Day 3: Diagnostics and Output

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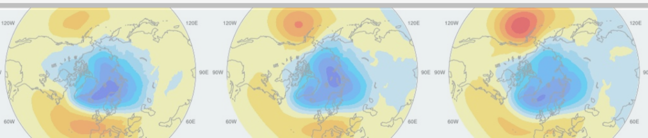
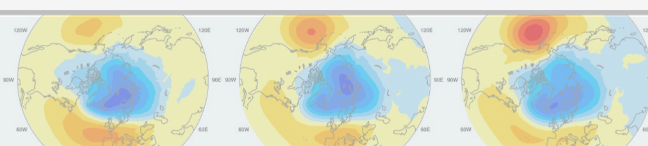
Special thanks to Adam Phillips who did 99% of the work.

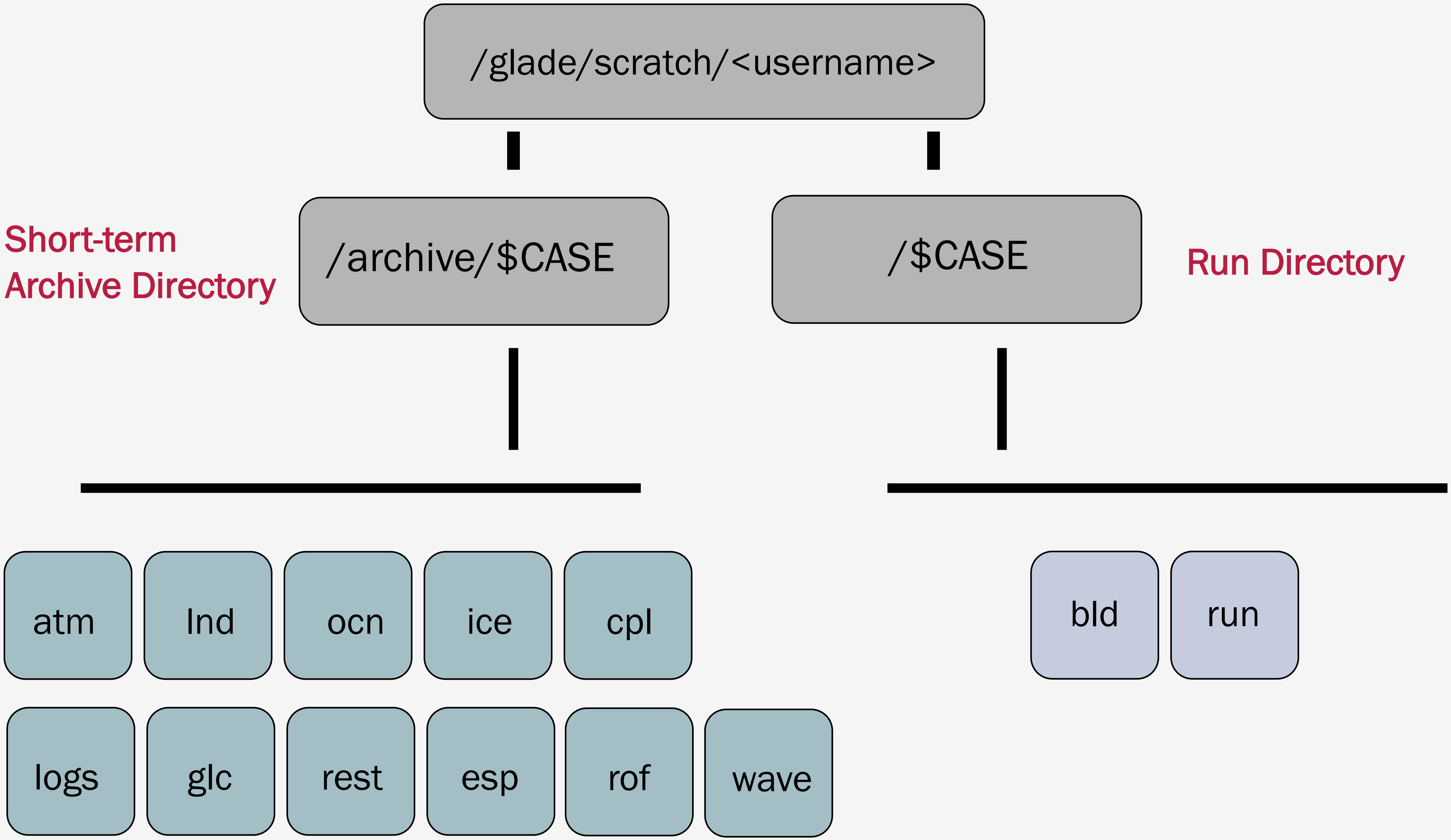


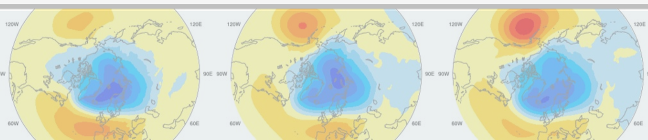
Outline

I. CESM2 output data and experiments
II. Introduction to the NetCDF format, ncdump
III. netCDF Operators (NCO) and Climate Data Operators (CDO)
IV. Quick-use tools: ncview, panoply
V. Introduction to NCL
VI. Introduction to Python and GeoCAT
VII. Practical Lab #3
    A. Diagnostics packages
    B. NCL post-processing scripts
    C. NCL graphics scripts
    D. Additional Exercises
    E. Challenges

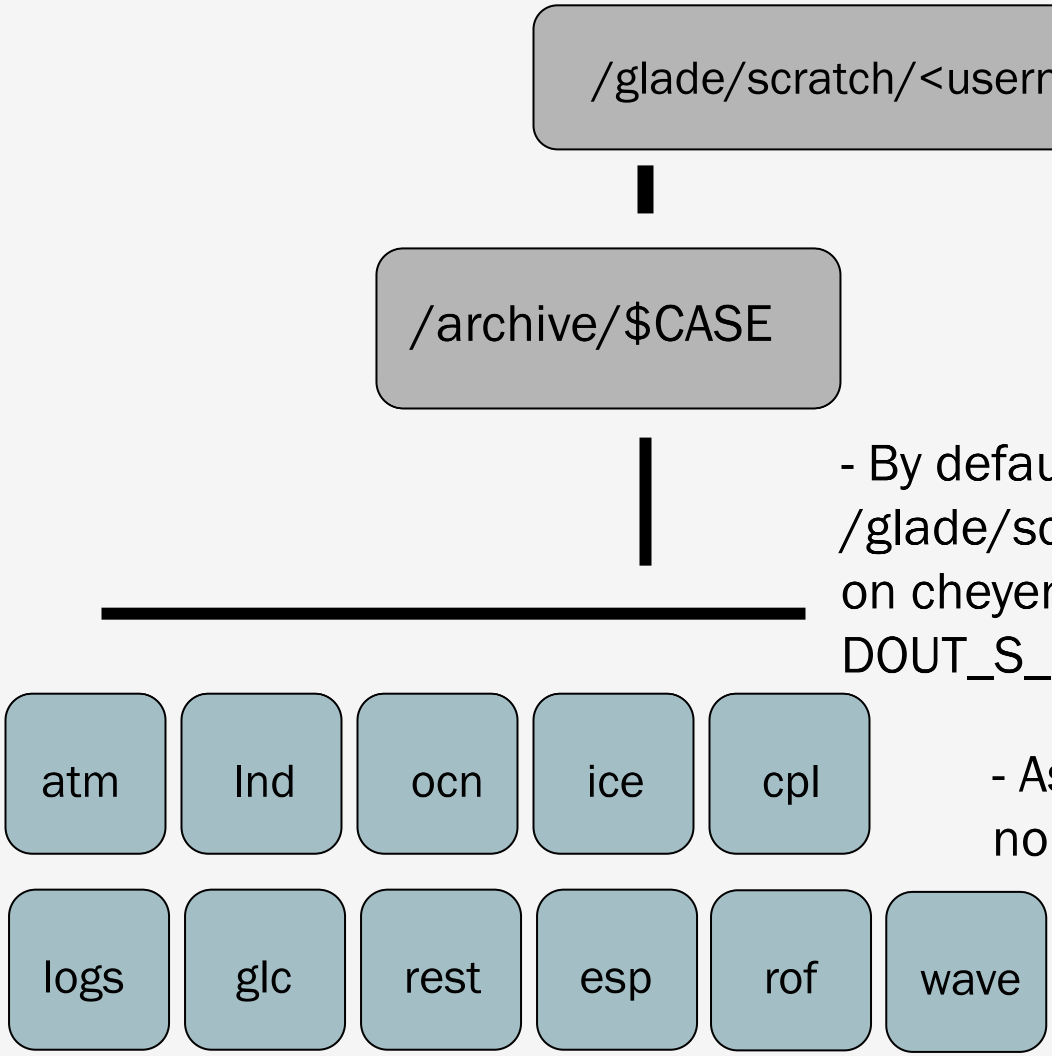


Short-term Archive and Run Directories



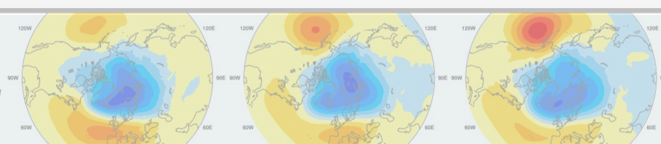


Short-term Archive Directory



- By default, short term archiver writes to /glade/scratch/<username>/archive/$CASE on cheyenne. To modify this path set DOUT_S_ROOT in env_run.xml.

- As of CESM2 long term archiving can no longer be used.



CESM History File Naming Conventions

All history output files are written in NetCDF format.

Location of history files in short-term archive directory:
/glade/scratch/<username>/archive/$case/<component>/hist
component = atm, ocn, etc.

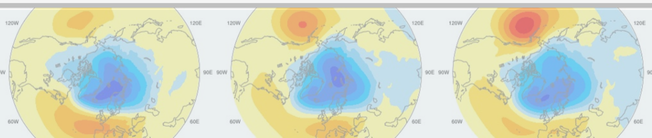
CESM distinguishes between different time sampling frequencies by creating distinct history files for each frequency. *Sampling frequencies are set by the user within the namelist.*

Example history file names:

f40_test.cam.h0.1993-11.nc   f40_test.clm2.h0.1993-11.nc
f40_test.pop.h.1993-11.nc   f40_test.cice.h.1993-11.nc

By default, h0/h denotes that the time sampling frequency is monthly.

Other frequencies are saved under the h1, h2, etc file names:
f40_test.cam2.h1.1993-11-02-00000.nc



CESM History Files vs. Timeseries Files

History files contain all variables for a component for a particular frequency, and are output directly from the model.

Timeseries files are created offline from the model, either by the official CESM workflow post-processing scripts (limited support, run on Cheyenne/DOE machines), or by individual user-generated scripts. Timeseries files span a number of timesteps, and contain only one (major) variable.

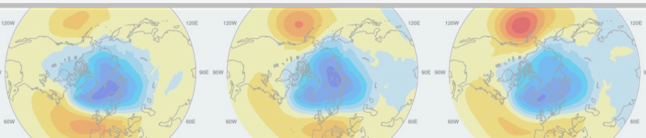
Timeseries files are considerably more useful in day-to-day research and are regularly distributed while history files are not.

Example history file: f40_test.cam.h0.1993-11.nc

- 1 monthly timestep (Nov. 1993)
- 200+ CAM variables (ex. PSL, TS, PRECC..)

Example timeseries file: f40_test.cam.h0.PSL.199001-199912.nc

- 120 monthly timesteps (Jan 1990 – Dec 1999)
- 1 CAM variable (PSL), along with auxiliary variables (time,lat,etc.)



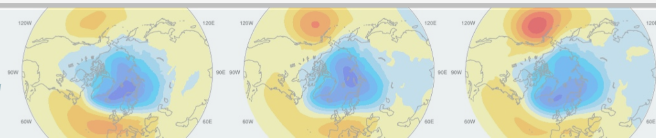
CESM CMIP5/6 Files

CESM CMIP files are similar to CESM timeseries files.

Example CMIP file: zg_Amon_CESM2_historical_r1i1p1f1_gn_185001-201412.nc.nc
- 1980 monthly timesteps (Jan 1850 – Dec 2014)
- 1 variable (zg), along with auxiliary variables (time,lat,etc.)

CESM CMIP files are designed to match CMIP/CMOR conventions, and thus metadata and auxiliary variables (ex. time) may not match CESM timeseries files.

CMIP variables may be a 1-to-1 match to CESM variables, or they may not be. Examine the data/metadata to check.



CESM & time variable

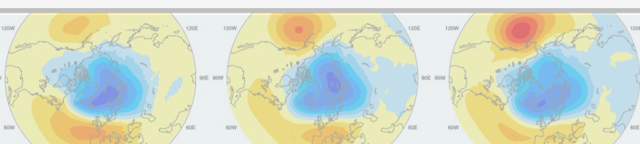
The time coordinate variable in CESM history and timeseries files represents *the end* of the averaging period for variables that are averages.

This is different from the time expressed in the file name. *For monthly files, the time given in the file name is correct.*

Example File: f.e11.FAMIPC5CN.f09_f09.rcp85.ersstv5.toga.ens10.cam.h0.2017-12.nc

When the time coordinate variable is translated, the time is 00Z January 1st 2018, even though the file holds averaged variables for *December 2017*.

```
cheyenne2-/glade/scratch/asphilli>ncl
 Copyright (C) 1995-2017 - All Rights Reserved
 University Corporation for Atmospheric Research
 NCAR Command Language Version 6.4.0
 The use of this software is governed by a License Agreement.
 See http://www.ncl.ucar.edu/ for more details.
ncl 0> fn = "f.e11.FAMIPC5CN.f09_f09.rcp85.ersstv5.toga.ens10.cam.h0.2017-12.nc"
ncl 1> a = addfile(fn,"r")
ncl 2> print("Translated time = "+cd_calendar(a->time,3))
(0)     Translated time = 2018010100
```

CESM & time variable

To verify the averaging period in the files, consult the time_bnds, time_bound or time_bounds variables in the file.

