

CESM-WACCM Tutorial

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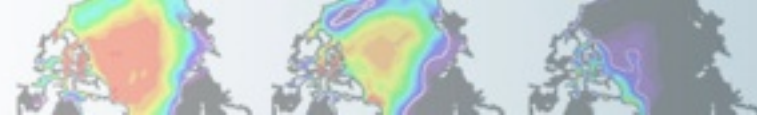
NCAR is sponsored by the National Science Foundation



WACCM

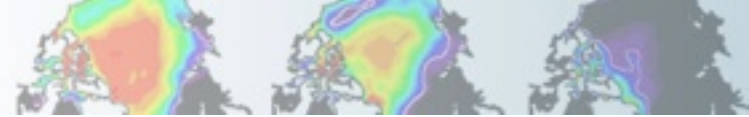
Whole Atmosphere
Community Climate Model



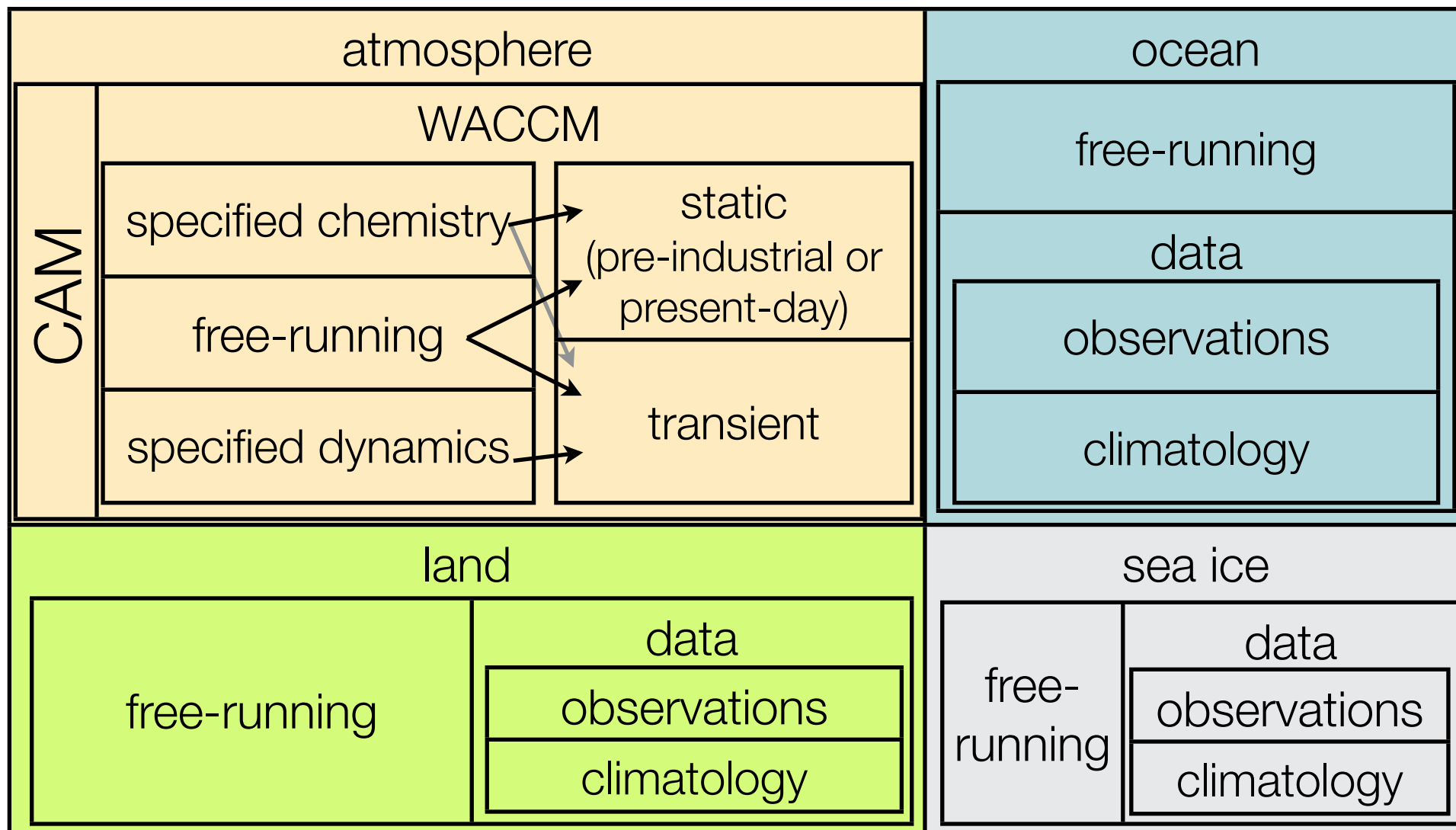


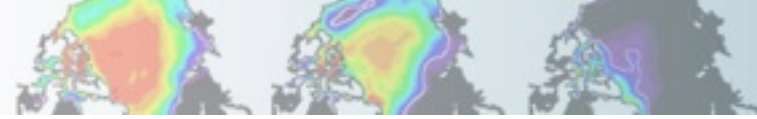
Outline

- 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

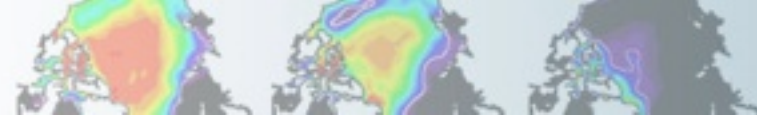
- Go to the scripts directory in your source code:

```
> cd $srkdir/scripts
```

- Review options for create_newcase command:

