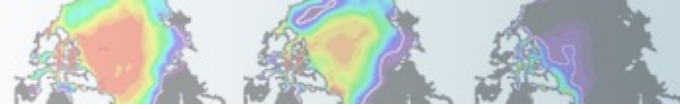# Ocean / Sea-ice Tutorial Session

Alper Altuntas, David Bailey, Michael Levy, Keith Lindsay

Climate and Global Dynamics Laboratory

National Center for Atmospheric Research

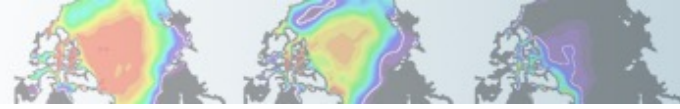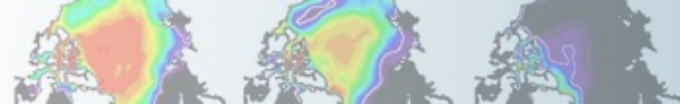# Your Friends: The Users Guides

CESM Users Guide:

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

CICE Users Guide:

http://www.cesm.ucar.edu/models/cesm2/sea-ice

POP2 and Ecosystem Users Guides:

http://www.cesm.ucar.edu/models/cesm2/ocean

Getting Help/Getting Involved

- Read the documentation.

- Use the CESM bulletin board (http://bb.cgd.ucar.edu/) to tap into community expertise and to share solutions to common problems.

- Send mail to cesm-help@cgd.ucar.edu

- Reach out to CESM Working Group liaisons.

Today's Exercises

- The code base will be the same as used for the rest of the tutorial in:

    /glade/p/cesm/tutorial/cesm2.1_tutorial2022

- Make sure to re-copy and source the .tcshrc or .profile files from /glade/p/cesm/tutorial/ to your home directory.
- You will be using the "G" component set at T62_g37 resolution.
- Each simulation will be run for 1 year.
- You will then use 'ncview' to see how each experiment differs from the control simulation.
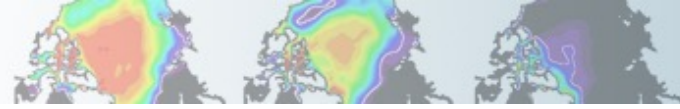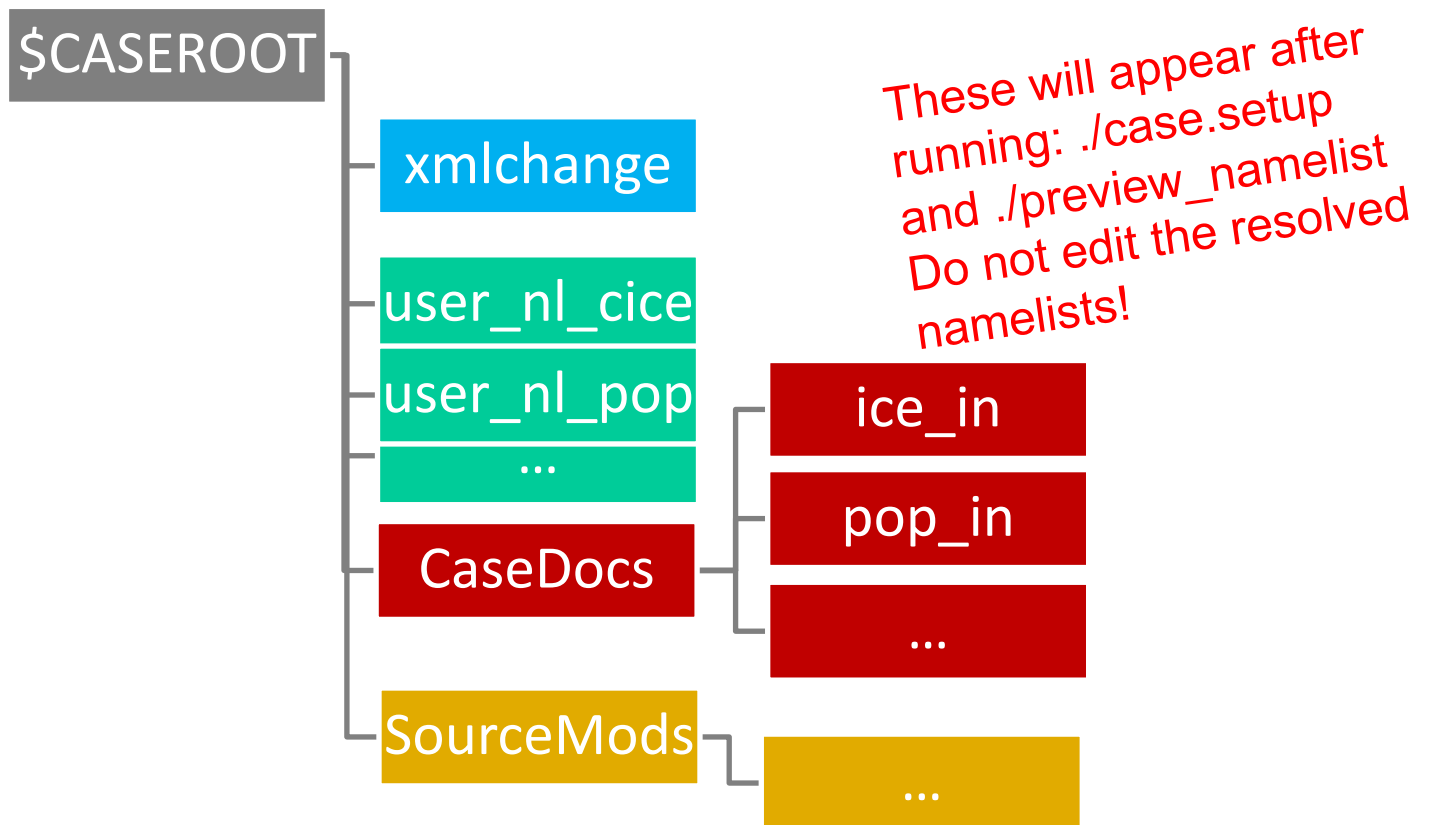
Today's Exercises

