Integrating Climate Techniques and Models to Explore New Avenues in Environmental Epidemiology

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erc

EARLY-ADAPT

Overview

1. The Adaptation Group
2. Epidemiological Modelling
3. Climate Impact Modelling
4. Innovation Tools

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What

A.

Who is adapting to climate change?

*Why? >> **Social Drivers** of Adaptation Inequalities*

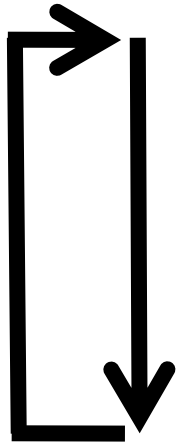
B.

Can we increase this adaptation?

*How? >> **Predictability** of Early Warning Systems*

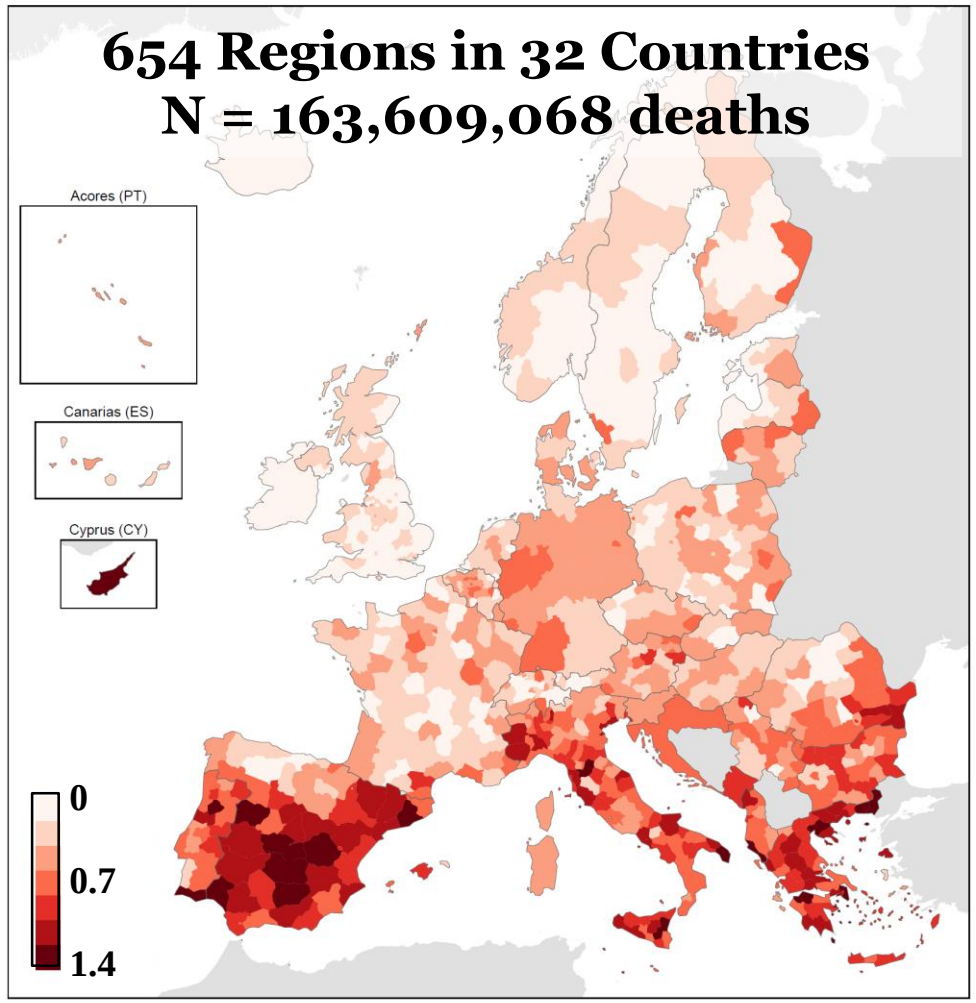
How

Interdisciplinary research between:



- ***Climate***: dynamics, modelling, forecasting, change, attribution;
- ***Epidemiology***: environment, vulnerability, adaptation;
- ***Social sciences***: drivers, socioeconomics, ageing, inequalities;
- ***Innovation***: disease forecasting, early warning systems.

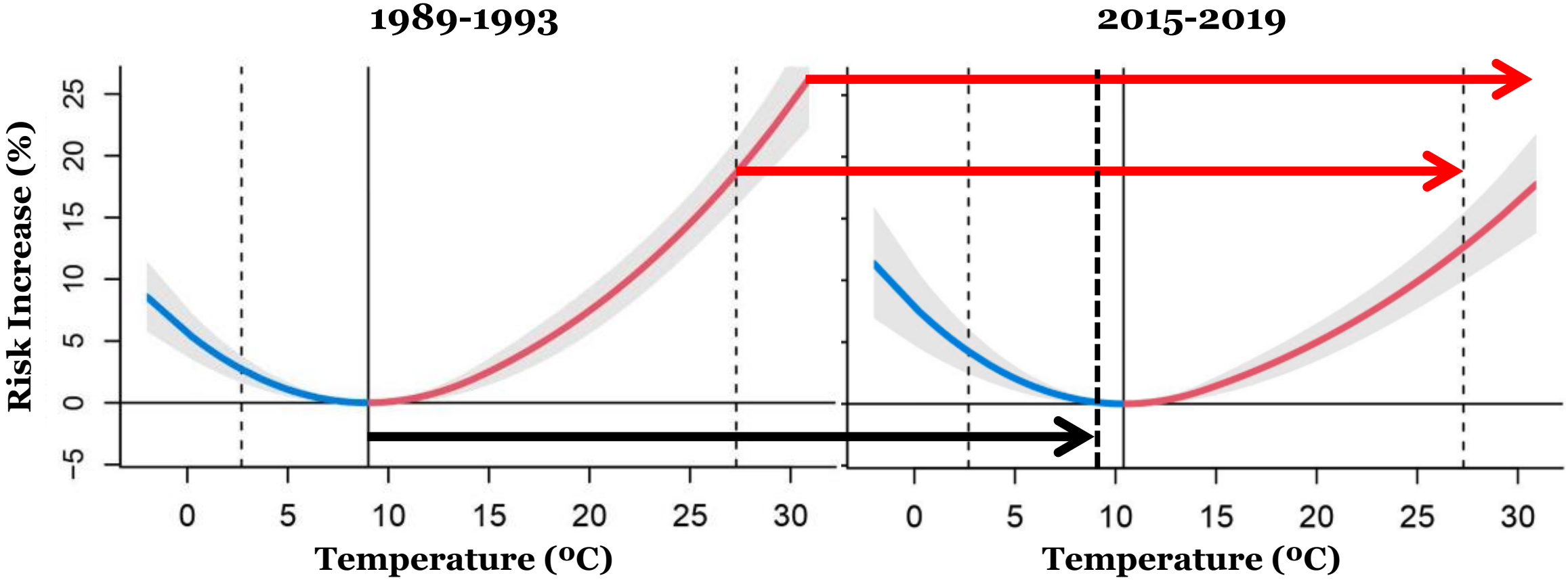
EARLY-ADAPT Database



5 Health Outcomes:
- **Mortality**
- Morbidity
- Occupational Accidents
- Motor Vehicle Accidents
- Births

For **Mortality** (*Europe / Other Continents*):
- Daily Data for 20-50 Years
- By Age, Sex and Cause of Death
- Regions: 700+ / 200+
- Municipalities: 59000+ / 10000+
- Population: 500M+ / 400M+
- Data Providers: 60+

Changes in Occupational Accidents



Vielma et al. *Environment International* (2024)

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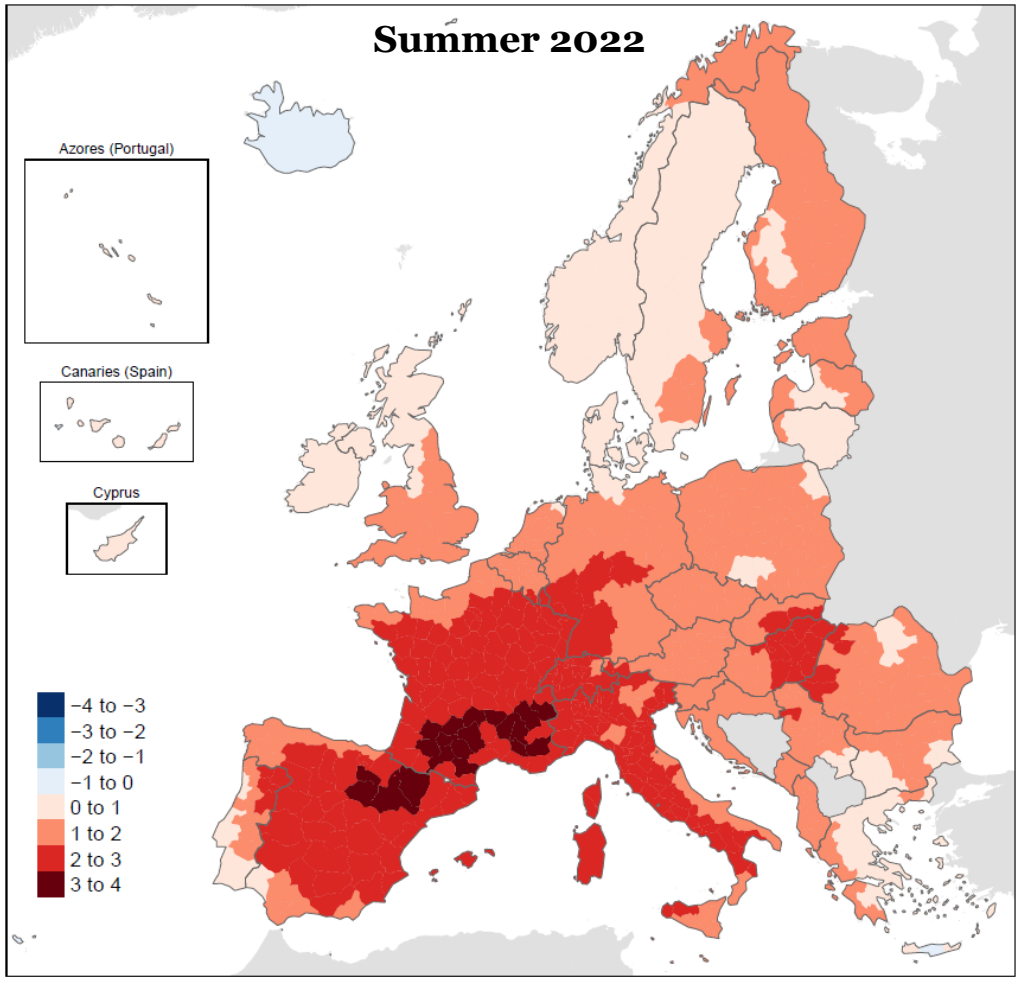
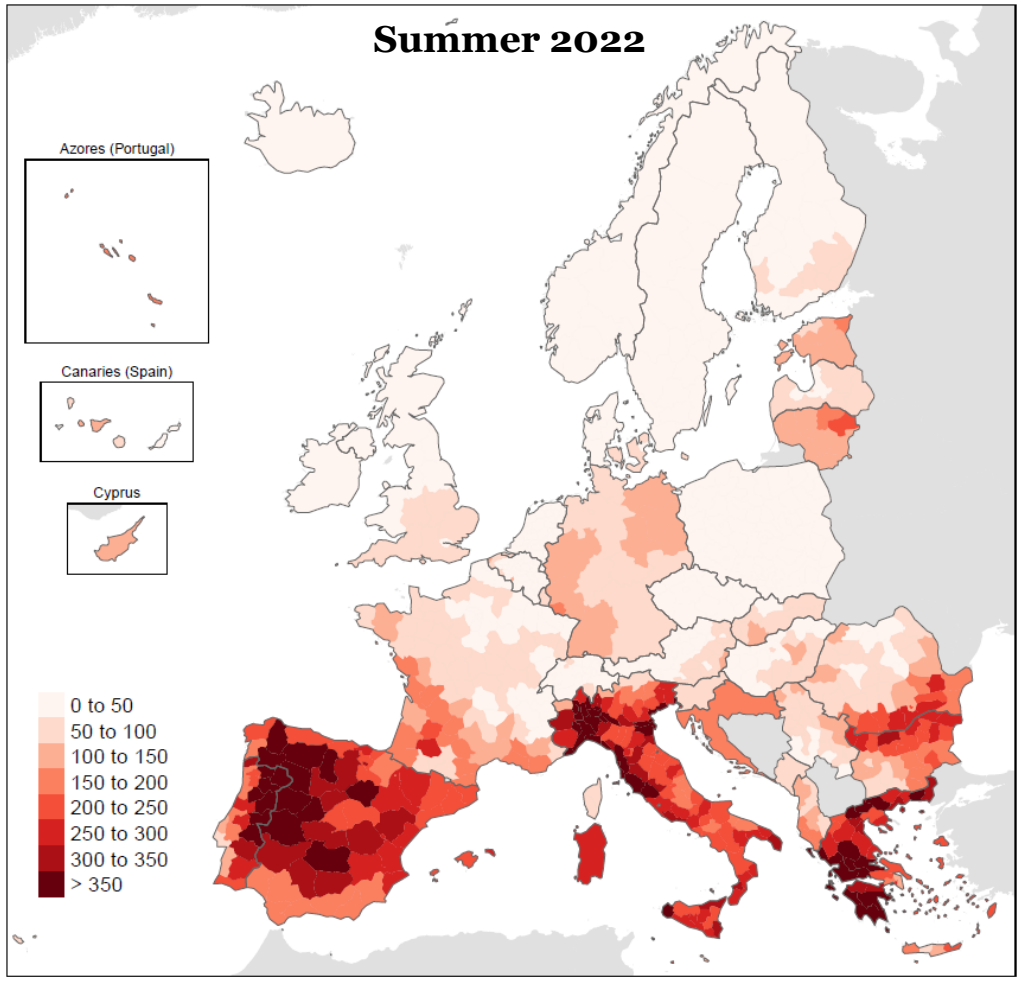
Temporally Aggregated Data

