US CLIVAR Working Group on Large Ensembles

The Large Ensembles Workshop

July 24 – 26, 2019

Boulder, Colorado

Credit: F. Lehner

Scientific Organizing Committee:

Clara Deser and Keith Rodgers (co-chairs)

Pedro DiNezio, Jen Kay, Flavio Lehner, Nikki Lovenduski, Karen McKinnon and Isla Simpson

Program Organizing Committee:

Jeff Becker, Mike Patterson and Jennie Zhu (US CLIVAR Project Office)

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115+ Participants (42 early career)

Diverse backgrounds:

atmosphere, ocean, land, biogeochemistry, air quality, health, economics, statistics.

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Why are we here?

- to exchange knowledge and ideas
- to foster new research directions and collaborations
- to inform a coordinated strategy for Large Ensembles

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What are “Large Ensembles” and what insights do they provide beyond CMIP?

Initial-condition Large Ensembles

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Many simulations performed with a single climate model and a single radiative forcing scenario, but starting from slightly different initial conditions.

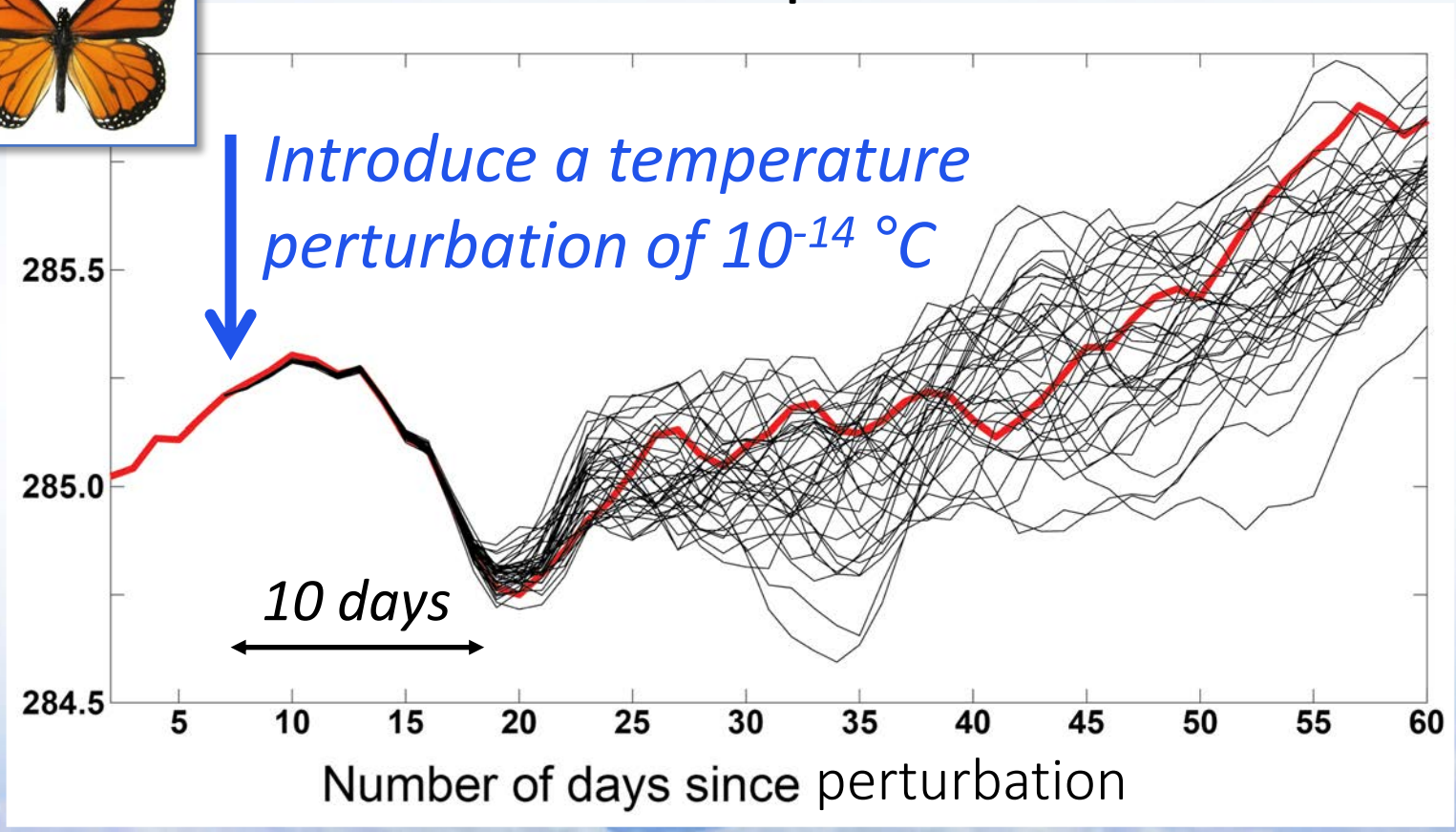
Emissions Scenario

+

Initial condition perturbation

Initial-condition Large Ensembles

Global Temperature



The CESM1 40-member Large Ensemble (Kay et al. 2015)

Initial-condition Large Ensembles

Unpredictable weather & climate 'noise'

