CVCWG update

Jun 10th, 2025

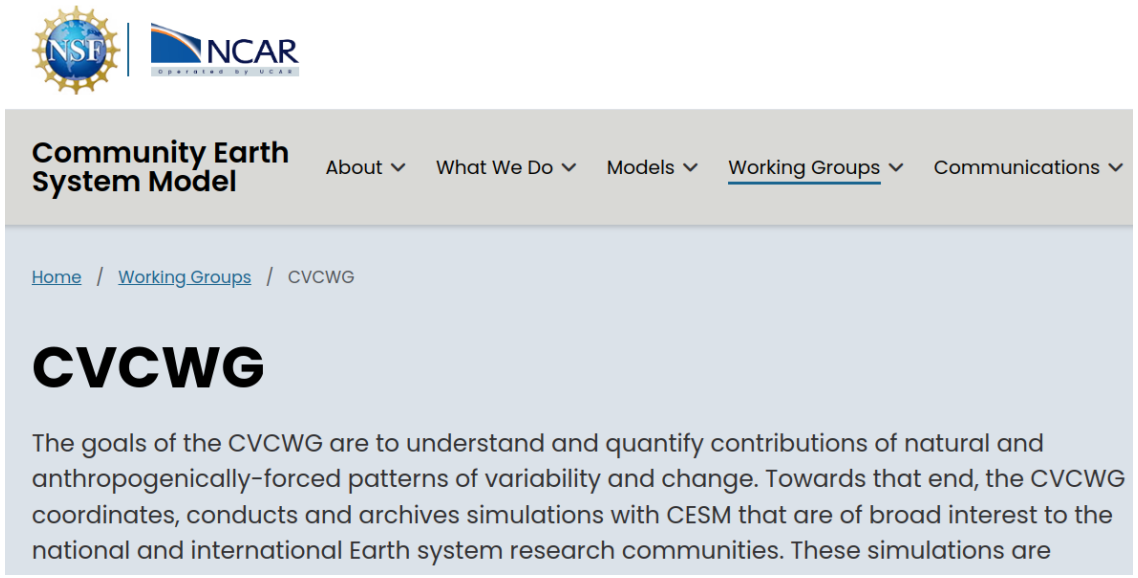
Co-Chairs: Isla Simpson (NSF NCAR), Aixue Hu (NSF CAR), Sarah Larson (NC State)

Liaisons: Adam Phillips (NSF NCAR), Gary Strand (NSF NCAR)

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

Climate Variability and Change Working Group Webpages

https://www.cesm.ucar.edu/working-groups/cvcwg



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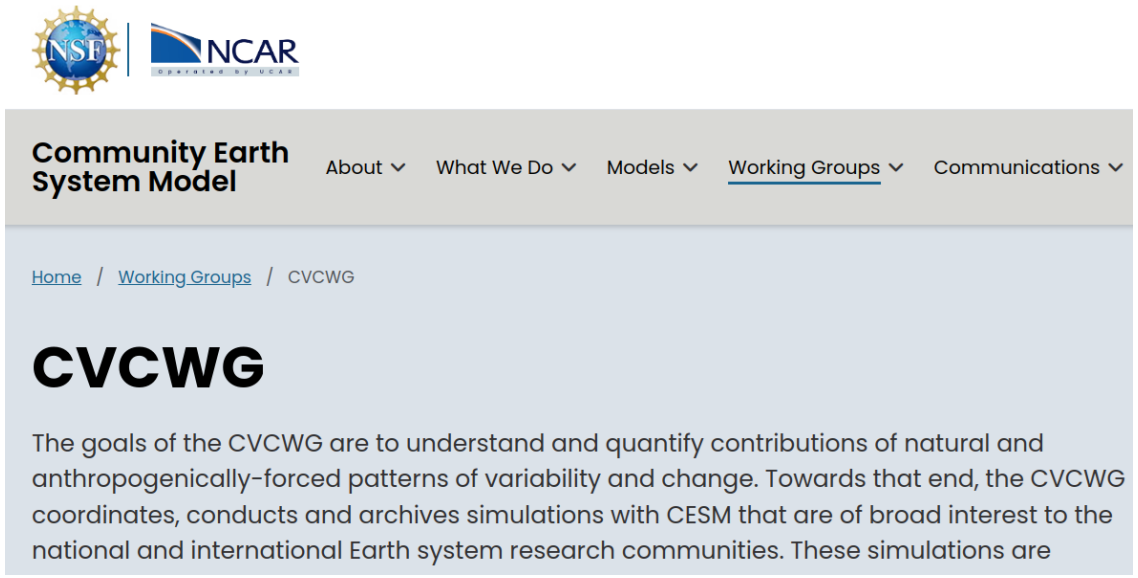

Our Simulations

Recent / Notable

- CESM2 Large Ensemble Project
- CESM2 83-level simulations
- CESM2 Single Forcing Large Ensemble Project
- CESM2 SSP5-8.5 Ensemble
- CESM2 SSP2-4.5 Ensemble
- CESM2 RFMIP simulations (complementary to the CESM2 large ensemble)
- CESM2 Tropical Pacific Pacemaker Ensemble
- CAM6 Pre-industrial Controls
- CAM6 Prescribed SST Ensembles (forced with ERSSTv5)
- CAM5 Prescribed SST Ensembles (forced with ERSSTv3b, ERSSTv4 and ERSSTv5)
- CESM1.1 Large Ensemble Project
- CESM1.1 Medium Ensemble
- CESM1.1 Single Forcing Large Ensemble Project
- CESM1.1 Tropical Pacific Pacemaker Ensemble
- CESM1.1 North Atlantic Pacemaker Ensemble
- CESM1.1 Indian Ocean Pacemaker Ensemble

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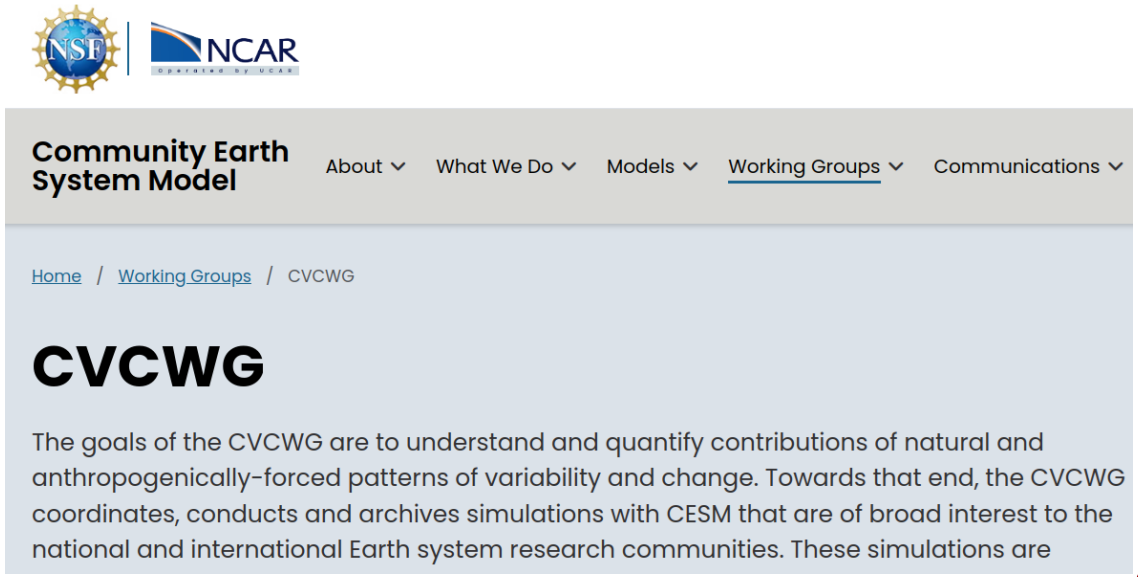

Data Acquisition

- **NCAR Internal**

  Location on NCAR's campaign store (accessible from NCAR CISL machines):

  ```
  /glade/campaign/collections/rda/data/d651055
  ```

- **Web Access**

  This data is available from the NSF NCAR Research Data Archive.

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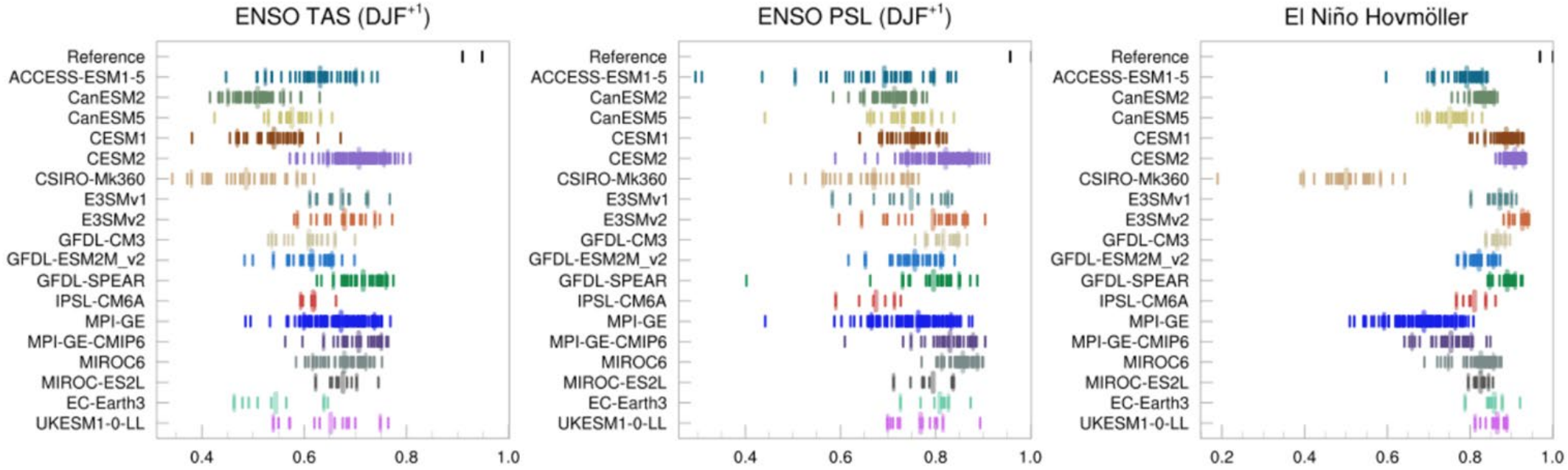
NEW Multi Model Large Ensemble Archive v2

Nicola Maher, Adam Phillips, Clara Deser

Updated large ensemble archive with 18 models, 15 2D variables, all on a consistent grid

Pattern Correlation w/ Obs



- CVDPv6 has been applied to the entire archive
- Links to the CVDPv6 analysis and data on casper and the RDA is available
- https://www.cesm.ucar.edu/community -projects/mmlea/v2

Contact: Nicola Maher (nicola.maher@anu.edu.au) or Adam Phillips (asphilli@ucar.edu) and Clara Deser (cdeser@ucar.edu)

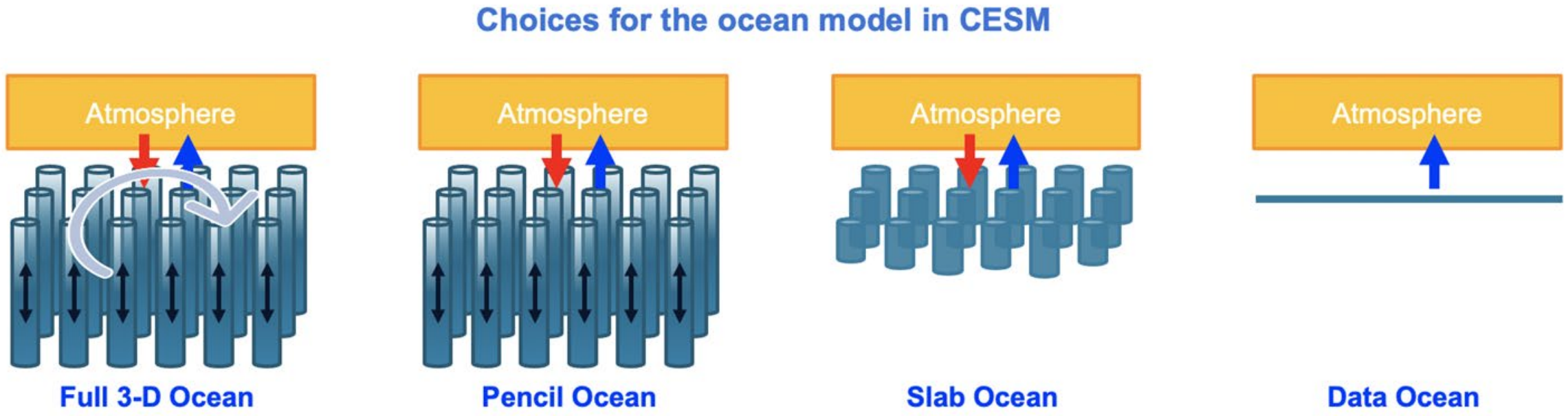
Simulations in the works

Pencil Model Simulations


Young-Oh Kwon and others

Gokhan Danabasoglu

The pencil model is now running and work is under way to release it within CESM2.



