

At a glance - Forest fire danger extremes in Europe under climate change: variability and uncertainty

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Forests and wildfires: an overview

Forests in Europe and their disturbances:

- Forests cover about 215 million ha in Europe (approx. 33% of total land area, source: [FOREST EUROPE 2015](#)).
- In the year 2017, in November the cumulated annual burnt area of Portugal, Spain, and Italy alone exceeded 0.8 million ha.
- In recent years, large forest fires repeatedly affected the continent, in particular the Mediterranean countries.

Weather/climate as main factors influencing wildfire potential:

- Precipitation, soil moisture** associated with fire occurrence.
- Temperature, drought stress:** abiotic + biotic disturbances.
- Wind speed:** rate at which a fire might spread following ignition.

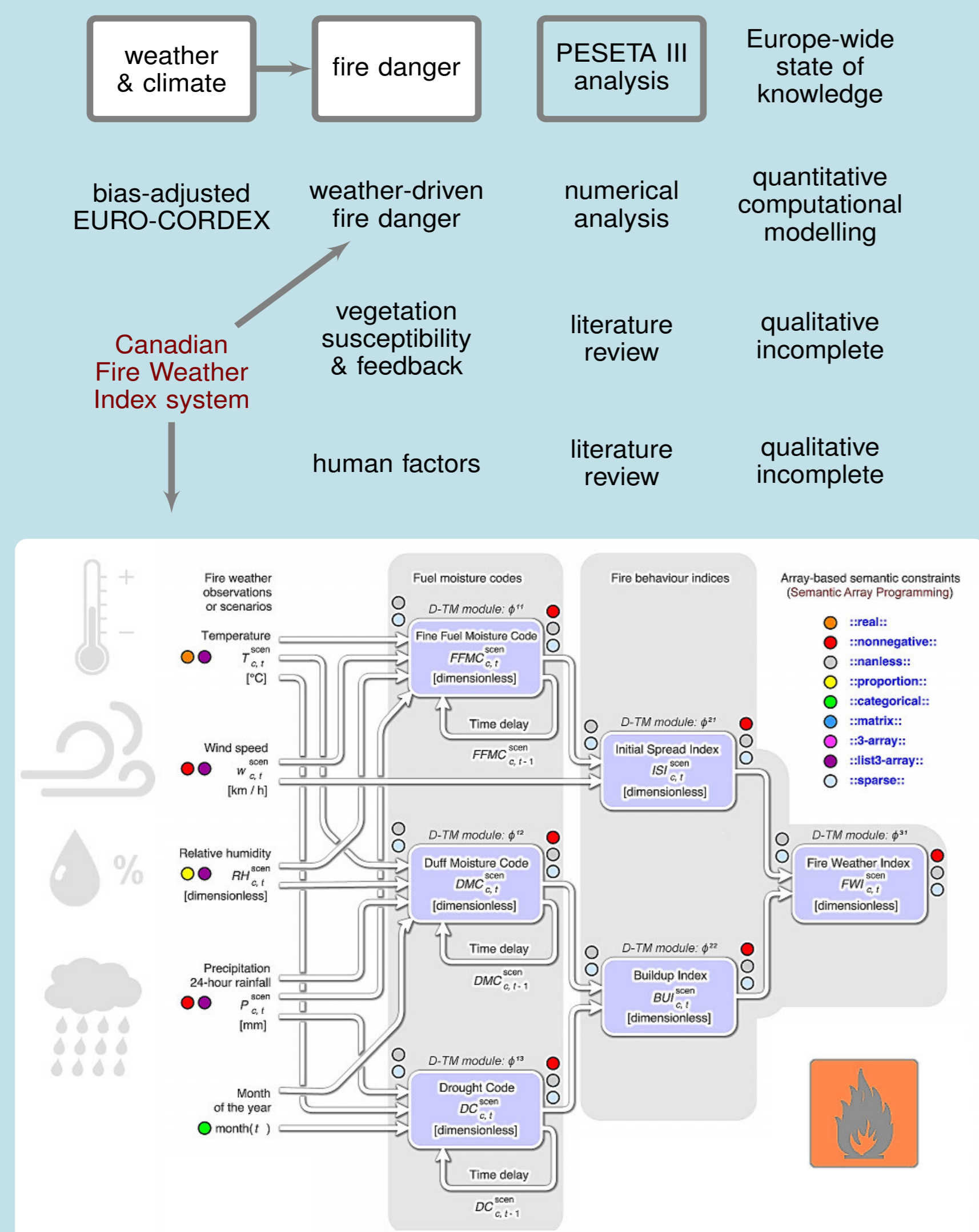
Other factors also affect the occurrence of fires:

- Vegetation** conditions and composition.
- Human behaviour.**

Methodology and limitations

Context: PESETA series of projects <https://ec.europa.eu/jrc/en/peseta>.

Factors: weather-driven fire danger; vegetation; human factors:



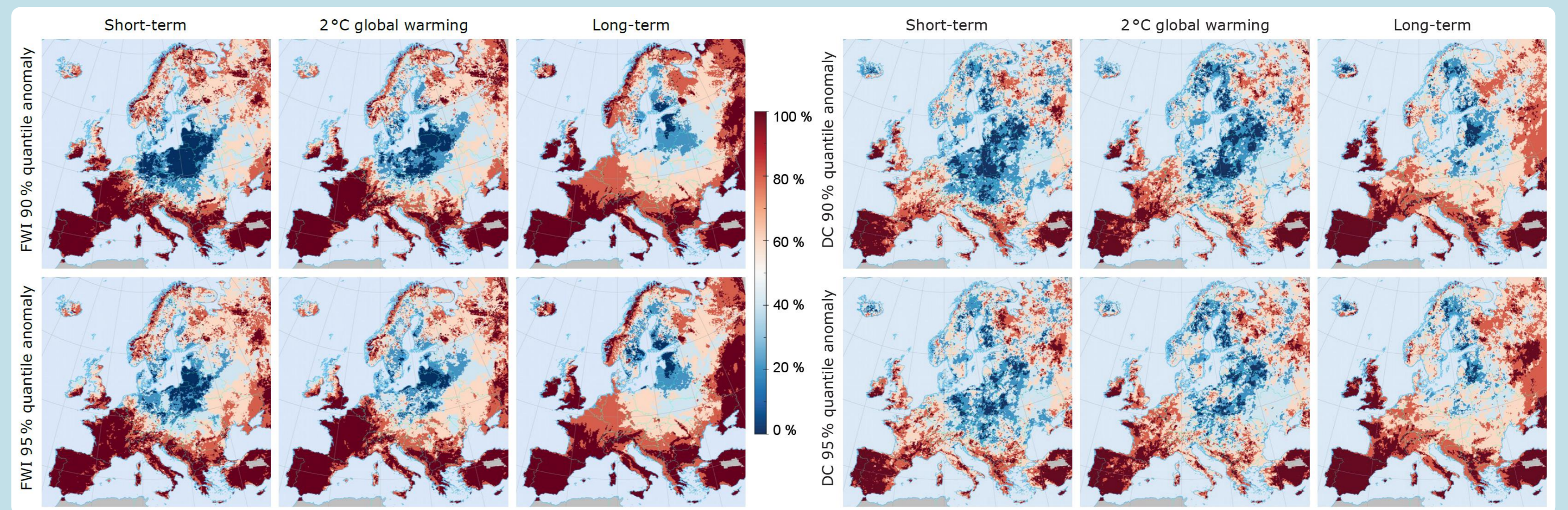
High-emission scenario: Representative Concentration Pathways (RCP) radiative forcing increase throughout the 21st century up to reach a high value ($\approx 8.5 \text{ W per m}^2$).

