Ocean / Sea-ice Tutorial Session
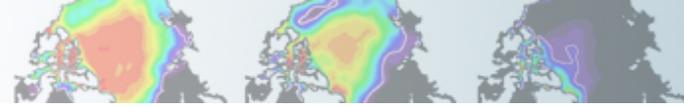
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National Center for Atmospheric Research

NSF

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NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

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Climate & Global Dynamics
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Your Friends: The Users Guides

CESM Users Guide:

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

CICE Users Guide:

http://www.cesm.ucar.edu/models/cesm2.0/sea-ice

POP2 and Ecosystem Users Guides:

http://www.cesm.ucar.edu/models/cesm2.0/ocean
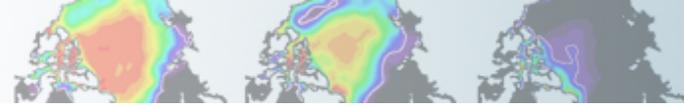
General Recommendations

- Choose unique, meaningful case names for your experiments and develop your own sensible case-naming conventions.

- Document your cases and any changes made before and during a run, such as source-code modifications, processor layout changes, timestep adjustments, bugfixes, etc. The README.case file is a natural place for this documentation.

- Before you modify any case files, make and keep a copy of the original.

- *Don't* overwrite input data files in the inputdata directories – create new files instead -- and modify your $CASE scripts accordingly.

- *Don't* modify source code or scripts in your CESM download directory – use SourceMods directories instead.
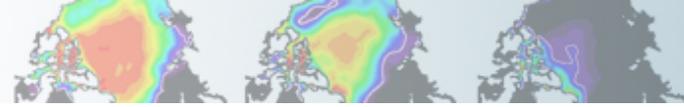
Debugging Suggestions

- Check your most recent log and *stderr*/*stdout* files in your $RUNDIR and $CASEDIR. You may need to check more than one of them; start with cesm.log.* (look for "exit" in the cesm.log file and look at lines preceding and following for information). Examine component log files, too.

- Set INFO_DBUG = 2 in env_run.xml and resubmit to get more output diagnostics.

- Confirm that you rebuilt your executables if you have made source-code modifications.

- Rebuild with DEBUG TRUE in env_build.xml and resubmit for a short run.
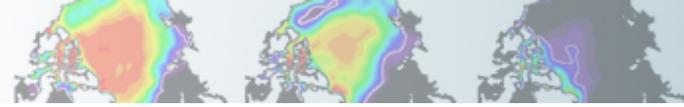
Ocean-Model Debugging Suggestions

- If your run fails because the ocean model solutions don't converge

    - Usually this is because either the ocean is getting bad forcing data from the coupler or something is terribly wrong with your modifications. Investigate the data being read by the ocean model and make sure that your changes are correct.

    - If everything looks okay, you can try cutting the ocean timestep by 20% and rerunning.

- Double-precision and/or more frequent ocean tavg files can be useful in debugging, but do not use in production runs!
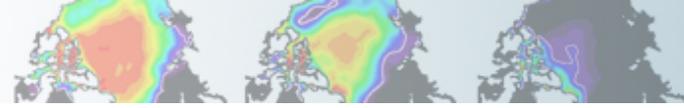
Getting Help/Getting Involved

- 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

- Join a CESM Working Group
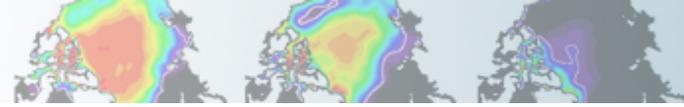
Today's Exercises

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

- You will be using the G component set at T62_gx3v7 resolution.
- Each simulation will be run for 1 year.
- You will then use 'ncview' to see how each experiment differs from the control simulation.
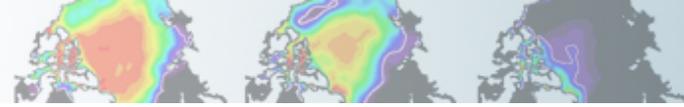
What is a G case?

- 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)

    - 60+ years (updated as new datasets are available)
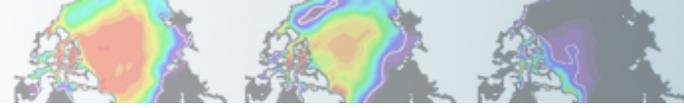
Ocean and Ice Resolved Namelists

> cd $CASE1

> ./case.setup

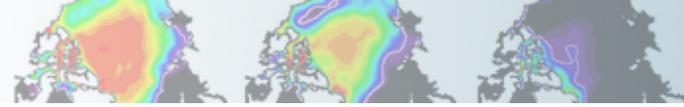> cd CaseDocs

> ls

ice_in   pop_in

* Note that you do not edit the resolved namelists. You put the relevant changes into user_nl_cice and user_nl_pop.

