

Newsletter

Issue No. 14
October 2025

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 NSF NCAR (e.g., WACCM, CAM-Chem, WRF-Chem) paralleling other activities to streamline and unify model developments.

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).

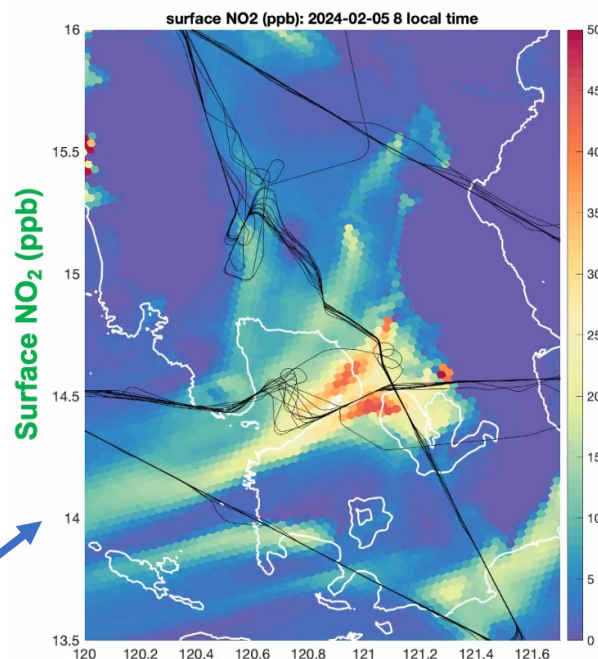
Summary of this issue

- ❖ MUSICA updates
- ❖ SIParCS Student interns create tutorial
- ❖ Presentations and Publications

MUSICA Library Release Version is available at

<https://github.com/NCAR/musica>

Preliminary results: surface NO₂ modelled with MUSICAv1 in the region surrounding of Manilla in the Philippines



We want to hear what you are doing with MUSICA! Please send us contributions to the newsletter (please email gaubert@ucar.edu)

MUSICA Updates

❖ MusicBox Interactive

- ✓ Chemistry box model using prescribed atmospheric conditions. It currently runs gas-phase chemistry only.
- ✓ Current chemical mechanisms available are Chapman, simple wall loss example for flow tube reactors, CB05, and MOZART-TS1. See [MusicBox interactive](#)
- ✓ Used to test chemical schemes, for classroom teaching or summer schools, or research focused on chemical sources and sinks.

Recent achievement:

- ✓ MusicBox and the MUSICA Python package tutorials available. See article on “SIParCS 2025” for more information.

In progress:

- *Development of scripts to extract output from WACCM and WRF-Chem to produce MusicBox input files.*
- *Testing MusicBox-CARMA, which is available in the python package.*

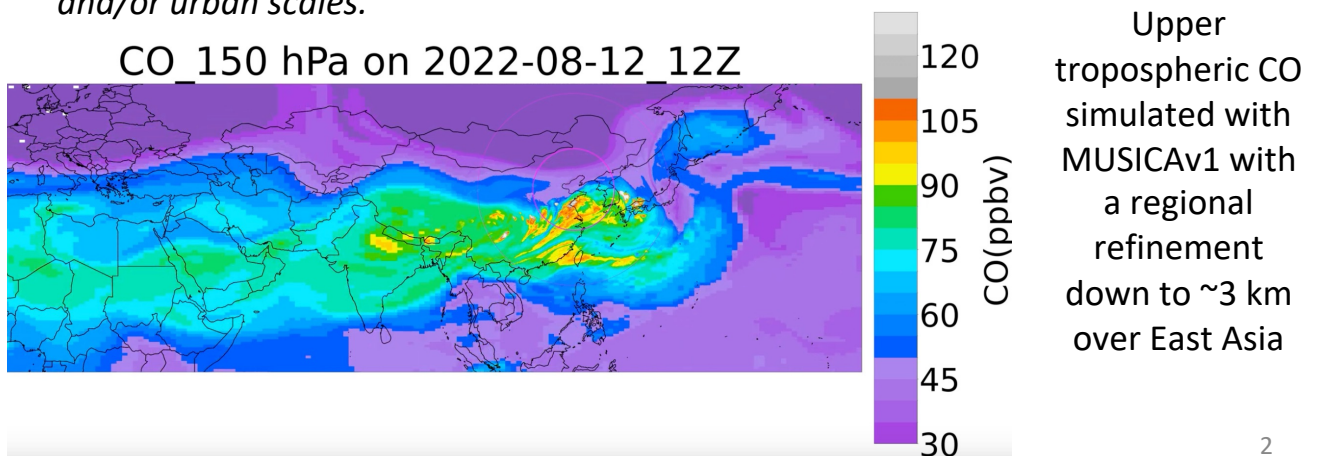
❖ MUSICA in CESM

- ✓ MUSICA_{v0} is a current configuration of CESM/CAM-chem with the spectral element dynamical core that allows global-to-regional variable resolution simulations.
- ✓ Used to study regional air quality, wildfire impacts, and the Asian monsoon system. See the recent publications and presentations.
- ✓ MUSICA Tools: <https://github.com/NCAR/MUSICA-Tools>
- ✓ Code datasets:

<https://wiki.ucar.edu/spaces/camchem/pages/646317602/Code+locations>

In progress:

- *Testing CESM3 and preparing the emissions for CMIP7.*
- *Testing MUSICA_{v1}, which uses the MPAS non-hydrostatic dynamical core, for cloud and/or urban scales.*



MUSICA Updates

❖ MPAS-A

- ✓ [MPAS-A](#) is a standalone atmosphere model used for numerical weather prediction. MPAS-A can be run as a global or regional model, used with the JEDI and DART DA systems, and offline meteorology. Its LES capability is in development.

In progress:

- *The NSF NCAR MPAS-A with GOCART-2G aerosols development is completed. It is currently being tested and improved before it can be released to the community.*
- *Work on connecting the MUSICA library with gas chemistry to the MPAS-A model continues in small, incremental steps.*

❖ NOAA UFS/CATchem

- ✓ CATChem is a chemistry driver and chemistry & aerosol components planned to connect to the NOAA UFS. It will provide a consistent modeling system for air quality forecasting and research.

Recent achievement:

- *Documentation of how to install and use MICM is complete. The documentation can be found at the [MICM github page](#).*

❖ Development of CAM-SIMA as part of the SIMA Project

- ✓ CAM-SIMA will replace CAM as the atmosphere component of CESM, using the spectral element and/or MPAS grid mesh – both with regional refinement capabilities.
- ✓ Its use of CCPP allows interoperability among schemes and easier maintenance of code. About CAM-SIMA

Recent achievement:

- *Demonstration of running the “Terminator chemistry” with CAM-SIMA accessing MICM and TUV-x in the MUSICA library. [Create web page](#).*

- ✓ The SIMA Project formally concluded after 3 years of funding from the NSF NCAR Director’s Office. Some SIMA activities, including CAM-SIMA development, will continue as part of the Community Software Facility. Learn more from [this announcement](#).

MUSICA Updates

❖ MUSICA v0.13.0 Release Notes

MICM

- ✓ Fixing various broken links in the documentation
- ✓ Minor updates to prepare for mixed-phase solving
- ✓ Performance improvements for the CUDA solver
- ✓ Choosing more strict tolerances for unit and integration tests

Music box interactive

- ✓ Documentation and tutorials for the Python interface
- ✓ Added support for the GPU version of MUSICA
- ✓ Fixed bug to support heterogenous reactions
- ✓ Combining the frontend and backend repositories in MusicBox Interactive

TUV-x

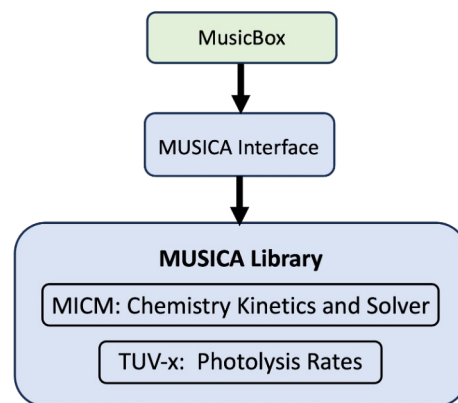
- ✓ Updates to the cmake packaging
- ✓ Using some newer cross section datasets
- ✓ Exposing more internal data for use in the MUSICA Python interface for TUVx

MUSICA

- ✓ Include a Python wrapper for some parts of TUVX
- ✓ Include a Python wrapper for CARMA
- ✓ Include the beginnings of a Javascript wrapper around MUSICA
- ✓ Documentation and tutorials for the Python interface

❖ MELODIES-MONET

- ✓ The GitHub v1 release is here: <https://github.com/NCAR/MELODIES-MONET/releases/tag/v1.0>
- ✓ Zenodo record is here: <https://zenodo.org/records/15776660>
- ✓ The v1.0 also has a readthedocs snapshot: <https://melodies-monet.readthedocs.io/en/v1.0/>



