Supplementary information

Table S1: Geographical division of the world used to identify extreme fire events (EFEs). These regions or modified continental biomes (MCBs) were obtained by splitting global biomes into the different continents, plus some additional modifications.

region_ID	Continental biomes that are part of the region
1	Africa-Deserts & Xeric Shrublands (northern hemisphere only)
2	Africa-Deserts & Xeric Shrublands (southern hemisphere only)
3	Africa-Flooded Grasslands & Savannas
4	Africa-Mediterranean Forests, Woodlands & Scrub (southern hemisphere only)
5	Africa-Montane Grasslands & Shrublands
6	Africa-Temperate Broadleaf & Mixed Forests
7	Africa-Tropical & Subtropical Dry Broadleaf Forests
8	Africa-Tropical & Subtropical Grasslands, Savannas & Shrublands (northern hemisphere only)
9	Africa-Tropical & Subtropical Grasslands, Savannas & Shrublands (southern hemisphere only)
10	Africa-Tropical & Subtropical Moist Broadleaf Forests
11	Asia-Boreal Forests/Taiga
12	Asia-Deserts & Xeric Shrublands
13	Asia-Flooded Grasslands & Savannas
14	Asia-Montane Grasslands & Shrublands
15	Asia-Temperate Broadleaf & Mixed Forests
16	Asia-Temperate Conifer Forests
17	Asia-Temperate Grasslands, Savannas & Shrublands
18	Asia-Tropical & Subtropical Dry Broadleaf Forests
19	Asia-Tropical & Subtropical Moist Broadleaf Forests; Asia-Mangroves; Asia-Tropical & Subtropical Grasslands, Savannas & Shrublands
20	Asia-Tundra
21	Africa-Mediterranean Forests, Woodlands & Scrub (northern hemisphere only); Asia-Mediterranean Forests, Woodlands & Scrub; Europe-Mediterranean Forests, Woodlands & Scrub; Africa-Temperate Conifer Forests
22	Europe-Boreal Forests/Taiga
23	Europe-Temperate Broadleaf & Mixed Forests
24	Europe-Temperate Conifer Forests
25	Europe-Temperate Grasslands, Savannas & Shrublands
26	Europe-Tundra
27	North America-Boreal Forests/Taiga
28	North America-Deserts & Xeric Shrublands
29	North America-Mediterranean Forests, Woodlands & Scrub
30	North America-Temperate Broadleaf & Mixed Forests

31	North America-Temperate Conifer Forests
32	North America-Temperate Grasslands, Savannas & Shrublands
33	North America-Tropical & Subtropical Coniferous Forests
34	North America-Tropical & Subtropical Dry Broadleaf Forests
35	North America-Tropical & Subtropical Grasslands, Savannas & Shrublands
36	North America-Tropical & Subtropical Moist Broadleaf Forests
37	North America-Tundra
38	Australia-Oceania-Deserts & Xeric Shrublands
39	Australia-Oceania-Mediterranean Forests, Woodlands & Scrub
40	Australia-Oceania-Montane Grasslands & Shrublands
41	Australia-Temperate Broadleaf & Mixed Forests; Australia-Montane Grasslands & Shrublands; Oceania-Temperate Broadleaf & Mixed Forests
42	Australia-Temperate Grasslands, Savannas & Shrublands
43	Australia-Oceania-Tropical & Subtropical Dry Broadleaf Forests
44	Australia-Tropical & Subtropical Grasslands, Savannas & Shrublands; Australia-Tropical & Subtropical Moist Broadleaf Forests; Oceania-Tropical & Subtropical Grasslands, Savannas & Shrublands
45	Australia-Oceania-Tropical & Subtropical Moist Broadleaf Forests
46	South America-Deserts & Xeric Shrublands
47	South America-Flooded Grasslands & Savannas
48	South America-Mediterranean Forests, Woodlands & Scrub
49	South America-Montane Grasslands & Shrublands
50	South America-Temperate Broadleaf & Mixed Forests
51	South America-Temperate Grasslands, Savannas & Shrublands
52	South America-Tropical & Subtropical Dry Broadleaf Forests
53	South America-Tropical & Subtropical Grasslands, Savannas & Shrublands-Southern Hemisphere
54	South America-Tropical & Subtropical Grasslands, Savannas & Shrublands-Northern Hemisphere
55	South America-Tropical & Subtropical Moist Broadleaf Forests

