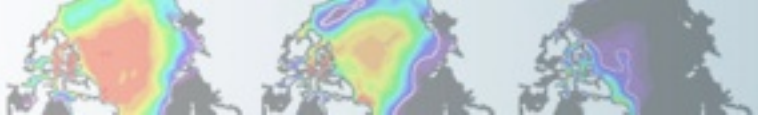

CESM-WACCM Tutorial

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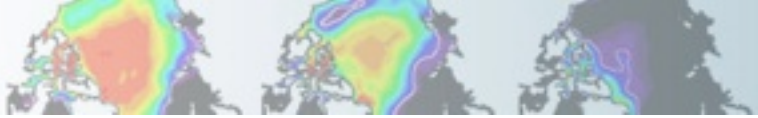
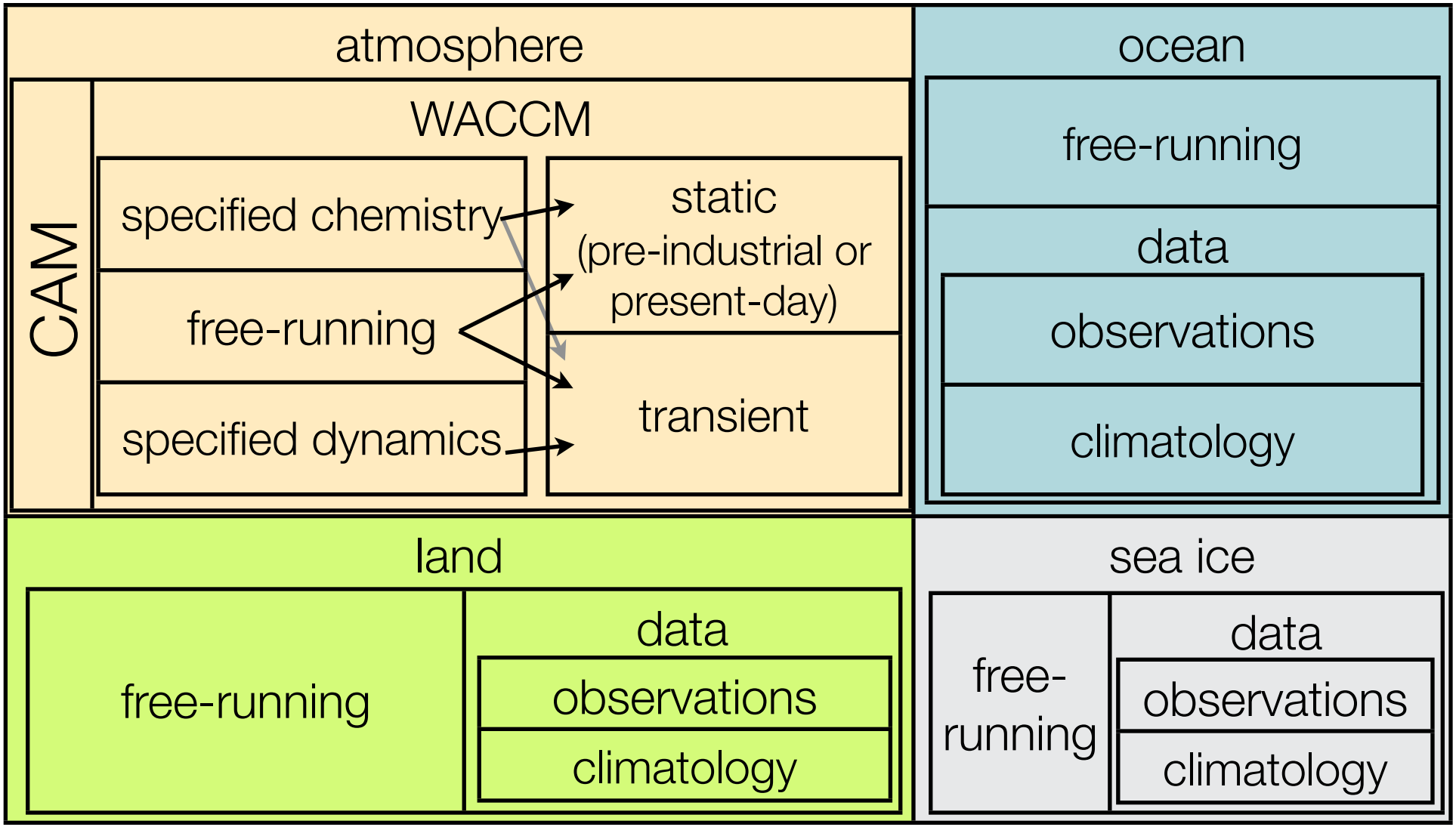


Outline

- CESM-WACCM component configurations
- Quickstart guide for present-day WACCM compset
- WACCM configurations and compsets
- How to change model output
- How to change a reaction rate
- How the solar spectrum is specified
- How to change a boundary condition
- How to change an initial condition
- Emissions at the surface and aloft
- Post-processing data analysis
- Validating CESM/WACCM
- WACCM customer support

CESM-WACCM component configurations



Quickstart guide for present-day WACCM compset

- Go to the scripts directory in your source code:

```
> cd $srcdir/scripts
```

- Review options for create_newcase command:

```
>create_newcase -list | less
  RESOLUTIONS:  name (shortname)
...
    1.9x2.5_1.9x2.5 (f19_f19)
    1.9x2.5_gx1v6 (f19_g16)
...
  COMPSETS:  name (shortname): description
...
    F_2000_WACCM (FW)
         Description: present-day cam/clm with prescribed ice/ocn
...
  MACHINES:  name (description)
    bluefire (NCAR IBM p6, os is AIX, 32 pes/node, batch system is LSF)
...
```

used with data ocean (F-compsets)

used with full ocean (B-compsets)

Quickstart guide for present-day WACCM compset

- create a new F_2000_WACCM case called “f.e10.FW.f19_f19.001” (see http://www.cgd.ucar.edu/cseg/run_case_naming_convention.html for case naming conventions):
  - `create_newcase -res f19_f19 -compset F_2000_WACCM -mach bluefire -case ~/cesm/case/f.e10.FW.f19_f19.001`
- go to your new case directory:
  - `cd ~/cesm/case/f.e10.FW.f19_f19.001`
- configure the case
  - `configure -case`
- create namelists for the atm, ocn, lnd, and ice components:
  - `./preview_namelists`
- namelists (atm_in, ice_in, lnd_in, docn_in) will appear in the CaseDocs subdirectory, as well as in your $rundir

Quickstart guide for present-day WACCM compset

- Check the newly generated namelist prior to build:

```
less CaseDocs/atm_in
&aerodep_flx_nl
 aerodep_flx_cycle_yr           = 2000
 aerodep_flx_datapath           = '/glade/proj3/cseg/inputdata/atm/cam/chem/trop_mozart_aero/aero'
 aerodep_flx_file               = 'aerosoldep_monthly_1849-2006_1.9x2.5_c090803.nc'
 aerodep_flx_specifier          = 'BCDEPWET', 'BCPHODRY', 'BCPHIDRY', 'OCDEPWET', 'OCPHODRY', 'OCPHIDRY',
'DSTX01DD', 'DSTX02DD',
  'DSTX03DD', 'DSTX04DD', 'DSTX01WD', 'DSTX02WD', 'DSTX03WD', 'DSTX04WD'
 aerodep_flx_type               = 'CYCLICAL'
/
&aerosol_nl
 soil_erod              = '/glade/proj3/cseg/inputdata/atm/cam/dst/dst_1.9x2.5_c090203.nc'
/
&aoa_tracers_nl
 aoa_tracers_flag               = .true.
/
&cam_inparm
 absems_data            = '/glade/proj3/cseg/inputdata/atm/cam/rad/abs_ems_factors_fastvx.c030508.nc'
 avgflag_pertape                = 'A'
 bnd_topo               = '/glade/proj3/cseg/inputdata/atm/cam/topo/USGS-gtopo30_1.9x2.5_remap_c050602.nc'
 dtime          = 1800
 efield_hflux_file              = '/glade/proj3/cseg/inputdata/atm/waccm/efld/coeff_hflux.dat'
 efield_lflux_file              = '/glade/proj3/cseg/inputdata/atm/waccm/efld/coeff_lflux.dat'
 efield_wei96_file              = '/glade/proj3/cseg/inputdata/atm/waccm/efld/wei96.cofcnts'
 fincl1         = 'AOA1', 'AOA2', 'BR', 'BRCL', 'BRO', 'BRONO2', 'CCL4', 'CF2CLBR', 'CF3BR', 'CFC11',
'CFC113', 'CFC12', 'CH2O',
  'CH3BR', 'CH3CCL3', 'CH3CL', 'CH3O2', 'CH3OOH', 'CH4', 'CL', 'CL2', 'CL2O2', 'CLDHGH', 'CLDLOW', 'CLDMED'
  'CLDTOT', 'CLO', 'CLONO2', 'CLOUD', 'CO', 'CO2', 'DTCOND', 'DTV', 'DUV', 'DVV', 'EKGWSPEC', 'FLNS', 'FLNS
```

