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

The MUSICA Team
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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)

Database of chemical mechanisms and data needed for solving chemistry

Allows easily changing the chemical mechanism

Will allow use of the same chemistry in different atmosphere models and

**MusicBox: MICM in a box model:** [https://github.com/NCAR/music-box](https://github.com/NCAR/music-box)

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
Choices for variable resolution atmosphere models

Spectral Element (SE - cubed sphere)

Currently running in CAM

Model for Prediction Across Scales (MPAS - hexagonal mesh)

Non-hydrostatic allowing for finer scales
Community Involvement Welcome

We invite the community to participate in development, evaluation and application of MUSICA:
https://www2.acom.ucar.edu/sections/multi-scale-chemistry-modeling-musica

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 is a configuration of the Community Earth System Model (CESM):

**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
Impact of higher resolution on chemistry versus increased chemical complexity

MUSICA-V0 – Results

Improving representation of fire emissions

Analysis of Korea air quality and impact of model resolution
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, Diagnostics and Experiments Software

- Modular framework
- User-friendly interface
- User Guides will be produced
- Tutorial for community, targeting students and postdocs

Community input requested
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