Scenario time period	Time code	Time interval	Model code	Year when the model GCM projects a global 2°C warming compared to pre-industrial level
Control period	cp	1981-2010	A, B, C, D, E	
Short-term	st	2021-2050	A, B, C, D, E	
2 degrees global warming	2d	2016-2045	D	2030 (period not ending after short-term)
		2021-2050	C	2035 (period not ending after short-term)
		2027-2056	B	2041
		2030-2059	A	2044
		2030-2059	E	2044
Long-term	lt	2071-2100	A, B, C, E	
		2071-2098	D	

Code (scen)	Institution(s)	Regional Climate Models	Driving Global Circulation Models
A	CLMcom	CCLM4-8-17	CNRM-CERFACS-CNRM-CM5
B	CLMcom	CCLM4-8-17	ICHEC-EC-EARTH
C	IPSL-INERIS	WRF331F	IPSL-IPSL-CM5A-MR
D	SMHI	RCA4	MOHC-HadGEM2-ES
E	SMHI	RCA4	MPI-M-MPI-ESM-LR

Uncertainty and limitations Control period: uncertainty propagation - from bias adjusted simulated "current" weather to fire danger

- Within PESETA III, the bias correction was applied only to **temperature and precipitation** components.
- Relative humidity (RH)** estimated from other bias-corrected variables as proxy for real bias-corrected relative humidity (unknown).
- The **wind speed** was not bias corrected - since the data required for the correction were not available.

