CESM Community Earth System Model

- **Atmosphere Models**
  - Community Atmosphere Model (CAM5)
  - Climatological Data Model (DATM)

- **Ocean Models**
  - Parallel Ocean Program (POP2)
  - Climatological/Slab-Ocean Data Model (DOCN)

- **Land Models**
  - Community Land Model (CLM4)
  - Climatological Data Model (DLND)

- **Sea Ice Models**
  - Community Ice CodE (CICE4)
  - Climatological Ice Model (DICE)

- **Land Ice Models**
  - Community Ice Sheet Model (Glimmer - CISM)

- **CESM Coupler**
  - CESM Coupler (CPL7)
<table>
<thead>
<tr>
<th>MODEL</th>
<th>Meteorological Fields</th>
<th>Tracer Advection</th>
<th>Aerosol Scheme</th>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAM4 fully coupled to ocean, land, ice model</td>
<td>Fully-interactive, i.e., dynamics consistent with model derived: O$_3$, CO$_2$, CH$_4$, N$_2$O, H$_2$O, CFC-11, CFC-12, O$_2$, NO Nudged by Meteorological Fields</td>
<td>Flux Form Finite Volume (Lin, 2004)</td>
<td>Aerosol bulk model Simulates aerosol heating</td>
<td>Tropospheric Chemistry 103 species</td>
</tr>
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<td>CAM SD (specified dynamics)</td>
<td>Flux Form Finite Volume (Lin, 2004)</td>
<td>Aerosol bulk model Simulates aerosol heating</td>
<td>Modal Aerosol Model</td>
<td>Stratospheric Chemistry additional 20 species</td>
</tr>
<tr>
<td></td>
<td>Resolution Horizontal: 1.9° x 2.5 0.9° x 1.25° Spectral Element Core</td>
<td></td>
<td></td>
<td>Or prescribed chemistry</td>
</tr>
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<td></td>
<td>Modal Aerosol Model</td>
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</tr>
</tbody>
</table>
Running CAMchem

➢ Available Component Sets
➢ Setup of the Simulation
➢ Changes to the Simulation
<table>
<thead>
<tr>
<th>Compsets</th>
<th>Model (phys)/radiation</th>
<th>Chemistry</th>
<th>Components /Meteorology</th>
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<tr>
<td>B_2000_TROP MOZART (BMOZ)</td>
<td>CAM4, active</td>
<td>trop_mozart</td>
<td>All active</td>
</tr>
<tr>
<td>F_2000_TROP MOZART (FMOZ)</td>
<td>CAM4, passive</td>
<td>trop_mozart</td>
<td>Prescr. ocn/ice, CLM dry dep</td>
</tr>
<tr>
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<td>trop_mozart</td>
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</tr>
<tr>
<td>F_SD_BAM (FSDBAM)</td>
<td>CAM4, passive</td>
<td>trop_bam</td>
<td>offline: GEOS5 (56lev)</td>
</tr>
<tr>
<td>F_TROP_STRAT_CHEM</td>
<td>CAM4, passive</td>
<td>trop/strat_mozart</td>
<td>Prescr. ocn/ice, clm dry dep</td>
</tr>
<tr>
<td>B_2000_CN CHEM (B2000CNCHM)</td>
<td>CAM4, active</td>
<td>super_fast_llnl</td>
<td>MEGAN VOC emis CLM dry dep, land nitrogen cycle</td>
</tr>
<tr>
<td>B_1850_CN CHEM (B1850CNCHM)</td>
<td></td>
<td></td>
<td></td>
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<td>B_2000_TROP_MOZART (BMOZ) F_2000_TROP_MOZART (FMOZ)</td>
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<td>Prescr. ocn/ice, clm dry dep, offline: GEOS5 (56lev)</td>
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<td>B_1850_CAM5 (B1850C5) B_1850-2000_CAM5 (B20TRC5) E_1850_CAM5 (E1850C5) F_AMIP_CAM5 (FAMIPC5) F_1850_CAM5 (F1850C5) F_2000_CAM5 (FC5)</td>
<td>CAM5, active</td>
<td>MAM</td>
<td></td>
</tr>
</tbody>
</table>
Chemistry/ Datasets

MOZART4 Chemistry: trop_mozart (103 species)
Including HCN, CH₃CH + C₂H₂, HCOOH

Strat_mozart Chemistry: trop_mozart + about 20 more species and reactions in the stratosphere
Including heterogeneous reactions

Emissions in trop_mozart for the past (Louisa Emmons)
- Biogenic, soil, ocean, volcano: POET, GEIA, etc. as described in Emmons et al., 2010.

Emissions in trop_mozart for RCP 4.5 scenario (Maria Val Martin)
MEGAN VOC emissions
Chemistry/ Datasets

Improved Climatology for the Stratosphere ($O_3$, NOy, CH$_4$, CO)
Time dependent 3D chemistry sources aircraft emissions

Meteorological Dataset (ESG)
- GEOS5: 1.9x2.5, 0.5x0.6  2004-present
- MERRA: 1.9x2.5 0.5x06, 1979-present

Depositions schemes

gas_wetdep_method =
- 'NEU' (J Neu's scheme)
- 'MOZ' (MOZART scheme)
Setup of a Simulation

Run the model out of the box (using an existing Compset)

- Create a new case called `<case_name>`:
  - `CESM_ROOT = (/glade/proj3/cseg/collections/cesm1_0_3)`
    Go to your model directory `CESM_ROOT`, then `cd scripts` and invoke:
    ```
    create_newcase -case $HOME/<case_name>
    -res f19_f19 (1.9x2.5)
    -compset COMPSET
    -mach bluefire (change ‘bluefire’ 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 `<home_dir>` (below, `<case_dir> is `<home_dir>/<case_name>`)
Setup of a Simulation

