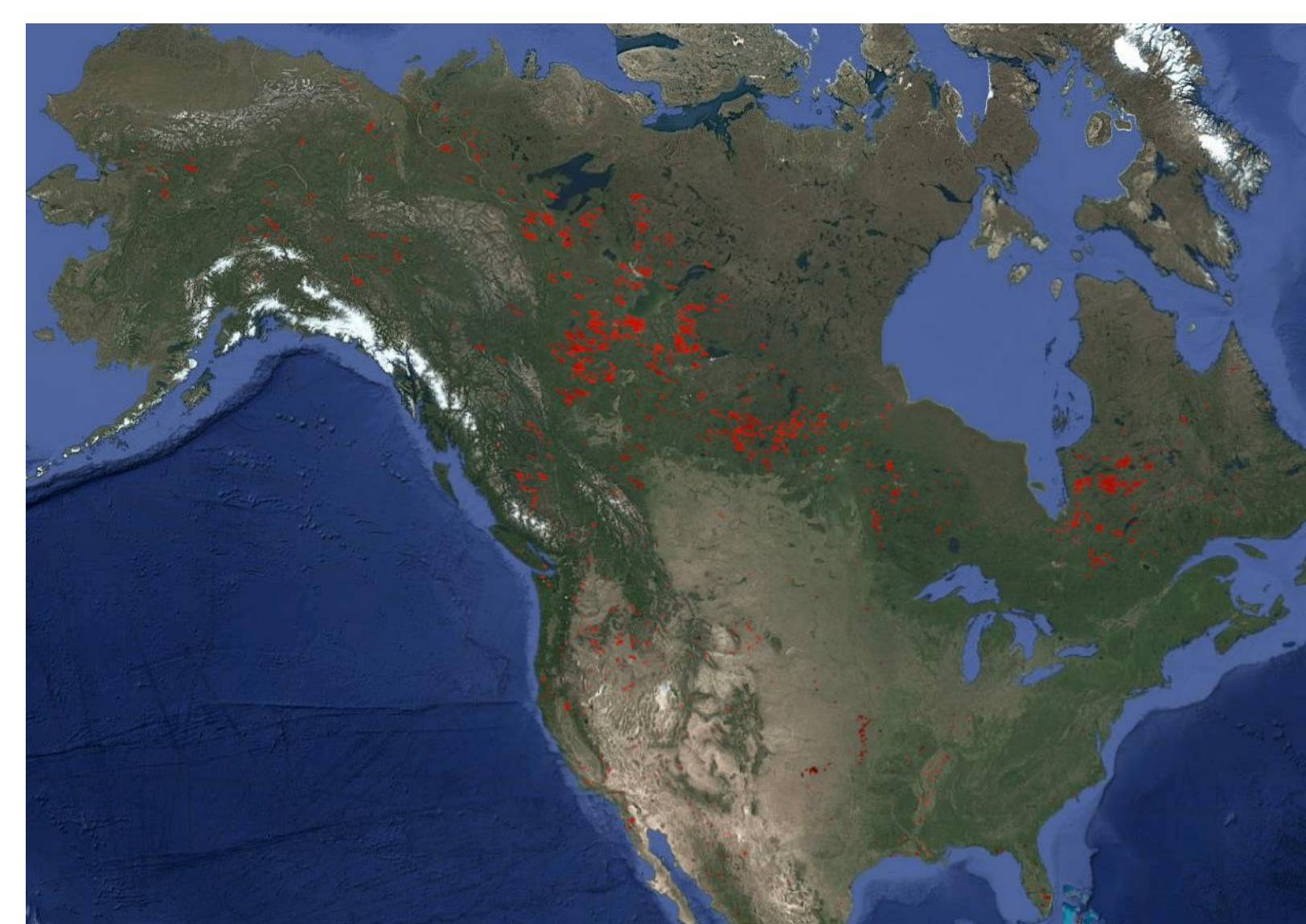
- Despite ongoing declines in global burned area, the increasing occurrence of **extreme fires** in forested regions has important implications for society and the environment.
- We introduce the concept of **Fire Weather Waves (FWWs)**, akin to the definition of heatwaves, and define them as prolonged dry, warm, and often windy conditions to emphasize the **temporally compounding nature** of extreme fire weather, which has remained underinvestigated at the global scale.
- By maintaining favorable conditions for fire ignition and spread over multiple consecutive days, we hypothesize that temporally compound fire weather extremes heighten extreme fire danger.

