Recent Trends in Temperature, Vulnerability and Heat-Attributable Mortality in Europe

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Data and Model

- Daily summer temperature and mortality data.
- **Spain**: Circulatory and respiratory mortality, 47 major cities, 1980-2015.
- **Europe**: All-cause mortality, 147 regions in 16 countries, 1998-2012.
- Standard quasi-Poisson regression model (DLNM).
- Control for (i) day of week, (ii) seasonality, and (iii) long-term trends.
- Multi-location association estimated with random-effects meta-analysis.
Temporal changes

• Standard DLNM for moving subperiods of X consecutive years:

  \[
  \log E(Y_t) = \text{intercept} + cb + dow + S1(\text{dos}, df = 2) : \text{factor(year)} + S2(\text{time}, df = 1 \text{ per decade})
  \]

• DLNM with interaction between time and the crossbasis matrix:
  - **t-DLNM**: 1998-2012.

  \[
  \log E(Y_t) = \text{intercept} + cb + dow + S1(\text{dos}, df = 2) : \text{factor(year)} + S2(\text{time}, df = 1 \text{ per decade}) + \text{int(time*cb)}
  \]
Is Adaptation to Heat Occurring in Spain?

Spain is reducing the vulnerability to heat at a nearly constant rate.

No change associated with the National Heat Prevention Plan (2004).

Achebak, Devolder, Ballester (2018)
Is Heat-Related Mortality Increasing in Spain?

Heat-related mortality:  
- Observed: -0.55% / decade, non-sign.  
- Predicted from 2003 temperatures  
- Predicted from 1984 temperatures

Achebak, Devolder, Ballester (2018)

Heat-related mortality is not increasing. The decline would have been larger without the observed 1ºC warming, both in a colder and warmer climate.

Achebak, Devolder, Ballester (2018)
(unpublished results)
Thanks!

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