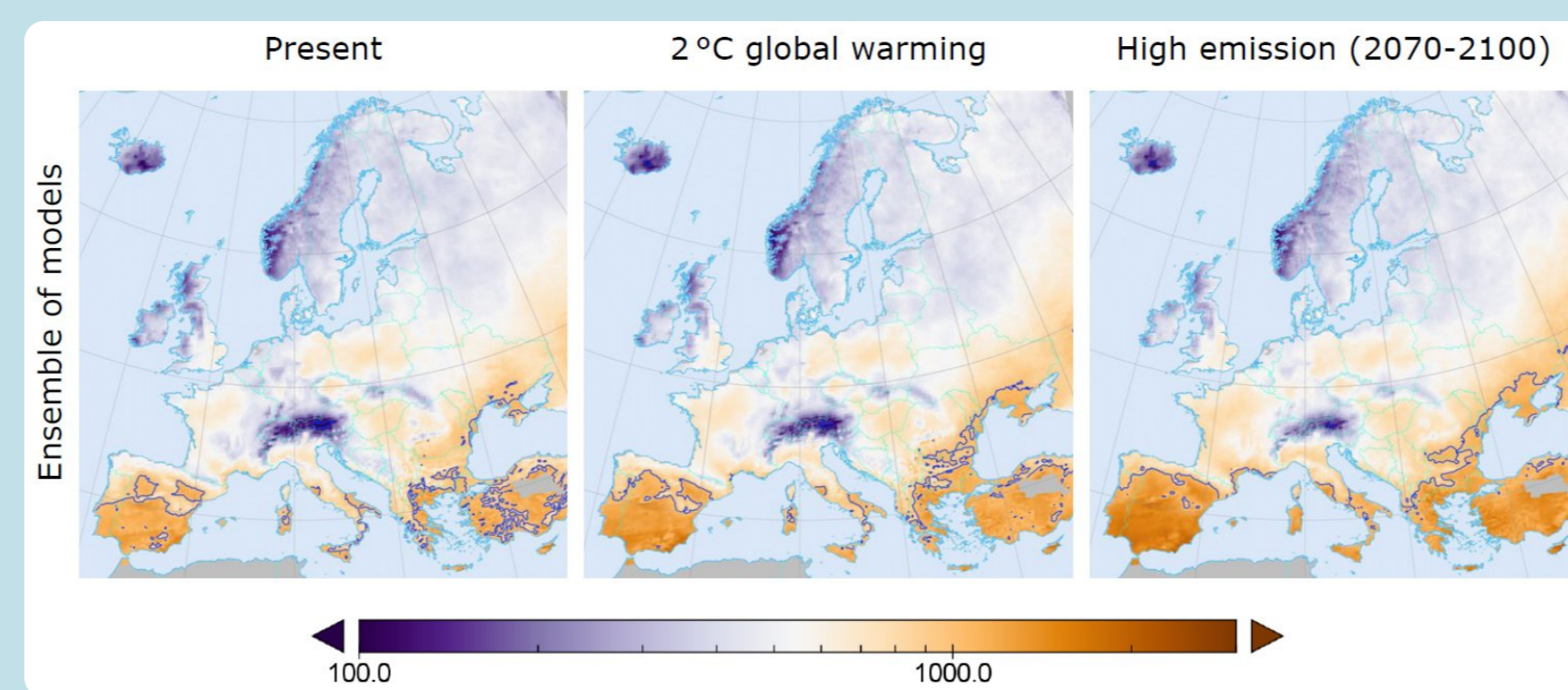


Robustness of estimated climate-driven change in the fire danger extremes (90% and 95% quantiles). Ensemble analysis for the anomaly of the Fire Weather Index (FWI) aggregated component (left) and focus on the effects of drier weather (Drought Code DC component, right). The agreement among models is shown on whether the difference between future and control period (anomaly) is positive.