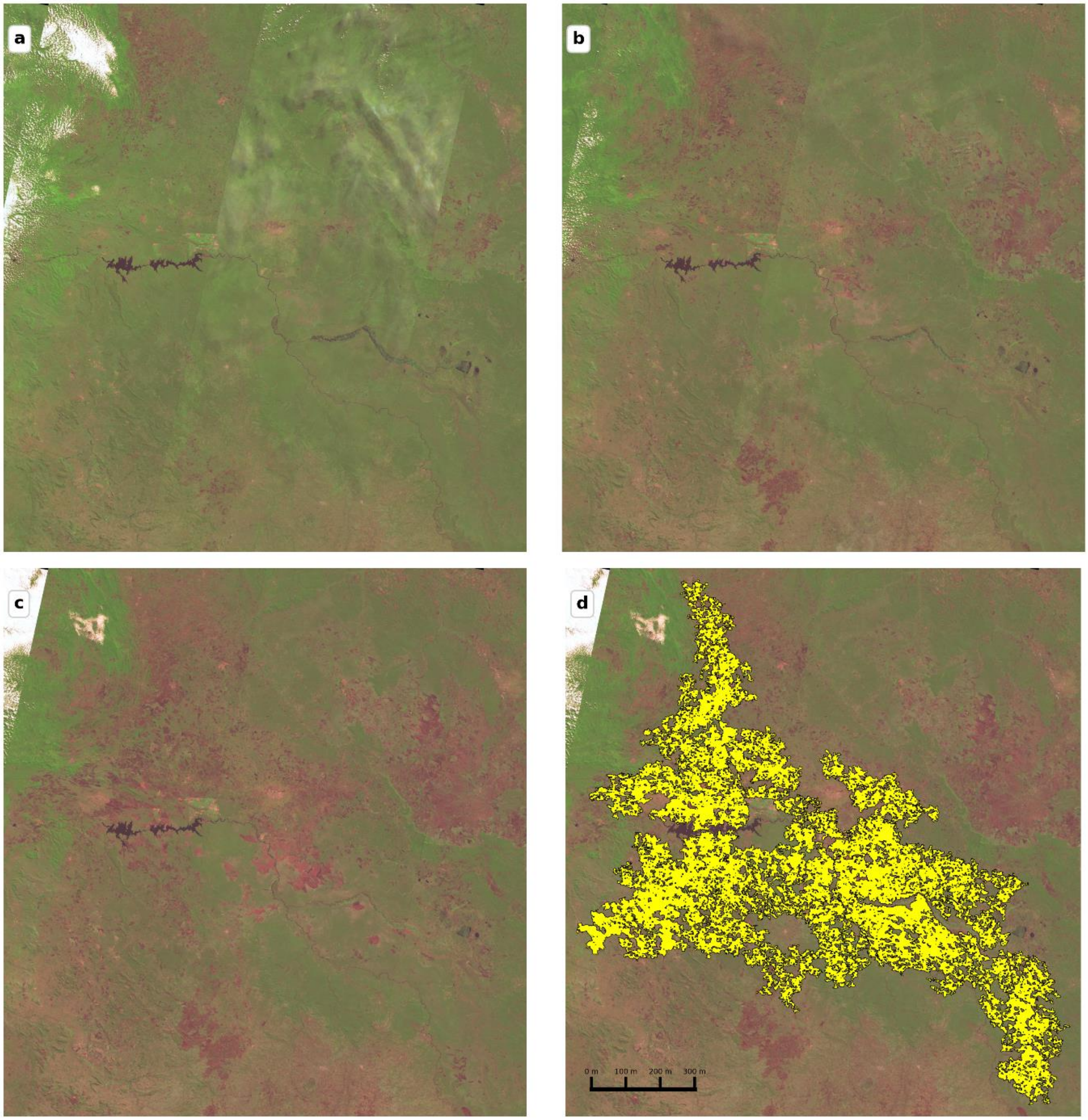

Figure S1: Satellite images and integration of fire events in the FRY database. Dark reddish-purple color shows the fire scars in all images. Image (a) shows a Landsat image from 14 May 2020 with few fire scars. Image (b), from 30 May 2020, shows a greater number of fires and more extensive burned areas. Image (c), from 15 June 2020, shows further expansion of the fire. Image (d) corresponds to a polygon from the FRY database (cut-off value of 12 days) that integrates all fires visible in images (a)-(c) as a single event, and its duration in the FRY database is from 24 April to 15 September, 2020, highlighting a limitation of the algorithm, as it can group together different fires that occurred several days apart into a single polygon.

