

Paleoclimate Working Group Update

THE 27th ANNUAL CESM WORKSHOP

*Co-Chairs: Jiang Zhu (NCAR)
Samantha Stevenson (UCSB), Ran Feng (UConn)*

Paleoclimate Group at NCAR: Bette Otto-Bliesner, Esther Brady



13 JUNE 2022



New Co-Chairs of the Paleoclimate Working Group (PaleoWG)

We thank previous co-chairs
for their contributions

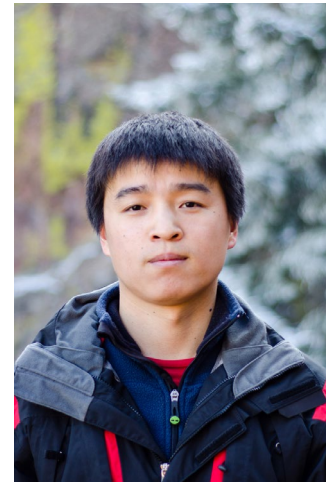
The new co-chairs are committed to
contribute to the CESM project &
serve the community



Esther Brady
(NCAR)



Arne Winguth
(UT Arlington)



Jiang Zhu
(NCAR)



Samantha
Stevenson
(UCSB)

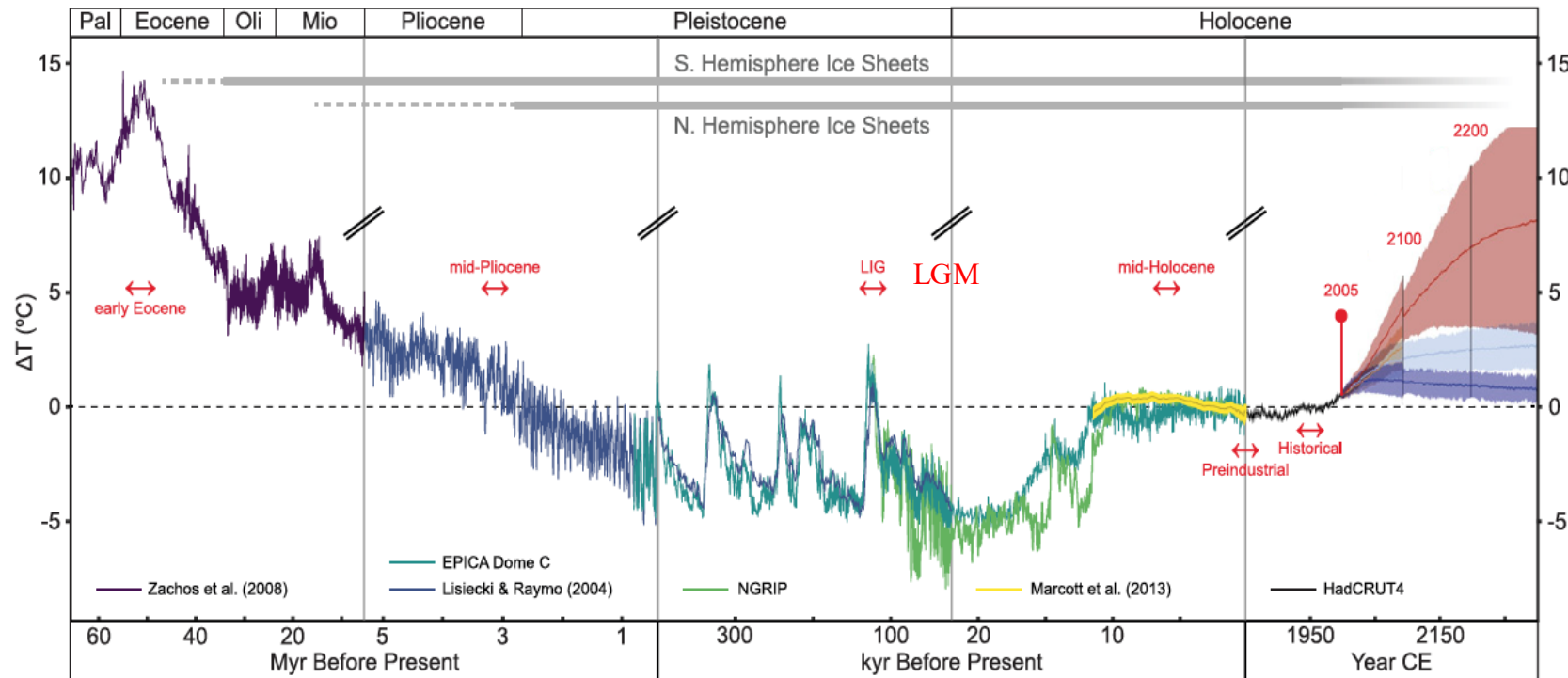


Ran Feng
(UConn)

