

Overview of CAM-chem development and diagnostics

AMWG/WAWG/CCWG 2023 Winter Meeting

Simone Tilmes, Co-Chair

Rafael Fernandez, External Co-Chair

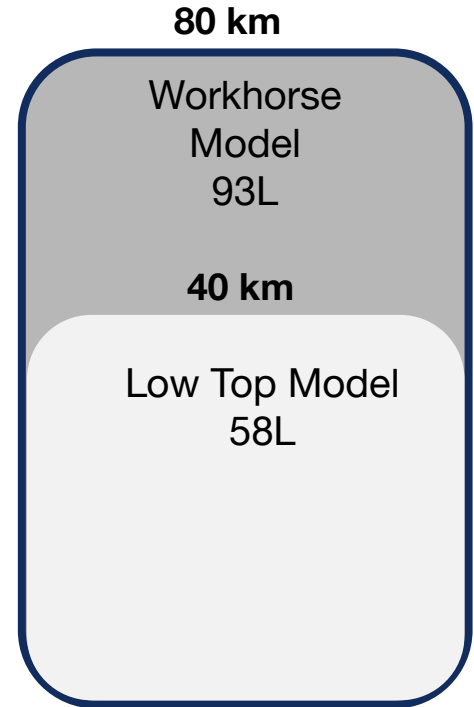
Rebecca Buchholz, Science Community Liaison

Francis Vitt, Software Engineer

Jan 31, 2023

Overview

- Major updates and developments
- Evaluation and diagnostic tools
- Discussion of user projects and needs



Wiki

Home

Created by WEG Administrator, last modified by Rebecca Buchholz on Jan 27, 2023

Current versions: CESM2.1 & CESM2.2 (with MUSICA v0)

Welcome to the CAM-chem Wiki

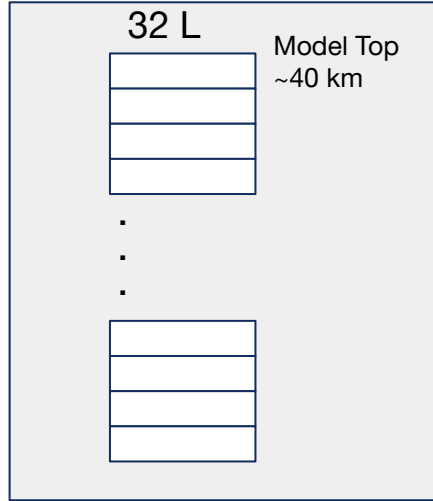
The **Community Atmosphere Model with Chemistry** (CAM-chem) is a component of the NCAR Community Earth System Model (CESM) and is used for simulations of global tropospheric and stratospheric atmospheric composition. Chemistry in CAM-chem is based on the MOZART family of chemical mechanisms, with various choices of complexity for tropospheric and stratospheric chemistry. The first version of CAM-chem is described in Lamarque et al. (2012). An overview of CESM2, which is based on CAM6, is provided by Danabasoglu et al. (2020), with details of the chemistry described in Emmons et al. (2020) and the secondary organic aerosols in Tilmes et al. (2019). CAM6-chem uses the MAM4 modal aerosol model (Liu et al., 2016).

Run	<ul style="list-style-type: none">• Get a Cheyenne Account• Quick Start - Run on Cheyenne (the NCAR HPC)• Home Machine (fully coupled version in CESM)• Glossary for **new users**• Release Versions and Compsets• Troubleshooting
Tutorials	<ul style="list-style-type: none">• CESM Tutorials• MUSICA Tutorial Series
Easy Changes and Common Resources	<ul style="list-style-type: none">• Changing Dates of Run• Changing Emissions Input• Changing Output (time and species)• Defining Meteorology for specified dynamics (on met field levels)• Defining Meteorology for physics-based nudging (on model levels)• Restart Files