Introduce a temperature perturbation of 10^{-14} °C

285.5

285.0

284.5

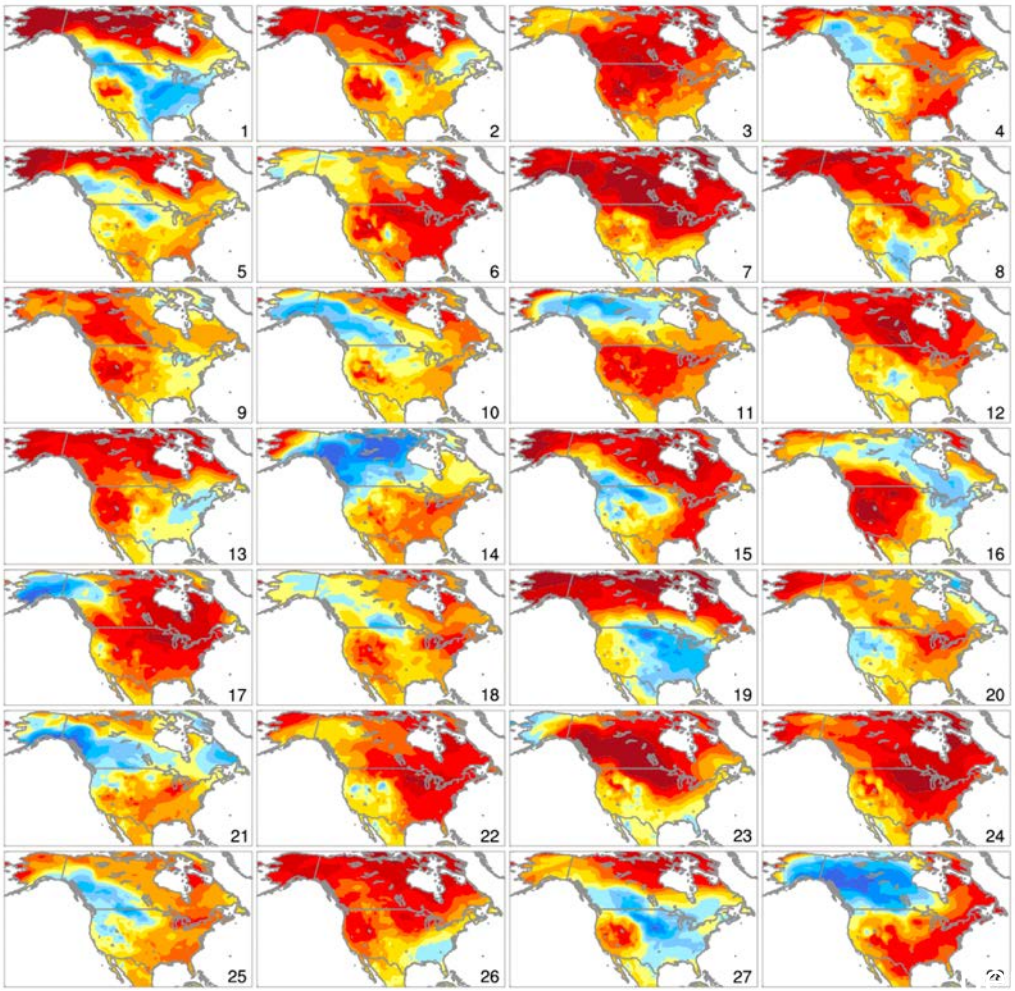
10 days

5 10 15 20 25 30 35 40 45 50 55 60

Number of days since perturbation

The CESM1 40-member Large Ensemble (Kay et al. 2015)

Temperature Change (1963-2012)



CESM1 Large Ensemble

CO_2

+

Deser et al., J. Climate 2016

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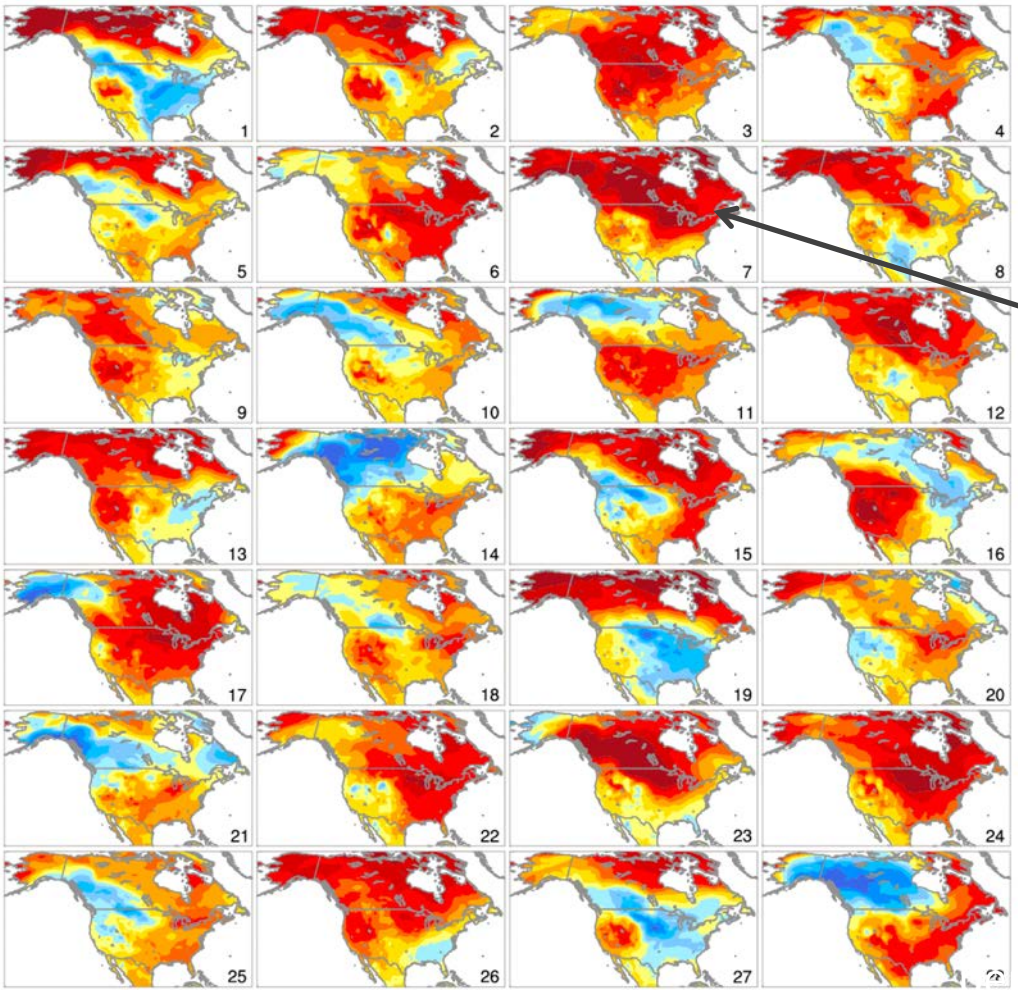
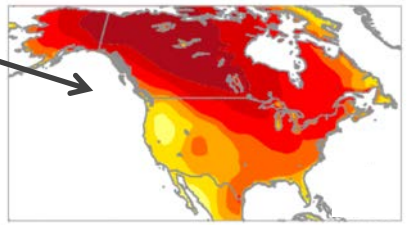


CESM1 Large Ensemble

Observed



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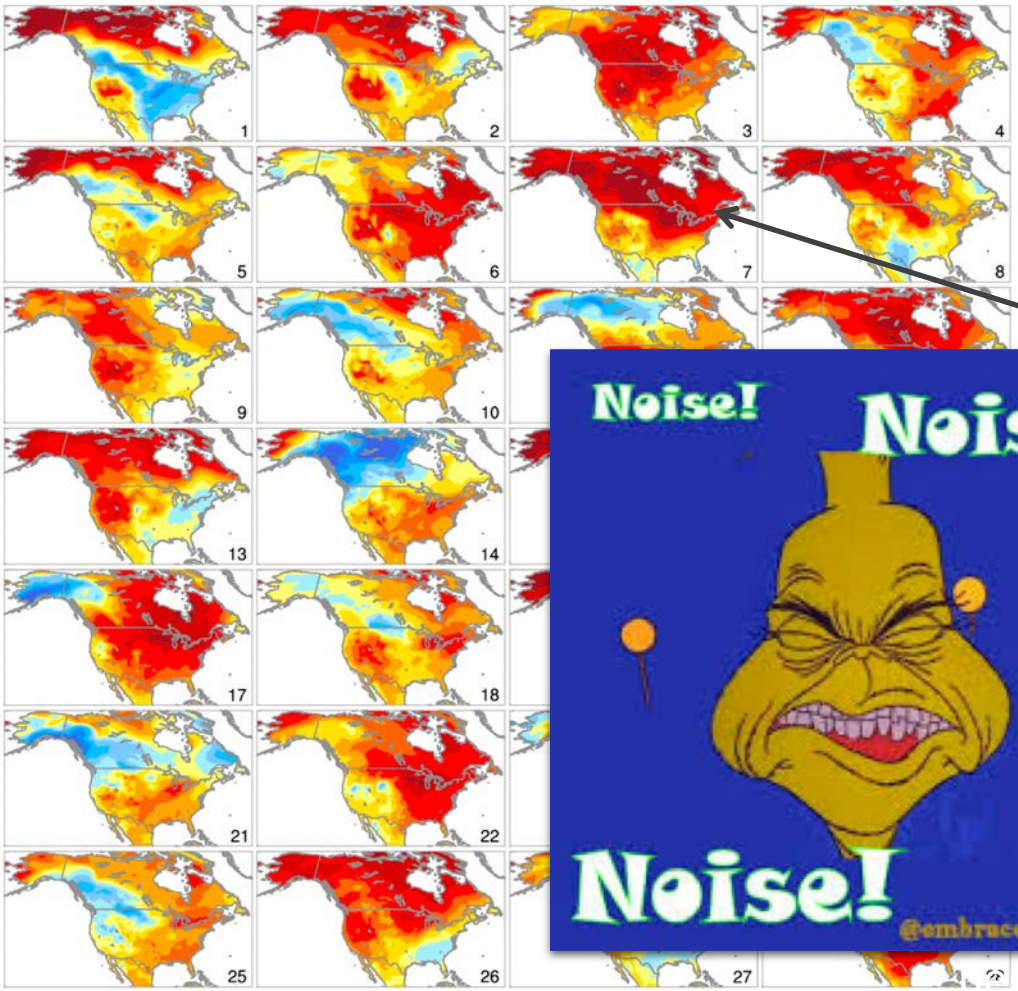