Science & research goals of PaleoWG

Conducting CESM paleoclimate simulations to contribute to the mission & objectives of CESM

- *Investigate Earth system forcing & response*
- *Use “real-world” data to provide out-of-sample assessment of Earth system models & to contribute to the model development*



*Burke et al.,
2018, PNAS*

CESM2-PaleoCalibr: an example of recent PaleoWG research



Zhu, Otto-Bliesner, Brady,
Gettelman, Bacmeister, Neale



Poulsen



Tierney



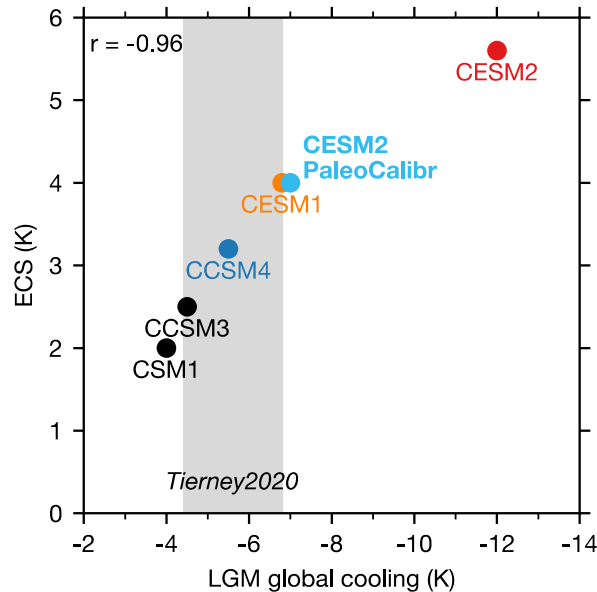
Shaw,
Kay



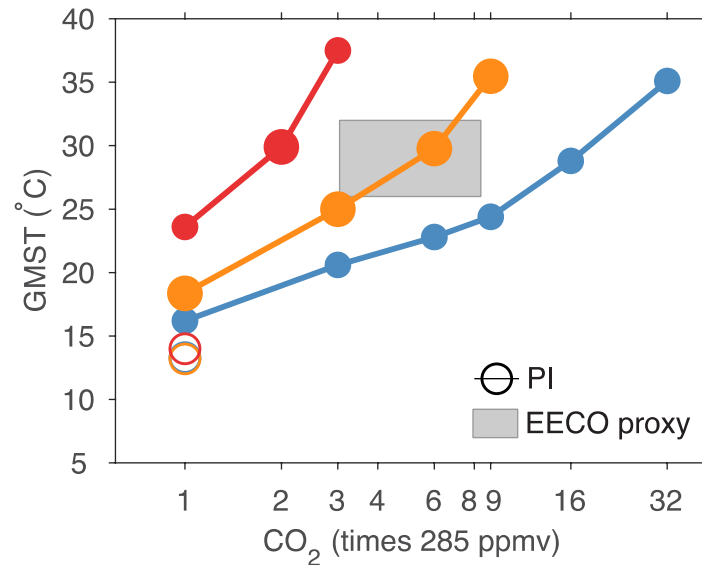
McGraw

CESM2 overestimates past extreme warming & cooling

LGM (21ka)