1. Control case (out-of-the-box)

2. Ocean model overflow turn-off experiment

3. Ice model "albedo" increase experiment

4. Increase zonal wind stress in the ocean
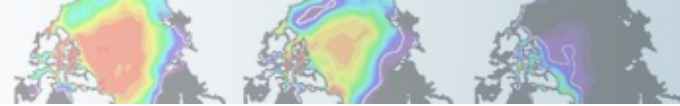
Customizing Experiments

➢ Three common mechanisms:

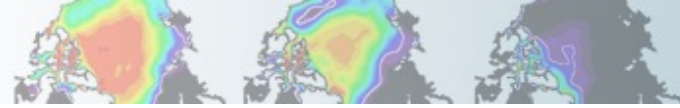(1) ./xmlchange,   (2) namelist changes, (3) SourceMods

$CASEROOT

xmlchange

user_nl_cice

user_nl_pop

...

CaseDocs

SourceMods

ice_in

pop_in

...

...

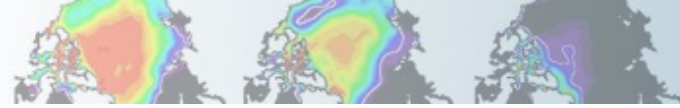These will appear after running: ./case.setup and ./preview_namelist Do not edit the resolved namelists!

Ocean Namelist

```
  n_lat_aux_grid = 180
  n_salt_trans_requested = .true.
  n_transport_reg = 2
  transport_reg2_names = 'Atlantic Ocean', 'Mediterranean Sea', 'Labrador Sea', 'GIN Sea', 'Arctic Ocean', 'Hudson Bay'
/
&context_nml
  b4b_flag = .false.
  lccsm = .true.
  lccsm_control_compatible = .false.
  lcoupled = .true.
  ldebug = .false.
/
&overflows_nml
  overflows_diag_outfile = '/glade/scratch/dbailey/gtest/run/./gtest.pop.do'
  overflows_infile = '/glade/scratch/dbailey/gtest/run/gx1v7_overflow'
  overflows_interactive = .true.
  overflows_on = .true.
  overflows_restart_type = 'ccsm_startup'
  overflows_restfile = './gtest.pop.ro'
/
&niw_nml
  lniw_mixing = .false.
  niw_boundary_layer_absorption =  0.7
  niw_energy_file = '/glade/p/cesmdata/cseg/inputdata/ocn/pop/gx1v6/forcing/niw_gx1v6_20100915.ieeer8'
  niw_energy_file_fmt = 'bin'
  niw_energy_type = 'blke'
  niw_local_mixing_fraction = 0.5
  niw_mix_max = 100.0
  niw_mixing_efficiency = 0.2
  niw_obs2model_ratio = 2.0
  niw_vert_decay_scale = 2000.0e02
/
```