<https://wiki.ucar.edu/display/camchem/Home>

Current and future configurations of CAM-chem

Current scientific release

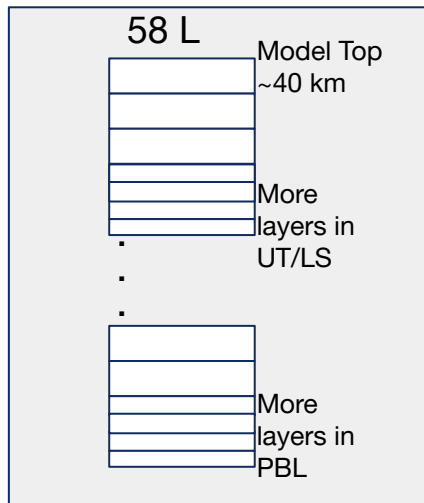
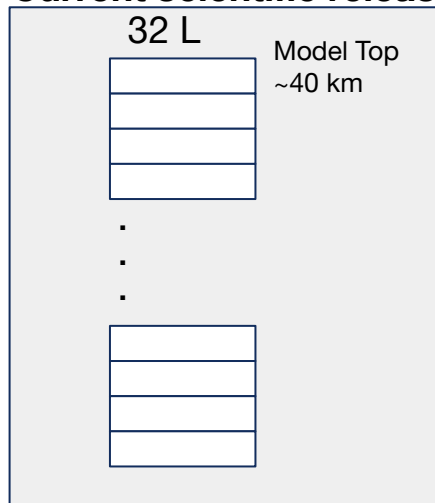


CESM2.2/CAM6 (Finite Volume default)

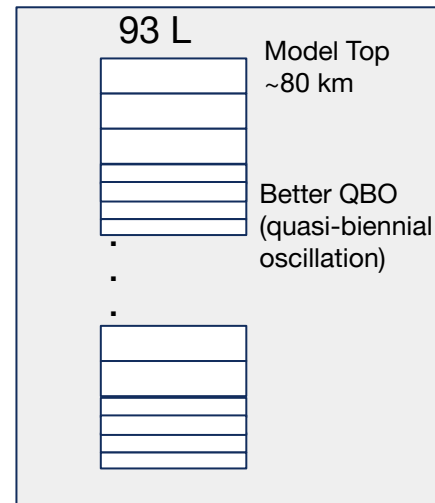
- Using Modal Aerosol Model with 4 modes (MAM4)
- Specified Dynamics (SD) uses MERRA2 on 32 L

Current and future configurations of CAM-chem

Current scientific release



Planned CAM "workhorse"



Will be used for specified chemistry

CESM2.2/CAM6 (Finite Volume default)

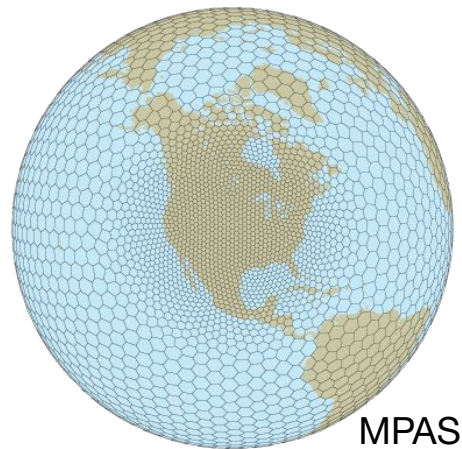
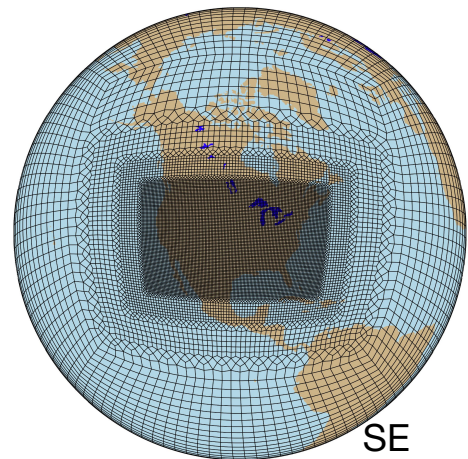
- Using Modal Aerosol Model with 4 modes (MAM4)
- Specified Dynamics (SD) uses MERRA2 on 32 L

CESM3/CAM7 (Spectral Element default)