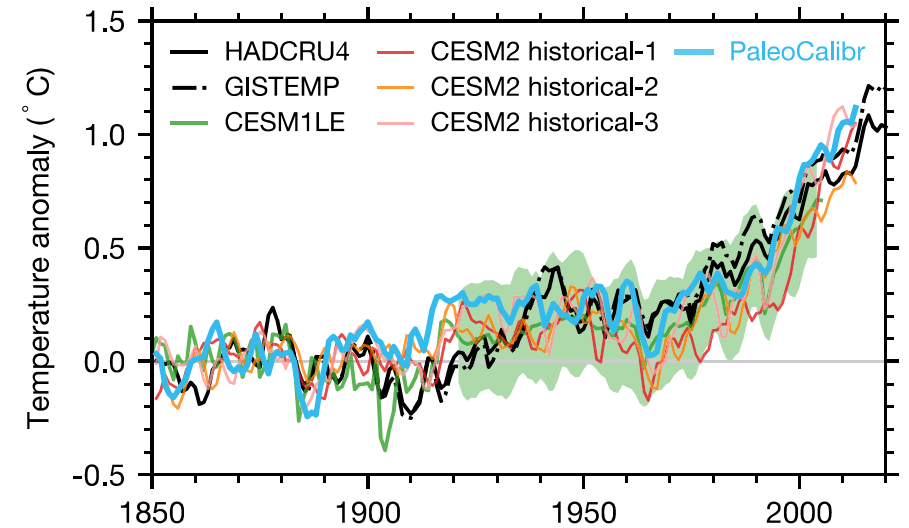


Early Eocene (55 Ma)



CESM2-PaleoCalibr

(fixes in microphysics & ice nucleation)



Brady et al., 2013, JC Otto-Bliesner et al., 2006, JC Shin et al., 2003, Clim. Dyn. Zhu et al., 2017, GRL
Zhu et al., 2019, Sci. Adv Zhu, et al., 2020, Nat. Clim. Change Zhu et al., 2021, GRL Zhu, et al., 2022, JAMES

CESM2(WACCM6ma) -PaleoCalibr simulation of the LGM

NCAR
CGD

Zhu, Otto-Bliesner, Brady, Lamarque

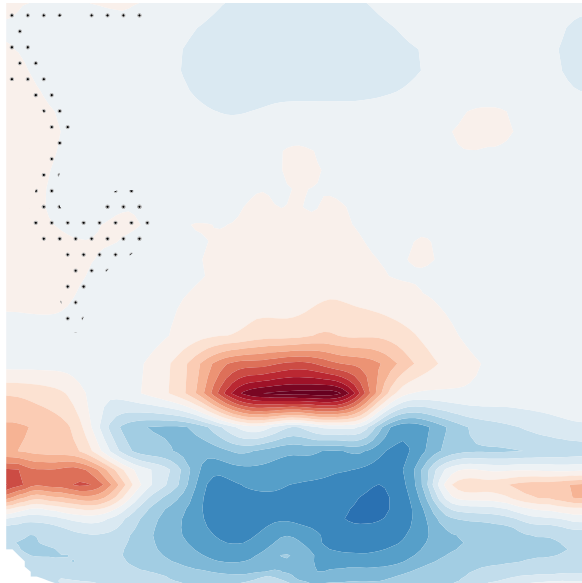
NCAR
ACOM

Garcia, Mills, Kinnison

Novelty: one of the first coupled LGM simulations with high -top atmos. & chemistry (*WACCM6ma vs CAM6*)

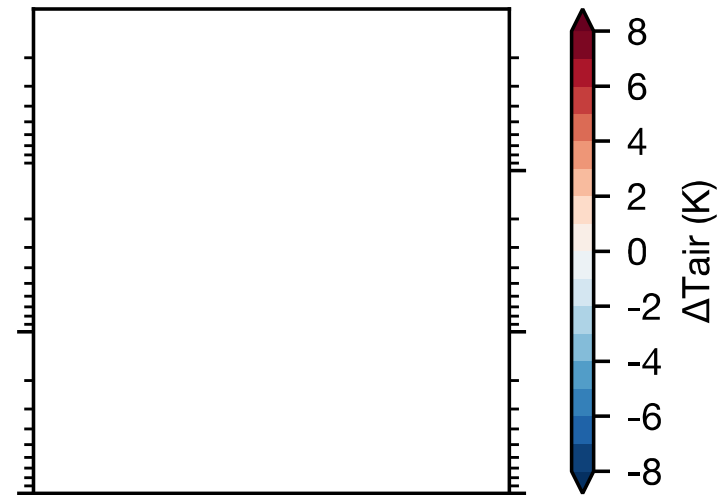
Major finding: stratospheric dynamics & chemistry have little impact (<5%) on surface climate

LGM Ozone change (%)



3) (%)