See http://www.cesm.ucar.edu/models/cesm1.0/cam/ for links to CAM namelist definition page

Quickstart guide for present-day WACCM compset

- build the model:

```
*.build
```

- check the charge accounts and wall time in your run script:

```
less *.run
#! /bin/tcsh -f
#BSUB -n 256
#BSUB -R "span[ptile=64]"
#BSUB -q regular
#BSUB -B
#BSUB -N
#BSUB -x
#BSUB -a poe
#BSUB -o poe.stdout.%J
#BSUB -e poe.stderr.%J
#BSUB -J f.e11.FW.f19_f19.001
#BSUB -W 0:19
#BSUB -P 12345678
```

send email when job begins

send email when job ends

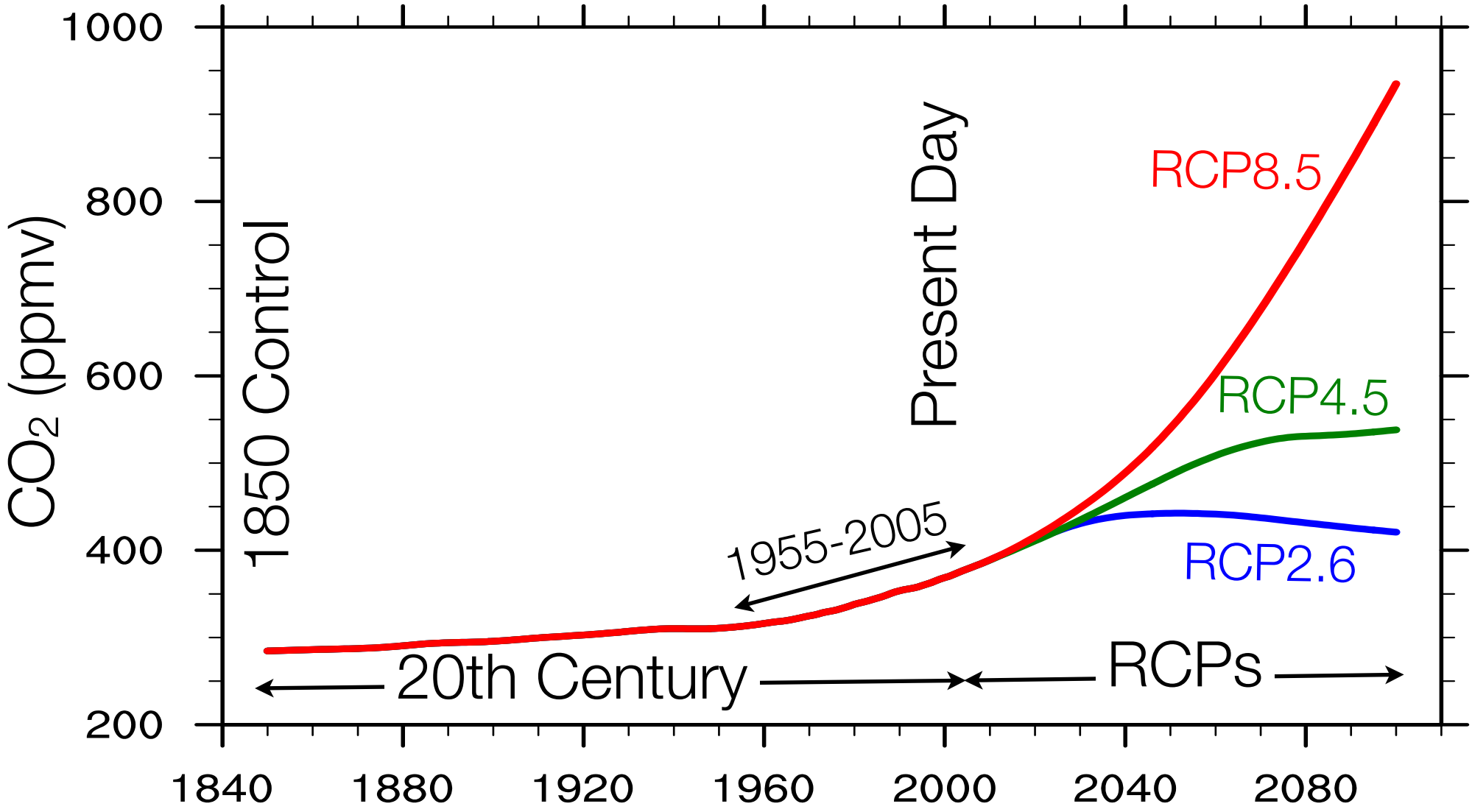
maximum wall time for job

charge account number

- submit the job to the batch queue (default 5-day run):

```
*.submit
```

Transient and static WACCM configurations



WACCM compsets with data ocean

- **F_1850_WACCM** (**F1850W**): Pre-industrial (perpetual year 1850AD)
- **F_1955-2005_WACCM_CN (F55WCN)**: 1955 to 2005 transient, with daily solar data and SPEs.
- **F_2000_WACCM** (**FW**): Present-day (perpetual year 2000AD). Scientifically validated at 1.9x2.5_1.9x2.5.
- **F_2000_WACCM_SC (FWSC)**: Specified chemistry, perpetual year 2000
- **F_SD_WACCM (FSDW)**: Specified dynamics
- **F_2000_WACCMX (FWX):** Present-day WACCM-X (thermosphere extension), constant solar max

WACCM compsets with fully coupled ocean

- **B_1850_WACCM** (short name **B1850W**): Pre-industrial (perpetual year 1850AD)
- **B_1850_WACCM_CN** (**B1850WCN**): Pre-industrial with carbon-nitrogen cycle in CLM. Scientifically validated at 1.9x2.5_gx1v6.
- **B_1850-2005_WACCM_CN** (**B20TRWCN**): 20th Century (1850-2005 transient) with carbon-nitrogen cycle in CLM. Scientifically validated at 1.9x2.5_gx1v6.
- **B_2000_WACCM_CN** (**BWCN**): Present-day (perpetual year 2000AD)
- **B_1955-2005_WACCM_CN** (**B55TRWCN**): 1955 to 2005 transient, with daily solar data and SPEs. Scientifically validated at 1.9x2.5_gx1v6.
- **RCP future scenarios**: 2005 to 2100 transient, with daily solar data and SPEs. Scientifically validated at 1.9x2.5_gx1v6.
  - **B_RCP2.6_WACCM_CN** (**BRCP26WCN**)
  - **B_RCP4.5_WACCM_CN** (**BRCP45WCN**)
  - **B_RCP8.5_WACCM_CN (BRCP85WCN)**

How do I change model output?

