# Documentation for CESM CAM4 and 5 with Chemistry (and Prescribed Dynamics); and WACCM; Running an existing component set (on yellowstone)

**More information on how to run CESM:** http://www.cesm.ucar.edu/models/cesm1.2/
**This documentation is for the release version cesm1_2! CESM1.2 contains NO scientifically validated component sets and as such is not to be used for scientific simulations.**
**http://www2.cesm.ucar.edu/models/scientifically-supported**

Skip the following step if you are not creating your own branch:
For a list of release versions, type:

- svn ls https://svn-ccsm-release.cgd.ucar.edu/model_versions/

Then you can check out the latest version:

- > mkdir ~/cesm
- > cd ~/cesm
- > svn co https://svn-ccsm-release.cgd.ucar.edu/model_versions/cesm1_2_0 cesm1_2_0_mycopy

## Creating, building and running

Pick One Component Set (**see tables below**), or find a list of all supported compsets:
http://www.cesm.ucar.edu/models/cesm1.2/cesm/doc/modelnl/compsets.html

## Roadmap for a CAM-Chem and WACCM model run (Quickstart):

1. Create a new case called <case_name>:
   **CESM_ROOT** = <release tag>
   On yellowstone: /glade/p/cesm/cseg/collections/cesm1_2_0
   Go to your model directory **CESM_ROOT**, then **cd scripts** and invoke:
   **create_newcase -case $CASE/<case_name> -res f19_f19 -compset <COMPSET> -mach yellowstone** (change **'yellowstone'** to your computer name)
   f19_f19: data ocean (finite volume of the atmosphere)
   f19_g16: active ocean
   A new directory **<case_name>** is created in your **$CASE** (below, **<case_dir>)** in **$CASE/<case_name>**
2. Setup your run: cd to **<case_dir>** and invoke ./cesm_setup
3. Make changes to defaults if desired (see description below)
   - edit **env_build.xml** to change calendar type (NO_LEAP, GREGORIAN), CAM_CONFIG_OPTS (e.g., to point to new mechanism file), different vertical levels. If you have to rebuild the model, make sure to invoke *.clean_build first
4. Configure and build the model in **<case_dir>**: **./*.build** file
5. Make changes to your namelist variable (if desired): edit file **user_nl_cam**, **user_nl_clm** ect. in **<case_dir>** to modify paths to emissions, output variables. **NOTE: changes in user_nl* files do not require new configuration or build.**
6. Invoke **./preview_namelists**
7. Check your model setup in CaseDocs: e.g., atm_in (namelist), chem_mech.in (chemistry mechanism)
   - Check run setup: **env_run.xml.** The default is a test run -- 5 days.. **NOTE: changes can be performed any time during the run**
8. **./*.submit** (or bsub < ./*.run on yellowstone)
   - default for model output is in **<run_dir>:**

**/glade/scratch/<username>/<case_name>/run**

- namelist that was used for run in **<run_dir>/atm_in**

**Modification of the run (no changes to the model configuration):**

1. edit **env_run.xml** to change run specifications, run type (startup, branch), start date (RUN_STARTDATE), run time, output, restart, type of archiving
2. open ***.run** to change run specific parameters, NOTE: there is a new 'small' queue for <2hour runs available that will be treated like premium but is cheaper.
3. after these changes you can just resubmit the run

Some additional useful information to point 1:
CONTINUE_RUN: needs to be set to TRUE to continue a run for several time segments
RESUBMIT: set value to the number of segments you want to run (value counts down during the simulation)
REST_OPTION: will write out restart files in the frequency chosen (e.g., nmonths every months)
REST_N: frequency of restart file output, 0: no restart file
DOUT_L_MS: archiving to mss is not a default and needs to be set

**Archiving:**

–short-term archiving in /glade/scratch/<username>/archive
–long-term archiving on the mass store :execute *.l_archive

**Modification of the namelist (can be done during the run, no compilation required):**

(nl definitions**:** http://www.cesm.ucar.edu/cgi-bin/eaton/namelist/nldef2html-pub)

edit **user_nl_cam** in your <case_dir> to change your namelist, for example, emissions, met fields, model output etc. Examples:

**add aircraft of satellite obs. track option:**

```
&satellite_options_nl
  sathist_fincl   =  species
  sathist_hfilename_spec   = '%c.cam2.aircraft.%y-%m-%d-%s.nc'
  sathist_track_infile          = '<aircraft track file location>'
/
```

**Running with MEGAN emissions: find detailed information here:**
**http://www.cesm.ucar.edu/working_groups/Chemistry/running_CESM1_MEGAN-v0408.pdf**

## Modification of the chemistry mechanism, example:

1. copy an input file in $CCSMROOT/models/atm/cam/chem_proc/input to your directory and name it: **my_mech.in**
2. edit **my_mech.in**
3. edit **env_build.xml** and add to :
   **<entry id="CAM_CONFIG_OPTS" ... usr_mech_infile my_mech.in" />**
4. if needed, modify source code (for example for wet-dep or dry-dep) and place in appropriate subdirectory of **<case_dir>/SourceMods/**:

