

Newsletter

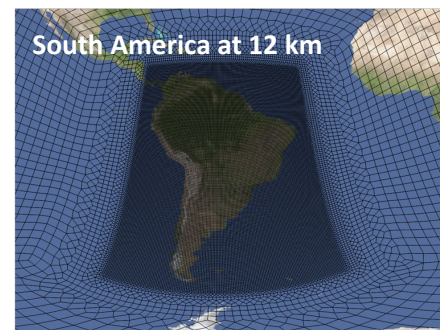
Issue No. 6
April 2023

of the Multiscale Infrastructure for Chemistry and Aerosols - MUSICA

MUSICA is a computationally feasible global modeling framework currently in development that allows for the simulation of large-scale atmospheric phenomena, while still resolving chemistry at emission and exposure relevant scales (down to 4 km). MUSICA will replace and extend the current community chemistry modeling efforts at NCAR (e.g., WACCM, CAM-Chem, WRF-Chem) paralleling other activities at NCAR to streamline and unify model developments.

Summary of this issue

- Evaluation of Model Simulated Ozone and its Precursors during the Michigan-Ontario Ozone Source Experiment (MOOSE)
- Software Development
- MUSICA Library Release
- Conference and Workshop Presentations



New! MUSICA Library Release Version is available at <https://github.com/NCAR/musica>

MUSICAv0 is an initial configuration based on the CESM Community Atmosphere Model with chemistry using the Spectral Element with Regional Refinement dynamical core.

MusicBox is a box model using a model independent chemistry module.

MELODIES is a modular framework to compare model results with observations.

MUSICA is part of **SIMA** (System for Integrated Modeling of the Atmosphere).

To contribute to the newsletter, please email alma@ucar.edu

Evaluation of Model Simulated Ozone and its Precursors Using High-Resolution Model Simulations during the Michigan-Ontario Ozone Source Experiment (MOOSE)

Contributed by **Noribeth Mariscal** (nmariscal@wayne.edu)

Wayne State University, Detroit, MI

To be Submitted in 2023

■ In short

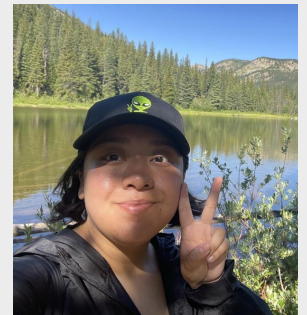
Southeast Michigan has been consistently classified as an ozone nonattainment area per NAAQS. This study takes advantage of MUSICA_{v0}'s regional refinement capabilities to simulate air quality over the state of Michigan. We use the default regional refinement grid (ne30x8 ~14 km over CONUS) and construct a finer domain (ne30x16 ~7 km) over Michigan to investigate the effects of horizontal grid resolution and spatial variation associated with O₃ production and loss during the MOOSE campaign. Simulation results are compared to surface, mobile, and aircraft measurements of chemical species such as CO, O₃, NO_x, and VOCs.

■ Findings

Because computational costs for regional refinement grids (i.e., ne30x8 CONUS) with updated chemistry are often high, this work aims to demonstrate that MUSICA_{v0}'s regional refinement capabilities can aid in local scale air quality projects by reducing cost even with the application of finer grid spacing. The preliminary findings of this work shows that horizontal grid resolution is important for emission flux distributions of chemical species, particularly when distinguishing between rural, suburban, and urban areas. Additionally, meteorological species (i.e., temperature) can be significantly changed between resolutions, therefore impacting chemical processes in the atmosphere and species lifetimes.

Noribeth Mariscal

Noribeth is currently a PhD student at Wayne State University. She visited NCAR as an ASP Graduate Visitor in the summer of 2022.



Noribeth's research focuses on tropospheric ozone chemistry and model evaluations against mobile and surface measurements. She has a particular interest in the Michigan domain.

Presented at the 2023 CESM Working Group Meeting:

<https://www.cesm.ucar.edu/sites/default/files/2023-03/2023-AMWG-N-Mariscal.pdf>

MUSICA Library Release

Checkout updates to the various components that make up the MUSICA library below! The MUSICA library will comprise all the aerosol and chemistry modules developed as part of the MUSICA project.