- Review list of current CAM history variables
  - Currently >2300 existing CAM history variables
  - Complete list is printed in atm.log.* file generated during each run in $rundir/run.
  - Search log file for "`MASTER FIELD LIST`" to review.

```
******* MASTER FIELD LIST *******
  1 US                    m/s
  2 VS                    m/s
  3 US&IC                 m/s
  4 VS&IC                 m/s
  5 PS&IC                 Pa
  6 T&IC                  K
  7 Q&IC                  kg/kg
  8 CLDLIQ&IC             kg/kg
  9 CLDICE&IC             kg/kg
 10 O3&IC                 kg/kg
 11 O&IC                  kg/kg
 12 O1D&IC                kg/kg
 13 O2&IC                 kg/kg
 14 O2_1S&IC              kg/kg
 15 O2_1D&IC              kg/kg
 16 N2O&IC                kg/kg
 17 N&IC                  kg/kg
 18 NO&IC                 kg/kg
 19 NO2&IC                kg/kg
 20 NO3&IC                kg/kg
 21 HNO3&IC               kg/kg
 22 HO2NO2&IC             kg/kg
 23 N2O5&IC               kg/kg
 24 CH4&IC                kg/kg
 25 CH3O2&IC              kg/kg
 26 CH3OOH&IC             kg/kg
 27 CH2O&IC               kg/kg
 28 CO&IC                 kg/kg
 29 H2&IC                 kg/kg
 30 H&IC                  kg/kg
 31 OH&IC                 kg/kg
 32 HO2&IC                kg/kg
 33 H2O2&IC               kg/kg
 34 CLY&IC                kg/kg
 35 BRY&IC                kg/kg
 36 CL&IC                 kg/kg
 37 CL2&IC                kg/kg
 38 CLO&IC                kg/kg
 39 OCLO&IC               kg/kg
 40 CL2O2&IC              kg/kg
 41 HCL&IC                kg/kg
 42 HOCL&IC               kg/kg
 43 CLONO2&IC             kg/kg
 44 BRCL&IC               kg/kg
 45 BR&IC                 kg/kg
 46 BRO&IC                kg/kg
 47 HBR&IC                kg/kg
 48 HOBR&IC               kg/kg
 49 BRONO2&IC             kg/kg
 50 CH3CL&IC              kg/kg
 51 CH3BR&IC              kg/kg
 52 CFC11&IC              kg/kg
 53 CFC12&IC              kg/kg
 54 CFC113&IC             kg/kg
 55 HCFC22&IC             kg/kg
 56 CCL4&IC               kg/kg
 57 CH3CCL3&IC            kg/kg
 58 CF3BR&IC              kg/kg
 59 CF2CLBR&IC            kg/kg
 60 CO2&IC                kg/kg
 61 N2p&IC                kg/kg
 62 O2p&IC                kg/kg
 63 Np&IC                 kg/kg
```

How do I change output of existing namelist variables?

- Create a user_nl_cam file in your $casedir:

```
avgflag_pertape   = 'A', 'I',  'I', 'A', 'A'
fincl1  = 'AOA1', 'AOA2', 'BR', 'BRCL', ...
fincl2  = 'PS', 'Z3', 'T', 'U', 'V', ...
fincl3  = 'PS:B', 'T:B', 'Z3:B', 'U:B', 'V:B', ...
fincl4  = 'PS', 'PSL', 'U', 'V', 'T', ...
fincl5  = 'MSKtem', 'PS', 'PSL', 'VTH2d', ...
fincl4lonlat = 10e_20n
fincl5lonlat = 10e:20e_15n:20n
mfilt   = 1,365,30,120,240
nhtfrq  = 0,-24,-24,-6,-3
```

- avgflag_pertape: averaging flag for all variables on history files (h0, h1, h2, etc.). Valid values are "A" (Average), "I" (Instantaneous), "X" (Maximum), "M" (Minimum), "B" (GMT 00:00:00 average), and "L" for local time history averaging.

- fincl1, fincl2, etc: list of variables added to default output on h0, h1, etc. Appended ":" sets averaging flag for the field.

- fexcl1, fexcl2, etc: list of variables excluded from default output on h0, h1, etc.

How do I change output of existing namelist variables?

- Create a user_nl_cam file in your $casedir:

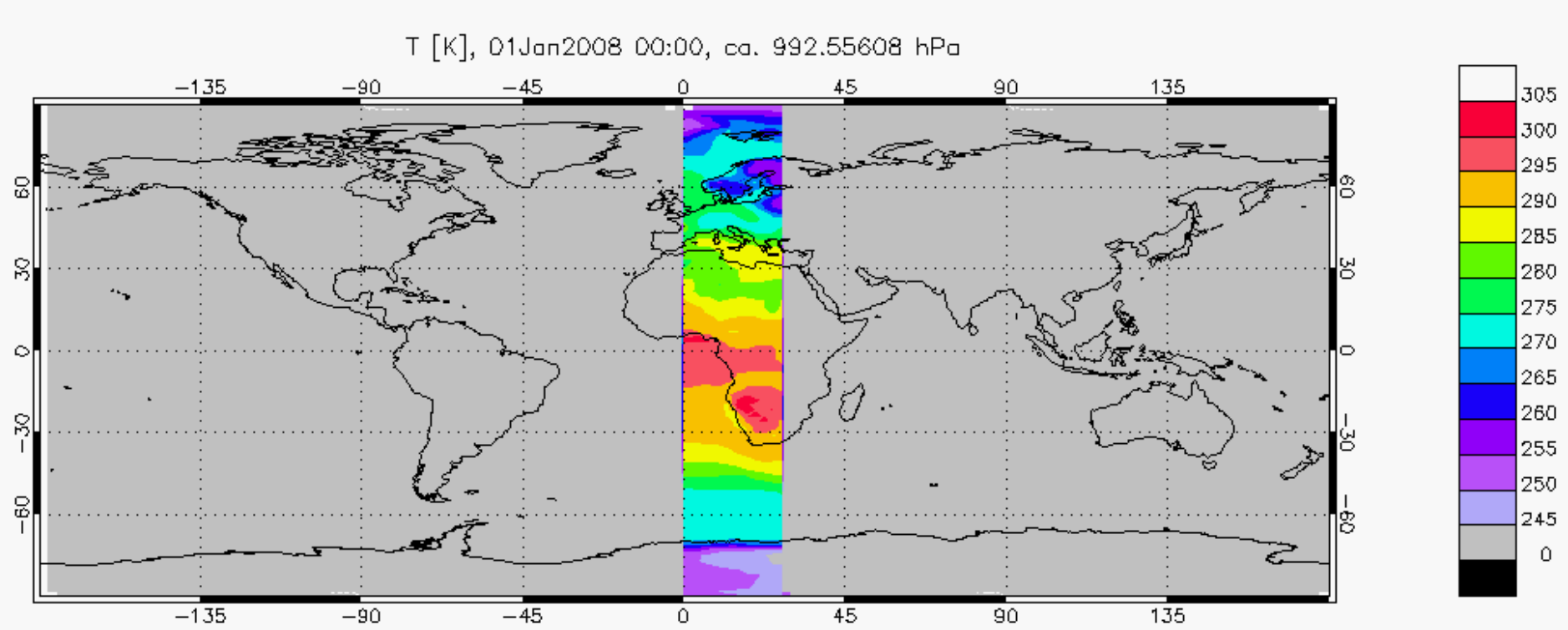
```
avgflag_pertape   = 'A', 'I',  'I', 'A', 'A'
fincl1  = 'AOA1', 'AOA2', 'BR', 'BRCL', ...
fincl2  = 'PS', 'Z3', 'T', 'U', 'V', ...
fincl3  = 'PS:B', 'T:B', 'Z3:B', 'U:B', 'V:B', ...
fincl4  = 'PS', 'PSL', 'U', 'V', 'T', ...
fincl5  = 'MSKtem', 'PS', 'PSL', 'VTH2d', ...
fincl4lonlat = 10e_20n
fincl5lonlat = 10e:20e_15n:20n
mfilt   = 1,365,30,120,240
nhtfrq  = 0,-24,-24,-6,-3
```

  - fincl[12345]lonlat: List of columns or contiguous columns at which the fincl[12345] fields will be output. '10e_20n' would pick the model column closest to 10°E longitude by 20°N latitude. '10e:20e_15n:20n' would select the model columns which fall with in the longitude range from 10-20°E and the latitude range from 15-20°N.
  - mfilt: maximum number of time samples written to h0, h1, etc.
  - nhtfrq: write frequencies for history files in timesteps (if positive) or hours (if negative). The h0 files may be monthly averages if nhtfrq(1) = 0.