Single column ocean model at each grid point → representation of mixed layer physics, prognostic mixed layer depth etc

Pencil Model Simulations

Young-Oh Kwon and others

Gokhan Danabasoglu

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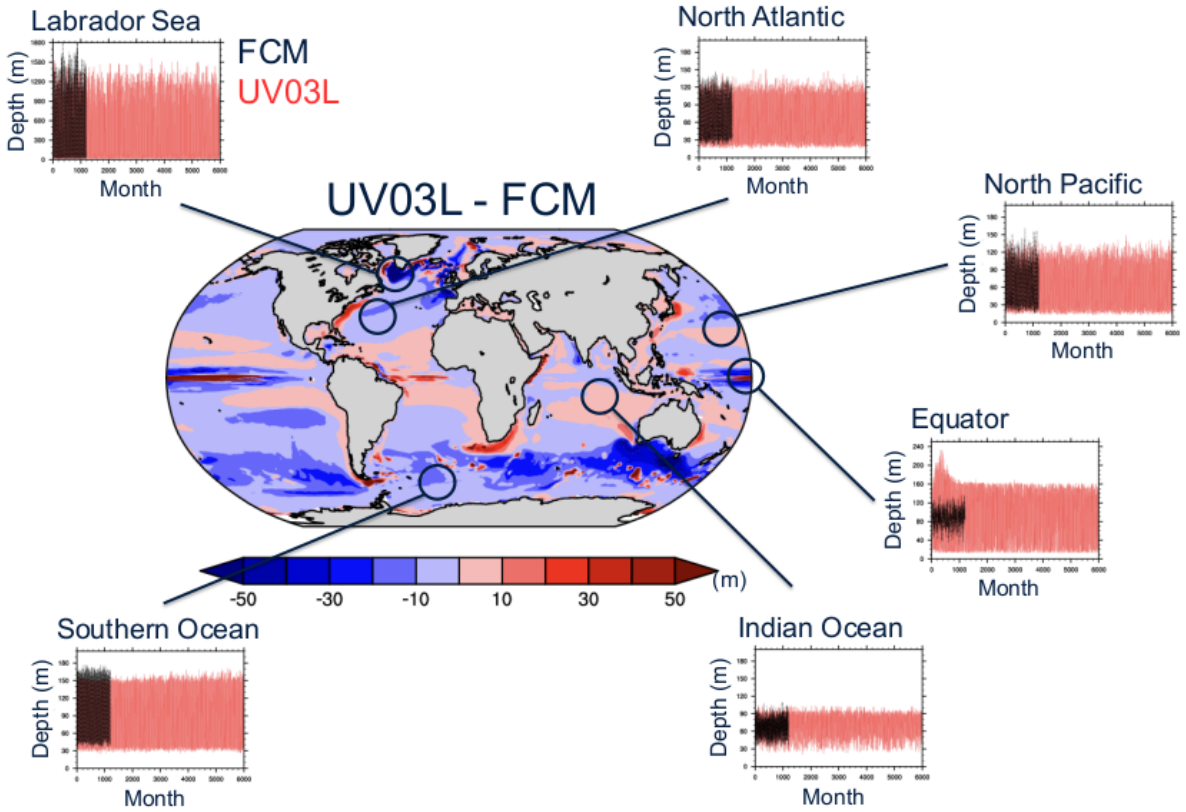
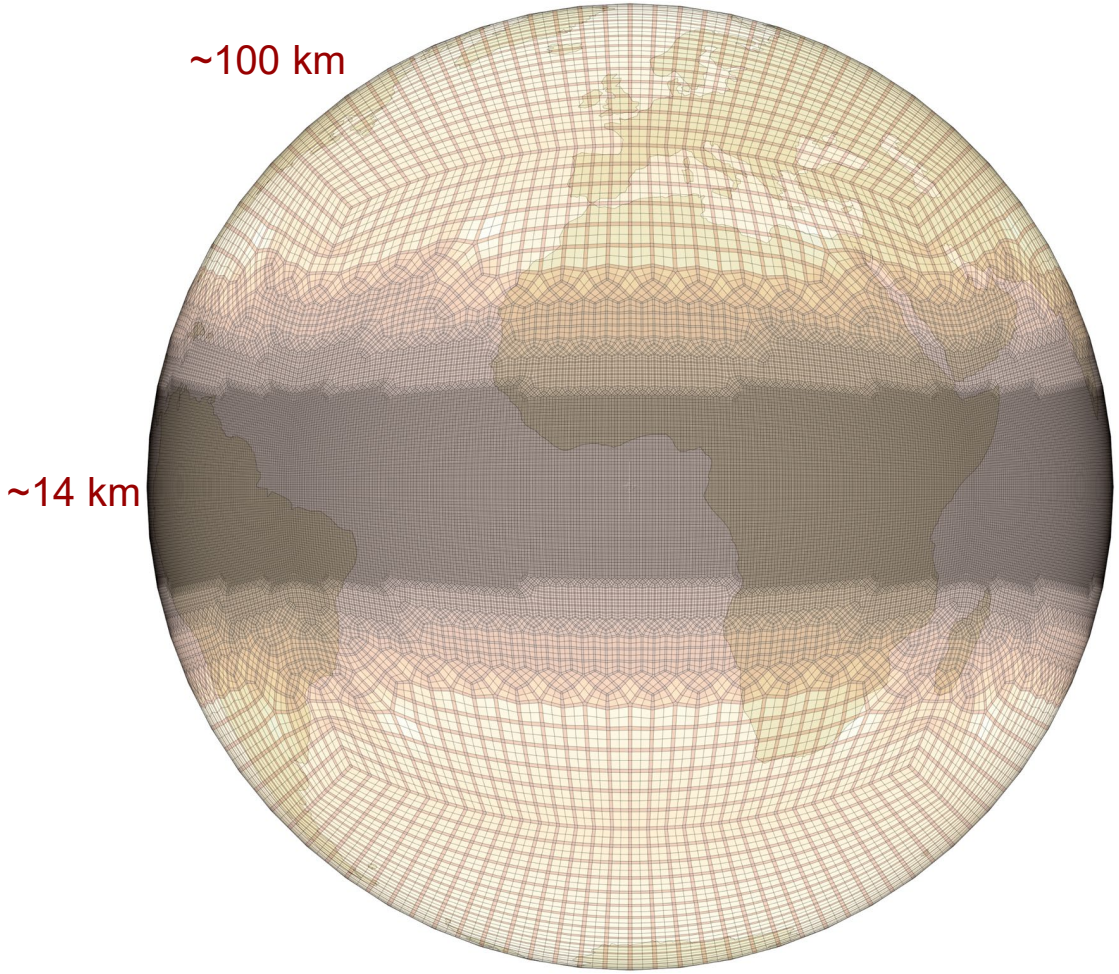
Two 500 year long pre-industrial controls have been performed with different forms of U/V restoring.

Data should be released soon.

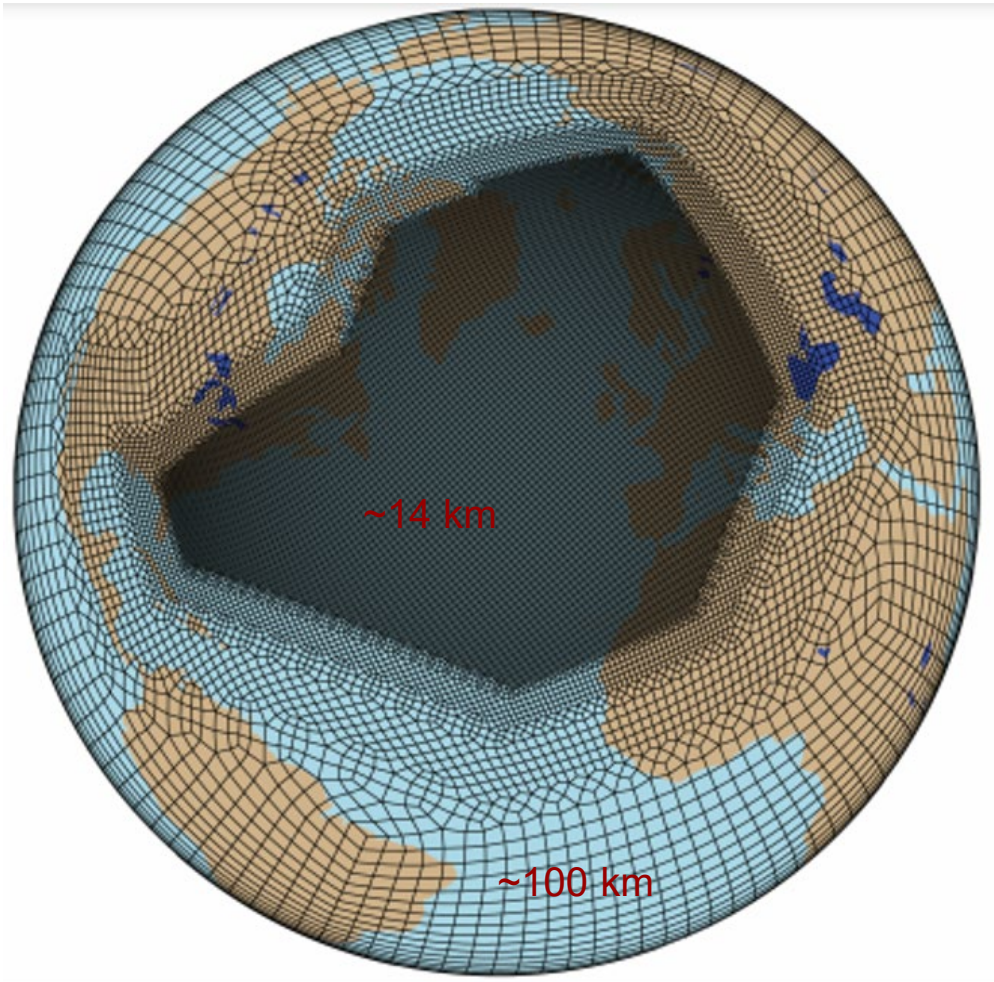
Poster by Jongsoo Shin



Regionally refined work



Brian Medeiros

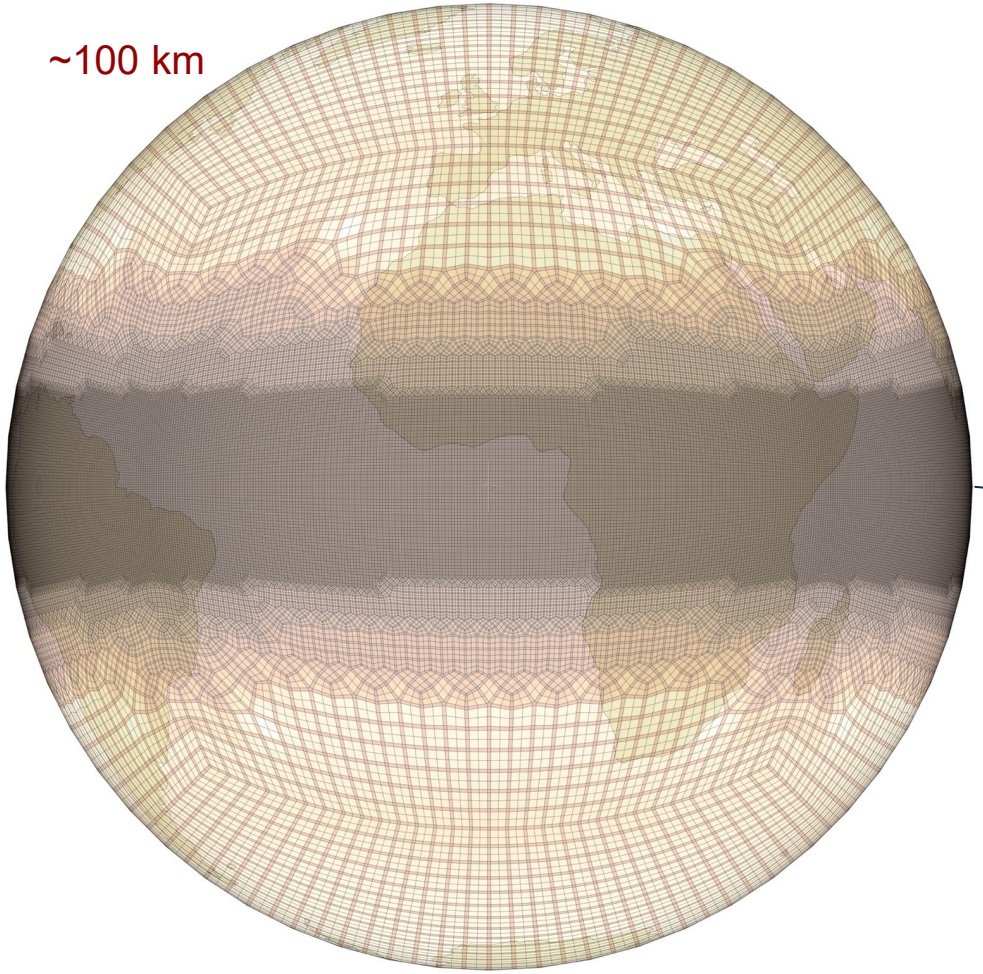


Isla Simpson, Robb Jnglin-Wills, Adam Herrington

Regionally refined work

~100 km

~14 km



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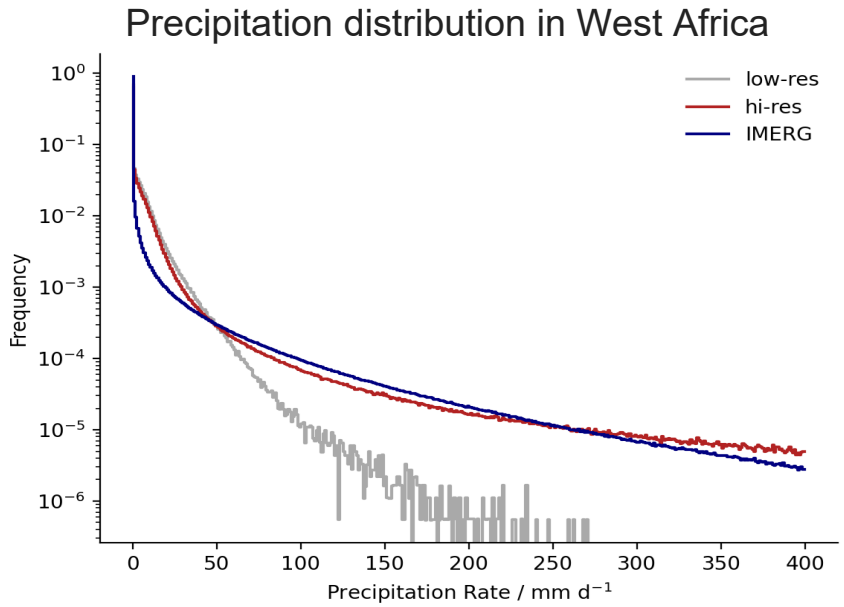
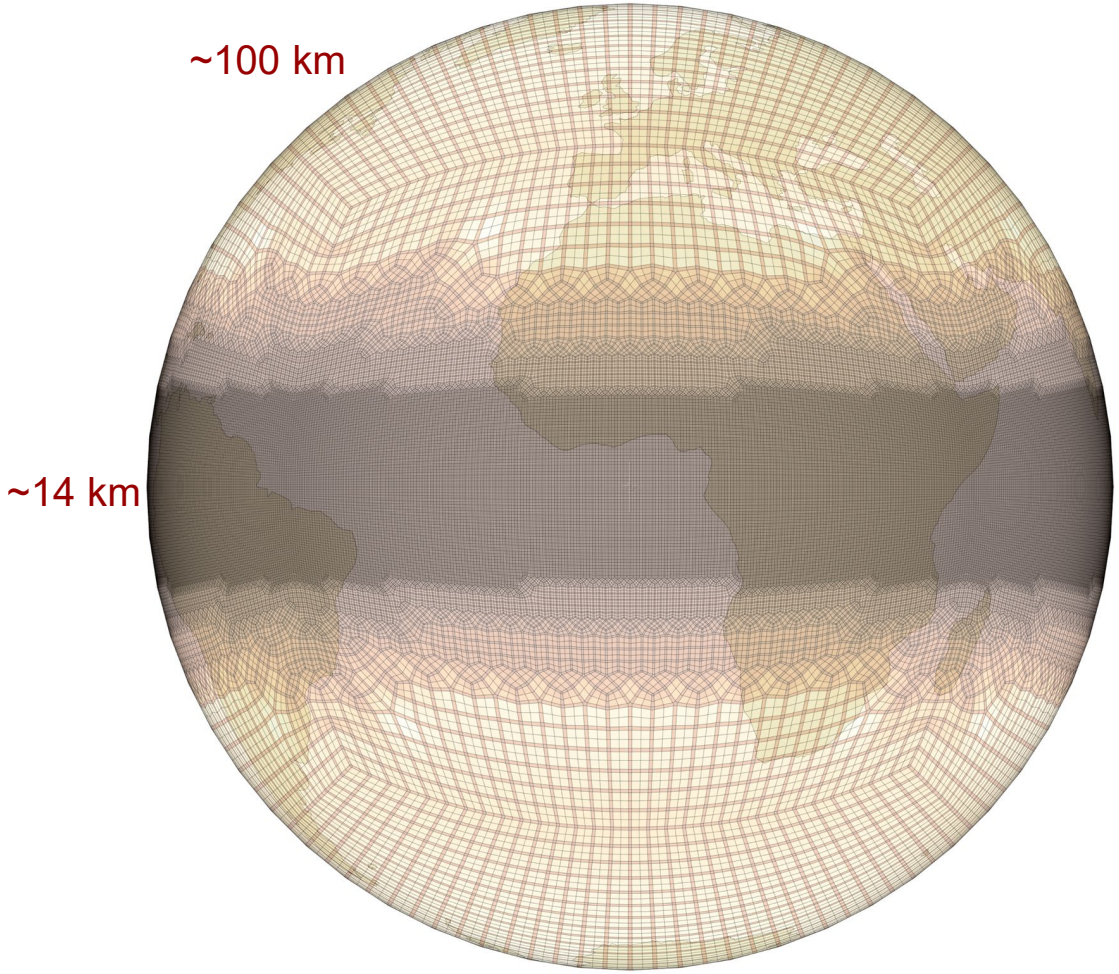