METHODOLOGY

- FWW**: we define FWWs as periods during which the daily FWI exceeds the ecoregion-specific 95th-percentile threshold (FWI95) for at least three consecutive days, with thresholds calculated from the 1979–2024 daily record.



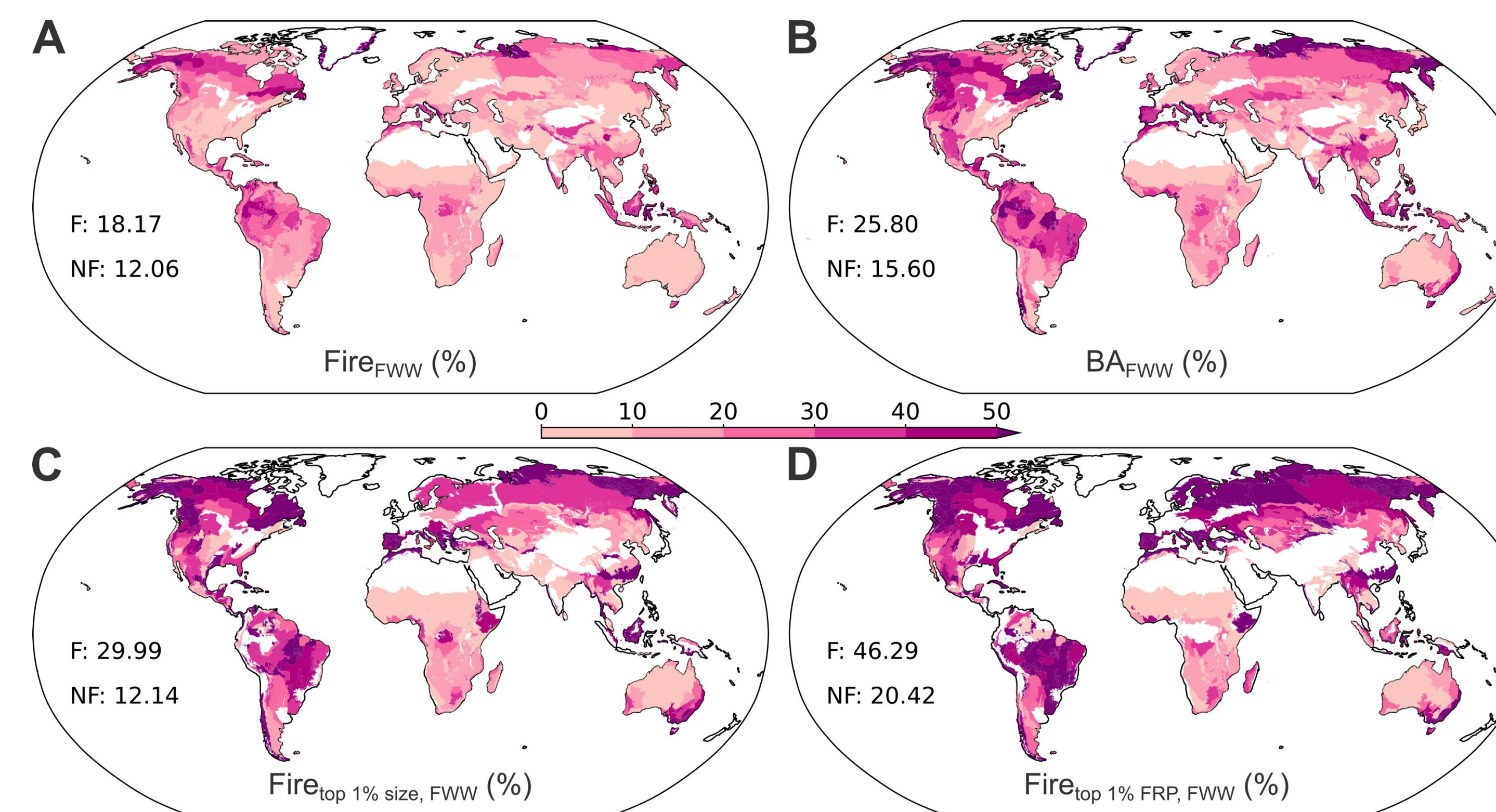
- Daily burned area**: burned area for each calendar day in km².
- Global Fire Atlas**: time and location of ignitions, perimeters, size, duration, spread, and Fire Radiative Power (FRP) for each individual fire.