Example File: f.e11.FAMIPC5CN.f09_f09.rcp85.ersstv5.toga.ens10.cam.h0.2017-12.nc

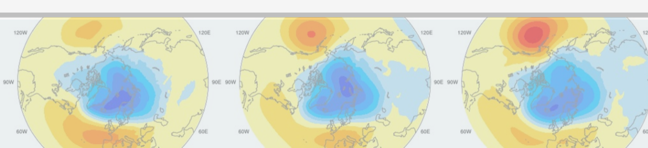
When the time_bnds variable is translated, the time averaging period is shown to be from 00Z Dec 1st 2017 through 00Z Jan 1st 2018.

```
cheyenne2-/glade/scratch/asphilli>ncl
 Copyright (C) 1995-2017 - All Rights Reserved
 University Corporation for Atmospheric Research
 NCAR Command Language Version 6.4.0
 The use of this software is governed by a License Agreement.
 See http://www.ncl.ucar.edu/ for more details.
ncl 0> fn = "f.e11.FAMIPC5CN.f09_f09.rcp85.ersstv5.toga.ens10.cam.h0.2017-12.nc"
ncl 1> a = addfile(fn,"r")
ncl 2> print("Translated time = "+cd_calendar(a->time,3))
ncl 3> time_bounds = a->time_bnds
ncl 4> copy_VarAtts(a->time,time_bounds)
ncl 5> print("Time bounds = "+cd_calendar(time_bounds,3))
(0,0)   Time bounds = 2017120100
(0,1)   Time bounds = 2018010100
```

Why is this done? With the time set at the end of the averaging period, this allows CESM to store instantaneous and averaged variables within the same file.

This issue only affects CESM history and timeseries files, not CESM CMIP files.

Best practice: Always verify the averaging period as shown.



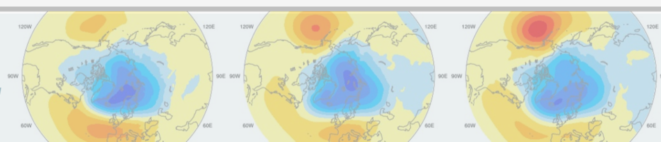
CESM Experiment Casename Conventions

A lot of information is stored in standardized CESM case names.
The convention is:
<compset char>.<code base>.<compset sname>.<resolution sname>[.opt_desc_string].<nnn>[opt_char]

<compset char>	= 1 character, first letter of compset
<code base>	= code base, “e21” for cesm2.1, “e20” for cesm2.0, “e10” for cesm1.0, ”c40” for ccsm4.0.
<compset sname>	= compset shortname
<resolution sname>	= resolution shortname
<.opt_desc_string>	= optional descriptive string, to be kept short if possible
<nnn>	= 3 digit number
[opt_char]	= optional single lower-cased letter; allowed to distinguish a group of cases that are very closely related

Examples: b.e21.B1850.f09_g16.CMIP6-piControl.001
f.e11.FAMIPCN.f09_f09.rcp85_ersstv5.005

One note about compsets: The first letter of the casename is indicative of the type of run it is: A coupled run (a “B” case), an atmosphere/land run (“F”), a land run (“I”), or an ocean/ice run (“G”). Other letters (A,Q,S,T,X) denoting less common configurations are also used.



CESM Experiments Websites

NCAR | UCAR | COMMUNITY EARTH SYSTEM MODEL CESM ®

PUBLICATIONS ABOUT HELP SEARCH ...

ADMINISTRATION WORKING GROUPS MODELS EVENTS

/ CESM Models / CESM Experiments

CESM Experiments

CCSM/CESM Models: Experiments and Resulting Output Data

CESM2.y.z

- CESM2 Experiments, Data and Diagnostic Output
- CESM2-LENS - Large Ensemble Community Project
- Climate Variability and Change Working Group Simulations

CESM1.3 HR

- A development version of CESM1.3 High-Resolution (HR) configuration is available

CESM1.2

- CESM1.2 Experiments, Data and Diagnostic Output
- Geoengineering Large Ensemble

CESM1.1.1

- CESM1.1.1 Experiments, Data and Diagnostic Output
- Low-Warming: 1.5°C - 2.0°C Targets
- CESM1-LENS - Large Ensemble Community Project
- ME - Medium Ensemble (part of the BRACE project)
- LME - Last Millennium Ensemble Project
- Prescribed SST AMIP Ensembles
- Single Forcings Project
- Tropical Pacific Pacemaker Project

CESM MODELS

Overview

CESM Releases

Experiments, Data & Diagnostic Output

Experiments

CMIP6

Projects

Community Projects

Simpler Models

Legacy

Legacy Releases: Older General/Run Info

RELATED INFORMATION

Downloading the CESM Code

Data Management & Distribution Plan

Development Project Policies & Terms of Use

Publication / Acknowledgment Information

CESM2 Included Packages Copyright

CESM2 Copyright

CESM Support Policy

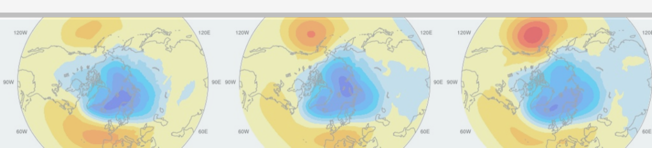
CESM COMMUNICATIONS

User Support Forums

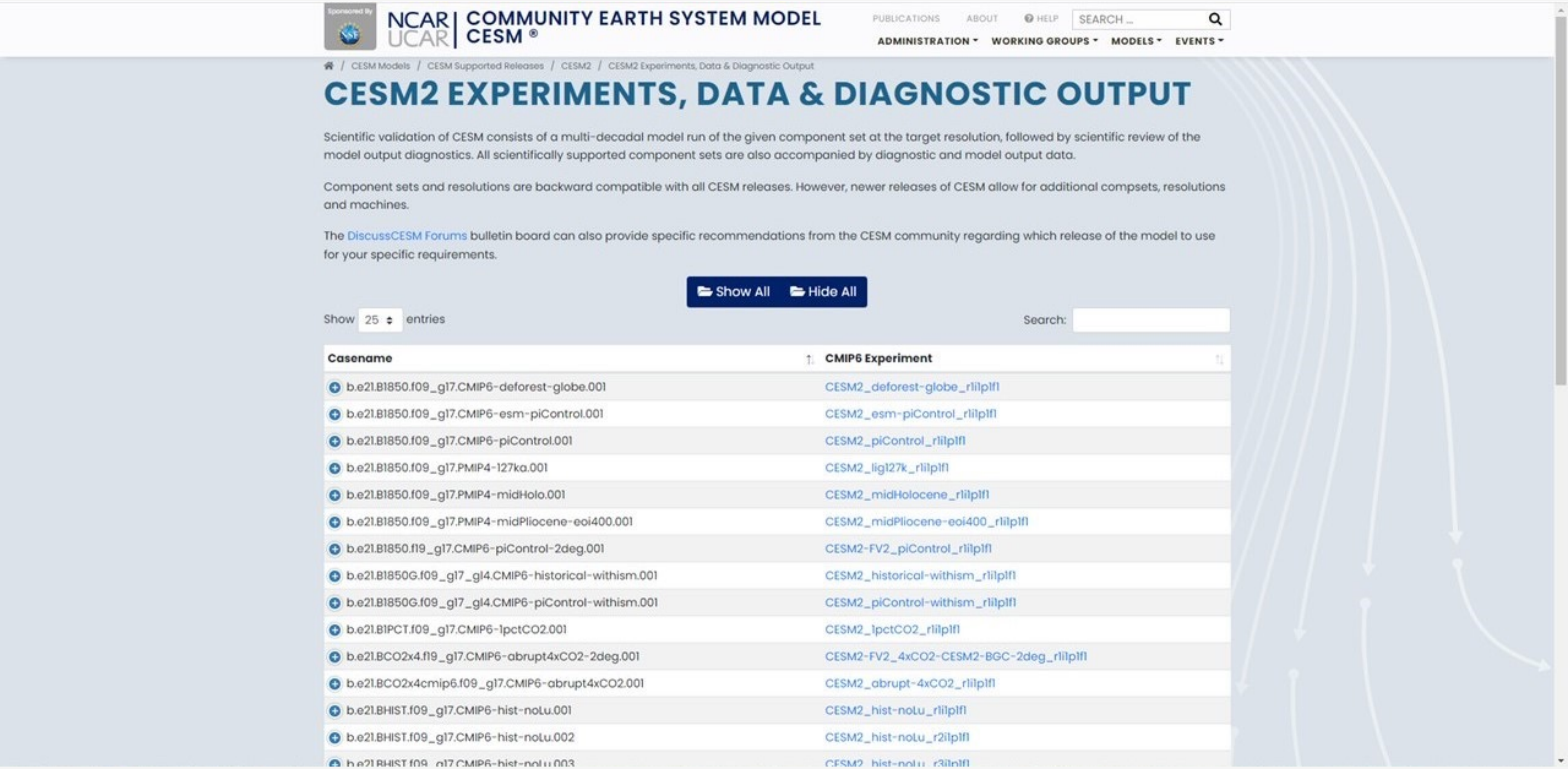
Mailing Lists

Contact CESM

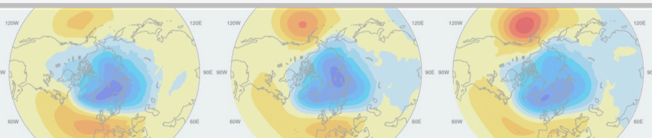
http://www.cesm.ucar.edu/experiments/



CESM Experiments Websites



https://csegweb.cgd.ucar.edu/experiments/public/



CESM Experiments Websites

Description of run with list of active components

Links to data on ESGF nodes and/or the NCAR-CDG; cheyenne directory also listed.

Diagnostic links provided for component packages and the CVDP.

https://csegweb.cgd.ucar.edu/experiments/public/

Casename	Size	Type	Model Version
b.e21.B1850.f09_g17.CMIP6-deforest-globe.001	1	CMIP6 Experiments	cesm2.1-exp003
b.e21.B1850.f09_g17.CMIP6-piControl.001	1	CMIP6 Experiments	cesm2.1-exp003

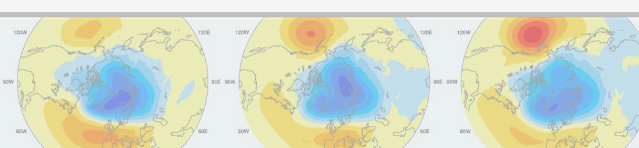
Title CMIP6 CESM2 piControl experiment with CAM6, interactive land (CLM5), coupled ocean (POP2) with biogeochemistry (MARBL), interactive sea ice (CICE5.1), and non-evolving land ice (CISM2.1)

Data Set Availability

Access Type	URL or Path
ESGF experiment data URL (45710.956 Gbytes per ensemble member)	https://esgf-node.llnl.gov/search/cmip6/?institution_id=NCAR&source_id=CESM2&experiment_id=piControl&variant_label=r1i1p1f1
NCAR users CMIP6 CESM2 native single-variable timeseries files	/glade/collections/cdg/timeseries-cmip6/b.e21.B1850.f09_g17.CMIP6-piControl.001
Caseroot files	https://svn-cesm2-expdb.cgd.ucar.edu/public/b.e21.B1850.f09_g17.CMIP6-piControl.001

Diagnostics Plot Sets

atmosphere diagnostics (2018-08-16)	
Description	
Link	http://webext.cgd.ucar.edu/B1850/b.e21.B1850.f09_g17.CMIP6-piControl.001/atm/
sea-ice diagnostics (2018-08-21)	
Description	
Link	http://webext.cgd.ucar.edu/B1850/b.e21.B1850.f09_g17.CMIP6-piControl.001/ice
land diagnostics (2018-08-21)	
Description	
Link	http://webext.cgd.ucar.edu/B1850/b.e21.B1850.f09_g17.CMIP6-piControl.001/lnd
ocean diagnostics (2018-11-07)	
Description	
Link	http://webext.cgd.ucar.edu/B1850/b.e21.B1850.f09_g17.CMIP6-piControl.001/ocn
climate variability diagnostics (2018-11-12)	
Description	Years 100-1199: Compared a 1100yr segment of CESM2 control to two 1100yr segments from CESM1 LENS control. Also compared eleven 100yr segments from the CESM2 control to twelve 100yr segments from the CESM1 LENS control.
Link	http://webext.cgd.ucar.edu/B1850/b.e21.B1850.f09_g17.CMIP6-piControl.001/cvdp/index.html