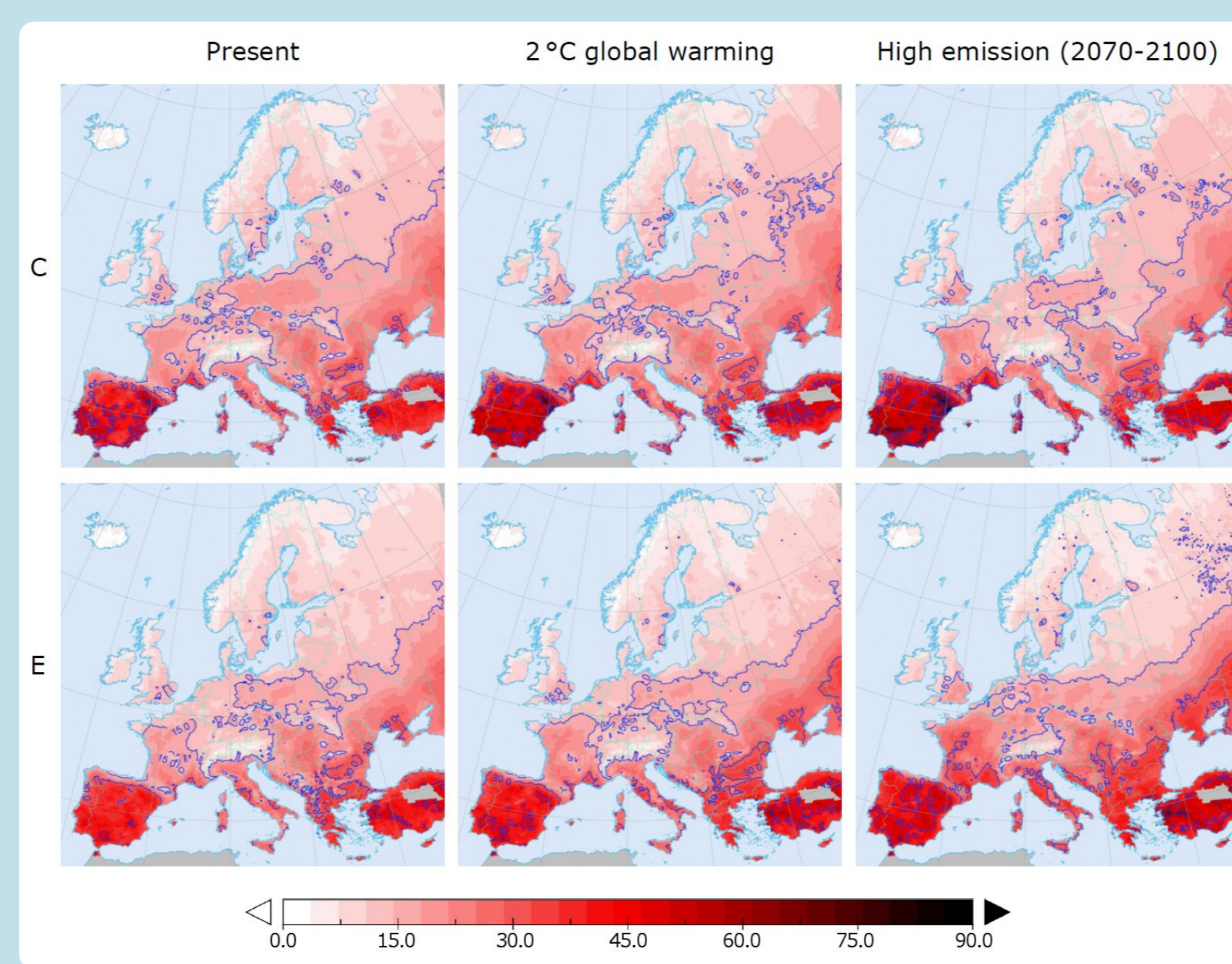
Main findings

Fuel moisture extremes: perspective

- Mediterranean region: decreasing fuel moisture levels. Drier regional patterns: weather-driven danger of forest fires higher.
- Low moisture areas extend northwards from the Mediterranean.
- The area of high fuel moisture surrounding the Alps in the present climate decreases in size with climate change.
- Moisture declines in Mediterranean are smaller with mitigation (global warming 2°C), but still predicted lower than at present.



Seasonal drought effects on fuel moisture of the deeper ground layer of organic matter, as estimated by a specific component of the FWI system. Contour lines denote corresponding orders of magnitude on the logarithmic scale (10, 100, 1000). Median values across five climate models.



Overall weather-driven forest fire danger according to two different climate models, selected to demonstrate the effect of different climate models. Contour lines: index increments by 15 units.

Fire danger extremes: perspective

- Despite some uncertainty in the magnitude of the effect of climate change, it is clear that the **fire danger driven by weather will increase around the Mediterranean**.
- Countries with the highest danger are Spain, Portugal and Turkey, Greece, part of central and southern Italy, Mediterranean France, and the coastal region of the Balkans.
- Northern Europe: relatively little **absolute** change in fire danger as directly driven by changing weather patterns.
- Relative** worsening in several mountain systems.

