# Atmosphere Model Example Exercises

*Community Atmosphere Model*

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# Community Atmosphere Model

## Examples

1. Turn off 'freeze-drying' approximation in CAM4 (*namelist change, Arctic*)
2. Increase orographic height over the western US by 50% (*dataset change, mid-latitude*)
3. Increase the triggering threshold for deep convection just over land (*code change, Tropical*)

## Key

Commands to be typed are in brackets `<type this>`

Code snippets just appear as `Courier`

A backslash '\' indicates typed command continues on next line (it does not mean return)

# Creating F-cases

- F-case refers to a specific model configuration with prescribed (observed data) ocean and prescribed sea-ice (thickness, area)

| Compset Type | Atmosphere | Land | Ocean | Ice |
|---|---|---|---|---|
| F | *Interactive* | *Interactive* | Data | Thermodynamic |
| B | *Interactive* | *Interactive* | *Interactive* | *Interactive* |

- Create a new F-case

<./create_newcase -case $CASEDIR -res T31_T31 -compset F_2000 -mach bluefire>

- Compare with B-case

<./create_newcase -case $CASEDIR -res T31_gx3v7 -compset B_1850_CN -mach bluefire>

# Control Case

### *Create newcase*

```
<cd /fs/cgd/csm/collections/cesm1_0_4_tutorial/scripts>
<./create_newcase -case $CASEDIR -res T31_T31 -compset F_2000 -mach bluefire>
<cd $CASEDIR>
```

### *Configure processor layout for F-case*

```
<./xmlchange -file env_mach_pes.xml -id NTHRDS_ATM -val 4>
<./xmlchange -file env_mach_pes.xml -id NTHRDS_LND -val 4>
<./xmlchange -file env_mach_pes.xml -id NTHRDS_ICE -val 4>
<./xmlchange -file env_mach_pes.xml -id NTHRDS_OCN -val 4>
<./xmlchange -file env_mach_pes.xml -id NTHRDS_CPL -val 4>
<./xmlchange -file env_mach_pes.xml -id NTHRDS_GLC -val 4>
```

### *Run length options (run for 2 months, takes <15 minutes)*

```
<./xmlchange -file env_run.xml -id STOP_N -val 2>
<./xmlchange -file env_run.xml -id STOP_OPTION -val nmonths>
```

### *Configure*

```
<./configure -case>
```

***** Same for most examples that follow to this point (each with different $CASENAME/$CASEDIR) *****

### *Build*

```
<./{$CASENAME}.bluefire.build>
```

# Control Case: cont

***Run file edits***

```
<emacs $CASENAME.bluefire.run>
    #BSUB -W = 2:00
```

***Submit***

```
<bsub < ./$CASENAME.bluefire.run>
```

***Checking jobs***

```
<bjobs>
<batchview | grep $LOGNAME>
```

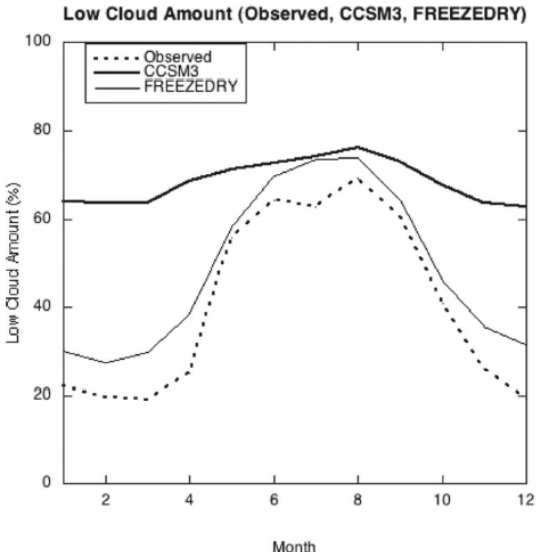
***Post-processing (e.g., compare $CASENAME1 with $CASENAME0)***