Temperature Anomaly (ºC)



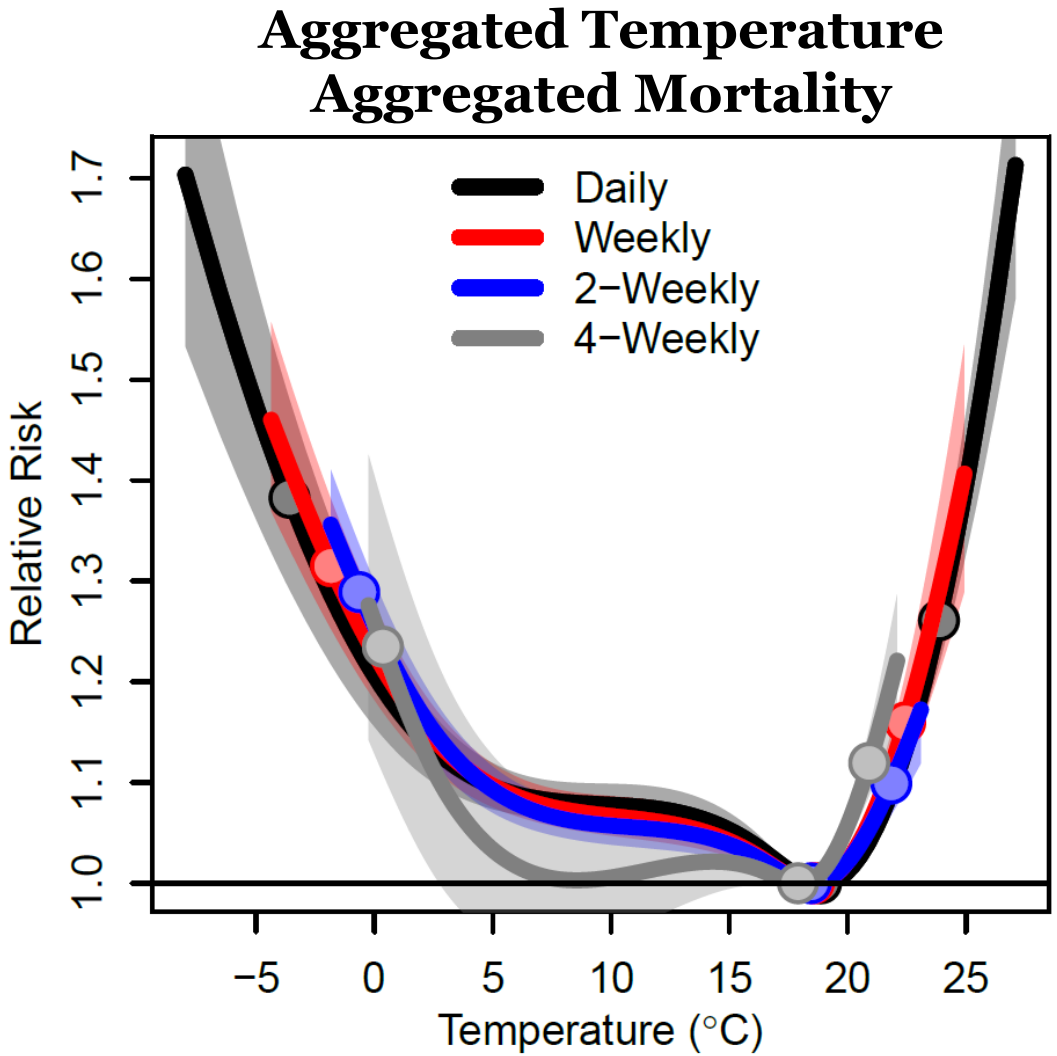
Heat Related Mortality (deaths / million)



van Daalen et al. *The Lancet Public Health* (2022)
van Daalen et al. *The Lancet Public Health* (2024)

Ballester et al. *Nature Medicine* (2023)
Gallo et al. *Nature Medicine* (2024)

Previous Approach



Ballester et al. *The Lancet Regional Health – Europe* (2024)

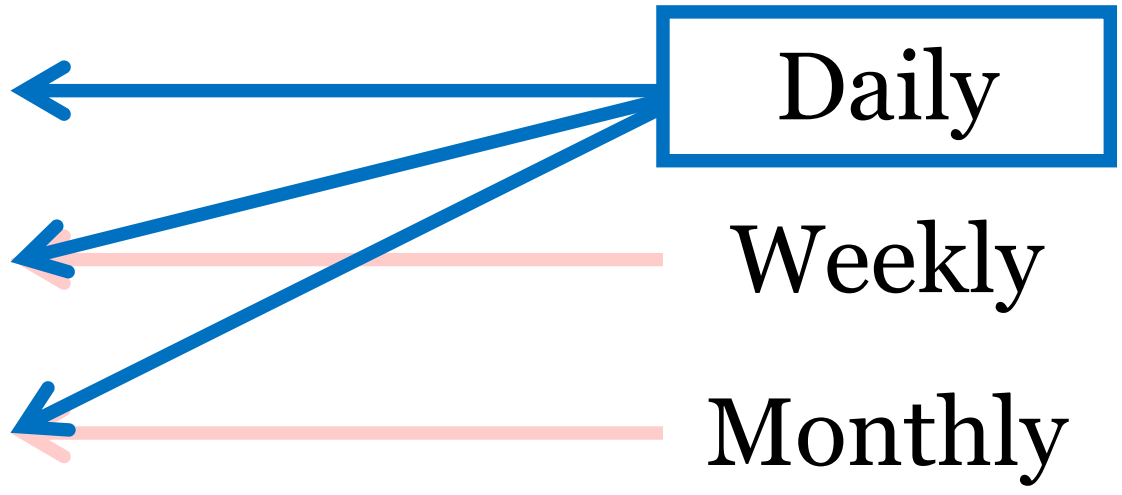
Previous Approach

Model	Response		Exposure
D|D	Daily	←	Daily
W|W	Weekly	← **OK, with biases**	Weekly
M|M	Monthly	← **Not OK!**	Monthly

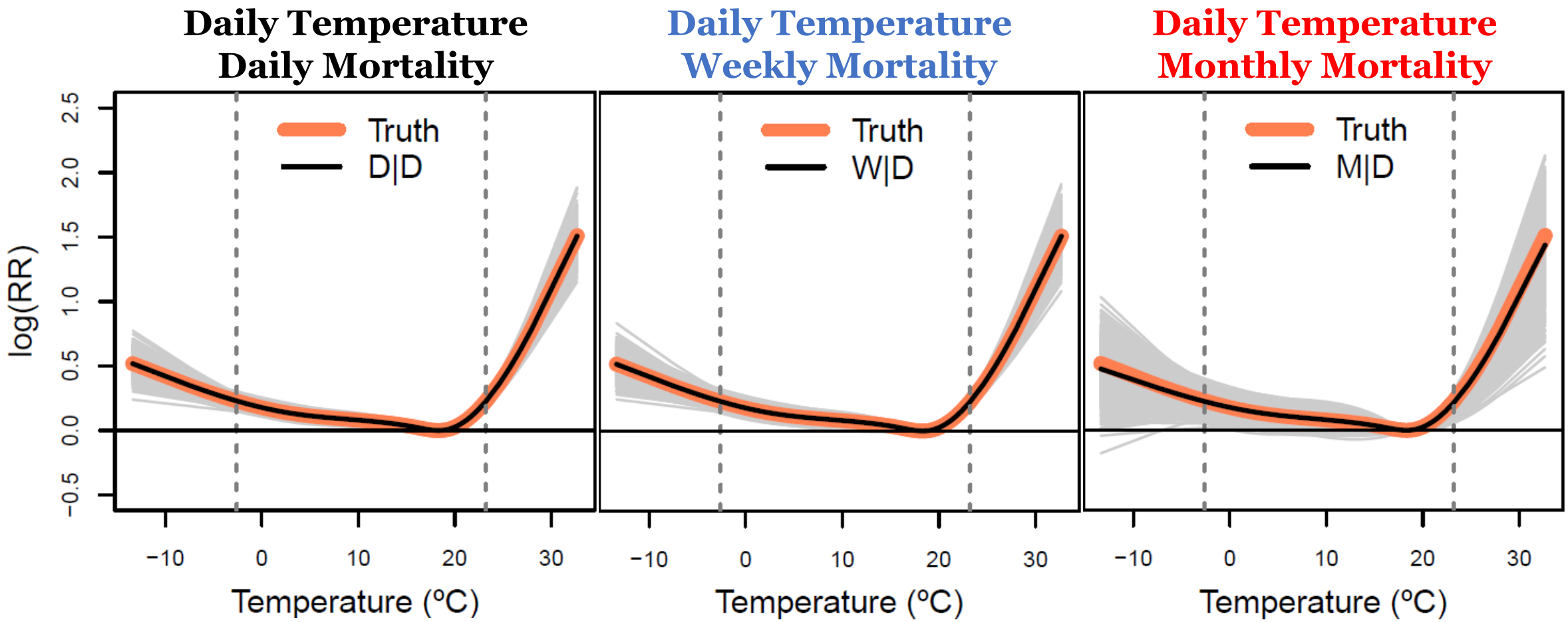
Ballester et al. *The Lancet Regional Health – Europe* (2024)