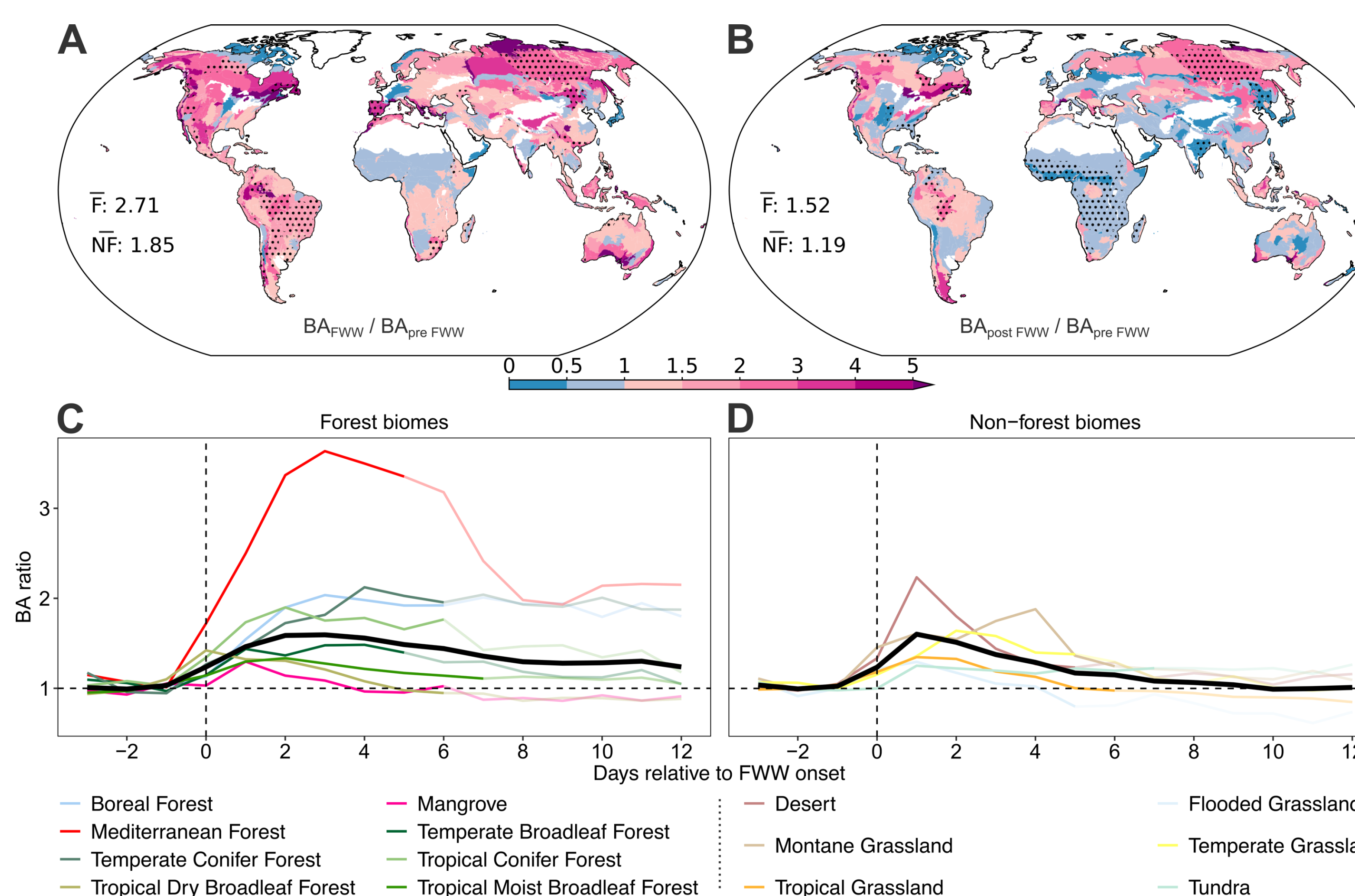
Feature	Value
GFA_v20250411_perimeters_2024_FRP_metr	
start_date	2024-07-23
Derived	
Actions	
fid	533969
fire_ID	240006645
lat	43.1604
lon	-117.558
size	287.47
perimeter	197.24
start_date	2024-07-23
start_DOY	205
end_date	2024-08-02
end_DOY	215
duration	11
fire_line	26.94
spread	26.13
speed	7.91
direction	southeast
direc_frac	0.37
MODIS_tile	h09v04
landcover	Grasslands
landc_frac	1
GFED_regio	2