Local time history averaging

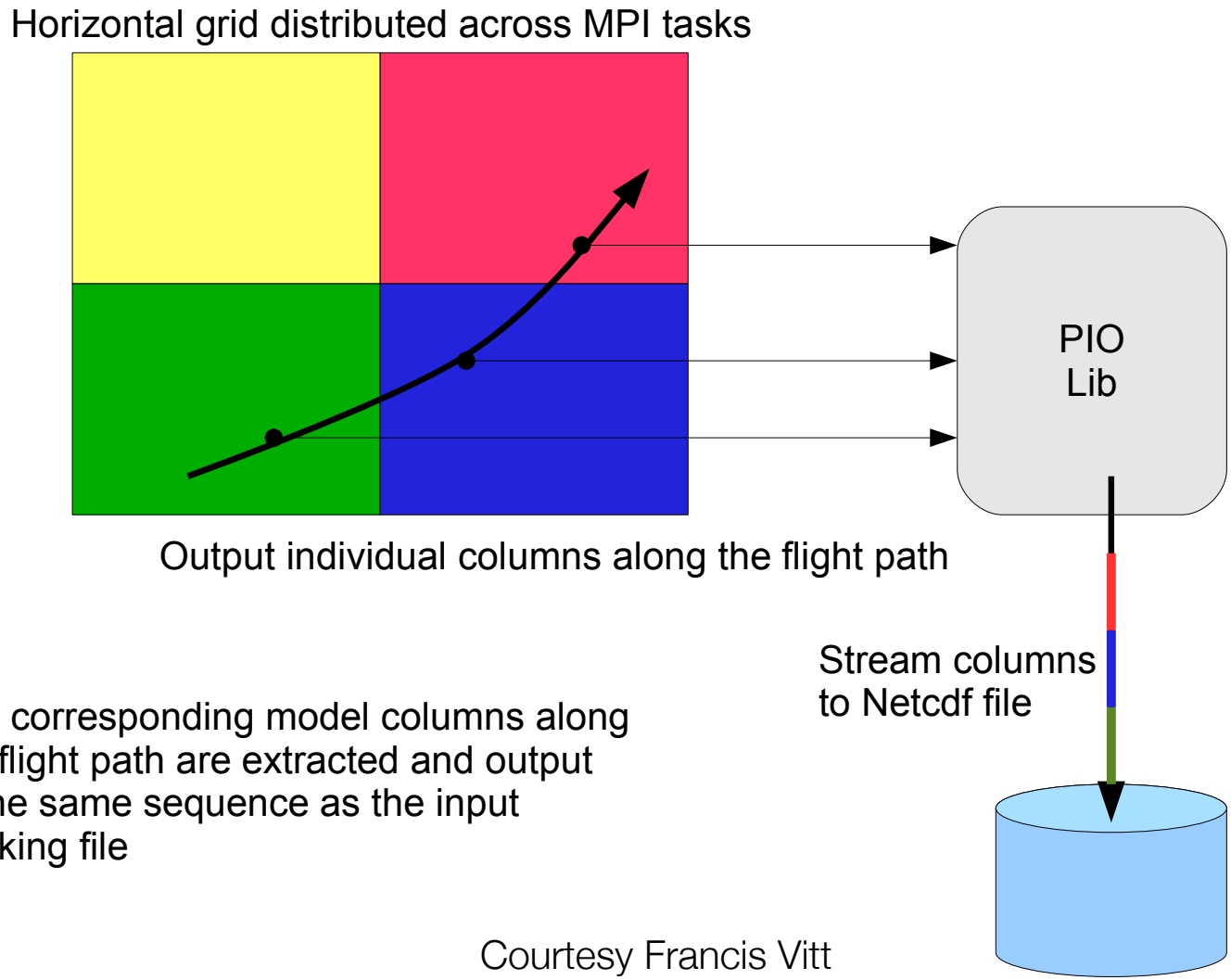
Namelist settings:

```
avgflag_pertape = 'A','L'
fincl2          = 'Q','T','PS'
lcltod_start    = 0,0
lcltod_stop     = 0,7200
```



History Column Sampling

- Sample the CAM history buffer along a specified path (satellite, aircraft)
- All history variables can be sampled
- At each timestep, output stream of model columns nearest to specified coordinates for +/- half a timestep in a sequence specified via a tracking file



Courtesy Francis Vitt

History Column Sampling

Namelist options:

```
sathist_fincl           = 'PS','Q','T','U','V','O3',...
sathist_track_infile    = '.../satellite_profilelist.nc'
sathist_mfilt           = 500000
sathist_hfilename_spec = '%c.cam2.sat.%y-%m-%d-%s.nc'
```

input file

output file format

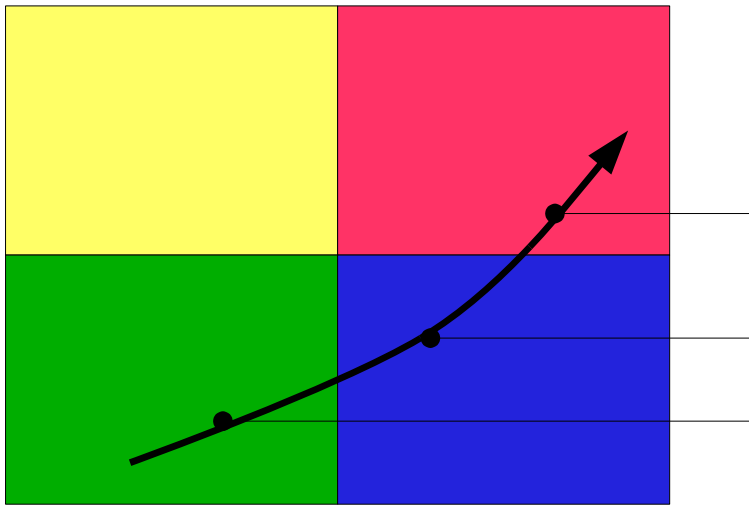
Tracking file:

profiles

```
Required variables:

    int time(profs) ;
        time:long_name = "time of day" ;
        time:units = "s" ;
    int date(profs) ;
        date:long_name = "date[yyyymmdd]" ;
        date:units = "yyyymmdd" ;
    float lat(profs) ;
        lat:long_name = "latitude" ;
        lat:units = "degrees" ;
    float lon(profs) ;
        lon:long_name = "longitude" ;
        lon:units = "degrees" ;
```

Horizontal grid distributed across MPI tasks



Courtesy Francis Vitt

How do I change output of existing namelist variables?

- Create a user_nl_cam file in your $casedir
- Generate a new namelist:

```
> cd $CASEROOT
> ./preview_namelists
```

- Check the newly generated namelist prior to rebuilding:

```
> cd $CASEROOT/CaseDocs
> less atm_in
```

```
&chem_inparm
 airpl_emis_file                  = '/fis/cgd/cseg/csm/inputdata/atm/cam/chem/trop_m
 clim_soilw_file                  = '/fis/cgd/cseg/csm/inputdata/atm/cam/chem/trop_m
 depvel_lnd_file                  = '/fis/cgd/cseg/csm/inputdata/atm/cam/chem/trop_m
 electron_file           = '/fis/cgd/cseg/csm/inputdata/atm/waccm/phot/electron.dat
 euvac_file              = '/fis/cgd/cseg/csm/inputdata/atm/waccm/phot/euvac.nc'
 euvacdat_file           = '/fis/cgd/cseg/csm/inputdata/atm/waccm/phot/euvac.dat'
 flbc_date               = 20000101
```

How do I create a new history variable?

- Modify source code to add calls to 2 routines governing history variables:
  - addfld: Add a field to the master field list. Called once at setup.
  - outfld: Accumulate (or take min, max, etc. as appropriate) input field into its history buffer for appropriate tapes. Called each timestep.
  - All modified routines go in `$CASEROOT/SourceMods/src.cam`
- Compile with modified source code:

```
> cd $CASEROOT
> $CASE.$MACH.build
```

How do I change a reaction rate?