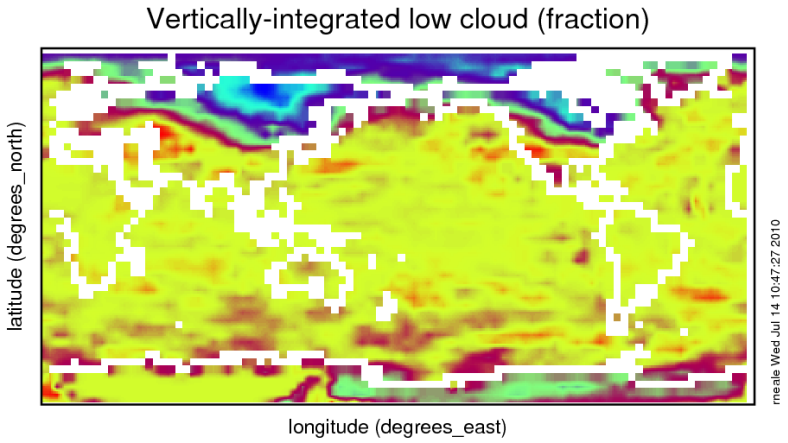
***Need to load the ncview module to use "ncview"***

```
<module load ncview-1.93f>
<cd /ptmp/$LOGNAME/archive/$CASENAME1/atm/hist>
<ncdiff ${CASENAME1}.cam2.h0.0001-01.nc ${CASENAME0}.cam2.h0.0001-01.nc \ $
    {CASENAME1}_diff.nc>
<ncview ${CASENAME1}_diff.nc>
```

# Example 1: *Namelist Change*

- **ACTION**: Switch off an approximation that reduces the cloud fraction in very dry atmospheric conditions (Vavrus and Walliser, 2008)




$$f = f \times \left[ \max(0.15, \min)\left( 1.0, \frac{q}{0.003} \right) \right].$$

# Example 1: *Namelist Change*

Follow ***control case*** example until before the configure

**Set freeze drying to .False.**

2 methods

1. Via env_conf.xml using xmlchange (configure *after this)*

```
<xmlchange -file env_conf.xml -id CAM_NAMELIST_OPTS -val "cldfrc_freeze_dry=.false.">
```

2. Via buildnamelist file (configure *before this)*

```
<cd Buildconf>
<emacs cam.buildnml.csh>
   &cldfrc_nl
   cldfrac_freeze_dry = .false.
```

***Return to Control Case at build point***

After build – check CAM namelist in the run directory to confirm above change

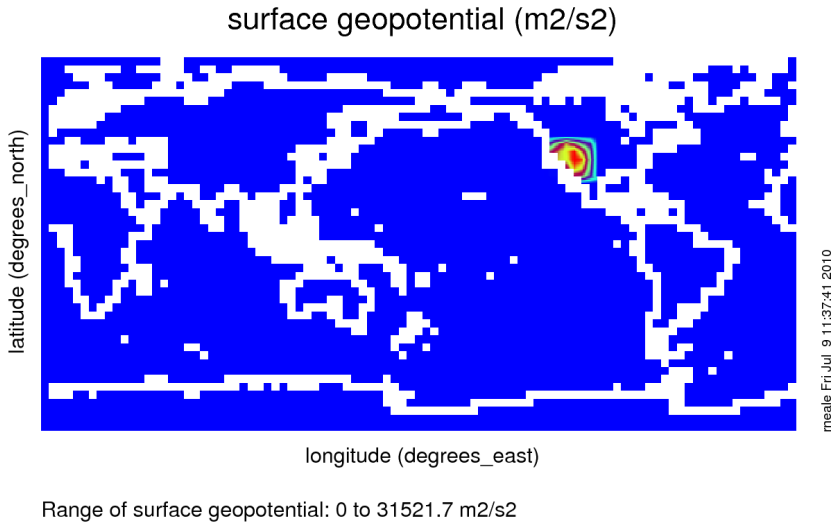
```
<less /ptmp/$LOGNAME/$CASENAME/run/atm_in>
```

