

Atmosphere Model Example Exercises

Community Atmosphere Model (CAM4)

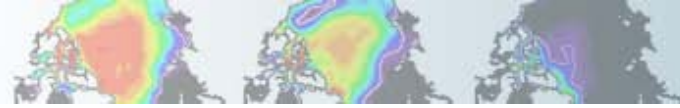
Whole Atmosphere Community Climate Model (WACCM4)

Chemistry-Climate Atmosphere Model (CAM-chem)



U.S. DEPARTMENT OF
ENERGY

Office of
Science



Community Atmosphere Model

Examples

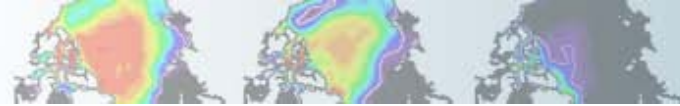
1. Turn off 'freeze-drying' approximation in CAM4
(*namelist change, Arctic*)
2. Increase orographic height over the western US by 50% (*dataset change, mid-latitude*)
3. Increase the triggering threshold for deep convection just over land (*code change, Tropical*)

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)

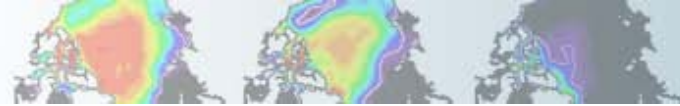
Compset Type	Atmosphere	Land	Ocean	Ice
F	<i>Interactive</i>	<i>Interactive</i>	Data	Thermodynamic
B	<i>Interactive</i>	<i>Interactive</i>	<i>Interactive</i>	<i>Interactive</i>

- 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_3_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>
```

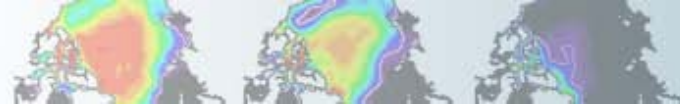
Configure

```
<./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
```

Dedicated node selection (Tutorial Only: X changes each day; see crib sheet)

```
#BSUB -U = Acc Num#X
```

```
#BSUB -P = Acc Num
```

Submit

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

Checking jobs

```
<bjobs>
```

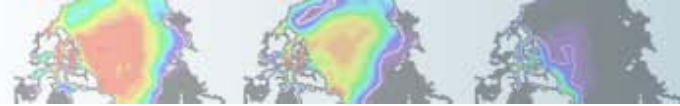
```
<batchview | grep $USERNAME>
```

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

```
<cd /ptmp/$USERNAME/archive/$CASENAME1/atm/hist>
```

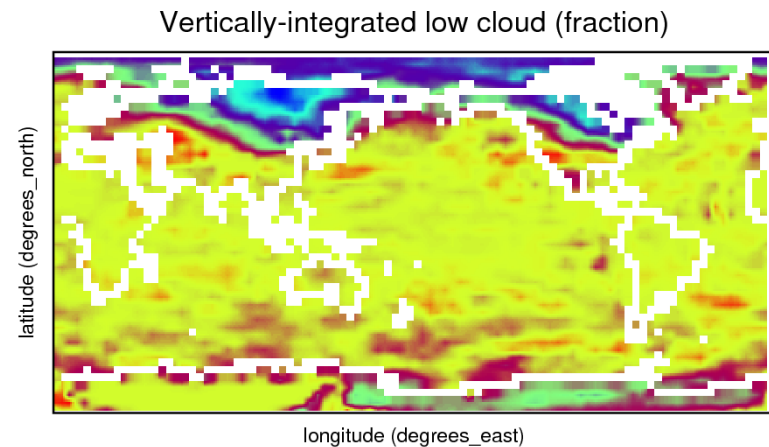
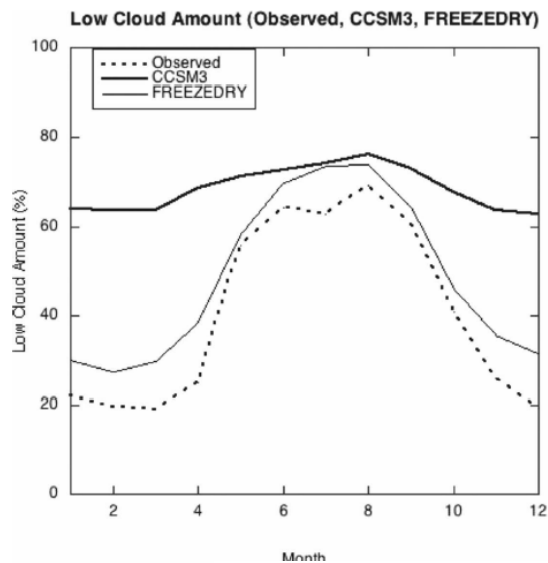
```
<ncdiff ${CASENAME1}.cam2.h0.0001-01.nc ${CASENAME0}.cam2.h0.0001-01.nc \  
  ${CASENAME1}_diff.nc>
```

