Effects of grid resolution on urban air quality simulation with MUSICAv0

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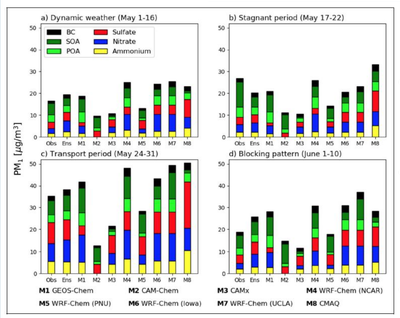
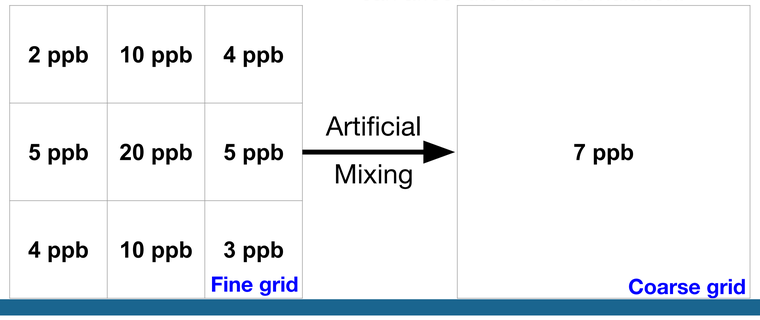
BACKGROUND



Park et al. (2021)

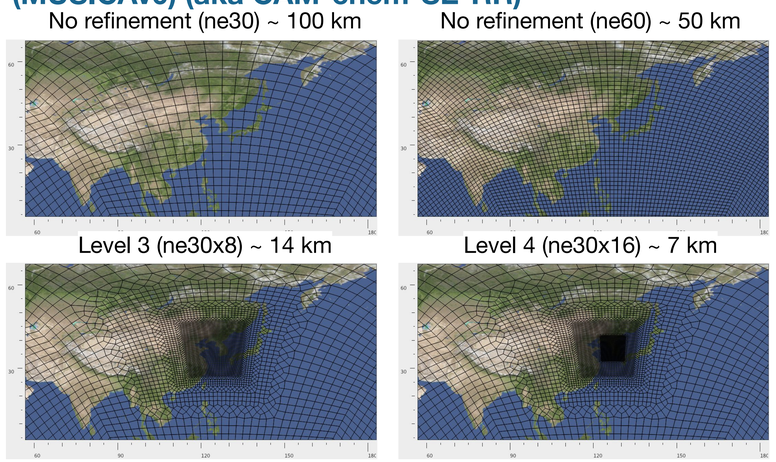
Chemical concentrations vary between models

- Model intercomparison studies have shown up to an order of magnitude differences of chemicals between models.
- There are several factors affecting these differences, including chemistry, deposition, meteorological fields, emission, transport, etc.
- However, even with the same dynamics, physics, and chemistry, grid resolution can affect the model simulation.



METHODS

Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICAv0) (aka CAM-chem-SE-RR)



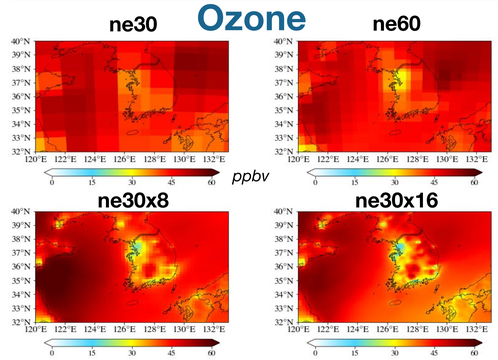
- MUSICAv0 enables studying atmospheric chemistry with different resolutions using the same host model (Pfister et al., 2020).
- Four different grids were set up to investigate the effects of grids on simulated atmospheric composition.

TAKE HOME POINTS

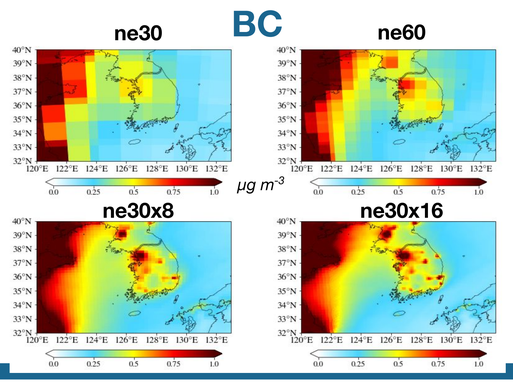
- **MUSICAv0 has been developed at NCAR to enable a computationally feasible global modeling framework with different horizontal resolutions for the region of interest. MUSICAv0 was released in the Community Earth System Model version 2.2.**
- **Two global grids (100 km and 50 km) and two regional grids (14 km and 7 km) show that chemical concentrations vary substantially even with the same chemical mechanism and dynamics.**
- **Higher model resolution becomes important for urban atmosphere with local sources, but the coarse grid is sufficient for rural background conditions.**
- **The model performance gets worse with fine grid resolution in some cases, implying that we need further study (e.g. chemical mechanism, emission, deposition) even if the model with coarse grid showed good performances over urban areas.**

