Climate Variability and Change Working Group

Update, Feb 2021

Co-chairs: *Isla Simpson, Aixue Hu, ShangPing Xie, Peter Gleckler*

Liasons: *Adam Phillips, Gary Strand*

Feb 18th, 2021

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Outline

- Update on new simulations available (or about to be available) to the community
- Plan for forthcoming simulations
- New resources of relevance to CVCWG
  - CVDP-LE - Clara Deser, Adam Phillips
  - Update on Climate Data Guide - Dave Schneider
- Update on new modelling tools under development by community members
  - Pencil model - Young-Oh Kwon
  - Mechanically Decoupled Ocean - Sarah Larson
- Open discussion:
  - What simulations would you like to see us do?
  - What analysis would you like to do on forthcoming simulations (let's make sure we have the right output)
  - Any other thoughts on CVCWG activities and directions

Since the last meeting...

- Jerry Meehl's term as co-chair of the CVCWG has ended. Jerry was a co-chair for 10 years. Thanks to Jerry for all his work toward the CVCWG

- Aixue Hu (CCR, CGD) has taken over from Jerry as co-chair of the CVCWG

New simulations available (or about to be available) to the community

CESM2 large ensemble

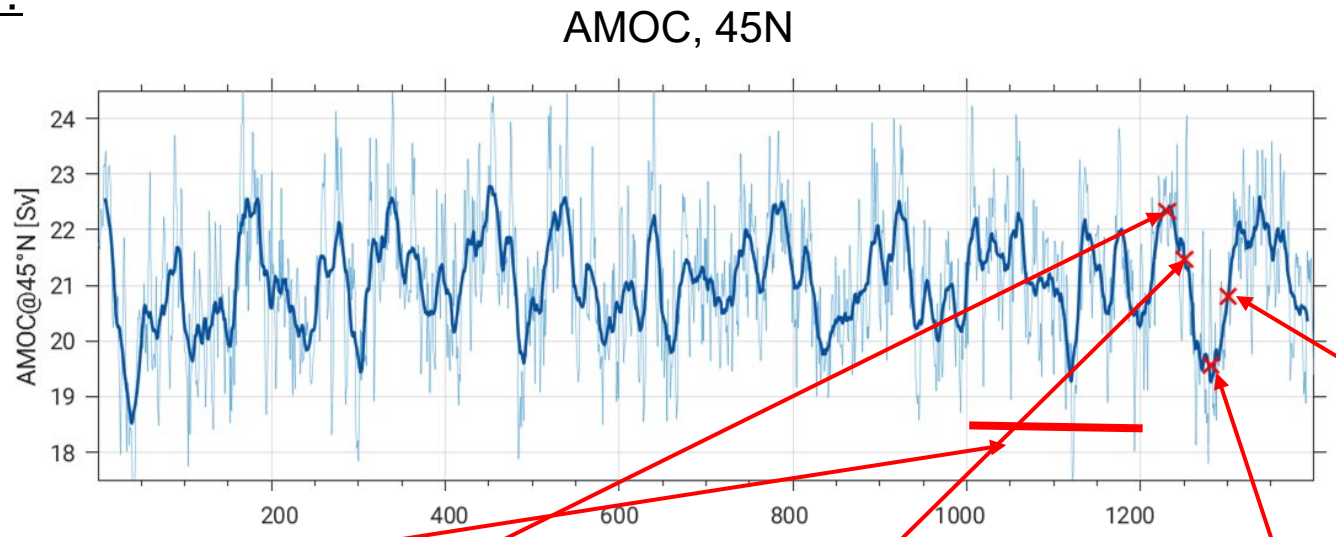
Project leads: Gokhan Danabasoglu, Clara Deser, Keith Rogers, Axel Timmermann

Important contributions from Nan Rosenbloom, Jim Edwards, Sun -Seon Lee and many others

CESM2 large ensemble

- 100 member ensemble
- 1850-2014 under historical forcings, 2015-2100 under SSP-3.7.0

Initialization strategy:



Some bug fixes and a change in biomass burning emissions in the late 20th/early 21st century between the first 50 and second 50 members

20 “macro” members initialized from 10 years intervals from year 1000-1200

20 “micro” members initialized from year 1231

20 “micro” members initialized from year 1251

20 “micro” members initialized from year 1281

20 “micro” members initialized from year 1301

https://www.cesm.ucar.edu/projects/community-projects/LENS2/

CESM2 large ensemble

- 100 member ensemble
- 1850-2014 under historical forcings, 2015-2100 under SSP-3.7.0

Current Status:

- Nearly 90 members completed
- Last 10 (MOARS with enhanced output) are about to begin.
- Description paper (Rogers et al) to be submitted soon. Expect data to become available in late spring/early summer

CVCWG simulations now available

- CAM6 prescribed SST ensembles now extended out to 2019 (Adam Phillips, Isla Simpson)
  - 10 member GOGA ensemble
  - 10 member TOGA ensemble

  https://www.cesm.ucar.edu/working_groups/CVC/simulations/cam6 -prescribed_sst.html