```
<ncview ${CASENAME1}_diff.nc>
```

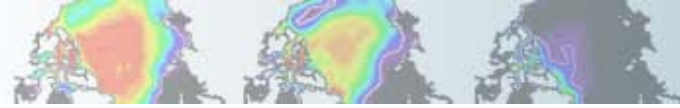


Example 1: *Namelist Change*

- 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_n1
```

```
cldfrac_freeze_dry = .false.
```

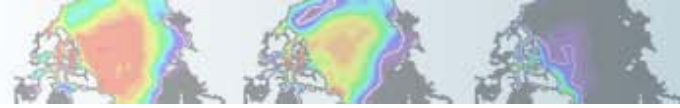
Return to *Control Case at build point*

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

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

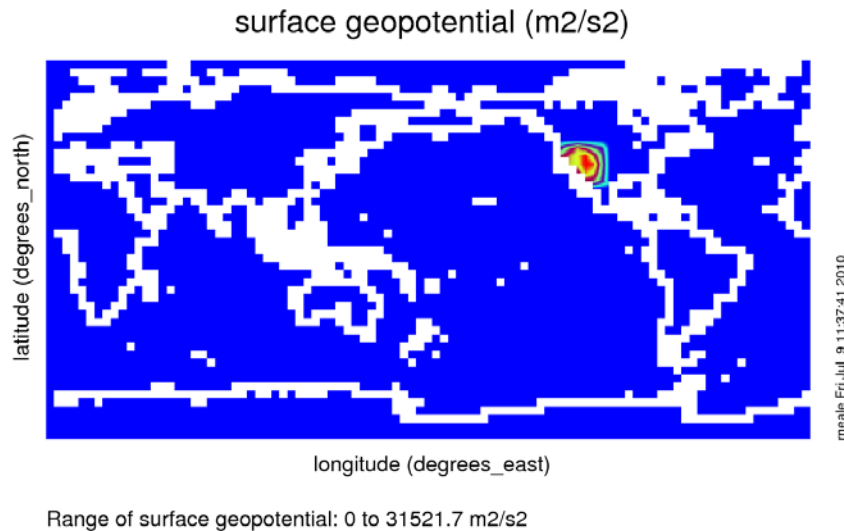
What to look for?

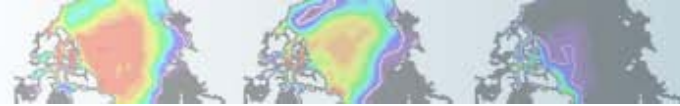
- ✓ Surface temperature (TS), surface energy budget (FSDS,FLNS), surface pressure (PS), cloud (CLDLow)