RESULTS

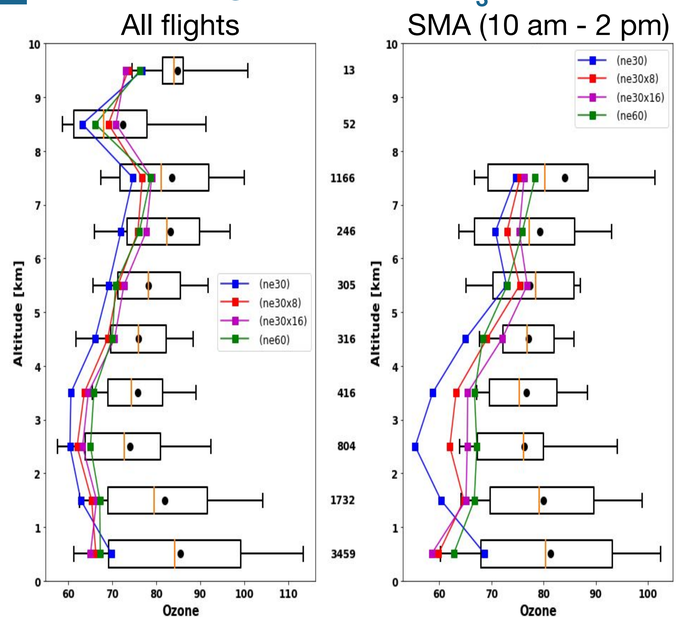
Ozone



BC

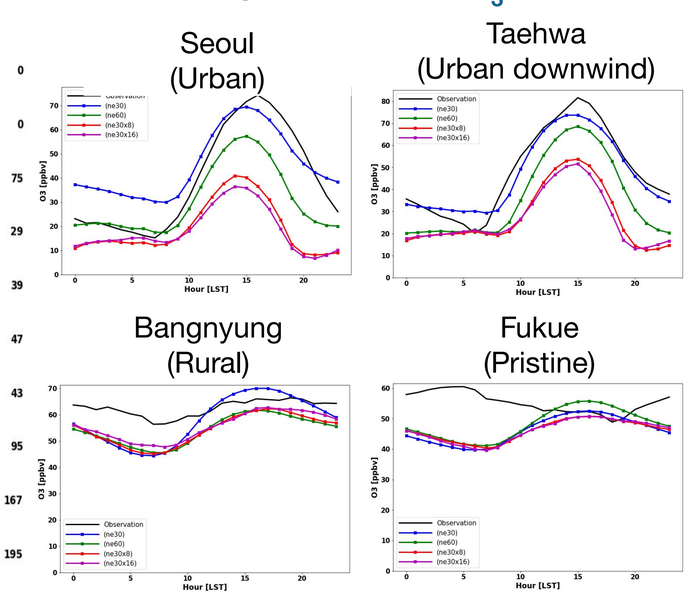


Evaluation against aircraft O_3 observation



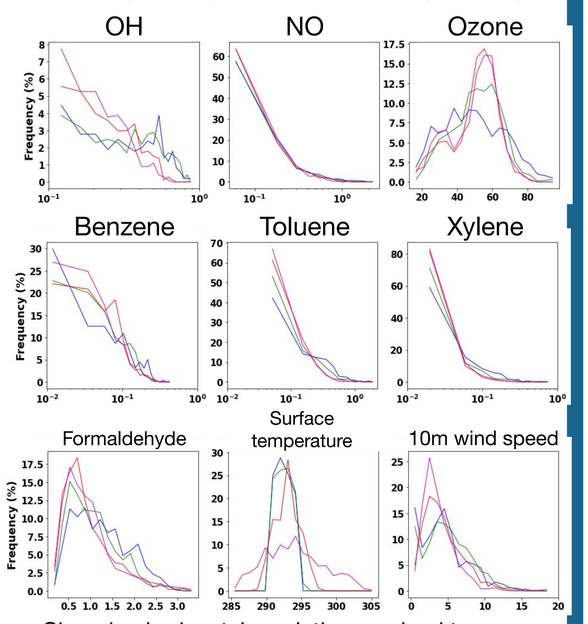
- The model generally underestimates measured ozone during the KORUS-AQ campaign.
- Changing model grid resolution can change ozone by more than 10 ppbv in some cases.

Evaluation against surface O_3 observation



- Higher model resolution is needed to capture urban chemistry with point sources, but the coarse grid is sufficient for rural background air.

Frequency distribution (Seoul)



- Changing horizontal resolution can lead to a different chemical regime in the model simulation.
- Meteorological variables that are needed to calculate chemistry also vary a lot.

ACKNOWLEDGMENTS

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Park et al., Multi-model intercomparisons of air quality simulations for the KORUS-AQ campaign, Elementa: Science of the Anthropocene, 9(1), doi:10.1525/elementa.2021.00139, 2021.
Pfister et al., : The Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA), Bull. Am. Meteorol. Soc., 101(10), E1743–E1760, 2020.