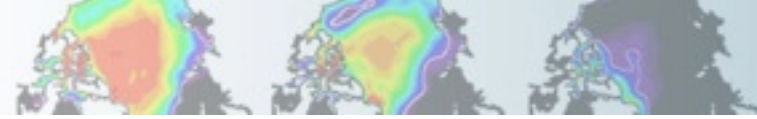
```
>create_newcase -list | less
RESOLUTIONS:  name (shortname)
...
  1.9x2.5_1.9x2.5 (f19_f19) ← used with data ocean (F-compsets)
  1.9x2.5_gx1v6 (f19_g16) ← used with full ocean (B-compsets)
...
COMPSETS:  name (shortname): description
...
  F_2000_WACCM (FW)
    Description: present-day cam/clm with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

```



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

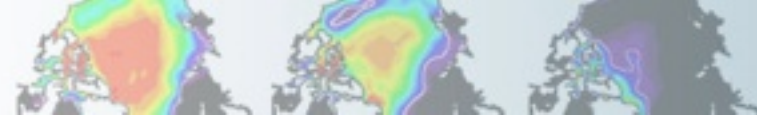
- Check the newly generated namelist prior to build:

```

▶ 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'
  fincll                        = 'AOA1', 'AOA2', 'BR', 'BRCL', 'BRO', 'BRONO2', 'CCL4', 'CF2CLBR', 'CF3BR', 'CFC11',
'CF313', '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
```

send email when job begins

```
#BSUB -N
```

send email when job ends

```
#BSUB -x
```

```
#BSUB -a poe
```

```
#BSUB -o poe.stdout.%J
```

```
#BSUB -e poe.stderr.%J
```

```
#BSUB -J f.e11.FW.f19_f19.001
```

maximum wall time for job

```
#BSUB -W 0:19
```

```
#BSUB -P 12345678
```

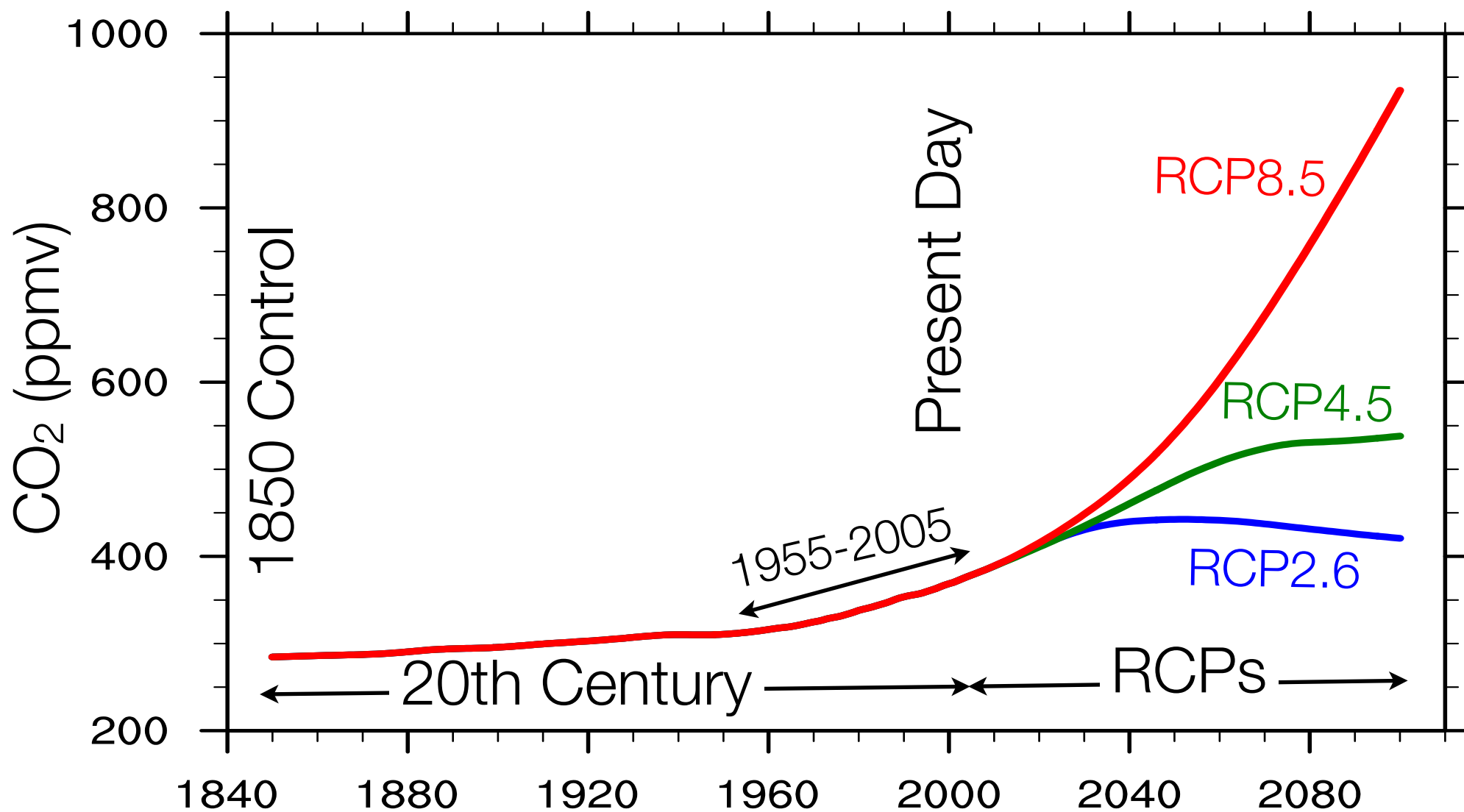
charge account number

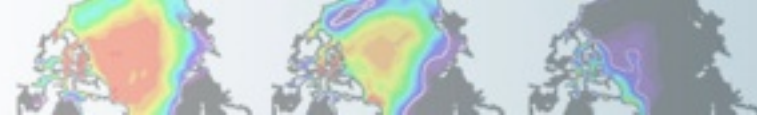
- submit the job to the batch queue (default 5-day run):