- The **chemistry preprocessor**: generates CAM Fortran source code to solve chemistry.
- Input: a simple ASCII file listing chemical reactions and rates.
- Sample input files are in `$CCSMROOT/models/atm/cam/chem_proc/inputs`
- Input files for default chemical mechanisms are in each source code subdirectory for mechanisms under `$CCSMROOT/models/atm/cam/src/chemistry/pp_*` (i.e. `pp_waccm_mozart`)

```
 SPECIES
     Solution
O3, O, O1D -> O, O2, O2_1S -> O2, O2_1D -> O2, ...
     End Solution

     Fixed
M, N2
     End Fixed
 End SPECIES

     Col-int
O3 = 0.
O2 = 0.
     End Col-int

 Solution Classes
     Explicit
      CH4, N2O, CO, H2, CH3CL, CH3BR, CFC11, CFC12, ...
     End explicit
     Implicit
      O3, O, O1D, O2, O2_1S, O2_1D, ...
     End implicit
 End Solution Classes

 CHEMISTRY
     Photolysis
[jo2_a] O2 + hv -> O + O1D ...
     End Photolysis

     Reactions
 [cph1,cph] O + O3 -> 2*O2      ; 8e-12, -2060 ...
     End Reactions
END CHEMISTRY
```

Modifying the chemical preprocessor input file

- Temperature-independent rates: k [cm^3 $molec^{-1}$ s^{-1}]= a_0

```
O1D + H2O -> 2*OH                          ; 2.2e-10
```

- Arrhenius type: k = a_0 * exp(b_0/T), where b_0 = (-E/R)

a_0, b_0

```
O + O3 -> 2*O2                             ; 8e-12, -2060
```

- Troe rate constant: k = α^x / (1 - β^2), where:

  $\alpha = k_0 * M / k_\infty$, $\beta = \log_{10}(\alpha)$, M= air density (molec cm^{-3}), T = temperature (K)

  $k_0 = a_0 * (300/T)^{**} a_1$, $k_\infty = b_0 * (300/T)^{**} b_1$, x= "exponential factor"

```
CH3CO3 + NO2 + M -> PAN + M          ; 8.5e-29, 6.5, 1.1e-11, 1., .6
```

a_0, a_1, b_0, b_1, x

- User-specified reaction rate:

```
[usr_O_O2] O + O2 + M -> O3 + M
```

rate defined in routine `mo_usrrxt.F90`

User-specified reaction rates

```
[usr_O_O2] O + O2 + M -> O3 + M
```

rate defined in routine `mo_usrrxt.F90`:

```
!-----------------------------------------------------------------
!       ... o + o2 + m --> o3 + m
!-----------------------------------------------------------------
    level_loop : do k = 1,pver
       tinv(:)            = 1._r8 / temp(:ncol,k)
       tp(:)              = 300._r8 * tinv(:)
       sqrt_t(:)          = sqrt( temp(:ncol,k) )
       if( usr_O_O2_ndx > 0 ) then
          rxt(:,k,usr_O_O2_ndx) = 6.e-34_r8 * tp(:)**2.4_r8
       end if
       if( usr_OA_O2_ndx > 0 ) then
          rxt(:,k,usr_OA_O2_ndx) = 6.e-34_r8 * tp(:)**2.4_r8
       end if
```

Building the model with new chemistry

- Copy a sample preprocessor input file to the case directory and edit it:

```
> cd $CASEROOT
> cp $CCSMROOT/models/atm/cam/src/chemistry/pp_waccm_mozart/chem_mech.in my_waccm_mech.in
> nedit my_waccm_mech.in &
```

- Edit the file `env_conf.xml` in the case directory to add the CAM configure option `-usr_mech_infile` pointing to the new preprocessor input file:

```
<!--"CAM configure options, see CAM configure utility for details (char)" -->
<entry id="CAM_CONFIG_OPTS"   value="-phys cam4 -chem waccm_mozart
-usr_mech_infile $CASEROOT/my_waccm_mech.in"  />
```

- Reconfigure:

```
> configure -cleanall
> configure -case
```

How is the solar spectrum specified?

- Namelist variables point to 2 files specifying solar forcing
  - `solar_parms_file`: F10.7, K_p, A_p
    - solar and geomagnetic parameters used for aurora, UBCs, and wavelengths shorter than Lyman-α

```
> grep solar_parms_file CaseDocs/atm_in
 solar_parms_file = '/fis/cgd/cseg/csm/inputdata/atm/waccm/phot/wa_smax_c100517.nc'
```

  - `solar_data_file`: tsi, ssi, tsi_ref, ssi_ref
    - Covers wavelengths longer than Lyman-α
    - Time-variation of total solar irradiance, as well as variability with λ

```
> grep solar_data_file CaseDocs/atm_in
 solar_data_file = '/fis/cgd/cseg/csm/inputdata/atm/cam/solar/
spectral_irradiance_Lean_1610-2009_ann_c100405.nc'
```

- `solar_parms_file`: F10.7, K_p, A_p

```
> ncdump /fis/cgd/cseg/csm/inputdata/atm/waccm/phot/wa_smax_c100517.nc
netcdf wa_smax_c100517 {
dimensions:
        time = UNLIMITED ; // (2 currently)
variables:
        float f107(time) ;
                f107:long_name = "10.7 cm solar radio flux (F10.7)" ;
                f107:units = "10^-22 W m^-2 Hz^-1" ;
        float f107a(time) ;
                f107a:long_name = "81-day centered mean of 10.7 cm solar radio flux (F10.7)" ;
        float kp(time) ;
                kp:long_name = "Daily planetary K index" ;
        short ap(time) ;
                ap:long_name = "Daily planetary a index" ;
                ap:units = "nanoTeslas" ;
        short isn(time) ;
                isn:long_name = "International Sunspot Number" ;
        int date(time) ;
                date:long_name = "current date (YYYYMMDD)" ;
data:
 f107 = 210, 210 ;
 f107a = 210, 210 ;
 kp = 4, 4 ;
 ap = 27, 27 ;
 isn = 0, 0 ;
 date = 101, 22000101 ;
}
```

List of dates between which other data are interpolated

- `solar_data_file`: tsi, ssi, tsi_ref, ssi_ref

- Data are given as a function of time (i.e. annually or daily) and wavelength
- tsi (time): total solar irradiance (W m^{-2})
- ssi (time, wavelength): solar spectral irradiance (mW m^{-2} nm^{-1})
- tsi_ref, ssi_ref: values for tsi and ssi averaged over the reference time period of years 1834-1867 (solar cycles 8-10).

```
netcdf spectral_irradiance_Lean_1610-2009_ann_c100405 {
dimensions:
        time = UNLIMITED ; // (400 currently)
        ref_time_bound = 2 ;
        wavelength = 3780 ;
variables:
        double tsi_ref ;
                tsi_ref:time_op = "average" ;
                tsi_ref:bounds = "ref_time_bound" ;
                tsi_ref:long_name = "average of tsi over ref_time_bound i
                tsi_ref:units = "W/m^2" ;
                tsi_ref:average_op_ncl = "dim_avg over dimension: time" ;
        double ref_time_bound(ref_time_bound) ;
                ref_time_bound:units = "days since 0000-01-01 00:00:00" ;
                ref_time_bound:long_name = "reference time interval bound
        int date(time) ;
                date:format = "YYYYMMDD" ;
        double time(time) ;
                time:calendar = "noleap" ;
                time:axis = "T" ;
                time:time_origin = "01-JAN-0000" ;
                time:units = "days since 0000-01-01 00:00:00" ;
        double wavelength(wavelength) ;
                wavelength:units = "nm" ;
                wavelength:long_name = "Wavelength of band center" ;
        double band_width(wavelength) ;
                band_width:units = "nm" ;
                band_width:long_name = "Wavelength width of band" ;
        double ssi_ref(wavelength) ;
                ssi_ref:time_op = "average" ;
                ssi_ref:bounds = "ref_time_bound" ;
                ssi_ref:long_name = "average of ssi over ref_time_bound i
                ssi_ref:units = "mW/m^2/nm" ;
                ssi_ref:average_op_ncl = "dim_avg over dimension: time" ;
        double tsi(time) ;
                tsi:units = "W/m^2" ;
                tsi:long_name = "Total Solar Irradiance at 1 a.u." ;
        double ssi(time, wavelength) ;
                ssi:units = "mW/m^2/nm" ;
                ssi:long_name = "Solar Spectral Irradiance at 1 a.u." ;
```

How do I change a boundary condition?

- Find an existing boundary condition file (LBC or UBC):

```
> grep lbc CaseDocs/atm_in
 flbc_date = 20000101
 flbc_file = '/path/to/inputdata/atm/waccm/lb/LBC_1765-2005_1.9x2.5.nc'
 flbc_list = 'N2O', 'HCFC22', 'H2', 'CO2', 'CH4', 'CH3CL', 'CH3CCL3', ...
 flbc_type = 'CYCLICAL'
> cd /path/to/inputdata/atm/waccm/lb
```

- Modify the existing netCDF BC data file (via NCL, NCO, IDL) to produce a new one:

```
> ncap -O  -s "CO2=CO2*0.833"  $infile $outfile

> ncatted -a units,CO2,o,c,"kg/kg" $outfile
```

- Change `flbc_file` or the appropriate `ubc_file` in your namelist to point your new file

How do I change an initial condition?