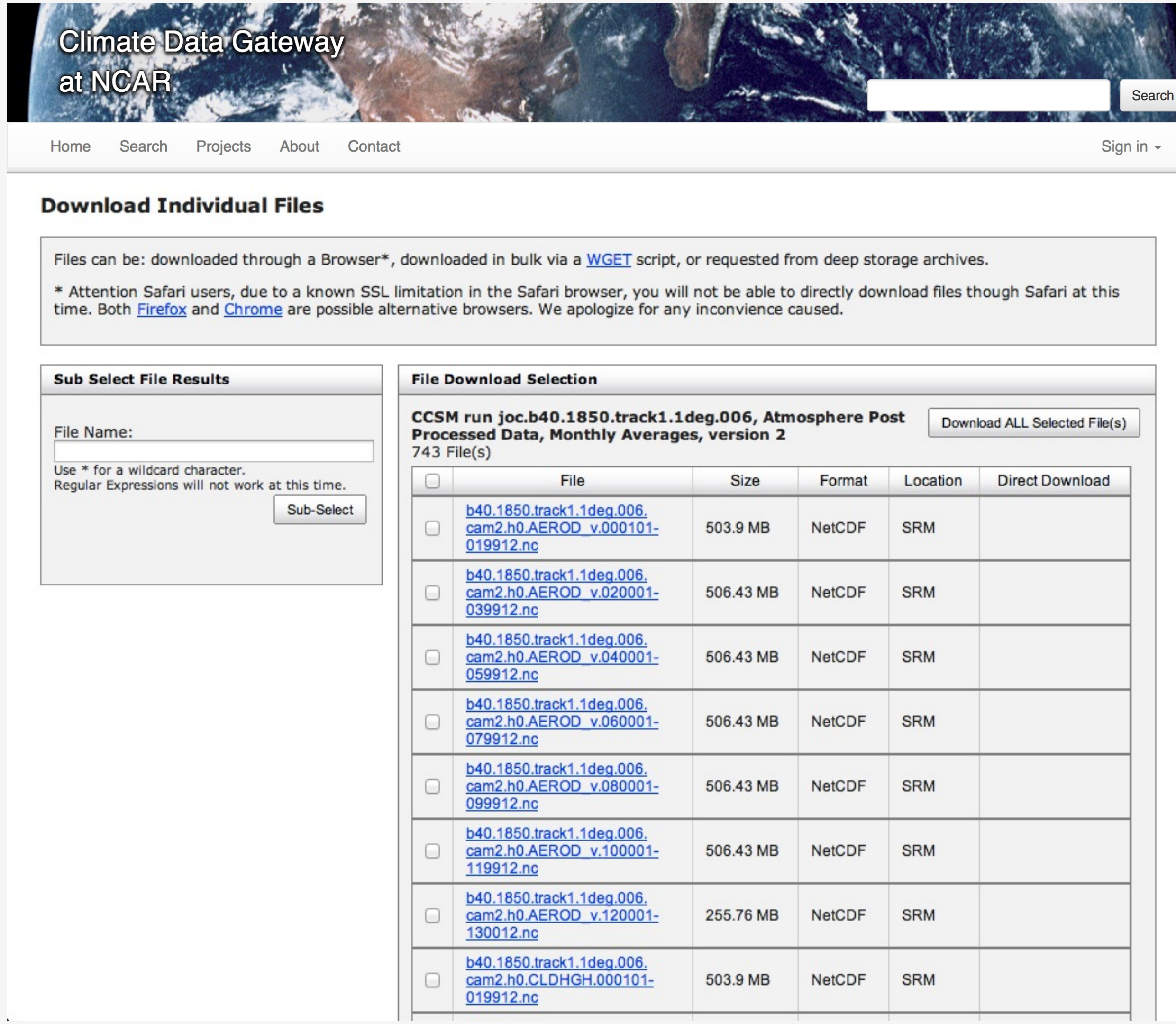
Climate Data Gateway at NCAR

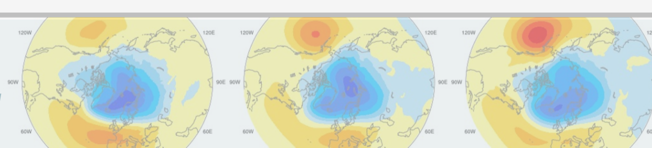
Publicly released CESM data is available via the CDG.

Registration is quick and easy. NCAR accounts are not required.

Timeseries data in CESM and CMIP formats are available.

https://www.earthsystemgrid.org/





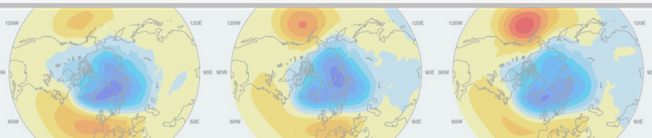
Notable CESM2 Simulations Currently Available

1850 Pre-industrial simulation w/CAM6 (2000yrs)
1850 Pre-industrial simulation w/WACCM6 (500yrs)

Large Ensemble (historical+ssp370 scenarios, 1850-2100,
100 members, 10 w/high frq output)

SSP2-4.5 Ensemble (ssp245 scenario, 2015-2100, 16 members)

CAM6 Prescribed SST AMIP Ensemble (1880-2021, 10 members)



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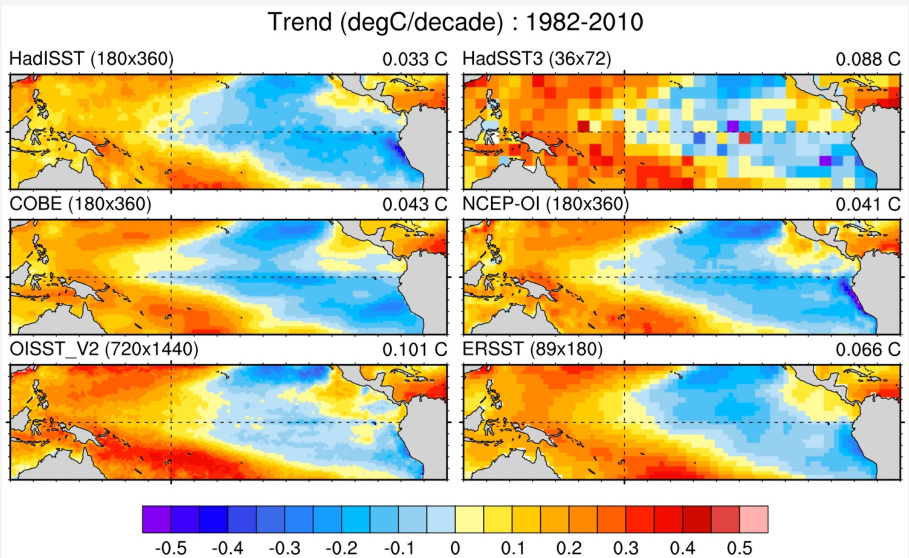
Concise and reliable expert guidance on the strengths, limitations and applications of climate data…



Comparison of SST data sets and their recent trends in the tropical Pacific

http://climatedataguide.ucar.edu

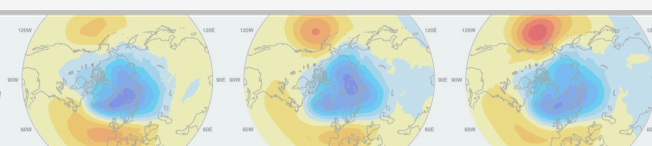
Describe observations used for Earth System Model evaluation; **150+ data sets** profiled

Data set pros and cons evaluated by **nearly 4 Dozen Experts** ('expert-user guidance')

Comparisons of many common variables: SST, precipitation, sea ice concentration, atmospheric reanalysis, etc.

140,000 unique visitors in 2014 (up from 41,000 in 2012)

For more info contact David P. Schneider, NCAR, Climate Analysis Section. dschneid@ucar.edu



Introduction to NetCDF

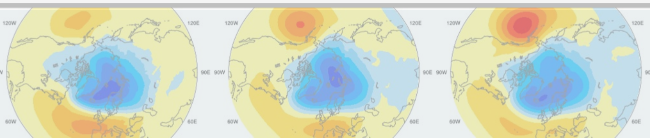
NetCDF stands for “network Common Data Form”

PROS: self-describing, portable, metadata friendly, supported by many languages including fortran, C, Matlab, ferret, GrADS, NCL, IDL, python; viewing tools like ncview/panoply; and tool suites of file operators (NCO, CDO).

CONS: compression not available until NetCDF4, oftentimes requires users to explicitly access information (not true in NCL or certain python packages like xarray)

http://www.unidata.ucar.edu/software/netcdf

http://www.unidata.ucar.edu/software/netcdf/docs/BestPractices.html



ncdump

ncdump is a netCDF utility that allows one to dump the contents of the netCDF file to screen or file.

To view the header of a netCDF file:

ncdump –h slp.mon.mean.nc

To view the contents of a variable:

ncdump –v slp slp.mon.mean.nc | less

To view the netCDF file type:

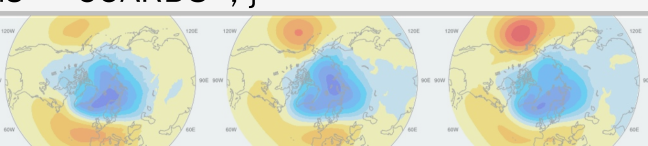
ncdump –k slp.mon.mean.nc

result: netCDF-4

To print readable date-time strings:

ncdump –t –v time slp.mon.mean.nc

```
netcdf slp.mon.mean {
dimensions:
        lon = 144 ;
        lat = 73 ;
        time = UNLIMITED ; // (744 currently)
variables:
        float lat(lat) ;
                lat:units = "degrees_north" ;
                lat:actual_range = 90.f, -90.f ;
                lat:long_name = "Latitude" ;
        float lon(lon) ;
                lon:units = "degrees_east" ;
                lon:long_name = "Longitude" ;
                lon:actual_range = 0.f, 357.5f ;
        double time(time) ;
                time:units = "hours since 1-1-1 00:00:0.0" ;
                time:long_name = "Time" ;
                time:actual_range = 17067072., 17609832. ;
        float slp(time, lat, lon) ;
                slp:long_name = "Sea Level Pressure" ;
                slp:valid_range = 870.f, 1150.f ;
                slp:actual_range = 960.1486f, 1082.558f ;
                slp:units = "millibars" ;
                slp:missing_value = -9.96921e+36f ;,
// global attributes:
                :title = “Monthly mean slp from the NCEP Reanalysis" ;
                :description = "Data is from NMC initialized reanalysis\n
                "(4x/day).  These are the 0.9950 sigma level values." ;
                :Conventions = "COARDS" ; }
```

netCDF Operators (NCO)

NCO is a suite of programs designed to perform certain “operations” on netCDF files, i.e., things like averaging, concatenating, subsetting, or metadata manipulation.

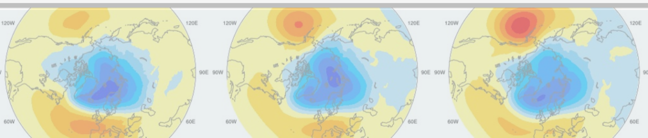
Command-line operations are extremely useful for processing model data given that modelers often work in a UNIX-type environment.

UNIX wildcards are accepted for many of the operators.

The NCO’s recognize missing data by the _FillValue attribute.
(missing_value is ignored.)

The NCO Homepage and Reference Manual can be found at http://nco.sourceforge.net

Note: There are many other netCDF operators beyond what will be described here.



netCDF Operators (NCO)

NCRA (netCDF record averager)

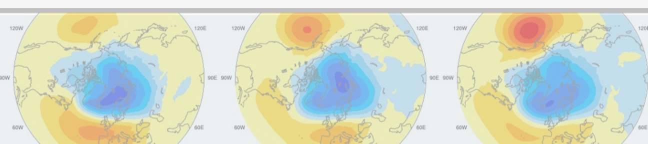
Example: ncra file1.nc file2.nc avgfile.nc

file1.nc = input model history file, for jan year 1
file2.nc = input model history file, for feb year 1
avgfile.nc = new file consisting of jan/feb averaged data for all fields found in the input model history file.

NCRCAT (netCDF record concatenator)

Examples: ncrcat file1.nc file2.nc out12.nc

out12.nc = new model history time series file consisting of the months of jan and feb, year 1. Each time-varying field in this file now has 2 time steps.



Introduction to netCDF Operators (NCO)

NCES (netCDF ensemble statistics, formerly NCEA)

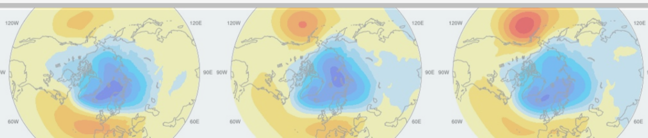
Example: nces amip_r01.nc amip_r02.nc amip_r03.nc amip_ENS.nc

amip_r01.nc = input file from ensemble member #1
containing monthly Jan-Dec year 1 data
amip_r02.nc = same as above but contains data from ensemble member #2
amip_r03.nc = same as above but contains data from ensemble member #3
amip_ENS.nc = new file consisting of monthly Jan-Dec year 1 data
averaged across the 3 ensemble members.

NCDIFF (netCDF differencer)

Example: ncdiff amip_r01.nc amip_r02.nc diff.nc

diff.nc = contains the differences between amip_r01.nc and amip_r02.nc.
Note: Useful for debugging purposes.



Introduction to netCDF Operators (NCO)

NCKS (netCDF “Kitchen Sink” = does just about anything)

Combines various netCDF utilities that allow one to cut and paste subsets of data into a new file.

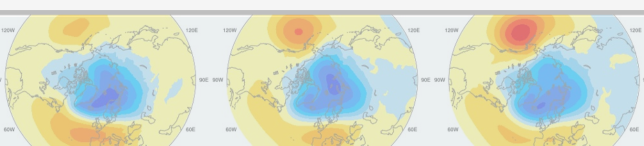
Example: ncks –v TEMP f40_test.pop.h.1993-11.nc f40_test.TEMP.199311.nc

f40_test.pop.h.1993-11.nc = input model history file (monthly)
-v TEMP = only grab the TEMP variable
f40_test.TEMP.1993-11.nc = output file containing TEMP + associated coordinate variables

Note #1: Only those variables specified by –v and their associated coordinate variables are included in the output file. As the variables date, TLAT, and TLONG are not coordinate variables of TEMP, they won’t be copied to the output file unless one does this:

```
ncks –v TEMP,date,TLAT,TLONG  f40_test.pop.h.1993-11.nc  f40_test.T.1993-11.nc
```

Note #2: Wildcards not accepted.



Introduction to netCDF Operators (NCO)

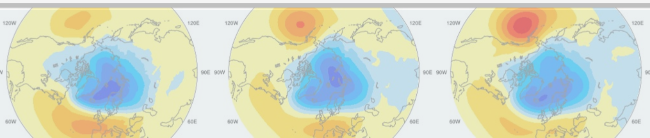
Other commonly used operators:

NCATTED (attribute editor)

NCRENAME (rename variables, dimensions, attributes)

NCFLINT (interpolates data between files)

NCPDQ (pack to type short or unpack files)



Introduction to netCDF Operators (NCO)

netCDF operator options

-v Operates only on those variables listed.

```
ncks –v T,U,PS in.nc out.nc
```

-x –v Operates on all variables except those listed.

```
ncrcat –x –v CHI,CLDTOT 1999-01.nc 1999-02.nc out.nc
```

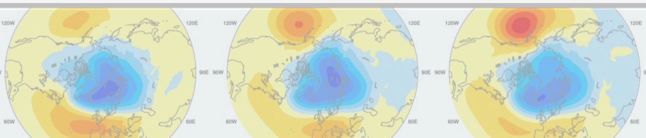
-d Operates on a subset of data.

```
ncks  -d lon,0.,180.   -d lat,0,63 in.nc out.nc
```

Real numbers indicate actual coordinate values, while integers indicate actual array indexes. In the above example, all longitudes will be grabbed from 0:180E, and the first 64 latitudes indexes will be grabbed.

