

## Acknowledgement

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## Background and Aim

Extreme temperatures and air pollution significantly threaten public health, with their combined effects amplifying health risks. However, understanding spatial inequalities and long-term trends in population exposure to these compounded threats remains unclear, hindering effective mitigation or adaptation strategies. This study aims to identify region-specific extreme-risk temperature (ERT) days and their co-occurrence with air pollution, by analyzing mortality data from 35 European countries using epidemiological models.

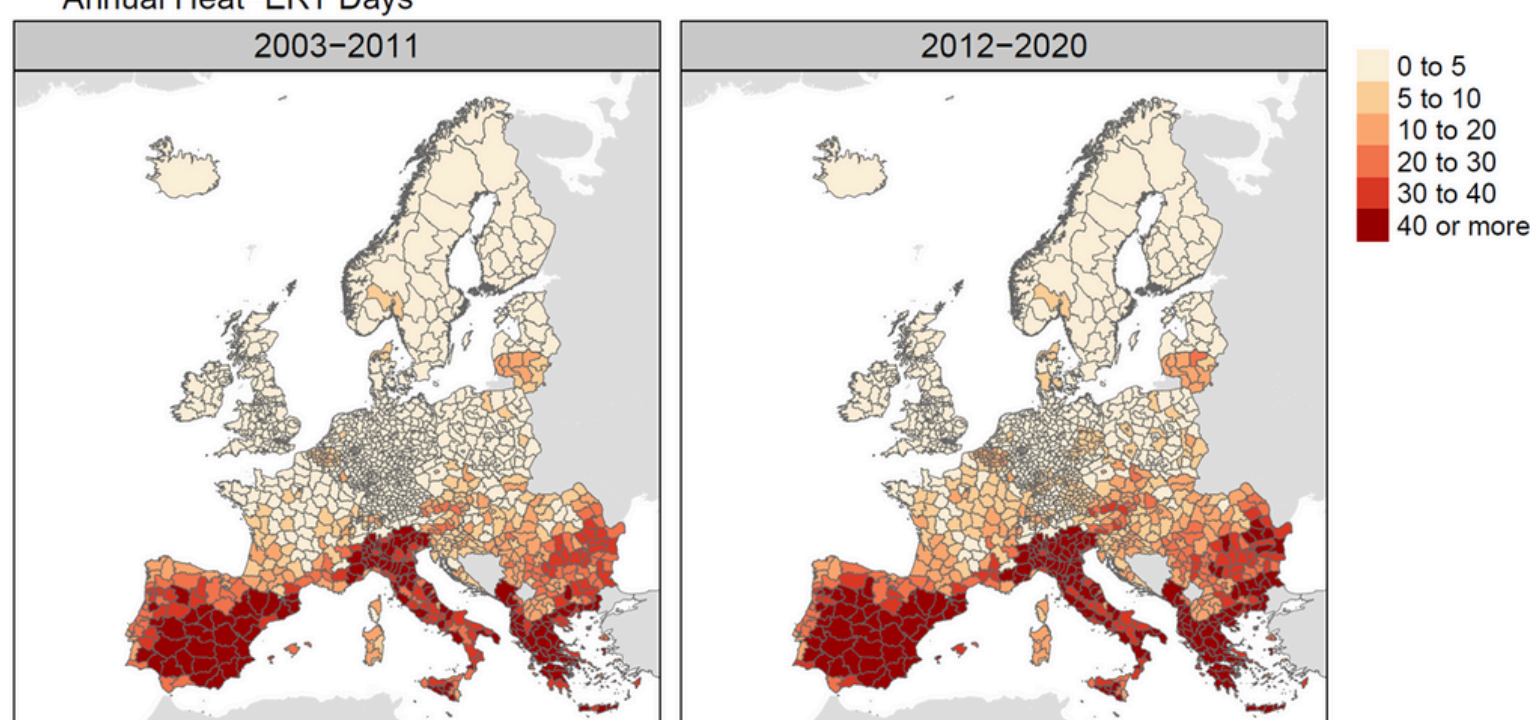
## Materials and Methods

- **Temperature-mortality relationships:** We employed a two-stage epidemiological model on weekly mortality data from Eurostat for over 543 million people across 35 European countries. This analysis derived location-specific temperature-mortality relationships, and identify the ERT days exceeding threshold risk for 1,426 NUTS-3 regions.
- **Identifying Compound ERT days:** We used high-resolution daily air pollution estimates (PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, O<sub>3</sub>) to identify ERT days exceeding WHO guidelines.
- **Spatial and temporal patterns:** We then analyzed the spatial distribution and temporal changes in these compound extreme temperature-air pollution events.