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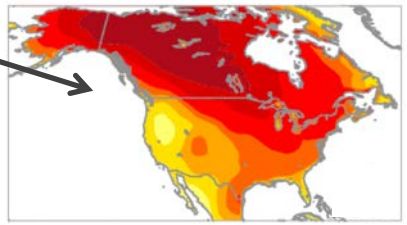
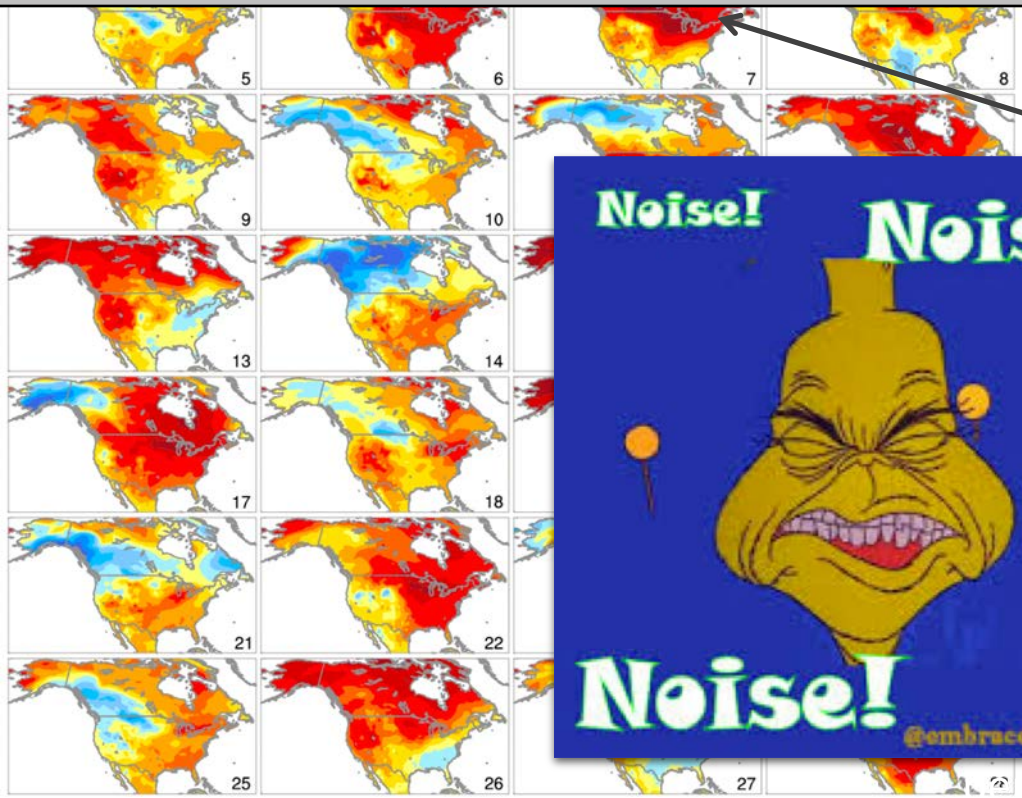


°C

cooling warming

Deser et al., J. Climate 2016

Unpredictable internal variability confounds attribution, model evaluation and model inter-comparison, especially on regional scales.



cooling warming

°C

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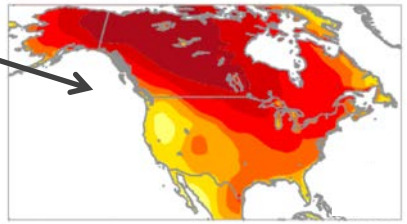
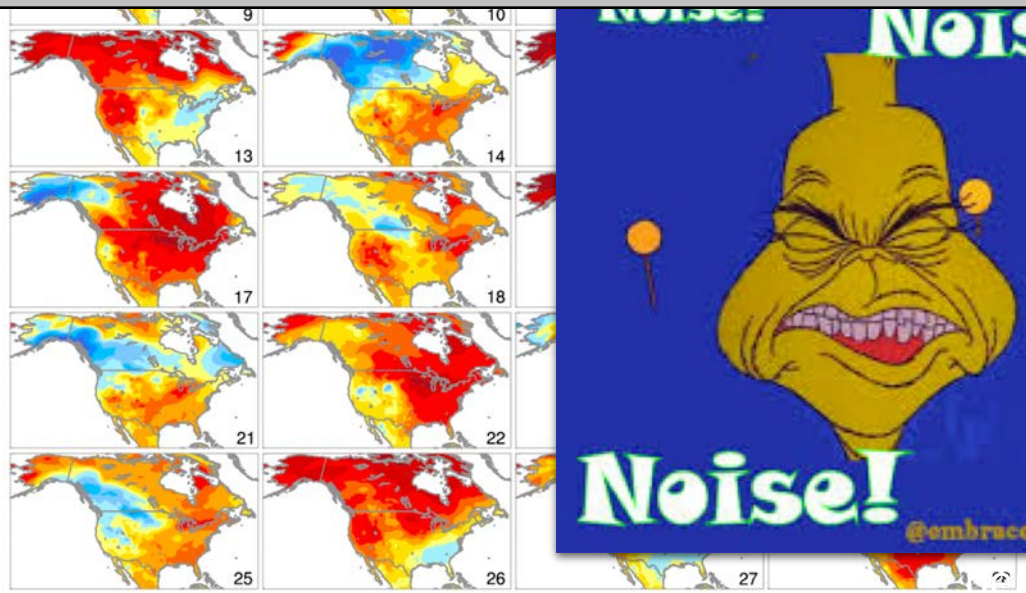
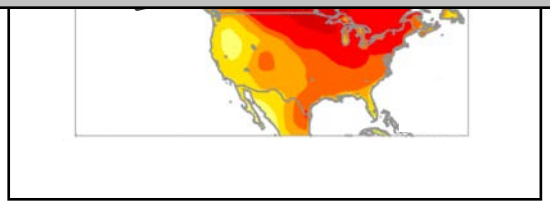


Deser et al., J. Climate 2016

Unpredictable internal variability confounds attribution, model evaluation and model inter-comparison, especially on regional scales.
It also introduces irreducible uncertainty to climate projections.