New Approach

Model	Response
D|D	Daily
W|D	Weekly
M|D	Monthly



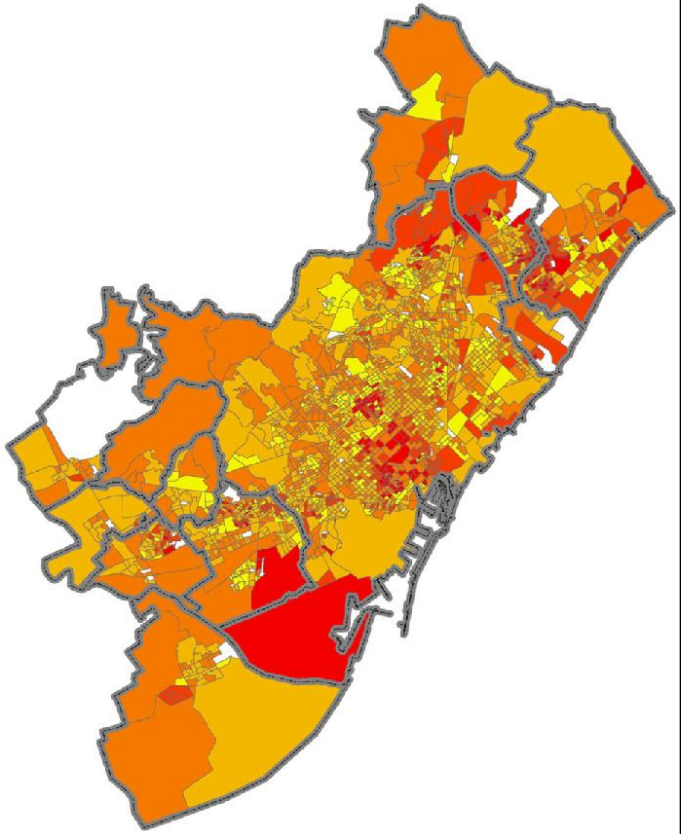
Unbiased Estimates



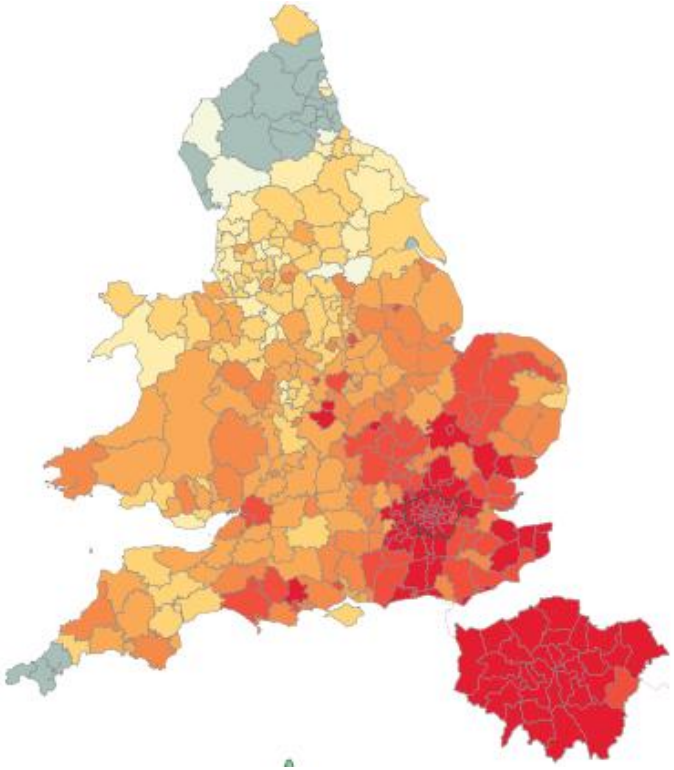
Basagaña and Ballester. *The Lancet Planetary Health* (2024)

Small-Area Analysis

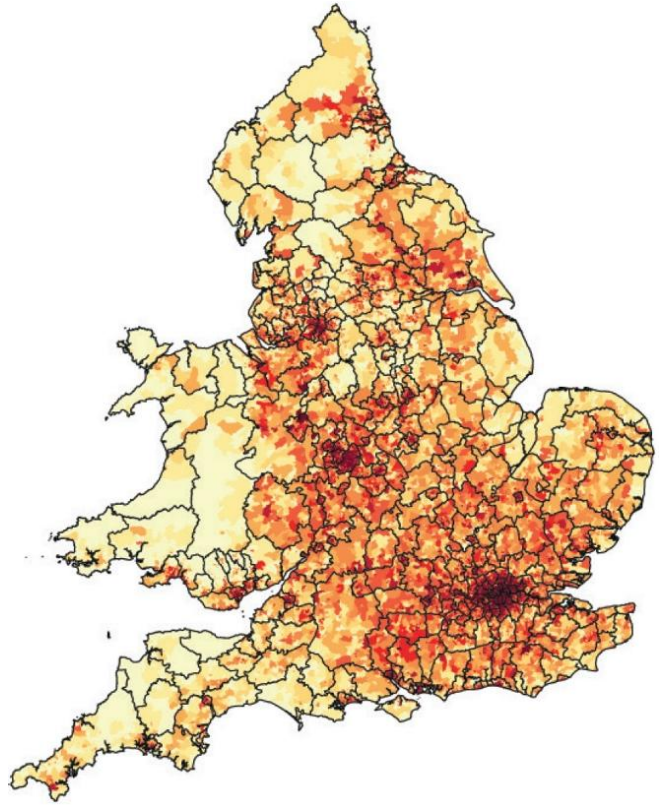
1) **Predictions methods**:
Xu et al.
Journal of Epidemiology & Community Health (2013)



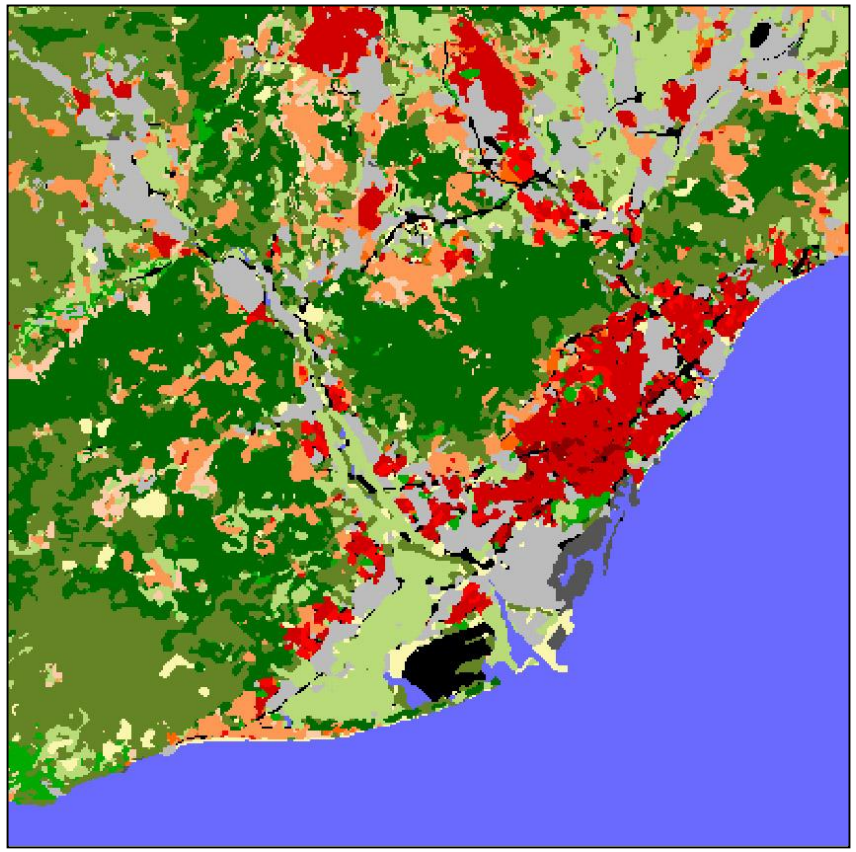
2) **Spatial methods**:
Bennet et al.
Nature Climate Change (2014)



3) **Case-time series**:
Gasparrini et al.
The Lancet Planetary Health (2022)