LGM ΔT
WACCM6ma – CAM6



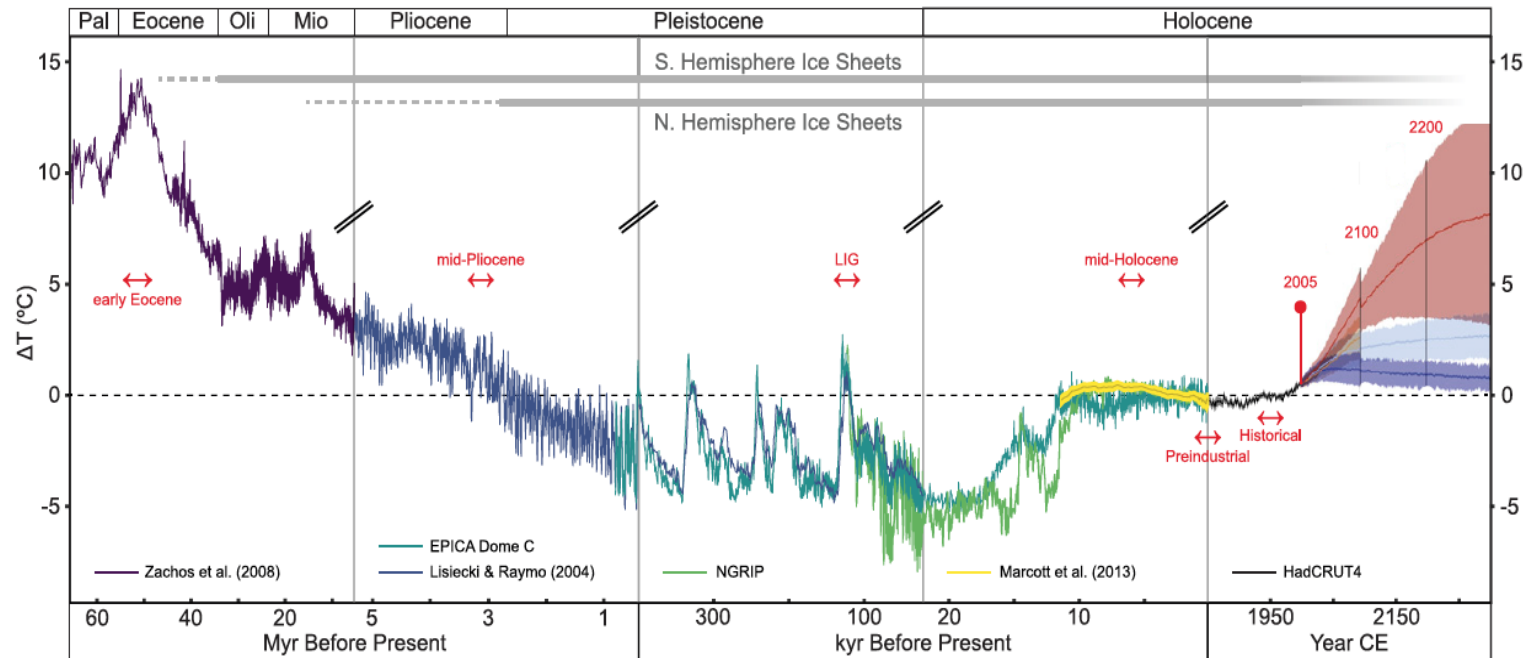
*Zhu et al., GRL,
submitted*

A paleoclimate perturbed parameter ensemble (PPE) in CAM6

NCAR Zhu, Otto-Bliesner, Brady (PaleoWG)
CGD Gettelman, Eidhammer (AMWG)

Objectives:

- Study state-dependence of the cloud feedback
- Investigate parameter uncertainty & mechanisms across a wide temperature change