***What to look for?***

✓ *Surface temperature (TS), surface energy budget (FSDS,FLNS), surface pressure (PS), cloud (CLDLOW)*

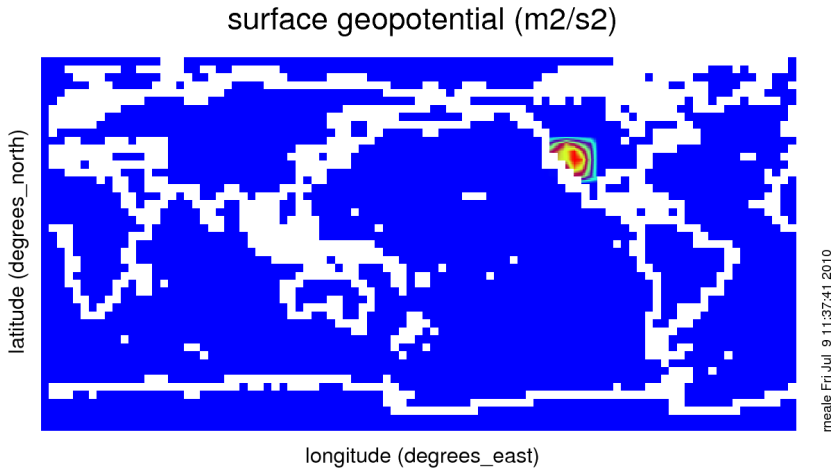
# Example 2: *Dataset change*

- ACTION: Change input boundary datasets (orography) by increasing it's value by 50% in the western USA

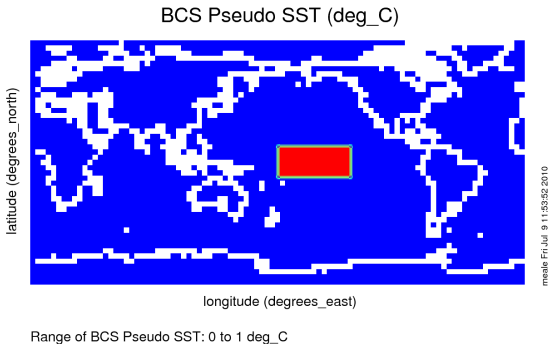


# Example 2: *Dataset change*

- ACTION: Change input boundary datasets (orography) by increasing it's value by 50% in the western USA




See alternative case 2a at the end to add a Sea Surface Temperature (SST) anomaly



# Example 2: *Dataset change*

- Follow guide for control example until configure ***then***

***Orography surface boundary data***

```
<emacs Buildconf/cam.buildnml.csh>
```

*Orography file is (specifies mean height **PHIS**)*

```
bnd_topo = '$DIN_LOC_ROOT/atm/cam/topo/USGS-gtopo30_48x96_c050520.nc'
```

*Central input data location (on bluefire)*

```
$DIN_LOC_ROOT = /fis/cgd/cseg/csm/inputdata
```

*Make a local copy*

```
<cp /fis/cgd/cseg/csm/inputdata/atm/cam/topo/USGS-gtopo30_48x96_c050520.nc \
USGS-gtopo30_48x96_c050520_orig.nc>
```

# Example 2: *Dataset change*

***Change orography surface boundary data***

*Use nco utilities to edit values on the file (**http://nco.sourgeforce.net**)*

*We will use a function called **ncap2 – (netCDF Arithmetic Averager)** single line command below*

```
<ncap2 -O -s 'lat2d[lat,lon]=lat ; lon2d[lat,lon]=lon' \
  -s 'omask=(lat2d >= 30. && lat2d <= 50.) && (lon2d >= 235. && lon2d <= 260.)' \
  -s 'PHIS=(PHIS*(1.+omask*0.5))' \
  USGS-gtopo30_48x96_c050520_orig.nc USGS-gtopo30_48x96_c050520.nc>
```

