# MUSICA*ctivities*

Newsletter

Issue No. 8
October 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

- Multiscale CO budget estimates across South America: quantifying local sources and long-range transport
- MUSICA Library Release
- Workshop Presentations and Publications
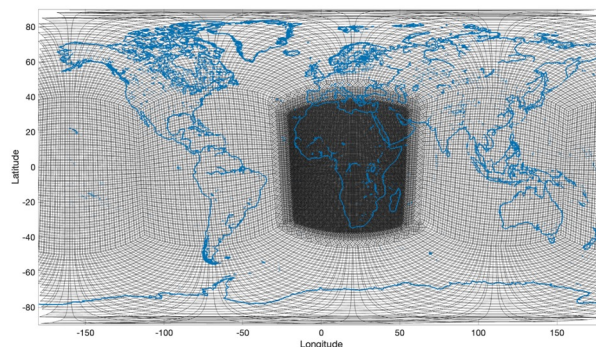
MUSICAv0 Africa at 28 km, Tang W. et al., 2023

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 gaubert@ucar.edu

MUSICA Science

Multiscale CO budget estimates across South America: quantifying local sources and long-range transport

*Contributed by* **Pablo Lichtig** *(pablo.lichtig@gmail.com)*
National Atomic Energy Commission and National Council of Science and Technology, Bs As, Argentina

▪ In short

Atmospheric chemistry and air pollution in the Southern Hemisphere remains understudied. This work constitutes the first application of the Multi-Scale Infrastructure for Chemistry and Aerosols version 0 with a variable resolution grid that zooms over South America.

In this paper, we perform a simulation for the year 2019 including a mesh refinement (ne30x4, ~28 km) and a control simulation at uniform resolution (ne30, ~111 km). We employ a system of CO tagged tracers to quantify the CO budget and to identify geographical origins of CO by sources.
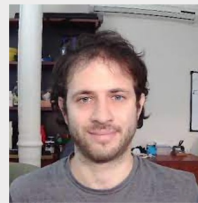
> ### *Pablo Lichtig*
>
> Pablo is currently a PhD student in Chemistry in University of San Martín. He visited NCAR in the summers 2022 and 2023.
>
> Pablo's research focuses on characterizing air pollution in South America by measuring aerosols in the fields and modeling with regional and global models.
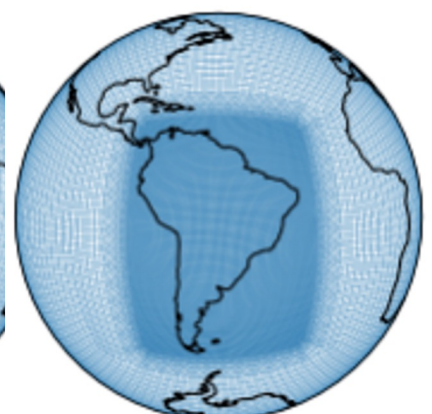
▪ Findings

CO main sources are secondary production and biomass burning.

We found that the biomass burning sources contributes the most to the CO variability.

During all the year, African fires remain a relevant source of CO in all the subcontinent, whereas the Amazon becomes the largest source of CO after August.

Global grid ~ 100 km   **South American grid at 28 km**

Lichtig, P., et al. (2023). Multiscale CO budget estimates across South America: quantifying local sources and long-range transport. To be submitted.

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.

- **TUV-x**
  - TUV-x includes a bug fix and updates to linear algebra functions.

- **TUV-x on the web!**
  - The new TUV-x Quick Calculator is implemented in alpha-test form on the web: **https://www.acom.ucar.edu/Models/TUV/Interactive_TUV/tuv-x.shtml**

  - As of the October 2023 MUSICA newsletter it supports most of the features of the "classic" TUV Calculator. The remaining features are disabled (clouds). We encourage MUSICA users to test the new calculator's operation; clicking **Go** will deliver a page of text output as before, along with a directory where you may download TUV-x output in NetCDF, CSV, and Text formats. The calculator also provides the JSON file that produced the output, and you may use this template as a basis for your own custom calculations.

