Future global mortality from changes in air pollution attributable to climate change*

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CHE Climate Change and Air Pollution webinar

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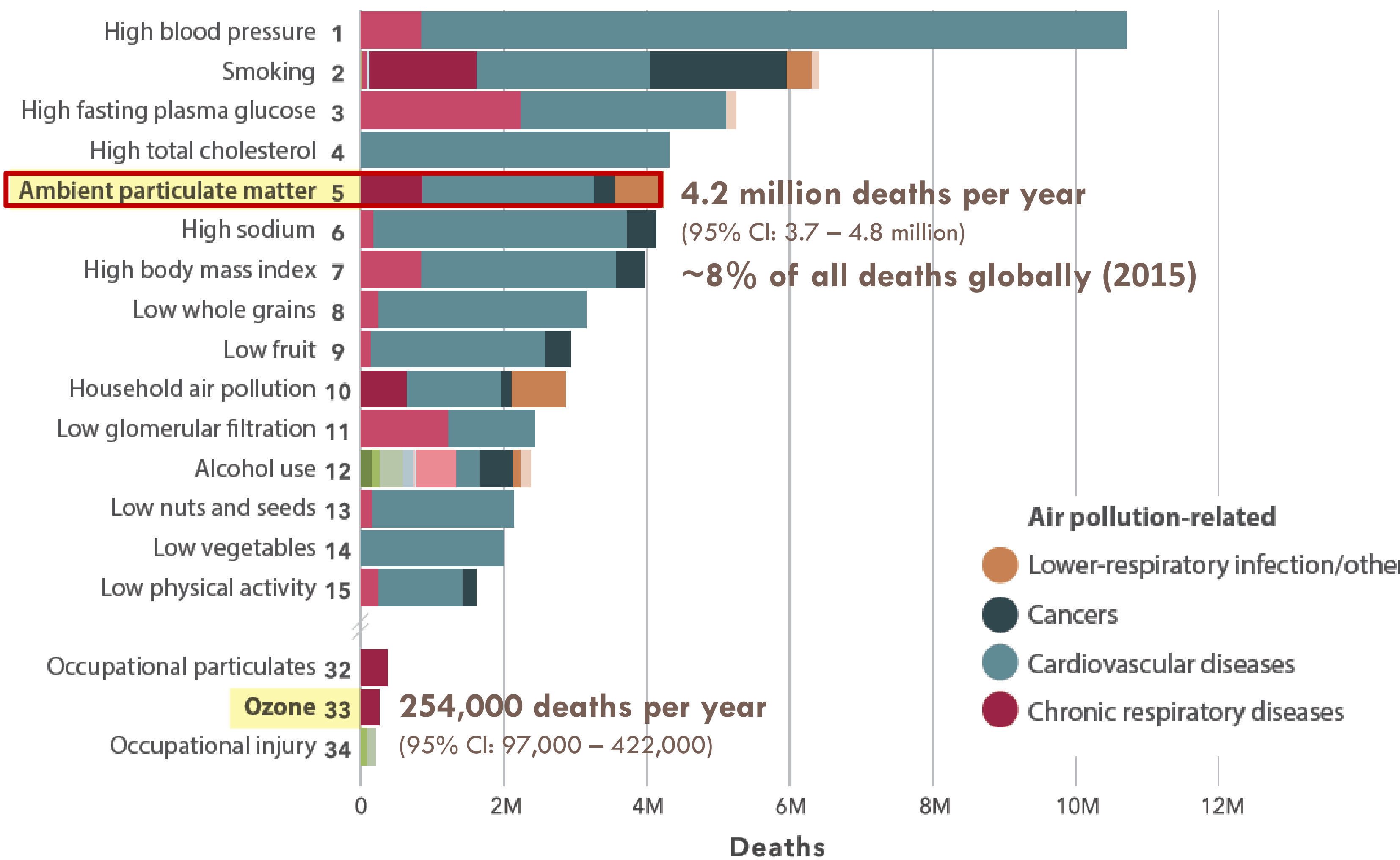
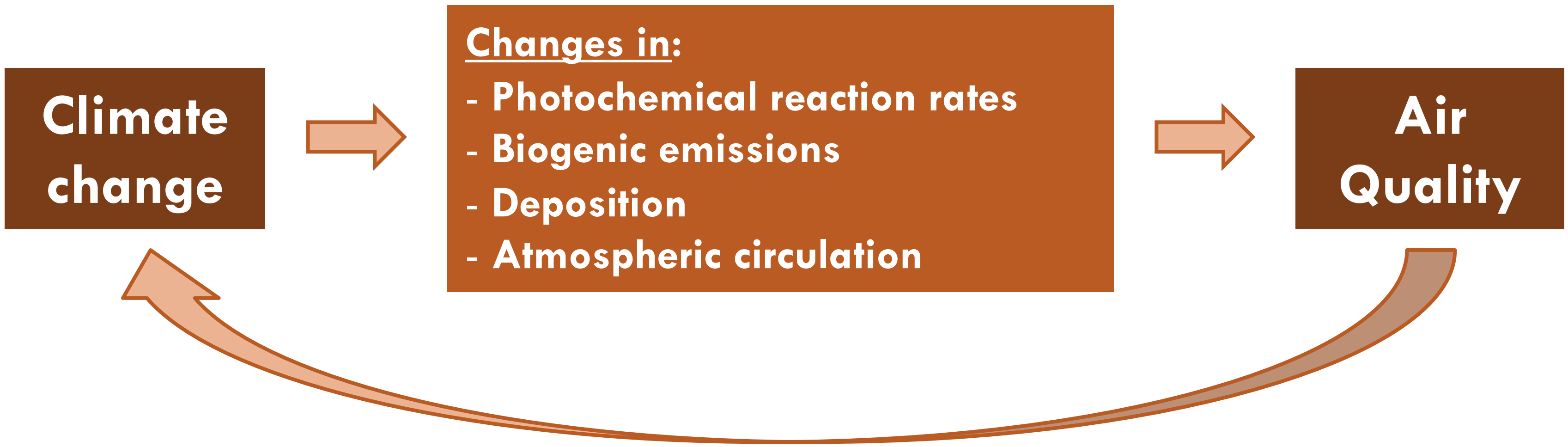
* Silva et al. (2017) *Nature Climate Change*, ***7*** (9): 647-651, doi:10.1038/nclimate3354

