

Using CAM-chem Output

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 on January 31.

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) 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 m.

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

An overview describing CESM output in general and suggesting some options for visualization and analysis can be found in the following lecture notes:

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

Unidata has some great python examples for atmospheric science:

<https://unidata.github.io/python-training/gallery/gallery-home/>

CAM-chem specific python examples will 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

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		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	<p>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:</p> <p>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</p> <p>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</p> <p>These diagnostic terms are now (CESM2) defined in the atm_in namelist (the rxn_rate_sums variable in the rxn_rates_diag_n1 group). These rate sums can be modified, or additional ones created, by the user in user_n1_cam.</p>
j<phorate_label>	/s	Photolysis rate constant
r_j<phorate_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])