Regionally refined work



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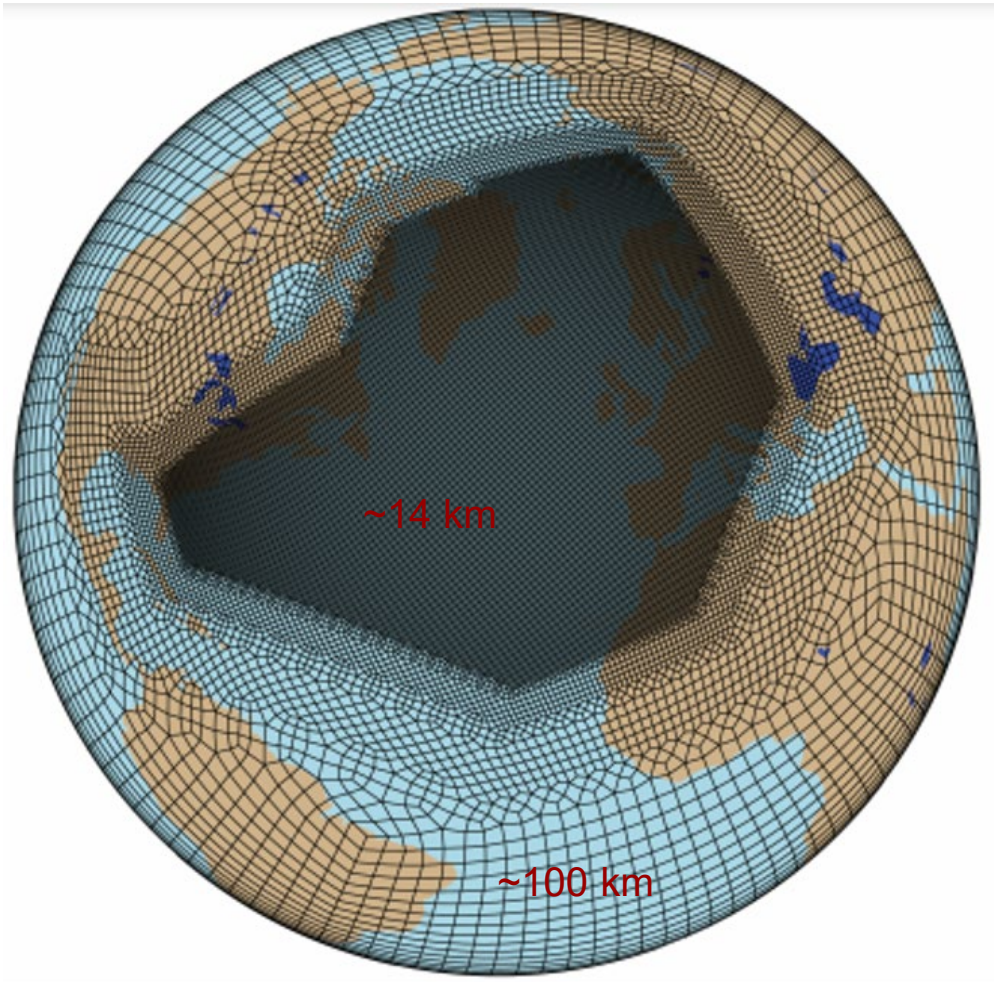

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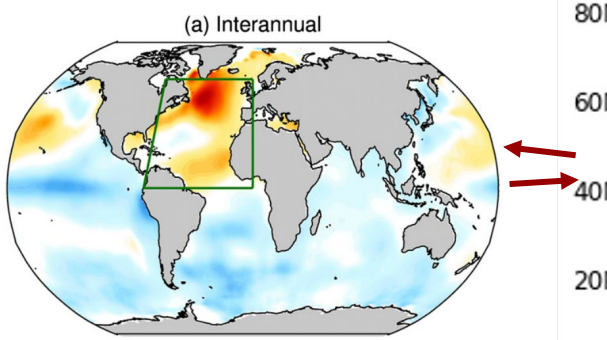
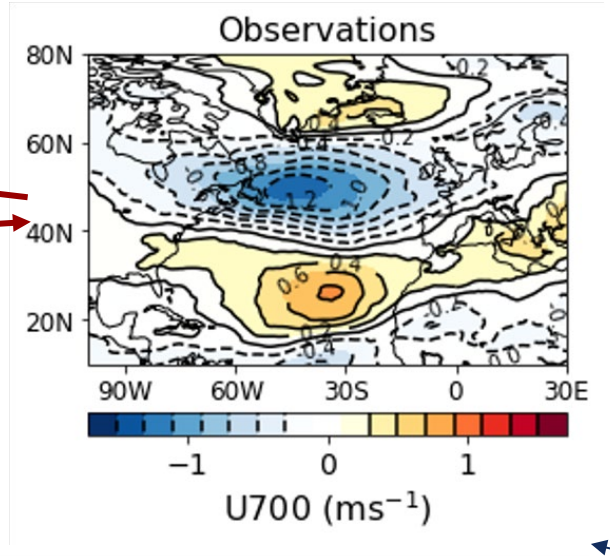
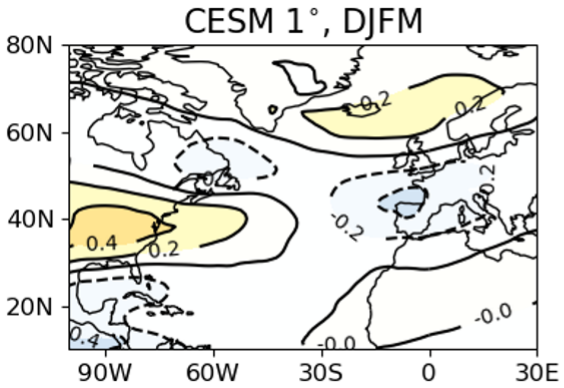
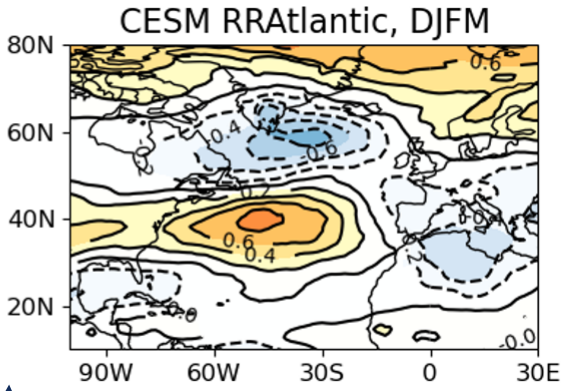
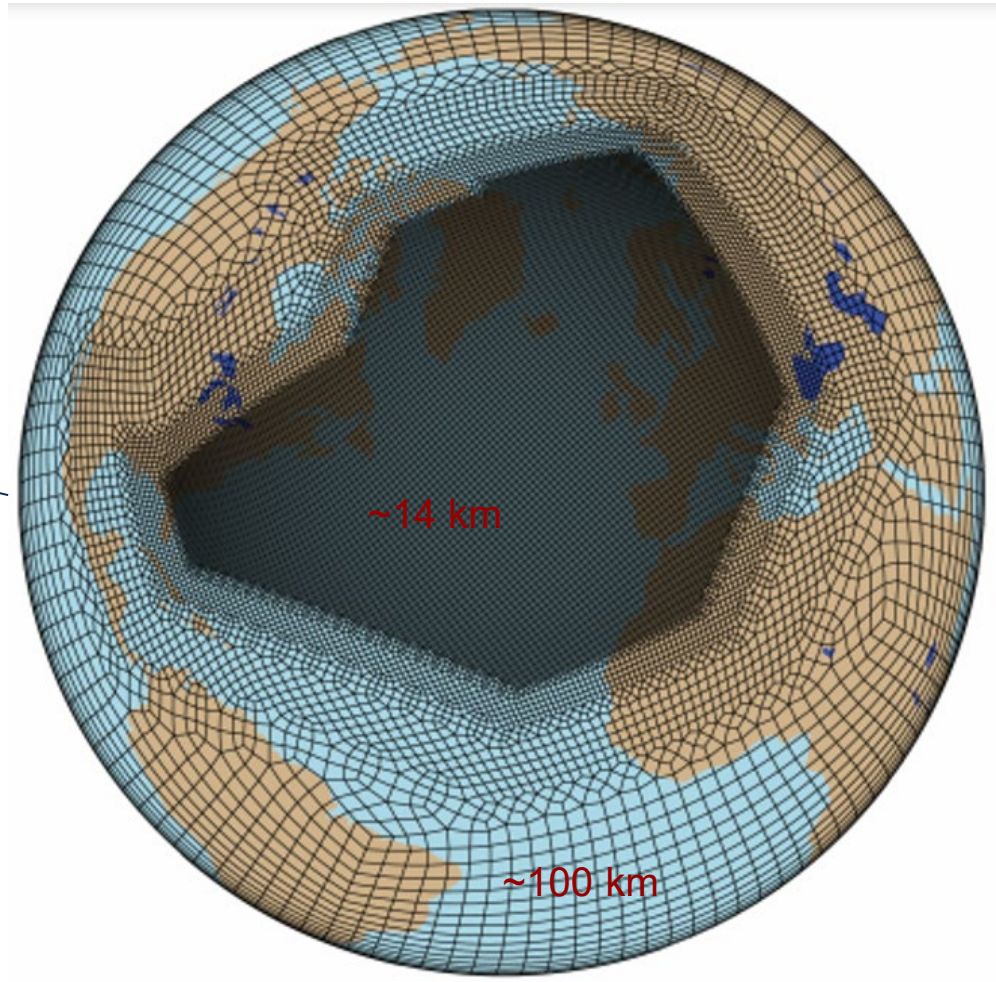










Regression of zonal wind onto the AMV

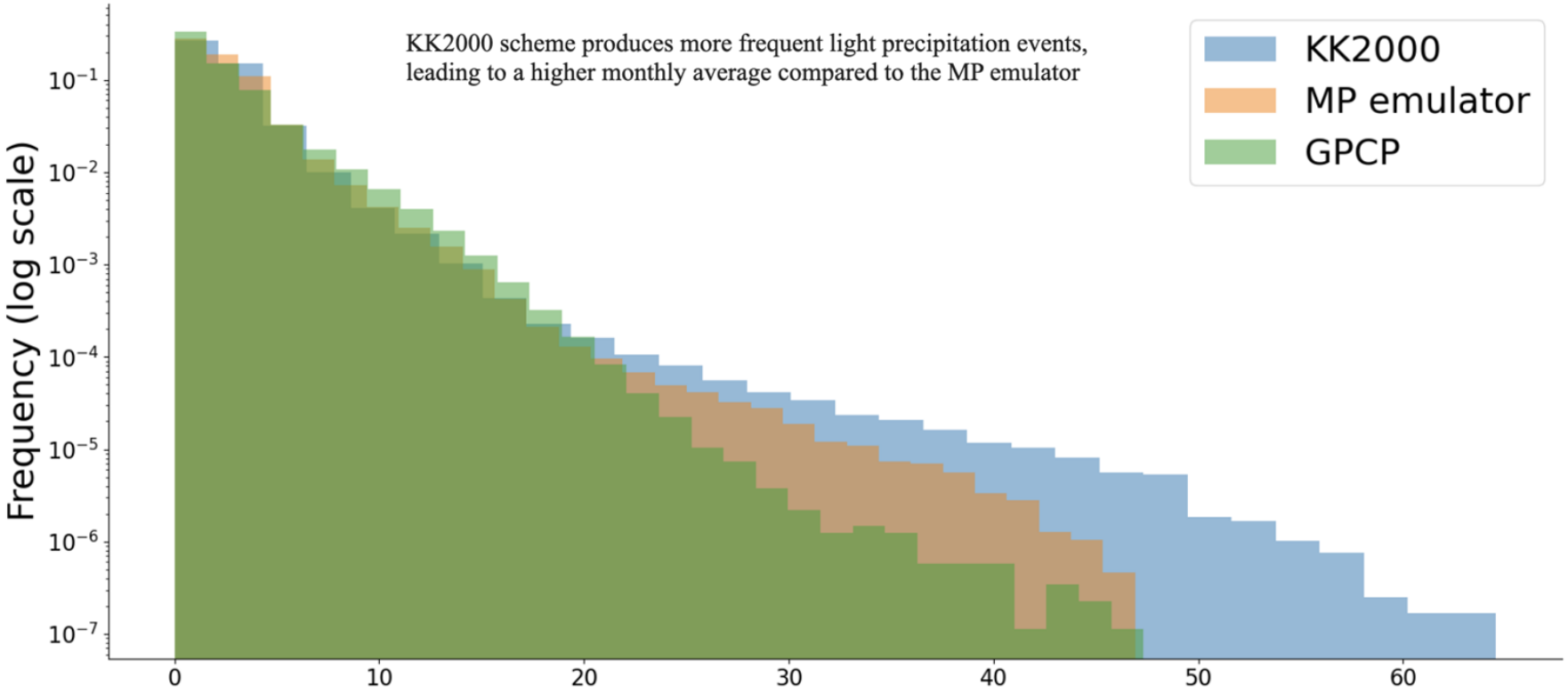
Isla Simpson, Robb Jnglin-Wills, Adam Herrington

Perturbed parameter experiments to tune ML based warm rain microphysics

Perturbed parameter ensembles are being used to tune a machine learning-based warm rain microphysics scheme which reduces the drizzle problem that occurs in the existing Khairoutdinov & Kogan (2000) physics based scheme

Addisu Semie

Brian Medeiros



CESM2 single forcing with CMIP5 aerosols (CMIP6 piControl background)

Emissions = CMIP6_piControl + (CMIP5 historical - CMIP5 piControl)