▶ `*.submit`



Transient and static WACCM configurations

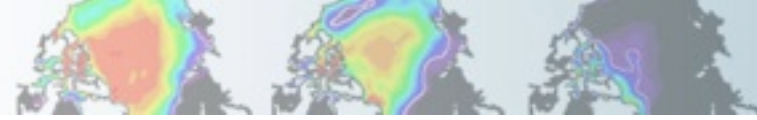




WACCM compsets with fully coupled ocean

- **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)**





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



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

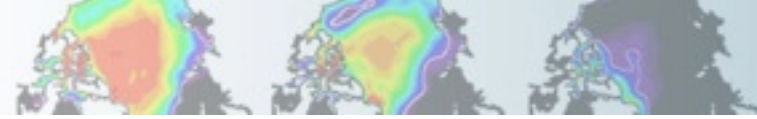
- Create a `user_nl_cam` file in your `$casedir`:

```

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

```

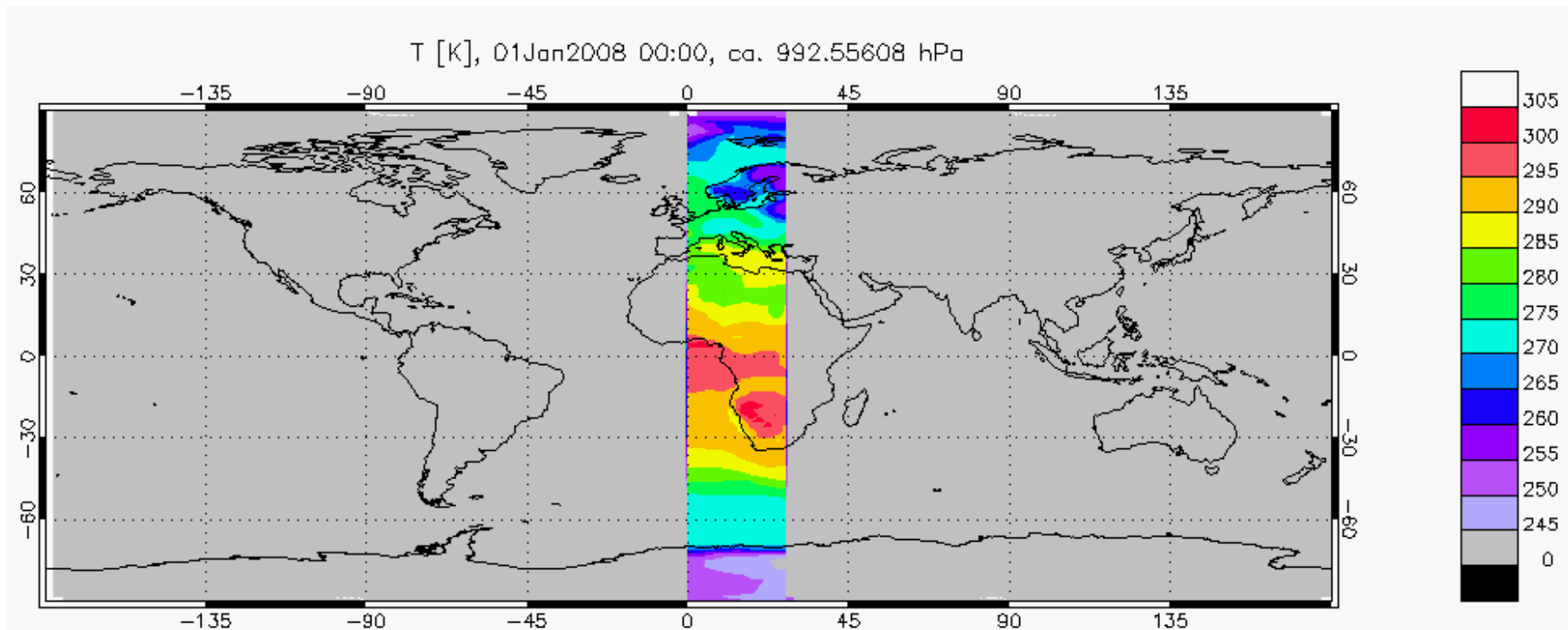
- `fincl[12345]lonlat`: List of columns or contiguous columns at which the `fincl[12345]` fields will be output. `'10e_20n'` would pick the model column closest to 10°E longitude by 20°N latitude. `'10e:20e_15n:20n'` would select the model columns which fall within the longitude range from 10-20°E and 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`.

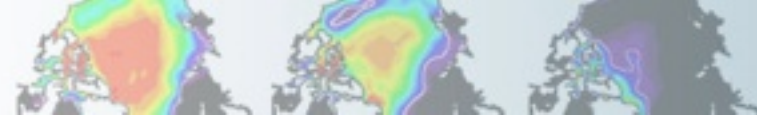


Local time history averaging

Namelist settings:

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

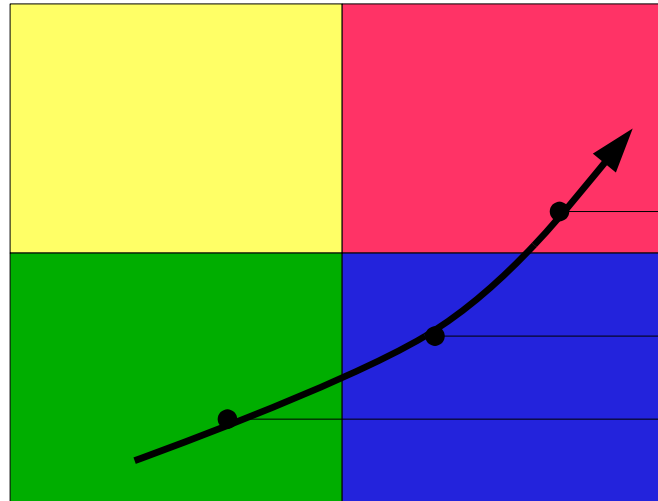




History Column Sampling

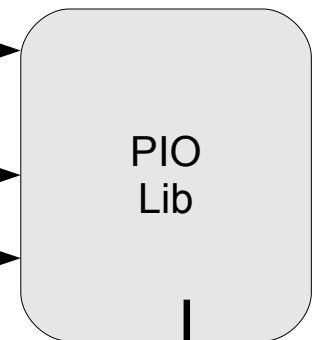
- Sample the CAM history buffer along a specified path (satellite, aircraft)
- All history variables can be sampled
- At each timestep, output stream of model columns nearest to specified coordinates for +/- half a timestep in a sequence specified via a tracking file