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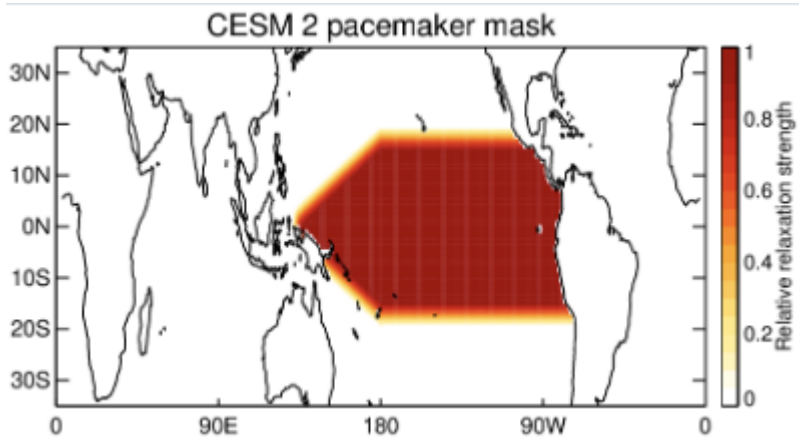
- CESM2 pacemaker ensemble now available (Isla Simpson, Nan Rosenbloom, Adam Phillips)
  - 10 member ensemble, 1880-2019
  - Relaxation of anomalies in tropical Pacific SSTs toward observations

  https://www.cesm.ucar.edu/working_groups/CVC/simulations/cesm2 -pacific_pacemaker.html



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  lips)

Instructions:

https://www.cesm.ucar.edu/working_groups/CVC/simulations/cesm2-pacific_pacemaker_instr.html

How to set up pacemaker experiments

This page describes how to set up pacemaker experiments using the CESM2 Tropical Pacific Pacemakers as an example.

Step 1: generate your nudging mask

The mask will determine where you are relaxing SSTs and where you are not. The mask must be defined on the ocean model grid that you are using. In this example, the mask is defined on the POP gx1v7 grid, which was used for the CESM2 tropical pacific pacemakers. Set the regions you want to nudge fully to 1, the regions you don't want to nudge to zero and regions of the buffer zone to some value in between zero and one. Here you can download an example POP grid definition file and python script that can be used to generate the mask used in the CESM2 tropical Pacific Pacemakers. This can be adapted to mask a region of your choosing.

Step 2: generate your SST forcing dataset

Your SST forcing dataset should consist of 1 file per/month with the naming convention XXX.nc.YYY.JULDAY.DAYOFMONTH. These files contains your SST forcing dataset interpolated onto the POP grid. For the case of the CESM2 tropical Pacific pacemakers, this SST forcing dataset is the models climatology from XXDATEXXX to XXDATEXXX derived from XXSIMSXX plus the anomalies from the XXDATEXX to XXDATEXX climatology from ERSSTv5. For those with access to the cheyenne supercomputer, this SST dataset can be found at

/glade/p/cesm/cvwg/proj/pacemaker_restore/input/restore/ModifiedSST_ERSSTv5.

Step 3: Combine your mask and forcing SST dataset in one location

Suppose your SST forcing dataset is located at /my/sst/forcing/data/ and your mask is located at /my/mask/mask.nc. Create a new directory for your case where you will link to both your SST forcing files and your mask. Suppose this directory is located at /ssts/for/my/case. Perform the follwing steps to combine your sst forcing data and mask in the required way

```
cd /ssts/for/my/case/
ln -s /my/mask/mask.nc ./XXX.nc
ln -s /my/sst/forcing/data/*.nc.* .
```

These steps have resulted in soft links to the mask and the SST forcing data in the same folder and the mask being given a name that corresponds to your SST forcing data name (XXX).

Step 4: Set up your case

Let's assume your CESM tag is located in $CESMROOT and you want to set up your case at the location $CASEROOT. You could set up the equivalent of the CESM2 tropical Pacific pacemakers using the following

```
cd $CESMROOT/cime/scripts
./create_newcase --case $CASEROOT --compset BHISTcmip6 --res f09_g17 --mach cheyenne --run-unsupport

cd $CASEROOT
./xmlchange RUN_TYPE=hybrid
./xmlchange RUN_STARTDATE="1880-01-01"
./xmlchange RUN_REFDIR=XDIRX
./xmlchange RUN_REFCASE=XCASEX
./case.setup
```

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  https://www.cesm.ucar.edu/working_groups/CVC/simulations/cesm2 -pacific_pacemaker_instr.html

- More in the CESM2 piControl series
  - 2000 year long coupled piControl
  - 1000 year long uncoupled piControl (SST climatology from the coupled run prescribed)
  - 500 year long uncoupled piControl (time varying daily SSTs corresponding to years 1000 -1500 prescribed)

  https://www.cesm.ucar.edu/working_groups/CVC/simulations/cam6 -picontrol.html

CVCWG simulations currently underway

- Single forcing large ensemble (Nan Rosenbloom, Sasha Glanville)
  - Prescribing time varying forcings in isolation while leaving other forcings fixed at 1850's values
  - 1850 - 2050 (or maybe 2100 depending on resources)
  - 10-15 members of each forcing planned (depending on resources)
  - 4 forcings
    - greenhouse gases (10 members completed to 2050)
    - industrial aerosols (5 members running)
    - biomass burning aerosols (5 members completed to 2050)
    - everything else (land use/land cover, ozone, solar, volcanoes) (starting soon)

- SSP2-4.5 ensemble (Nan Rosenbloom, Adam Phillips)
  - A 10-15 member ensemble (depending on resources) of 2014-2100 simulations under the SSP2-4.5 forcing scenario, to complement the CESM2 LENS (which used the SSP3-7.0 scenario)

Forthcoming simulations

Simulations planned for the coming 1.5 years

- Regionally refined (1/8th deg) North Atlantic AMIP simulation

Proposed simulation:

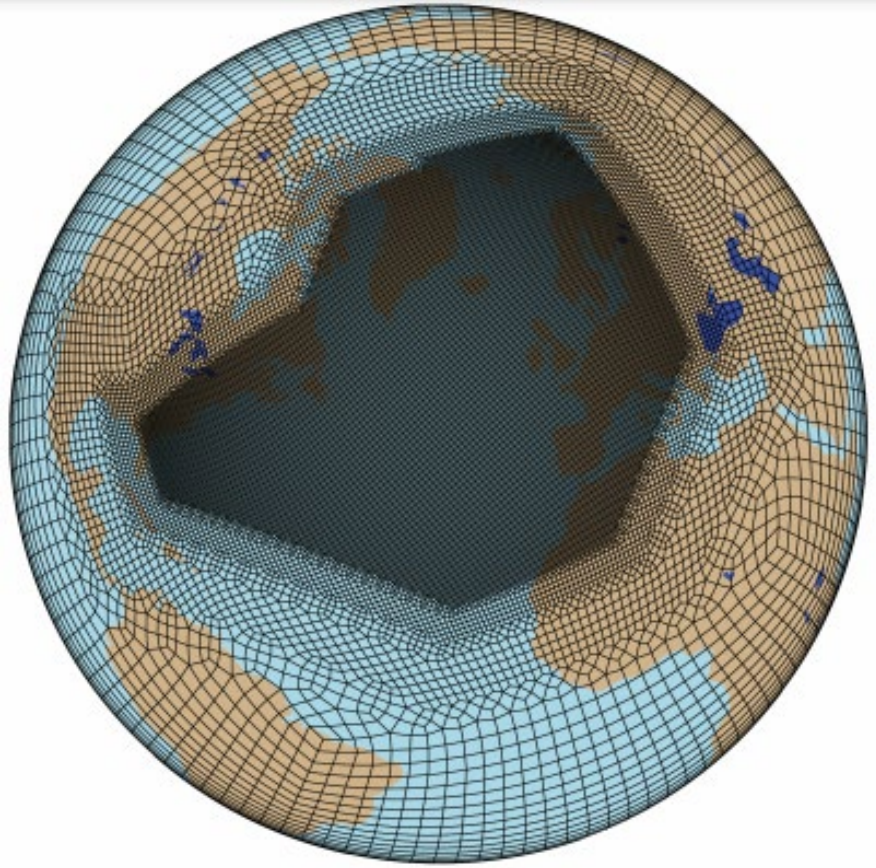
- 1950-present day
- HadISST2 (¼) SSTs (highresmip protocol)

Primary Motivation:

- Deficient North Atlantic jet stream variability in relation to North Atlantic SST variability. Does the nature of coupling between SST variability and the North Atlantic circulation change as we go to resolutions > 1/4deg?

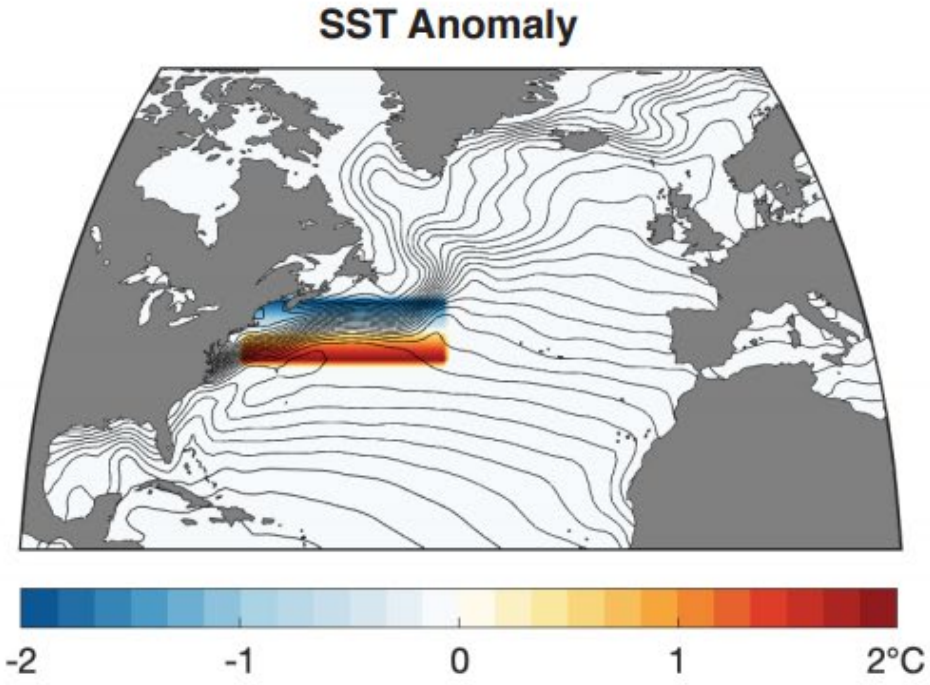
Other motivations:

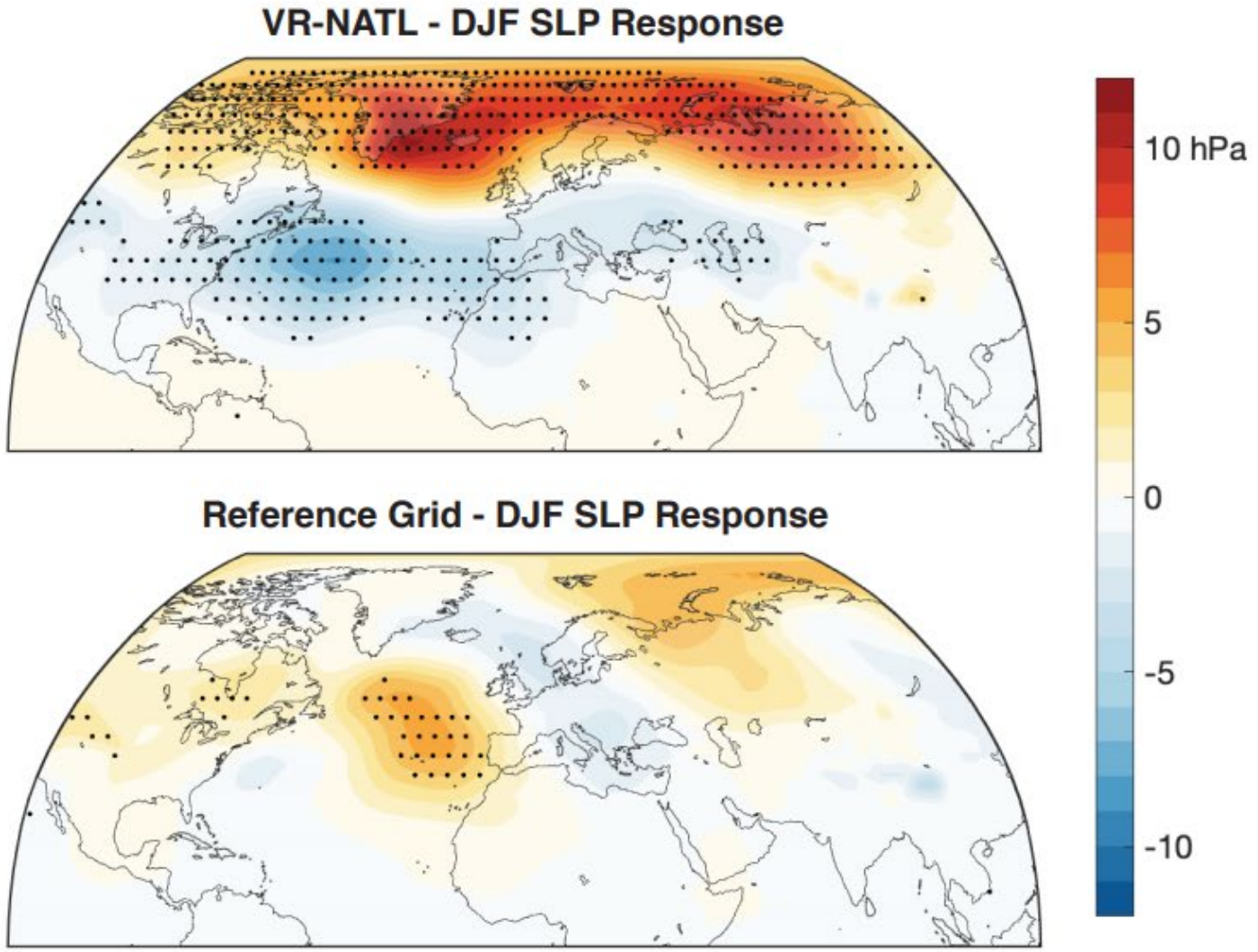
- study of polar lows (Marta Moreno Ibanez (UQAM)
- What would you like to look at? Tell us so we can be sure to save the right output.



Thanks to Adam Herrington, Robb Jnglin WIlls

Initial test of this configuration with an idealized SST perturbation (Robb Jnglin Wills)





Simulations planned for the coming 1.5 years

- High vertical resolution pre-industrial control

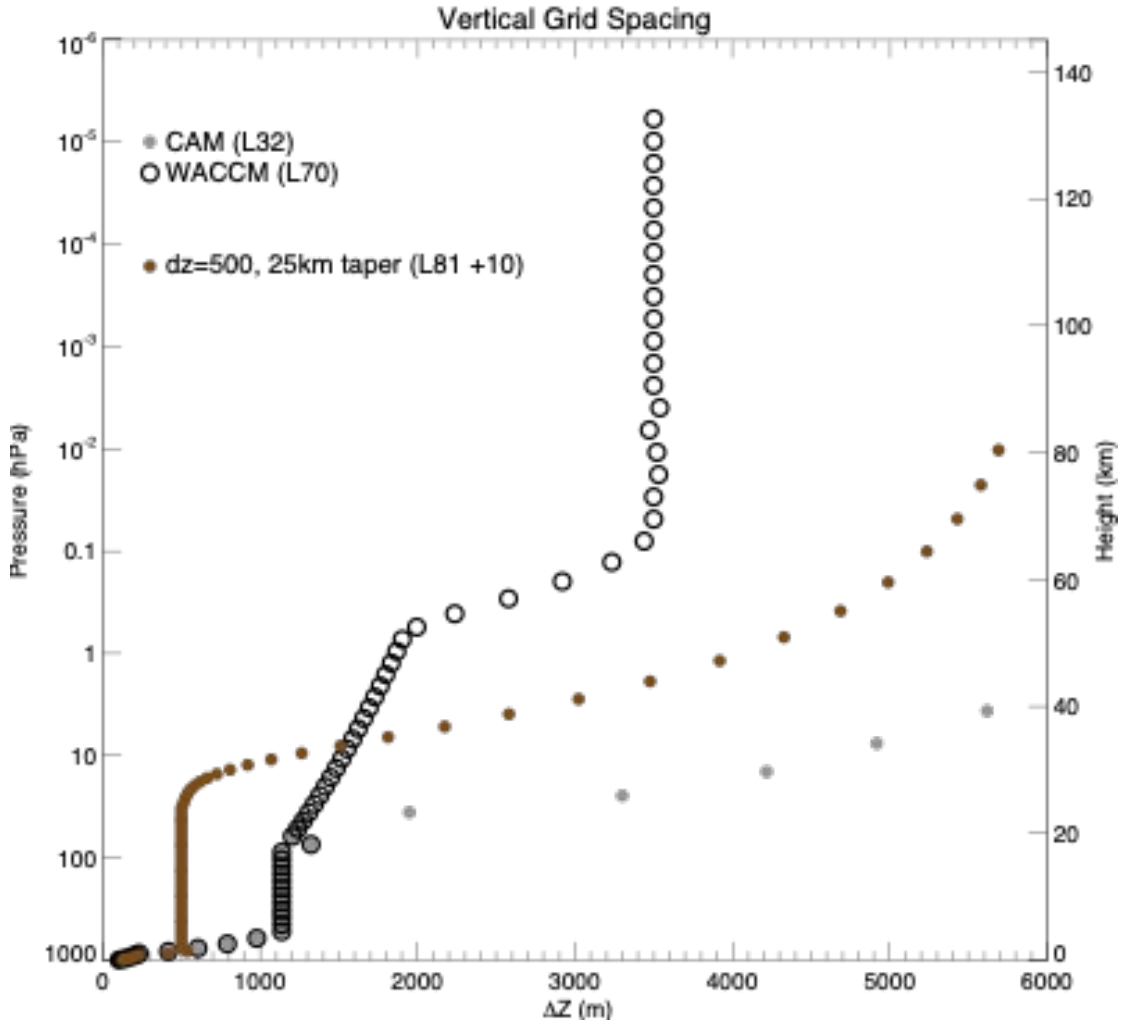
CAM7 will have a higher top and enhanced vertical resolution.