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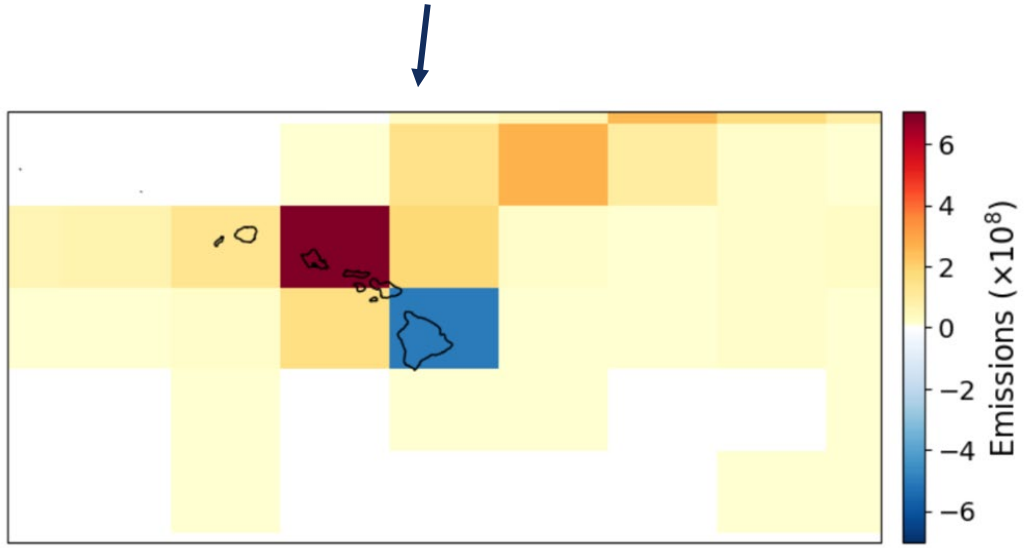

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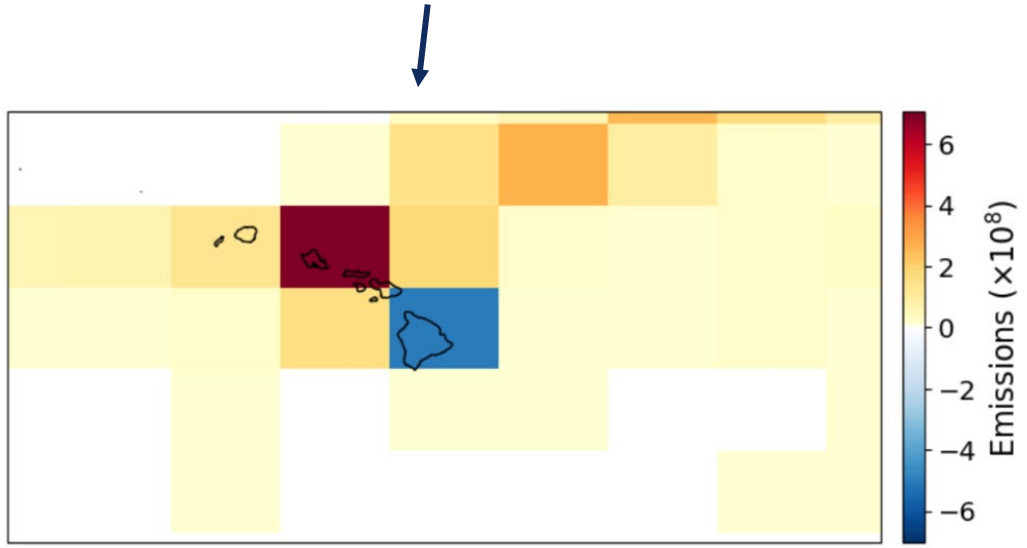
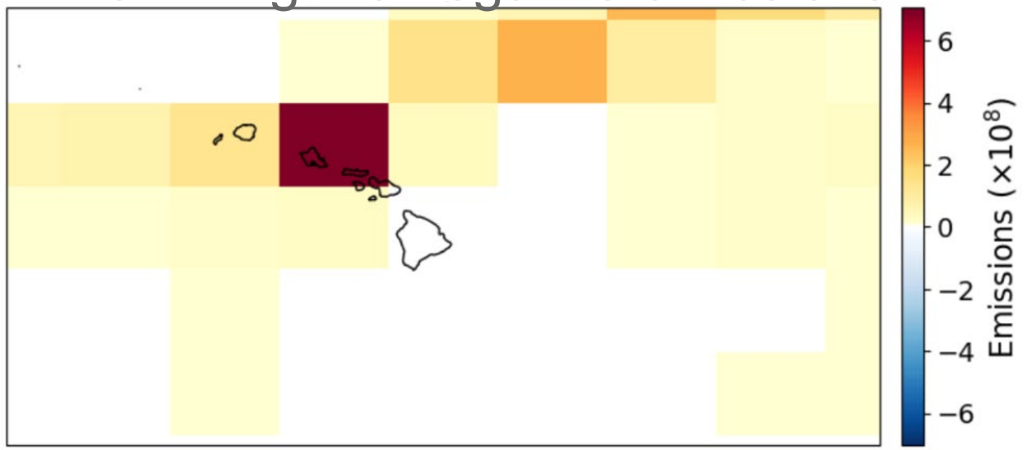
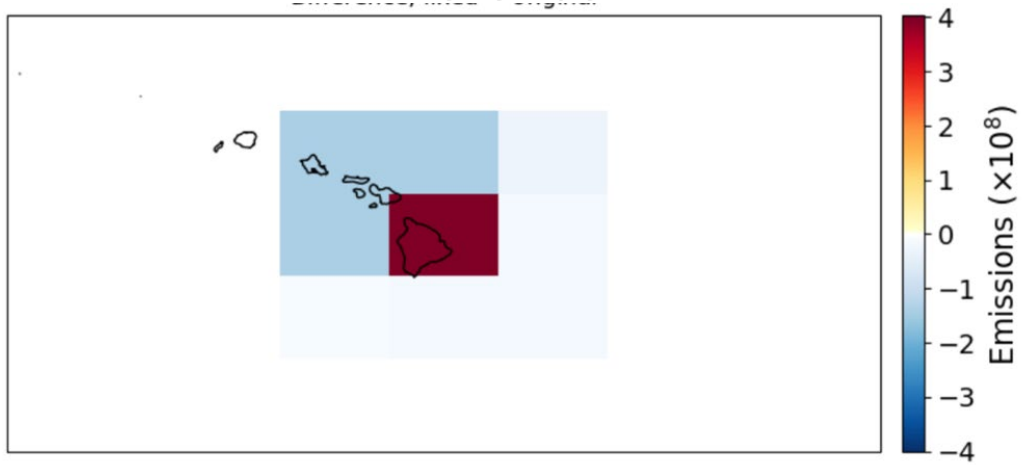


After fixing the negative emissions



Difference



TBI co-EX (For investigating Tropical -Basin Interactions) with CESM2

Aixue Hu, Steve Yeager, Nan Rosenbloom, Sasha Glanville, Teagan King

Historical: 1850-2021 (CVCWG); Hindcasts (start years 1978-2021) (ESPWG)

Tier 1: anomaly restoring; a. standard pacemaker

b.

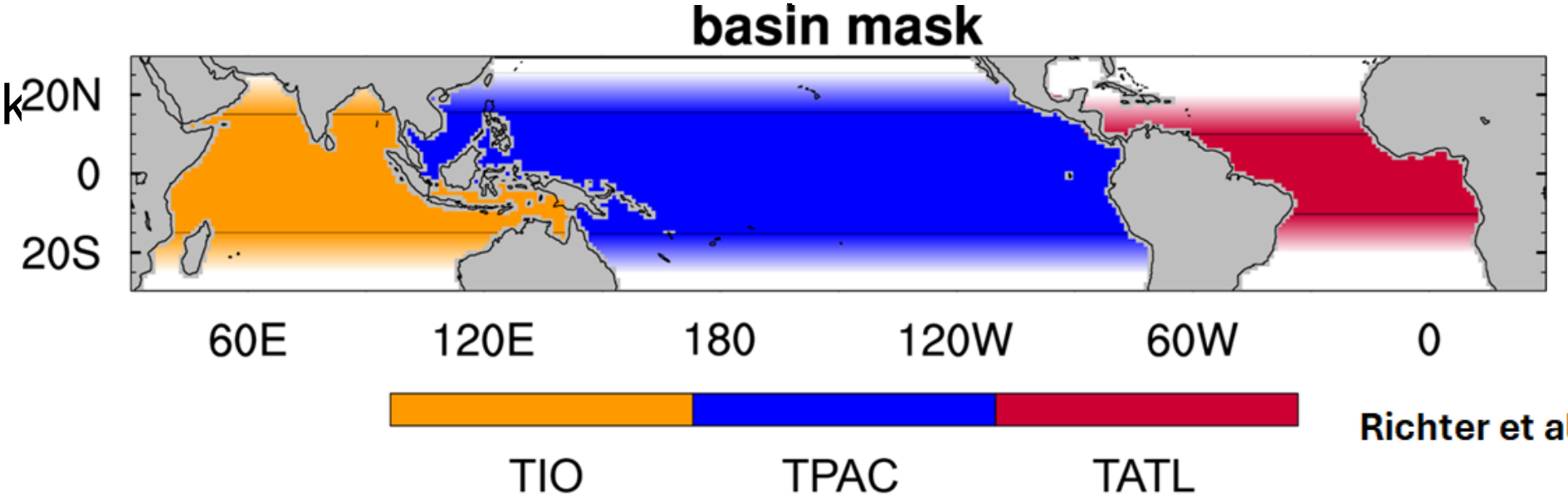
pacemaker hindcast

Tier 2: full field restoring; a. standard pacemaker

6 models
7 groups

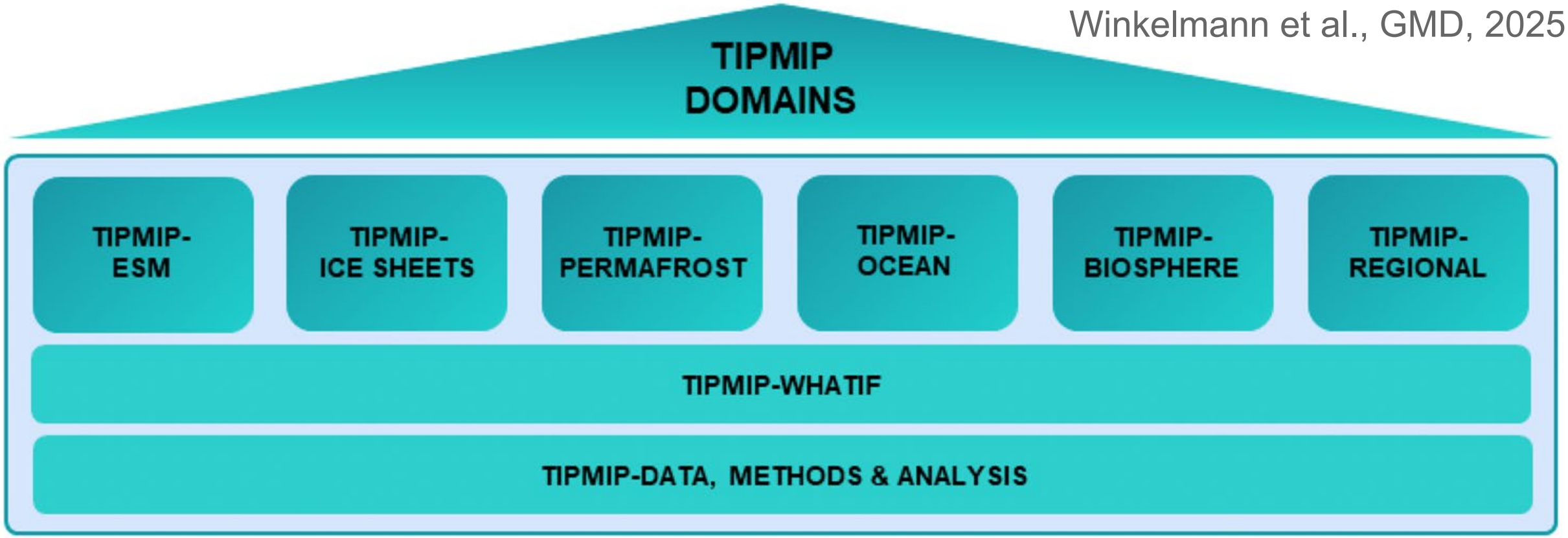
Richter et al., GMD, 2025

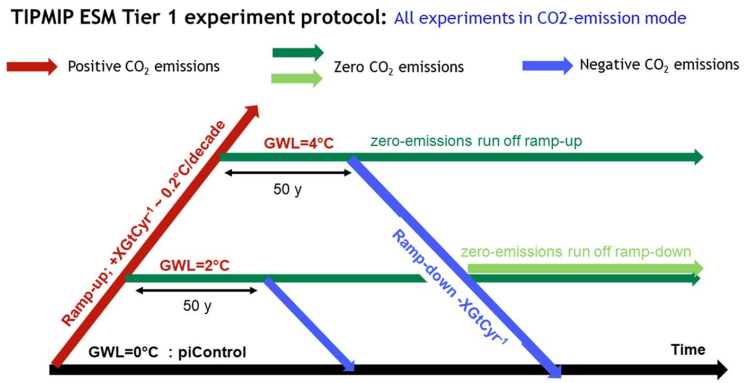
pacemak

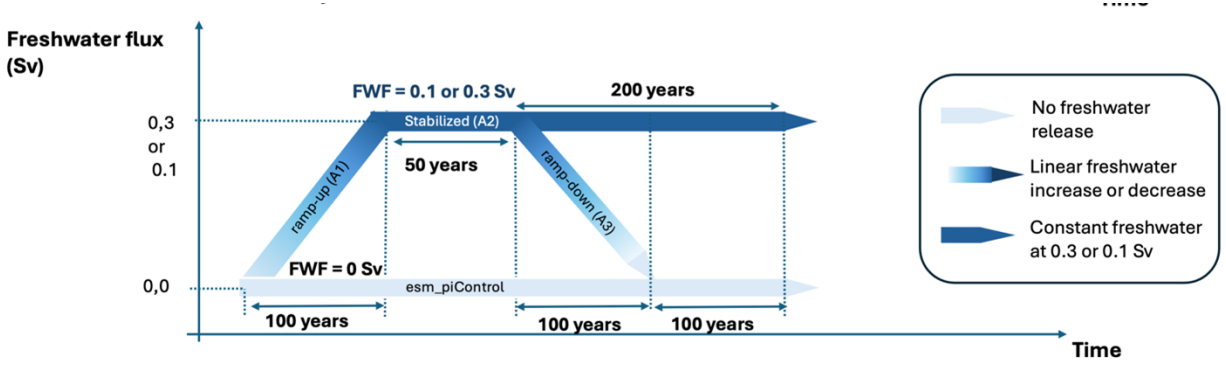


TIPMIP governing structure

Winkelmann et al., GMD, 2025







https://tipmip.pik-potsdam.de/about/governance_structure_domains/

Future Plans

Once CESM3 is available we'll start running the standard baseline simulations that CVCWG typically performs e.g., AMIP ensemble, Pacemaker ensembles etc.

If you'd like to join us for more detailed discussion on future plans for the working group, join us for the winter working group meeting.

Join the CVCWG mailing list:

https://www.cesm.ucar.edu/about/faqs

Q: Can I receive CESM working group updates in my email inbox?

A: Of course!

View the list below and click on the name to get more information about the list, or to subscribe, unsubscribe, and change the preferences on your subscription. If you have issues with subscribing to a list, then email fair@ucar.edu.