- MAM5 (5 modes) when chemistry implemented
- New upper boundary conditions from WACCMX (D. Marsh)
- Marine Organic Aerosol
- Dust module emissions updates
- TUV-x: easy to add new code; online; aerosol interaction

Dynamical core overview

- **SE - CSLAM (pg3)**: Spectral Element dynamical core on a cubed sphere, Conservative Semi-Lagrangian Multi-tracer dynamical core with finite-volume transport (CSLAM). No current regional refined capability. **The current new workhorse in CESM2.X/3**
- **SE (RR)**: Spectral Element dynamical core with regional refinement options.
- **FV**: Finite Volume (FV)
- **FV3**: a non-hydrostatic cubed-sphere version of FV
- **MPAS**: Model for Prediction Across Scales, cloud resolving, a global version of Weather Research and Forecasting, WRF, model discretized on a Voronoi grid. Regional refinement option, (experimental: need to compare with SE-RR).



Responsibilities of the workhorse model

- The CAM-chem workhorse run provides oxidants to CAM
 - Current update: CGD has run the 58/93 version with specified chemistry, simple SOA and updated MAM4 (with prescribed stratospheric aerosols)
 - CAM-chem is running on L58 (with topography bug fix) (https://github.com/NCAR/amwg_dev/issues/202)
- Provide a scientifically validated configuration
- Provide a benchmark

New boundary conditions for regional modeling

New CAM-chem community simulation:
output saved for boundary conditions in
regional modeling

<https://wiki.ucar.edu/display/camchem/CESM2.2%3ACAM-chem+as+Boundary+Conditions>

Subsets of the data can be requested

<https://www.acom.ucar.edu/cesm/subset.shtml>

NCAR | National Center for Atmospheric Research
UCAR | Atmospheric Chemistry Observations & Modeling

COMMUNITY EARTH SYSTEM MODEL (CESM): SUBSET DOWNLOAD

CESM results for a subset of the globe and a range of dates can be downloaded from this page. Output is provided every 6 hours. Each request is provided as a single netcdf file. We **strongly** recommend that you **download a single day** for your region to check the file size and then request a range of dates that will result in a manageable file size. **Requests for time spans longer than 32 days are not supported.** Questions about CAM-Chem and requests for additional dates can be addressed to Rebecca Buchholz (buchholz at ucar . edu).

Direct data download is also available from the NCAR [Research Data Archive](#); registration is required.

The 'date' and 'dasesc' variables contain the date and time of the CAM-Chem output. To verify the date of the downloaded files, please use 'ncdump -v date'. The program ncview does not properly interpret the 'time' variable and calculates an erroneous date.

CAM-Chem results are available for January 1, 2001 to December 31, 2020. Further details are available at the Wiki page [CESM2.2:CAM-chem as Boundary Conditions](#). For more recent dates, consider using [WACCM forecasts](#). If you require further information, please contact Rebecca Buchholz (buchholz at ucar . edu).

Please enter your contact information in the space below:

- E-mail:

November 10, 2020: The personal data (e-mail) that you provide to [UCAR/ACOM](#) here is necessary to identify you as a user of [CAM-Chem model output](#) and to notify you when your data packet is ready. We also provide update notices by e-mail. The optional personal data provided below will be used to organize discussion forums ([example](#)). We do not use your personal data outside of UCAR/ACOM, and we share only non-personal aggregated data for reporting purposes to third parties. For more information about Privacy at UCAR, see UCAR's [Privacy](#) and [Cookies](#) Notices.

- Your name (optional):
- Affiliation (optional):
- Intended usage (optional):

MUSICA updates

MUSICA: MUlti-Scale Infrastructure for Chemistry & Aerosols

<https://wiki.ucar.edu/display/MUSICA/MUSICA+Home>

(1) Three bug reports:

- CLM bug affecting MEGAN emissions (July 2022)
- SE advection bug (critical over steep orography)
- Secondary bug in SE advection (high latitude noise)

Bug fixes are available in the latest release of the model

(2) MUSICA & GEOS-Chem

(3) Integrating MICM into NOAA Unified Forecasting System (UFS)

(4) The Generalized Aerosol/Chemistry INTerface (GIANT)