A paleoclimate perturbed parameter ensemble (PPE) in CAM6

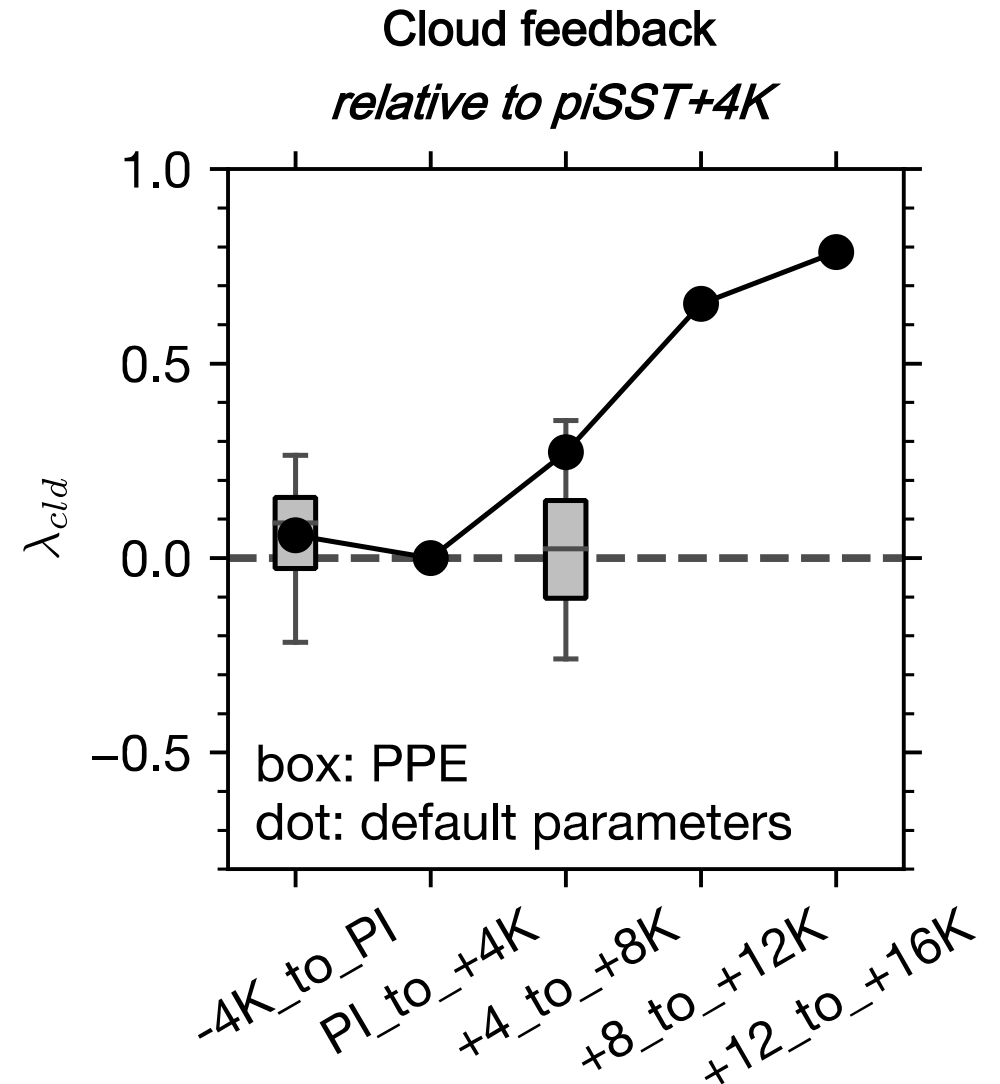
Setup: *thanks to Gettelman & Eidhammer*

- $\sim 2^\circ$ CAM6 with PaleoCalibr fixes
- 250 ensembles sampling 45 parameters (Latin Hypercube sampling)
- 5 years each
- piSST & -4 , $+4$, $+8$, $+12$, $+16$ K

Future direction:

- Patterned warming/cooling
- Coupled PPE
- ...

Poster: 3:20-4:50pm (MT) on Tuesday



CESM2(CISM) transient simulation of the Holocene

(9ka–preindustrial)

NCAR Otto-Bliesner, Brady, Zhu (PaleoWG)
CGD Lipscomb, Leguy (LIWG)