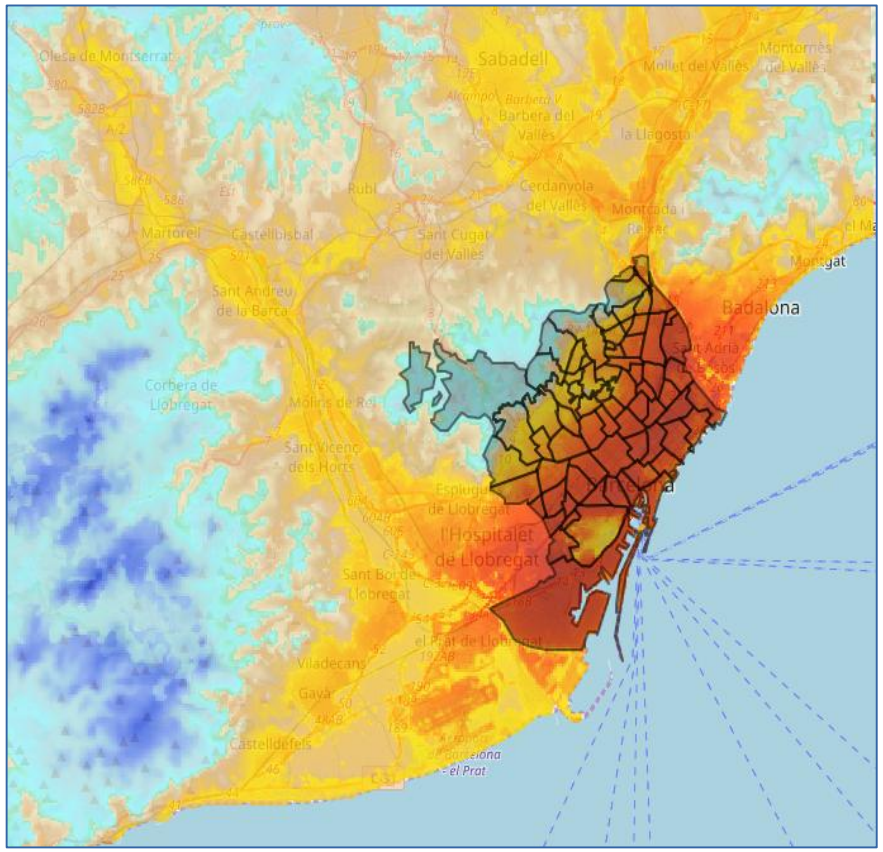


Urban Climate Modelling



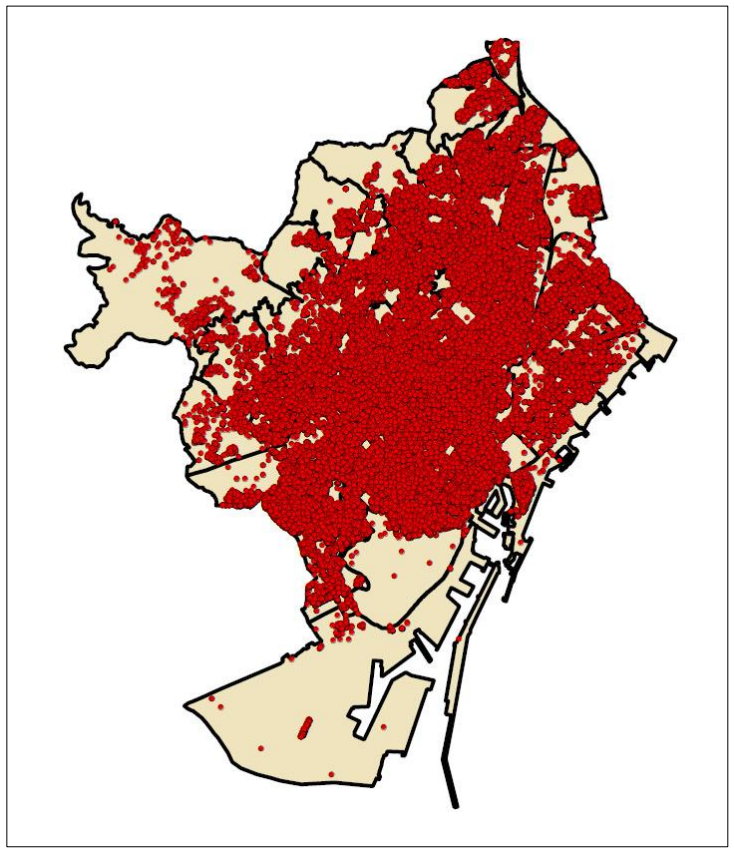
Land Use Map

based on Local Climate Zones



Temperature at 100m

from Urban Climate Model



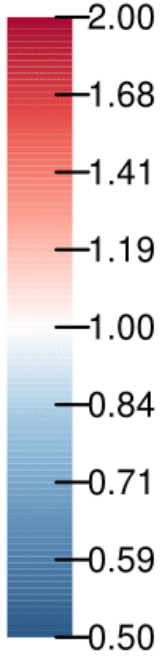
Deaths

from Individual Records

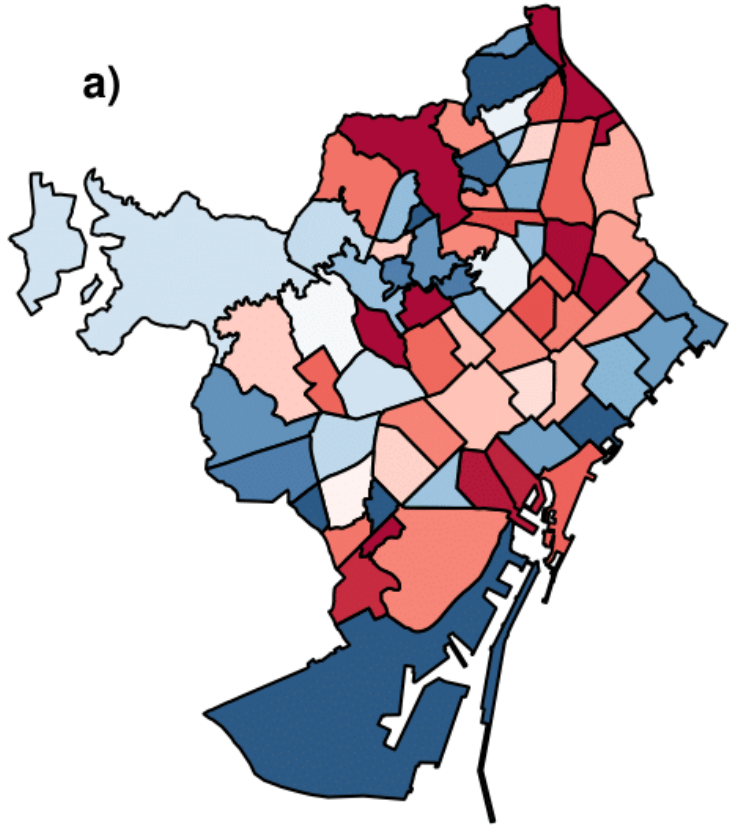
Spatial Bayesian DLNM

DLNM = Distributed Lag Nonlinear Model

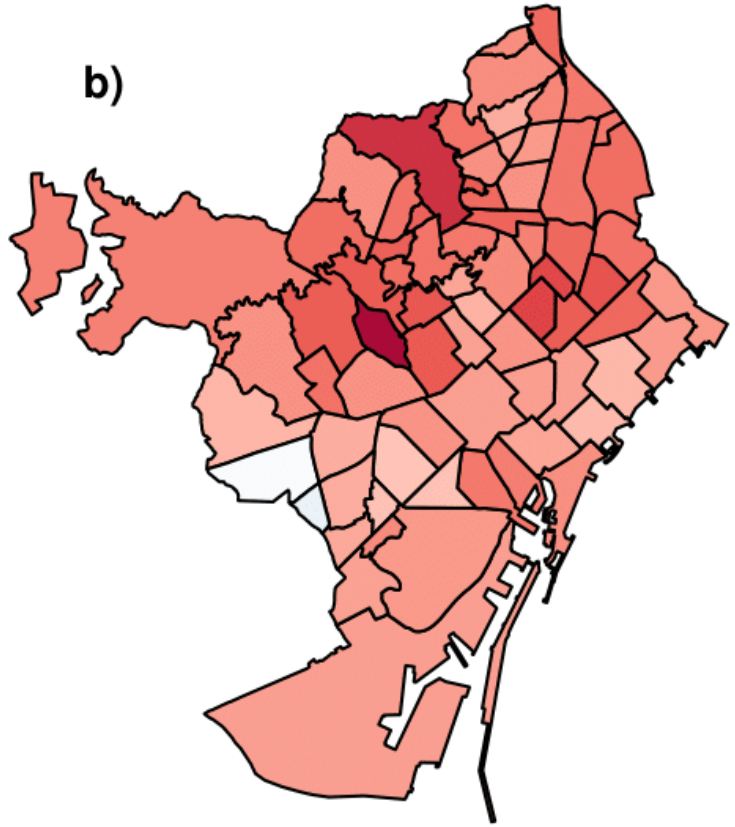
Relative Risk at Percentile 99



Independent Bayesian DLNM



Spatial Bayesian DLNM



Quijal-Zamorano et al. *International Journal of Epidemiology* (2024)