Sea-Ice Namelist

```
    aspect_rapid_mode = 1.0
    conduct = "MU71"
    dsdt_slow_mode = -1.5e-07
    kitd = 1
    ktherm = 2
    phi_c_slow_mode = 0.05
    phi_i_mushy = 0.85
    rac_rapid_mode = 10
/
&dynamics_nml
    advection = "remap"
    cf = 17.0
    kdyn = 1
    krdg_partic = 1
    krdg_redist = 1
    kstrength = 1
    mu_rdg = 4.0
    ndte = 120
    revised_evp = .false.
/
&shortwave_nml
    ahmax = 0.3
    albedo_type = "default"
    albicei = 0.45
    albicev = 0.75
    albsnowi = 0.73
    albsnowv = 0.98
    dt_mlt = 1.50
    kalg = 0.0
    r_ice = 0.0
    r_pnd = 0.0
    r_snw = 1.25
    rsnw_mlt = 1500.
    shortwave = "dEdd"
/
```

What is a G case?

(G) 2000_DATM%NYF_SLND_CICE_POP2_DROF%NYF_SGLC_WW3

(G1850ECO) 1850_DATM%NYF_SLND_CICE_POP2%ECO_DROF%NYF_SGLC_WW3

./query_config --compsets

./query_config --grids

- Coupled ocean – sea-ice

- Forced with the Coordinated Ocean-ice Reference Experiments (CORE) version 2, atmospheric data sets (Large and Yeager 2009)

- G by default is forced with normal year forcing (NYF)

    - 12 months of data that repeats

- GIAF is interannually varying forcing (we will not use this in the tutorial)

- Note that the CORE forcing is being replaced by the JRA55
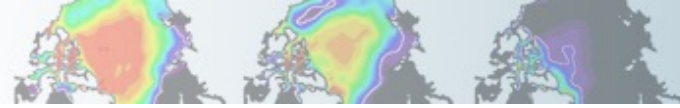
Exercise #1
Control Simulation

1. Create a new case using the following details. Indicate in the case name that this is the "control" *.

    - component set: G

    - resolution: T62_g37

2. The default is for the simulation to run for 5 days. Change this to 1 year using the xmlchange command.

3. Build and run the model.

4. *Optional* Try setting up a similar case with the G1850ECO component set. Note the differences with the G component set. You can run this if you wish.

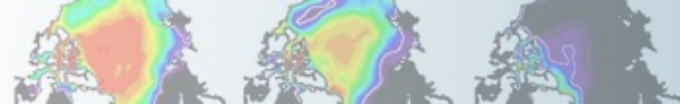* Example casename: g.e21.G.T62_g37.control.001
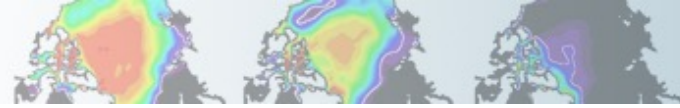
Exercise #2

Turn off the overflow parameterization

1. Create a clone of your control simulation. In the $SRCROOT/cime/scripts directory, issue the following command:
   create_clone --case $NEWCASEDIR --clone $OLDCASEDIR

2. Then, verify that it retained the run time of 1 year.

3. In $NEWCASEDIR, add the relevant namelist changes to the user_nl_pop file. (Hint: search for overflows_nml in CaseDocs/pop_in)

   overflows_on = .false.
   overflows_interactive = .false.