Example 2: *Dataset change*

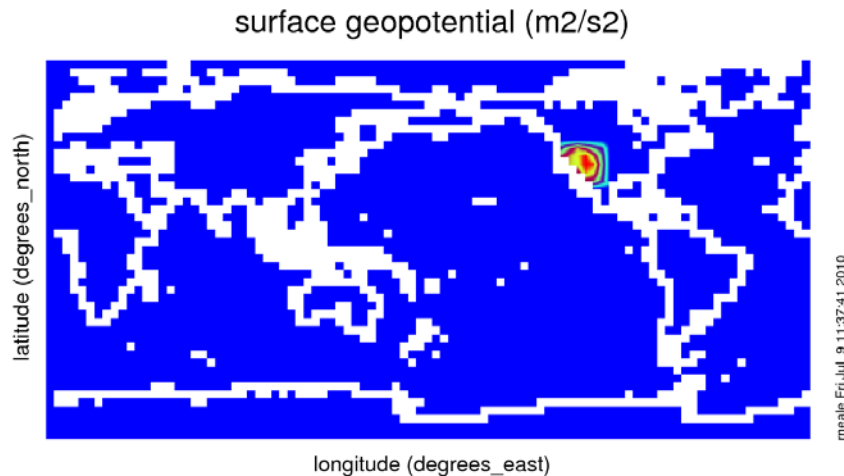
- ACTION: Change input boundary datasets (orography) by increasing it's value by 50% in the western USA





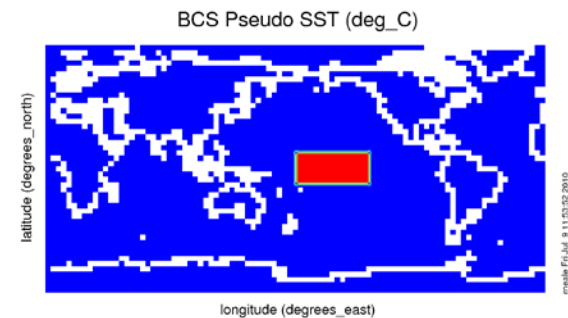
Example 2: Dataset change

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

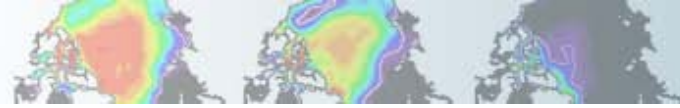


Range of surface geopotential: 0 to 31521.7 m2/s2

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



Range of BCS Pseudo SST: 0 to 1 deg_C



Example 2: Dataset change

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

Orography surface boundary data

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

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

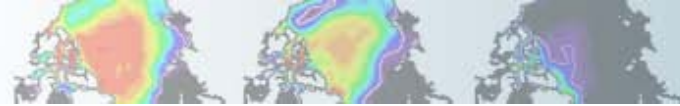
```
bnd_topo = '$DIN_LOC_ROOT/atm/cam/topo/USGS-gtopo30_48x96_c050520.nc'
```

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.sourceforge.net>)

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

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

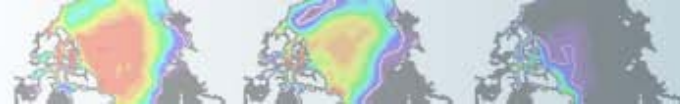
1. Define 2D latitude and longitude arrays

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

3. Apply mask to 2D field (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 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

```
<cd $CASEDIR>
```

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

Copy changed orography boundary data to run directory

```
<cd Buildconf>
```

```
<cp USGS-gtopo30_48x96_x050520.nc /ptmp/$USERNAME/$CASENAME/run>
```

```
<cd $CASEDIR>
```