- Copy an existing initial condition file:

```
> grep ncdata CaseDocs/atm_in
 ncdata='/path/to/inputdata/atm/waccm/ic/icfile.cam2.i.2000-01-01-00000.nc'

> cd /path/to/inputdata/atm/waccm/ic
```

- Modify the existing netCDF input data file (via NCL, NCO, IDL) to produce a new one:

```
> ncap -O  -s "CO2=CO2*0.833"  $infile $outfile

> ncatted -a units,CO2,o,c,"kg/kg" $outfile
```

- Change `nc_data` in your namelist to point your new file
- Run as an initial run

Emissions at the surface and aloft

- Emissions are set from files defined in the namelist
  - Surface emissions:

```
 srf_emis_cycle_yr                = 2000
 srf_emis_specifier               = 'CH2O -> /glade/proj3/cseg/inputdata/atm/cam/
chem/1850-2000_emis/IPCC_emissions_houw_CH2O_1850-2000_1.9x2.5.c09
 srf_emis_type                    = 'CYCLICAL'
```

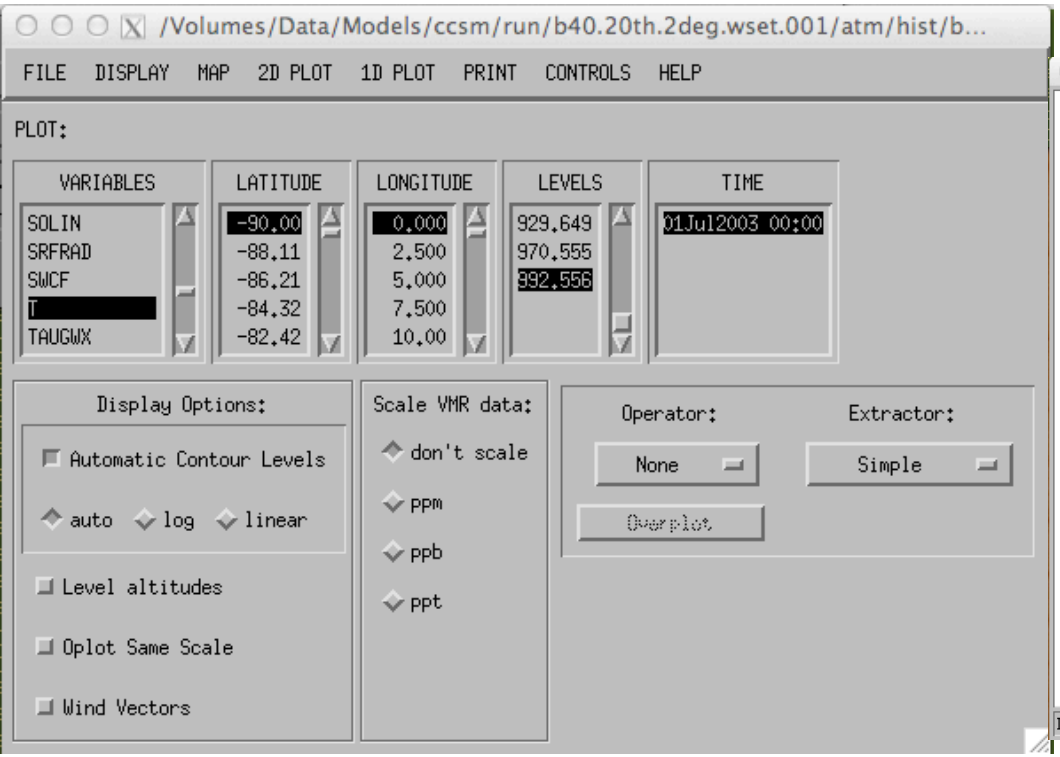
  - 3D emissions (i.e. aircraft):

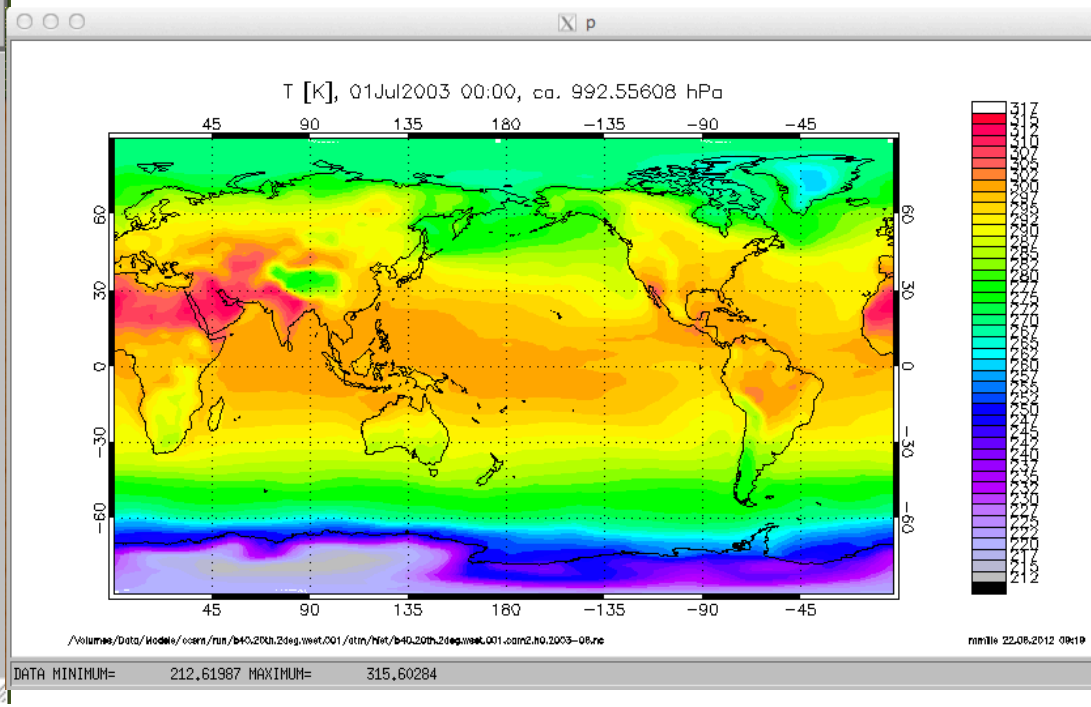
```
 ext_frc_cycle_yr                 = 1999
 ext_frc_specifier                = 'CO      -> /glade/proj3/cseg/inputdata/atm/cam/
chem/trop_mozart/emis/extfrc.CO.1.9x2.5_c101206.nc',
   'NO      -> /glade/proj3/cseg/inputdata/atm/cam/chem/trop_mozart/emis/extfrc.NO.
1.9x2.5_c101206.nc'
 ext_frc_type           = 'CYCLICAL'
```

- `srf_emis_type` and `ext_frc_type` may be set to
  - `'FIXED'`: no time variability
  - `'CYCLICAL'`: repeating an annual seasonal cycle
  - `'SERIAL'` : interpolate linearly between dates
  - `'INTERP_MISSING_MONTHS'`: interpolate between years, preserving the seasonal cycle

Post-processing data analysis

- CESM history files are in standard netCDF format, and may be analyzed with standard analysis tools, including Matlab, IDL, NCL, and NCO.
- GEOV is an IDL-based viewer for geophysical history files created by NCAR's CAM, WACCM and MOZART models. GEOV can be downloaded from the WACCM webpage (http://www.cesm.ucar.edu/working_groups/WACCM/).