4. Build and run the model for 1 year.

Exercise #3
## Change the snow albedo (on sea ice)

1. Create a clone of your control simulation.

2. Find the **r_snw** namelist parameter (in CaseDocs/ice_in) and increase this value to +2.00, by adding the change to user_nl_cice.

3. Build and run the model for 1 year.

   * Note that this is a tuning parameter that specifies the number of standard deviations away from the base optical properties in the shortwave radiative transfer code.
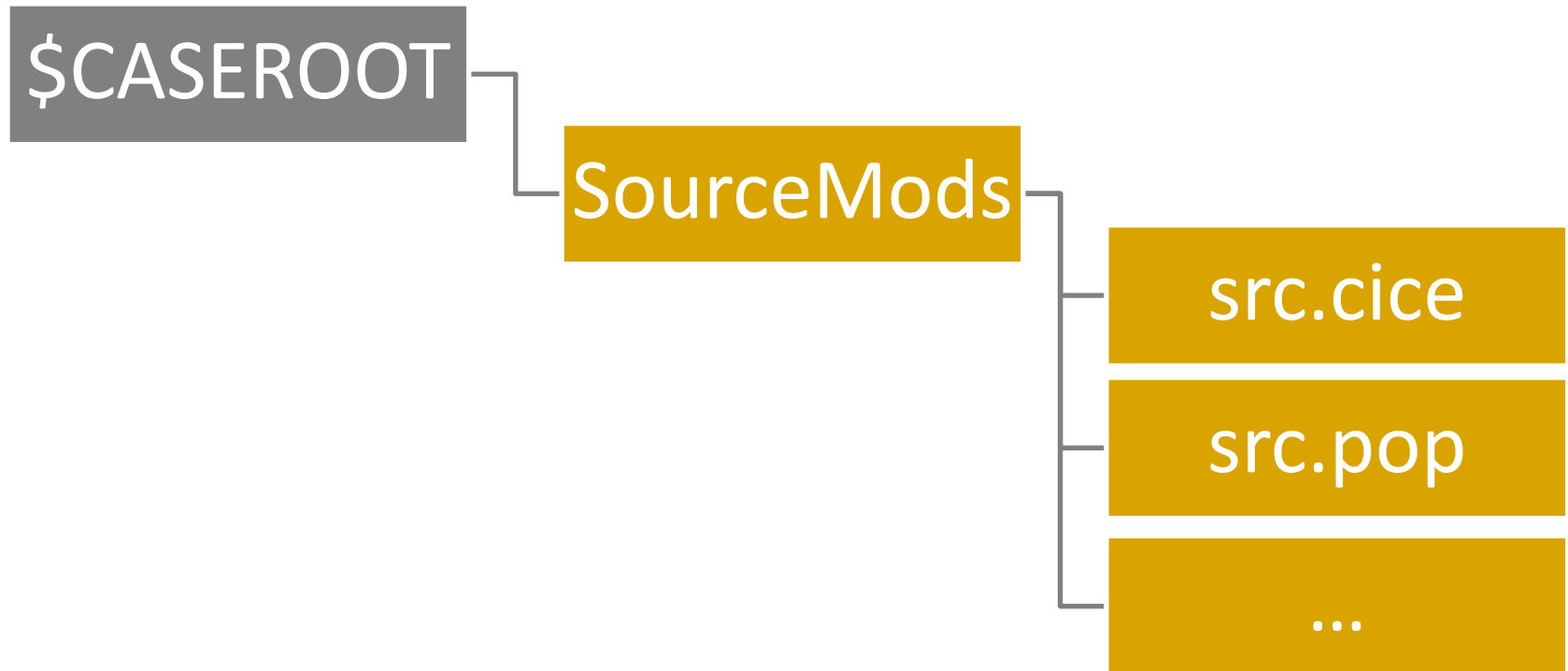
   rsnw_nonmelt = 500 – r_snw * 250 (in microns);
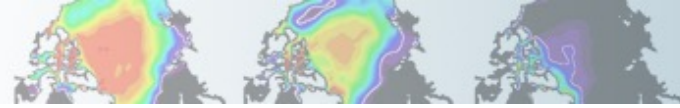   - higher r_snw → lower rsnw_nonmelt,
     - lower rsnw_nonmelt → higher albedos