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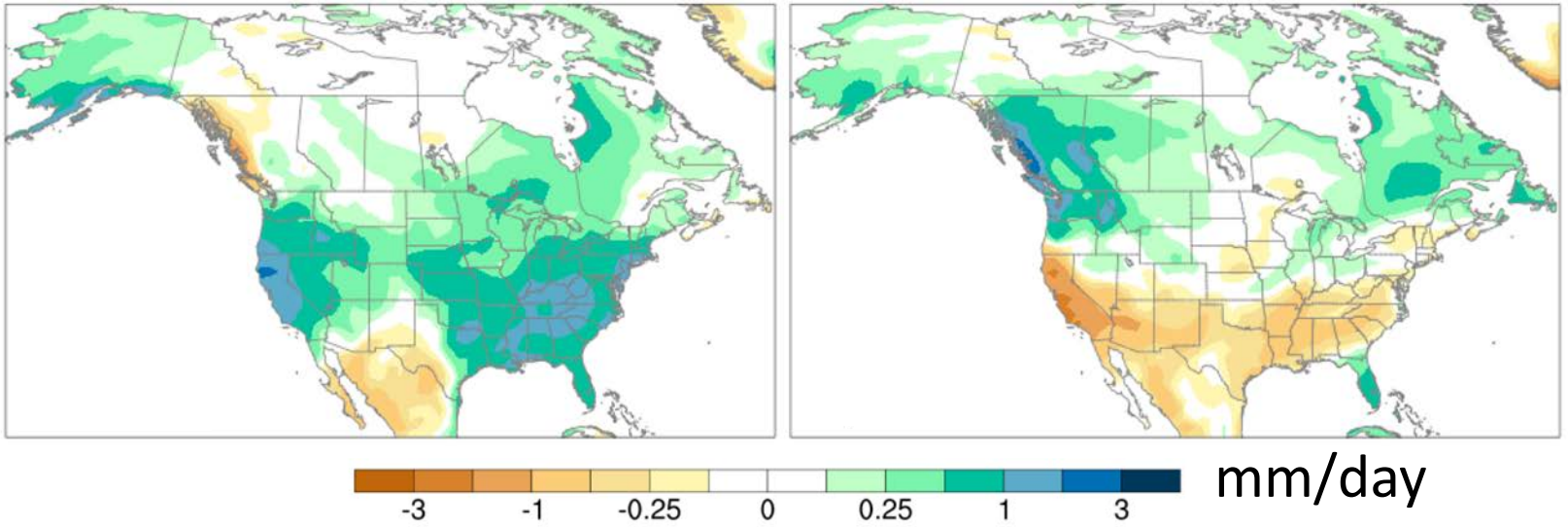
Winter Precipitation Change (2010-2060)



Updated from Deser et al., 2014

Unpredictable internal variability confounds attribu… inter-com… …les. It al… …nty to climate projections.

CMIP archive confounds model uncertainty with internal variability uncertainty.

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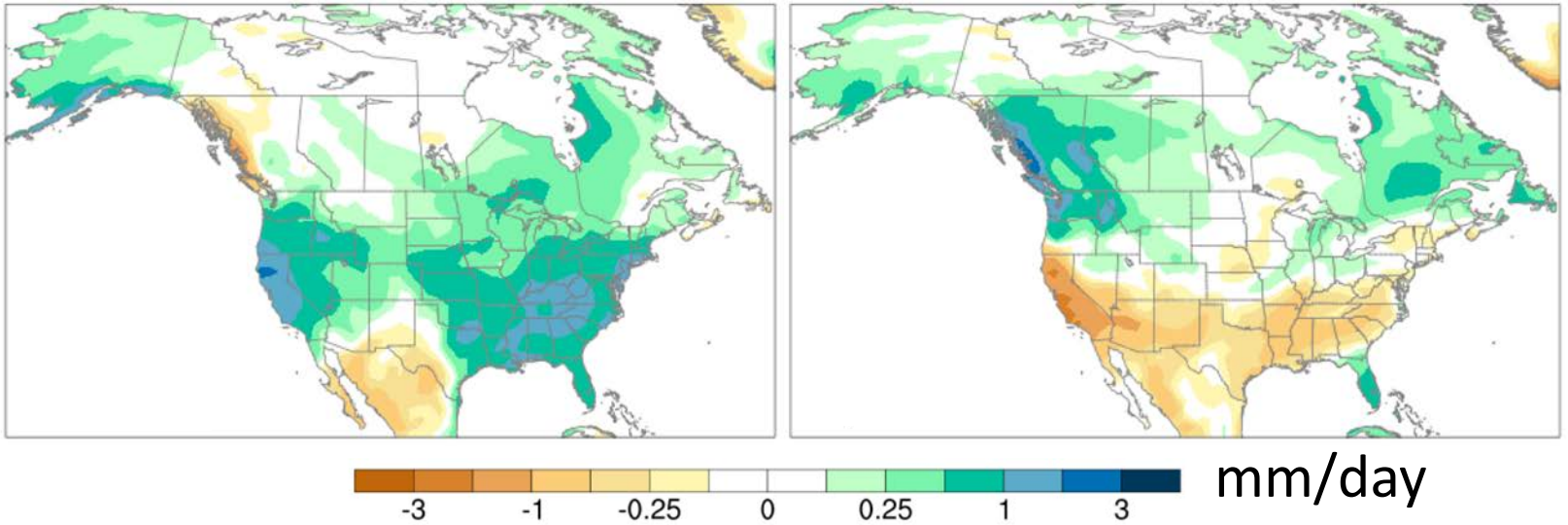

Updated from Deser et al., 2014

Workshop Overview

- **Progress in Large Ensemble research**
  - multi-model LE archive, observational LE, decadal prediction.

