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The impact of wildfires on marine systems: a chemical fingerprint case study from the 2024 Iberian fires

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Human activities, such as greenhouse gas emissions, are causing climate change at unprecedented rates. Among other effects, climate change is known to increase the likelihood of wildfires across the world's forested regions (e.g., [1]). In a positive feedback, wildfires, in turn, enhance carbon emissions, with recent estimates from the fifth Global Fire Emissions Database placing global landscape fire emissions at 3.4 Pg C y^{-1} [2].

Additionally, fires may further impact the environment through pyrogenic particle deposition, altering runoff and chemical fluxes in terrestrial systems as well as in downstream aquatic and marine environments. In the marine realm, released chemical elements may, on one hand, act as fertilizers (e.g., Fe), but also as toxins (e.g., Co, Ni). These mechanisms exert opposing effects on phytoplankton growth and biodiversity; thus, their interplay and potential synergistic impacts on marine ecosystems constitute a critical avenue of investigation.

The Iberian Peninsula is increasingly prone to wildfires due to climate-driven intensification of heatwaves and droughts. Concurrently, its western margin hosts a region of seasonally enhanced marine primary productivity driven by both upwelling and riverine inputs. Intense forest fires occurred in NW Iberia in September 2024, burning over 130,000 hectares within a few days. Strong easterly winds transported extensive smoke plumes covering ~100,000 km² over the western Iberian margin [3], creating ideal conditions to study wildfire impacts on marine ecosystems.

In this work, part of the WIMPRO project, we present the preliminary chemical signatures of environmental samples affected by the 2024 fires and plume deposition. Samples were analyzed to determine P, V, Mn, Fe, Ni, Co, Cu, Zn, As, Cd, and Pb concentrations due to their relevance for fertilization and toxicity. Results are evaluated against regional chlorophyll-a anomalies, upwelling indices, and river discharge derived from satellite observations in the weeks following the fires.

References:

[1] Abatzoglou, JT, *et al*. 2025. *Nature Communications*, 16, 6390.

[2] van der Werf, GR, *et al.* 2025. *Sci Data* 12, 1870.

[3] https://www.copernicus.eu/en/media/image-day-gallery/severe-wildfires-portugal-september-2024