Many other things will also change.

The CVCWG will run a piControl simulation with CAM6 physics but with the new vertical grid (absent boundary layer changes).

This will allow for a clean comparison of the representation of climate variability between the old and new vertical resolutions.

Will serve as a validation step prior to initialized hindcasts with this confuguration that will be performed by Scripps CW3E



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  - 1000 year long piControl
  - 10 member historical ensemble from 1850-2014

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- Stochastic physics piControl
  - Computing time has been set aside for a 1000-year piControl with stochastic physics, if the stochastic physics configuration can be tuned up and ready.

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- Regionally refined tropical belt
  - A regionally refined tropical belt AMIP simulation from 1979-2015 will be performed with 0.25 degree resolution in the tropics (30S-30N) for analysis of tropical cyclones, MJO, atmospheric rivers (Brian Medeiros)

New resources

https://www.cesm.ucar.edu/working_groups/CVC/cvdp-le/

NCAR UCAR

CGD's Climate Analysis Section

Climate Variability Diagnostics Package

for Large Ensembles

A new automated tool and data repository for exploring and evaluating modes of interannual-to-decadal climate variability and their forced changes.

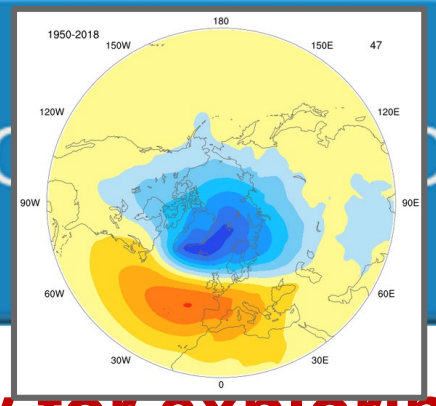
Phillips, A. S., C. Deser, J Fasullo, D. P. Schneider and I. R. Simpson, 2020: Assessing Climate Variability and Change in Model Large Ensembles: A User's Guide to the "Climate Variability Diagnostics Package for Large Ensembles", doi:10.5065/h7c7-f961

- ***Summary metrics on ensemble-mean and ensemble-spread.***

Code available on github; CGD seminar tutorial video (Nov 2020).

https://www.cesm.ucar.edu/working_groups/CVC/cvdp-le/

NCAR | CGD's Climate Analysis Section
UC Climate Variability Diagn ckage



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: Assessing Climate Variability
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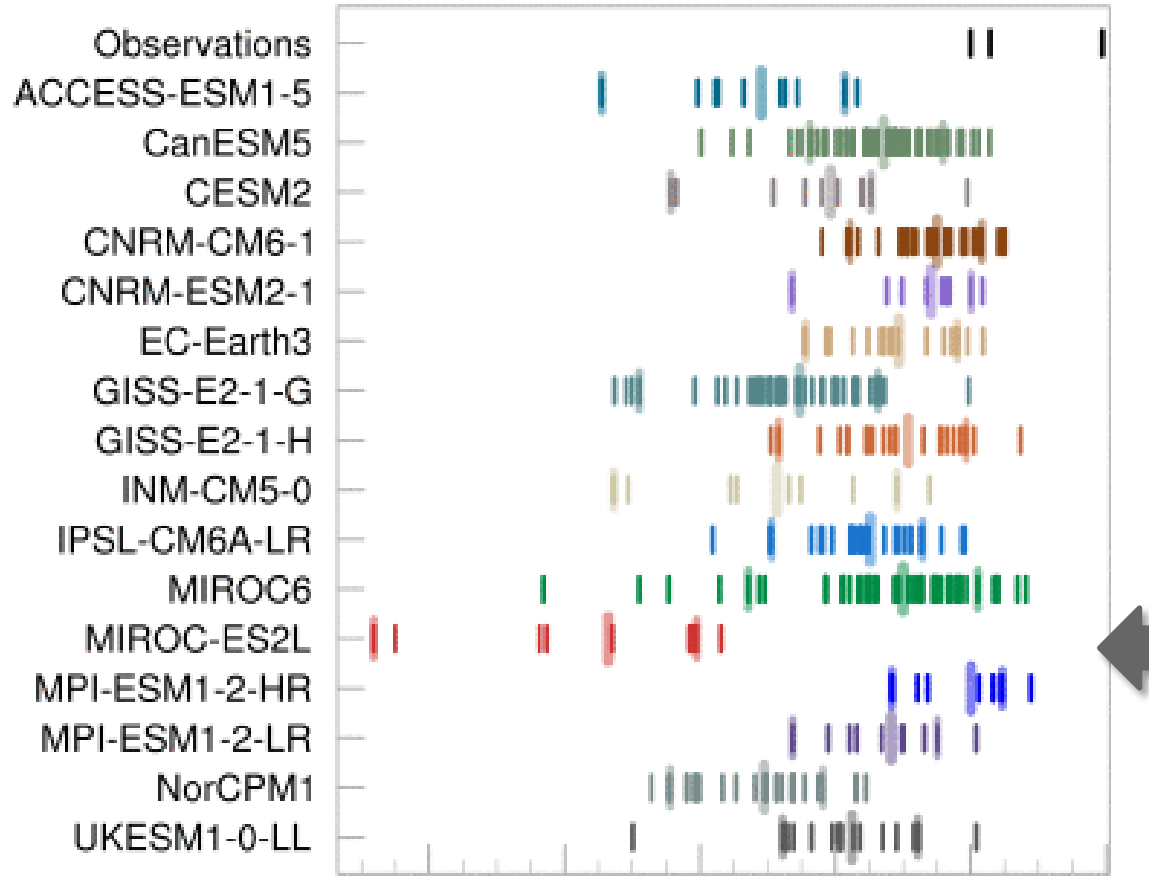
➢ *Sun l ensemble spread*