Return to *Control Case AFTER build point*

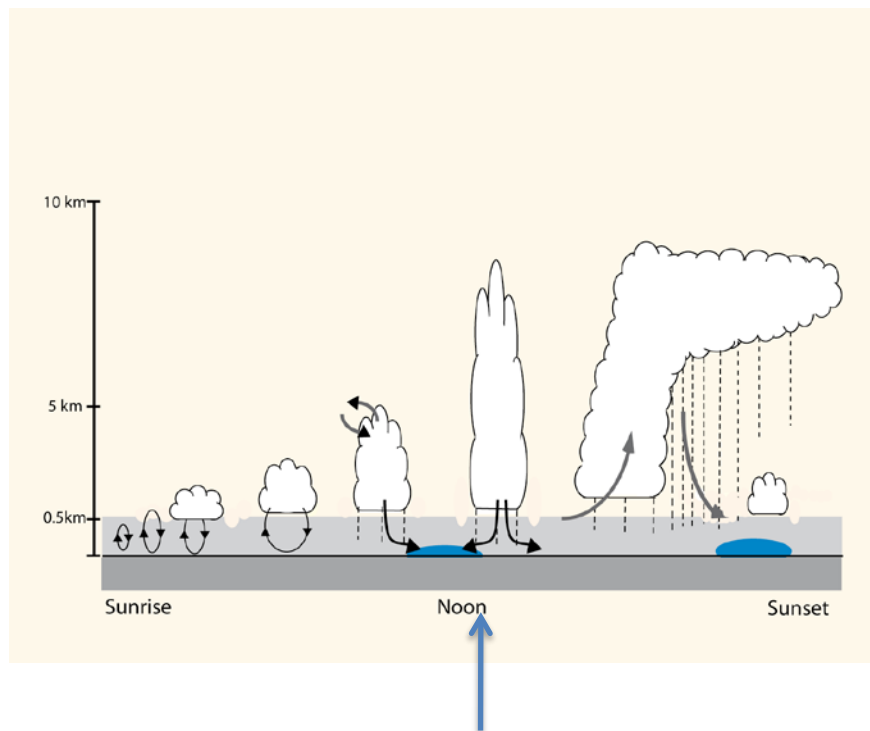
What to look for?

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

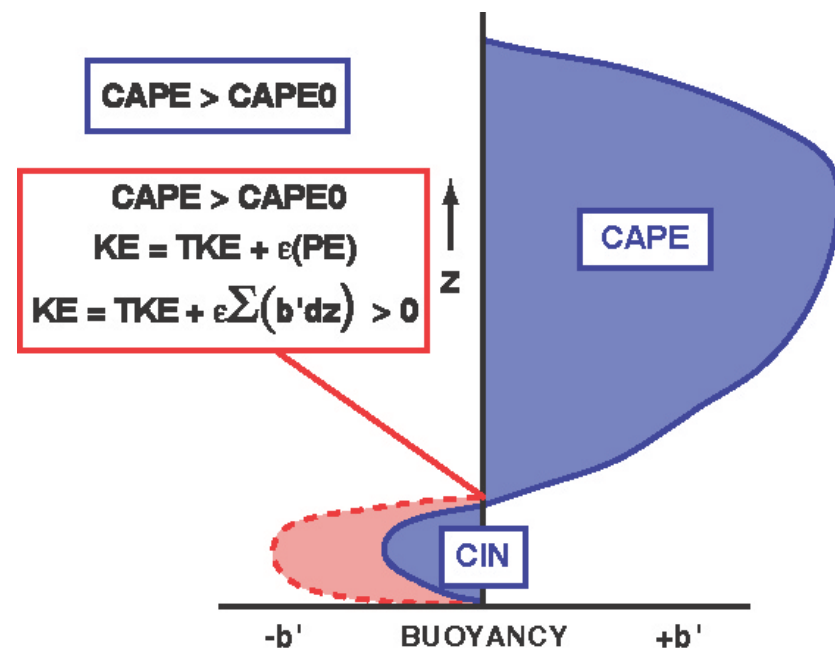


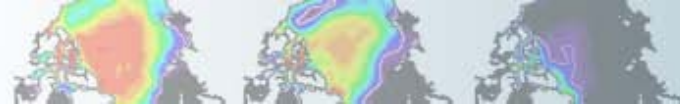
Example 3: Code Change

- 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**

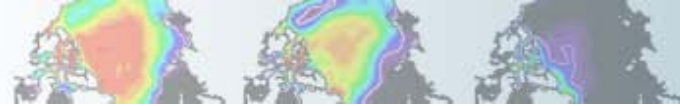
Copy fortran code file that controls deep convection calculation (Zhang and McFarlane, 1995) to local code mod directory for the atmosphere

```
<cp /fs/cgd/csm/collections/cesm1_0_3_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_conv` (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
```

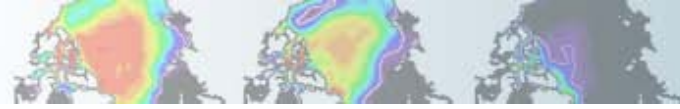
Scale the existing trigger value by 10x if land fraction is >50%