U
UNIVERSITY OF
OREGON Bartlein

USGS Shafer
science for a changing world

Novelty: interactive ice sheet & climate

Objectives: use simulation & paleo-data to

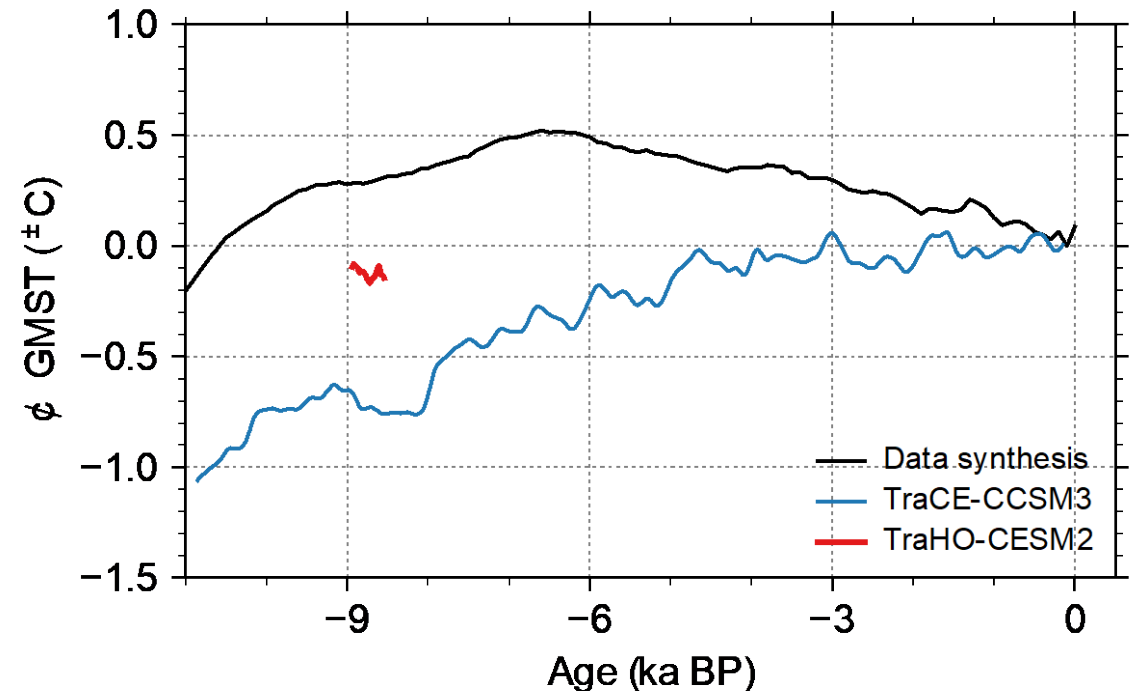
- Study evolution of mean climate & variability
- Study climate-ice sheet interactions

Setup:

- Coupled CESM2(CISM2)
- $\sim 2^\circ$ atmos./land & $\sim 1^\circ$ ocean/ice
- Offline vegetation using BIOME4

The Holocene Temperature Conundrum

See Liu et al., 2014, PNAS



CESM2(WACCM6ma) past1000 simulation: CMIP6/PMIP4 Tier 1

NCAR
CGD

Otto-Bliesner, Brady, Zhu (PaleoWG)
P. Lawrence, Kluzek (LMWG)