CESM AMWG CESM Atmosphere Model Working Group List

CESM Biogeochemistry CESM Biogeochemistry Working Group List

CESM Chemistry CESM Chemistry Working Group List

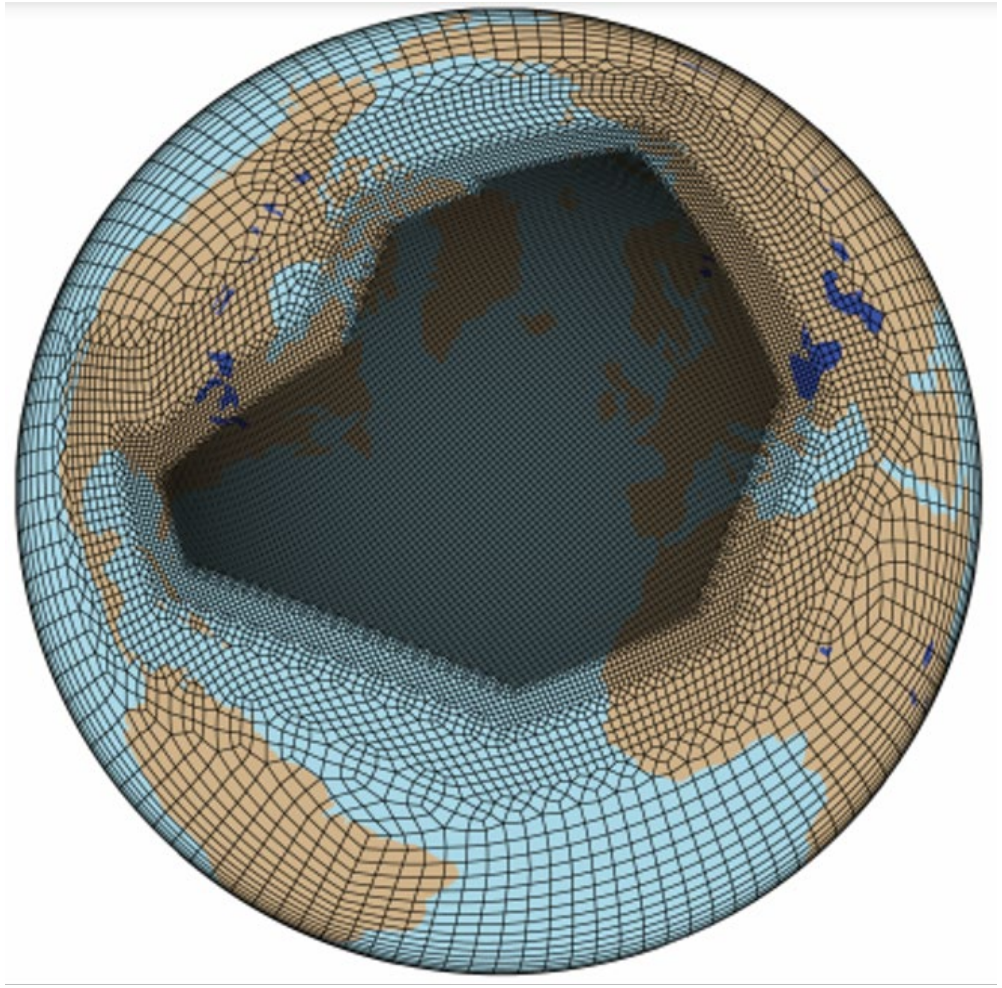
CESM CVCWG Working Group List

Extra Slides

Regionally refined North Atlantic AMIP simulations with CESM2

Isla Simpson, Robb Jnglin-Wills, Adam Herrington, and others

- 1958-present day
- CAM-SE (1/8th degree in the North Atlantic)
- Prescribed SSTs from the CESM1 1/10th degree FOSI simulation



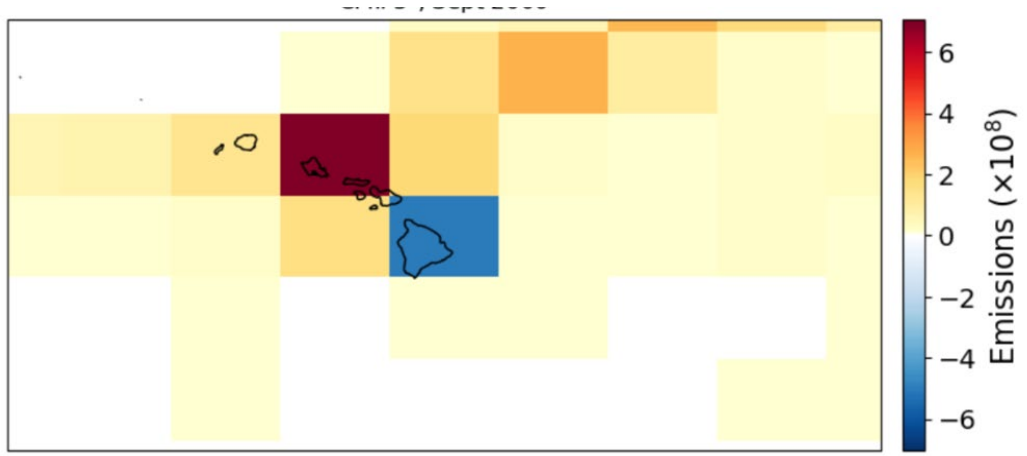
Motivation: How does North Atlantic jet stream variability/eddy mean flow feedbacks change at high resolution? Does ocean → atmosphere coupling change at high resolution?

Simulation is completed out to 2014.

Should become available sometime in the coming year

CESM2 single forcing with CMIP5 aerosols (CMIP6 piControl background)

Emissions = CMIP6_piControl + (CMIP5 historical - CMIP5 piControl)



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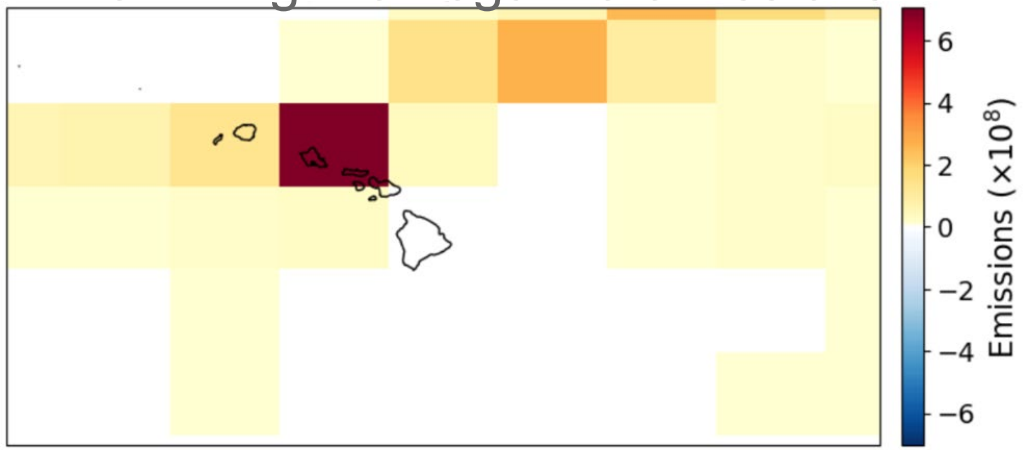
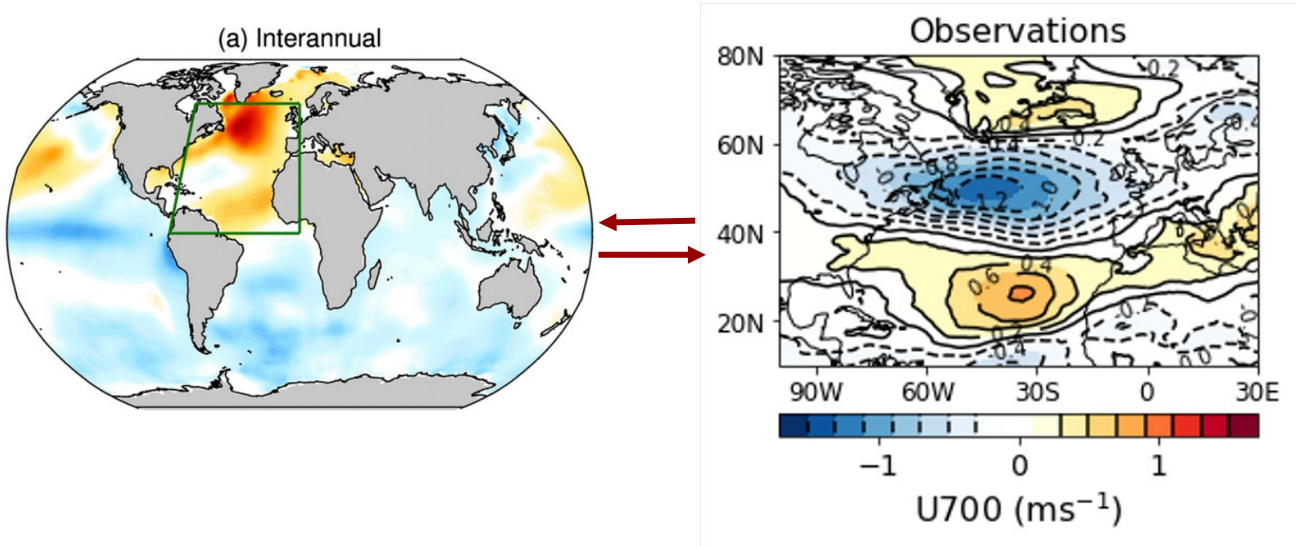
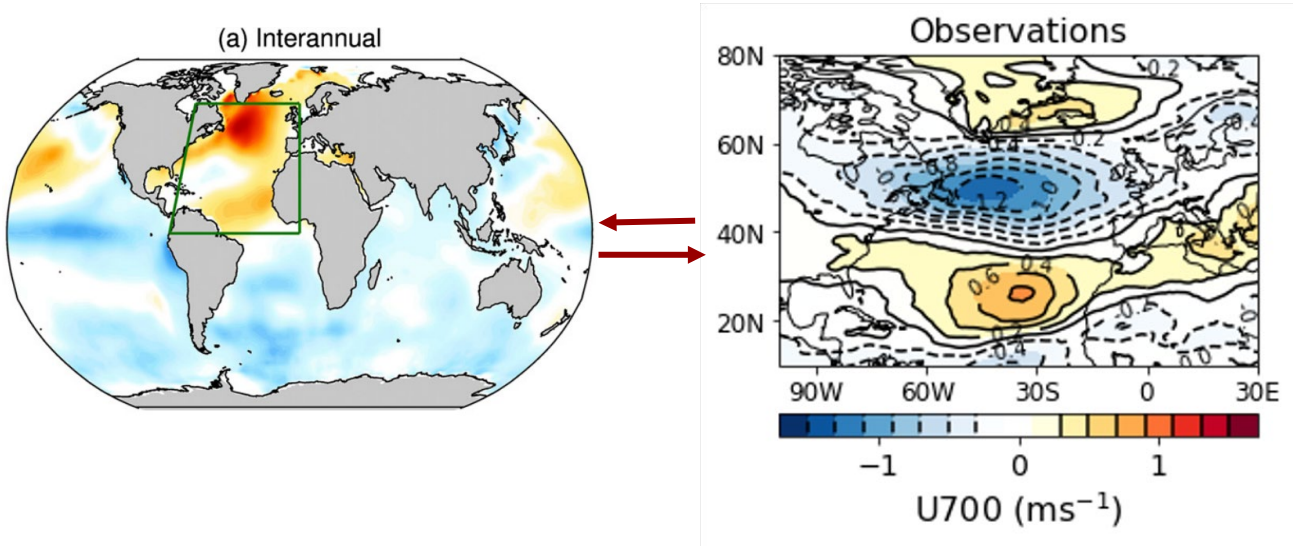


Interannual regression of zonal wind on to the AMV

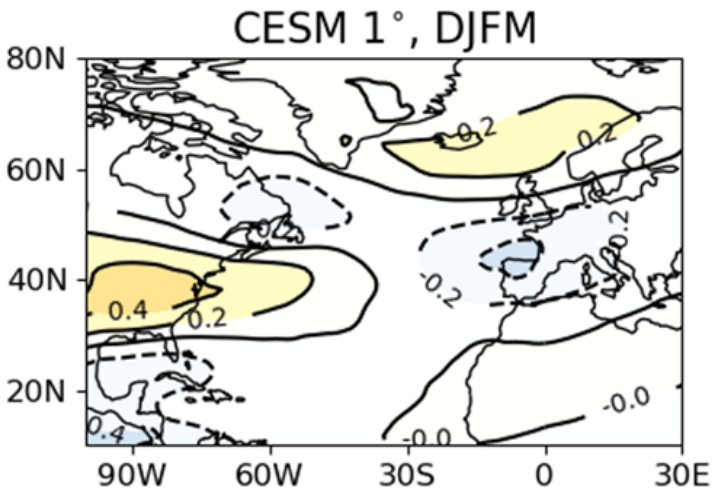


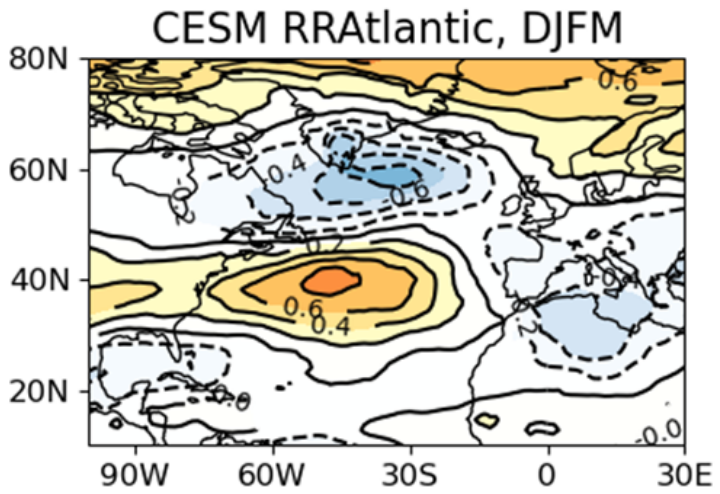
Regression of DJFM 700 hPa zonal wind onto the AMV

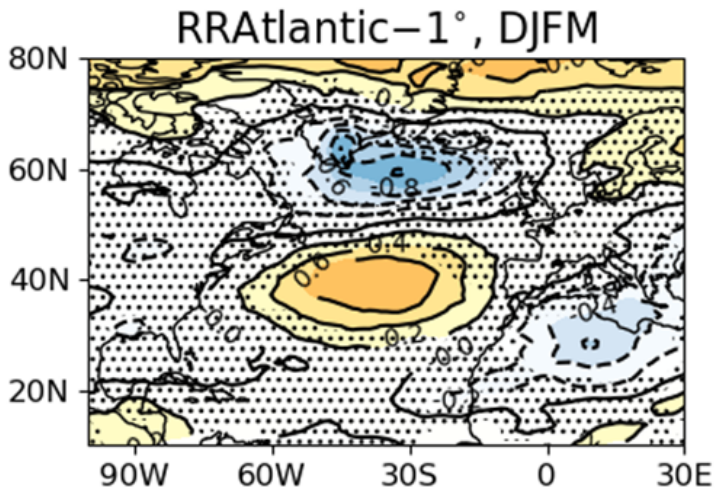
Interannual regression of zonal wind on to the AMV