And in routine `zm_conv` after

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

Add `real(r8) :: capelmt_mask`

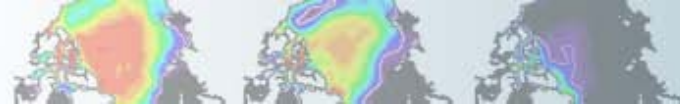
Return to Control Case AFTER configure point



Example 3: Code Change

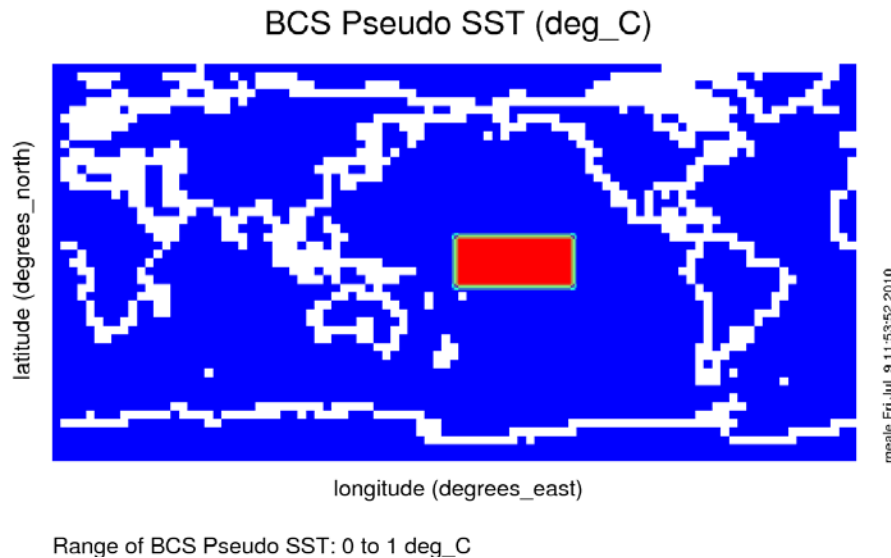
What to look for? (may require longer than 1 month for good signal)

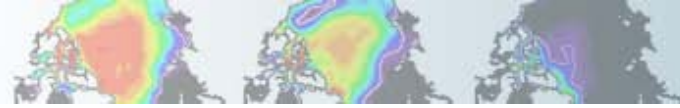
- ✓ *Surface temperature (TS), surface fluxes (LHFLX,SHFLX), cloud (CLDLow), rainfall (PRECT) over land*
- ✓ *How does it affect the diurnal cycle? (if feeling brave output hourly rainfall (PRECT) and surface temperature (TS) over a limited land region - refer to Thursday practical)*



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 configure ***then***
Sea surface temperature (SST) surface boundary data

```
<cd Buildconf>
```

```
<emacs docn.buildnml.csh>
```

SST file is (specifies monthly mean SST = SST_cpl)

```
set dat_datpath = $DIN_LOC_ROOT/ocn/docn7/SSTDATA
```

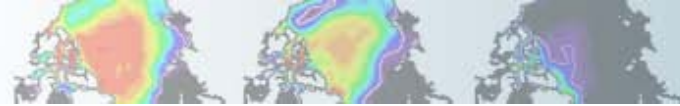
```
set dat_datfile = sst_HadOIBl_bc_48x96_clim_c050526.nc
```

Central input data location (on bluefire)

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

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.sourceforge.net>)

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

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

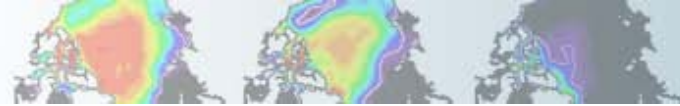
1. Define 2D latitude and longitude arrays

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 dataset to namelist files

```
<emacs docn.buildnml.csh>
```

Change

```
dat_datpath = $DIN_LOC_ROOT/ocn/docn7/SSTDATA
```

To

```
dat_datpath = ./
```

Build model

```
<cd $CASEDIR>
```

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

Copy changed orography boundary data to run directory

```
<cd Buildconf>
```

```
<cp sst_HadOIBl_bc_48x96_clim_c050526.nc /ptmp/$USERNAME/$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)