- files originally in /models/atm/cam/src/chemistry/mozart/ go in **<case_dir>/SourceMods/src.cam/**
- files originally in models/drv/shr/ (e.g., seq_drydep_mod.F90) go in **<case_dir>/SourceMods/src.share/**

5. invoke ***.clean_build** and ***.build** to rebuild your model
6. if you have trouble configuring (e.g., errors in your mechanism file), edit the **configure** script: **env_case.xml** commenting out the line: rm -rf $CASEBUILD. This allows you to track down how far the pre-processor got, etc. However, you have to invoke **cesm_setup** –clean and **cesm_setup** again

## Add new species:

You have to modify the setup of the mechanism if you add more species: models/atm/cam/src/chemistry/..

If you want to add a species that will be dry/wet deposited, you might have to adjust the following routines:

- models/drv/shr/seq_drydep_mod.F90
- models/atm/cam/src/chemistry/mozart/mo_drydep.F90 (subroutine drydep_xactive)
- models/lnd/clm/src/clm4_0/biogeochem/DryDepVelocity.F90
- Add your new species in the masterlist: models/atm/cam/bld/namelist_files/master_drydep_list.xml, master_gas_wetdep_list.xml, master_aer_wetdep_list.xml, ect if needed

If you add a species with dry depostion that is not listed in the species_name_table list in models/drv/shr / seq_drydep_mod.F90, you can map it to one of the species in the list, as done in the subroutine seq_drydep_init.F90

## Available Deposition Schemes:

Dry Deposition:
namelist options in drv_flds_in (drydep_inparm):
drydep_list = list of species (controlled through the masterlist now)
drydep_method =
'table' (prescribed method in CAM)
'xactive_atm' (interactive method in CAM)
'xactive_lnd' (interactive method in CLM)

Wet Depostion (wash out):
namelist options in atm_in (wetdep_inparm)
gas_wetdep_list = list of species
gas_wetdep_method =
'NEU' (J Neu's scheme)
'MOZ' (MOZART scheme)

**Available Chemistry Mechanisms for CESM CAM-Chem:**

- MOZART4 Chemistry: trop_mozart (103 species) including HCN,$CH_3CH$ + $C_2H_2$, HCOOH
- MOZART4 trop-start mozart (122 species) including stratospheric heterogeneous reactions
- MOZART4 +mam 4 additional reactions on aerosols
- MAM get information from the Chemistry (SO2, DMS, H2SO4) to calculate the aerosol modes. If chemistry is not included, these values are prescribed using a climatology.
- Superfast Chemistry (15 species)

**Available Chemistry Mechanisms for CESM WACCM:**

- Standard WACCM chemistry: waccm_mozart (59 species) for stratospheric chemistry
- Specified Chemistry, SC-WACCM: waccm_ghg (5 species): CH4, N2O, CFC11, CFC12, & H2O for use with prescribed stratospheric ozone
- WACCM with sulfur chemistry: waccm_mozart_sulfur (66 species) adds 7 sulfur-bearing gases, including OCS, to the standard WACCM chemistry, for use with the CARMA sulfate model
- WACCM with modal aerosols: waccm_mozart_mam3 (78 species) for use with WACCM5 (under development)

**Additional input files for default chemical mechanisms are in each source code subdirectory for mechanisms under $CCSMROOT/models/atm/cam/src/chemistry/pp_* (i.e. pp_waccm_mozart)**

**Emissions: Default path on Yellowstone:** /glade/p/cesm/cseg/inputdata/atm/cam/chem/emis

**For trop_mozart (MOZART-4):**

MOZART-4 standard emissions (Emmons et al., GMD, 2010)
/glade/p/cesm/cseg/inputdata/atm/cam/chem/emis/1992-2010/

Default for offline model runs:
–Anthropogenic: POET, with REAS over Asia (time-varying for 1997-2010; 1997 used for 1992-1996).
–Biomass burning: GFED-v2 - 1992-1996: avg of 1999-2007; 1997-2008: for each year/month; 2009-2010: FINN.
–Biogenic, soil, ocean, volcano: POET, GEIA,

Species emitted for standard mozart-4 chemistry:
NO, CO, C2H6, C2H4, C3H8, C3H6, BIGALK, BIGENE, TOLUENE
ISOP, C10H16, CH2O, CH3CHO, CH3OH, C2H5OH, CH3COCH3, MEK
CB1, CB2, OC1, OC2, SO2, DMS, NH3, HCN, CH3CN, C2H2, HCOOH

If running with FINN fire emissions, also have:
NO2, BIGALD, CH3COCHO, CH3COOH, CRESOL, GLYALD, HYAC, MACR, MVK

Improved Climatology for the Stratosphere based on IPCC model runs based on WACCM
($O_3$, NOy, $CH_4$, CO)

ACCMIP and RCPs, speciated for trop_mozart:
/glade/p/cesm/cseg/inputdata/atm/cam/chem
1850-2000_emis
2000-2100_RCP45
2000-2100_RCP85

If running with MEGAN, must create emissions files for all MEGAN species, with the biogenic emissions removed (if have other types, such as bb).