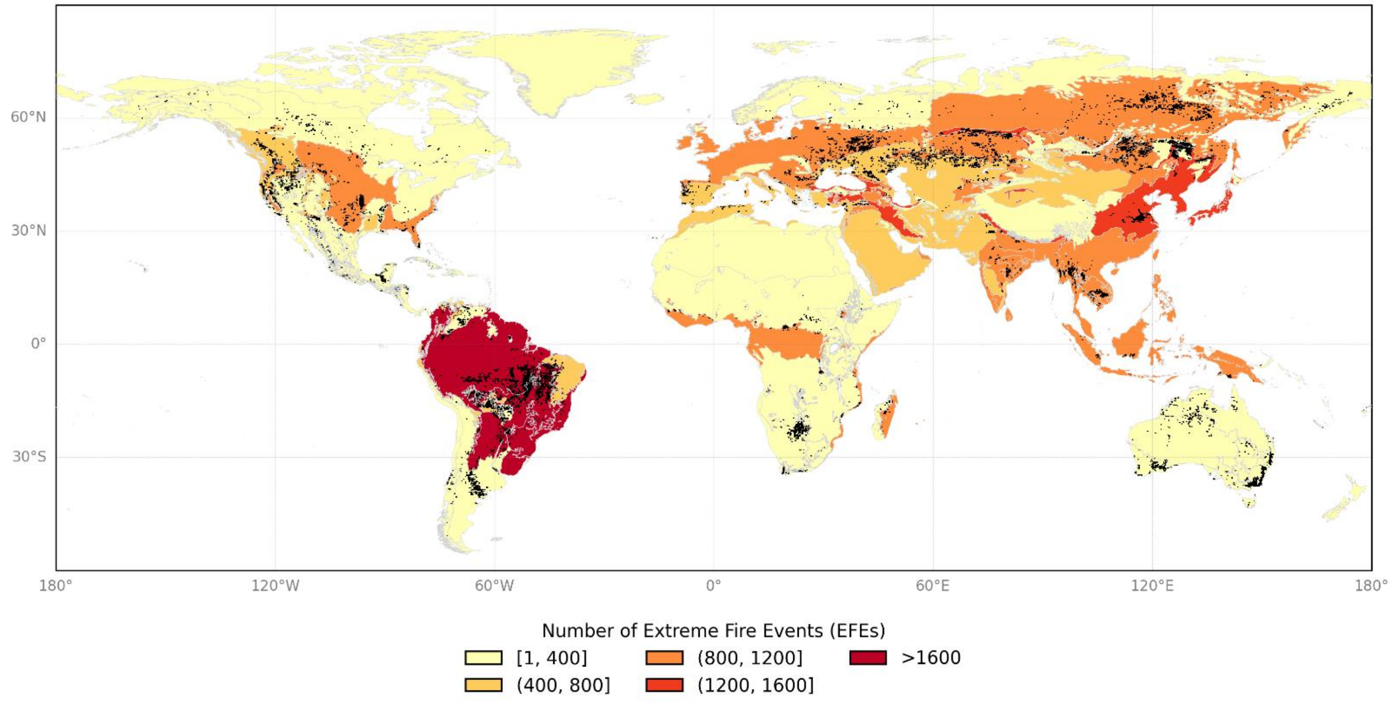

Figure S2: Spatial distribution of the total number of extreme fire events (EFEs) accumulated by modified continental biome (MCBs) at the global scale during the period 2003-2022. The color of each MCB represents the total number of EFEs recorded within that region, grouped into intervals of increasing frequency. The black dots indicate the location of the grid cells where EFEs were identified within each MCB.

