Using CAM-chem Output

Summary of output files

CAM-chem output is saved as gridded files. Finite volume simulations use a regular grid.

Time: Instantaneous time saves exactly at the time specified. Average time saves at the end of the time period. For example a month average of January 1 to 31 will save at midnight between January 31 and February 1.

Altitude: Vertical layers are sigma hybrid coordinates. You can convert into layer centers or edge pressures using the conversion factors (P0, hyam/hyai, hybm/hybi - where "m" are associated with the mid-points/centers and "i" are associated with the interfaces/edges) combined with surface pressure. NCL has an example of converting hybrid to pressure coordinates: https://www.ncl.ucar.edu/Document/Functions/Built-in/pres_hybrid_ccm.shtml. The variable 'Z3' contains altitude in meters.

Horizontal resolution: Latitude and longitude coordinates are saved and represent center values of the grid box.

Examples for working with output

An overview describing CESM output in general and suggesting some options for visualization and analysis (e.g. including quick looks with ncdump, ncview, panoply) can be found in the following lecture notes:

http://www.cesm.ucar.edu/events/tutorials/2017/practical3-phillips.pdf

A growing collection of python examples specific for CAM-chem can be found here:

https://ncar.github.io/CAM-chem/

MUSICA is developing some visualization tool examples under "viewing output":

https://wiki.ucar.edu/display/MUSICA

Explanations of output diagnostic variables

An example list of possible history file variables can be found here: CAM-chem History Fields. You can find the possible history fields for your own specific model build by looking in a log file for your setup simulation and searching for "MASTER FIELD LIST".

Output variable	Units	Definition
SF_<species>	kg/m2/s	Emissions of species (Surface Flux)
MEG_<species>	kg/m2/s	Biogenic emissions calculated by MEGAN in CLM
LNO_PROD	molecules/cm3/s	3D lightning NO emissions
LNO_COL_PROD	Tg-N/yr	vertically integrated lightning NO emissions
DV_<species>	cm/s	Dry Deposition Velocity of species
DF_<species>	kg/m2/s	Dry Deposition Flux of species
DTWR_<species>	kg/kg/s	Washout Rate of species (3D field)
WD_<species>	kg/m2/s	Wet Deposition vertically integrated flux. Note: prior to CESM2 this was output in units (kg/grid-box/s).
<species>_CHMP <species>_CHML	molecules/cm3/s	Total chemical production and loss for species (based on equations found in $CASE/CaseDocs/chem_mech.doc).

O3_Prod O3_Loss	molecules /cm3/s	For ozone, the gross production and loss terms (CHMP, CHML) are not particularly useful as they include the fast cycling reactions, so O3_Prod and O3_Loss are defined to represent the sum of the rate-limiting reactions of the OddOx family (O3 + O + O1D + NO2). These are the key terms in the OddOx equations. In hindsight, these O3_Prod and O3_Loss names probably should not have the name O3_ in them. These reactions are aimed primarily at deriving the tropospheric photochemical smog chemistry. The main reactions are: O3_Prod = NO_HO2 + CH3O2_NO + PO2_NO + CH3CO3_NO + C2H5O2_NO + .92*ISOPAO2_NO + .92*ISOPBO2_NO + MACRO2_NOa + MCO3_NO + C3H7O2_NO + RO2_NO + XO2_NO + .9*TOLO2_NO + .9*PHENO2_NO + .9*C6H5O2_NO + .9*BENZO2_NO + .9*MALO2_NO + .9*BZOO_NO + .9*ACBZO2_NO + .9*DICARBO2_NO + .9*MDIALO2_NO + .9*XYLOLO2_NO + .9*XYLENO2_NO + TERPO2_NO + TERP2O2_NO + NTERPO2_NO + ALKO2_NO + ENEO2_NO + EO2_NO + MEKO2_NO + HOCH2OO_NO + jonitr O3_Loss = O1D_H2O + OH_O3 + HO2_O3 + H_O3 + C3H6_O3 + .9*ISOP_O3 + C2H4_O3 + .8*MVK_O3 + 0.8*MACR_O3 + MTERP_O3 + BCARY_O3 These diagnostic terms are now (CESM2) defined in the atm_in namelist (the **rxn_rate_sums** variable in the rxn_rates_diag_nl group). These rate sums can be modified, or additional ones created, by the user in user_nl_cam.
j<photorate_label>	/s	Photolysis rate constant
r_j<photorate_label>	molecules /cm3/s	Photolysis rate (j * species density)
<rxnrate_label>		Reaction rate constant (e.g., "O1D_H2O" gives k for O1D+H2O)
r_<rxnrate_label>	molecules /cm3/s	Reaction rate (k * [O1D] * [H2O])

Molecular weight values

Users can find the chemical formula used by CAM-chem for each compound in: ./CaseDocs/chem_mech.in or chem_mech.doc

The molecular weights used in CAM-chem can be found in this file: species_molwts_2021-05-07.csv

Unit conversions

There are some instructions about converting different units on the Using MOZART-4 output page, that have some relevance for CAM-chem output.