2023 CESM Workshop - Chemistry Climate Working Group Meeting

Comparison of Urban Air Quality Simulations during the KORUS-AQ campaign by Regionally Refined vs Global Uniform Grids With the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA) Version 0

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Wednesday 2:45 - 3:00 PM Center Green Auditorium / Center Bay



MUSICA (Multi-Scale Infrastructure for Chemistry and Aerosols)

- **MUSICAv0** was released in the latest Community Earth System Model (**CESM**) version 2.2
- Based on CAM-chem (Community Atmosphere Model with detailed chemistry) with Spectral Element (SE) dynamical core and Regional Refinement (CAM-chem-SE-RR)



More information at: https://wiki.ucar.edu/display/MUSICA/MUSICA+Home



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Global uniform grids vs Regional refinement (RR) grids over South Korea



Global uniform grids vs Regional refinement (RR) grids over South Korea



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How and how much will the results change if the resolution of the global chemistry models gets better?



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Model simulation period and setup

Dataset for model evaluation:

The Korea-United States Air Quality (KORUS-AQ) campaign
Urban field campaign with a number of aircraft observations

 West Sea
 0
 100
 200
 300

 Image: Construction of the sea of the s

Simpson et al. (2020)

Campaign & Model simulation period: May-June 2016

Model simulation cases:

- Four different grids (\sim 7, \sim 14, \sim 50, \sim 100 km)
- Monthly anthropogenic emissions
- Monthly + Diurnal anthropogenic emissions





Black carbon concentrations at the surface





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Ozone mixing ratios at the surface





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Grid resolution also affects nighttime ozone: larger changes than the effects of diurnal cycle of emissions





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Other chemical species are also affected by grid resolution





Different oxidants result in different oxidation pathways of VOCs

(e.g., monoterpenes)



18

Hour [KST]

24

6



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Evaluation against aircraft measurements: Ozone and NOx



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Evaluation against aircraft measurements: OH and VOCs (Benzene and isoprene)



Significant differences of OH and VOCs due to grid resolution below 2 km, but similar values above 2 km
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Summary



Thank you!

Global Climate & Chemistry models have evolved in the direction of increasing grid resolution



AeroCom model intercomparison study for organic aerosols (Tsigaridis et al., 2014) \rightarrow 1.125° ~ 5°

AeroCom model intercomparison study for nitrate (Bian et al., 2017) \rightarrow 0.5° ~ 3.75°

AeroCom model intercomparison study for aerosol optical depth (Gliß et al., 2021) $\rightarrow 0.4^{\circ} \sim 3.0^{\circ}$

"Increasing the resolution of a model by a factor of **two** means about **ten times** as much computing power will be needed" (UCAR SCIED)



A unified infrastructure to simulate atmospheric chemistry and aerosols across local to regional to global scales.

- □ does not need lateral and upper boundary conditions.
- Seamless two-way feedback process.