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Adaptation options

Key strategies

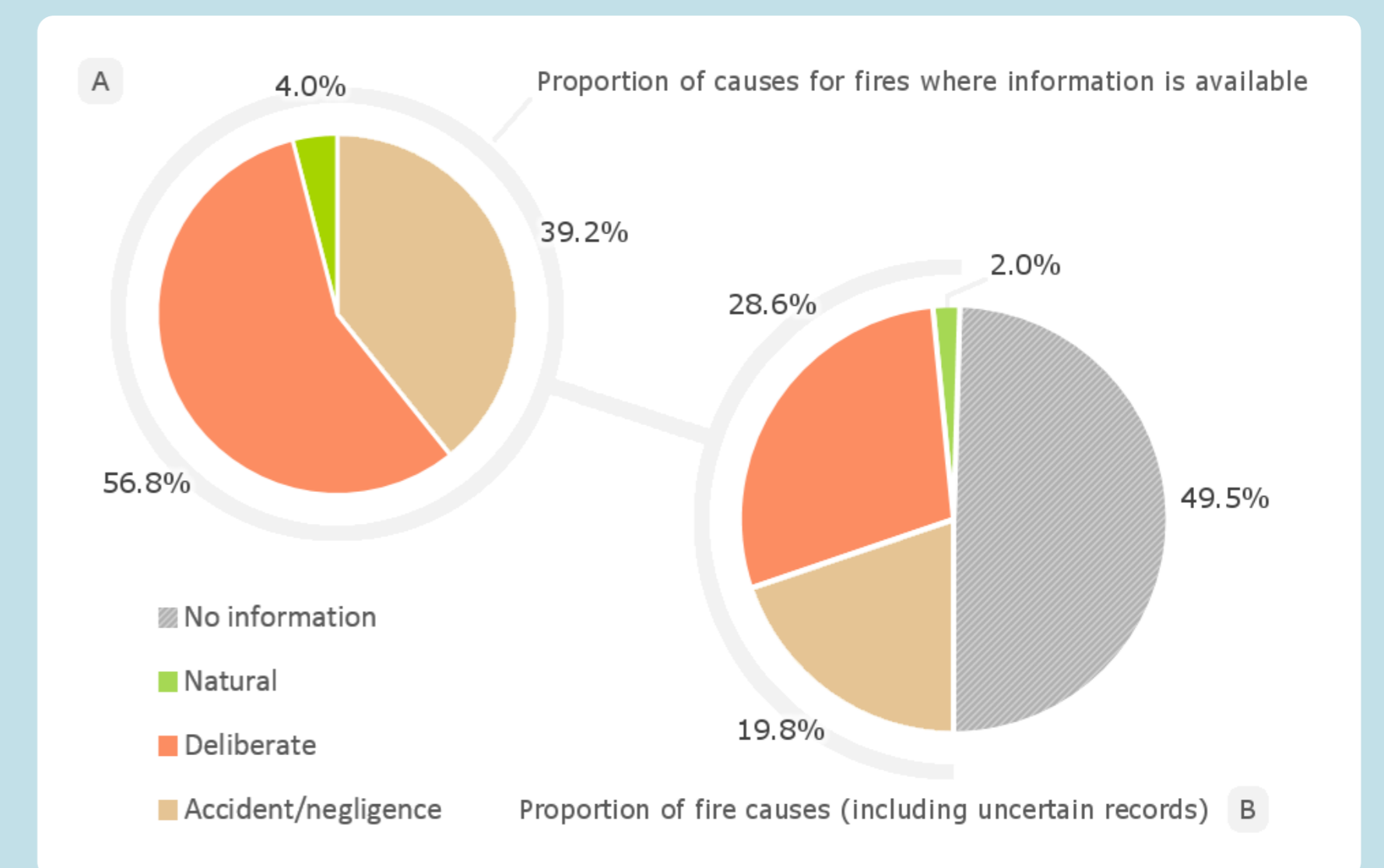
- Vegetation management to reduce severe-fires likelihood.
- Fuel treatments to mitigate fire hazard in dry forests.

Limited, partial evidences worth further investigation

- Some** biodiversity-conservation protected areas may be affected less by wildfires than unprotected areas, despite with more fuel.
- Specific **old-growth forests** may be associated with lower fire severity than densely stocked even-aged young stands.
- Some **tree plantations** might be more subject to severe fire compared with multi-aged forests.
- Diversity** of fire resistance/resilience traits might be more effective than simple functional richness (biodiversity is not enough).

Policy-relevant variability and uncertainty

- Highly variable** forest communities **fire-resilience**: depends on **species composition**, and emergent properties of mixtures.
- Different species have different levels of resilience to fires, as well as different levels of flammability.
- Some ecosystems and vegetation associations more adapted to fire disturbances with mechanisms to mitigate the post-fire recovery, **as long as the interval between fires is not too short**.
- In **wrongly selected mixtures**, the impact of forest fires might even be **aggravated**. Therefore, deepening the understanding of resistance, resilience and habitat suitability of mixtures of forest tree species is recommended.



Data from 19 European countries, Fire Database of EFFIS, <https://doi.org/10.2788/86859>.

Human factors

- Human activity** (whether accidental, negligent or deliberate) is one of the **most common causes of fire**.
- For this reason, the main causes of fire should be minimized, which includes
 - looking at the social and economic factors** that lead people to start fires,
 - increasing **awareness** of the danger,
 - encouraging good behaviour and sanctioning offenders.

Reference This is a summary from the following work. Please, refer to it for any detail:

de Rigo, D., Libertà, G., Houston Durrant, T., Artés Vivancos, T., San-Miguel-Ayanz, J., 2017. **Forest fire danger extremes in Europe under climate change: variability and uncertainty**. Publication Office of the European Union, Luxembourg, 71 pp. ISBN: 978-92-79-77046-3, <https://doi.org/10.2760/13180> EUR 28926 EN, Catalogue Number: KJ-NA-28926-EN-N

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