■ MUSICA Library Release Version 0.2.0

- Repository: <https://github.com/NCAR/musica>
- Highlighted features or updates
 - Includes updated TUV-x and MUSICA-Core versions

■ TUV-x Version 0.4.0

- Repository: <https://github.com/NCAR/tuv-x>
- Description: The TUV-x photolysis calculator is a runtime-configurable tool that calculates photolysis rate constants and diagnostic dose rates using standardized input data. The tool accepts user-provided radiation fields, or calculates them using the Delta-Eddington or n-Stream methods. The tool can be used as a stand-alone executable or through an API, and can be embedded in a 3D atmosphere model for added flexibility.
- Highlighted features or updates
 - ACOM has deployed a web-based version of the Quick TUV Calculator for internal development and testing. This calculator will become available for beta testing in a later release.
 - TUV-x has been extended to allow host applications to specify conditions for photolysis and dose rate calculations.
 - TUV-x is being added to CAM and may be ready for CAM-7.

■ MUSICA-Core Version 0.2.0

- Repository: <https://github.com/NCAR/musica-core>
- Description: MUSICA-Core is a collection of common utilities and algorithms needed by MUSICA software bundled into a single library. This library is agnostic of the model it is used in, but crucially is designed to allow runtime configurability of each of our models.
- Highlighted features or updates
 - A data structure that helps to apply scalar mappings across a list of various objects. This is runtime configurable

MUSICA Library Release

Checkout updates to the various components that make up the MUSICA library below! The MUSICA library will comprise all the aerosol and chemistry modules developed as part of the MUSICA project.

■ Music Box Interactive 2.0.0

- Repository: <https://github.com/NCAR/music-box-interactive>
- Highlighted features or updates
 - Hosted service with multi-user capabilities
 - Released internally to ACOM scientists for testing

Conference and Workshop Presentations

CESM Winter 2023 Working Group meeting, Boulder

<https://www.cesm.ucar.edu/events/working-groups/2023/atmos>

- **Louisa Emmons**, Model-Independent Chemistry Module
- **Doug Kinnison**, Inclusion of Inline photolysis module (TUV-x) in CESM2 MUSICAv0
- **Haipeng Lin**, The Harmonized Emissions Component (HEMCO) 3.0 as a versatile multi-model emissions component implemented within MUSICA/CAM-chem
- **Noribeth Mariscal**, Evaluation of Model Simulated Ozone and its Precursors Using High-Resolution Model Simulations during the Michigan-Ontario Ozone Source Experiment (MOOSE)
- **Ren Smith**, Evaluating the representation of the Asian summer monsoon UTLS composition in CESM using airborne in situ observations
- **Jun Zhang**, Relative Contributions of Anthropogenic and Lightning Nitrogen Sources in the Upper Troposphere during the Asian Summer Monsoon

AMS 2023, Denver

- **Louisa Emmons**, Regional-Scale Modeling in a Global Model MUSICAv0: Multi-scale Infrastructure for Chemistry and Aerosols
 - **Duseong Jo**, 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
 - **Wenfu Tang**, Application of the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA) over Africa
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- **Wenfu Tang** presented MUSICA at the International Space Science Institute (ISSI) Workshop on "The use of geostationary satellites to improve air quality characterization and forecasts" which was held from 20-23 March 2023 in Bern, Switzerland.

Upcoming Workshops and Publications

Upcoming workshops

- **CESM Workshop 2023: June 12-15, Boulder, Colorado (hybrid)**
- **WRF and MPAS Users' Workshop, June 20-23, Boulder, Colorado (hybrid)**

Both these workshops will include a side meeting on MUSICA. Be sure to look for an announcement of those side meetings!

Publications

- Tang, W., Pfister, G. G., Kumar, R., Barth, M., Edwards, D. P., Emmons, L. K., & Tilmes, S. (2023). Capturing high-resolution air pollution features using the Multi-Scale Infrastructure for Chemistry and Aerosols version 0 (MUSCIAv0) global modeling system. *Journal of Geophysical Research: Atmospheres*, 128, e2022JD038345. <https://doi.org/10.1029/2022JD038345>.