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  - Model evaluation
  - Methodological test-bed
  - Extreme events
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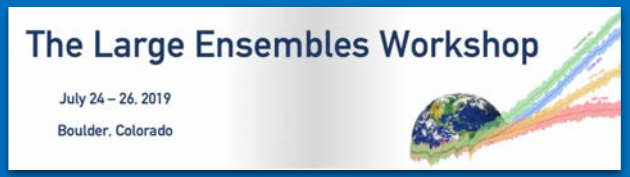

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Interactive Workshop
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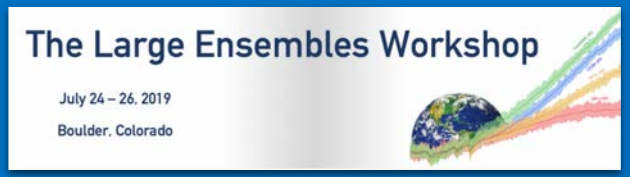

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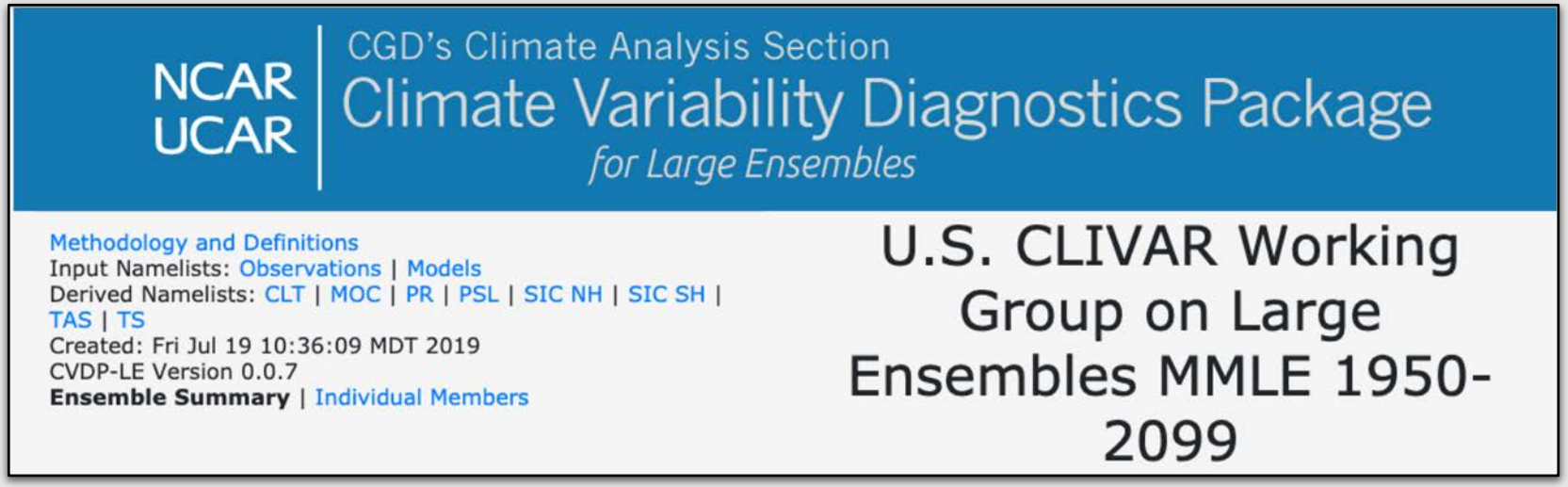
Outcomes
- Foster usage of LEs
- Advance new applications of LEs
- Inform a future coordinated LE



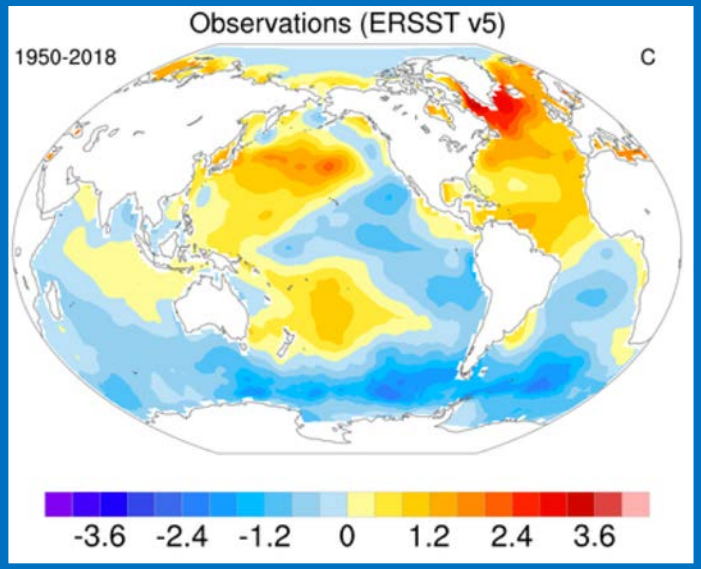
Defining modes of internal variability in an era of forced climate change

In progress (Adam Phillips)

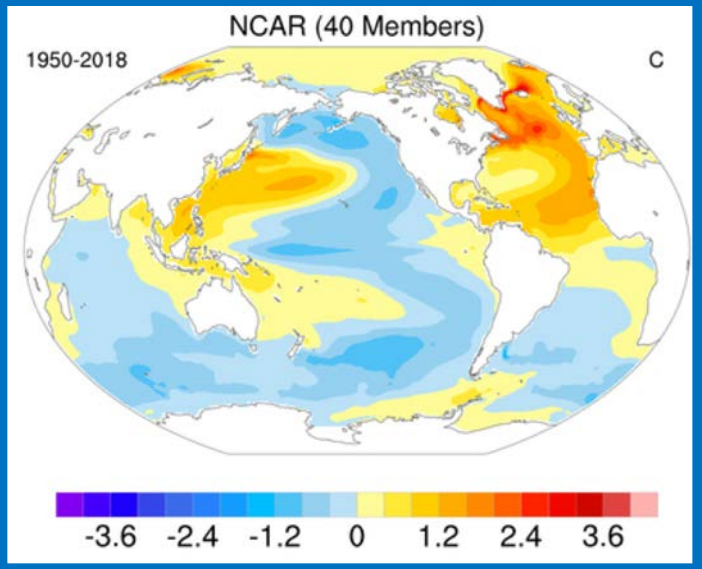
The Atlantic Multidecadal Oscillation (AMO)

Index: 10-year low-pass filtered

North Atlantic SST – Global mean SST (Trenberth and Shea, 2015)



