## Development of a MUlti-Scale Infrastructure for Chemistry and Aerosols - MUSICA

#### The MUSICA Team

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NCAR UCAR

#### **MUSICA: MUlti-Scale Infrastructure for Chemistry & Aerosols**

A new model-independent infrastructure, which will enable chemistry and aerosols to be simulated at different resolutions in a coherent fashion

Will facilitate use of a variety of

chemistry schemes, physics parameterizations and atmospheric models

**Coupled** to other **earth system** component models (land, ocean, sea ice, etc.)

Whole atmosphere framework: troposphere to thermosphere



https://www2.acom.ucar.edu/sections/multi-scale-chemistry-modeling-musica

MUSICA Vision paper published in BAMS (Pfister et al., 2020: https://doi.org/10.1175/BAMS-D-19-0331.1)

## **Model-Independent Chemistry Module (MICM)**



- Allows easily changing the chemical mechanism
- Will allow use of the same chemistry in different atmosphere models and



#### MusicBox: MICM in a box model: <a href="https://github.com/NCAR/music-box">https://github.com/NCAR/music-box</a>

Available with command-line control or browser interface Allows for easy:

- Modification of chemical mechanism
- Specification of initial and time-varying environment
  Browser interface plots results, allows comparison of 2 mechanisms



**MUSICA** 



#### **Choices for variable resolution atmosphere models**





**MUSICA** Multiscale Infrastructure for Chemistry and Aerosols

## **Community Involvement Welcome**

We invite the community to participate in development, evaluation and application of MUSICA: <a href="https://www2.acom.ucar.edu/sections/multi-scale-chemistry-modeling-musica">https://www2.acom.ucar.edu/sections/multi-scale-chemistry-modeling-musica</a> Working groups:

- Model Architecture
- Emissions and Deposition
- Chemical Schemes
- Aerosols
- Physics, Transport, sub-scale Processes
- Whole Atmosphere
- Evaluation and Data Assimilation

Visit MUSICA website to join working groups Implementation plans are being developed



#### **MUSICA-V0 - released in CESM2.2**



MUSICA-V0 is a configuration of the Community Earth System Model (**CESM**):

MUSICAvo

**CAM-chem** (Community Atmosphere Model with Chemistry)

With Spectral Element (SE) dynamical core and Regional Refinement (RR)

**CAM-chem-SE-RR** 

At finer resolution, emissions and chemistry are more accurately represented

Pollutants are simulated on human exposure-relevant scales Global feedbacks are directly included

Most of the grid points are in refined region, so no additional cost to simulate the whole globe

Users can create their own grids





#### **MUSICA-V0 – Results**

Impact of higher resolution on chemistry versus increased chemical complexity







Improving representation of fire emissions

Analysis of Korea air quality and impact of model resolution





#### Simulations in support of ACCLIP Asian Summer Monsoon Chemical and Climate Impact Project



**MUSICA** 

COLLE

~50km

~30km



The regionally-refined MUSICA grid enhances the convective transport of pollutants by the Asian monsoon into the UTLS when compared to WACCM.

Sampling these air masses is a key objective of the ACCLIP field phase in summer 2022!



# **MELODIES for MUSICA:** A modular framework to compare model results and observations of atmospheric chemistry

MELODIES: Model EvaLuation using Observations, Dlagnostics and Experiments Software



EarthCube



#### **MUSICA Goals**

- To be developed collaboratively with university and government researchers
- To become the next-generation community infrastructure for atmospheric chemistry & aerosol research
- To deepen existing, and establish new, working relations of the research community with a variety of users ranging from the research community to stakeholders
- To contribute to both advancing the science and to providing relevant and actionable information for the development of mitigation policies or warning systems

#### **Community Involvement**

#### Visit the NCAR ACOM MUSICA website

https://www2.acom.ucar.edu/sections/multi-scale-chemistry-modeling-musica To:

- Join email list to receive MUSICA updates
- Join working groups
- Learn about MUSICA and MusicBox Tutorials Coming Soon!
- Access existing MUSICA-V0 simulations
- Contribute to MELODIES