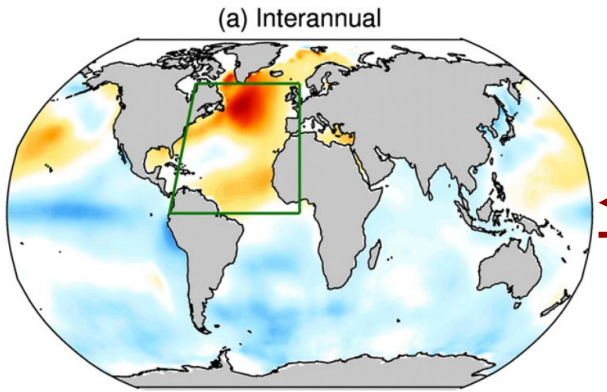
Regression of DJFM 700 hPa zonal wind onto the AMV

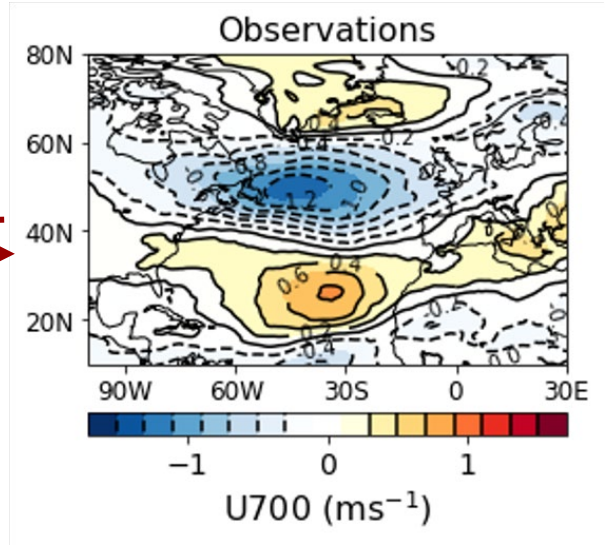






Interannual regression of zonal wind on to the AMV

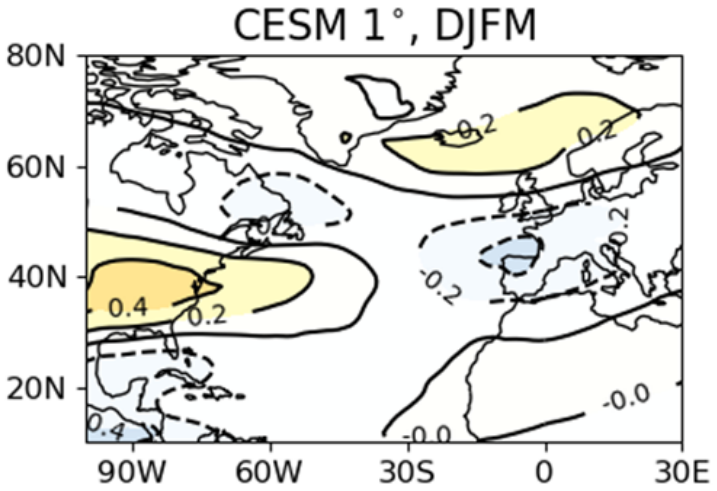


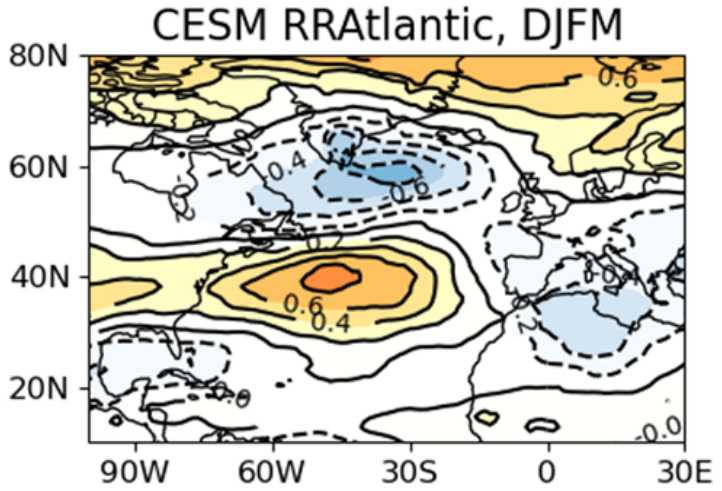


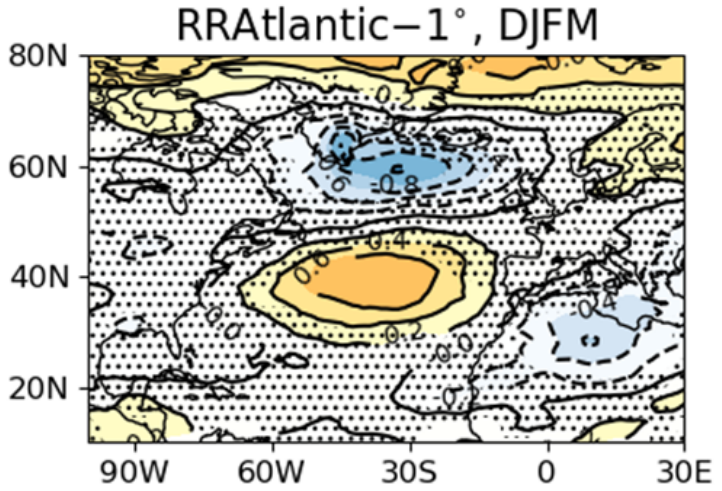
Regression of DJFM 700 hPa zonal wind onto the AMV

Next Steps:

- Understand this difference
- Run with low resolution SSTs
- Run with SSTs from decadal predictions i.e., SST variability caused by the ocean circulation







CESM2 large ensemble

Note: not run by the CVCWG

Historical → SSP3-7.0, 1850-2100

100 members

Articles / Volume 12, issue 4 / ESD, 12, 1393–1411, 2021

https://doi.org/10.5194/esd-12-1393-2021

Article | Assets | Peer review

Research article | **Highlight paper** |

Ubiquity of human-induced changes in climate variability

Keith B. Rodgers, Sun-Seon Lee, Nan Rosenbloom, Axel Timmermann, Gokhan Danabasoglu, Clara Deser, Jim Edwards, Ji-Eun Kim, Isla R. Simpson, Karl Stein, Malte F. Stuecker, Ryohei Yamaguchi, Tamás Bódai, Eui-Seok Chung, Lei Huang, Who M. Kim, Jean-François Lamarque, Danica L. Lombardozzi, William R. Wieder, and Stephen G. Yeager

CESM2 single forcing large ensemble

Historical → SSP3-7.0, 1850-2050

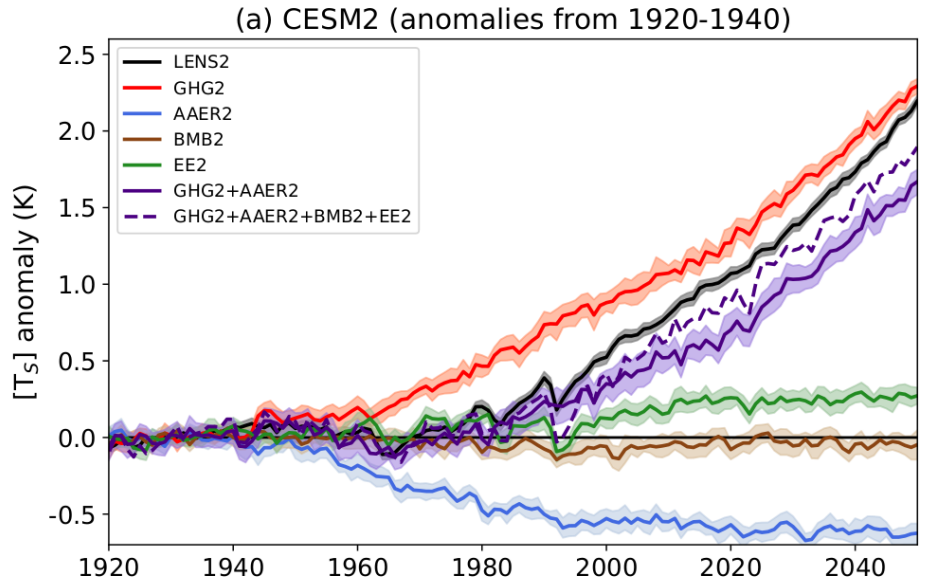
AAER (20 members): only anthropogenic aerosols evolving

GHG (15 members): only greenhouse gases evolving

BMB (15 members): only biomass burning aerosols evolving

EE (15 members): all other forcings evolving

xAER (10 members): everything except anthropogenic aerosols evolving



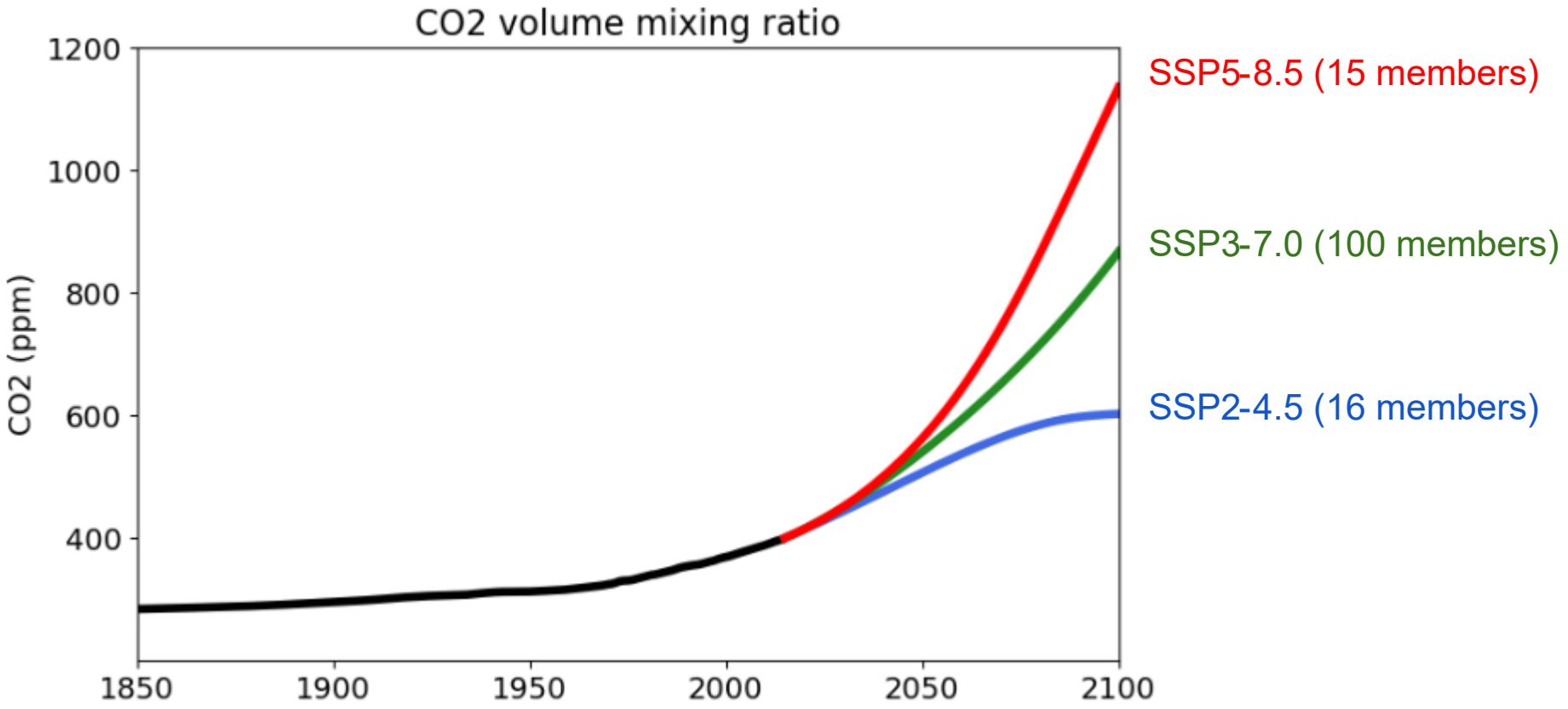
Simpson et al (2023), J.Clim.

SSP5-8.5 ensemble

Adam Phillips, Nan Rosenbloom

A 15 member ensemble with the SSP5-8.5 now complements the existing SSP3 -7.0 large ensemble and the SSP2-4.5 medium ensemble.

https://www.cesm.ucar.edu/working_-groups/climate/simulations/cesm2_-ssp585



RFMIP simulations

Isla Simpson, Nan Rosenbloom

A 3 member ensemble of the RFMIP “piClim-histall” experiment is available following the protocols of LENS2.

- prescribed climatological SSTs taken from years 401 to 2000 of the CESM2 piControl
- 1850-2014 under CMIP6 historical forcings (with the smoothing of biomass burning emissions in the late 20th/early 21st centuries - the “smbb” forcing of LENS2 (second 50 members)).

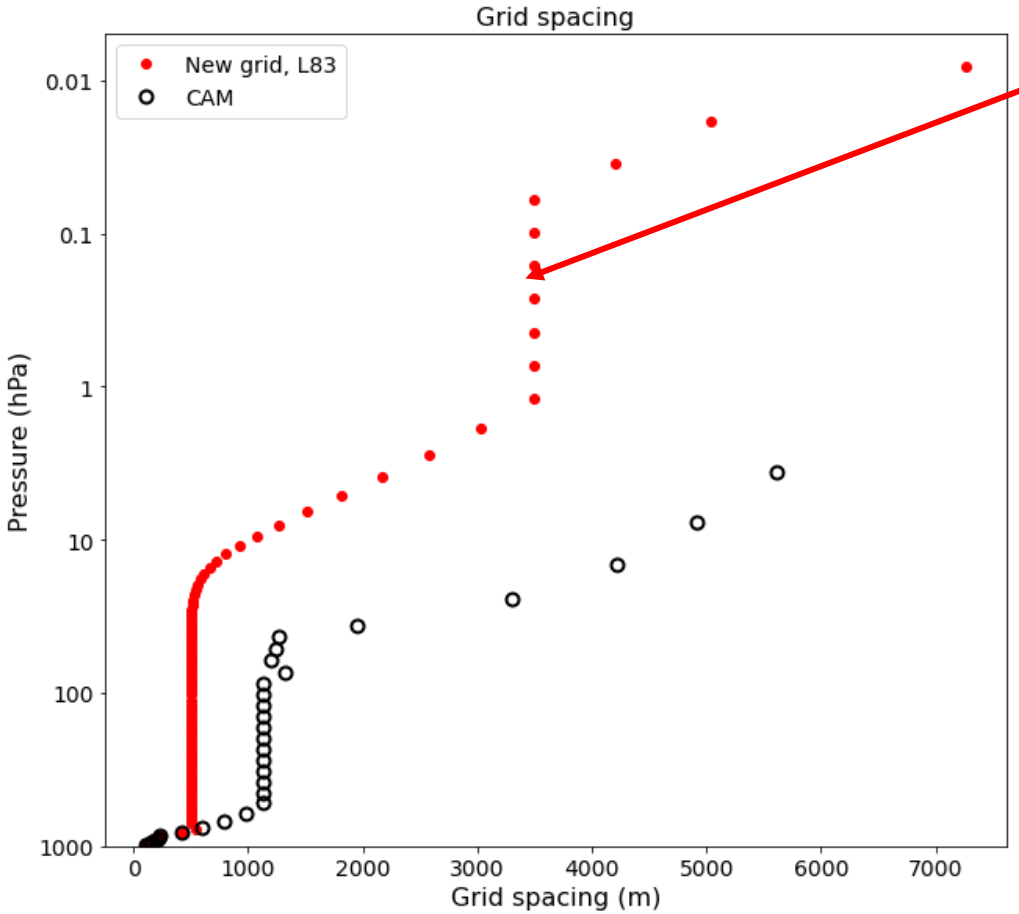
Useful for

a. diagnosing the transient effective radiative forcing
b. examining the direct impact of external forcings more generally