1950-2018



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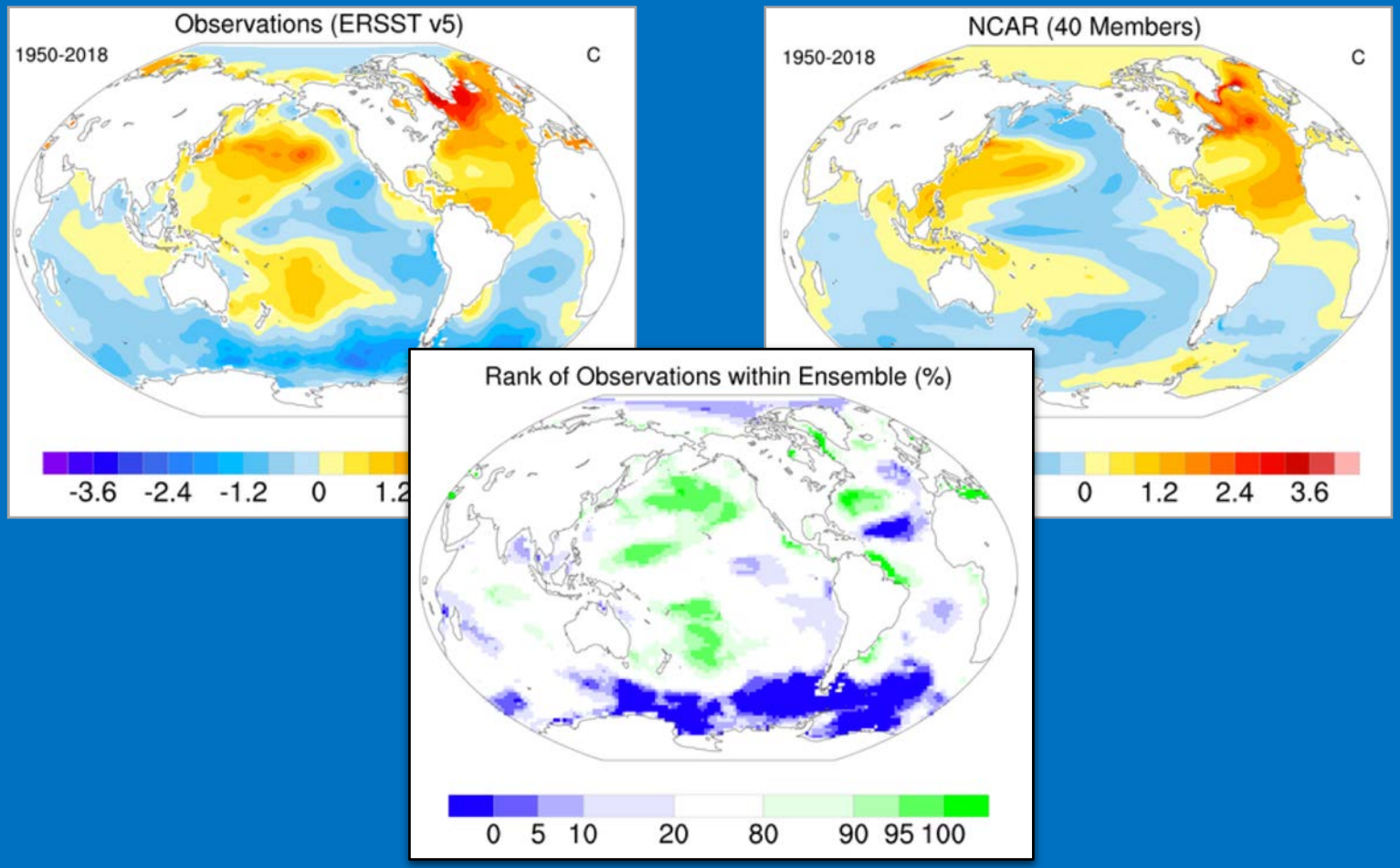

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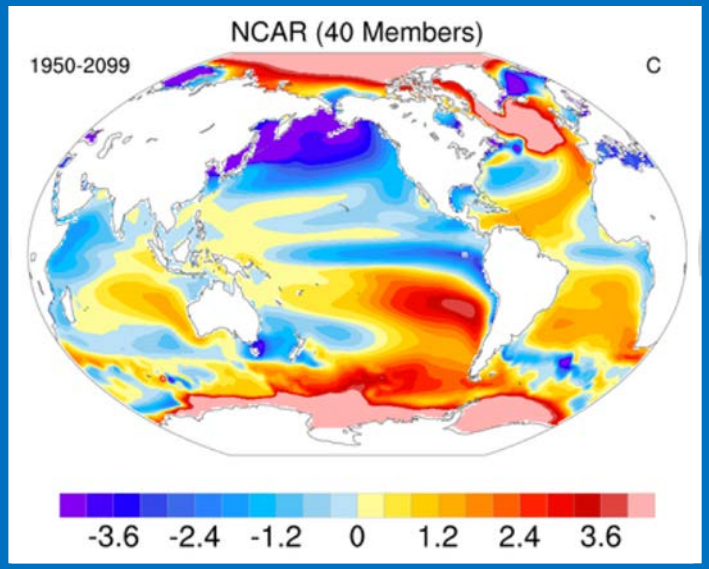
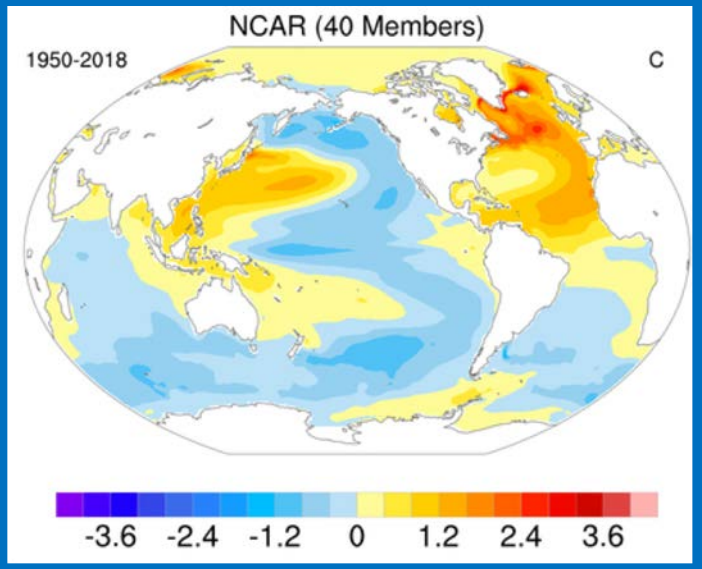


1950-2099



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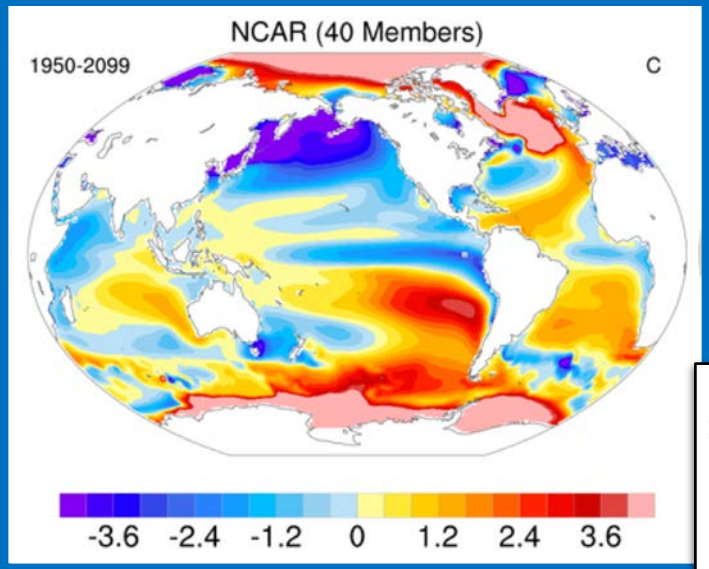
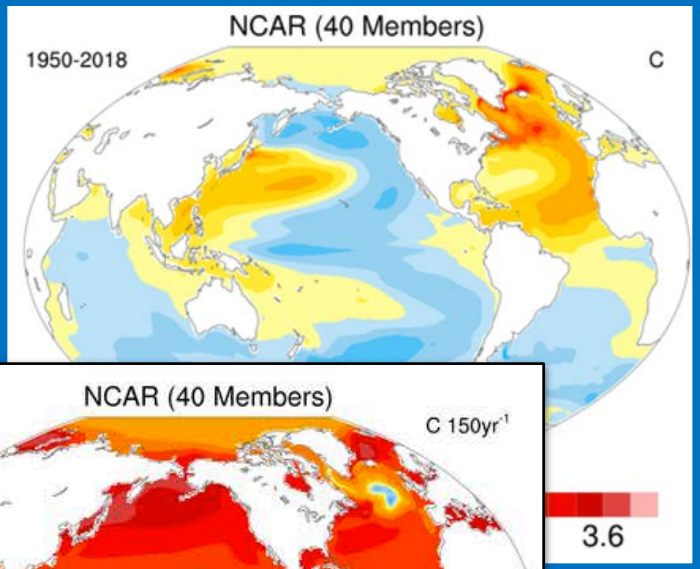
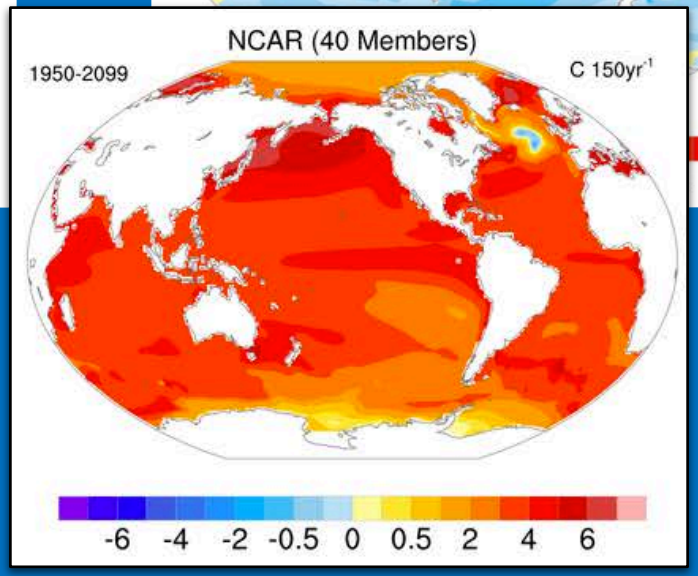