Air pollution is a leading risk factor for global premature mortality



Air quality and climate change



- **Ozone:**
  - Likely **increase in polluted regions during the warm season,** particularly in urban areas and during pollution episodes
  - Likely **decrease in remote regions** (background ozone)

- **$PM_{2.5}$:**
  - **Effects are uncertain and vary regionally**
    (different changes in precipitation, wildfires and biogenic emissions, different $PM_{2.5}$ composition, etc.)

Premature mortality due to ambient air pollution

Air Quality Modeling

Ozone and $PM_{2.5}$ concentrations
(base case and control)

Epidemiological studies

Relative risk of death attributable to changes in pollutant concentrations

Baseline mortality rate × **Attributable fraction** × **Exposed Population**

- Respiratory diseases
- Cardiovascular diseases
- Lung Cancer

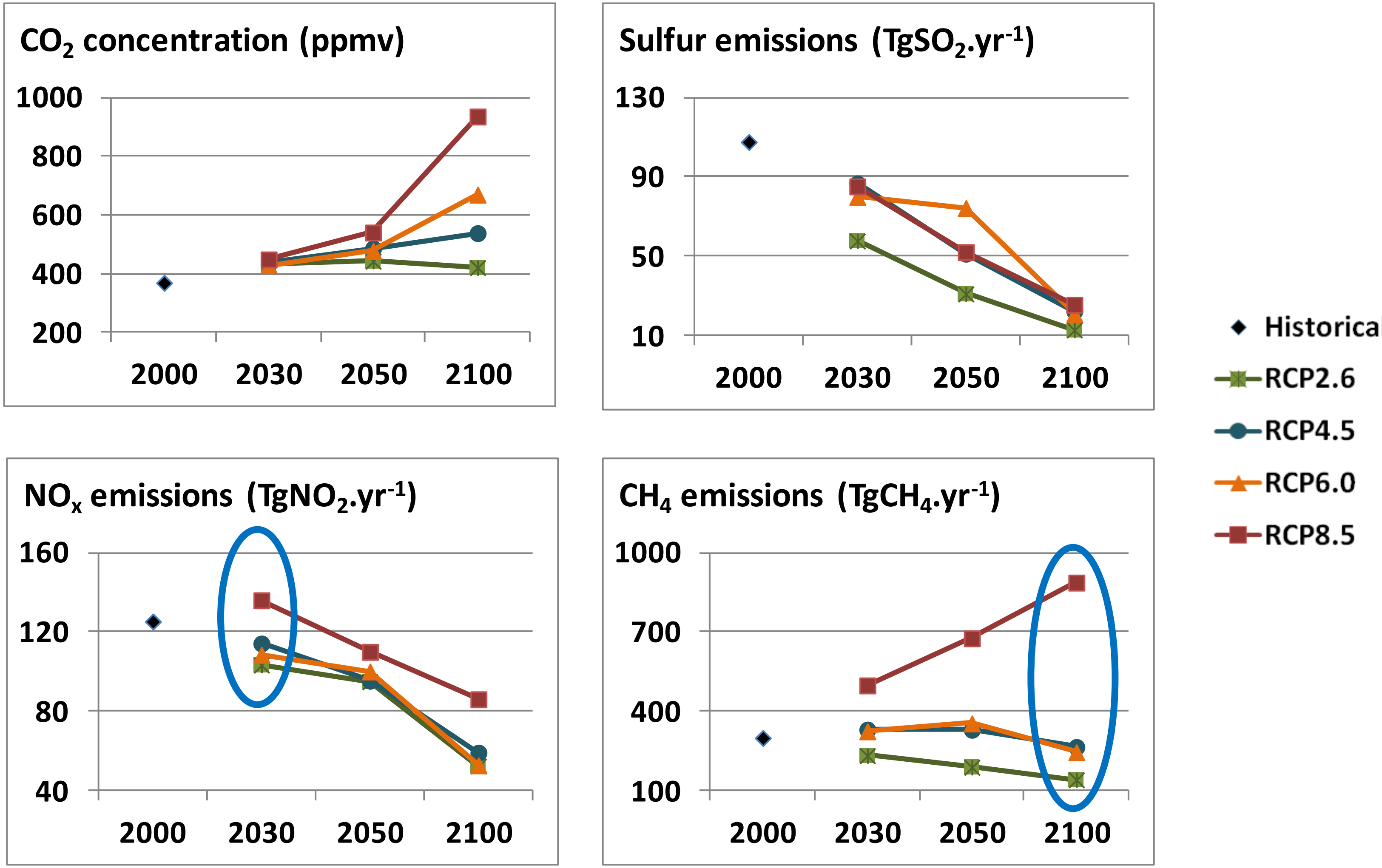
- Adult population

= **Premature mortality**

Estimate air pollutant concentrations

- Observations from surface air quality monitoring sites
- Observations from remote sensing
- Output from air quality modeling
- Model/data fusion (combining observations with modeling output using statistical methods)

Representative Concentration Pathways (RCPs)