NCAR
ACOM

Garcia, Mills



UNIVERSITY OF
CAMBRIDGE

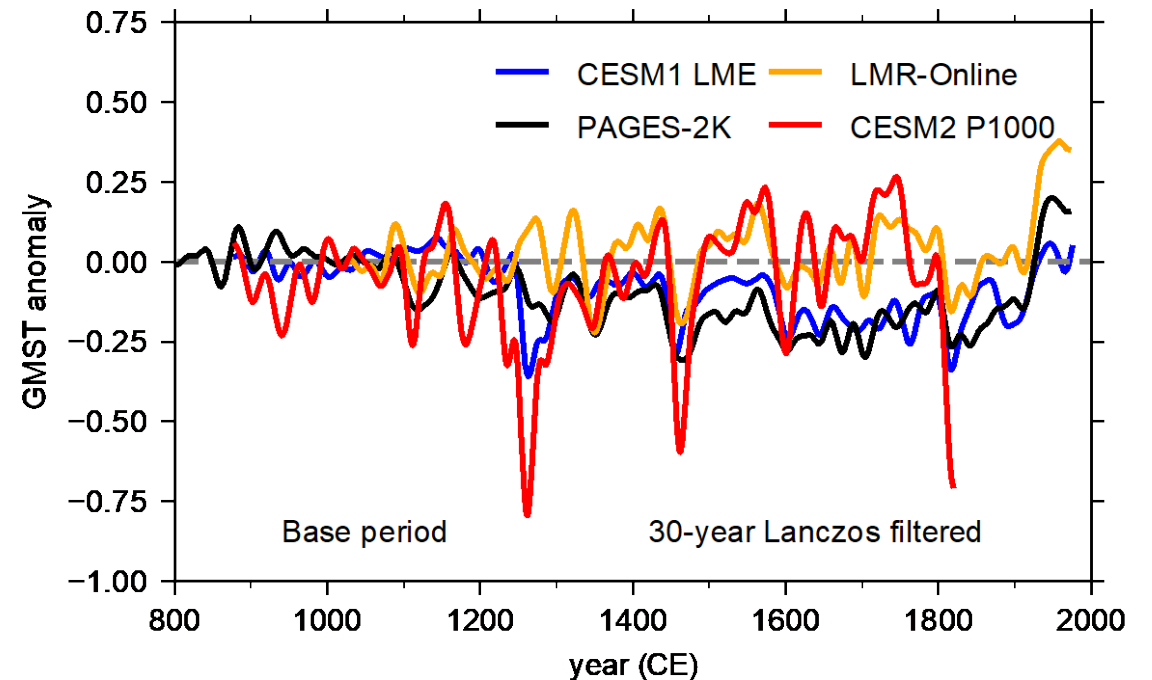
Schmidt

Novelty: high-top atmos. & chemistry

Objectives: volcanic eruptions & natural climate variability

Setup:

- CESM2(WACCM6ma)
- $\sim 2^\circ$ atmos./land & $\sim 1^\circ$ ocean/ice
- PMIP4 volcanic emissions, solar, LULC, GHG, Orbital, ...



Otto-Bliesner et al., 2016, BAMS
Perkins and Hakim, 2021, Paleo & Paleo

'PaleoWeather': An unprecedented set of high-res. paleo simulations

Accelerated
Scientific
Discovery
(ASD)