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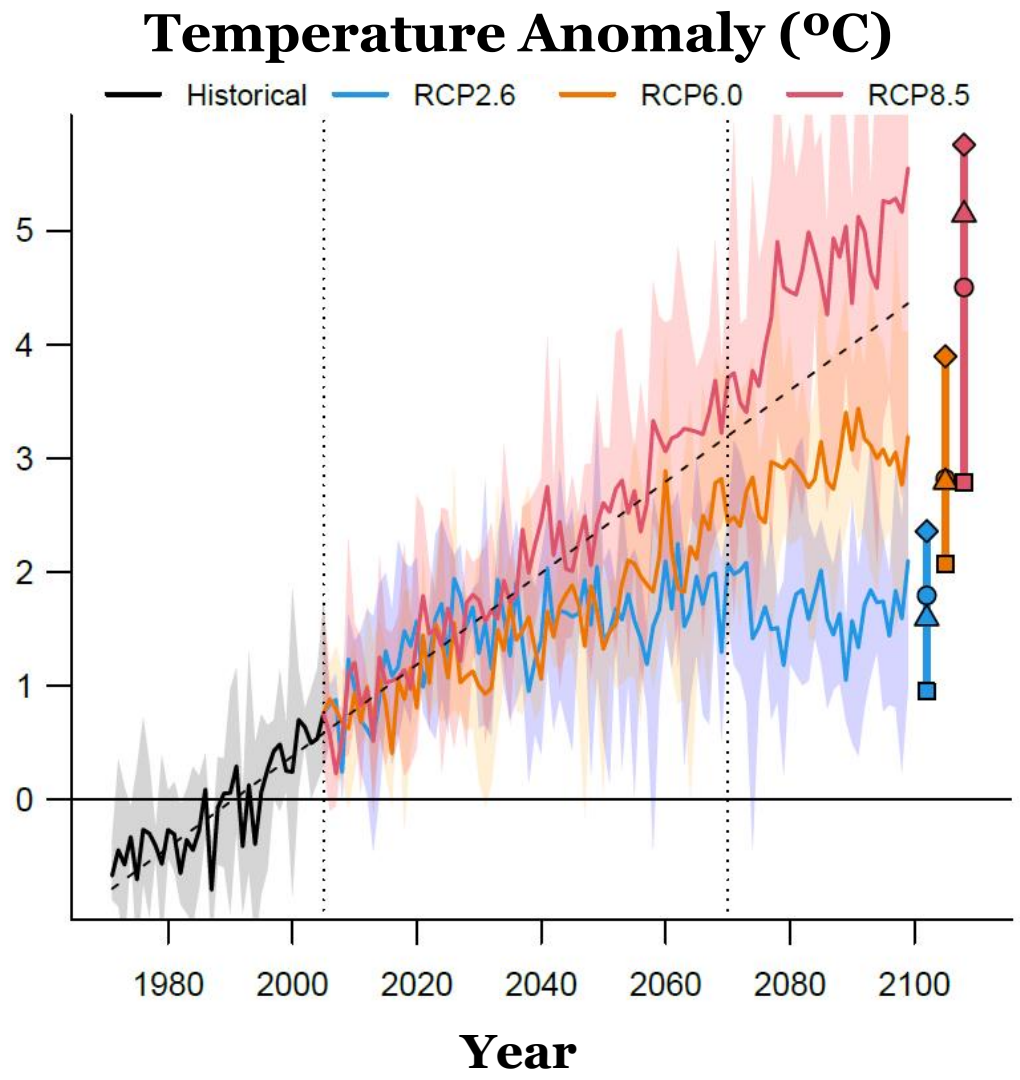
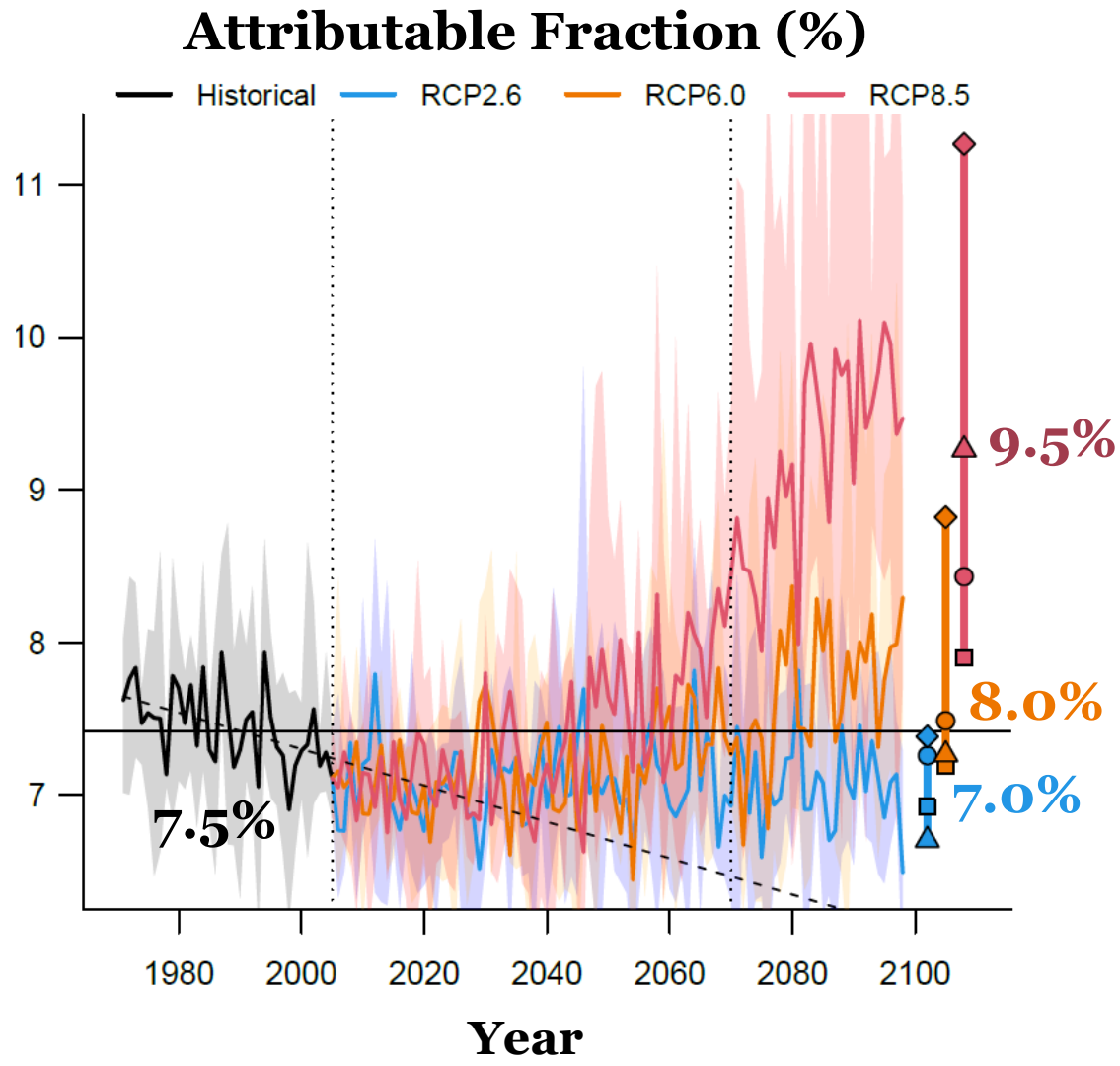
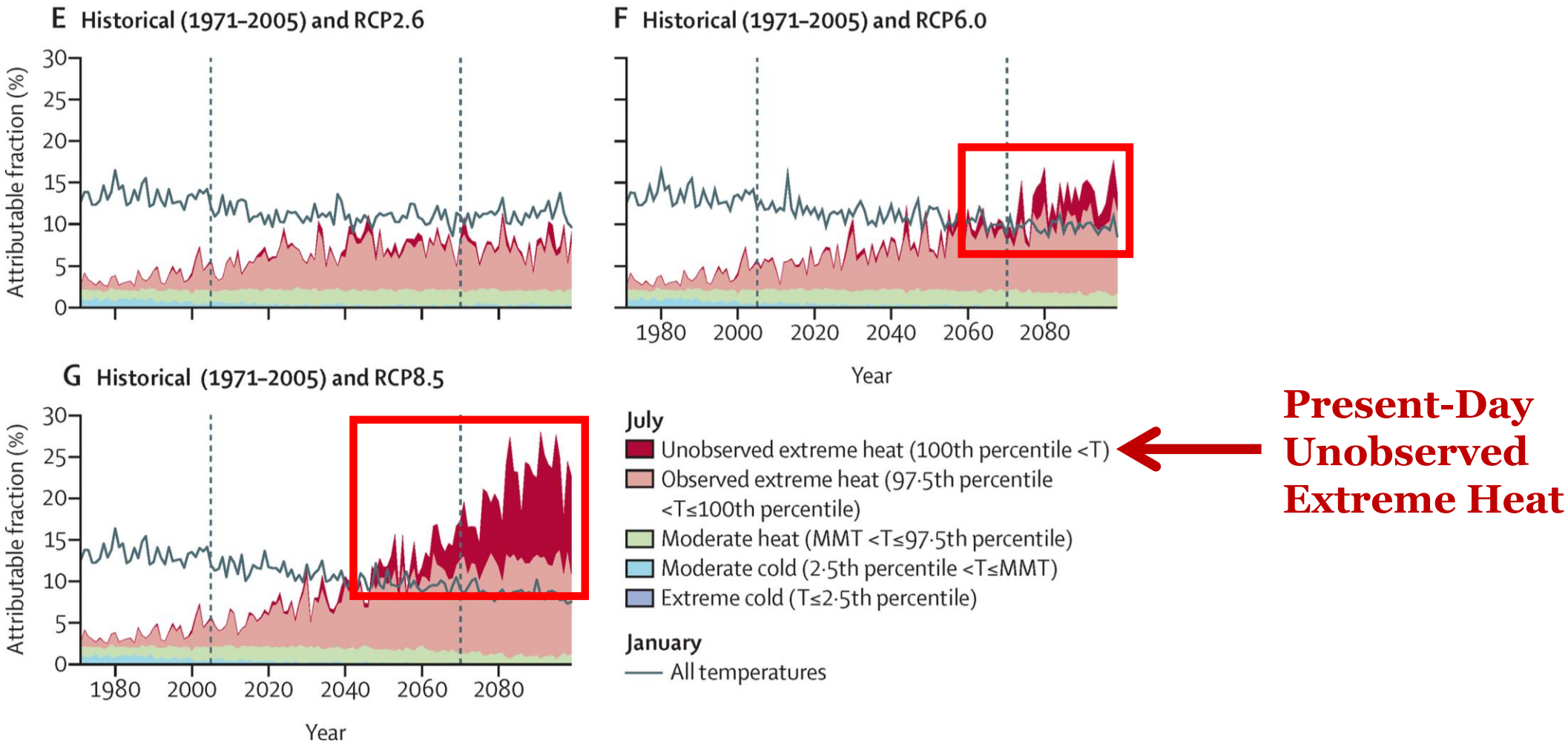
Climate Change Impact Projections





Martínez-Solanas et al. *The Lancet Planetary Health* (2021)