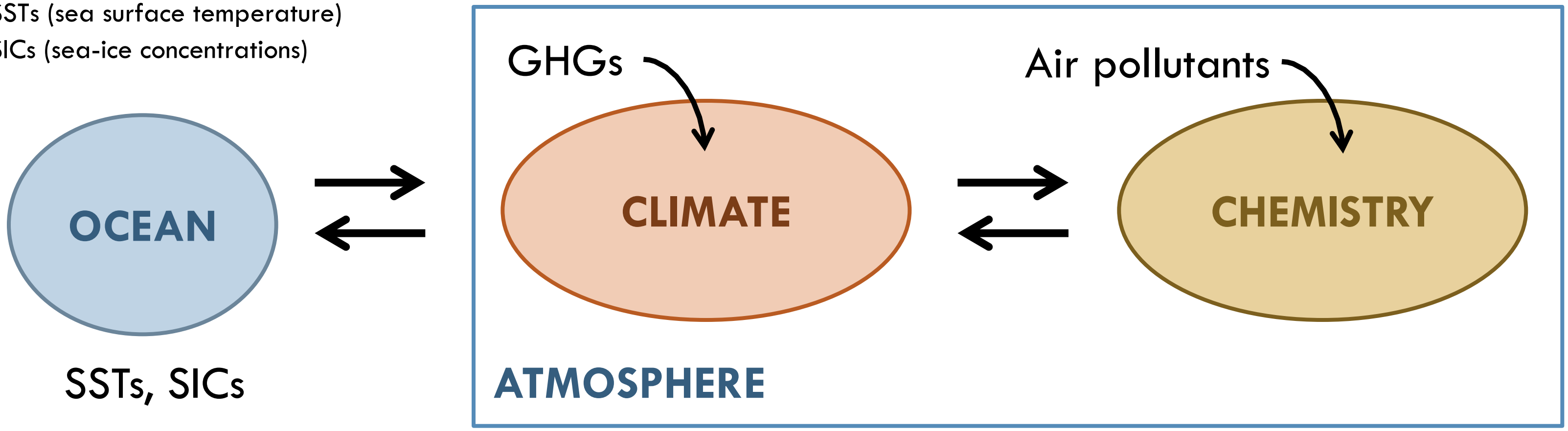


Source: RCP Database - http://tntcat.iiasa.ac.at:8787/RcpDb/dsd?Action=htmlpage&page=compare

ACCMIP model ensemble

- Simulations in 2030, 2050, 2100
- Main purpose: study climate forcing

SSTs (sea surface temperature)
SICs (sea-ice concentrations)