NCAR
CGD

Otto-Bliesner, Brady,
Zhu, Sun, Nusbaumer



Feng,
Tabor



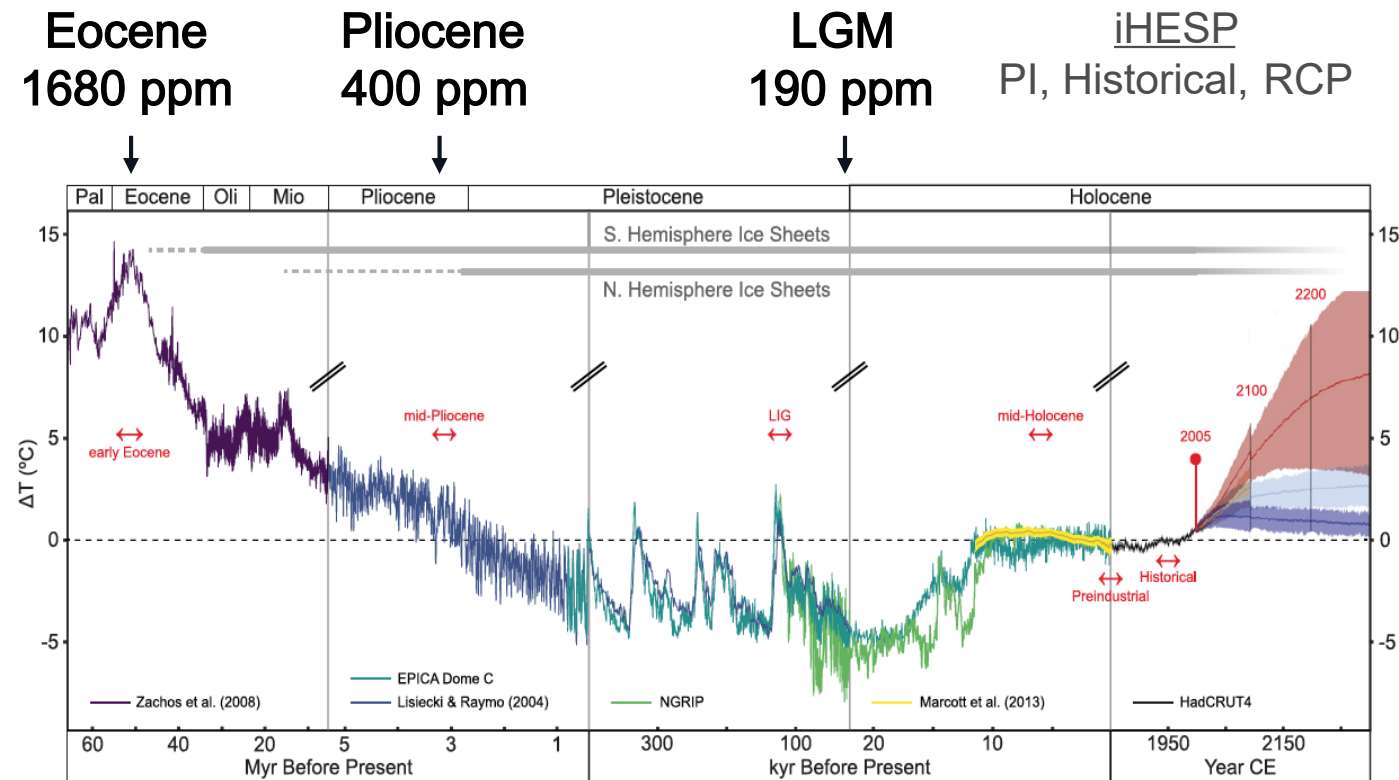
Tierney,
Walters

Novelty: high-res. & water isotopes

Objectives: study weather & water extremes across Earth's history

Setup:

- iHESP_CESM1.3 with water isotopes
- Fully coupled: $\sim 0.25^\circ$ atmos./land & 0.1° ocean/sea ice



Paleoclimate Advances Webinar Series (PAWS)

Organizing Committee: Bhattacharya (Syracuse U), Feng (UConn.), Konecky (Washington U), Sun (NCAR), Tabor (UConn.) & Zhu (NCAR)

Recordings & more: <https://www.cesm.ucar.edu/events/webinars/paws/>

Sign up: <https://groups.google.com/a/ucar.edu/g/paws>

#1 Global temperature reconstruction for past 500 Million years



#2 Atmospheric CO₂ & carbon cycle reconstruction



#3 Climate sensitivity & paleoclimate



PaleoWG activities at the Workshop

Oral presentations

- 8:30-12pm (MT), Wednesday, Jun. 15th
- 13 Talks
- Lunch & networking at 12:20pm

Poster on paleo-PPE

- 3:20–4:50pm, Tuesday, Jun. 14th

Thank you!

Wednesday, June 15

* All times are Mountain Time

Time	Topic / Title	Speaker
8:30	Welcome and logistics	Co-Chairs
8:35	<i>PalMod Initiative</i> : PalMod overview and Climate variability on centennial-to-millennial scales in CESM	Ute Merkel
8:55	<i>PalMod Initiative</i> : Carbon cycle simulations for MIS3: for three time slices	Takasumi Kurahashi-Nakamura
9:10	<i>PalMod Initiative</i> : Integrating water isotopes: glacial-interglacial changes: variability and temperature dependencies	Tamás Kovács
9:25	Partitioning meridional heat transport in DeepMIP simulations	Fanni Kelemen
9:40	Moisture source and isotopic changes in the Yucatán Peninsula during the Last Glacial Maximum	Alexander Thompson
9:55	Dipole Response of Millennial Variability in Tropical South American Precipitation and $\delta^{18}\text{O}_p$ During the Last Deglaciation	Yuntao Bao
10:10	An ESL compatible model of the Younger Dryas	Jesse Velay-Vitow
10:25	Break	
10:40	Ensemble of hosing simulations validated against past changes helps predict future changes in tropical climate	Pedro DiNezio
10:55	One Drought and One Volcanic Eruption Influenced the History of China: The late Ming Dynasty Mega-drought	Kefan Chen
11:10	Land surface feedback drives distinct east-west dynamics in the termination of the Green Sahara	Deepak Chandan
11:25	Water isotopic imprints of Pacific Walker Circulation responses to CO ₂ decline during the late Pliocene	Theodor Mayer
11:40	Mid-Pliocene North American Monsoon in Weather Resolving Coupled Simulations	Mary Grace Albright
11:55	Boundary condition dependency of temperature responses to CO ₂ forcing during the late Pliocene	Ran Feng
12:10	Break	
12:20	PaleoWG CSL proposal discussion & networking	