1950-2099

Linear Trend



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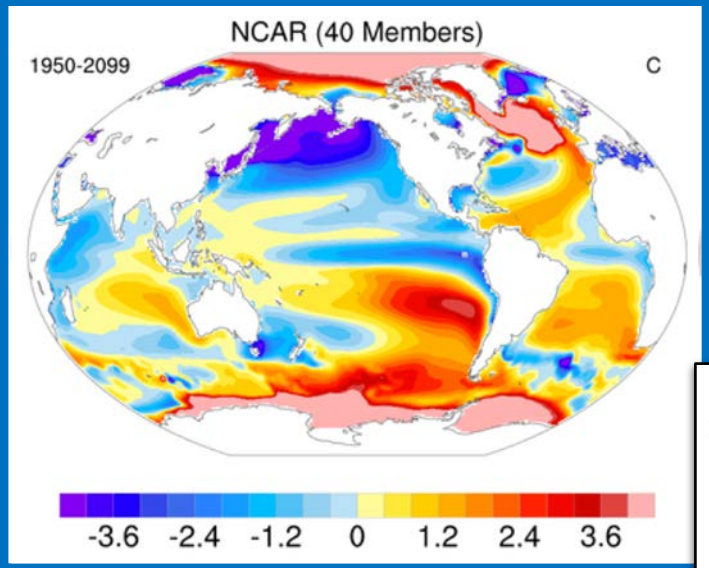

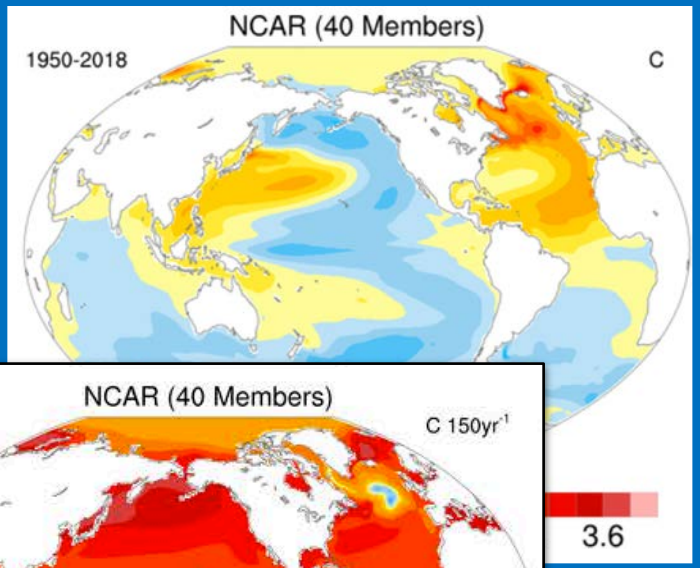

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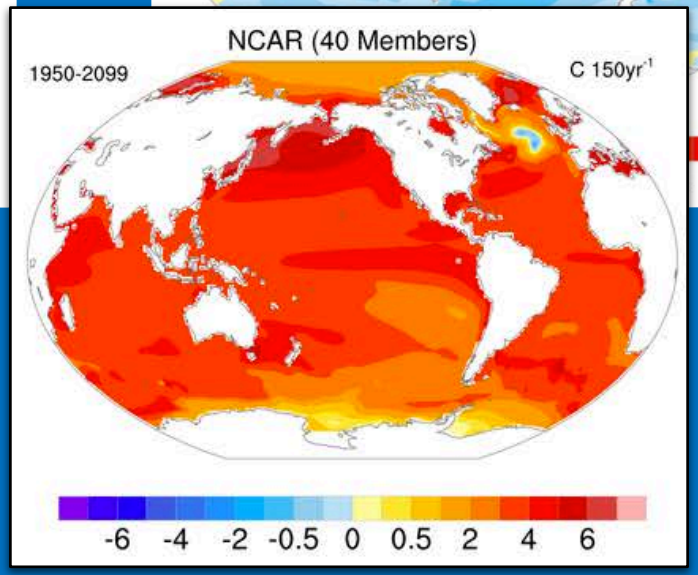

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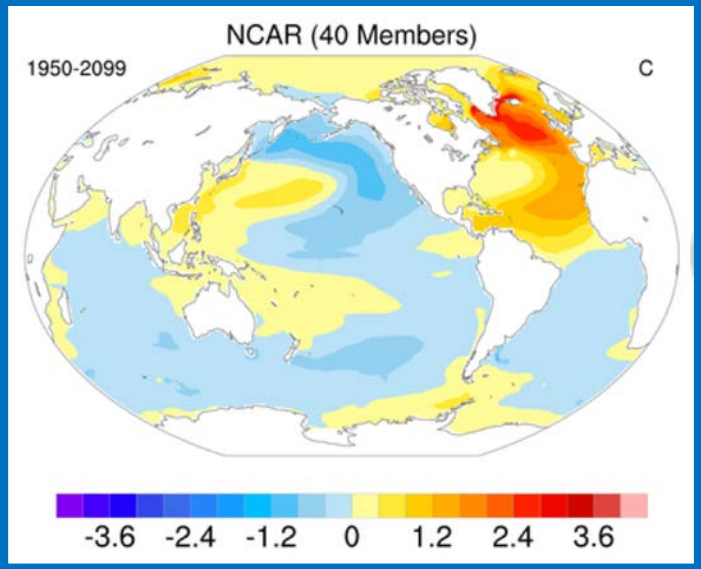
North Atlantic SST – ***Ensemble mean SST***