# Ocean Namelist

```
&transports_nml
  lat_aux_grid_type       = 'southern'
  lat_aux_begin           = -90.0
  lat_aux_end             =  90.0
  n_lat_aux_grid          = 180
  moc_requested           = .true.
  n_heat_trans_requested = .true.
  n_salt_trans_requested = .true.
  transport_reg2_names    = 'Atlantic Ocean','Mediterranean Sea','Labrado
  n_transport_reg         = 2
/

&context_nml
  lcoupled                 = .true.
  lccsm                    = .true.
  b4b_flag                 = .false.
  lccsm_control_compatible = .false.
/

&overflows_nml
  overflows_on             = .true.
  overflows_interactive    = .true.
  overflows_infile         = '$overflow_filename'
  overflows_diag_outfile = '${output_d}o'
  overflows_restart_type = 'ccsm_$runtype'
  overflows_restfile       = '${output_r}o'
/
```
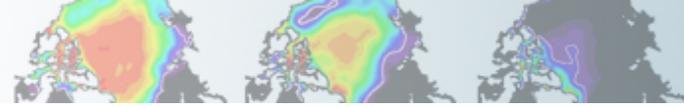
Sea-ice Namelist

```
 lcdf64          = .true.
 pointer_file           = 'rpointer.ice'
 xndt_dyn               =  1.0
/
&grid_nml
 grid_file              = '$DIN_LOC_ROOT/ocn/pop/gx3v7/grid/horiz_grid_20030806.ieeer8'
 grid_format            = 'bin'
 grid_type              = 'displaced_pole'
 kcatbound              =  0
 kmt_file               = '$DIN_LOC_ROOT/ocn/pop/gx3v7/grid/topography_20100105.ieeei4'
/
&ice_nml
 advection              = 'remap'
 albedo_type            = 'default'
 albicei                = 0.30
 albicev                = 0.68
 albsnowi               = 0.63
 albsnowv               = 0.91
 dt_mlt_in              =  2.00
 evp_damping            = .false.
 kdyn           =  1
 kitd           =  1
 krdg_partic            = 1
 krdg_redist            = 1
 kstrength              =  1
 ndte           =  120
 r_snw          =  -2.00
 rsnw_melt_in           =  2000.
 shortwave              = 'dEdd'
/
```
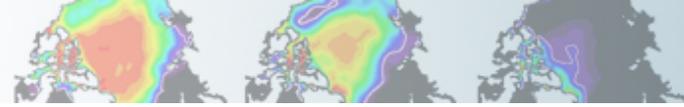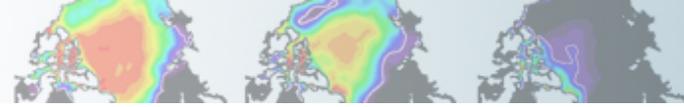
Exercise #1
Control Simulation

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

    - component set: G

    - resolution: T62_gx3v7

2. The default is for the simulation to run for 5 days. Change this to 1 year in env_run.xml

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.

    Don't forget to run cesm_setup!

Exercise #2

Turn off the overflow parameterization

1. Create a clone of your control simulation. Verify that it retained the run time of 1 year. In the $CODEROOT/cime/scripts directory, issue the following command:

   create_clone --case $NEWCASEDIR --clone $OLDCASEDIR

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

   overflows_on = .false.

   overflows_interactive = .false.

3. Build and run the model for 1 year.
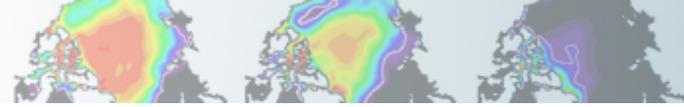
Exercise #3
## Change the snow albedo

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,
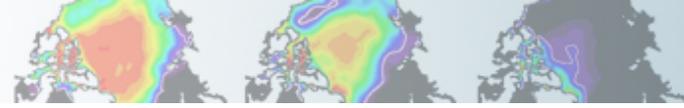   - lower rsnw_nonmelt → higher albedos
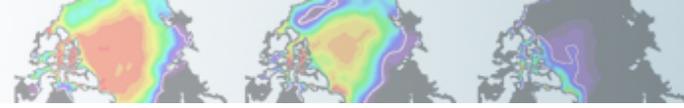
More advanced modifications that require changes in the source model modules / subroutines: SourceMods

> cd $CASEDIR

> ls SourceMods

src.cice   src.pop …………

Exercise #4
Increase zonal wind stress in the ocean
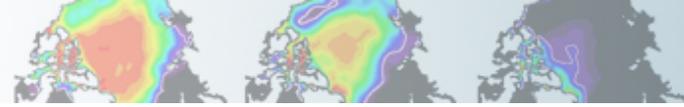
1. Create a clone of your control simulation.

2. Copy forcing_coupled.F90 file:

   cp $CODEROOT/components/pop/source/forcing_coupled.F90
      $CASEDIR/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
```
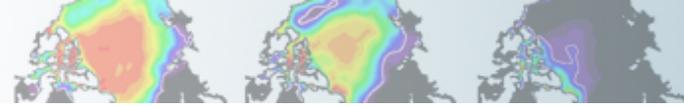
Post Processing and Viewing

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.
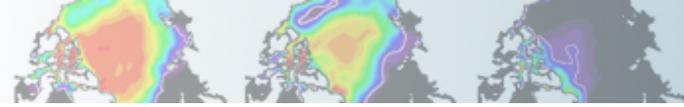
Exercise Questions

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?