## Results

Across 1426 European regions, heat-ERT days rose from an average of 13.76 days per year during 2003-2011 to 17.09 days per year during 2012-2020.

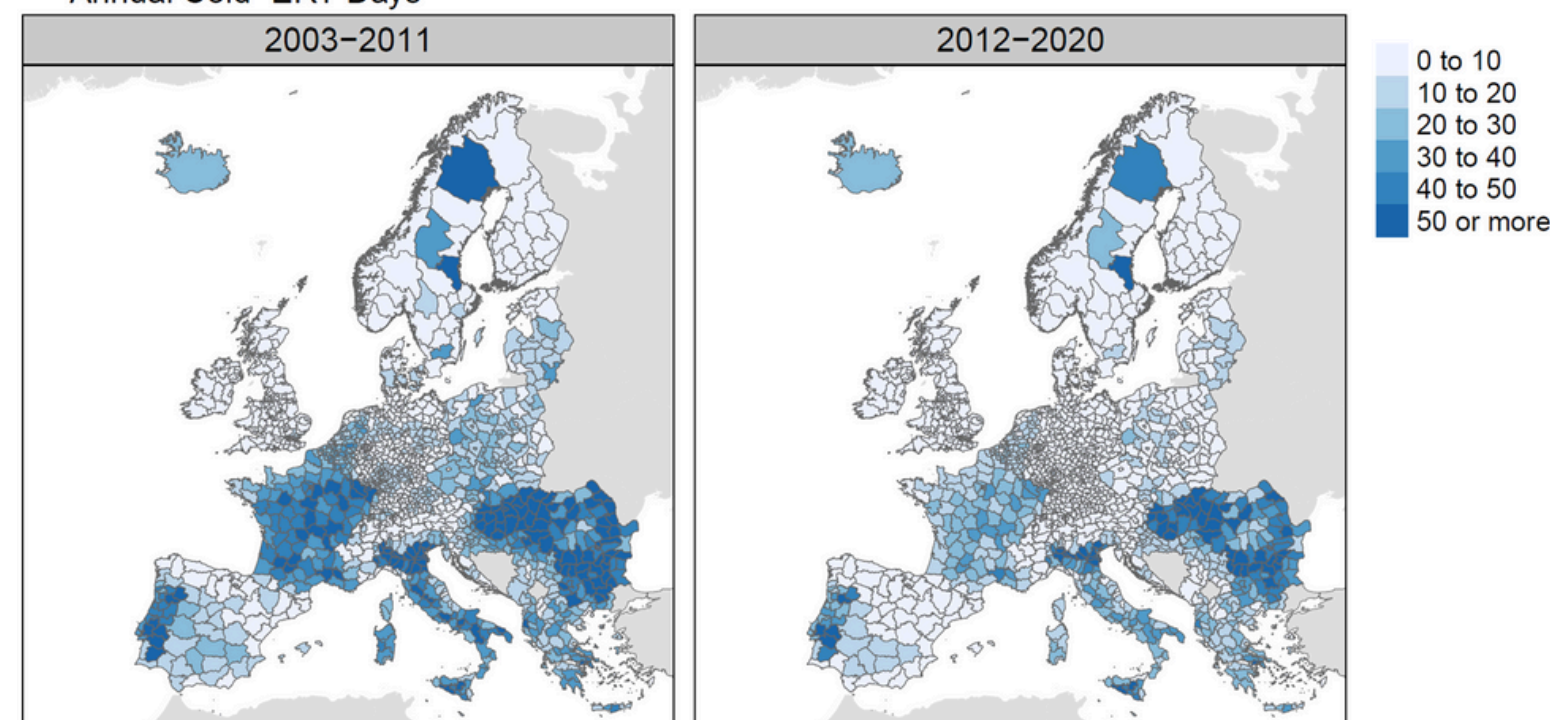
Annual Heat-ERT Days



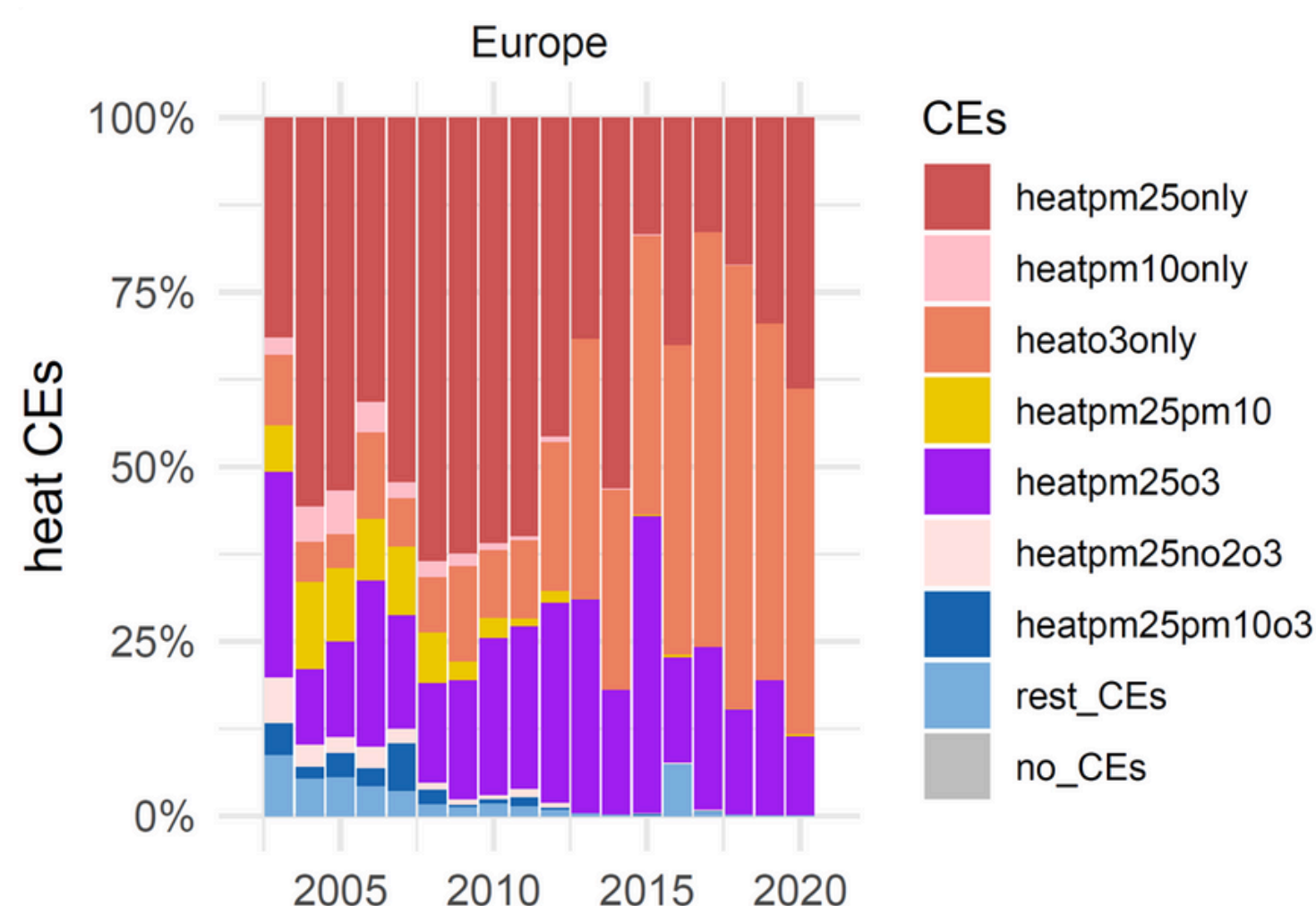
## Results

Conversely, cold-ERT days decreased from an average of 20.69 to 12.94 days per year over the same period. Southeastern Europe experienced higher frequencies of both heat and cold ERT days.

Annual Cold-ERT Days



Heat-compound episodes rose from 7.58 to 8.49 days per year over periods, driven by heat-O<sub>3</sub> events, while cold-compound episodes declined from 15.61 to 9.53 days per year, with cold-PM<sub>2.5</sub> events remaining the predominant threat.



## Conclusion

Our study identifies region-specific risk thresholds to unveil spatial disparities and changes in extreme temperature events, especially when coupled with air pollution. This understanding is crucial for tailoring adaptation strategies, facilitating subsequent health assessments, and implementing effective mitigation measures to safeguard public health.