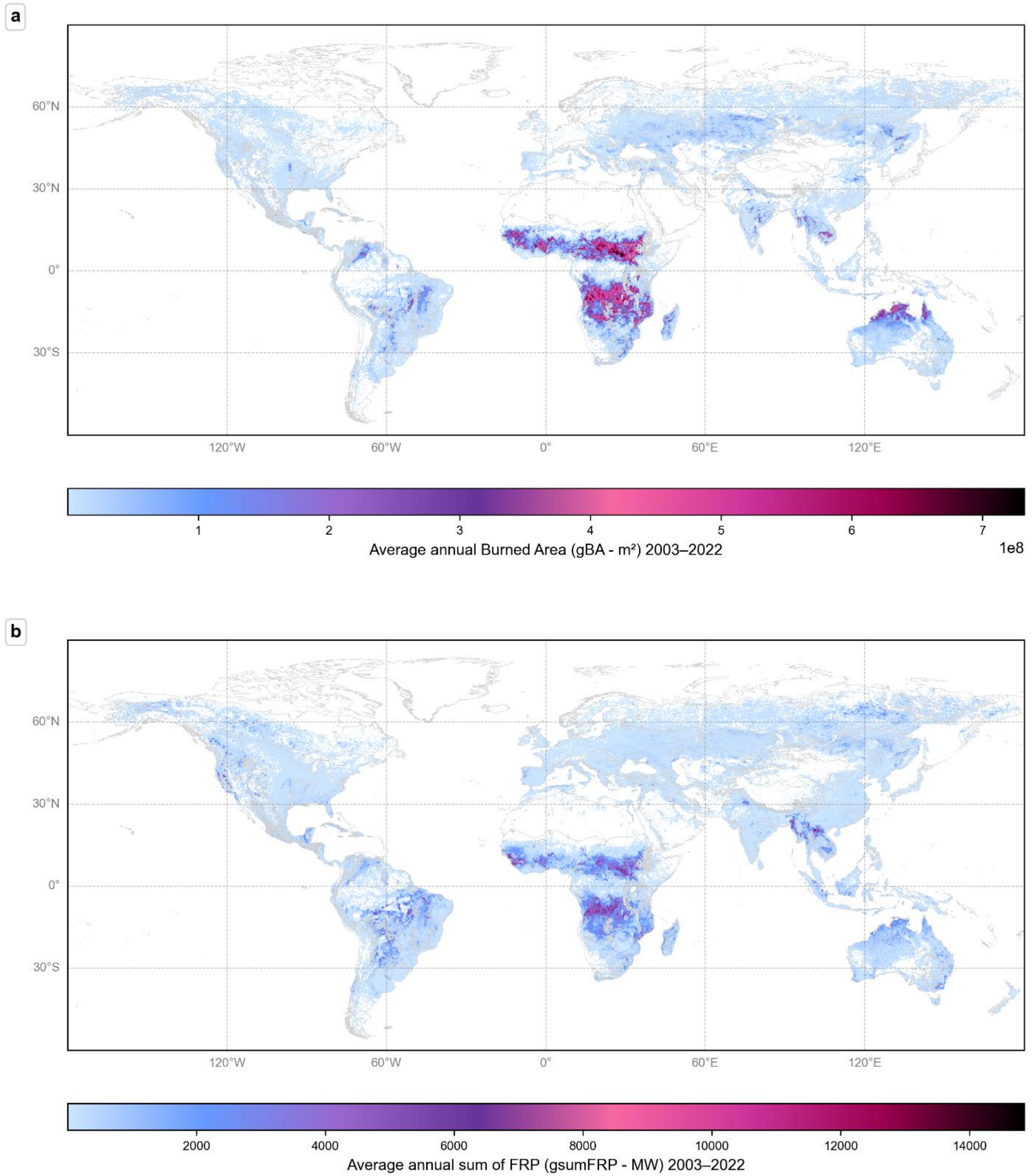

Figure S3: Spatial distribution of the average annual Burned Area – BA (panel a) and sum of FRP (panel b) over the period 2003-2022. Cell-month events (CMEs) with recurrent extreme fire events (EFEs) tend to show higher average BA and sum of FRP, reflecting greater fire activity.