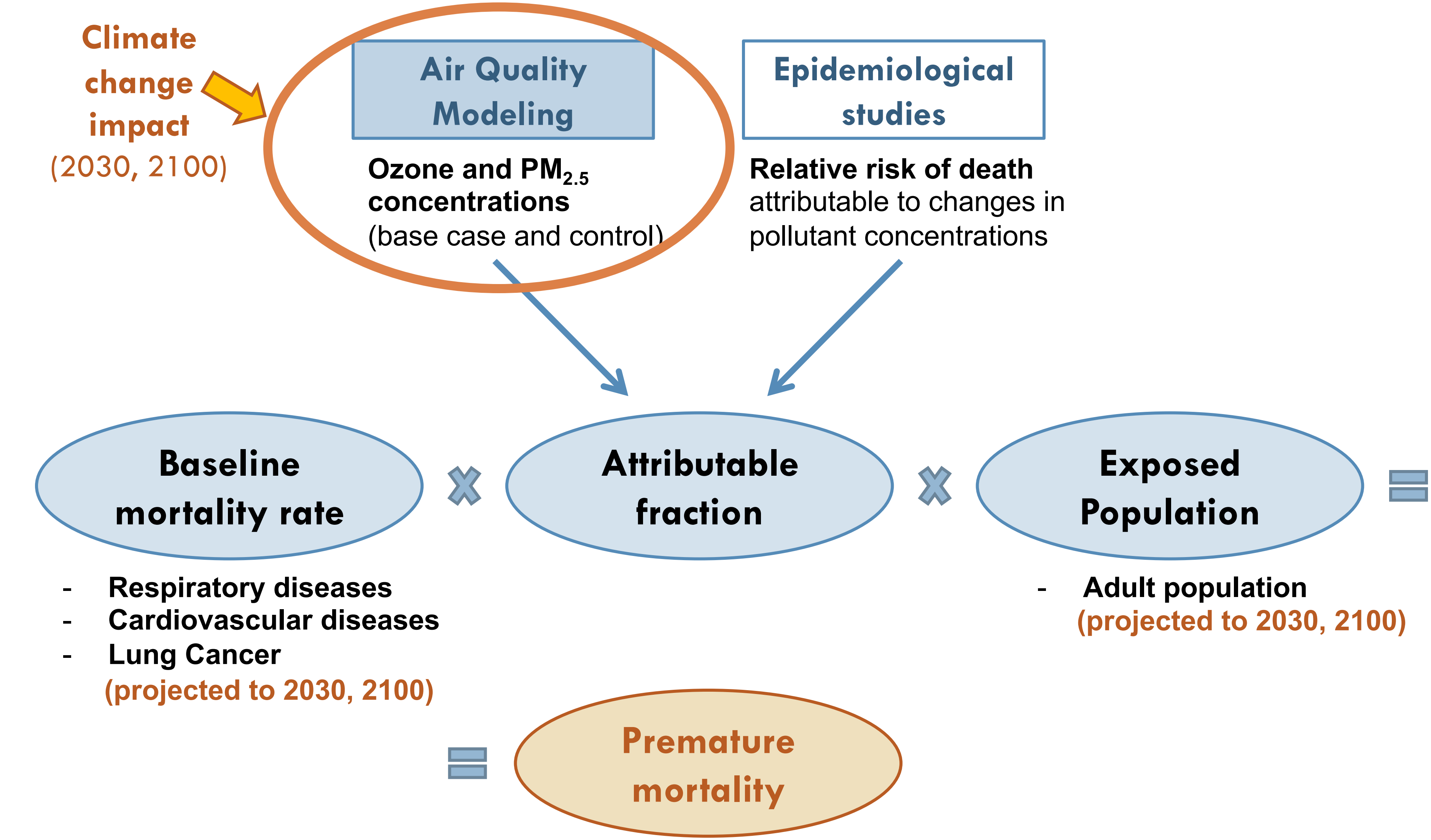
Ocean-Atmosphere Chemistry-Climate Model (fully coupled)	GISS-E2-R
Chemistry-Climate Model (driven by SSTs and SICs)	CESM-CAM-superfast, CMAM, EMAC, GEOSCCM, GFDL-AM3, HadGEM2*, MIROC-CHEM, NCAR-CAM3
Chemistry-General Circulation Model (driven by SSTs and SICs)	LMDz-ORINCA*, STOC-HadAM3*, UM-CAM*
Chemical Transport Model	CICERO-OsloCTM2*, MOCAGE