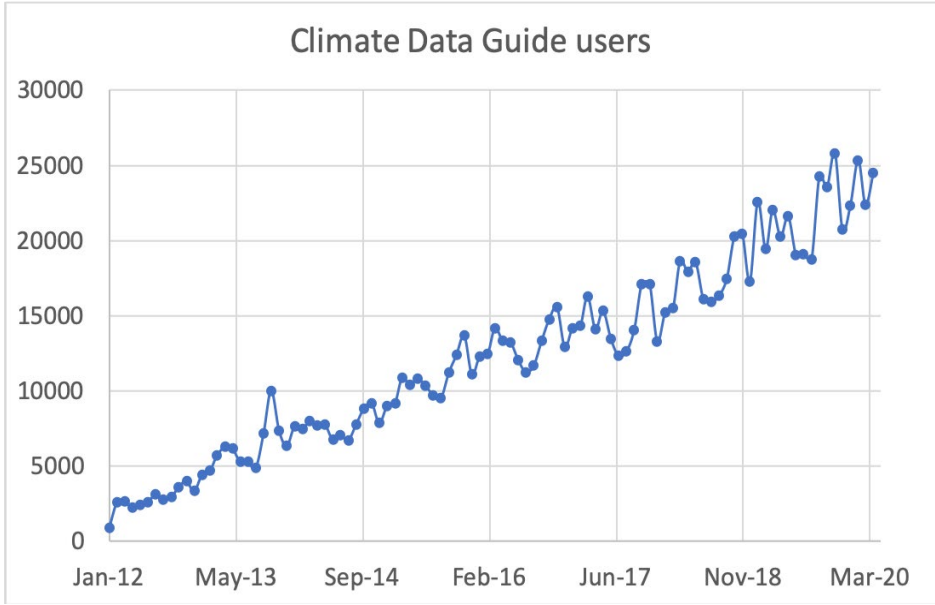
ar tutorial video

CMIP6 models: Winter NAO Pattern Correlations



Models are structurally different if their distributions do not overlap.

- Consistent user growth
  - ~26,000 users per month growing at 15% -20% year-over-year
  - 60% members of university community
  - Community experts contribute expert guidance on data strengths & limitations



- Plan to modernize the web interface
  - Support from NSF for 2020-2023
  - Enitirely new website will be built using Drupal

- New Board of Advisors (BOA)
  - Experts from a range of disciplines
  - Meets quarterly
  - Advising on increasing & diversifying the datasets covered and overall direction of the *Guide*

Over 1 million users 2012-present

BOA members: *Dan Amrhein, Arlene Fiore, Pierre Gentine, Zachary Labe, Brooke Medley, Angie Pendergrass, Sarah Purkey, Colin Raymond, Claudia Stubenrauch, Arianna Varuolo Clarke*

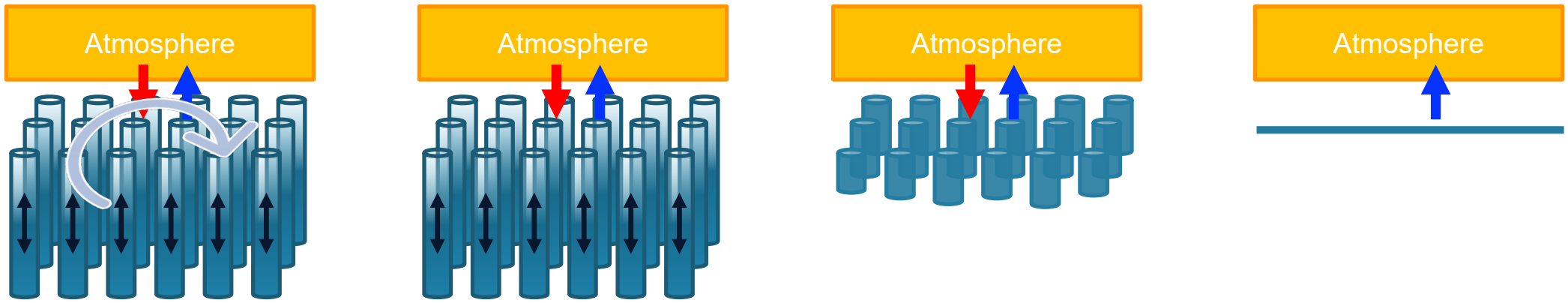
ex officio: *Clara Deser, David Schneider*

New modelling tools under development by community members

“Pencil” Ocean Model (=an array of 1-D ocean columns)

Young-Oh Kwon, Ivan Lima, Gokhan Danabasoglu, Mike Levy, Jim Benedict, Bob Tomas, Clara Deser, Amy Clement, …