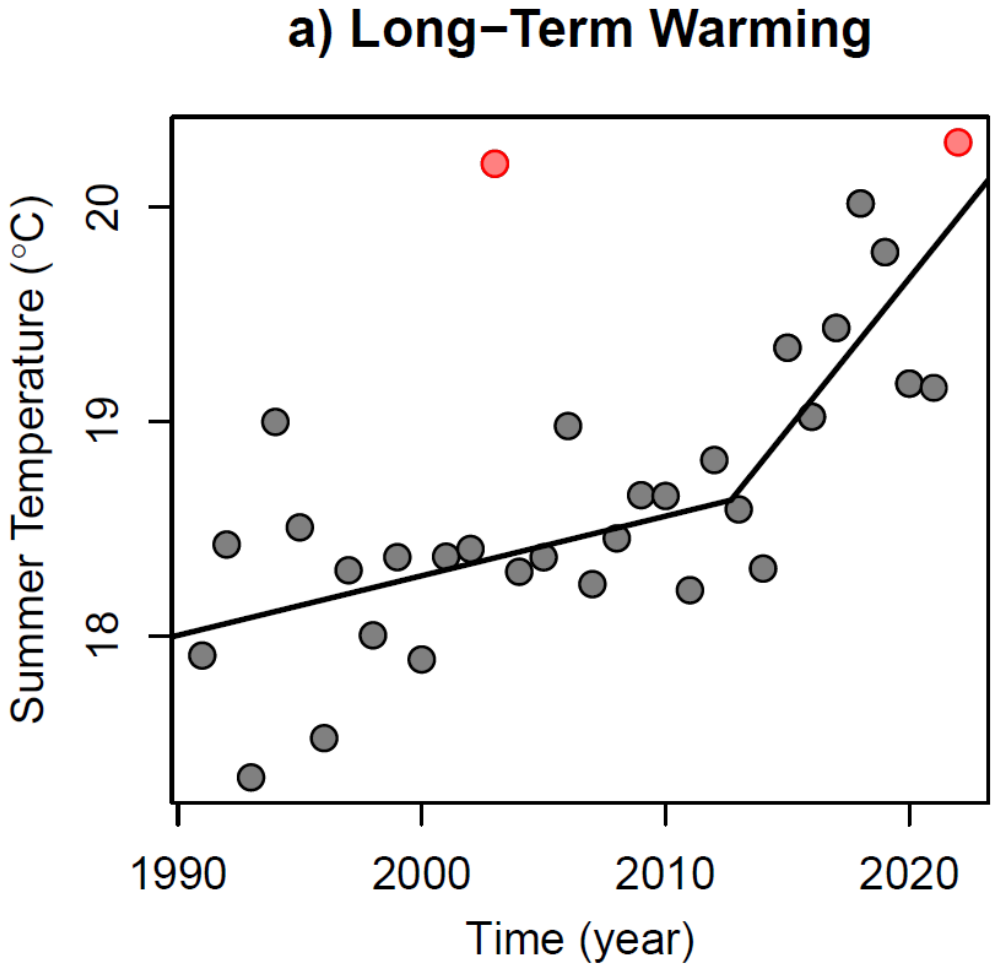
Unobserved Extreme Heat

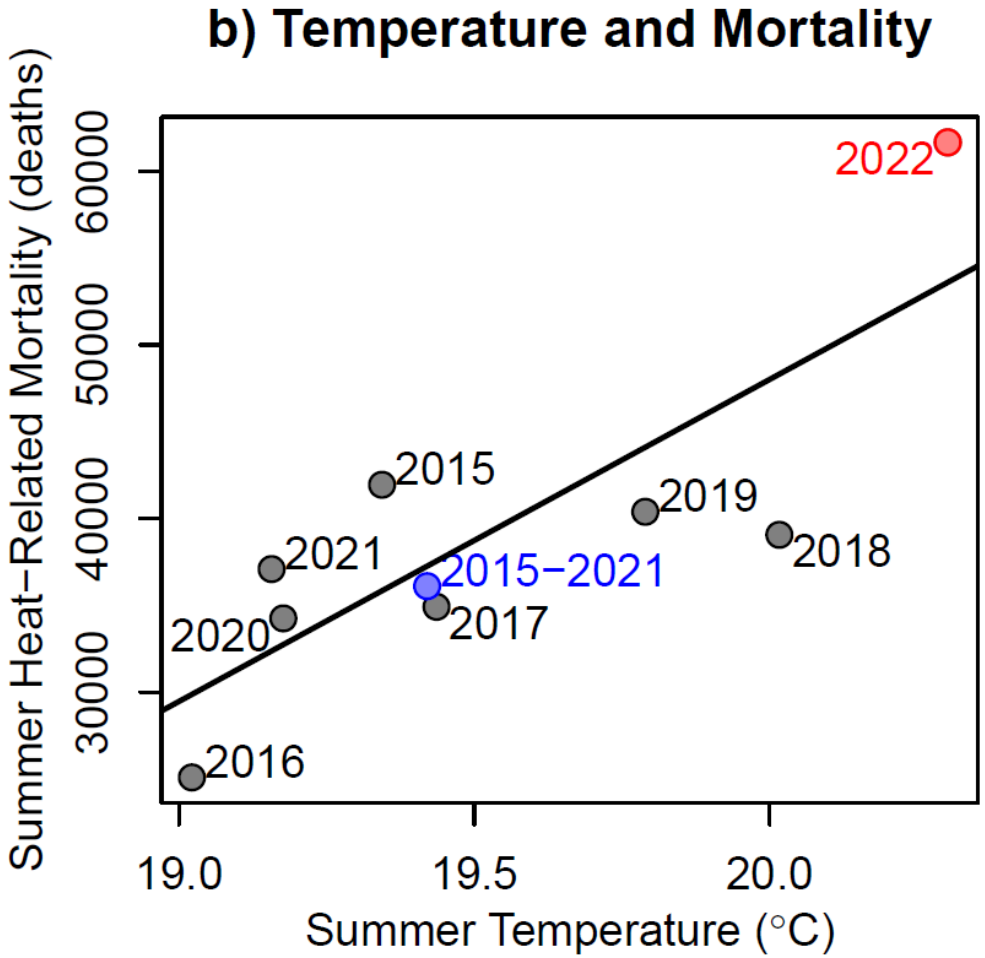


Present-Day Unobserved Extreme Heat

Quijal-Zamorano et al. *The Lancet Planetary Health* (2021)

The Record-Breaking 2022 Summer

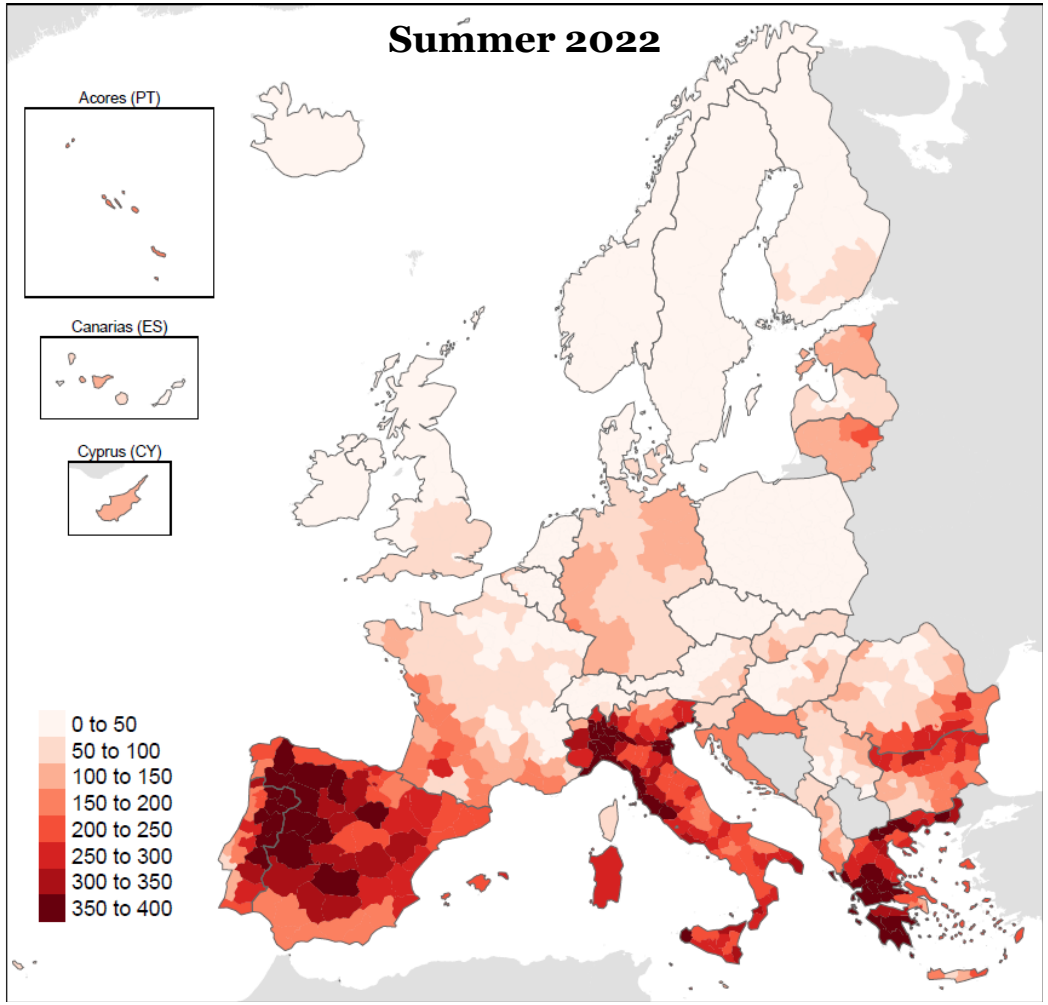




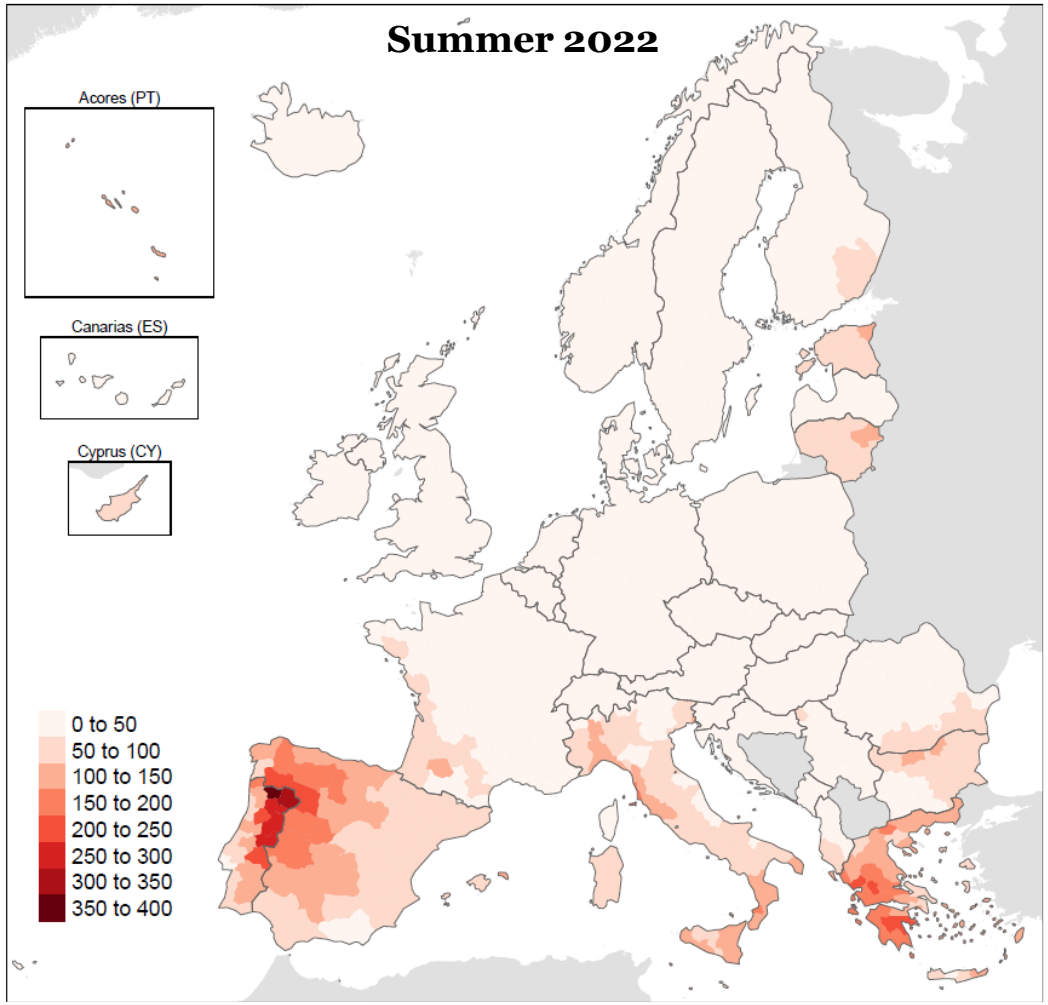
Ballester et al. *Nature Medicine* (2023)

Climate Change Impact Attribution

Factual Mortality (deaths/million)



Counterfactual Mortality (deaths/million)