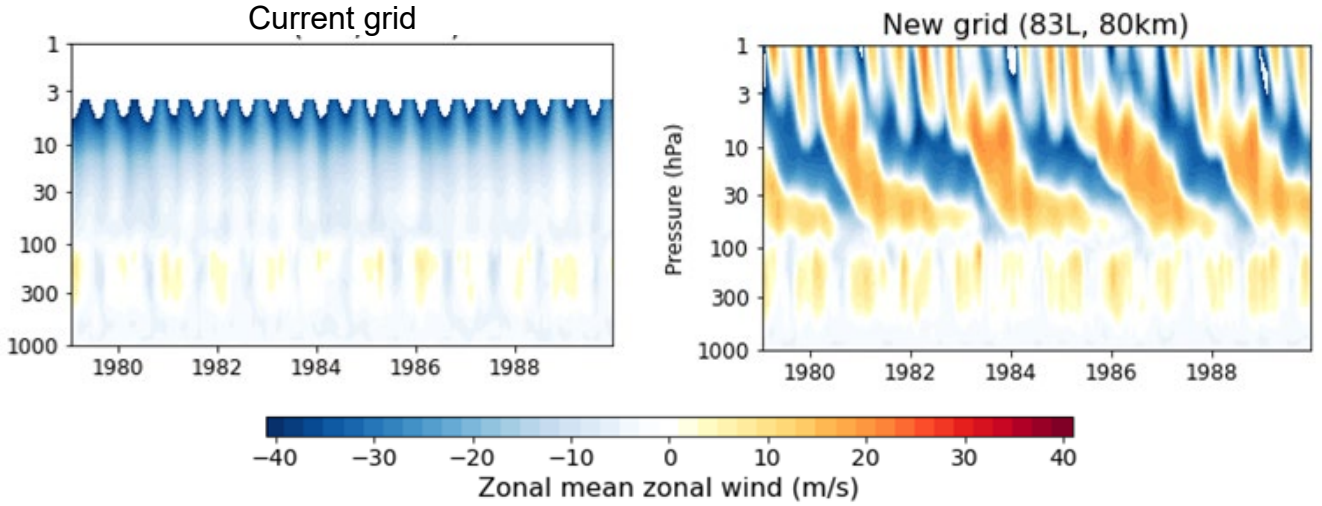
https://www.cesm.ucar.edu/working-groups/climate/simulations/cesm2-rfmip

L83 simulations

Nan Rosenbloom, Isla Simpson



Next generation grid for CAM (excluding additional levels in the boundary layer)



- 100 year piControl
- 3 coupled historical simulations (1850 -2100, historical → SSP3-7.0)
- 3 AMIP simulations (1979-2020)
- Nudged QBO simulations for QBOi

Described in Simpson et al, submitted to JAMES

Tropical Belt

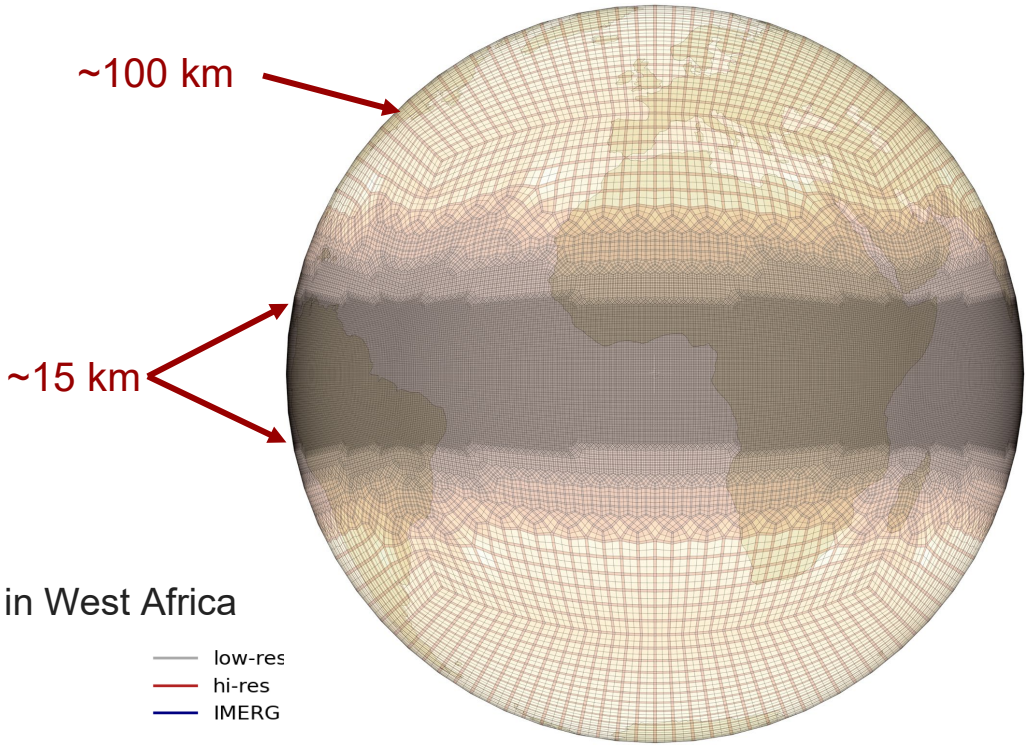
Brian Medeiros

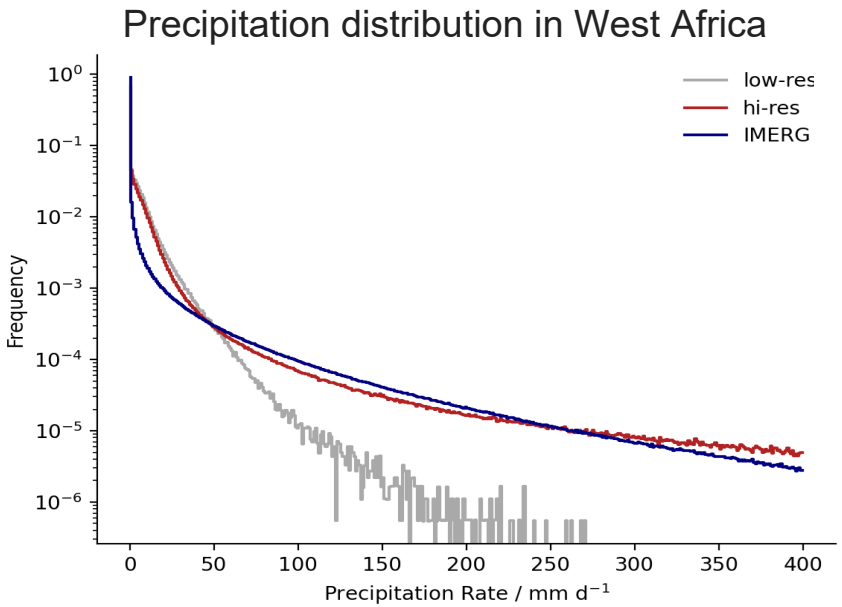
Goal:

- Explore the impacts of enhanced horizontal resolution in the tropics

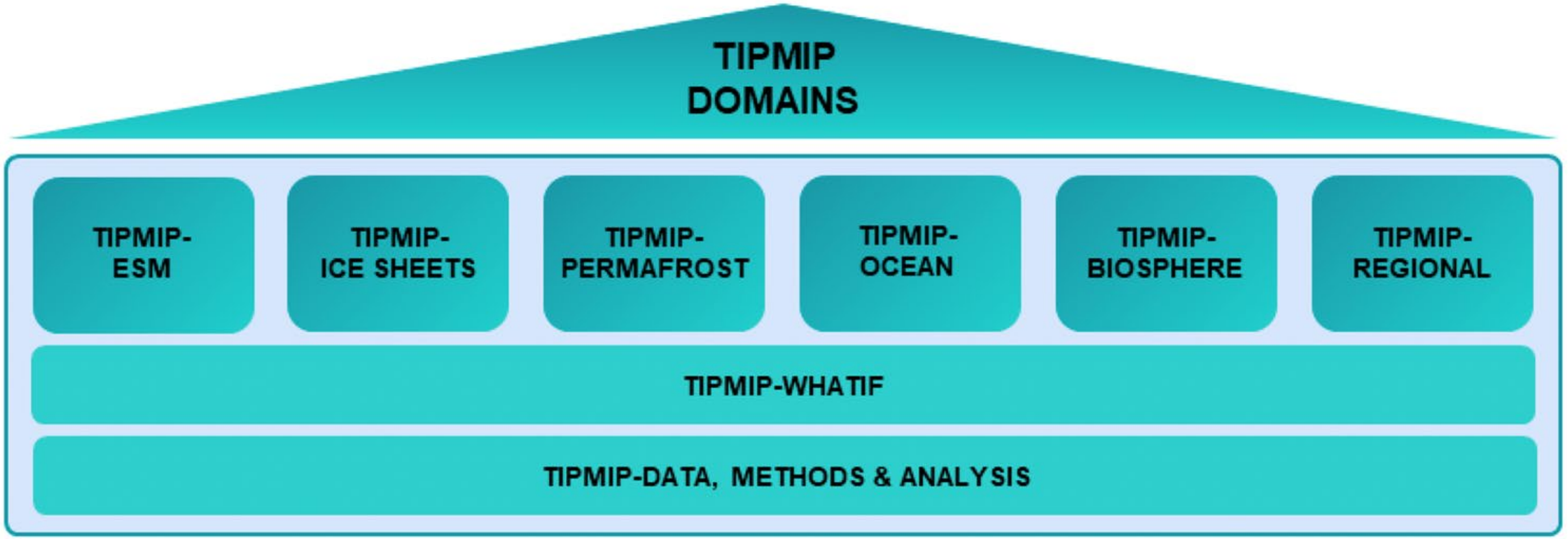
Setup:

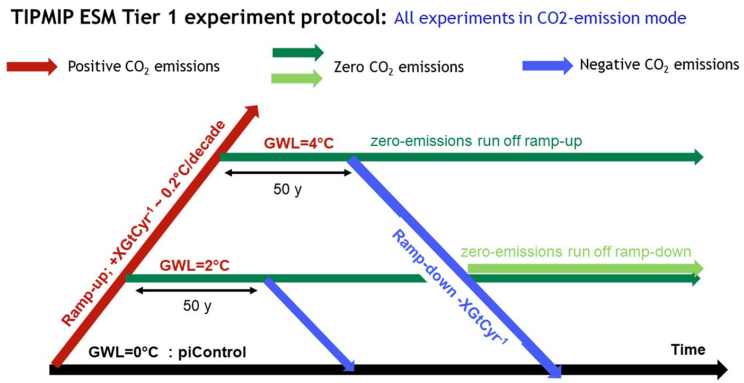
- Regional refinement down to 15 km in the tropics, 100km in extatropics (ne30->ne240)
- Standard CAM6 physics, no re-tuning, 5-minute timestep
- 7-year simulation (F2000, L32), 2-years allowed for spin up
- Limited output because of volume, but designed to describe mean climate, tropical waves, and extremes (including ARs and TCs)
- Data is on glade if there's interest (ask Brian)
- Hoping to follow up with L58, CAM7, and AMIP forcing

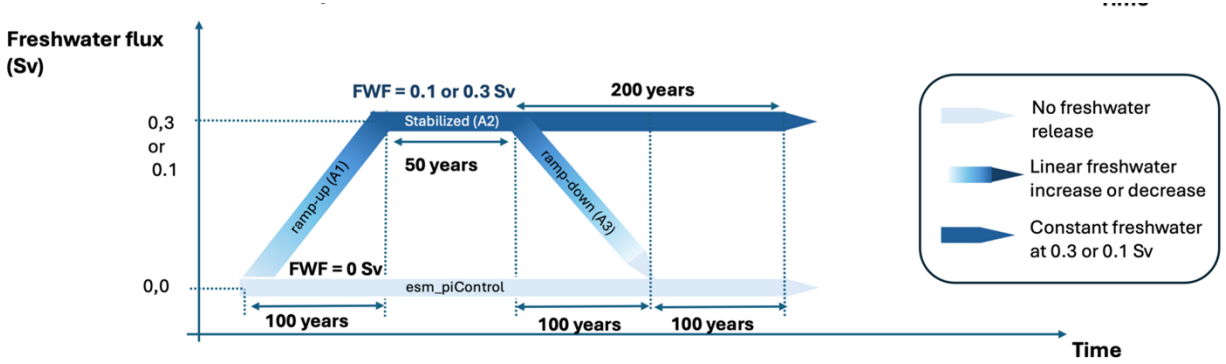




TIPMIP governing structure







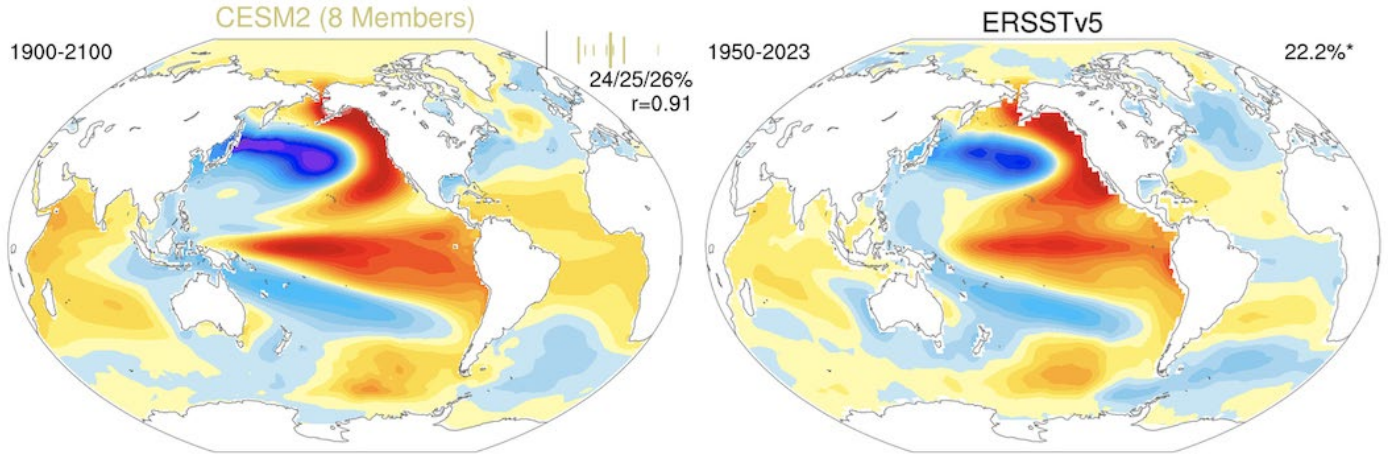
https://tipmip.pik-potsdam.de/about/governance_structure_domains/

Diagnostics and other datasets

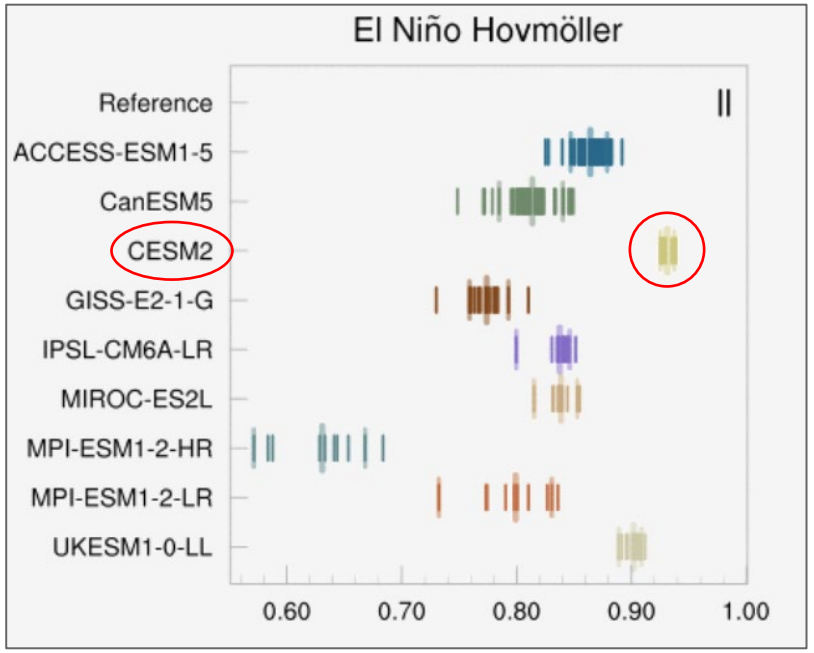
NEW-ish Climate Variability Diagnostics Package (version 6 release)

Automated analysis tool and data repository for assessing modes of variability and trends.