MUSICA Science

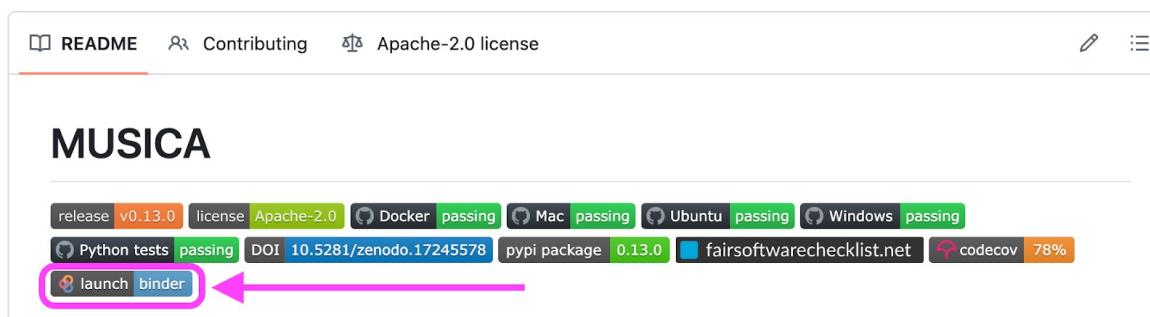
SIParCS 2025

Contributed by Kyle Shores (kshores@ucar.edu), NSF NCAR

Summer 2025 brought two extremely capable interns to ACOM through the CISL SIParCS internship program. Angela Pak is a PhD candidate from University of Illinois Urbana-Champaign in Materials Science and Engineering, and Aidan Winney is a first-year master's student at the University of Florida in computer science. Together, Angela and Aidan authored several interactive tutorials demonstrating how to use MUSICA and MusicBox for various applications in Python. They also integrated these tutorials into our documentation. This effort strengthened MUSICA's accessibility and showcased use cases such as Latin Hypercube Sampling and parallel processing with Dask.



The tutorials can be found in the Musica documentation and the MusicBox documentation. Additionally, they added support for Binder links on the Github repository (musica, music-box) READMEs. Binder links will build and launch a Jupyter notebook instance which allows you to run the tutorials yourself, without having to do any setup. Find the Binder badge on the readmes and try the tutorials out!



The MUSICA team and CISL thank Angela and Aidan for their time this summer. You can find a recording of their final presentation on the CISL SiParCS website: <https://www.cisl.ucar.edu/outreach/internships/2025presentations>

Presentations and Publications

Publications

1. Mariscal, N., et al.: **Evaluation of Ozone and its Precursors using the Multi-Scale Infrastructure for Chemistry and Aerosols Version 0 (MUSICAv0) during the Michigan-Ontario Ozone Source Experiment (MOOSE)**, Geosci. Model Dev., <https://gmd.copernicus.org/articles/18/6737/2025/>, 2025.

Presentations

- ✓ Pablo Lichtig, **Multiscale CO Budget Estimates Across South America: Quantifying Local Sources and Long Range Transport**, [poster presentation](#), ECR IGAC-iCACGP Online Conference, September 2025. [Poster prize winner !](#)
- ✓ Bianca Meotti, **Assessing Temporal Emission Variability Using MUSICAv0 and NASA TEMPO**, poster presentation, 2025 Fall Symposium, Raleigh NC, October 2025. Bianca Meotti, **Assessing Temporal Emission Variability Using MUSICAv0 and NASA TEMPO**, poster presentation, 2025 Fall Symposium, Raleigh NC, October 2025.
- ✓ Wenfu Tang, **Modeling interactions between meteorology, long-range transport, and local air pollution during the ASIA-AQ field campaign**, Oral presentation, AOGS Annual Meeting, Singapore, July 2025.
- ✓ Jun Zhang, **Source Attribution to Surface Ozone in Asia during ASIA-AQ: NOx tagging in MUSICAv0**, Oral presentation, AOGS Annual Meeting, Singapore, July 2025.
- ✓ Jun Zhang, **Sources and Regional Attributions to Upper Troposphere Nitrogen Oxides during the Asian Summer Monsoon**, Oral presentation, BACO-2025, Busan, South Korea, July 2025.
- ✓ Jun Zhang, **Source Attribution to Surface Ozone in Asia during ASIA-AQ: NOx tagging in MUSICAv0**, poster presentation, ECR IGAC-iCACGP Online Conference, September 2025.
- ✓ Shane Visaga, **Air quality impacts of Maritime Continent fires using MUSICAv0 with peat implementation in FINNv2.5**, poster presentation, ECR IGAC-iCACGP Online Conference, September 2025.
- ✓ Hyerim Kim, **Model evaluation and source contribution of PM2.5 and ozone in Southeast Asia during the ASIA-AQ campaign**, poster presentation, ECR IGAC-iCACGP Online Conference, September 2025.
- ✓ Nattamon Maneenoi, **Geostationary Fire Detections Improve Burned Area Estimates in Southeast Asia**, poster presentation, ECR IGAC-iCACGP Online Conference, September 2025.
- ✓ Noribeth Mariscal, **Quantifying the Contribution of Emissions and Transport to Ozone Production and Loss Processes: A Case Study of Southeast Michigan**, poster presentation, ECR IGAC-iCACGP Online Conference, September 2025.
- ✓ Noribeth Mariscal, **Quantifying the Contribution of Emissions and Transport to Ozone Production and Loss Processes: A Case Study of Southeast Michigan**, poster presentation, The International Conference on Chemical Weather and Chemical Climate, UM6P, Benguerir, Morocco, October 2025.