-h Override automatic appending of the global history attribute with the NCO command issued (which can be very long)

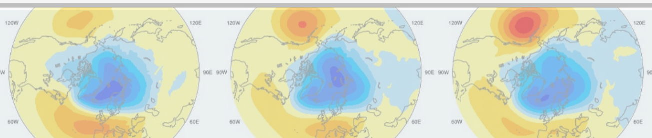
More options exist beyond what was discussed here.



Introduction to netCDF Operators (NCO)

Note that you can wrap the NCO’s into a script

```
begin
 syear= "1920"    ; YYYY
 eyear ="2029"    ; YYYY
 emonth = "12"
 time_s = "{1,2}*"   ; "0*" = default, {1,2}* for 20C simulations
 mrun = "b.e11.B20TRLENS_RCP85.f09_g16.xbmb.011"
 indir = "/glade/scratch/dbailey/archive/"+mrun+"/"
 outdir = "/glade/scratch/asphilli/"+mrun+"/"
 atm_vars = (/“PSL”,”PRECC","PRECL","TS"/)
;—————————————————————————————————
 if (.not.fileexists(outdir)) then
   system("mkdir "+outdir)
 end if
 do gg = 0,dimsizes(atm_vars)-1
     ofile = outdir+mrun+".cam.h0."+atm_vars(gg)+"."+syear+"01-"+eyear+emonth+".nc”
     system("ncrcat –h -v "+atm_vars(gg)+" "+indir+"atm/hist/*.h0."+time_s+" "+ofile+” &")
 end do
end
```

Introduction to Climate Data Operators (CDO)

CDO are very similar to the NCO. Within the CDO library there are over 600 command line operators that do a variety of tasks including: detrending, EOF analysis, meta data modification, statistical analysis and similar calculations.

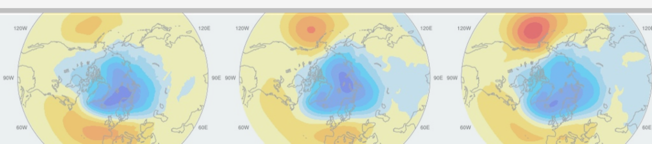
CDO are not currently used in the diagnostics packages, so we will not go into specifics here. We mention the CDO to make you aware of their existence.

The CDO Homepage can be found at:

https://code.zmaw.de/projects/cdo/

CDO documentation can be found at:

https://code.zmaw.de/projects/cdo/wiki/Cdo#Documentation

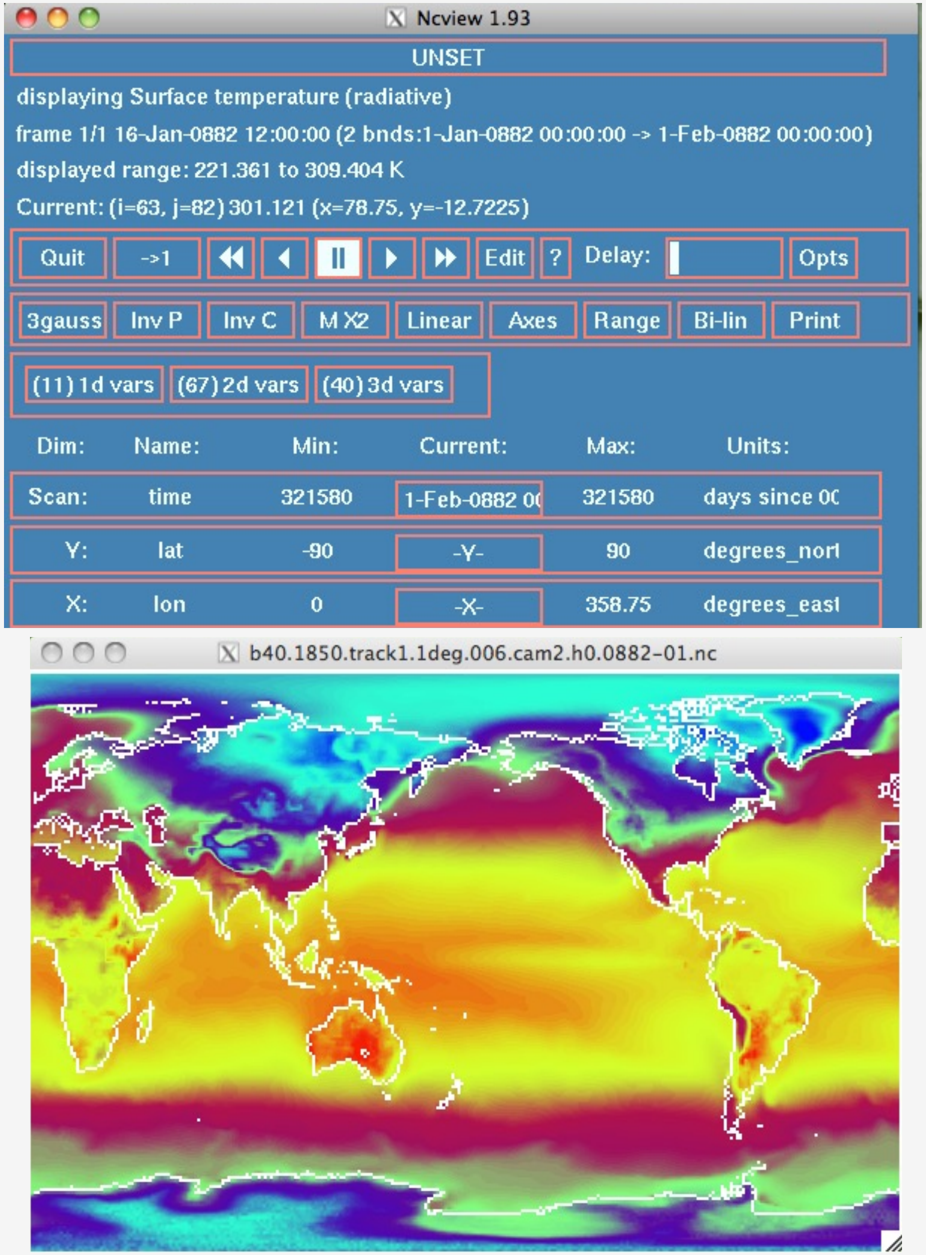


ncview

ncview is a graphical interface which allows one to quickly view the variables inside a netCDF file.

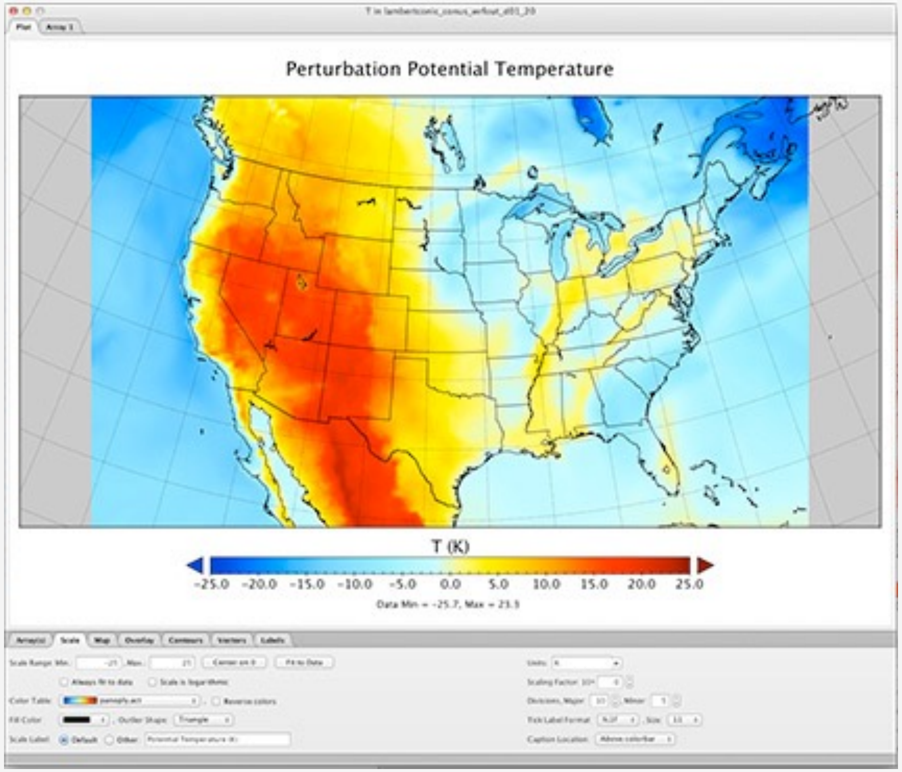
Example: ncview file1.nc

ncview allows you to interactively visualize a selected variable across a selected range (time, spatial).



Panoply

Panoply is another GUI application that allows one to quickly view data in a netCDF, HDF, or GRIB format (amongst others). Similar to ncview, but more powerful, panoply allows the user to perform simple calculations, apply masks, and to quickly create spatial or line plots.



Note: v4.10.8 requires Java SE 8 runtime environment or newer. Documentation is improving, with numerous demonstration tutorials/videos and How-To's.

The Panoply homepage can be found at:

http://www.giss.nasa.gov/tools/panoply/

NCAR Command Language (NCL)

What NCL is known for:

- Easy I/O. NetCDF, Grib, Grib2, shapefiles, ascii, binary.
- Good graphics; utmost flexibility in design.
- Functions tailored to the geosciences community.
- All encompassing website with 1000+ examples.
- Open source. Free to download and use.

For more information, or to get started learning NCL:

http://www.ncl.ucar.edu/get_started.shtml

Page through the NCL mini-language and processing manuals

http://www.ncl.ucar.edu/Document/Manuals

However, NCL is now in a maintenance stage, and most active development has moved to Python.

http://www.ncl.ucar.edu

Python

What Python is known for:

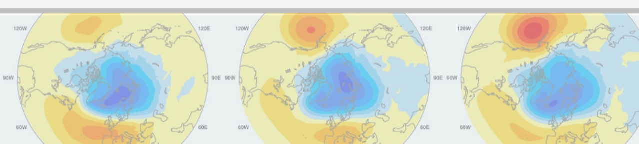
- Open Source. Free to download and use.

- Wide range of applications and packages available, along with a huge user base and ~1 gazillion online tutorials.

- Active development in packages related to the geosciences.

If you are new to python and its application
To the geosciences, then I would recommend starting with Project Pythia:

https://foundations.projectpythia.org/landing-page.html



Geoscience Community Analysis Toolkit (GeoCAT)

NCAR is working on a python-based replacement for NCL called GeoCAT. This includes functions for both plotting and analysis:

https://geocat.ucar.edu/

Just like NCL, the GeoCAT team is working on implementing a collection of Examples to show how it can be used. You can find those examples here:

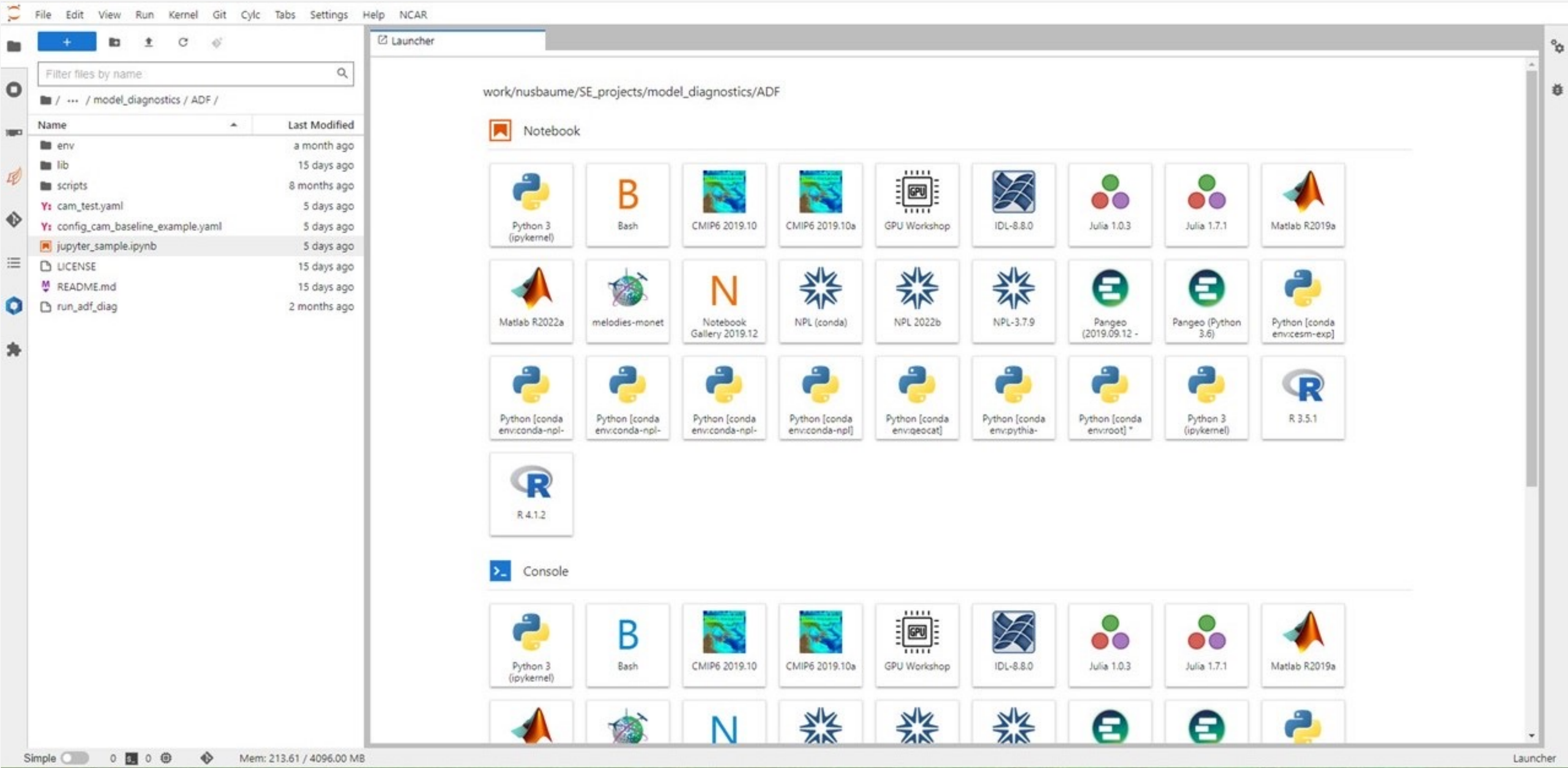
https://geocat-examples.readthedocs.io/en/latest/

MetPy

If you also work with weather data, then you might also want to checkout out MetPy, which is under UCAR as well:

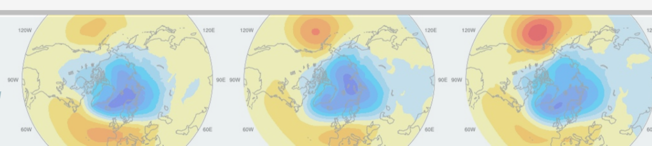
https://unidata.github.io/MetPy/latest/

Jupyterhub



Jupyterhub is a web browser interface to the CISL machines, and allows for the creation and use of Jupyter notebooks:

https://jupyterhub.hpc.ucar.edu

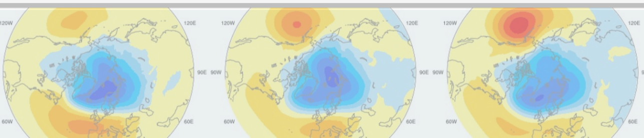


Using NCL in Practical Lab #3

Within the lab, you are going to be provided NCL scripts that post-process the monthly model data that you created and draw simple graphics.