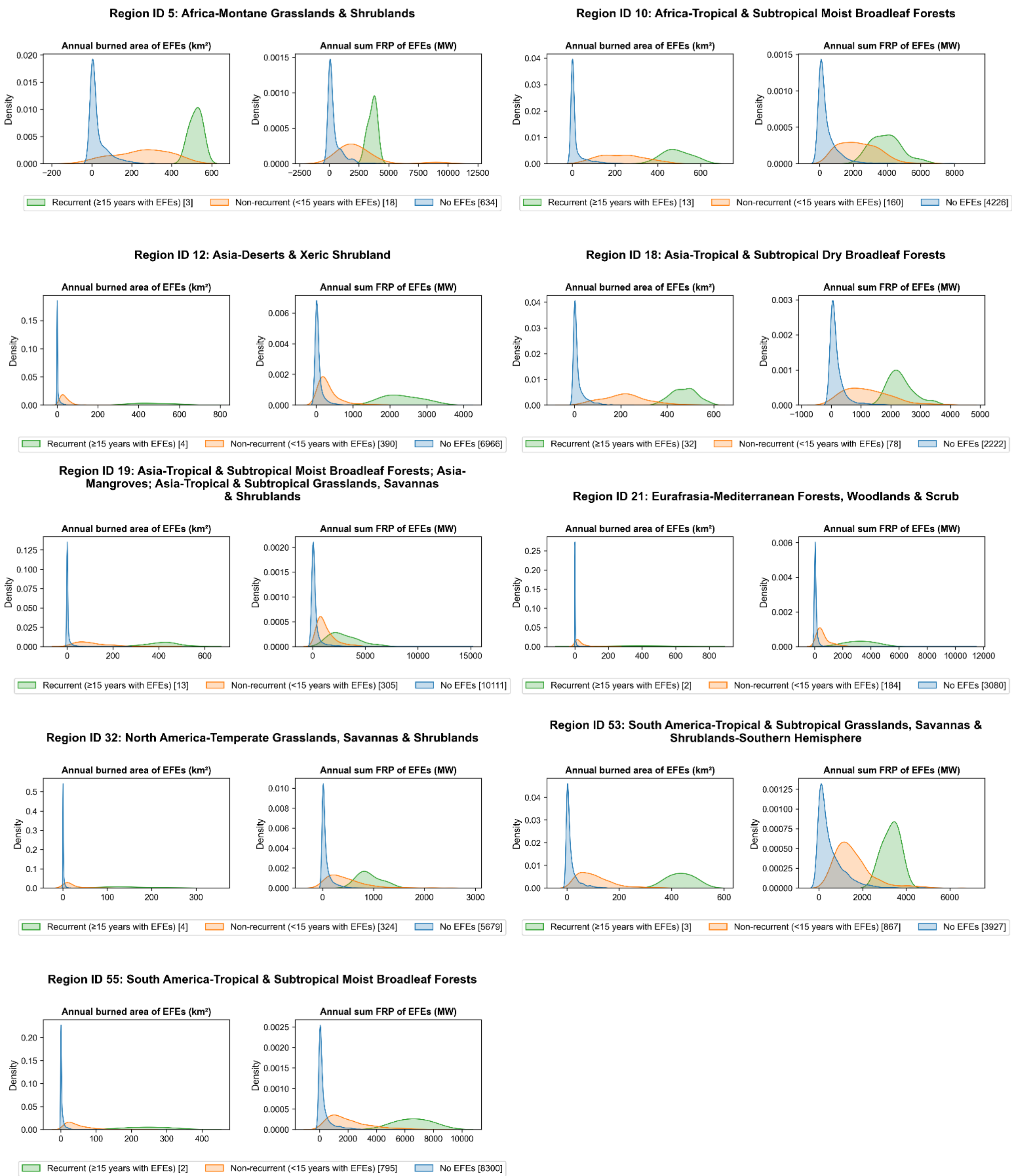
Region ID 5: Africa-Montane Grasslands & Shrublands
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [3]
Non-recurrent (<15 years with EFEs) [18]
No EFEs [634]
Region ID 10: Africa-Tropical & Subtropical Moist Broadleaf Forests
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [13]
Non-recurrent (<15 years with EFEs) [160]
No EFEs [4226]
Region ID 12: Asia-Deserts & Xeric Shrubland
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [4]
Non-recurrent (<15 years with EFEs) [390]
No EFEs [6966]
Region ID 18: Asia-Tropical & Subtropical Dry Broadleaf Forests
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [32]
Non-recurrent (<15 years with EFEs) [78]
No EFEs [2222]
Region ID 19: Asia-Tropical & Subtropical Moist Broadleaf Forests; Asia-Mangroves; Asia-Tropical & Subtropical Grasslands, Savannas & Shrublands
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [13]
Non-recurrent (<15 years with EFEs) [305]
No EFEs [10111]
Region ID 21: Eurafrasia-Mediterranean Forests, Woodlands & Scrub
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [2]
Non-recurrent (<15 years with EFEs) [184]
No EFEs [3080]
Region ID 32: North America-Temperate Grasslands, Savannas & Shrublands
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [4]
Non-recurrent (<15 years with EFEs) [324]
No EFEs [5679]
Region ID 53: South America-Tropical & Subtropical Grasslands, Savannas & Shrublands-Southern Hemisphere
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [3]
Non-recurrent (<15 years with EFEs) [867]
No EFEs [3927]
Region ID 55: South America-Tropical & Subtropical Moist Broadleaf Forests
Annual burned area of EFEs (km²)
Annual sum FRP of EFEs (MW)
Density
Recurrent (≥15 years with EFEs) [2]
Non-recurrent (<15 years with EFEs) [795]
No EFEs [8300]