1

2

3

**1. Define 2D latitude and longitude arrays**

**2. Create a mask – setting = 1 for the desired lat/lon range; elsewhere = 0**

**3. Apply mask to 2D field (PHIS = surface geopotential = gZ) – 1.5x PHIS in region of interest**

***Check data***

```
<ncdiff -v PHIS USGS-gtopo30_48x96_c050520.nc \
USGS-gtopo30_48x96_c050520_orig.nc PHIS_diff.nc>
<ncview PHIS_diff.nc>
```

# Example 2: *Dataset change*

***Apply changed dataset to namelist files***

```
<emacs Buildconf/cam.buildnml.csh>
```

Change

```
    bnd_topo = '$DIN_LOC_ROOT/atm/cam/topo/USGS-gtopo30_48x96_c050520.nc'
```

To

```
    bnd_topo = './USGS-gtopo30_48x96_c050520.nc'
```

***Build model***

```
<./{$CASENAME}.bluefire.build>
```

***Copy changed orography boundary data to run directory***

```
<cp USGS-gtopo30_48x96_x050520.nc /ptmp/$LOGNAME/$CASENAME/run>
<cd $CASEDIR>
```

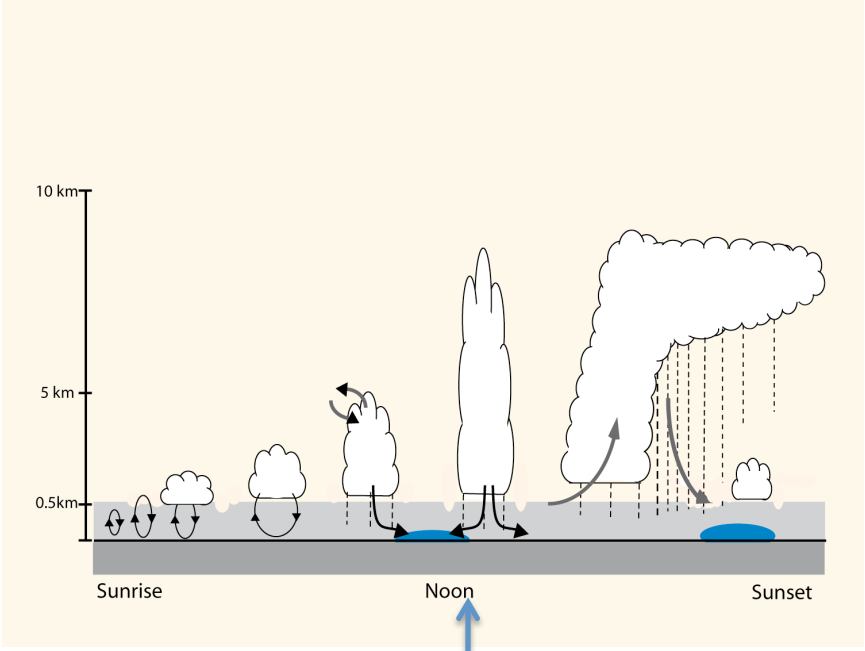
***Return to Control Case AFTER build point***