Choices for the ocean model in CESM



Full 3-D Ocean | Pencil Ocean | Slab Ocean | Data Ocean

Progresses so far:

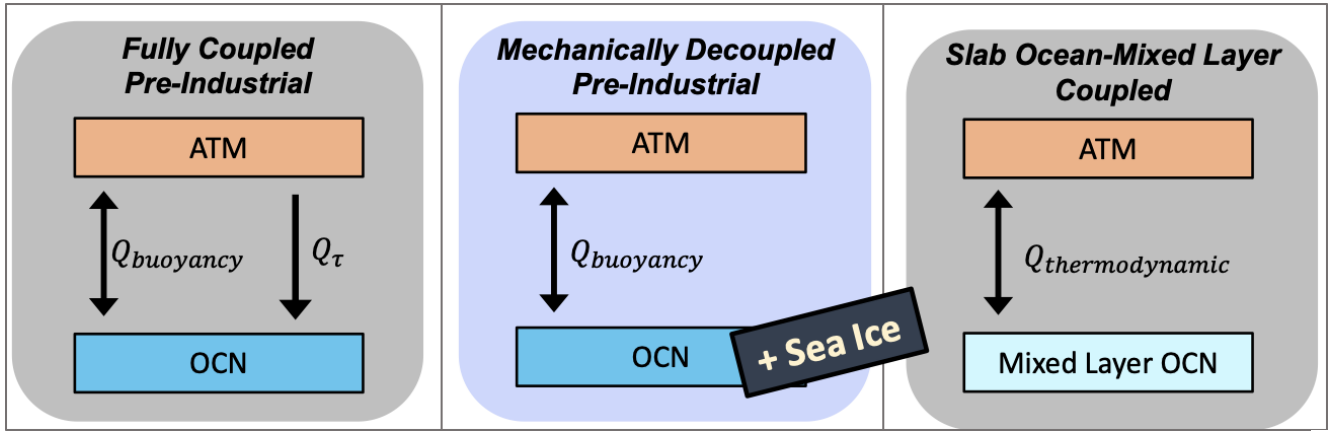
- Implemented the Pencil Ocean model in the ocean component model POP for CESM1.1.1 and CESM2.2.0.
- Conducted multiple ~10-yr test simulations.
- Implementing the Pencil Ocean model in the CESM2 LENS version (CESM2.1.4).

Next steps:

- Long (multi-century?) preindustrial control simulation of the Pencil Ocean coupled CESM2.1.4.
- Implement additional Ekman transport term to the Pencil Ocean model.

Progress towards a Mechanically Decoupled** CESM2

Sarah Larson, Kay McMonigal, Dave Bailey (CICE), Isla Simpson (config coordination)

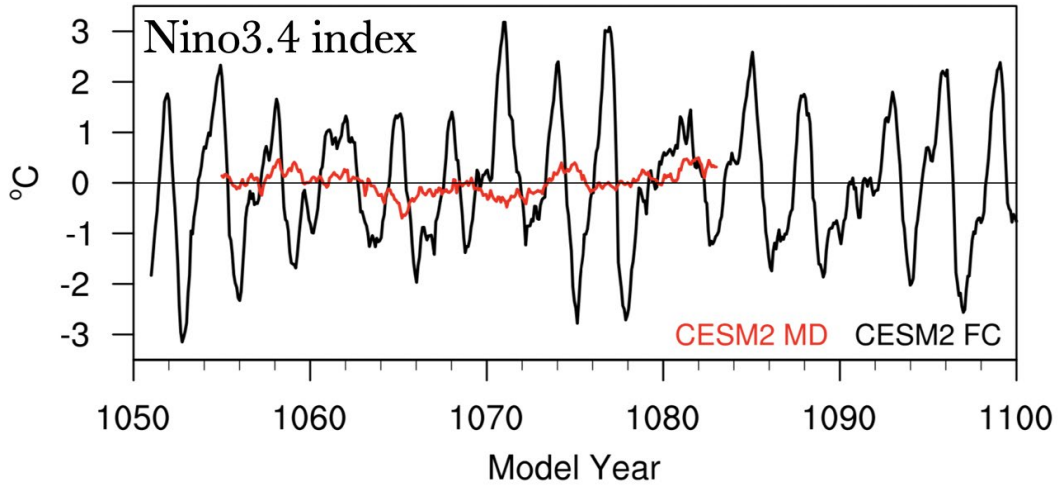


Experiments

- 500-600 year piControl (30 yrs complete)
- 30 member historical ensemble (**forcing?**)
- 30 member future ensemble (2022)

Recent progress:

- Decoupled CICE from anomalous momentum fluxes
- Code changes rewritten for netcdf capability
- Increased temporal frequency of the prescribed wind stress (POP) and U/V_bot (CICE) forcing to 6-hourly to resolve the solar cycle
- MD CESM2.1.4 branched from CESM2 CMIP6 piControl yr 1051