What is meant by post-processing: Convert the model history data from one time step all variables on one file to all time steps, one variable per file. (Also convert CAM 3D data from hybrid-sigma levels to selected pressure levels.)

The diagnostic script suites all use NCL (except the ADF), and you will have the opportunity to run these as well.



Diagnostics Packages

What are they?

A set of NCL/python scripts that automatically generate a variety of different plots from model output files that are used to evaluate a simulation.

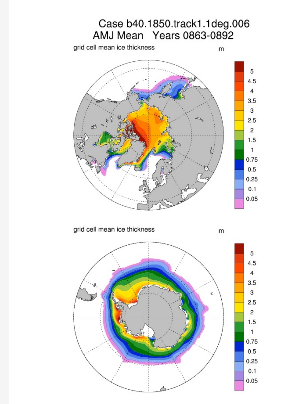
How many packages are there?

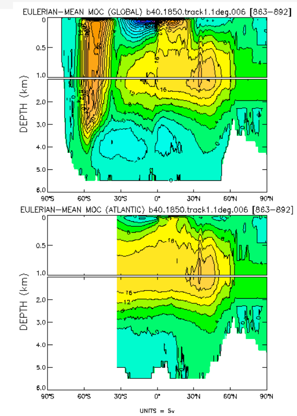
4 Comp: Atmosphere, Ice, Land, Ocean
1 Next Generation Comp: ADF
2 Climate: CVDP, CVDP-LE

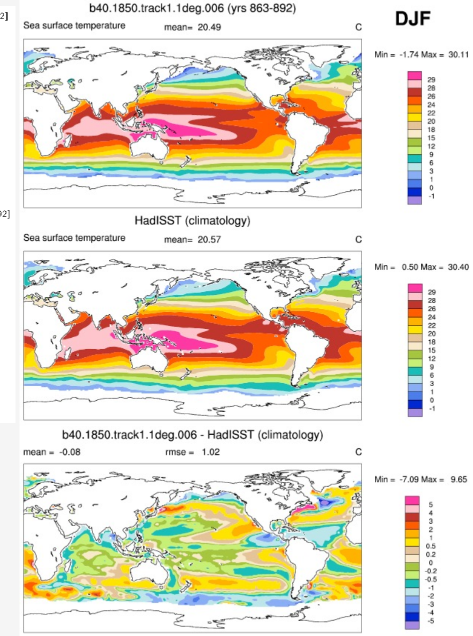
Why are they used?

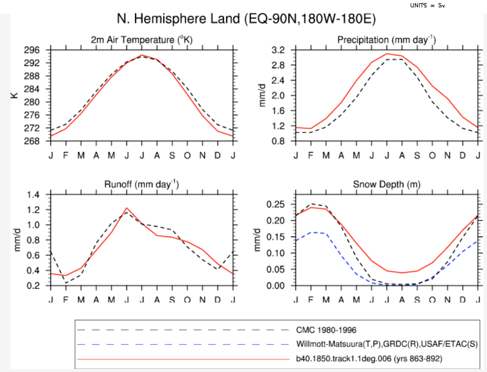
The diagnostics are the easiest and fastest way to get a picture of the mean climate of your simulation. They can also show if something is wrong.

Note: The component diagnostics packages can be used as the first step in the research process, but the general nature of the calculations does not lend itself to in-depth investigation.

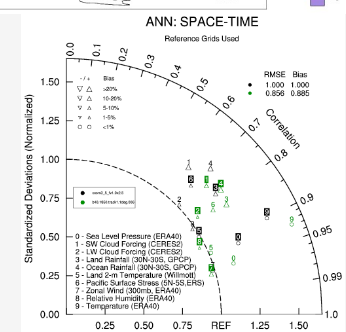


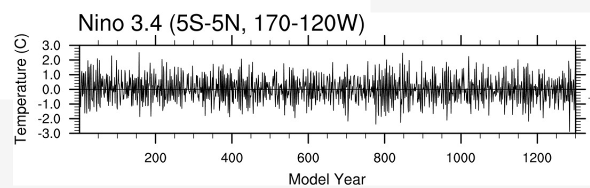




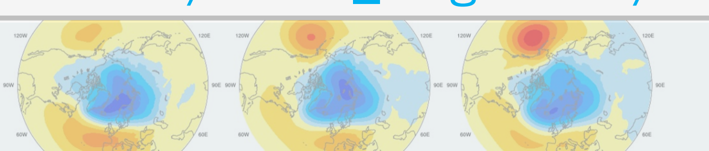



```
++++++++++++++++++++++++++++++
CPL7 Surface Energy Budget for Years:  1 1300
  (+ ==> model gains heat, - ==> model loses heat)
          FREEZE      MELT    RUNOFF        SW        LW       LAT       SEN       NET  (W/m^2)
        --------  --------  --------  --------  --------  --------  --------  --------
  ATM:     0.000     0.000     0.000  -167.337    64.023    85.696    17.776     0.157
  OCN:     0.128    -0.992    -0.062   124.207   -41.138   -71.886   -10.366    -0.109
ICE_N:    -0.062     0.365     0.000     0.495    -0.862    -0.101     0.159    -0.005
ICE_S:    -0.066     0.627     0.000     0.609    -1.313    -0.265     0.399    -0.009
  LND:     0.000     0.000     0.062    42.027   -20.710   -13.444    -7.969    -0.034

O+I+L:    -0.000     0.000     0.000   167.338   -64.023   -85.696   -17.777    -0.158

  OCN NET renormalized:   -0.15341

    Mean ATM frac:    1.00000
    Mean OCN frac:    0.65350
  Mean ICE_N frac:    0.02278
  Mean ICE_S frac:    0.03198
    Mean LND frac:    0.29174
++++++++++++++++++++++++++++++
```



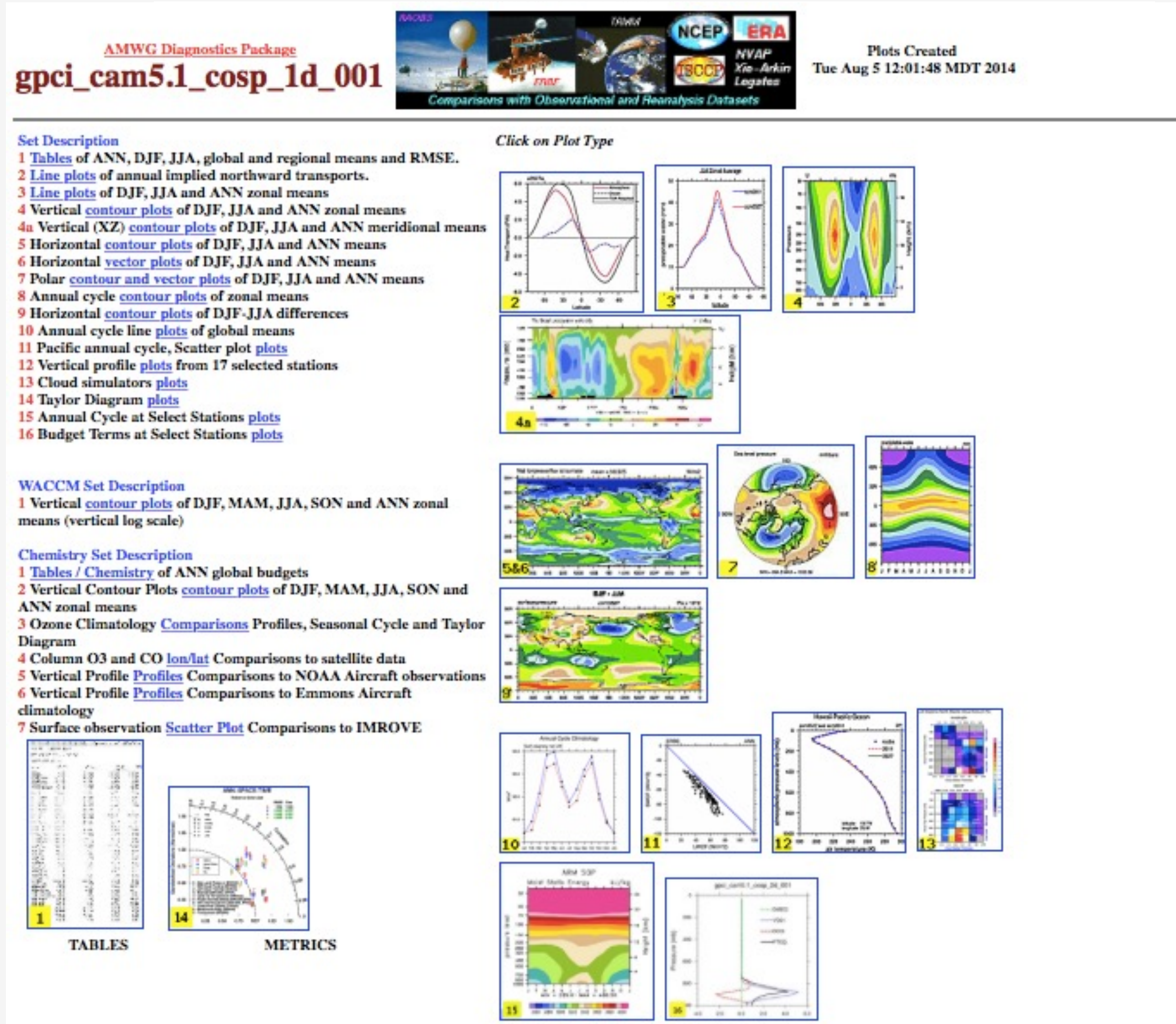


http://www.cesm.ucar.edu/models/cesm2.0/model_diagnostics/



Diagnostics Packages

AMWG Diagnostics Package Output


AMWG Diagnostics Package

gpci_cam5.1_cosp_1d_001

Comparisons with Observational and Reanalysis Datasets

Plots Created
Tue Aug 5 12:01:48 MDT 2014

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 Cloud simulators plots
14 Taylor Diagram plots
15 Annual Cycle at Select Stations plots
16 Budget Terms at Select Stations plots

WACCM Set Description
1 Vertical contour plots of DJF, MAM, JJA, SON and ANN zonal means (vertical log scale)

Chemistry Set Description
1 Tables / Chemistry of ANN global budgets
2 Vertical Contour Plots contour plots of DJF, MAM, JJA, SON and ANN zonal means
3 Ozone Climatology Comparisons Profiles, Seasonal Cycle and Taylor Diagram
4 Column O3 and CO lon/lat Comparisons to satellite data
5 Vertical Profile Profiles Comparisons to NOAA Aircraft observations
6 Vertical Profile Profiles Comparisons to Emmons Aircraft climatology
7 Surface observation Scatter Plot Comparisons to IMROVE

TABLES

METRICS

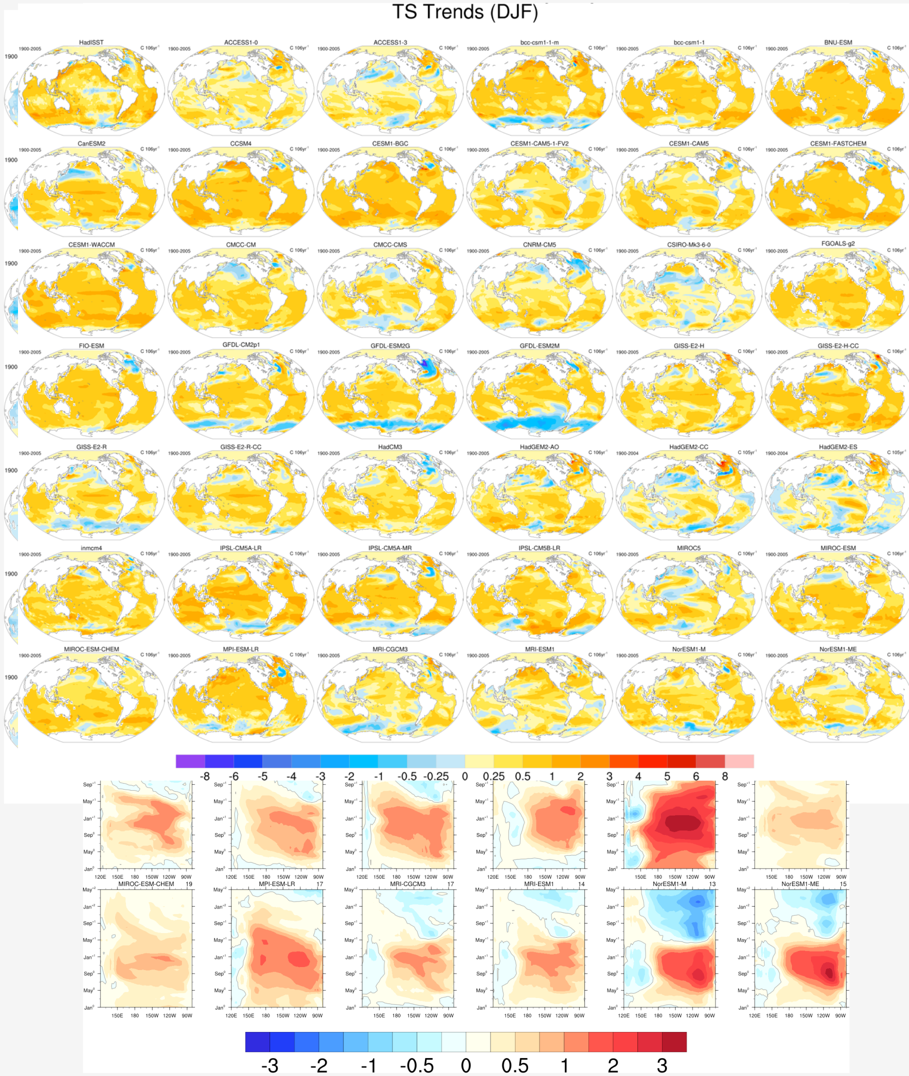
Click on Plot Type

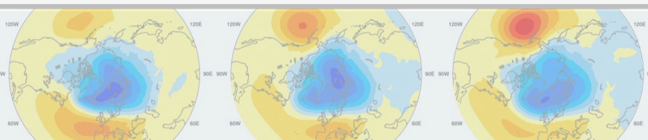
Climate Variability Diagnostic Package

The Climate Variability Diagnostics Package (CVDP) is the newest of the diagnostics packages. The CVDP calculates the major modes of variability (AMO, PDO, NAM, etc.), AMOC metrics, and trends amongst other calculations.