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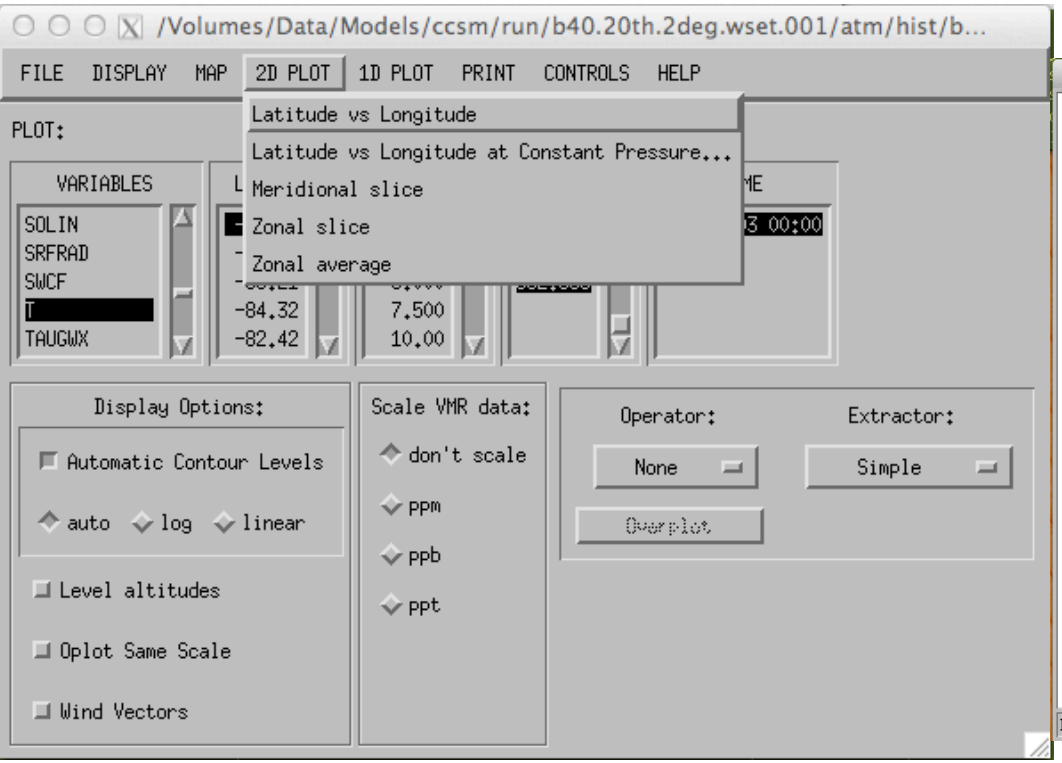
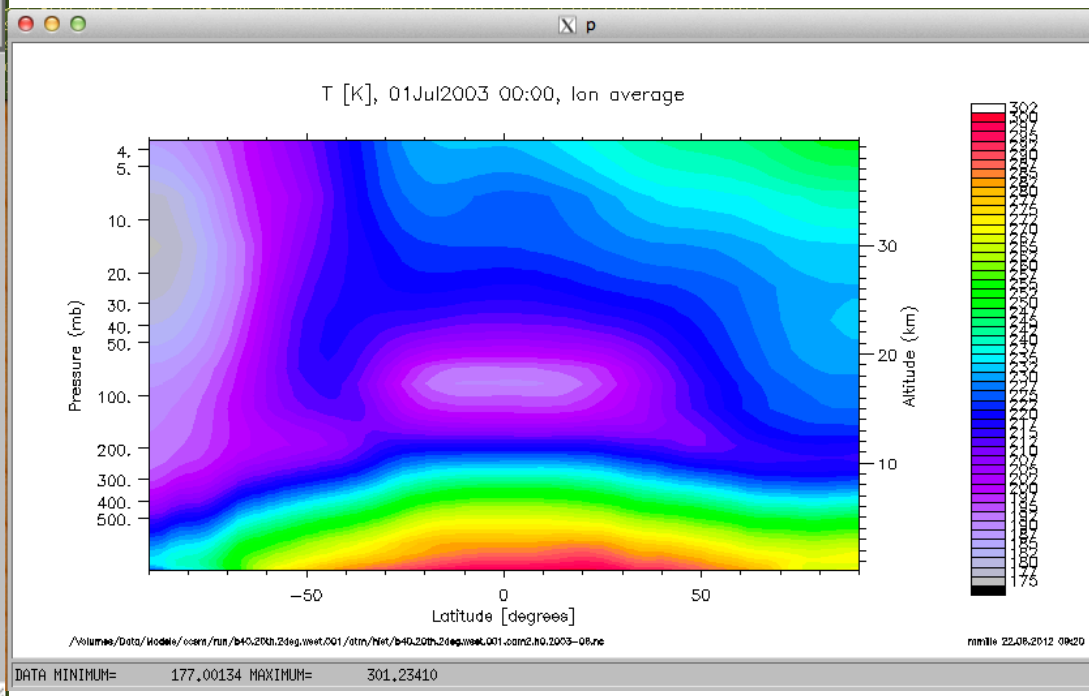
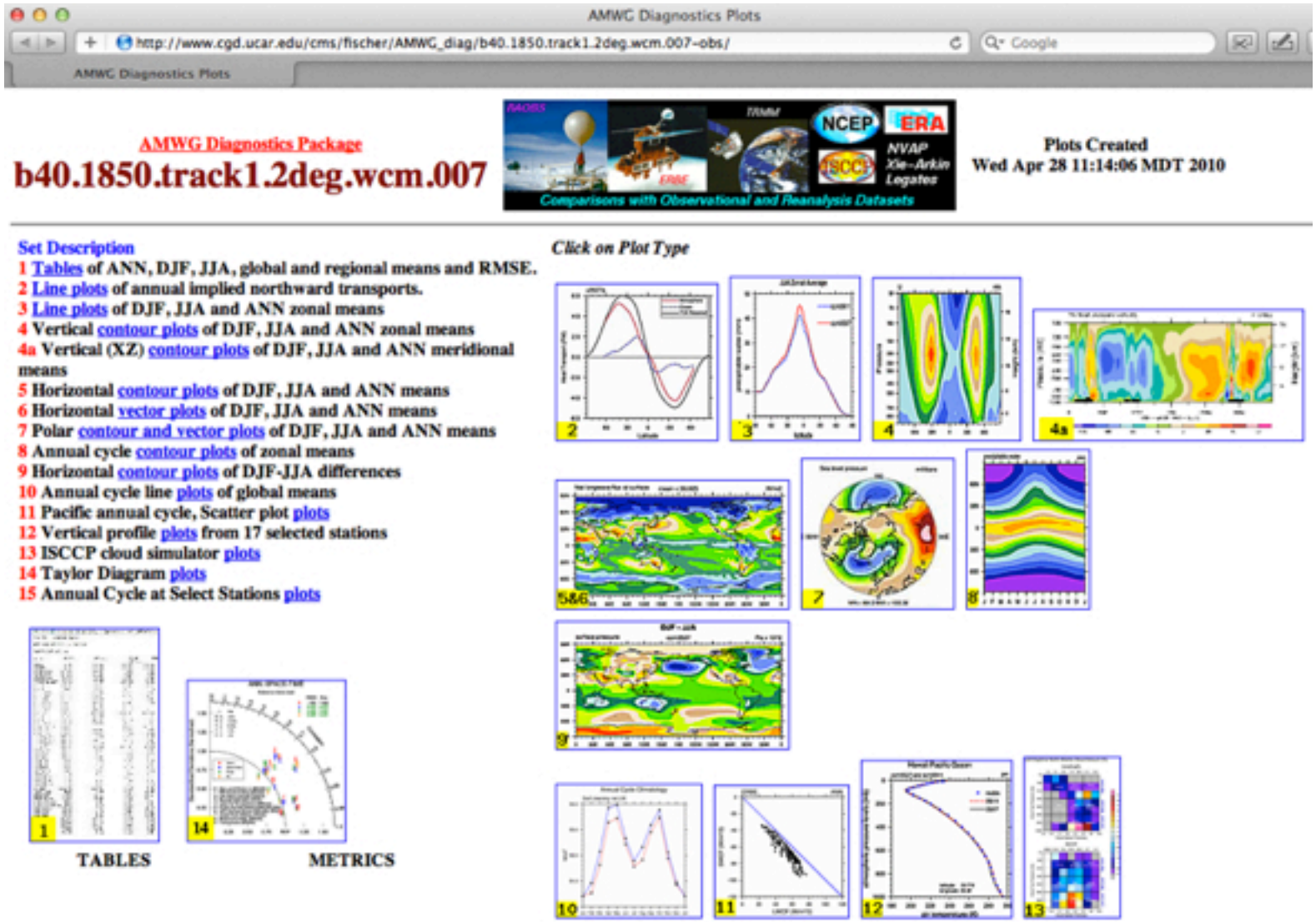