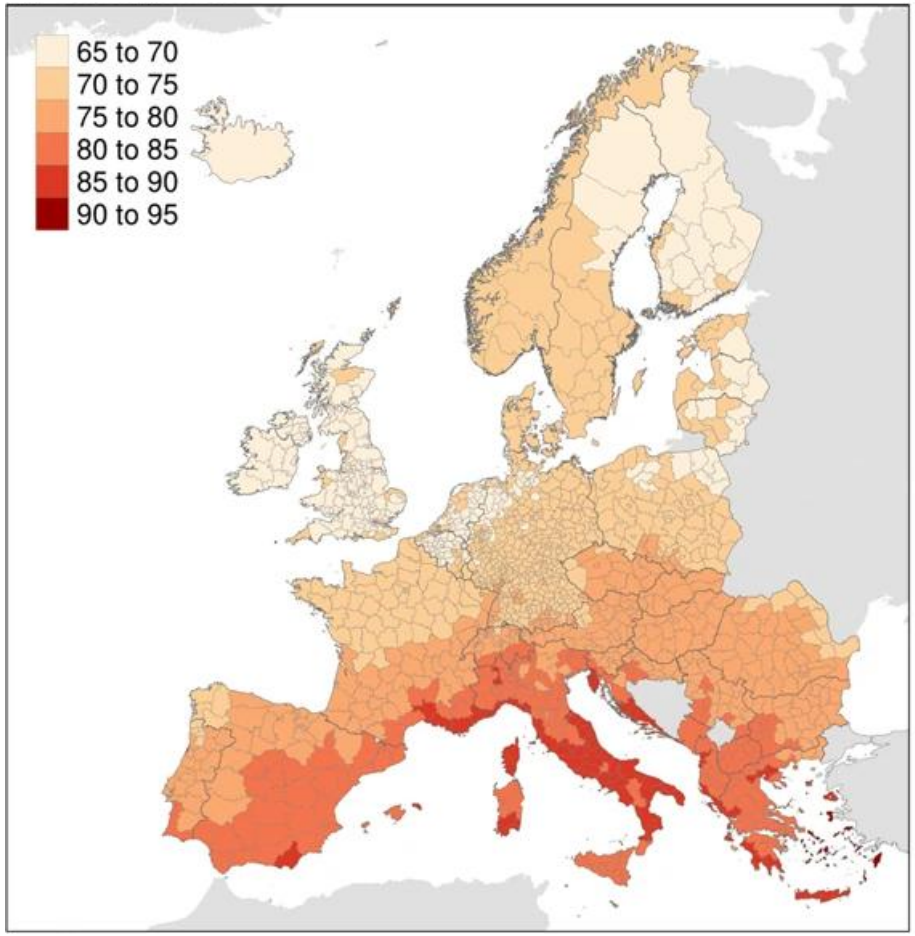


Beck et al. *npj Climate and Atmospheric Science* (2024)

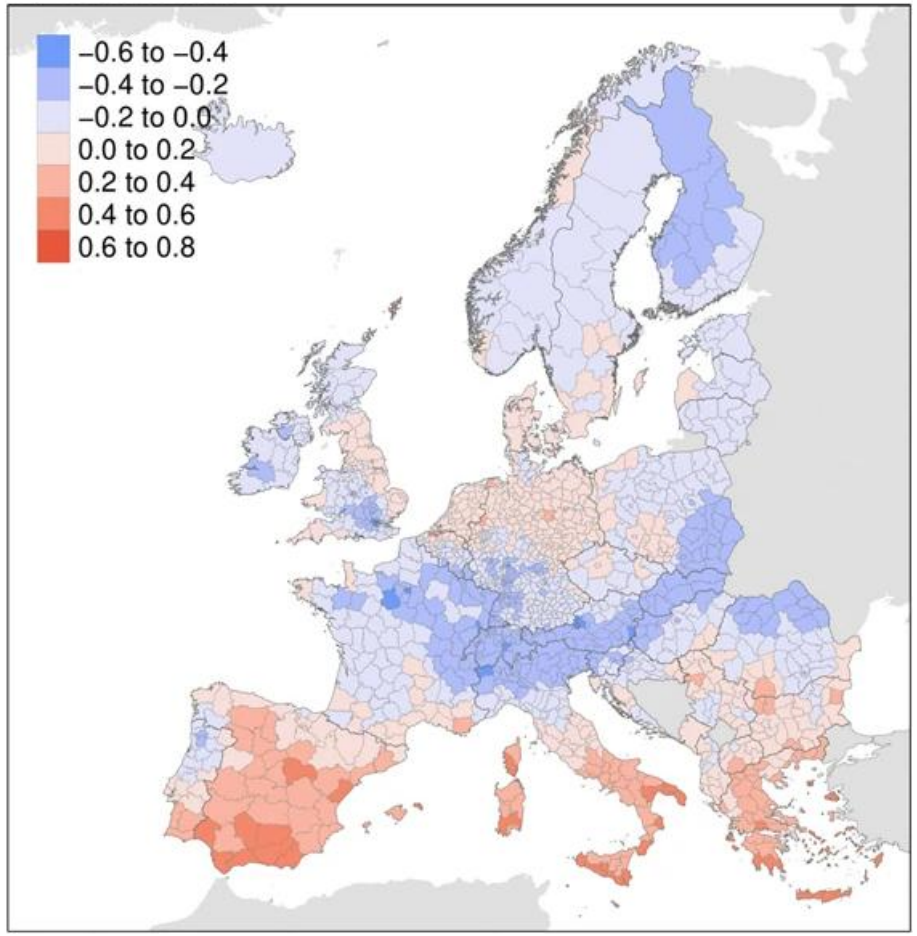
Air Pollution Estimation

Daily $PM_{2.5}$, PM_{10}, O_3 and NO_2 since 2003 at 10 km resolution

Average Ozone (µg/m³)



Trend in Ozone (%)



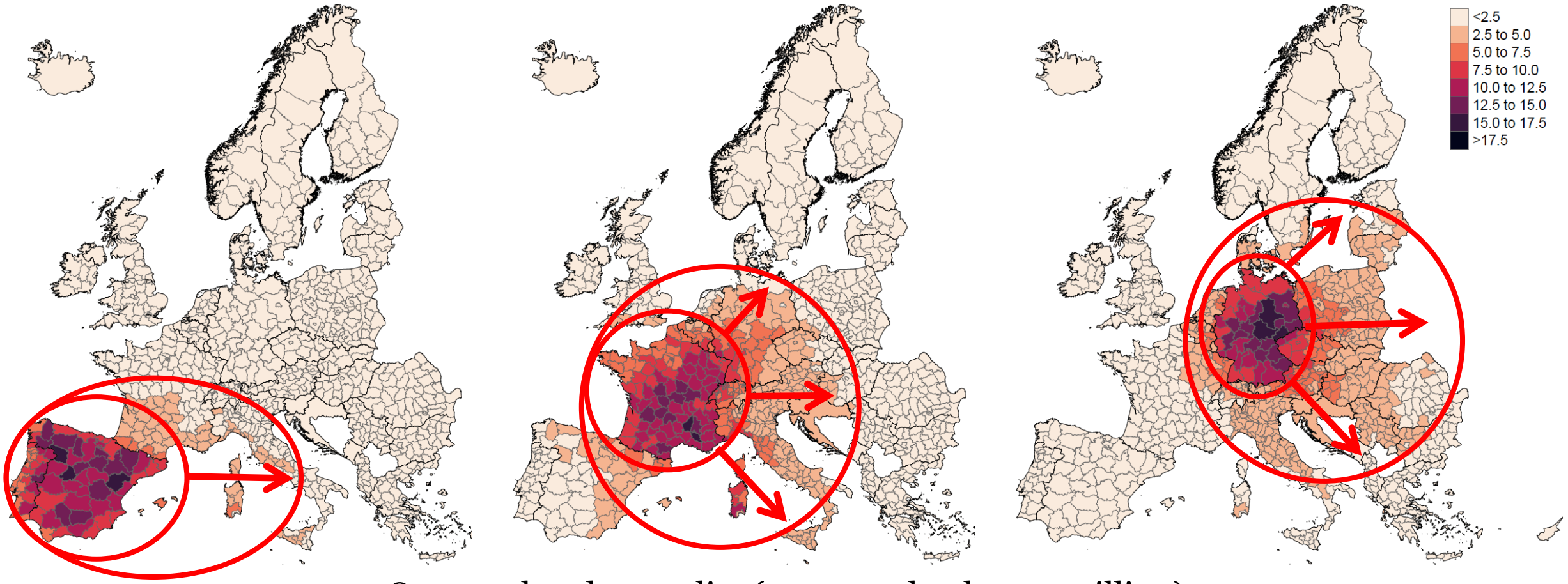
Chen et al. *Nature Communications* (2024)

Atmospheric Disease Transport

Ozone from **Spain**

Ozone from **France**

Ozone from **Germany**



Ozone related mortality (summer deaths per million)

Garatachea et al. *Comm. Earth & Environment* (2024)

Achebak et al. *Nature Medicine* (2024)