Unlike the other diagnostics packages, this package is run over decades/centuries and allows multiple simulations to be input at once. Data from the CMIP3/5/6 archives are also allowed, allowing intercomparisons between CESM and other models. Calculations can be output to netCDF files for future use.

The CVDP is a component of the Earth System Model Validation Tool (ESMValTool).





Climate Variability Diagnostic Package

The CVDP website also contains a Data Repository where we provide CVDP output for many of the CMIP3, CMIP5 and CMIP6 simulations, as well as for general CESM simulations.

CVDP | Data Repository

The CVDP Data Repository holds CVDP output (graphics and data files) from numerous CMIP and CESM integrations. To access the output, simply select *Images* or *Data* for the desired model intercomparison listed in the Table below. The data are stored as tar files: within each tar file there are multiple netCDF files corresponding to each component member included in the comparison. To see an example of the netCDF file metadata, click here.

The CVCWG freely distributes these results for non-commerical purposes and is not responsible for errors in the data or within the CVDP. Use the distributed data at your own risk. Note that not all output fields may be relevant for a particular set of model simulations. For example, modes of decadal variability are not meaningful if the period of record is too short.

When presenting results either in oral or written form, please acknowledge the NCAR Climate Analysis Section's Climate Variability Diagnostics Package. An overview paper of the CVDP can also be cited:

Phillips, A. S., C. Deser, and J. Fasullo, 2014: A New Tool for Evaluating Modes of Variability in Climate Models. *EOS*, **95**, 453-455, doi: 10.1002/2014EO490002.

More information on the CMIP3 and CMIP5 archives can be found here and here. Questions and feedback about the CVDP Data Repository are welcomed and should be posted on the CESM Bulletin Board.

CVDP Info
- Home
- News
- Code
- Observations
- Data Repository
- Support
- Known Issues

CESM Comparisons

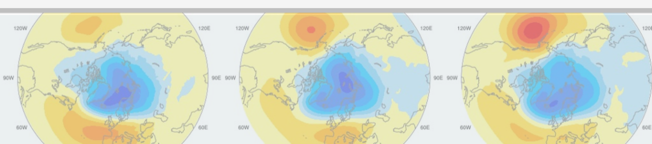
CESM1 CAM5 BGC Large Ensemble 1920-2015	Images	Data	CESM1 CAM5 BGC Large Ensemble 1979-2015	Images	Data
CESM1 CAM5 BGC Large Ensemble 2016-2044	Images	Data	CESM1 CAM5 BGC Large Ensemble 2016-2100	Images	Data
CESM1 Last Millennium	Images	Data	CESM1 Last Millennium bycen	Images	Data
CCSM4 Comparison	Images	Data			

CMIP5 Comparisons

CMIP5 - 1pctCO2	Images	Data	CMIP5 - amip	Images	Data
CMIP5 - Historical	Images	Data	CMIP5 - Last Glacial Maximum	Images	Data
CMIP5 - midHolocene	Images	Data	CMIP5 - past1000	Images	Data
CMIP5 - past1000bycen	Images	Data	CMIP5 - piControl	Images	Data
CMIP5 - rcp26	Images	Data	CMIP5 - rcp45	Images	Data
CMIP5 - rcp60	Images	Data	CMIP5 - rcp85	Images	Data

CMIP3 Comparisons

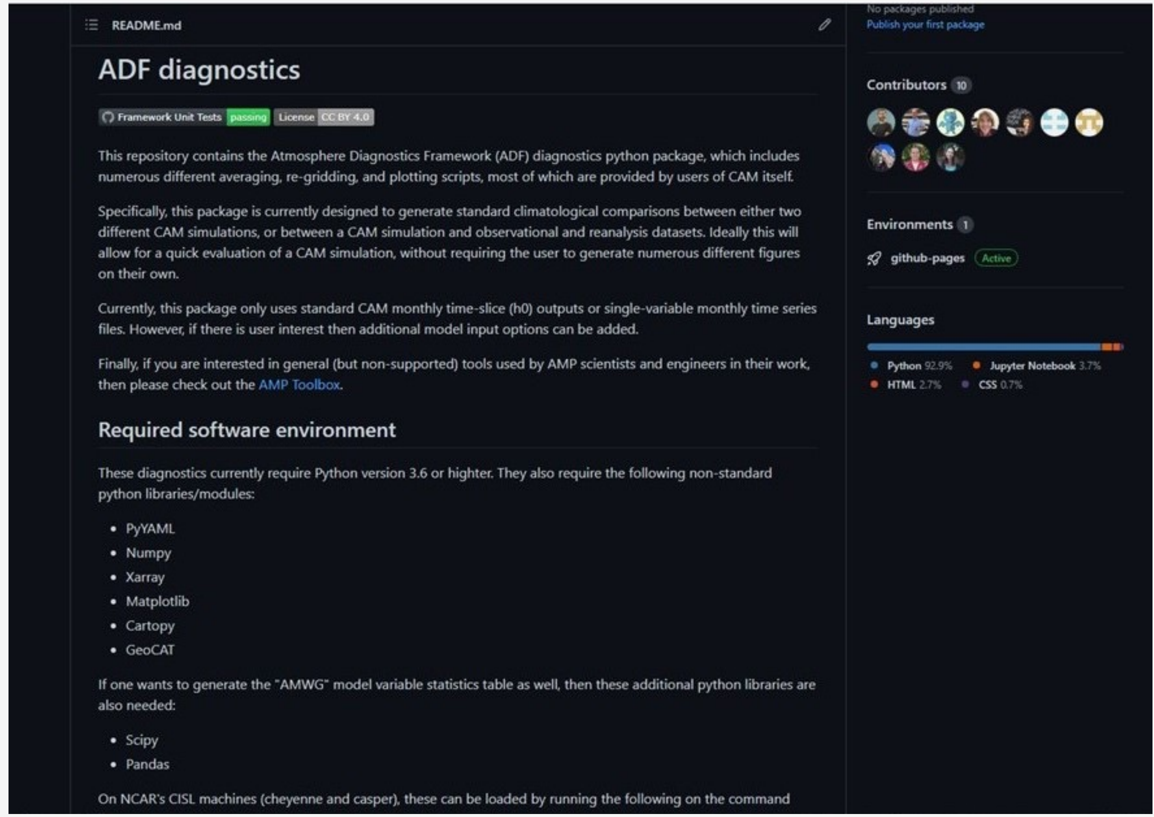
http://www.cesm.ucar.edu/working_groups/CVC/cvdp/



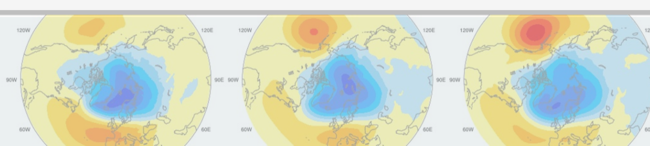
AMWG Diagnostics Framework (ADF)

The ADF is the start of a new crop of diagnostics packages which are almost entirely python-based, and designed to be easily portable to other institutions, as well as take advantage of new development work at UCAR and elsewhere.

The ADF will currently only work for CAM data, although it can also automatically run the CVDP as well.



https://github.com/NCAR/ADF



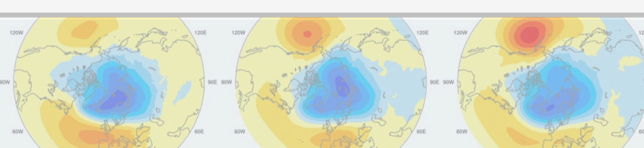
Diagnostics Packages

Many different types of comparisons are possible using the options provided. Here, we have you set a few options to compare observations to your model run. You can also use the diagnostics to compare model runs to one another, regardless of model version.

Typically, 10-25 year time slices of data are analyzed using the component diagnostics. (Exception: The ocean timeseries diagnostics are usually run on the entire simulation.) Here, you only have ~3 years of data, so that's what we will use.

The diagnostics packages are all available off of github. If you wish to take these diagnostics packages back with you to your home institution, you will need to have the netCDF operators and NCL installed, as well as Image Magick.

After running a diagnostics package, it is suggested you open up Firefox on cheyenne/casper as the created images are linked using a webpage. If Firefox gives you any trouble, you can always tar up the diagnostic results and scp them to a machine of your choosing.



Diagnostics Packages

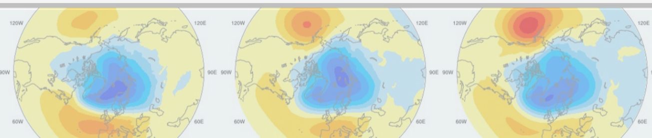
Each component diagnostics package has different requirements in terms of the minimum amount of data required for them to run. (Ocean: 12 months, Atmosphere, Land: 14 months, Ice: 24 months)

If you do not have the amount of data needed to run a specific diagnostics package, there is a directory set up with 3 years of a Day 2 case here:
/glade/scratch/asphilli/archive/b.day2.1
(Path also given in test_data_location.txt file found in scripts/ directory.)

Only complete years can be analyzed by the packages, and there has to be an additional December before the 1st analyzed year or an additional January and February the year after the last analyzed year. If you have 14 complete years of data you *cannot* set the first analyzed year to 1 and the last analyzed year to 14. Either set the first analyzed year to 2 or the last analyzed year to 13.

Do not enter leading 0's. example: "12" not "0012"

You can usually ignore the various NCL/convert warning messages within the log files, as frequently there are model variables missing that the packages expect. You will know when it is an error message you should address.



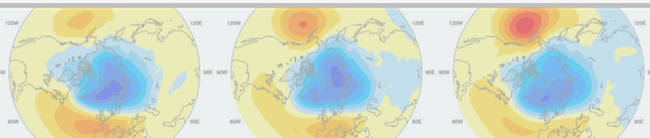
Practical Lab #3

Within the lab, you will have the opportunity to play with the CESM history files that you created. There are 6 sets of diagnostics scripts, 4 NCL post-processing scripts, and 7 NCL graphics creating scripts. You will also be able to try out the various software packages discussed earlier (ncview, NCO, etc.).

The following slides contain information about how to run the various scripts on cheyenne, along with exercises that you can try. It is suggested that you first focus on running those scripts written for the model component that you're most interested in. For instance, if you're an oceanographer, try running the ocean diagnostics script, along with the ocean post-processing script and ocean graphics NCL scripts.

Once you've completed running one of the diagnostics packages, take a run at one of the other packages, or try the exercises/challenges on the last two slides.

You are not expected to run every diagnostics package and exercise.



Diagnostics reference slide

For the 4 component packages, review slides 39-43, run through slides 43-48 for a general setup, then if you are running…

The **Atmospheric Model WG diagnostics**: Run through slides 49-50 to submit, run and view the diagnostics.

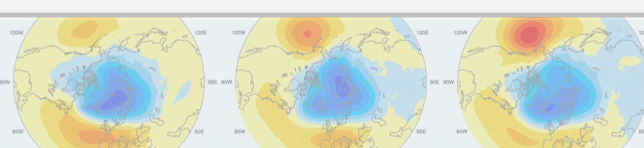
The **Land Model WG diagnostics**: Run through slides 51-52 to submit, run and view the diagnostics.

The **Ocean Model WG diagnostics**: Run through slides 53-55 to submit, run and view the diagnostics.

The **Ice Model WG diagnostics**: Run through slides 56-58 to submit, run and view the diagnostics.

For the stand alone **Climate Variability Diagnostics Package (CVDP)**: Review slides 39-43, then run through slides 59-62.

For the **ADF**: Review slides 39-43, then run through slides 65-66.



Getting Started

Reminder: Do not copy and paste, as hidden characters can mistakenly get copied.

To set up your environment for today's lab:

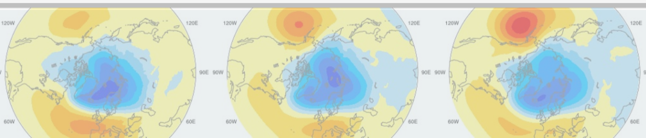
1) Login to cheyenne by issuing this command:

   ssh –Y cheyenne.ucar.edu

   alternatively one can use

   ssh –Y <username>@cheyenne.ucar.edu

2) If you want to try the ADF or the CVDP via the ADF, then skip directly to slide 65. Otherwise just continue to the next slide.



Getting Started

2) **For tcsh users:** You should have a .tcshrc file already present in your home directory. If you do not, please copy over the following file:
```
cp /glade/p/cesm/tutorial/tcshrc  ~/.tcshrc
```

Then, change to your home directory and source the file:
```
cd; source .tcshrc
```

If you have an existing .tcshrc file and do not wish to overwrite it please copy the contents of the /glade/p/cesm/tutorial/tcshrc file to your .tcshrc file.

For bash users: You may have a .profile file already present in your home directory. If you do not, please copy over the following file:
```
cp /glade/p/cesm/tutorial/profile  ~/.profile
```

Then, change to your home directory and source the file:
```
cd; source .profile
```

If you have an existing .profile file and do not wish to overwrite it please copy the contents of the /glade/p/cesm/tutorial/profile file to your .profile file.