- **MusicBox**
  - References to the old MICM were removed and build instructions were updated.

- **MusicBox Interactive**
  - Try out the tool here: **https://musicbox.acom.ucar.edu/home**

  - No new updates to MusicBox Interactive have been released, but we are still encouraging anyone to play around with the tool. Let us know if you have any feature requests or issues at github.com/NCAR/music-box-interactive-client .

- **MUSICA-Core**
  - A few unused functions were removed from the library.

MUSICA Library Release

- **MICM**

  - The MUSICA software engineers spent most of their time diligently updating MICM to ACOM software standards and removing the need for a preprocessor to run chemistry. MICM solves gas-phase chemistry with all values calculated at runtime using a generic solver. Additionally, Just-In-Time (JIT) compilation was added, which allows the solver to be runtime configurable and be as fast as solutions which use preprocessing.

  - MICM is also gaining GPU capabilities. Software engineers (SEs) from the NCAR Computational and Information Science Laboratory (CISL) and their fantastic SciParcs intern Qina Tan in collaboration with ACOM SEs are adding GPU support for MICM, which will be part of an upcoming MICM release.

- **MUSICA**

  - The largest update is to the MUSICA Software Development Plan. This version removes the requirement to use the Trello board and allows interactions to be more flexible and take place where scientists and software developers feel most comfortable communicating.

  - A C interface for MUSICA is under development using a corresponding Fortran wrapper. This release contains an early (and buggy) version of these interfaces. A stable and functional interface that allows for the use of MICM in Fortran is anticipated in the next release.

Workshop Presentations and Publications

Presentations

- **Louisa Emmons,** Urban Air Quality Across the Globe with MUSICAv0, Meteorology and Climate - Modeling for Air Quality Conference at UC-Davis, Sept. 13-15.
- **David Fillmore**, The MELODIES MONET Atmospheric Composition Diagnostics Package, Meteorology and Climate - Modeling for Air Quality Conference at UC-Davis, Sept. 14.
- **Alma Hodzic**, Advancing Aerosol Research with the Next Generation Multiscale Infrastructure for Chemistry and Aerosols (MUSICA) and High-resolution Measurement Networks, AAAR, Portland, Oct. 2.
- **Wenfu Tang**, MUSICAv0: Multi-Scale Infrastructure for Chemistry and Aerosols, Digital Twins Webinar Series, Sept. 26.
- **Mary Barth**, Modeling multiscale chemistry and aerosols associated with convective transport in the Asian Summer Monsoon, IUGG 28th General Assembly, Berlin, Germany

Town Hall at AGU23 (hybrid)

Next-Generation Modeling of Atmospheric Composition with the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA)
Wednesday, 13 December 2023: 18:30 - 19:30 PST, Moscone Center, Room: 2008 - West

Publications

- Jo, Duseong, et al.: **Effects of Grid Resolution and Emission Inventory on Urban Air Quality Simulation with the Multi-Scale Infrastructure for Chemistry and Aerosols (MUSICA) Version 0**, *Journal of Advances in Modeling Earth Systems*, https://doi.org/10.1029/2022MS003458, 2023.
- Lin, H., Jacob, D. J., Lundgren, E. W., Sulprizio, M. P., Keller, C. A., Fritz, T. M., Eastham, S. D., Emmons, L. K., Campbell, P. C., Baker, B., Saylor, R. D., and Montuoro, R.: **Harmonized Emissions Component (HEMCO) 3.0 as a versatile emissions component for atmospheric models: application in the GEOS-Chem, NASA GEOS, WRF-GC, CESM2, NOAA GEFS-Aerosol, and NOAA UFS models**, *Geosci. Model Dev.*, 14, 5487–5506, https://doi.org/10.5194/gmd-14-5487-2021, 2021.
- Tang, W., Emmons, L. K., Worden, H. M., Kumar, R., He, C., Gaubert, B., et al.: **Application of the Multi-Scale Infrastructure for Chemistry and Aerosols version 0 (MUSICAv0) for air quality in Africa**, *Geosci. Model Dev.*, https://doi.org/10.5194/gmd-2023-50, in press, 2023.