   CICE Liaison: David Bailey,
   dbailey@ucar.edu
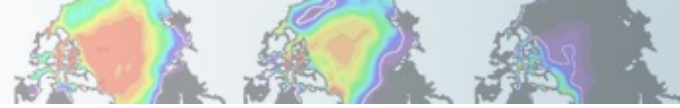
More advanced modifications that require changes in the source model modules / subroutines: SourceMods

$CASEROOT

SourceMods

src.cice

src.pop

…

Exercise #4
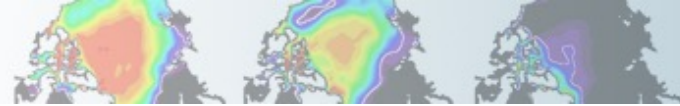## Increase zonal wind stress in the ocean

1. Create a clone of your control simulation.

2. Copy **forcing_coupled.F90** file:

   cp $SRCROOT/components/pop/source/forcing_coupled.F90
      $CASEROOT/SourceMods/src.pop

3. Modify subroutine **rotate_wind_stress** in **forcing_coupled.F90** to increase the first (x) component of the wind stress by 25%.

4. Build and run the model for 1 year.

```fortran
!BOP
! !IROUTINE: rotate_wind_stress
! !INTERFACE:

  subroutine rotate_wind_stress (WORK1,WORK2)

! !DESCRIPTION:
!  This subroutine rotates true zonal/meridional wind stress into local
!  coordinates, converts to dyne/cm**2, and shifts SMFT to the U grid
!
! !REVISION HISTORY:
!  same as module

! !INPUT PARAMETERS:

   real (r8), dimension(nx_block,ny_block,max_blocks_clinic), intent(in) ::  &
      WORK1, WORK2          ! contains taux and tauy from coupler


!EOP
!BOC
#if CCSMCOUPLED
!-----------------------------------------------------------------------
!
!  local variables
!
!-----------------------------------------------------------------------

   integer (kind=int_kind) :: iblock
   integer (POP_i4)        :: errorCode


!-----------------------------------------------------------------------
!
!  rotate and convert
!
!-----------------------------------------------------------------------

   SMFT(:,:,1,:) = (WORK1(:,:,:)*cos(ANGLET(:,:,:)) +  &
                    WORK2(:,:,:)*sin(ANGLET(:,:,:)))*  &
                   RCALCT(:,:,:)*momentum_factor
   SMFT(:,:,2,:) = (WORK2(:,:,:)*cos(ANGLET(:,:,:)) -  &
                    WORK1(:,:,:)*sin(ANGLET(:,:,:)))*  &
                   RCALCT(:,:,:)*momentum_factor
```
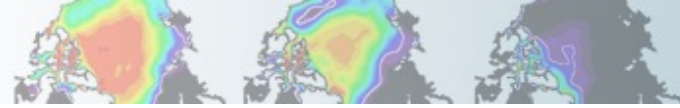
Post Processing and Viewing

1. Create an annual average of the 1st year's data for each of the simulations using the 'ncra' command.

   ```
   ncra $OUTPUT_DIR/*.pop.h.0001*nc $CASENAME.pop.h.0001.nc
   ```
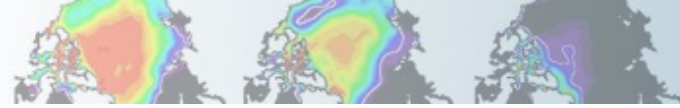
2. Create a file that contains the differences between each of the experiments and the control simulation.

   ```
   ncdiff $CASENAME.pop.h.0001.nc $CONTROLCASE.pop.h.0001.nc
         $CASENAME_diff.nc
   ```

3. Examine the variables within each annual mean and the difference files using 'ncview'.

   ```
   ncview $FILENAME.nc
   ```

4. You can also take a look at other monthly-mean outputs or component log files.

Exercise Questions

1. What variables do you expect to change when you turn off the overflow parameterization? What variables show a difference between this experiment and the control case and how different are they?

2. What changes do you see from the control case with an increased snow albedo? What time of year did you start your run and which season do you expect to see the biggest impact for shortwave changes?

3. What are the impacts of increased zonal wind stress? Where do you think the impacts would be the largest in the ocean?