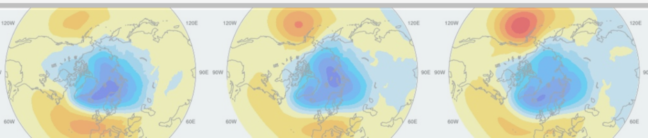
Getting Started

3) cd to your home directory, then create a new directory named scripts, and cd into it:

```
cd
mkdir scripts
cd scripts
```

Copy all files from my CESM_tutorial directory over to your scripts directory, and rename hluresfile (sets NCL defaults) to .hluresfile:

```
cp –R /glade/u/home/asphilli/CESM_tutorial/* .
mv hluresfile ../.hluresfile
```

Running the Component Diagnostics

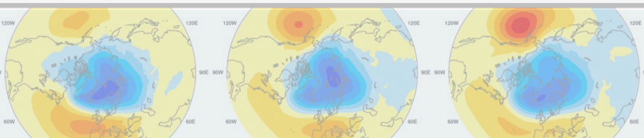
The following pages contain instructions on how to run each of the four component diagnostics packages. Each qsub submission you make should take on the order of ~5 minutes.

Note that the general CESM (component) diagnostics instructions are located here:
https://github.com/NCAR/CESM_postprocessing/wiki/cheyenne-and-DAV-quick-start-guide

Customized instructions for the tutorial are given over the next few slides. You will need to change all settings that are encased in < >.

1) Set up your python environment:
   cesm_pp_activate

2) Create a directory to house the CESM postprocessing code:
   mkdir /glade/scratch/<username>/cesm-postprocess



Running the Component Diagnostics

3) Decide which simulation you will run the diagnostics on, either your run or the test case specified in ~/scripts/test_data_location.txt. Then run create_postprocess to set up your post-processing directory, and cd to that directory as follows:

create_postprocess --caseroot /glade/scratch/<username>/cesm-postprocess/<model-run>

cd /glade/scratch/<username>/cesm-postprocess /<model-run>

For instance, if you are running on your b.day2.1 simulation:

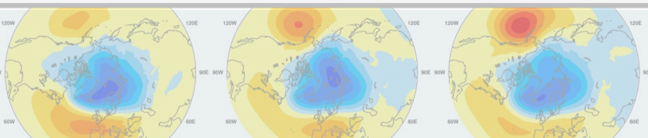
create_postprocess --caseroot /glade/scratch/<username>/cesm-postprocess/b.day2.1

cd /glade/scratch/<username>/cesm-postprocess /b.day2.1

Reminder: Your model data location:

/glade/scratch/<username>/archive/<model-run>

Note the - - syntax (*not* separated by a space)



Running the Component Diagnostics

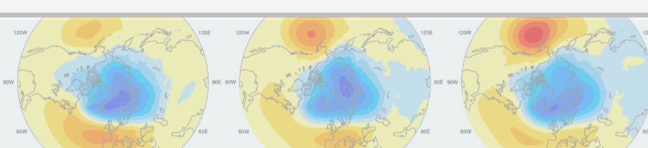
4) You will now set options in various .xml files in preparation for running. You can do the modifications by hand, or you can do them by using the pp_config command. It is *highly recommended* that you use the pp_config command as that will check that your changed settings are valid.

   The first file that needs modification is env_postprocess.xml. (Note that if you alternatively set up your cesm-processing directory (step 3) within the archive directory of your model run, you can skip this step as everything should be set automatically.)

Set the location of the model data:
./pp_config --set DOUT_S_ROOT=<full path of model run archive path to be analyzed>
(Example: ./pp_config --set DOUT_S_ROOT=/glade/scratch/<username>/archive/b.day2.1)

Tell the diagnostics what kind of grids to expect. Our tutorial simulations use 1.9x2.5_gx1v7:

```
./pp_config --set ATM_GRID=1.9x2.5
./pp_config --set LND_GRID=1.9x2.5
./pp_config --set ICE_GRID=gx1v7
./pp_config --set OCN_GRID=gx1v7
./pp_config --set ICE_NX=320
./pp_config --set ICE_NY=384
```

Running the Atmospheric Diagnostics Package

Remember that the atmospheric diagnostics need at least 14 months to run, and that you can only specify complete years. The steps to run the atmospheric diagnostics are as follows:

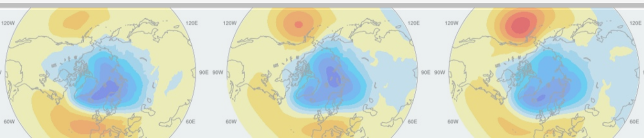
1) The following commands edit settings in env_diags_atm.xml.

```
./pp_config --set
ATMDIAG_OUTPUT_ROOT_PATH=/glade/scratch/<username>/diagnostics-output/atm
./pp_config --set ATMDIAG_test_first_yr=<set to first year to be analyzed>
./pp_config --set ATMDIAG_test_nyrs=<set to # of years to be analyzed>
```

2) Before the atmospheric diagnostics can be run, monthly climatologies must be calculated and written to netCDF files.

To run the atmospheric averages script: qsub atm_averages
To monitor your job(s) status: qstat –u <username>
To stop your job: qdel <Job ID retrieved from qstat>

You can check progress by checking the newest log file in logs/. If in a log file you notice that things have gone wrong, you can stop your job.



Running the Atmospheric Diagnostics Package

3) Once the averages have successfully completed (check the end of the newest log file), you can submit the diagnostics script:

   qsub atm_diagnostics

4) Again monitor the status of your submission by checking the newest log file in the logs/ directory. Do not be concerned by various error messages (like convert error messages) from individual scripts in the log files. If the submission completed successfully the log file will end with “Successfully completed generating atmosphere diagnostics”.

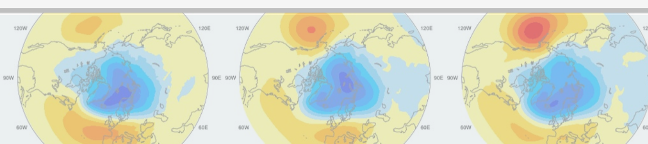
5) Once the diagnostics are complete, cd to the location of the diagnostics:

cd /glade/scratch/<username>/diagnostics-output/atm/diag/<model-run>-obs.<y0>-<y1>

   y0 = first year of analysis, y1 = last year of analysis

   and open the index.html in firefox to examine the output:
   firefox index.html &

For more information about the AMWG Diagnostics Package:
http://www.cesm.ucar.edu/working_groups/Atmosphere/amwg-diagnostics-package/



Running the Land Diagnostics Package

Remember that the land diagnostics need at least 14 months to run, and that you can only specify complete years. The steps to run the land diagnostics are as follows:

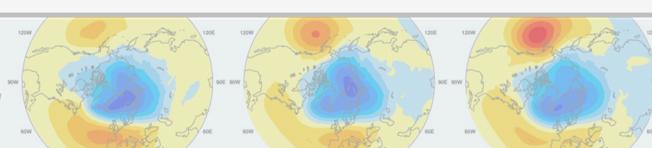
1) The following commands edit settings in env_diags_lnd.xml.

```
./pp_config --set
    LNDDIAG_OUTPUT_ROOT_PATH=/glade/scratch/<username>/diagnostics-output/lnd
./pp_config --set LNDDIAG_clim_first_yr_1=<set to first year to be analyzed>
./pp_config --set LNDDIAG_clim_num_yrs_1=<set to # of years to be analyzed>
./pp_config --set LNDDIAG_trends_first_yr_1=<set to first year to be analyzed>
./pp_config --set LNDDIAG_trends_num_yrs_1=<set to # of years to be analyzed>
```

2) Before the land diagnostics can be run, monthly climatologies must be calculated and written to netCDF files.

To run the land averages script:	qsub lnd_averages
To monitor your job(s) status:	qstat –u <username>
To stop your job:	qdel <Job ID retrieved from qstat>

You can check progress by checking the newest log file in logs/. If in a log file you notice that things have gone wrong, you can stop your job.



Running the Land Diagnostics Package

3) Once the averages have successfully completed (check the end of the newest log file), you can submit the diagnostics script:

   qsub lnd_diagnostics

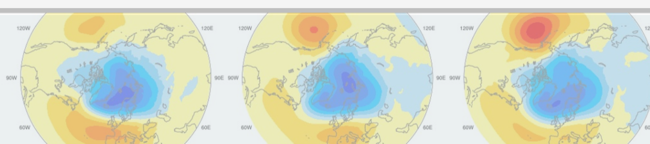
4) Again monitor the status of your submission by checking the newest log file in the logs/ directory. Do not be concerned by various error messages (like convert error messages) from individual scripts in the log files. If the submission completed successfully the log file will end with “Successfully completed generating land diagnostics”.

5) Once the diagnostics are complete, cd to the land diagnostics directory:

cd /glade/scratch/<username>/diagnostics-output/lnd/diag/<model-run>-obs.<yr1>_<yr2>

   and open the setsIndex.html in firefox to examine the output:
   firefox setsIndex.html &

For more information about the LMWG Diagnostics Package:
http://www.cesm.ucar.edu/models/cesm1.2/clm/clm_diagpackage.html



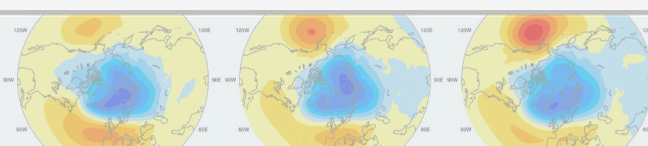
Running the Ocean Diagnostics Package

Historically the ocean diagnostics package consisted of three separate sets of scripts, one that compared a model run to observations, one that compared a model run to another model run, and one that calculated timeseries. Here, you will compare your simulation to observations and calculate ocean timeseries. Remember that the ocean diagnostics need at least 12 months to run, and that you can only specify complete years. The steps to run the ocean diagnostics are as follows:

1) The following commands edit settings in env_diags_ocn.xml.

```
./pp_config --set OCNDIAG_YEAR0=<set to first year to be analyzed>
./pp_config --set OCNDIAG_YEAR1=<set to last year to be analyzed>
./pp_config --set OCNDIAG_TSERIES_YEAR0=<set to first year to be analyzed>
./pp_config --set OCNDIAG_TSERIES_YEAR1=<set to last year to be analyzed>
./pp_config --set OCNDIAG_TAVGDIR=/glade/scratch/<username>/
    diagnostics-output/ocn/climo/tavg.$OCNDIAG_YEAR0.$OCNDIAG_YEAR1
./pp_config –set OCNDIAG_WORKDIR=/glade/scratch/<username>/
    diagnostics-output/ocn/diag/<model-run>.$OCNDIAG_YEAR0.$OCNDIAG_YEAR1
```

If the latter two commands result in an error message, instead of using ".$OCNDIAG" syntax use ".\$OCNDIAG". Alternatively, edit the env_diags_ocn.xml file manually to set those two directory paths.



Running the Ocean Diagnostics Package

2) Before the ocean diagnostics can be run, monthly climatologies must be calculated and written to netCDF files.

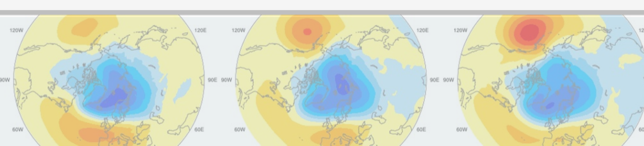
To run the ocean averages script:	qsub ocn_averages
To monitor your job(s) status:	qstat –u <username>
To stop your job:	qdel <Job ID retrieved from qstat>

You can check progress by checking the newest log file in logs/. If in a log file you notice that things have gone wrong, you can stop your job.

3) Once the averages have successfully completed (check the end of the newest log file), you can submit the diagnostics script:

qsub ocn_diagnostics

4) Again monitor the status of your submission by checking the newest log file in the logs/ directory. Do not be concerned by various error messages (like convert error messages) from individual scripts in the log files. If the submission completed successfully the log file will end with “Successfully completed generating ocean diagnostics .....”.



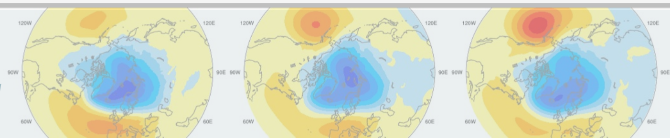
Running the Ocean Diagnostics Package

5) Once the diagnostics are complete, cd to the location of the diagnostics:

```
cd /glade/scratch/<username>/diagnostics-output/ocn/diag/<model-run>.<yr1>-<yr2>
```

and open the index.html in firefox to examine the output:

```
firefox index.html &
```

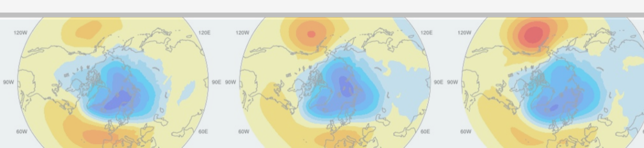
Running the Ice Diagnostics Package

Remember that the ice diagnostics need at least 24 months to run , and that you can only specify complete years. The steps to run the ice diagnostics are as follows:

1) The following commands edit settings in env_diags_ice.xml.

```
./pp_config --set ICEDIAG_BEGYR_CONT=<set to first year to be analyzed>
./pp_config --set ICEDIAG_ENDYR_CONT=<set to last year to be analyzed>
./pp_config --set ICEDIAG_YRS_TO_AVG = <set to # of years to average over>
./pp_config --set ICEDIAG_PATH_CLIMO_CONT=/glade/scratch/<username>/diagnostics-output/ice/climo/$ICEDIAG_CASE_TO_CONT/
./pp_config --set ICEDIAG_DIAG_ROOT=/glade/scratch/<username>/diagnostics-output/ice/diag/$ICEDIAG_CASE_TO_CONT/
```

If the latter two commands result in an error message, instead of using "/$ICEDIAG" syntax use "/\$ICEDIAG". Alternatively, edit the env_diags_ice.xml file manually to set those two directory paths.