EOF1 Pacific Decadal Variability (quadratic detrending)



Pattern Correlation w/ Obs



- New detrending options: linear and quadratic, 30 -year high-pass filter, remove ensemble mean
- Reference data can be either observations or model simulations.
- CAM-SE data is regridded automatically.
- https://www.cesm.ucar.edu/projects/cvdp
- Aiming for a python version by the end of this year

Contact: Adam Phillips and Clara Deser (Climate Analysis Section)

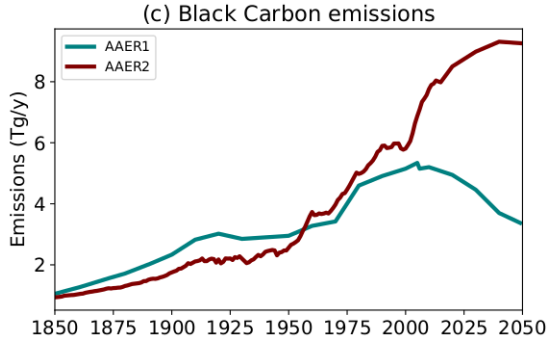
Future simulation plans

Forthcoming Simulations with CESM2

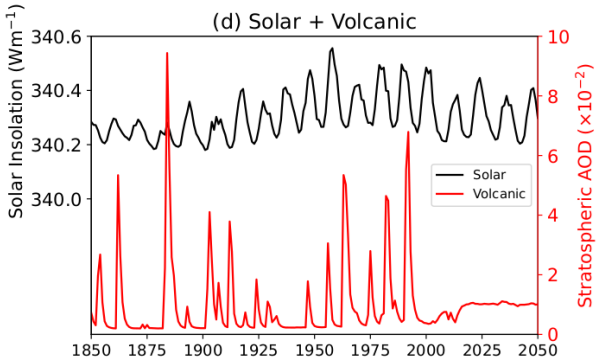
- Aerosol only ensemble with CESM2 with CMIP5 aerosol emissions.

- *Needs some work to figure out the forcings*

  CMIP6 piCtrl + (CMIP5 historical - CMIP5 piCtrl)



- Volcanoes only ensemble



- More regionally refined work (North Atlantic and Tropics)

- Simulations in which the mean state of the tropical Pacific is bias corrected

- *There are indications that biases in the mean state of the tropical Pacific could be impacting on forced trends in the tropical Pacific and preventing models from capturing the La Nina-like trend seen in obs (Zhuo et al. 2024).*

Plans for simulations with CESM3

- GOGA simulations, 1850-2024

  CESM3 with prescribed observation-based SSTs and sea-ice.
  3 members for 1850-2024, 7 members for 1958-2922

- Mid-top 1850 piControl with prescribed climatological SSTs

  Allows for characterization of the internal variability of the atmosphere-land alone without SST variability or feedbacks.

- Contribution to additional CESM3 ensemble members to whatever form of CESM3 large-ensemble we decide to do.

- Development of a CESM3 mechanically decoupled simulation with CESM3 (S. Larson)

  The ocean only experiences time variations in the buoyancy forcing from the atmosphere and momentum fluxes are prescribed. Has been used to gain insights of the dynamical of natural variability in CESM.

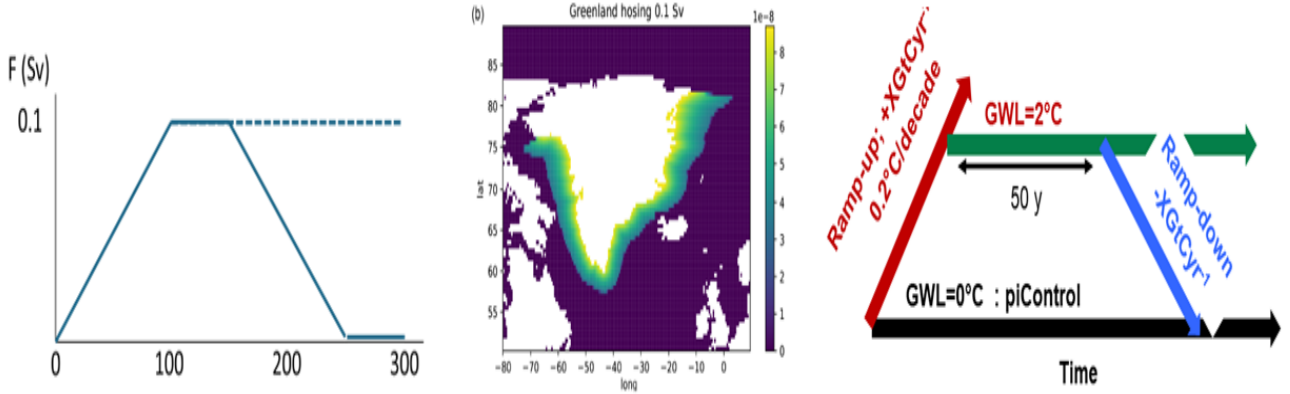
Questions? Discussion?

https://www.cesm.ucar.edu/working -groups/climate

TIPMIP Ocean domain experiments

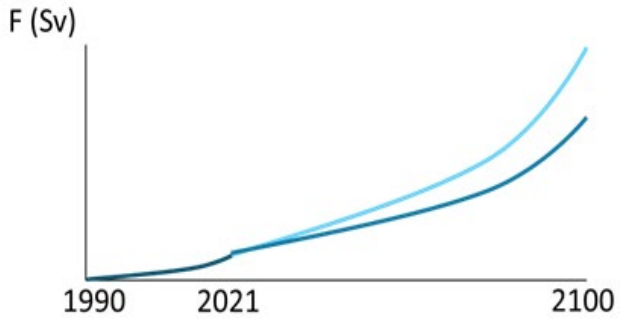
A. TipMIP-AMOC

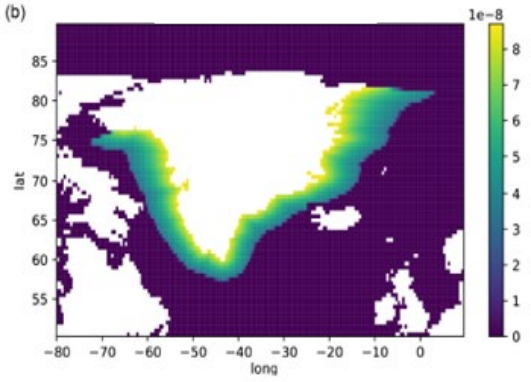
How does the combination of warming and Greenland freshwater input impact the AMOC and its recovery?



B. Greenland freshwater experiments

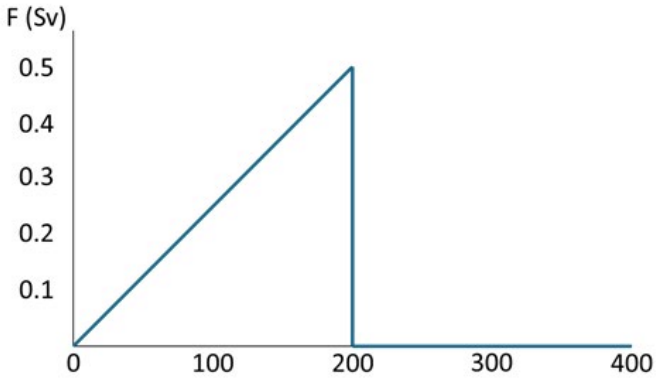
How did/will the AMOC respond to realistic and projected sources of Greenland freshwater?

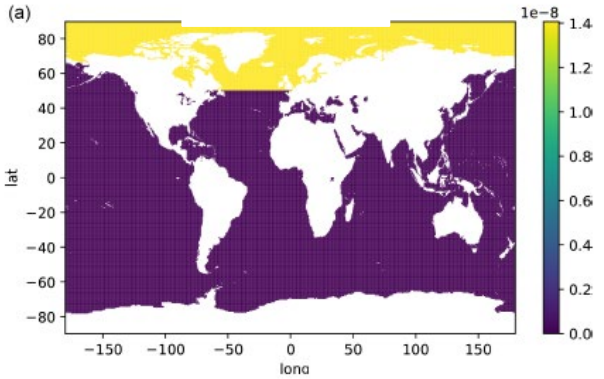




C. Freshwater ramp-up/off

Where is the stability threshold of the AMOC with respect to North Atlantic freshwater forcing?





TBI co-EX (For investigating Tropical -Basin Interactions)

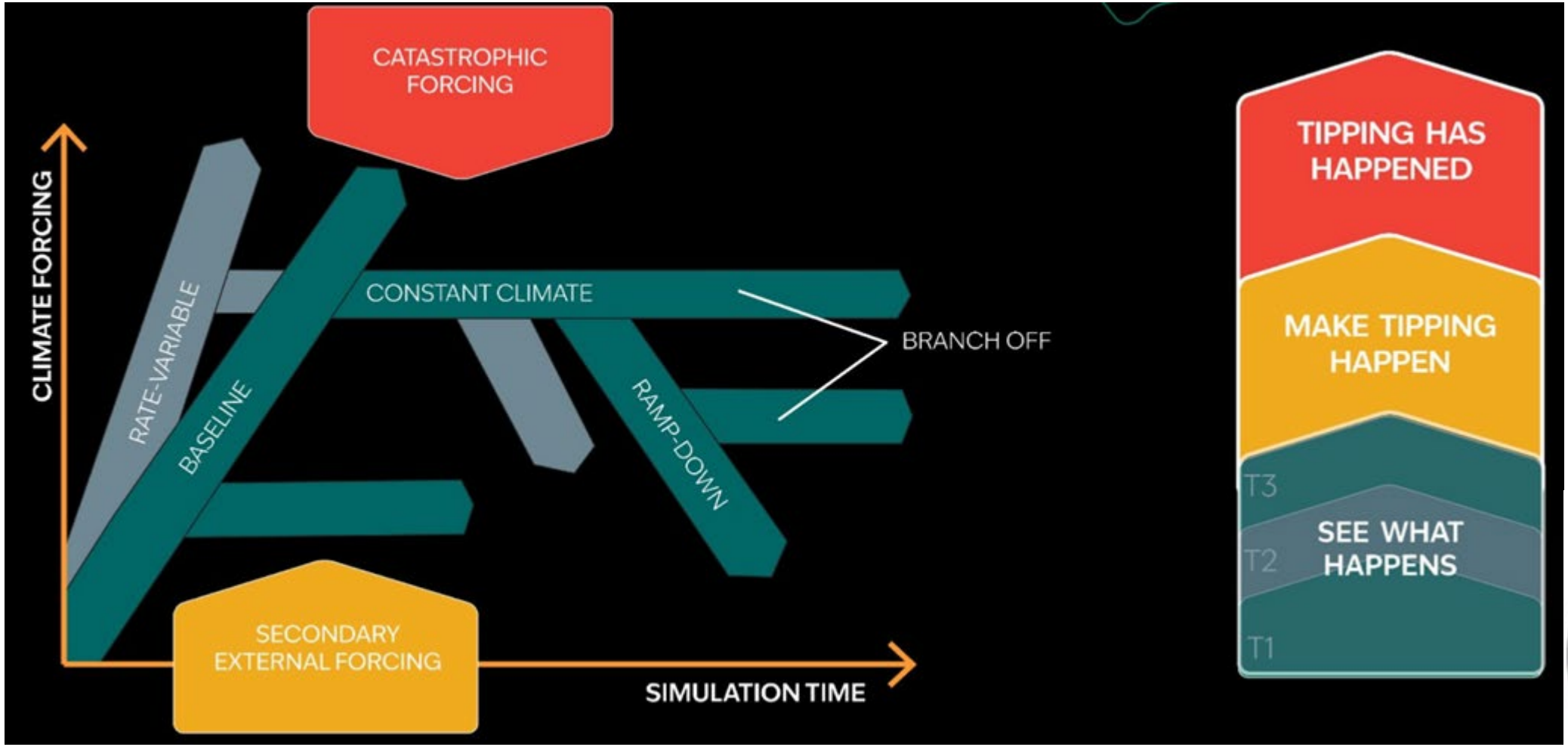
Current status of TBI co -EX:

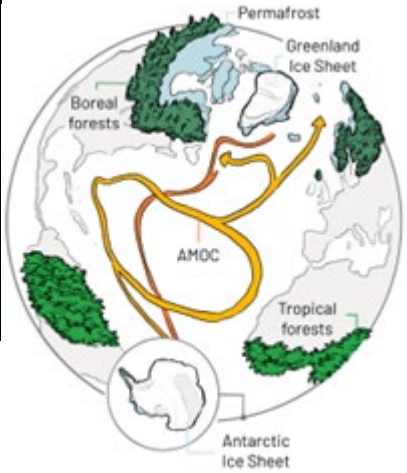
Model	Center	Type of experiment	Status
CESM2	US NSF NCAR	pmaker hindcast	completed
CESM2	US NSF NCAR	standard pmaker	completed
CESM2	SCSIO, China	Tier 2 expmnts	completed
NorCPM	U. of Bergen	hindcast+standard	completed
SINTEX-F2	JAMSTEC	pmaker hindcast	completed
MIROC6	JAMSTEC, University of Tokyo/NIES	hindcast+standard	ongoing
ACCESS-CM2	CSIRO, Australia	standard pmaker	in preparation
IPSL-CM6A-LR	IPSL, France	standard pmaker	completed

Richter et al., GMD, 2025

Tipping point model intercomparison project (T/PMIP

International program office: Potsdam Institute for Climate Impact Research





Winkelmann et al., 2025