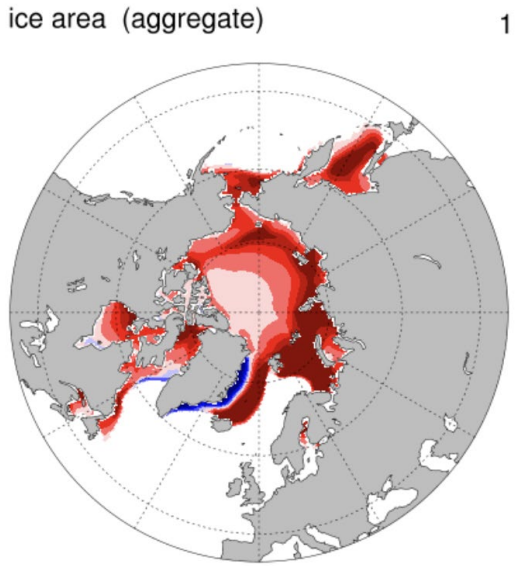


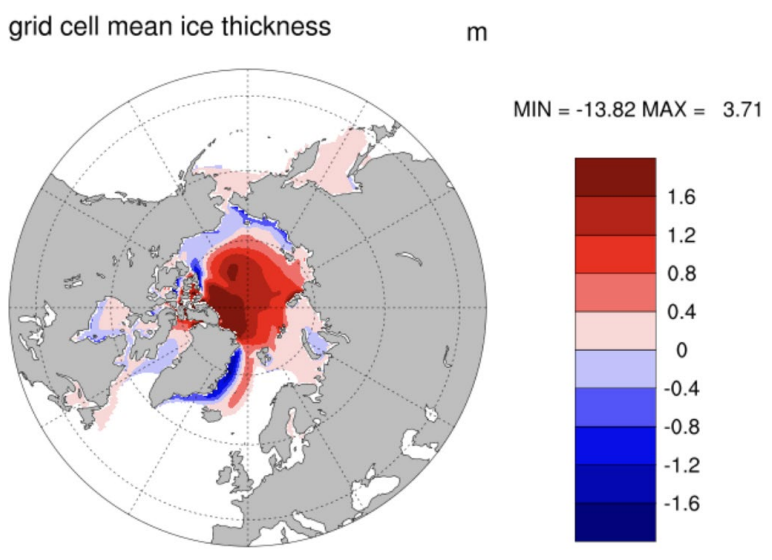
**No anomalous momentum flux forcing of POP and CICE

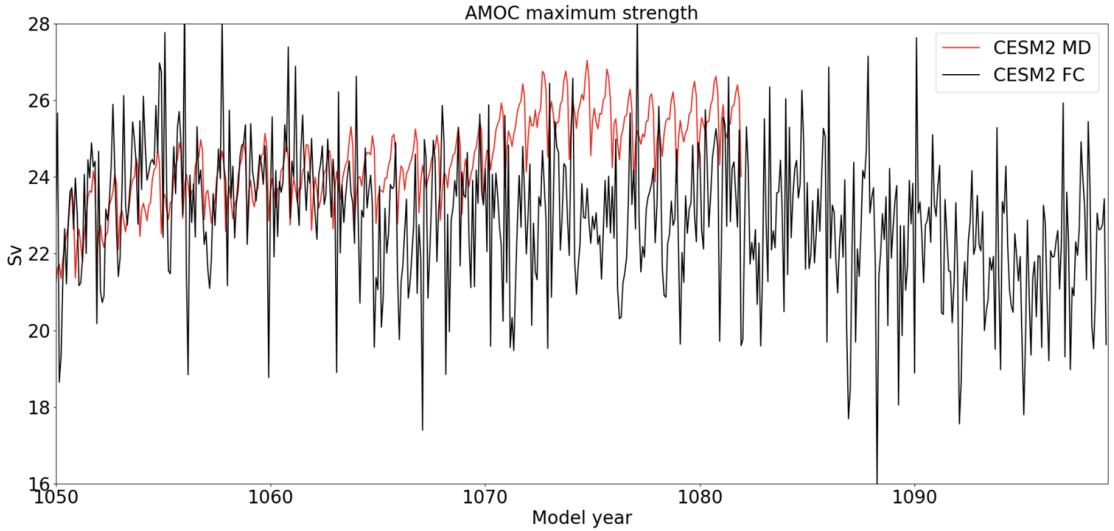
Progress towards a Mechanically Decoupled CESM2

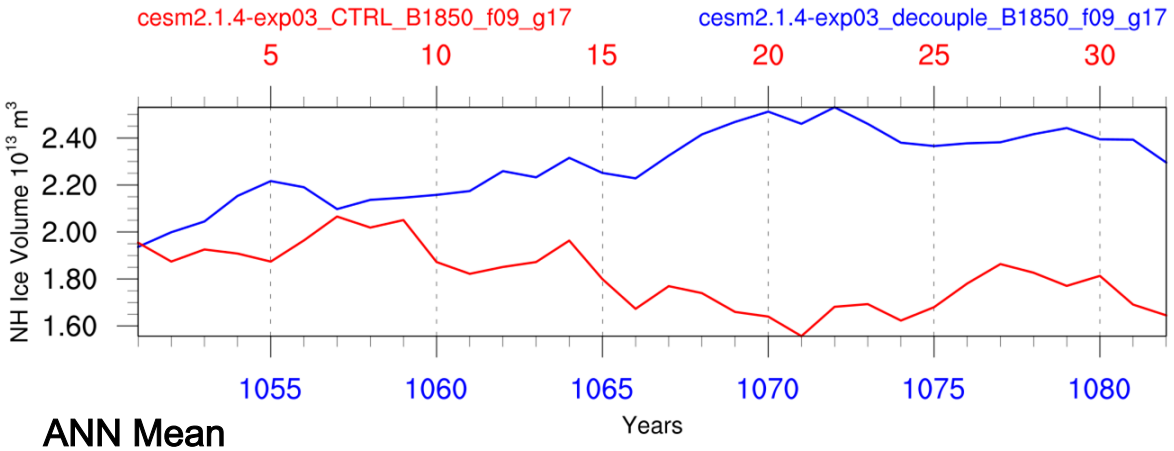
Making sense of the sea ice response

- Branched from same restart files
- Seasonality agrees with FC
- Ice velocities slow down
- Volume and area increase









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OPEN DISCUSSION

Any questions on what you have just seen?

Any other simulations you'd like to see the CVCWG do?

Any thoughts on the experimental design/output variables for any of the forthcoming simulations?

Any other thoughts?