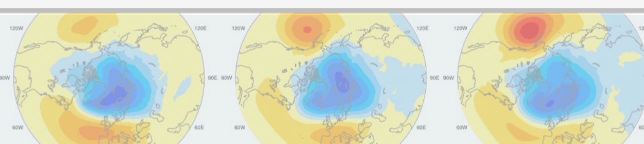
Running the Ice Diagnostics Package

2) Before the ice diagnostics can be run, monthly climatologies must be calculated and written to netCDF files.

To run the ice averages script:	qsub ice_averages
To monitor your job(s) status:	qstat –u <username>
To stop your job:	qdel <Job ID retrieved from qstat>

You can check progress by checking the newest log file in logs/. If in a log file you notice that things have gone wrong, you can stop your job.

3) Once the averages have successfully completed (check the end of the newest log file), you can submit the diagnostics script:
qsub ice_diagnostics



Running the Ice Diagnostics Package

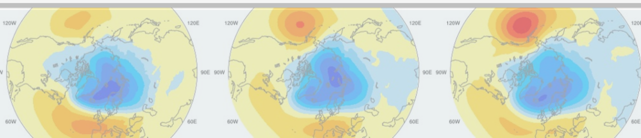
4) Again monitor the status of your submission by checking the newest log file in the logs/ directory. Do not be concerned by various error messages (like convert error messages) from individual scripts in the log files. If the submission completed successfully the log file will end with “Successfully completed generating ice diagnostics”.

5) Once the diagnostics are complete, cd to the location of the diagnostics:

   cd /glade/scratch/<username>/diagnostics-output/ice/diag/<model-run>/<model-run>-obs/yrs<yr1>-<yr2>

   and open the index.html in firefox to examine the output:

   firefox index.html &



NCL post-processing scripts

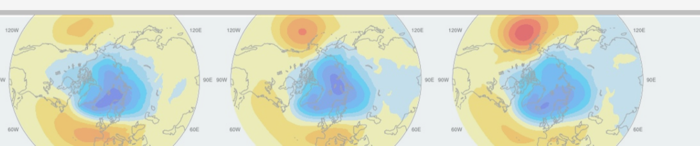
All 4 post-processing scripts are quite similar, and are located in your scripts directory. To list them, type: ls *create* . If these scripts are used for runs other than the tutorial runs, note that the created netCDF files may get quite large (especially pop files). This can be mitigated by setting concat and concat_rm = False.

To set up the post-processing scripts, alter lines 4-12 (7-16 for atm). There are comments to the right of each line explaining what each line does.

To run the atm script (for example), type the following:

```
ncl atm.create_timeseries.ncl
```

All 4 scripts will write the post-processed data to work_dir (set at top of each script)/processed/<run>. Once the post-processing is complete, we can use the new files in our NCL graphics scripts, or view them via ncview.



NCL Graphics Scripts

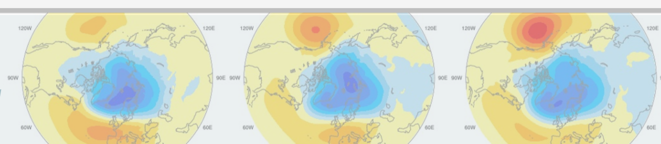
These scripts are set up so that they can read either raw history files from your archive directory (lnd,ice,ocn history files) or the post-processed files after they've been created by the NCL post-processing scripts.

You will need to modify the user defined file inputs at the top to point to your data files, either your raw history files or your newly created post-processed files. Once the files are modified, to execute the scripts, simply type (for example):
ncl atm_latlon.ncl .   To see the script output use gv: gv atm_latlon.ps

There are 7 NCL graphics scripts available for you to run:

atm_latlon.ncl	atm_nino34_ts.ncl	ice_south.ncl
ice_north.ncl	lnd_latlon.ncl	ocn_latlon.ncl
ocn_vectors.ncl		

The ocn_vectors.ncl allows you to compare one ocean history file to another, and is more complicated (you can modify the first 50 lines) than the other 6 scripts. To run them, simply set the options at the top of the script.



Climate Variability Diagnostics Package

The CVDP is different from the component diagnostic packages, in that the CVDP is run on timeseries/post-processed data (only), and can be run on non-CESM data. Input models do not need to be on the same grid. The CVDP can also be run on 2+ simulations at once. Entire simulations (spanning 100's of years) can be passed into the package, but note that your ~5yr tutorial simulations are too short to put in the CVDP.

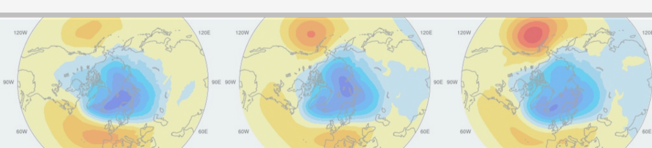
All input file names must end with the standard CMIP5/6 file naming syntax "YYYYMM-YYYYMM.nc". Soft links can be used to meet this requirement.

The CVDP reads in 8 variables: aice, MOC, PRECC, PRECL, PSL, SNOWDP, TREFHT, and TS. (CMIP names: sic/siconc, msftmyz/msftmz, pr, psl, snd, tas, ts)

Three scripts need to be set up to run the CVDP:
namelist (lists the location of model run data to be analyzed)
namelist_obs (specified which observational datasets to use)
driver.ncl (sets CVDP options)

For the lab session, you will have the chance to run the CVDP on three simulations from the CESM1 Large Ensemble Project.

https://www.cesm.ucar.edu/projects/community-projects/LENS



Climate Variability Diagnostics Package

1) Login to Cheyenne, then jump onto a processing machine:
   execcasper –A UESM0011   (=log on to casper)

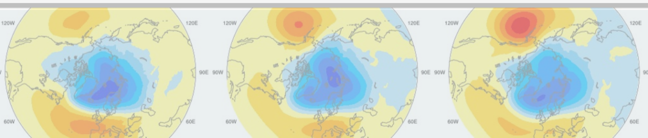
   Note: If X11 forwarding is not working on casper, open a 2nd terminal window on cheyenne, and use this second window for editing/viewing.

2) cd to your scripts directory, then into CVDP:
   cd ~/scripts/CVDP

3) Open up the **namelist** using your favorite text editor:
   gedit namelist   (or use xemacs, vi, etc.)

   The format of each row in **namelist** is as follows:
   Run Name | Path to all data for a simulation | Analysis start year | Analysis end year

   Modify each of the three rows so that the analysis start and end years are specified as 1979 and 2015. (They can be different though.) Note that " | " serves as the delimiter.



4) Open up the **namelist_obs**:

    gedit namelist_obs   (or use xemacs, vi, etc.)

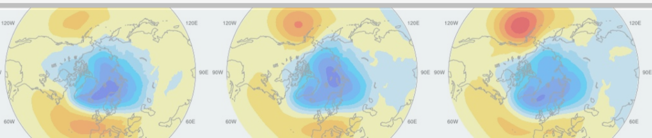
    The format of each row in **namelist_obs** is as follows:
    Variable | Obs Name | Path to obs dataset | Analysis start year | Analysis end year

    namelist_obs is already set appropriately, so no changes need to be made. These datasets are not distributed with the CVDP, but can be downloaded online. Note that one can specify as many datasets as needed per variable, and that MOC, SNOWDP, aice_nh and aice_sh do not have observational datasets and are not listed.

5) Open up the **driver.ncl**:

    gedit driver.ncl   (or use xemacs, vi, etc.)

    Modify:
    line 7   replace “user” with your username
    line 18   change “False” to “True” to output calculations to netCDF



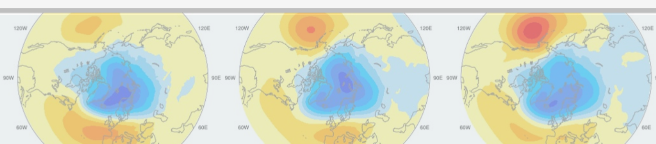
Climate Variability Diagnostics Package

6) Run the CVDP on one of cheyenne's compute nodes by submitting **driver.ncl**:

    ncl driver.ncl

7) Once the CVDP is complete (~20 mins), cd to the outdir specified in driver.ncl, fire up a firefox window, and open up the index.html file:

    cd /glade/scratch/<username>/CVDP
    firefox index.html &



The AMWG Diagnostics Framework

1. Access Casper, which is the Data Analysis and Visualization machine:

```
execcasper –A UESM0011 -l select=1:ncpus=8
```

2. Modify environment to use the NCAR python library (NPL):

```
module unload python
module load git
module load conda
conda activate npl
```

If running the CVDP via the ADF, then you also need to load ncl:

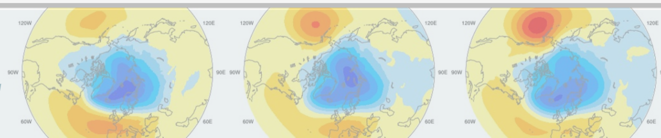
```
module load ncl
```

3. Download the ADF from Github:

```
git clone https://github.com/NCAR/ADF.git
cd ADF
```

4. Copy tutorial config file to your own ADF directory:

```
cp ~nusbaume/ADF_tutorial.yaml ADF_tutorial.yaml
```

The AMWG Diagnostics Framework Cont.

5. Modify the "ADF_tutorial.yaml" file.

   gedit ADF_tutorial.yaml (can also use emacs, vi, nano, etc.)
   set variable "user" to your username (e.g. nusbaume)

   If also running the CVDP via the ADF, then also set the variable "cvdp_run" to true

   Finally, the ADF defaults to model vs baseline model. If you prefer to compare against obs, also set "compare_obs" to true.

6. Run the ADF

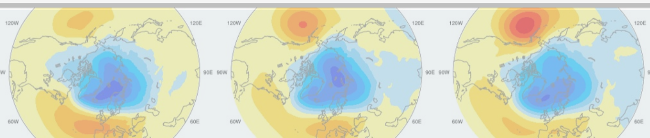
   ./run_adf_diag ADF_tutorial.yaml

7. Examine the output

   cd /glade/scratch/<username>/ADF/plots/b.day2.1_1_3_vs_b.e20.BHIST.f09_g16.20thC.125.02/
   firefox index.html

   If also running the CVDP via the ADF, then you can also access the CVDP results here:

   cd /glade/scratch/<username>/ADF/cvdp/b.day2.1/output
   firefox index.html



Exercises

1) Use ncdump to examine one of the model history files. Find a variable you've never heard of, then open up the same file using ncview, and plot that variable.

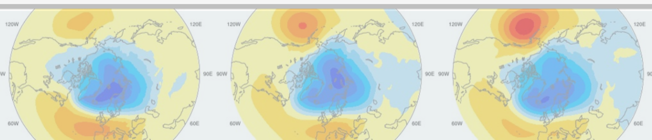
2) Modify one of the NCL scripts to plot a different variable.

3) Use the netCDF operators to difference two files. Plot various fields from the difference netCDF file using ncview.

4) Use the netCDF operators to concatenate sea level pressure and the variable date from all the monthly atmospheric history files (.h0.) from one of your model simulations into one file.

5) Same as 5), but only do this for the Northern Hemisphere.

6) Same as 6), but don't append the global history file attribute.



Challenges

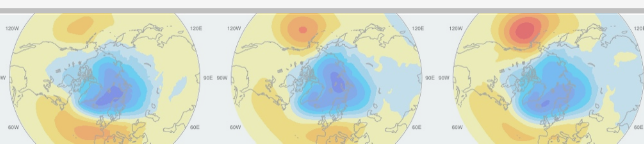
1) Add a variable or 3 to one of the post-processing scripts, then modify one of the NCL scripts to plot one of the new variables.

   Alternatively, try adding additional variables to the ADF (look in the ADF_tutorial.yaml file for how to do that).

2) Use the atmospheric diagnostics package to compare 2 simulations to one another. (Use one or two of the model simulations provided in test_data_location.txt).

   Alternatively, use the ADF to compare the model against observations (look in the ADF_tutorial.yaml file for how to do that).

3) Use the ocean diagnostics package to compare 2 simulations to one another.



SUPPLEMENTAL SLIDES

ImageMagick

ImageMagick is a free suite of software that that can be used to display, manipulate, compare or convert images. It can also be used to create movies.

There are two ways to use ImageMagick. One way is to simply display the image and alter it using pop-up menus visible after clicking on the image:

```
display plot1.png
```

A second way is to alter an image at the command line, which is usually the faster and cleaner way to do it:

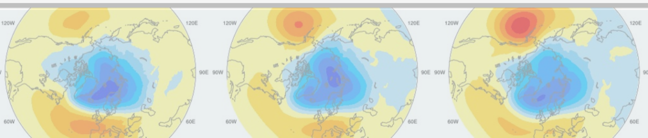
```
convert –density 144 –rotate 270 plot2.ps plot2.jpg
```

(set the resolution to 2x default, rotate the image 270 degrees, and convert to a jpg.)

There are many options available when using convert, some of which you may need to use depending on your version of ImageMagick:

```
convert -trim +repage –background white –flatten plot2.ps plot2.png
```

(crop out all the possible white space, reset various settings, set the background to white, create a canvas based on white background while merging layers, and convert to a png.)



ImageMagick

To compare two images (ps, pdf, png, gif, jpg, etc):

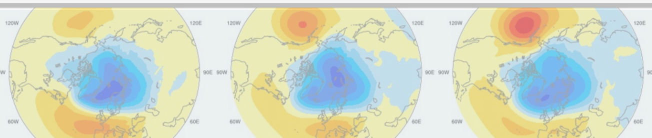
compare image1.png image2.png diff.png

diff.png will have red outlines showing what is different between image1 and image2, while the rest of diff.png is faded out. This works for a number of formats, including ps, pdf, png, gif and jpg.)

To create a movie from the command line:

convert –loop 0 –adjoin –delay 35 *.gif movie.mp4

(loop through the movie once, create the movie (-adjoin), and increase the time between slides (-delay 0 is the default))



Gv (Ghostview)

Ghostview is a simple program that allow one to view postscript files:

ghostview plot4.ps (do a which ghostview to see the path on cheyenne)

Once displayed, one can alter the orientation of the image, or change its' size, or print specific pages amongst a group of pages. For viewing postscript (or encapsulated postscripts), ghostview should be used.

http://pages.cs.wisc.edu/~ghost/gv/index.htm

xxdiff

xxdiff allows one to quickly compare two or three scripts and highlights differences:

xxdiff script1.f script2.f

http://furius.ca/xxdiff/