Figure S4: Each subplot shows, for each modified continental biome (MCB) containing recurrent extreme fire events (EFEs), the distribution (kernel density estimate) of annual burned area (left panels) and annual sumFRP (right panels). EFEs are defined based on the gBA+gsumFRP criterion. CMEs are grouped into those with recurrent EFEs (green; at least 15 years with EFEs), non-recurrent EFEs (orange; EFEs in at least one but fewer than 15 years), and no EFEs (blue). Distributions are normalised independently to ensure visibility of groups with fewer data points. The number of CMEs in each group is indicated in brackets in the legend.

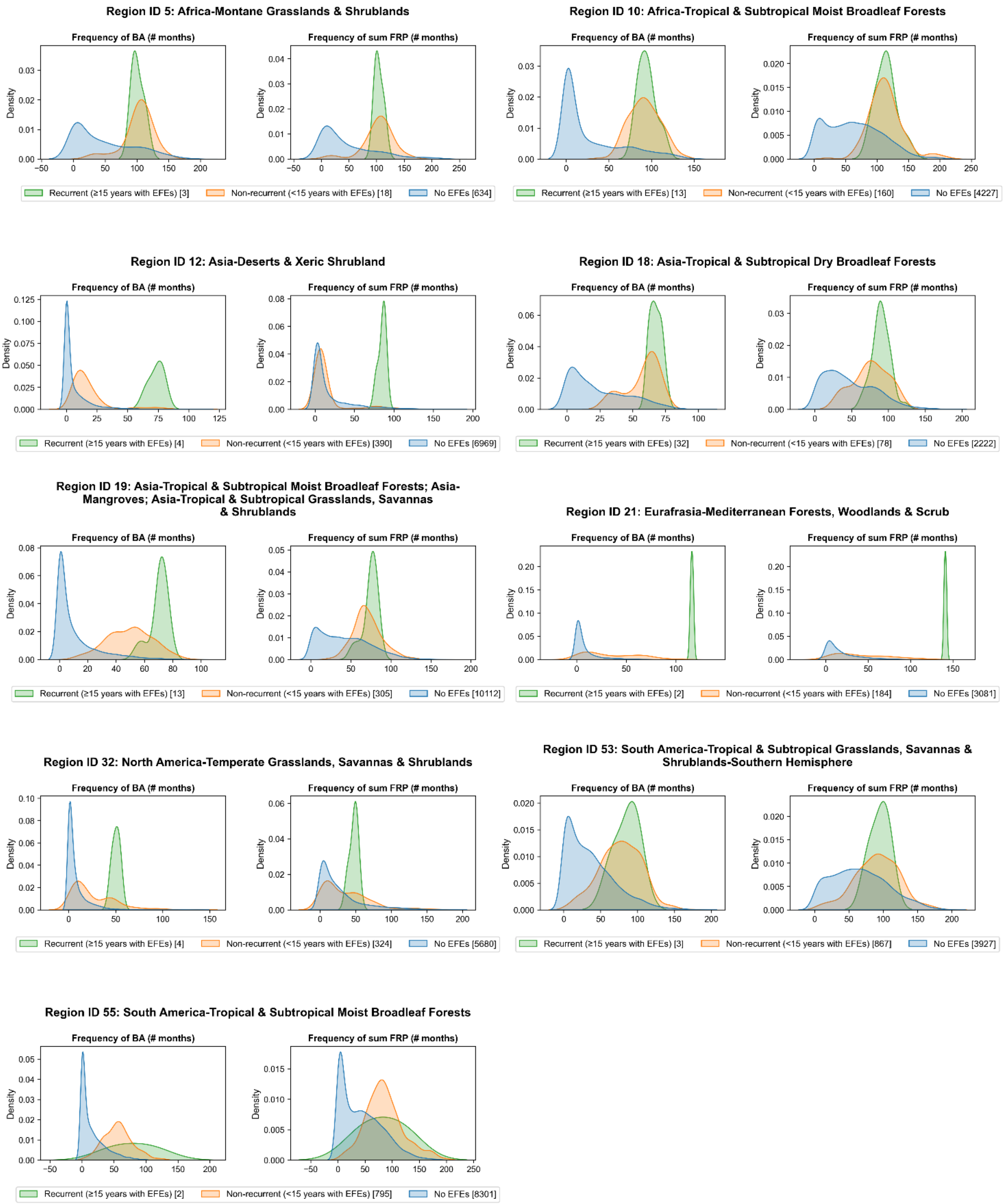
Region ID 5: Africa-Montane Grasslands & Shrublands
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [3]
Non-recurrent (<15 years with EFEs) [18]
No EFEs [634]
Region ID 10: Africa-Tropical & Subtropical Moist Broadleaf Forests
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [13]
Non-recurrent (<15 years with EFEs) [160]
No EFEs [4227]
Region ID 12: Asia-Deserts & Xeric Shrubland
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [4]
Non-recurrent (<15 years with EFEs) [390]
No EFEs [6969]
Region ID 18: Asia-Tropical & Subtropical Dry Broadleaf Forests
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [32]
Non-recurrent (<15 years with EFEs) [78]
No EFEs [2222]
Region ID 19: Asia-Tropical & Subtropical Moist Broadleaf Forests; Asia-Mangroves; Asia-Tropical & Subtropical Grasslands, Savannas & Shrublands
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [13]
Non-recurrent (<15 years with EFEs) [305]
No EFEs [10112]
Region ID 21: Eurafrasia-Mediterranean Forests, Woodlands & Scrub
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [2]
Non-recurrent (<15 years with EFEs) [184]
No EFEs [3081]
Region ID 32: North America-Temperate Grasslands, Savannas & Shrublands
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [4]
Non-recurrent (<15 years with EFEs) [324]
No EFEs [5680]
Region ID 53: South America-Tropical & Subtropical Grasslands, Savannas & Shrublands-Southern Hemisphere
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [3]
Non-recurrent (<15 years with EFEs) [867]
No EFEs [3927]
Region ID 55: South America-Tropical & Subtropical Moist Broadleaf Forests
Frequency of BA (# months)
Frequency of sum FRP (# months)
Density
Recurrent (≥15 years with EFEs) [2]
Non-recurrent (<15 years with EFEs) [795]
No EFEs [8301]

