Temperature, climate and health Results from the MCC Project

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### July/August 2003 heat wave in Europe



[From NASA Earth Observatory]



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#### Impact on mortality in Paris

#### Daily mortality in Paris: 2000–2010 and summer 2003





#### Climate change: the 'hockey stick'



[Adapted from Mann et al, Geo Res Lett (1999)]



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## Complex temperature-health relationships



[From Curriero et al, AJE (2002)]



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#### The MCC Network

The Multi-City Multy-Country (MCC) Research Network is an international collaboration aiming at producing epidemiological evidence on associations between weather and health

Advantages:

- Global perspective: data from multiple locations within several countries, including populations with different characteristics and exposed to various climatic conditions
- Flexible modelling framework allowing non-linear/lagged responses, separation of effects due to cold/heat and moderate/extreme temperature, and assessment of effect modification



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## MCC participants and funding

#### Participants:

- Antonio Gasparrini
- Ana Maria Vicedo-Cabrera
- Francesco Sera
- Ben Armstrong
- Yuming Guo
- Shilu Tong
- Micheline Stagliorio Coelho
- Paulo Saldiva
- Eric Lavigne
- Patricia Matus Correa
- Nicolas Valdes Ortega
- Haidong Kan
- Samuel Osorio
- Jan Kysely

- Ales Urban
- Jouni Jaakkola
- Niilo Ryti
- Mathilde Pascal
- Ariana Zeka
- Patrick Goodman
- Paola Michelozzi
- Matteo Scortichini
- Masahiro Hashizume
- Yasushi Honda
- Magali Hurtado
- Julio Cesar De La Cruz
- Xerxes Seposo
- Noah Scovronick

- Fiorella Acquaotta
- Ho Kim
- Aurelio Tobias
- Carmen Iniguez
- Bertil Forsberg
- Daniel Oudin Astrom
- Martina Ragettli
- Yue-Liang Leon Guo
- Chang-fu Wu
- Michelle Bell
- Antonella Zanobetti
- Joel Schwartz
- Tran Ngoc Dang
- Do Van Dung

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#### The MCC dataset

Largest dataset ever collected: data from 520 locations in 28 countries within the period 1972–2015, including 109 million deaths

**Countries:** Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Czech Republic, Estonia, Finland, France, Iran, Ireland, Italy, Japan, Mexico, Moldova, Philippines, South Africa, South Korea, Spain, Sweden, Taiwan, Thailand, UK, USA, Vietnam

**Daily time series** of mortality counts (all-cause, CVD, respiratory, others), temperature (mean, min, max), humidity, air pollution ( $PM_x$ ,  $O_3$ ,  $NO_x$ ,  $SO_2$ , CO)

Location-specific meta-variables on climatological, geographical, infrastructural, demographic, socio-economic characteristics



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## Modelling framework

First-stage generalized linear model with quasi-Poisson family, modelling the daily mortality counts with:

- a distributed lag non-linear model (DLNM) expressing a bi-dimensional exposure-lag-response function between temperature and health outcomes
- spline functions to model trend/seasonality, indicators for day of the week, and (optionally) functions for modelling time-varying confounders
- Second-stage multivariate meta-regression to pool DLNMs estimates, including climatological, socio-economic, demographic, and infrastructural meta-predictors
- **3** Computation of excess mortality for total and cold/heat components in each city, then aggregated by area and decade, with empirical CI



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#### Exposure-response curves



[From Gasparrini et al, The Lancet 2015]



#### **Excess mortality**



[From Gasparrini et al, The Lancet 2015]



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## Some interpretation...

#### australia

# Tony Abbott says climate change is 'probably doing good'

Former Australian PM delivers speech in London comparing global warming action to 'killing goats to appease volcano gods'



Former Australian prime minister Tony Abbott as delivered a speech in London to a climate-sceptic thinktank.



#### **ISI-MIP** dataset

- Global simulation dataset of daily meteorological variables including historical (1860–2005) and projection (2006–2100) periods
- Simulations from 5 global climate models (GCM) (HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, GFDL-ESM2M, and NorESM1-M) from the CMIP5 archive of IPCC, under 4 emission scenarios (RCP2.6, RCP4.5, RCP6.0, and RCP8.5)
- Downscaled over a 0.5  $^\circ$   $\times$  0.5  $^\circ$  grid through bias correction using re-analysis temperature data



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#### Scenarios of global warming



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1990-99

2030-39

Year

2070-79

0

1990-99

2030-39

Year

2070-79



#### Projected heat/cold excess



[From Gasparrini et al, accepted for publication]

#### Map: change in heat excess



[From Gasparrini et al, accepted for publication]



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#### Projected net change



[From Gasparrini et al, accepted for publication]

#### Map: net change

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[From Gasparrini et al, accepted for publication]



#### Discussion

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This represents the **largest epidemiological study** on health impact projections under climate change scenatior, covering **hundreds of locations** in various regions

Results show a **general pattern of increase** in temperature-related excess mortality, especially under more extreme scenarios, but with important **geographical differences** 

Impacts are much reduced under milder global warming scenarios, confirming the benefits of the implementation of mitigation policies to reduce GHG emissions

Plan to expand the data and analysis to areas not covered in the current study, such as Africa and the Middle East, to attempt a **global assessment** 

Need to extend the analysis to less simplistic scenarios including adaptation and changes related to pathways in socio-economic, demographic, infrastractural characteristics