Horizontal grid distributed across MPI tasks

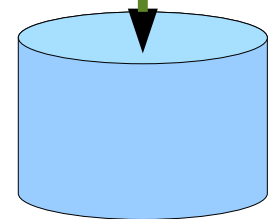


Output individual columns along the flight path

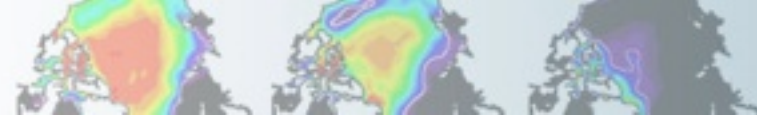
The corresponding model columns along the flight path are extracted and output in the same sequence as the input tracking file



Stream columns to Netcdf file



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

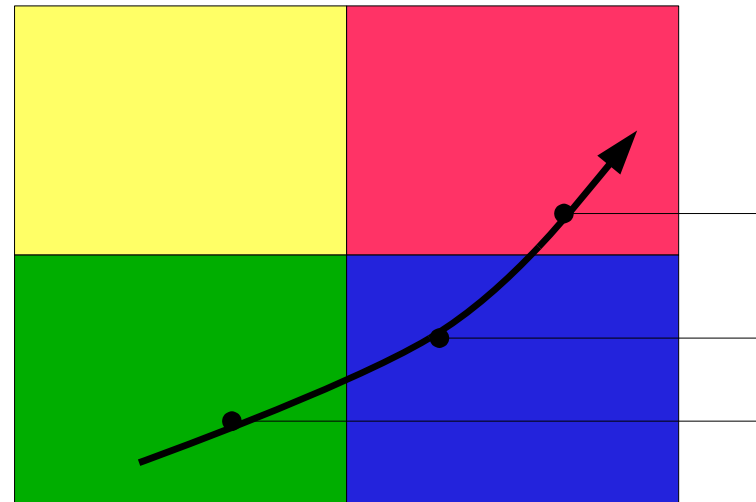
Tracking file:

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 = "longititude" ;
lon:units = "degrees" ;
```

profiles

Horizontal grid distributed across MPI tasks



Courtesy Francis Vitt

How do I change output of existing namelist variables?

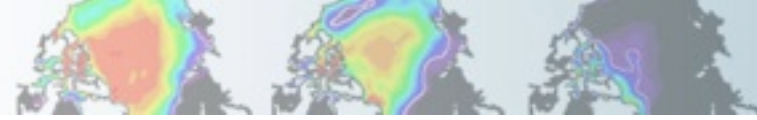
- Create a user_nl_cam file in your \$casedir
- Generate a new namelist:

```
> 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_r
clim_soilw_file           = '/fis/cgd/cseg/csm/inputdata/atm/cam/chem/trop_r
depvel_lnd_file           = '/fis/cgd/cseg/csm/inputdata/atm/cam/chem/trop_r
electron_file             = '/fis/cgd/cseg/csm/inputdata/atm/waccm/phot/electron.da
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

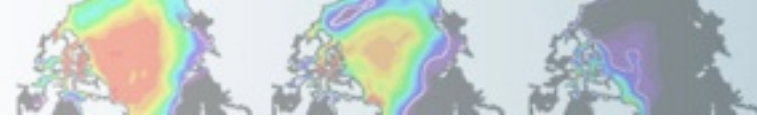
  Fixed
M, N2
  End Fixed
End SPECIES

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
  
```

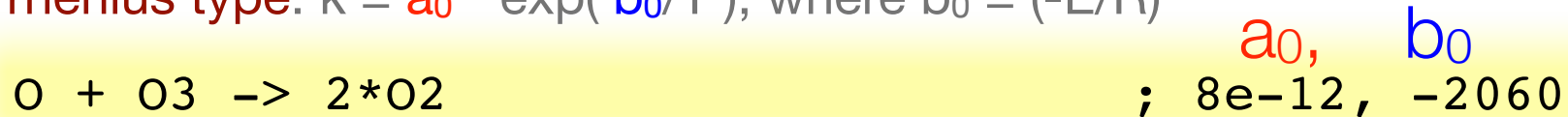


Modifying the chemical preprocessor input file

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



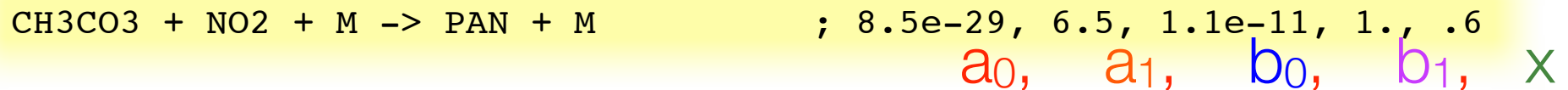
- **Arrhenius type:** $k = a_0 * \exp(b_0/T)$, where $b_0 = (-E/R)$



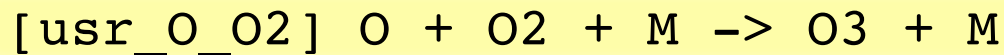
- **Troe rate constant:** $k = \alpha^x / (1 - \beta^2)$, where:

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

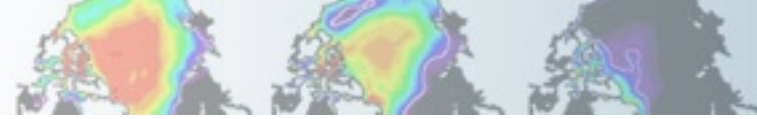
$$k_0 = a_0 * (300/T)^{a_1}, \quad k_\infty = b_0 * (300/T)^{b_1}, \quad x = \text{“exponential factor”}$$



- **User-specified reaction rate:**



rate defined in routine mo_usrrxt.F90

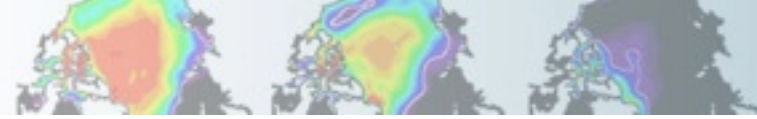


User-specified reaction rates