RESULTS

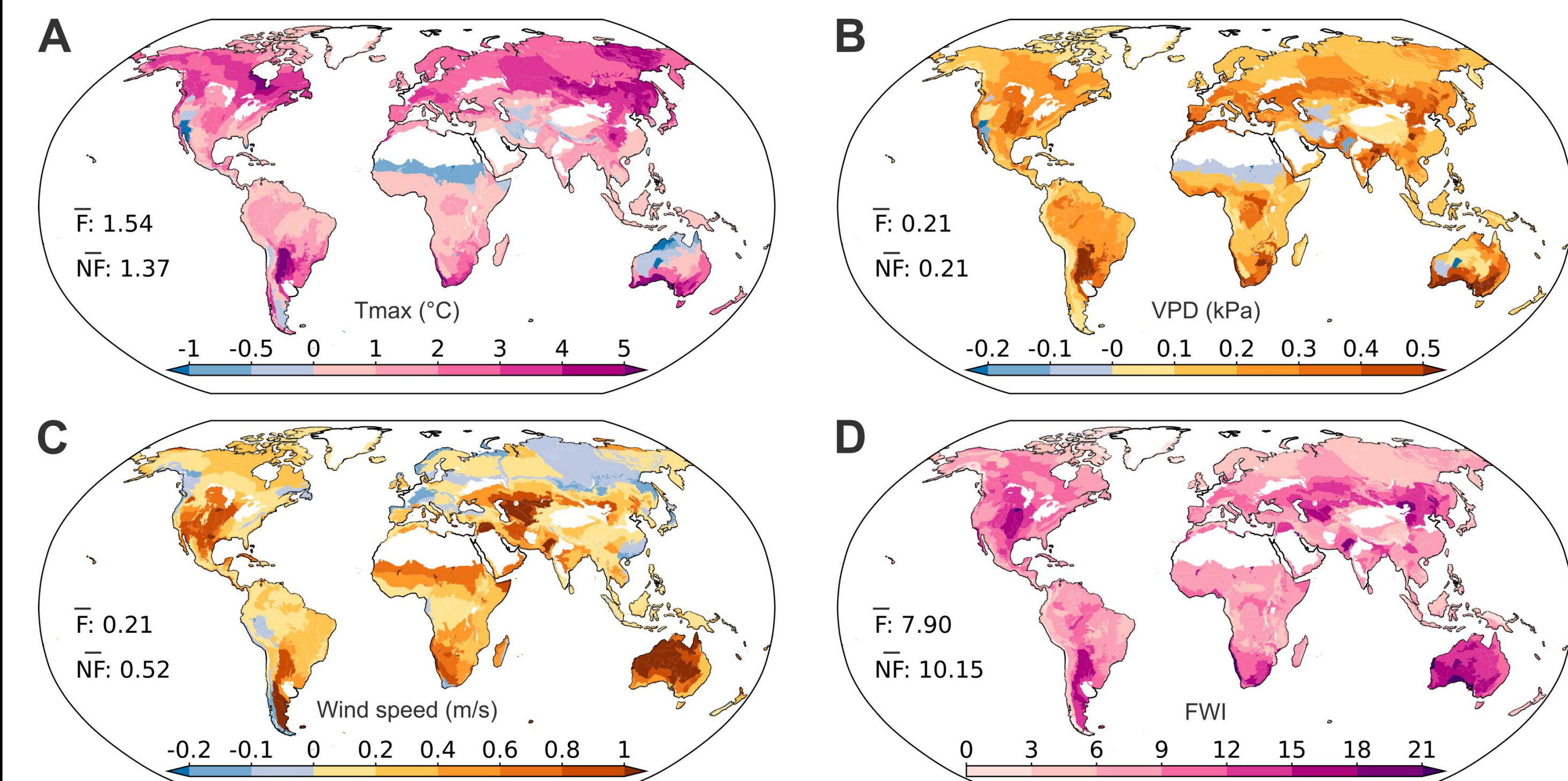
- FWWs are strongly associated with fire activity, particularly in forested areas. In forest ecoregions during 2002–2024, although FWW days accounted for only 4% of all days, 18% of individual fires in the Global Fire Atlas ignited on FWW days, and 26% of the area burned occurred on FWW days.
- The relationship between FWWs and the most extreme fires is even stronger. Across forest ecoregions during the same period, 30% and 46% of the top 1% largest and most energetic fires, respectively, ignited on FWW days.