Modification to the Simulation: in your $HOME

• env_conf.xml, env_build.xml, env_run.xml, env_case.xml, env_mach_pers.xml

• *.run to change run specific parameters (length per segment, account number)

• Changes to the model scripts: Source Mods
Setup of a Simulation

Run the model out of the box (using an existing Compset)

- Create a new case called <case_name>:
  - CESM_ROOT = (/glade/proj3/cseg/collections/)
    Go to your model directory CESM_ROOT, then cd scripts and invoke:
    ```
    create_newcase -case $HOME/<case_name>
    -res f19_f19  (1.9x2.5)
    -compset $COMPSET
    -mach bluefire  (change ‘bluefire’ to your computer name)
    -skip_rundb
    ```
    f19_f19: data ocean (finite volume of the atmosphere); f19_g16: active ocean
  - A new directory <case_name> is created in your <home_dir> (below, <case_dir> is <home_dir>/<case_name>)

- Configure the case, in <case_dir>: configure --case

- Build the model: ./*.build file

- Run the model: bsub < ./*.run (or ./*.submit) for bluefire
  - model output is in <run_dir>: /ptmp/<username>/<case_name>/run
  - namelist that was used for run in <run_dir>/atm_in

- Archiving:
  - short-term archiving in /ptmp/<username>/archive
  - long-term archiving on the mass store
Setup of a Simulation

Information of my simulation (don’t change those):

- `<case_dir>/CaseStatus` model setup and history of simulations
- `<case_dir>/CaseDocs/atm_in` namelist for atmospheric components
Setup of a Simulation

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

- ***.run** to change run specific parameters (length per segment, account number)

- **env_run.xml**: change run specifications, run time, output, restart etc.,
  - CONTINUE_RUN: needs to be set to TRUE to continue a run
  - 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
  - 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

- **after these changes you can just resubmit the run**
Changes to the Simulation

Modification to the namelist (f.ex. model output, emission, met field) (http://www.cesm.ucar.edu/cgi-bin/eaton/namelist/nldef2html-pub)

• open empty user_nl_cam in your <case_dir>,
• edit user_nl_cam in your <case_dir> from atm_in file
  • fincl …
  • ncdata: initial condition file
  • met_data_file, met_data_path (meteorology)
  • bnd_topo (boundary conditions for offline model runs)
  • srf_emisSpecifier (emissions)
  • srf_emis_type = ‘CYCLICAL’; srf_emis_cycle_yr = 2000
  • for SERIAL ‘srf_emis_cycle_yr’ this is not allowed
  • srf_emis_type = ‘FIXED’; srf_emis_fixed_ymd = 20000101
  • nudging

• &satellite_options_nl: sathist_fincl, sathist_hfilename_spec, sathist_track_infile
• configure –clean_namelist to unlock env_conf.xml
• configure –case in your <case_dir> (you do not need to rebuild the model)
• run the model
Changes to the Simulation

Modification of your output in the namelist
The default history file from CAM is a monthly average.

**nhtfrq**: change the output frequency
- If **nhtfrq**=0, the file will be a monthly average
- If **nhtfrq**>0, frequency is input as number of timesteps.
- If **nhtfrq**<0, frequency is input as number of hours.

**mfilt**: change timestep in the history file
- **mfilt** = 1 one time sample on each history file (monthly averages)
- **avgflag_pertape** = ‘A’,’I’ average or instantaneous output

**fincl1-6**: customize your CAM history files:
*The file “h0” contains the default variables (in the code: “call add_default”). This includes the variables necessary for the AMWG package.*
*For the files “h1” to “h5”, the user has to specify the variables to output.*
Changes to the Simulation

Modification to your configuration: env_conf.xml

• edit env_conf.xml in your <case_dir>
  • RUN_STARTDATE: change start date of the simulation
    (including possible changes to the namelist)
  • CAM_CONFIG_OPTS:
    • change vertical levels (-offline_dyn –lev nn)
    • modify chemical mechanism (-usr_mech_infile)

• configure –cleanall to unlock env_conf.xml
• configure –case in your <case_dir>
• rebuild the model
• run the model
Changes to the Simulation

Modification of your calendar option: GREGORIAN/ NO_LEAP

- edit `env_run.xml`
  - change CALENDAR value = “NO_LEAP” to “GREGORIAN”
  - default for SD model runs is “GREGORIAN”, else it is “NO_LEAP”

- edit `env_build.xml` in your `<case_dir>`
  - calendar option: set USE_ESMF_LIB to TRUE
  - invoke *.clean_build
  - build your model again: invoke *.build
Latest Developments

• History sampling along observation tracks
  ➢ Satellite track (more than one dataset can be included)
  ➢ Aircraft flight path

• Local time averaging history output (C. Bardeen)
History sampling along observation tracks

Tracking file determines sequence of coordinates and time
- Uses nearest model time: maximum deviation from observation time is +/- half the time step of the current model time
- Uses nearest lon/lat model coordinate to the observed values

Horizontal grid distributed across MPI tasks

Output individual columns along the flight path

The corresponding model columns along the flight path are extracted and output in the same sequence as the input tracking file

Stream columns to Netcdf file
Local Time Averaging

Namelist settings:
avgflag_pertape = 'A','L'
fincl2 = 'Q','T','PS'
lcltod_start = 0,0
lcltod_stop = 0,7200