Post-processing data analysis

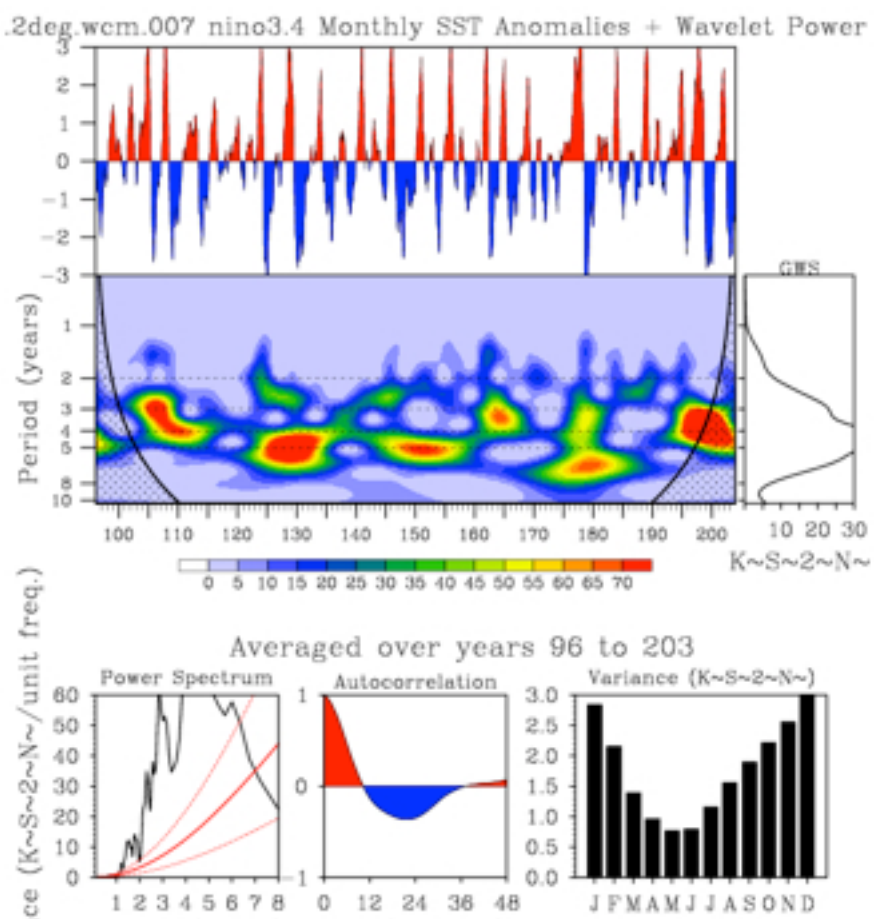
CAM diagnostic packages are described under CAM Post-Processing Utilities on the CAM documentation page at http://www.cesm.ucar.edu/models/cesm1.0/cam/.



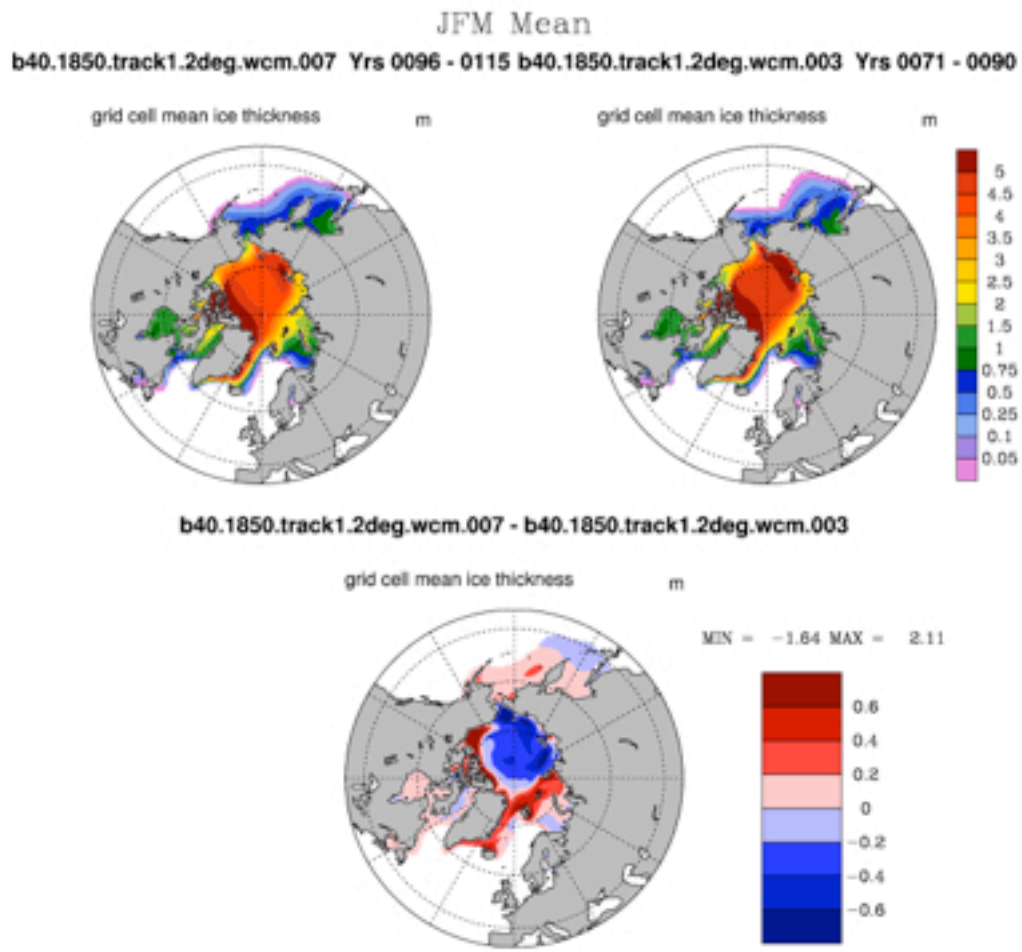
Post-processing data analysis

Diagnostic packages for all model components (atmosphere, land, ice, and ocean) can be found from the component post-processing utilities page (http://www.cesm.ucar.edu/models/cesm1.0/model_diagnostics/).

Ocean ENSO



Sea Ice Thickness



Validating CESM/WACCM

- Users may validate their implementation of CESM/WACCM by repeating experiments we have done at NCAR, and using the component post-processing utilities to compare the climate generated to output we have made available publicly on the Earth System Grid (http://www.earthsystemgrid.org).
- Please visit our CESM 1.0 experiments and diagnostics page (http://www.cesm.ucar.edu/experiments/cesm1.0/) for an updated list of experiments with links to output data locations.
- Output from additional experiments will be made available on a timeline in accordance with the CMIP5 data policy.

CESM1 (WACCM) 2° Pre-Industrial Control **Case Name**: b40.1850.track1.2deg.wcm.007 **Data Availability**: ESG (years 156-185)	156-185 w/observations	Atm	Ice	Land	Ocean	CCR	Ocean Timeseries
CESM1 (WACCM-X) 2° Present Day Control **Case Name**: f.e10.FWX.f19_f19.control.001 **Data Availability**: CESM	2001 w/observations	Atm	Ice	Land	---	---	---

Case Name: b40.1850.track1.2deg.wcm.007
Machine: NCAR:bluefire
CMIP5 ID: ----
Compset: B_1850_WACCM_CN
Resolution: 1.9x2.5_gx1v6
Years: 96-295
Time Frequencies Saved: Monthly, Daily, Subdaily
Initialization: year 156
Start/End Dates: 4/16/10, at year 260 as of 3/1/11
Data Release Date (Full): 11/1/11

Case Name: f.e10.FWX.f19_f19.control.001
Machine: NCAR:bluefire
CMIP5 ID: ----
Compset: F_2000_WACCMX (publicly available 2/21/12)
Resolution: 1.9x2.5_1.9x2.5
Years: 1/2001-2/2002
Time Frequencies Saved: Monthly, Daily, Subdaily
Initialization: startup run type
Start/End Dates: 2/8/12, ongoing
Data Release Date (Full): 2/17/12

WACCM Customer Support

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