Effects of grid resolution on the global mortality burden of fine particulate matter and ozone

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Introduction

Effects of Air Quality Resolution on Associated Health Impact Assessments

- Human health impact assessments using air quality models to simulate exposure concentrations at coarse resolutions can result in uncertainties in health impact estimates because of poorly aligning population and air pollutant concentrations, such as in urban areas.

Global Mortality Burden of $PM_{2.5}$ and O_3

- GBD2017 estimated 2.9(2.5-3.4) million of deaths attributable to ambient $PM_{2.5}$ pollution and 0.47(0.18-0.77) million of deaths attributable to ambient O_3 pollution per year globally.
- Burnett et al. (2018) estimated 8.9 (7.5-10.3) million of deaths attributable to ambient $PM_{2.5}$ pollution in 2015 globally, using an updated function.

Objectives

Goal

- We aim to quantify the effect of grid resolution on estimates of global premature mortality attributable to ozone (O_3) and fine particulate matter ($PM_{2.5}$)

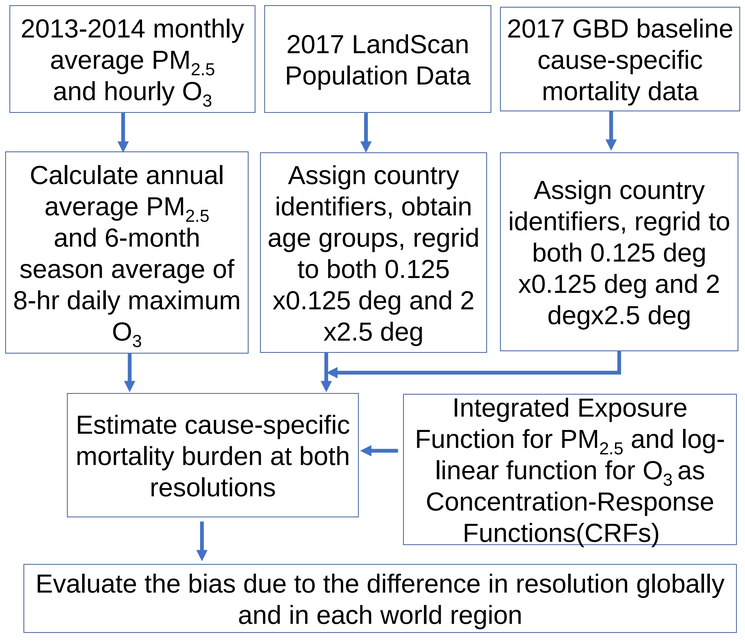
Specific Objectives

- Estimate global premature mortality at a fine resolution of 0.125 x 0.125 deg, an unprecedented fine resolution for a global air quality model, and at a coarse resolution of 2 x 2.5 deg to evaluate the bias due to the difference in resolution
  - Simulations at both resolutions are outputs from a 2013-2014 simulation of global atmospheric chemistry from the NASA Goddard Earth Observing System Model version 5 Earth system model (GEOS-5 ESM) with GEOS-chem chemistry (G5NR-chem).
- Re-grid the fine resolution to coarser resolutions and repeat the mortality calculation, to estimate the contributions to the overall bias at coarse resolution from model chemistry vs. exposure
- Evaluate biases caused by coarse resolution and the contributions from model chemistry and exposure globally and in each world region.

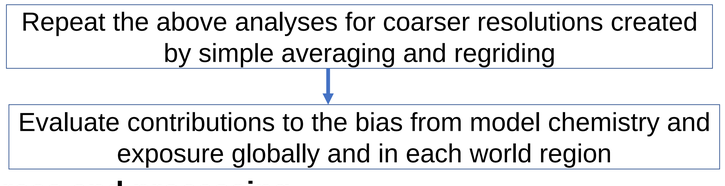
Materials and Methods

Experimental Design

Step1



Step2



Data sources and processing

Pollutant Concentrations

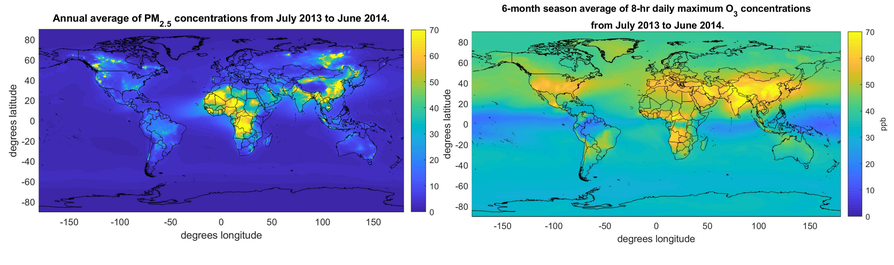


Figure 1. Concentrations of annual average $PM_{2.5}$ and 6-month season average of 8-hr daily maximum O_3 at 0.125 x 0.125 deg from 2013 to 2014

Materials and Methods (CONT.)

- Pollutant concentrations are outputs from a Jul 2013-Jun 2014 simulation of global atmospheric chemistry from the GEOS-5 ESM with G5NR-chem.

Population and mortality data

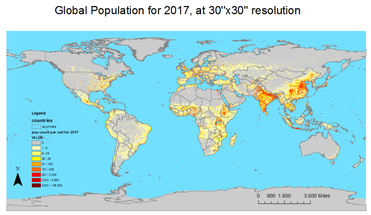


Figure 2. Global population count per cell for 2017

- Population≥ 30 years old are considered in the health impact assessment

Health Impact Assessment

- Premature mortality attributable to $PM_{2.5}$ is estimated using the CRF from Burnett et al.(2014) for COPD.
- Premature mortality attributable to O_3 is estimated using the CRF from Turner et al. (2016) for schemic heart disease (IHD), cerebrovascular disease (Stroke), COPD, and lung cancer (LC), and Type II diabetes.

Next steps

- Finish data processing for both resolutions
- Estimate mortality burden for both resolutions
- Evaluate the bias due to the difference in resolution
- Perform uncertainty analysis

Acknowledgements

We acknowledge National Aeronautics and Space Administration (NASA) Health and Air Quality Applied Science Team for funding this project, and Junhua Liu and Christoph A. Keller for providing the NASA air quality model outputs.

References

- Burnett, R. T. et al.(2014). An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. *Environmental Health Perspectives*,*122*(4), 397–403.
- Burnett R. et al. (2018). Global estimates of mortality associated with long-term exposure to outdoor fine particulate matter *Proceedings of the National Academy of Sciences* , 115 (38) 9592-9597.
- Bright EA et al. (2018). LandScan 2017.Oak Ridge National Laboratory SE, Oak Ridge, TN.
- GBD 2017 Risk Factor Collaborators.(2018). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017.*Lancet*.
- Hu Lu et al.(2018). *Geosci. Model Dev.* 11, 4603–4620.
- Punger EM, West JJ. (2013). The effect of grid resolution on estimates of the burden of ozone and fine particulate matter on premature mortality in the USA. *Air Quality and Atmospheric Health,* 6:563-573.