Figure S5: **Each subplot shows, for each modified continental biome (MCB) recurrent extreme fire events (EFEs), the distribution (kernel density estimate) of the number of months a CME presented fire activity in terms of annual burned area (left panels) and annual sumFRP (right panels). EFEs are defined based on the gBA+gsumFRP criterion. CMEs are grouped into those with recurrent EFEs (green; at least 15 years with EFEs), non-recurrent EFEs (orange; EFEs in at least one but fewer than 15 years), and no EFEs (blue). Distributions are normalised independently to ensure visibility of groups with fewer data points. The number of CMEs in each group is indicated in brackets in the legend.**

Table S2: **Extreme, large or catastrophic fire events identified in scientific literature and their detection in the extreme fire events (EFEs) database. Eighteen of the twenty events were detected, including some of the most significant ones, which supports the validity of the database for identifying extreme fires.**

Fire	Year	Reference	Detected in EFEs database	EFEs detected (dates and regions)
1. Algarve and central Portugal fires	2003	Exploring the occurrence of mega-fires in Portugal (Tedim et al., 2013).	Yes	July-September Mediterranean Forests (Region ID 21)
2. Alaska	2004	Alaska's exceptional 2004 fire season (Shulski et al., 2005).	Yes	July in Boreal Forests (region ID 27) and August 2004 in Tundra (region ID 37)
3. Northwest Territories fires-Canada	2014	An Assessment of Surface and Atmospheric Conditions Associated with the Extreme 2014 Wildfire Season in Canada's Northwest Territories (Kochtubajda et al., 2019).	Yes	July and August, only Boreal Forests (region ID 27)
4. British Columbia	2017	Attribution of the Influence of Human-Induced Climate Change on an Extreme Fire Season (Kirchmeier-Young et al., 2019).	Yes	July-September in Boreal Forests (region ID 27) and June-September in Temperate Conifer Forests (region ID 31)
5. Megafires in Chile	2017	Megafires in Chile 2017: Monitoring multiscale environmental impacts of burned ecosystems (De la Barrera et al., 2018).	Yes	January and March in Mediterranean Forests (region ID 48). January to March 2017 in Temperate Broadleaf & Mixed Forests (region ID 50)
6. Sierra de la Culebra- Spain	2022	An integrated assessment of carbon emissions from forest fires beyond impacts on aboveground biomass. A	Yes	June and July in Mediterranean Forests (region ID 21)