* No stratospheric chemistry

Research Objectives

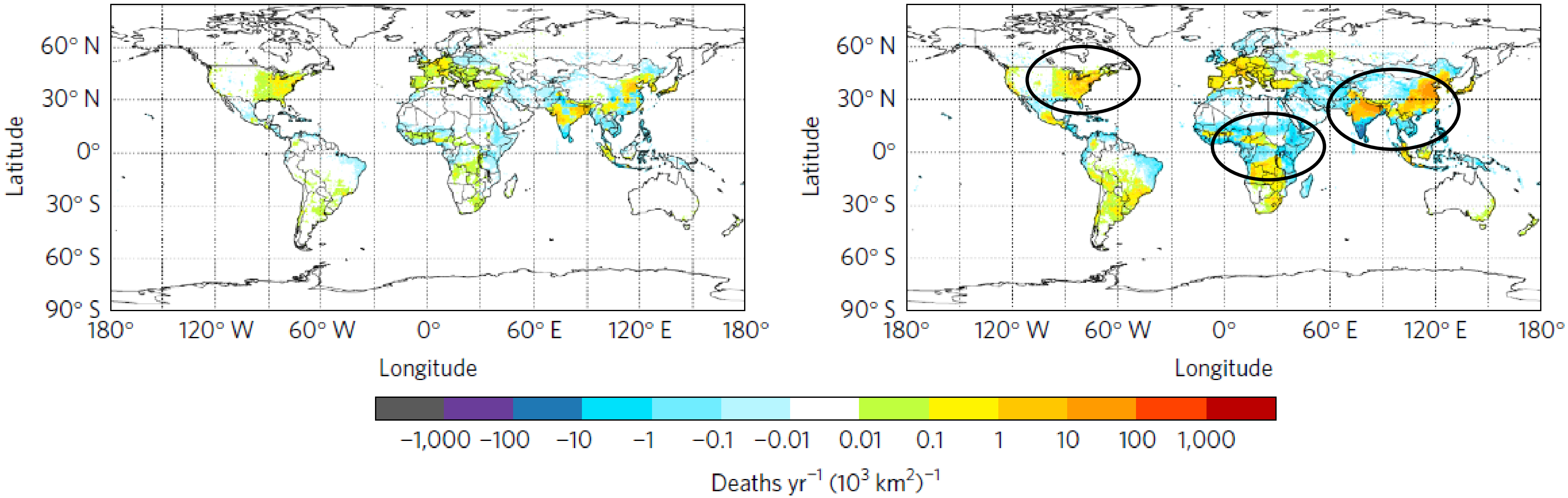
- **Use modeled ozone and $PM_{2.5}$ concentrations from the ACCMIP ensemble to quantify the global ozone- and $PM_{2.5}$-related mortality impacts of:**
  - **Future concentrations** considering the effects of both emissions and climate change - four RCP scenarios;
  - **Future climate change** by using pairs of simulations – one simulation ensemble with present emissions and climate and one with present emissions but future climate (RCP8.5 climate).

Premature mortality due to ambient air pollution



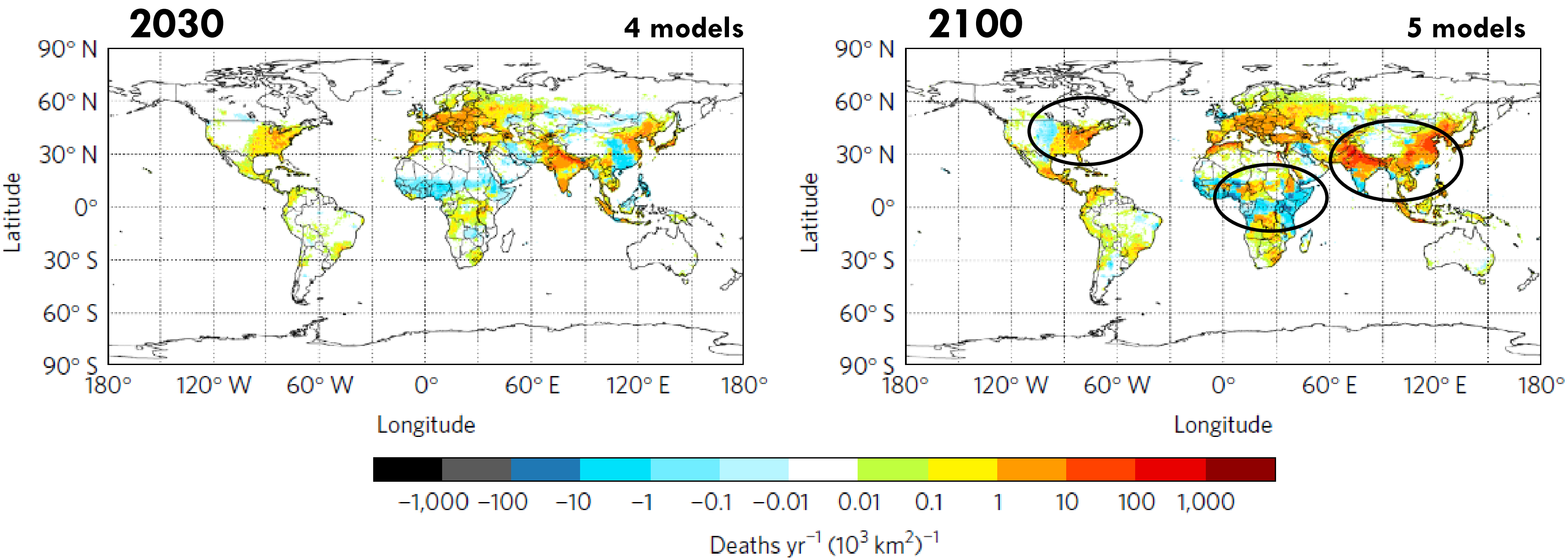
Impact of Climate Change: ozone mortality