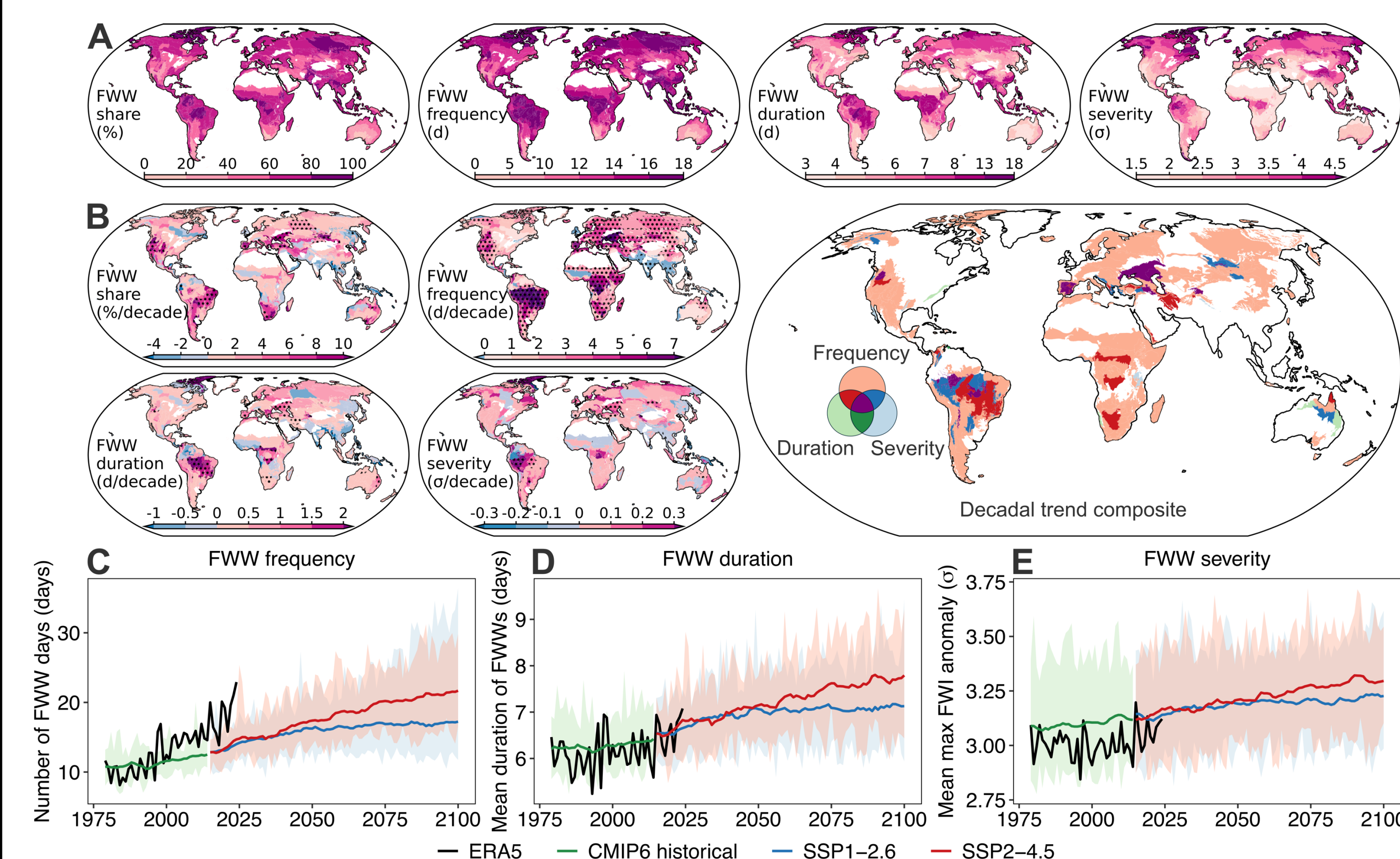
- Fire activity increases during and immediately after FWWs compared to the days immediately preceding the events.
- Compared with non-forest fires, forest fires exhibit a larger and more persistent increase in daily burned area in response to FWWs, particularly in Mediterranean forests.



- Widespread warmer, drier, and windier conditions are observed during FWWs. In higher latitudes, the average daily maximum temperature on FWW days is 2–5 °C higher than the three-day pre-FWW average.
- Mid-latitudes experience stronger winds during FWWs, leading to an abrupt increase in fire danger that coincides with FWWs.



- FWWs occur most frequently in boreal and tropical regions, where the annual average number of FWW days exceeds 14 during 1979–2024.
- FWW frequency has significantly increased across a majority of burnable lands during 1979–2024. Climate projections indicate that FWWs will increase throughout the 21st century.



ACKNOWLEDGEMENTS

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