Fire	Year	Reference	Detected in EFEs database	EFEs detected (dates and regions)
		showcase using airborne lidar and GEDI data over a megafire in Spain (Pascual and Guerra-Hernández, 2023).		
7. Camp- California	2018	The fastest-growing and most destructive fires in the US (2001 to 2020) (Balch et al., 2024).	Yes	November in Mediterranean forest (region ID 29) and Temperate Conifer Forests (region ID 31)
8. Marshall- Colorado	2021		No	EFE not detected because the affected area was too small (2,400 ha), resulting in BA and sum of FRP anomalies below the detection threshold.
9. Anderson Creek	2016		Yes	March in Temperate Grasslands, Savannas & Shrublands (Region ID 32)
10. Black summer Australia	2019-2020	What Do the Australian Black Summer Fires Signify for the Global Fire Crisis(Nolan et al., 2021).	Yes	September 2019-February 2020 in Temperate Broadleaf & Mixed Forests; Montane Grasslands & Shrublands (Region ID 41), Mediterranean Forests (Region ID 39) and Tropical & Subtropical region (Region ID 44)
11. August Complex Fire California	2020	Megafires in a Warming World: What Wildfire Risk Factors Led to California's Largest Recorded Wildfire (Varga et al., 2022).	Yes	August-October in Temperate Conifer Forests (Region ID 31) and Mediterranean Forests (region ID 29)
12. Lena-Vilyui interfluve of Central Yakutia-Siberia	2021	The Impact of Catastrophic Forest Fires of 2021 on the Light Soils in Central Yakutia (Desyatkin et al., 2024).	Yes	July-September in Boreal Forests/Taiga (region ID 11)
13. Peloponnisos, Greece	2007	Fire behaviour of the large fires of 2007 in Greece (Athanasiou and Xanthopoulos, 2010).	Yes	July-August in Mediterranean Forests (region ID 21)

Fire	Year	Reference	Detected in EFEs database	EFEs detected (dates and regions)
14. Mati, Greece	2018	Forest Fire Analysis with Sentinel-2 Satellite Imagery: The Case of Mati (Greece) in 2018 (Bitek and Erenoğlu, 2022).	No	EFE not detected because the affected area was too small (1,500 ha), resulting in BA and sum of FRP anomalies below the detection threshold.
15. Black Saturday, Autralia	2009	Anatomy of a catastrophic wildfire: The Black Saturday Kilmore East fire in Victoria, Australia (Cruz et al., 2012).	Yes	February in Temperate Broadleaf & Mixed Forests; Montane Grasslands & Shrublands (Region ID 41),
16. Pedrógão Grande, Portugal	2017	Influence of Convectively Driven Flows in the Course of a Large Fire in Portugal: The Case of Pedrógão Grande (Pinto et al., 2022).	Yes	June Mediterranean Forests (region ID 21)
17. Sumatra, Kalimantan, and West Papua, Indonesia	2015	Spatial evaluation of Indonesia's 2015 fire-affected area and estimated carbon emissions using Sentinel-1 (Lohberger et al., 2018).	Yes	July-August in Kalimantan, and September-October in West Papua/ Tropical & Subtropical Moist Broadleaf Forests (Region ID 19). No events detected in Sumatra.
18. Amazonia	2019	Climate influence on the 2019 fires in Amazonia (Dong et al., 2021).	Yes	August-September in Flooded Grasslands & Savannas (region ID 47), Tropical & Subtropical Dry Broadleaf Forests (region ID 52), Tropical & Subtropical Grasslands, Savannas & Shrublands (region ID 53), Tropical & Subtropical Moist Broadleaf Forests (region ID 55).
19. Siberian Taiga Fires (Russia)	2003	Satellite-derived 2003 wildfires in southern Siberia and their potential influence on carbon sequestration (Huang et al., 2009).	Yes	May-June in Asia-Boreal Forests/Taiga (region ID 11), Temperate Broadleaf & Mixed Forests (region ID 15),

Fire	Year	Reference	Detected in EFEs database	EFEs detected (dates and regions)
				Temperate Conifer Forests (region ID 16), Temperate Grasslands and Savannas & Shrublands (region ID 17).
20. Sierras de Córdoba-Argentina	2020	Córdoba Wildland Fires Assessing Fire Risk Factors in Córdoba, Argentina using Earth Observations (Raines et al., 2024).	Yes	June, August and September in Tropical & Subtropical Grasslands, Savannas & Shrublands (region ID 53).

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