2030 **9 models** **2100** **10 models**



3,340 premature deaths / year **43,600 premature deaths / year**

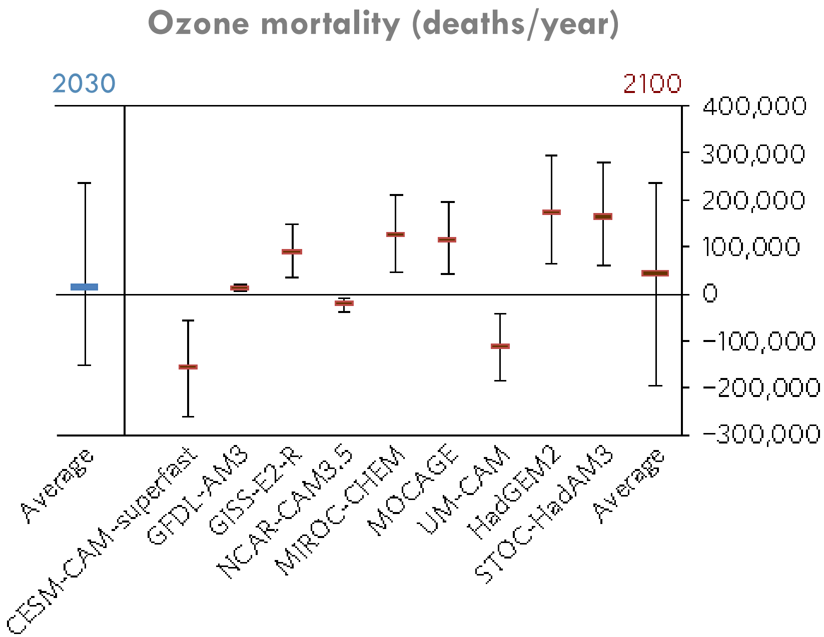
Impact of Climate Change: $PM_{2.5}$ Mortality



55,600
premature deaths/year

215,000
premature deaths/year

Uncertainty: multi-model differences



Climate change under RCP8.5 (2100):

Ozone

43,600 (-195,000 to 237,000) premature deaths/year

Fine PM (not shown here)

215,000 (-76,100 to 595,000) premature deaths/year

Methodological highlights

- **Output from simulations with ensemble of global chemistry-climate models**
- **Isolated effect of climate change in 2030 and 2100 (as projected under RCP8.5)** on air pollution-related premature mortality (considering year 2000 emissions)

Main Findings

- **Most individual models yield increased mortality from climate change, but some yield decreases, suggesting caution in interpreting results from a single model**
- **Climate change mitigation is likely to reduce air pollution-related mortality**

Conclusions

Impact of Climate Change

- **RCP8.5 climate change in 2100 will likely increase global premature mortality**
  - **Ozone: 43,600 (-195,000 to 237,000)** deaths/year;
  - **$PM_{2.5}$: 215,000** (-76,100 to 595,000) deaths/year;
- **Increases occur in all regions, except Africa,** especially in highly populated and highly polluted areas.
- **Uncertainty in modeled air pollutant concentrations** contributes the most to uncertainty in mortality estimates

Climate change mitigation is likely to reduce air pollution-related mortality

Air quality and climate change policies should be better integrated

- Co-benefits
- Global scale
- Regional differences

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THANK YOU

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