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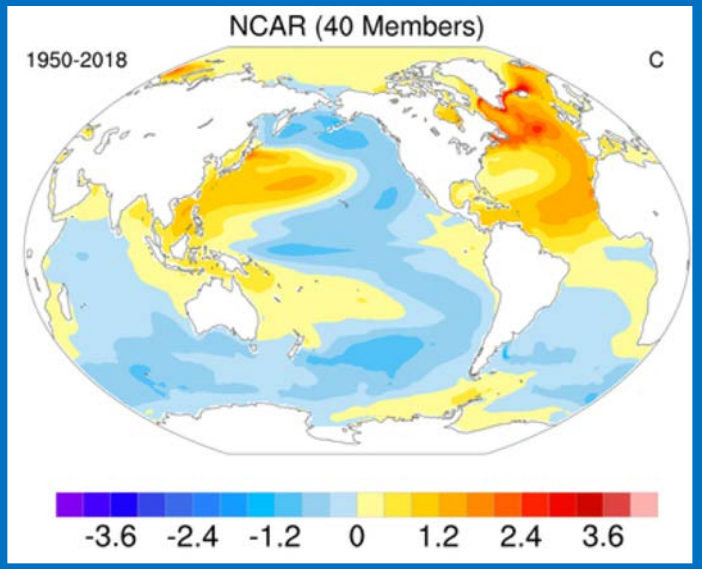


1950-2018

UCAR Participant Code of Conduct

Expected behaviors:

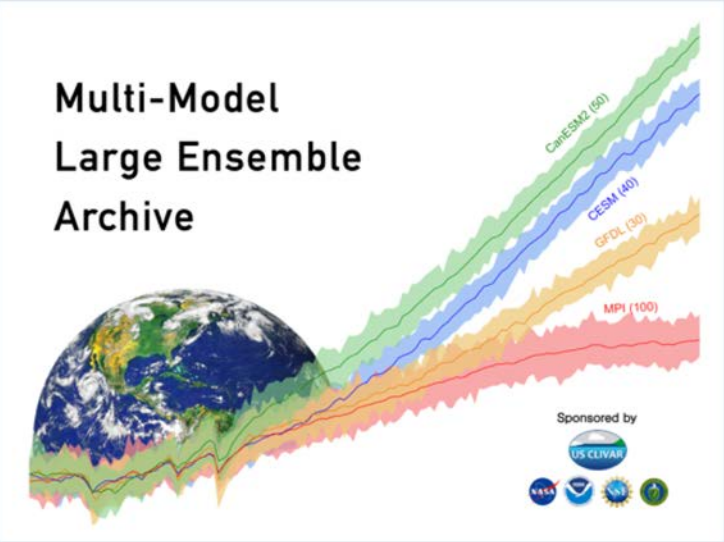
- Treat all participants with respect and consideration
- Be considerate and collaborative
- Critique ideas rather than individuals
- Be mindful of your surroundings and of your fellow participants
- Alert workshop organizers or UCAR staff if you notice someone in distress or any dangerous situation
- Respect the rules and policies of the event and the venue

Full versions of the participant code of conduct are available at https://www.ucar.edu/who-we-are/ethics-integrity/codes-conduct/participants

The designated point of contact for reporting violations or concerns is Clara Deser.

Extra

Multi-Model Large Ensemble Archive

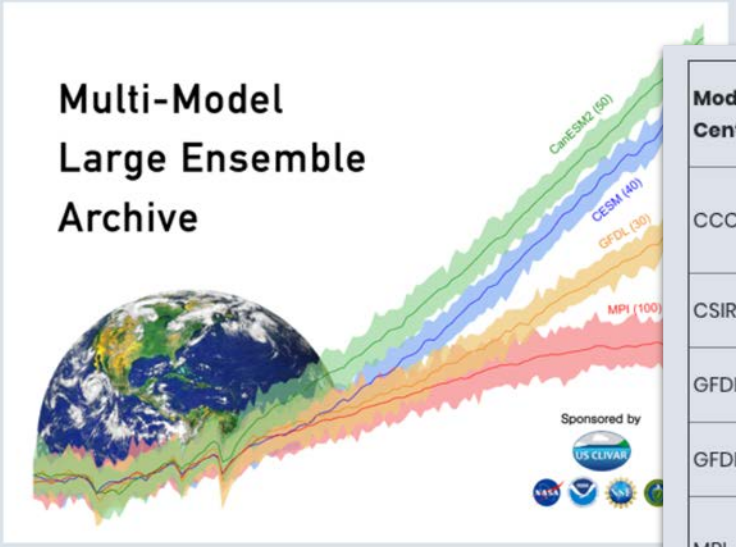


As part of its activities, the US CLIVAR Working Group on Large Ensembles has produced a centralized data archive of initial-condition Large Ensembles conducted with currently up to 7 CMIP5-class climate models. This archive contains gridded fields of key variables at both daily and monthly resolution, and is publicly accessible via the NCAR Climate Data Gateway or via NCAR's supercomputer for users with a Cheyenne account (/glade/collections/cdg/data/CLIVAR_LE). The Table below provides a summary of the salient characteristics of the models and simulations contained within the archive. Further discussion of the utility and applications of the archive is given in Deser et al. (2019).

Please direct questions about this archive to Dr. Flavio Lehner [flehner@ucar.edu] or Dr. Clara Deser [cdeser@ucar.edu]. When presenting results based on the Multi-Model Large Ensemble Archive in either oral or written form, please acknowledge the US CLIVAR Working Group on Large Ensembles.

www.cesm.ucar.edu/projects/community-projects/CLIVAR-LE/

Multi-Model Large Ensemble Archive



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Modeling Center	Model Version	Model Resolution (atm/ocn)	Years	Initialization Method	Number of Members	Forcing	Reference
CCCma	CanESM2	~2.8°x2.8°/~1.4°x0.9°	1950-2100	Macro and Micro	50	historical, rcp85	Kirchmeier-Young et al. (2017)
CSIRO	MK3.6	~1.9°x1.9°/~1.9°x1.0°	1850-2100	Macro	30	historical, rcp85	Jeffrey et al. (2013)
GFDL	ESM2M	~2.0°x2.5°/~1.0°x0.9°	1950-2100	Macro	30	historical, rcp85	Rodgers et al. (2015)
GFDL	CM3	~2.0°x2.5°/~1.0°x0.9°	1920-2100	Micro	20	historical, rcp85	Sun et al. (2018)
MPI	MPI-ESM-LR	~1.9°x1.9°/nominal 1.5°	1850-2100	Macro	100	historical, rcp26, rcp45, rcp85	Maher et al. (2019)
NCAR	CESM1	~1.3°x0.9°/nominal 1.0°	1920-2100	Micro	40	historical, rcp85	Kay et al. (2015)
SMHI/KNMI	EC-EARTH	~1.1°x1.1°/nominal 1.0°	1860-2100	Micro	16	historical, rcp85	Hazeleger et al. (2010)

www.cesm.ucar.edu/projects/community-projects/CLIVAR-LE/