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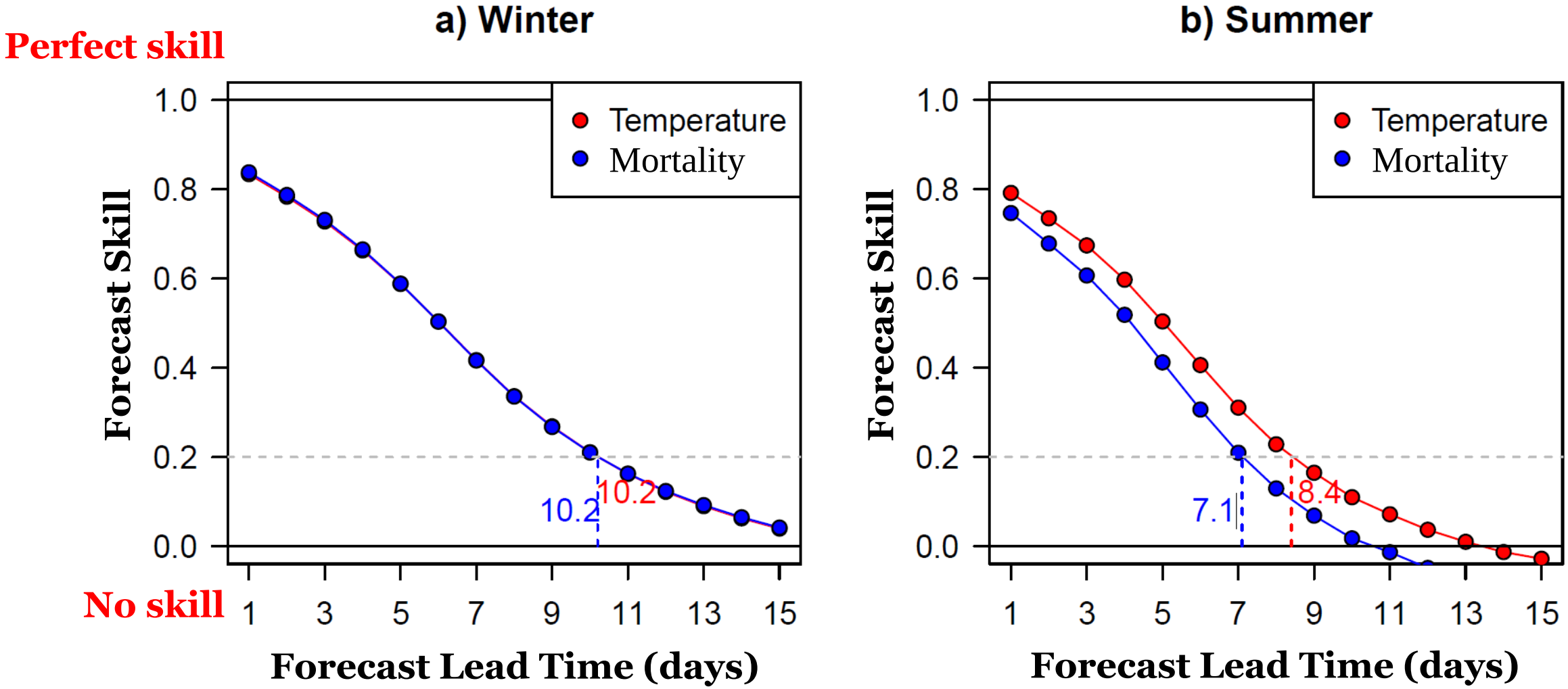
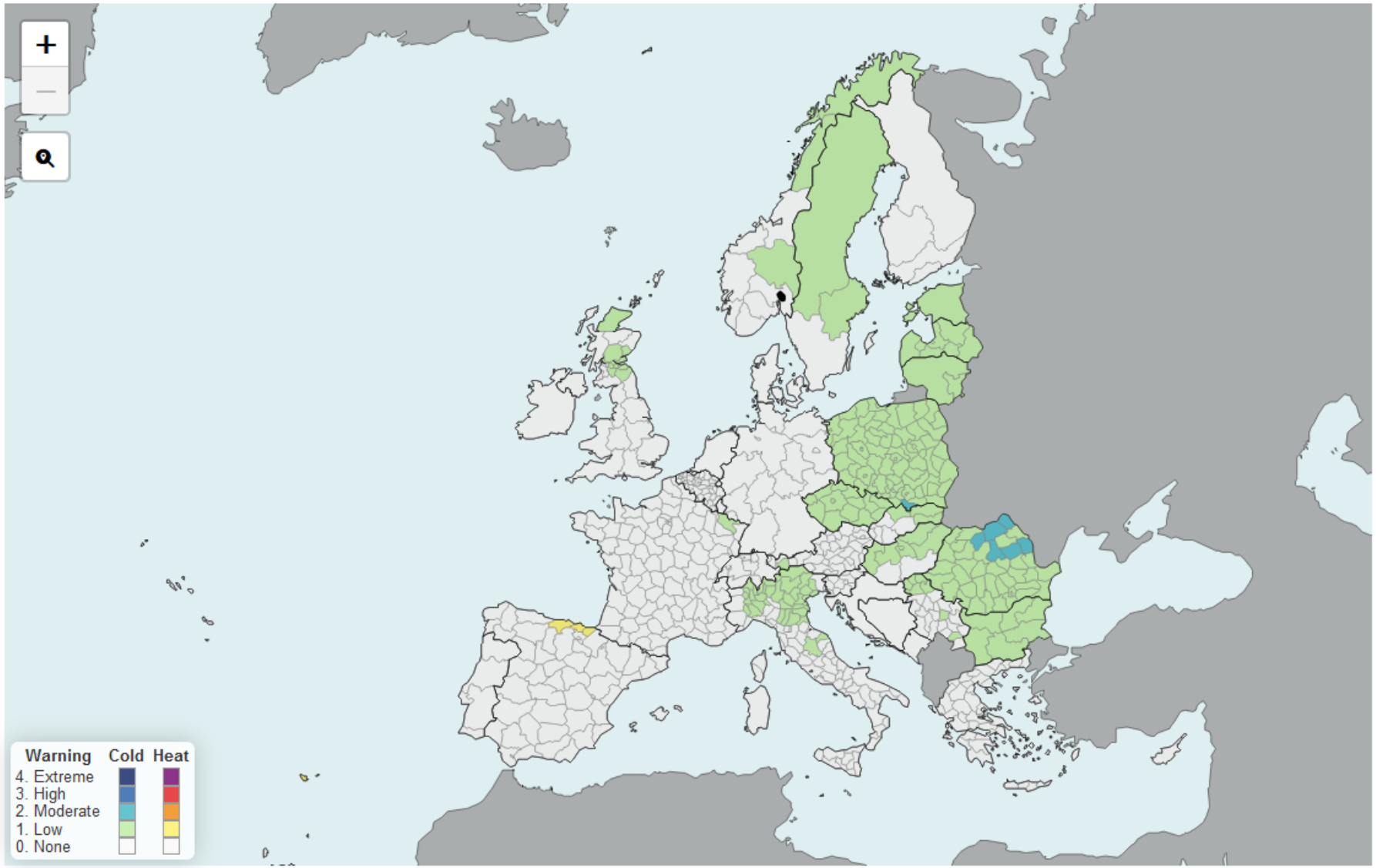
Disease Forecast Skill



Quijal-Zamorano et al. *Science Advances* (2024)

Forecaster-Dot-Health



Forecast | Surveillance

Forecast issue time:
13-Oct-2024 00 UTC

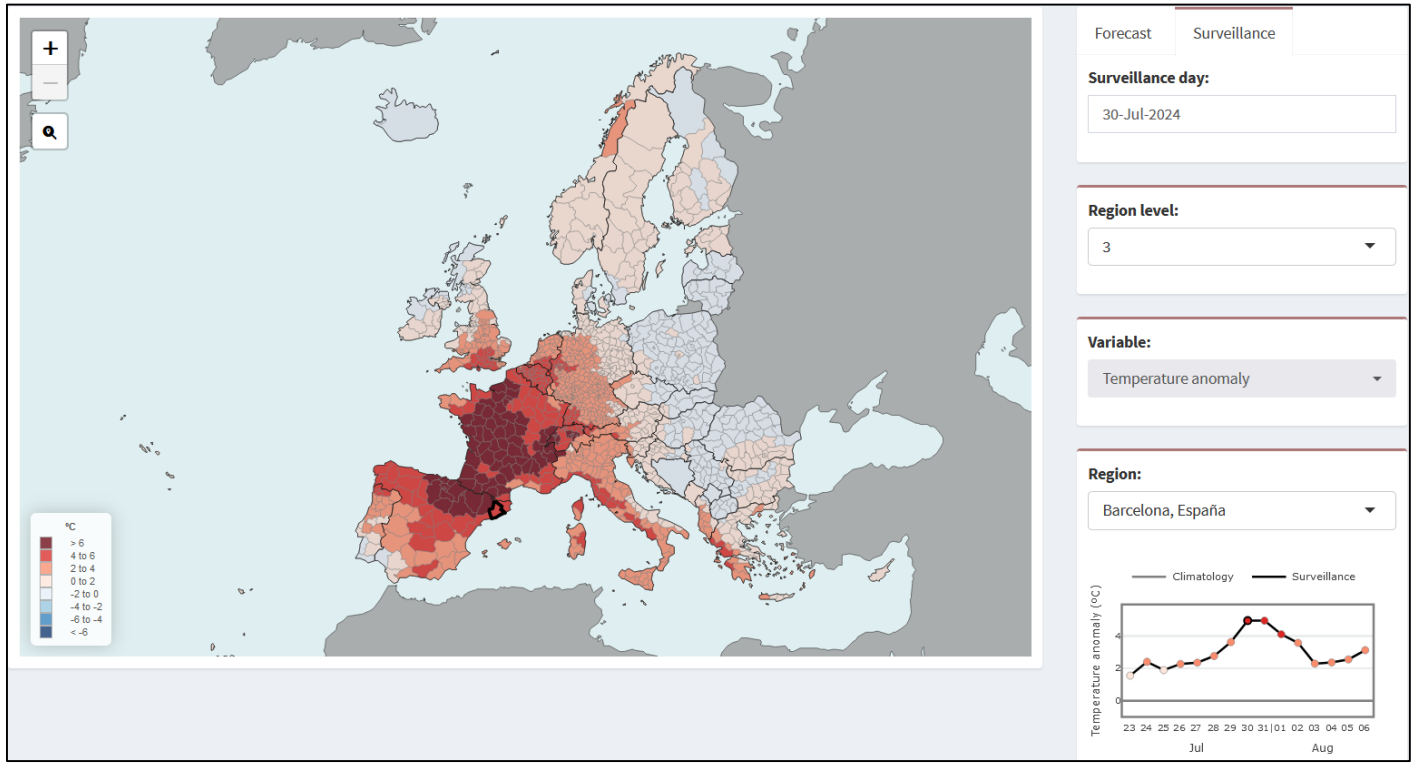
Forecast target day:
15-Oct-2024

Group category:
Overall population, All diseases

Region:
Oslo, Norge

13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Oct

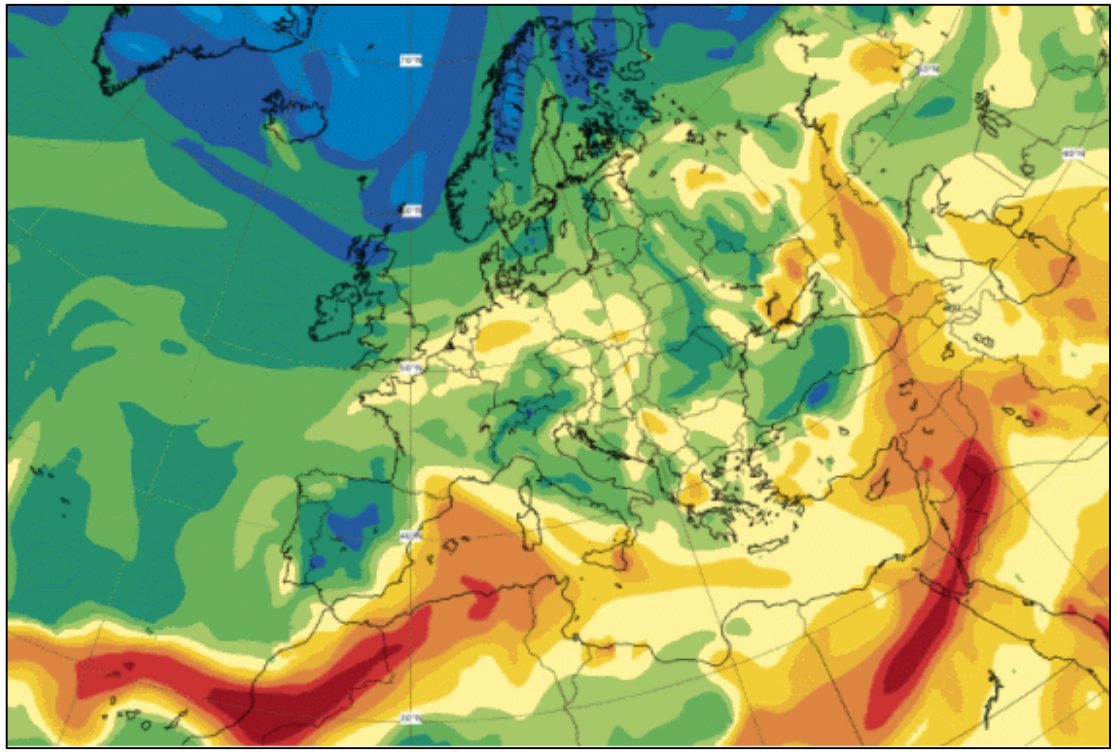
Operational Early Warning System



June 2024:

Heat and Cold Related Mortality

ERC Proof-of-Concept ***HHS-EWS***



Autumn 2025:

$PM_{2.5}$, PM_{10}, O_3, NO_2 Related Mortality

ERC Proof-of-Concept ***FORECAST-AIR***

Thanks!!

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EARLY-ADAPT

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