***What to look for?***

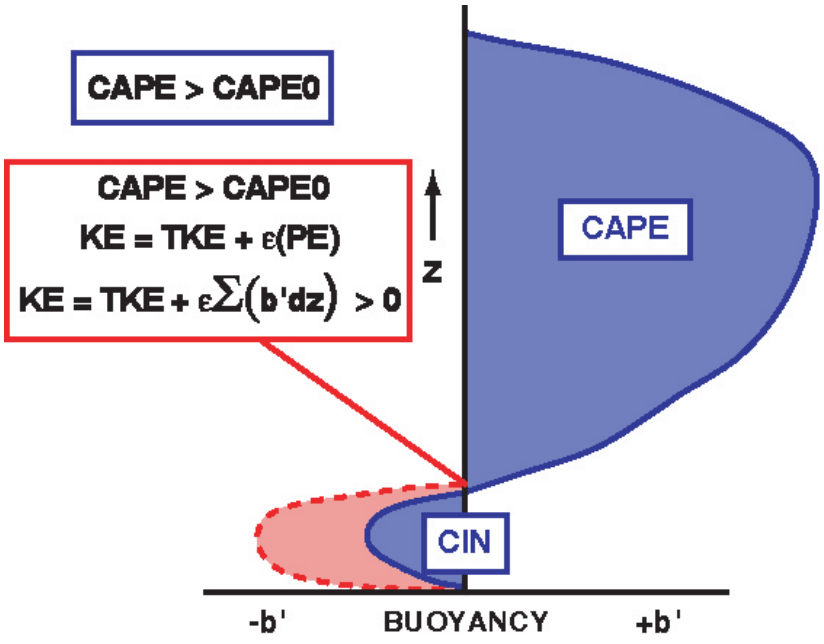
- ✓ *Surface temperature (TS), surface pressure (PS), cloud (CLDLOW), rainfall (PRECT), winds (OMEGA,U,W)*

# Example 3: *Code Change*

- ACTION: Increase the minimum required CAPE to initiate convection of land (convective trigger) to examine the mean affects of delaying the initiation of convection




Models peak around noon
Too early



# Example 3: *Code Change*

- Follow guide for control example until configure ***then***

***Copy fortran code file that controls deep convection calculation (Zhang and McFarlane, 1995) to local code mod directory for the atmosphere***

```
<cp /fs/cgd/csm/collections/cesm1_0_4_tutorial/models/atm/cam/src/physics/cam/zm_conv.F90 \
    SourceMods/src.cam>
<cd SourceMods/src.cam>
<emacs zm_conv.F90>
```

Search for following lines

```
if (cape(i) > capelmt) then
 lengath = lengath + 1
 index(lengath) = i
end if
```

The minimum CAPE (capelmt) for triggering convection (= 70 J/kg) everywhere.

Let's increase the value over land (x10 to 700 K/kg) to analyze what the mean effect of delaying convection is.

# Example 3: *Code Change*

So change the following in sub-routine ***zm_convr (use 'ctrl s' to search in emacs)***

```
if (cape(i) > capelmt) then
 lengath = lengath + 1
 index(lengath) = i
end if
```

To

```
if (cape(i) > capelmt_mask) then
 lengath = lengath + 1
 index(lengath) = i
end if
```

Use a local variable for the convection trigger

And before this add

```
if (landfrac(i) > 0.5_r8) then
 capelmt_mask = 10._r8*capelmt
else
 capelmt_mask = capelmt
end if
```

Scale the existing trigger value by 10x if land fraction is >50%

And in routine ***zm_convr*** after

```
use phys_control, only: cam_physpkg_is
```