Aircraft emissions (time-dependent, 3D, for NO, CO, SO2, BC, etc.):
/glade/p/cesm/cseg/inputdata/atm/cam/chem/emis/

**For MAM surface and external forcings:**
/glade/p/cesm/cseg/inputdata/atm/cam/chem/trop_mozart_aero/emis/

**Available Meteorological Datasets: (ESG)**
the location is:
http://www.earthsystemgrid.org/browse/viewDataset.htm?datasetId=f9a382be-53c5-11e0-80e4-00c0f03d5b7c

for MERRA, and
http://www.earthsystemgrid.org/browse/viewDataset.htm?datasetId=9d662678-4e5c-11e0-80e4-00c0f03d5b7c

GEOS5: 1.9x2.5, 0.5x0.6 2004-present
MERRA: 1.9x2.5 0.5x06, 1979-present

On Yellowstone:
/glade/p/cesm/cseg/data_tmp/

| Compsets: CESM1.2.0 CAM-Chem, grid:1.9x2.5 | Model (phys)/ radiation/grid | Chemistry | Components / Meteorology |
|---|---|---|---|
| **CAM4, static ocean:** | CAM4, active | | **Full ocn/ice, CLM4.0** |
| B_2000_TROP_MOZART (BMOZ) | **f19_g16** | trop_mozart | +MEGAN |
| B_2000_MOZSOA (BMOZSOA) | | +soa chemistry | **data ocn/ice** |
| F_2000_TROP_MOZART (FMOZ) | | trop_mozart, soa | +MEGAN |
| F_2000_MOZSOA (FMOZSOA) | **f19_f19** | trop_mozart, soa | +MEGAN |
| F2000_C4SSOA_L40 (FSOA) | | trop/strat soa | +MEGAN |
| **CAM4, specified dynamics:** | CAM4, passive | | **transient data ocn/ice,** |
| FGEOS_C4BAM_L40CN (FSDBAM) | **f19_f19** | trop_bam | **CLM4.0/CN, GEOS5** |
| FGEOS_C4MOZ_L40CN (FSDCHM) | | trop_mozart | |
| **CAM5, static ocean:** | CAM5, active | | **Full ocn/ice CLM4.0/** |
| B_2000_MOZMAM_CN (BMOZMAM) | **f19_g16** | trop_mozart,mam | **CN** |
| B_2000_STRATMAM3_CN (BSTRATMAM3) | | trop/strat mam | |
| B_2000_STRATMAM7_CN | | trop/strat mam7 | |
| F_2000_MOZMAM_CN (FMOZMAM) | | trop mam | **data ocn/ice,** |
| F_2000_STRATMAM3_CN | **f19_f19** | trop/strat mam | **CLM4.0_CN** |
| F_2000_STRATMAM7_CN | | trop/strat mam7 | |
| **CAM4 superfast chemistry** | CAM4, active | **super_fast_llnl** | **MEGAN VOC** |
| B_2000_CN_CHEM (B2000CNCHM) | **f19_g16** | | **CLM4.0/CN** |
| B_1850_CN_CHEM (B1850CNCHM) | | | transient full ocn/ice |
| B_1850-2000_CN_CHEM (B20TRCNCHM) | | | |
| F_1850_CN_CHEM (F1850CNCHM) | **f19_f19** | | static full ocn/ice |

| CESM1.2.0(WACCM) Compsets | Supported Grids | Components / Meteorology |
|---|---|---|
| **Full ocean, static:** | **f19_g16** | **CLM4.0/CN** |
| B_1850_WACCM_CN (B1850WCN) | | pre-industrial |
| B_2000_WACCM_CN (BWCN) | | present day |
| **Full ocean, transient:** | **f19_g16** | **CLM4.0/CN** |
| B_1850-2005_WACCM_CN (B20TRWCN) | | annual solar variability |
| B_1955-2005_WACCM_CN (B55TRWCN) | | daily solar variability |
| B_RCP2.6_WACCM_CN (BRCP26WCN) | | daily solar variability |
| B_RCP4.5_WACCM_CN (BRCP45WCN) | | daily solar variability |
| B_RCP8.5_WACCM_CN (BRCP85WCN) | | daily solar variability |
| **Data ocean, static:** | **f19_f19, f45_f45** | **CLM4.0** |
| F_1850_WACCM (F1850W) | | pre-industrial |
| F_2000_WACCM (FW) | | present day |
| F_2000_WACCM_SC (FWSC) | | specified chemistry |
| F_2000_WACCMX (FWX) | | thermosphere extension, solar max |
| F_1996_WACCMX (FWX1996) | | thermosphere extension, solar min |
| **Data ocean, transient:** | **f19_f19, f45_f45** | **CLM4.0/CN, daily solar variability** |
| F_1955-2005_WACCM_CN (F55WCN) | | |
| FGEOS_C4WCM_L40CN (FSDW) | | GEOS5 nudging |