Diagnostic framework development

Atmospheric Diagnostic Framework, **ADF**, python tools developed in collaboration with Justin Richling (CGD) to replace the previous diagnostics written in NCL (<https://github.com/NCAR/ADF>)

- Currently developing:
 - Budget Tables (including for SE): chemistry and aerosols
 - Zonal aerosol evaluation
 - MODIS and MERRA AOD climatology comparison maps (D. Fillmore)
 - MOPITT CO new climatology comparison maps (V9J)
- Upcoming:
 - Ozone profile climatologies
 - Chemistry zonal mean evaluation

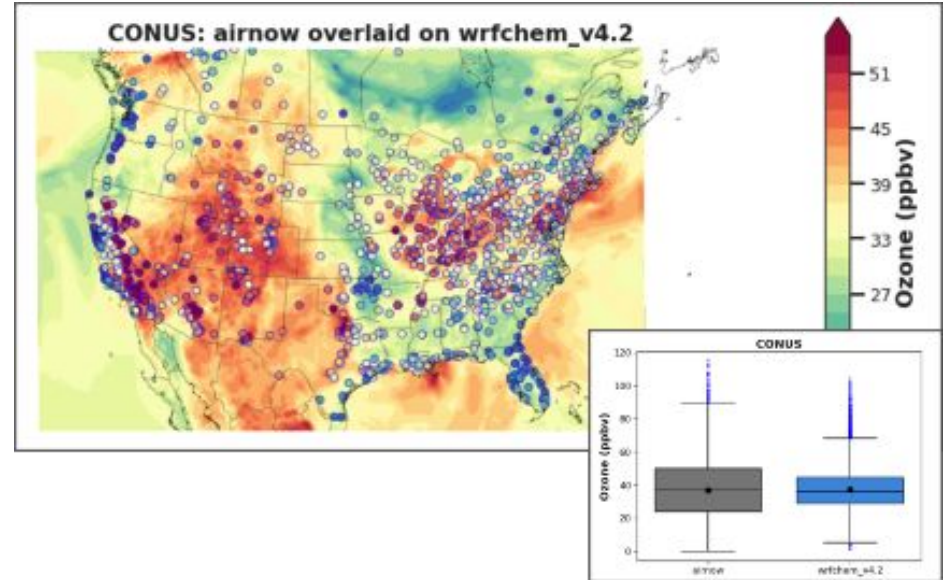
Model Evaluation with MELODIES MONET

MELODIES: Model EvaLuation using Observations, Diagnostics and Experiments Software
MONET: Model and ObservaTION Evaluation Toolkit



A modular framework to compare model results and observations of atmospheric chemistry

<https://github.com/NOAA-CSL/MELODIES-MONET>



Louisa Emmons, Rebecca Buchholz, David Fillmore, Duseong Jo, Ben Gaubert, Simone Tilmes, Gabriele Pfister, Helen Worden – NCAR/ACOM
Ave Arellano - U. Arizona; Gao Chen - NASA Langley
Becky Schwantes et al. – NOAA/CSL (& GSL); Barry Baker – NOAA/ARL
& the community

Discussion Slide

Model intercomparison: CCMI-2, HTAP-fire, TOAR2, ISA-MIP, CMIP7

<https://wiki.ucar.edu/display/camchem/MIPs>

- Who is involved? Are there missing MIPs?

Model development:

- Which configurations are required?



Extra

Testing plans for the workhorse model

- Perform a 20 year climate run (1979-1999) (re-running due to topography issue, avail after WGM)
 - 58L SE-CSLAM
 - prescribed SST
 - free running
- The use new code with all updates from Simone's slides
- Upper boundary conditions
- Produce oxidants (from free running with prescribed SST)
- Regrid MERRA2 to 58L or 93L to be able to run specified dynamics
- Compare 58L with and without chem, to CMIP6 FV and to 32L FV & SD

GitHub links

All AMWG development:

https://github.com/NCAR/amwg_dev/issues

CAM7 development run plans and progress:

https://github.com/NCAR/amwg_dev/discussions/193

L58 chemistry development plans and progress:

https://github.com/NCAR/amwg_dev/discussions/200