```
[usr_0_02] 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_0_02_ndx > 0 ) then  
        rxt(:,k,usr_0_02_ndx) = 6.e-34_r8 * tp(:)**2.4_r8  
    end if  
    if( usr_OA_02_ndx > 0 ) then  
        rxt(:,k,usr_OA_02_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:

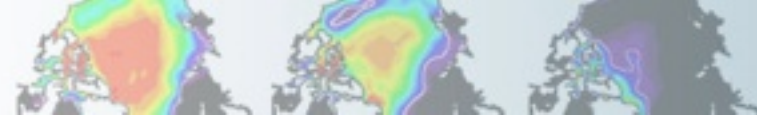
```
> cd $CASEROOT
> cp $CCSMROOT/models/atm/cam/src/chemistry/pp_waccm_mozart/chem_mech.in my_waccm_mech.in
> nedit my_waccm_mech.in &
```

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

```
> 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, Kp, Ap`

```

> 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 ;
}
  
```

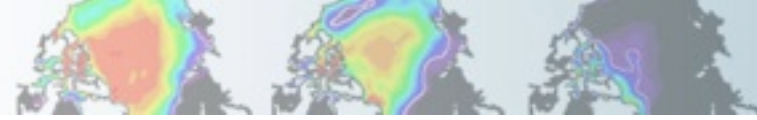
List of dates between which other data are interpolated



- `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 ($\text{mW m}^{-2} \text{nm}^{-1}$)
- `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?

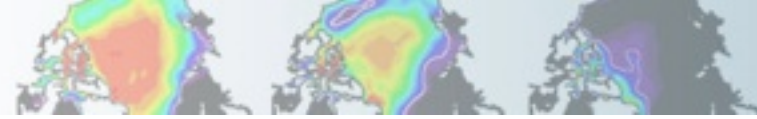
- Find an existing boundary condition file (LBC or UBC):

```
> 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
```

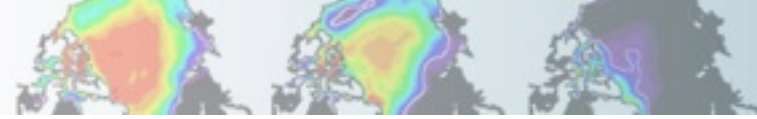
- Modify the existing netCDF input data file (via NCL, NCO, IDL) to produce a new one:

```
> 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:

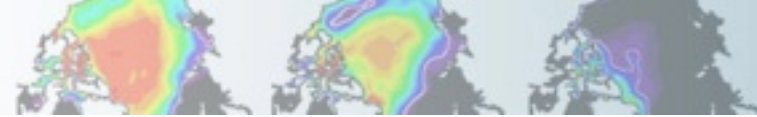
```
srf_emis_cycle_yr      = 2000
srf_emis_specifier     = 'CH20 -> /glade/proj3/cseg/inputdata/atm/cam/
chem/1850-2000_emis/IPCC_emissions_houw_CH20_1850-2000_1.9x2.5.c09
srf_emis_type          = 'CYCLICAL'
```

- 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/).

Window title: /Volumes/Data/Models/ccsm/run/b40.20th.2deg.wset.001/atm/hist/b...

FILE DISPLAY MAP 2D PLOT 1D PLOT PRINT CONTROLS HELP

PLOT:

VARIABLES	LATITUDE	LONGITUDE	LEVELS	TIME
SOLIN	-90.00	0.000	929,649	01Jul2003 00:00
SRFRAD	-88.11	2,500	970,555	
SWCF	-86.21	5,000	992,556	
T	-84.32	7,500		
TAUGWX	-82.42	10,00		

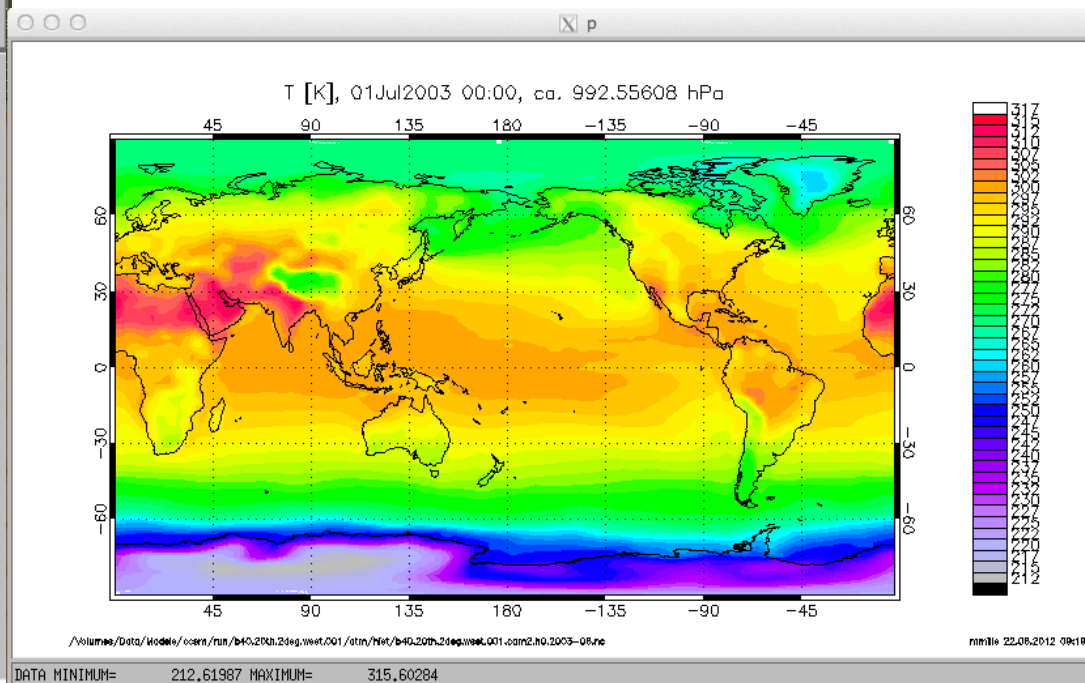
Display Options:

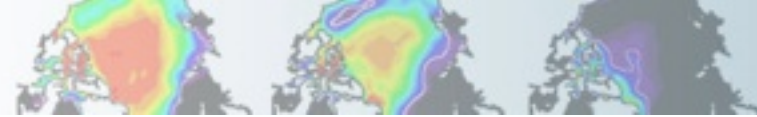
- Automatic Contour Levels
- auto log linear
- Level altitudes
- Oplot Same Scale
- Wind Vectors

Scale VMR data:

- don't scale
- ppm
- ppb
- ppt

Operator:





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/).

FILE DISPLAY MAP 2D PLOT 1D PLOT PRINT CONTROLS HELP

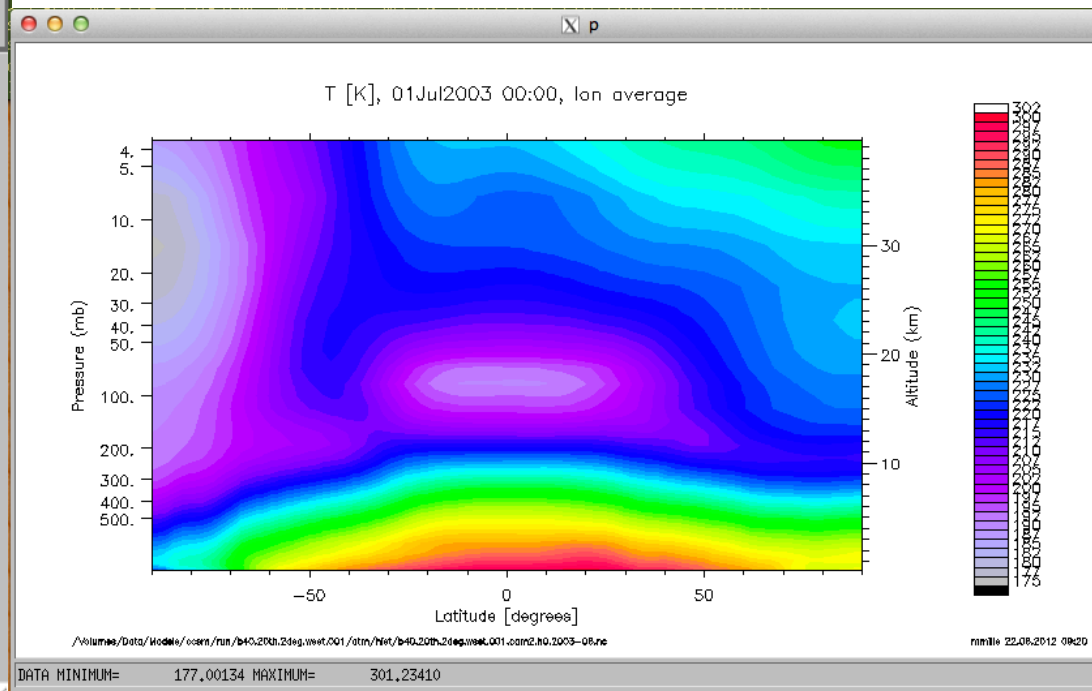
PLOT: Latitude vs Longitude
Latitude vs Longitude at Constant Pressure...
Meridional slice
Zonal slice
Zonal average

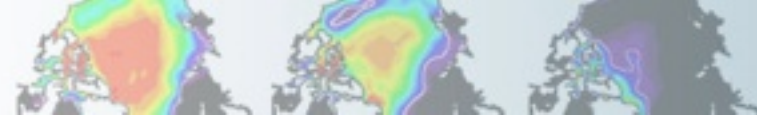
VARIABLES: SOLIN, SRFRAD, SWCF, T, TAUGWX

Display Options: Automatic Contour Levels, auto, log, linear, Level altitudes, Oplot Same Scale, Wind Vectors

Scale VMR data: don't scale, ppm, ppb, ppt

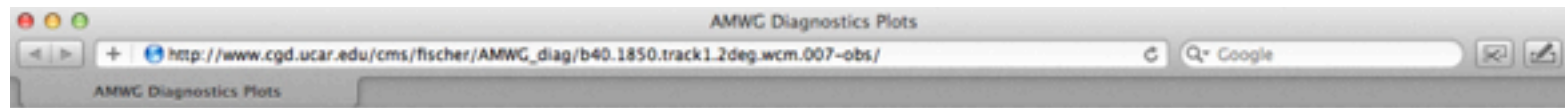
Operator: None, Extractor: Simple, Overplot





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/>.