Add `real(r8) :: capelmt_mask`

***Return to Control Case AFTER configure point***

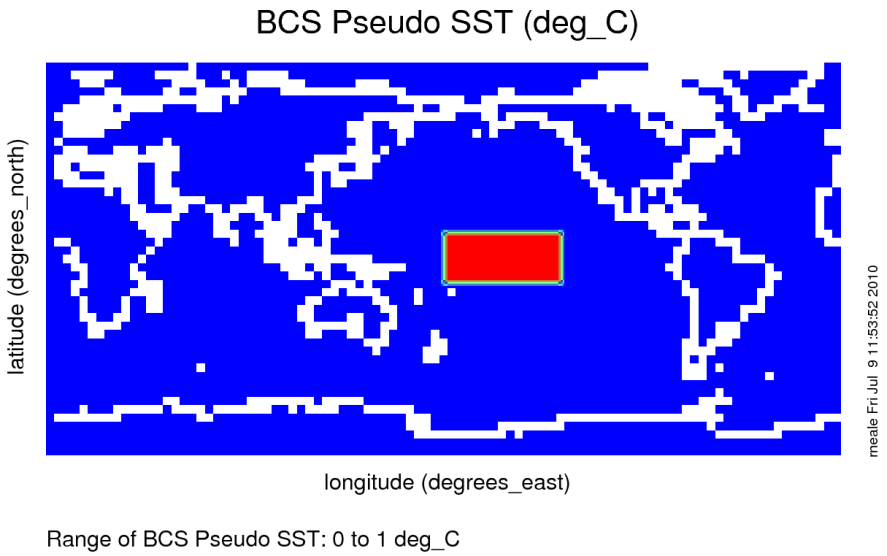
# Example 3: *Code Change*

***What to look for? (may require longer than 1 month for good signal)***

- ✓ *Surface temperature (TS), surface fluxes (LHFLX,SHFLX), cloud (CLDLOW), rainfall (PRECT) over land*
- ✓ *How does it affect the diurnal cycle? (if feeling brave output hourly rainfall (PRECT) and surface temperature (TS) over a limited land region - refer to Thursday practical)*

# Example 2a: *Dataset change*

- ACTION: Change input boundary datasets (Sea Surface Temperature) by increasing it's value by 2K in the tropical Central Pacific



# Example 2a: *Dataset change*

- Follow guide for control example until before the configure:

*You need to modify the SST file. This file is located in the central input data location:*

```
$DIN_LOC_ROOT/ocn/docn7/SSTDATA/sst_HadOIBl_bc_48x96_clim_c050526.nc
with $DIN_LOC_ROOT = /fis/cgd/cseg/csm/inputdata  (on bluefire)
```

*Copy file to your local directory*

```
<cp /fis/cgd/cseg/csm/inputdata/ocn/docn7/SSTDATA/
   sst_HadOIBl_bc_48x96_clim_c050526.nc \
   sst_HadOIBl_bc_48x96_clim_c050526_orig.nc>
```

# Example 2a: *Dataset change*

### *Change SST surface boundary data*

*Use nco utilities to edit values on the file (**http://nco.sourgeforce.net**)*

*We will use a function called **ncap2 – (netCDF Arithmetic Averager)** single line command below*

```
<ncap2 -O -s 'lat2d[lat,lon]=lat ; lon2d[lat,lon]=lon' \
-s 'omask=(lat2d >= -10. && lat2d <= 10.) && (lon2d >= 180. && lon2d <= 240.)' \
-s 'SST_cpl=(SST_cpl+omask*2.)' \
sst_HadOIBl_bc_48x96_clim_c050526_orig.nc sst_HadOIBl_bc_48x96_clim_c050526.nc>
```

1. Define 2D latitude and longitude arrays
2. Create a mask – setting = 1 for the desired lat/lon range; elsewhere = 0
3. Apply mask to 2D field (SST_cpl): +2K in region of interest (equatorial Pacific)

### *Check data*

```
<ncdiff -v SST_cpl sst_HadOIBl_bc_48x96_clim_c050526.nc \
sst_HadOIBl_bc_48x96_clim_c050526_orig.nc SST_cpl_diff.nc>
<ncview SST_cpl_diff.nc>
```

# Example 2a: *Dataset change*

***Apply changed SST***

```
<./xmlchange -file env_conf.xml -id DOCN_SSTDATA_FILENAME \
  -val "./sst_HadOIBl_bc_48x96_clim_c050526.nc">
<./xmlchange -file env_conf.xml -id DOCN_SSTDATA_YEAR_START -val "0">
<./xmlchange -file env_conf.xml -id DOCN_SSTDATA_YEAR_END -val "0">
```

***Build model***

```
<cd $CASEDIR>
<./{$CASENAME}.bluefire.build>
```

***Copy changed SST data to run directory***

```
<cp sst_HadOIBl_bc_48x96_clim_c050526.nc /ptmp/$LOGNAME/$CASENAME/run>
```

***Return to Control Case AFTER build point***

***What to look for?***

- ✓ *Surface temperature (TS), surface pressure (PS), cloud (CLDLOW), rainfall (PRECT), winds (OMEGA,U,W)*