AMWG Diagnostics Package
b40.1850.track1.2deg.wcm.007

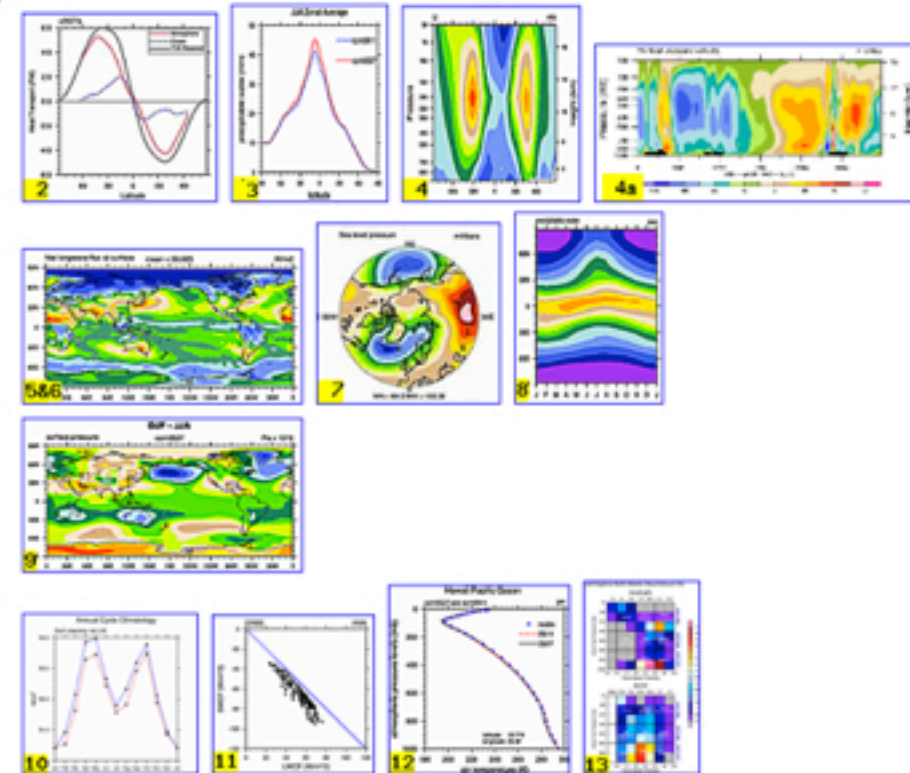
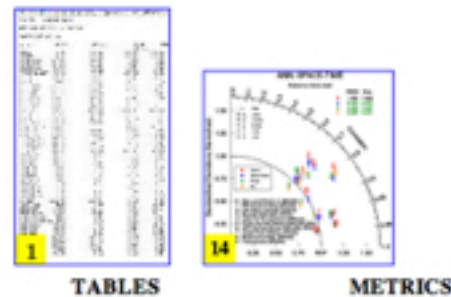


Plots Created
 Wed Apr 28 11:14:06 MDT 2010

Set Description

- 1 **Tables** of ANN, DJF, JJA, global and regional means and RMSE.
- 2 **Line plots** of annual implied northward transports.
- 3 **Line plots** of DJF, JJA and ANN zonal means
- 4 **Vertical contour plots** of DJF, JJA and ANN zonal means
- 4a **Vertical (XZ) contour plots** of DJF, JJA and ANN meridional means
- 5 **Horizontal contour plots** of DJF, JJA and ANN means
- 6 **Horizontal vector plots** of DJF, JJA and ANN means
- 7 **Polar contour and vector plots** of DJF, JJA and ANN means
- 8 **Annual cycle contour plots** of zonal means
- 9 **Horizontal contour plots** of DJF-JJA differences
- 10 **Annual cycle line plots** of global means
- 11 **Pacific annual cycle, Scatter plot plots**
- 12 **Vertical profile plots** from 17 selected stations
- 13 **ISCCP cloud simulator plots**
- 14 **Taylor Diagram plots**
- 15 **Annual Cycle at Select Stations plots**

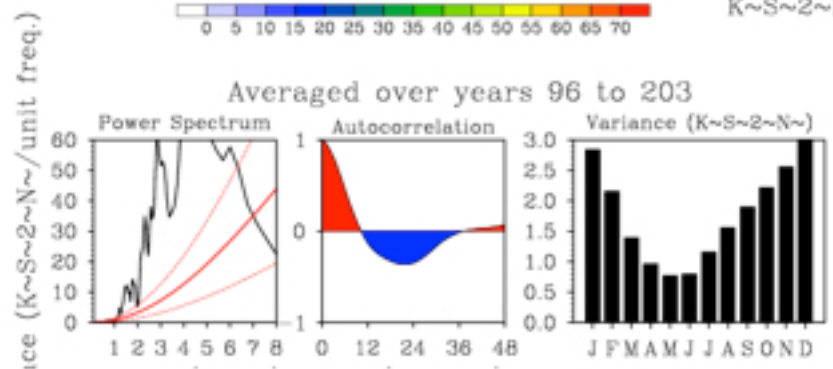
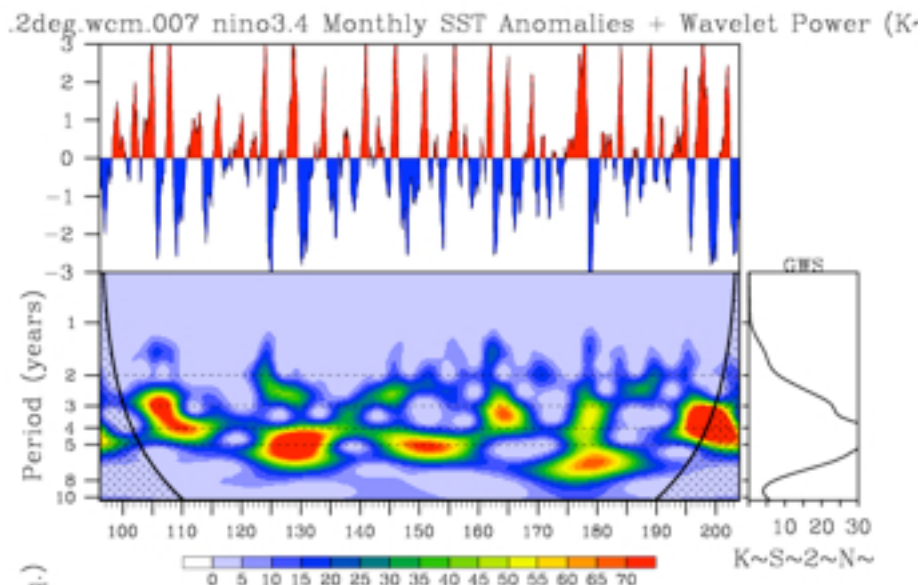
Click on Plot Type



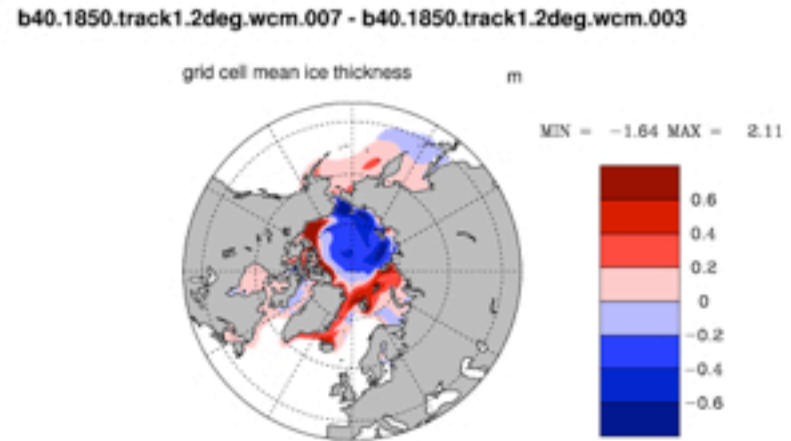
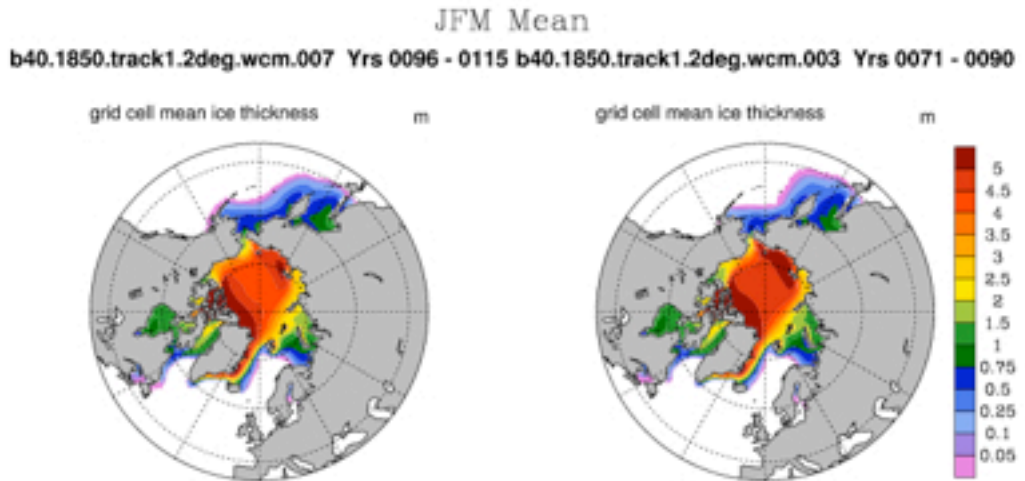
Post-processing data analysis

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/) (http://www.cesm.ucar.edu/models/cesm1.0/model_diagnostics/).

Ocean ENSO



Sea Ice Thickness





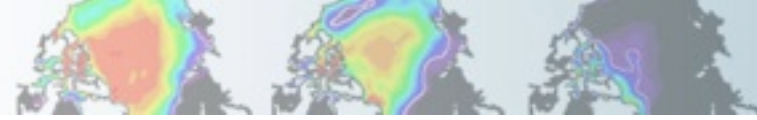
Validating CESM/WACCM

- 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.

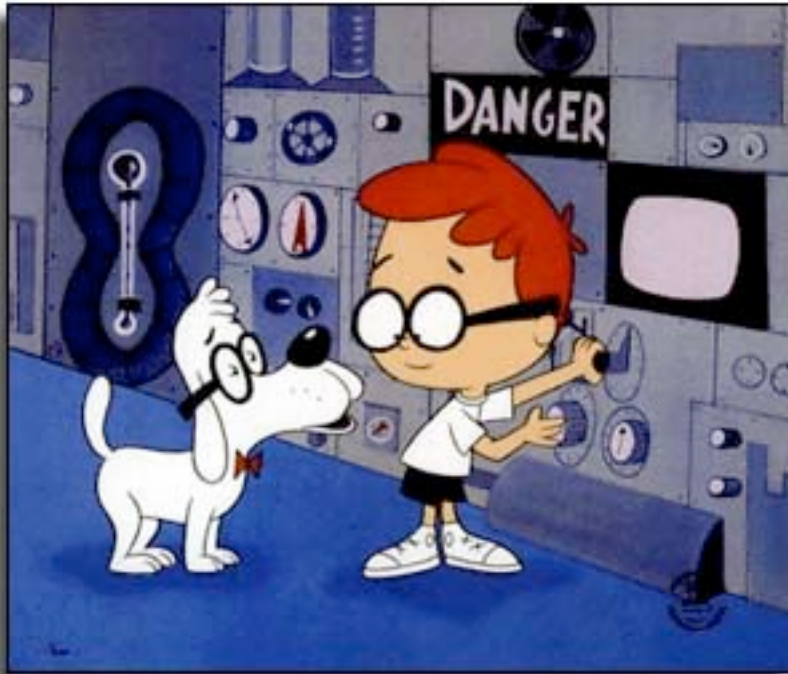
CESM1 (WACCM) 2° Pre-Industrial Control Case Name: b40.1850.track1.2deg.wcm.007 Data Availability: ESG (years 156-185)	156-185 w/observations	Atm	Ice	Land	Ocean	CCR	Ocean Timeseries
CESM1 (WACCM-X) 2° Present Day Control Case Name: f.e10.FWX.f19_f19.control.001 Data Availability: CESM	2001 w/observations	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_qx1v6](#)
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](#)



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