CESM Paleoclimate Working Group

Highlights of Activities

Esther C. Brady,
NCARCo-Chair, presenter
Arne Winguth, *University of Texas, Arlington,*
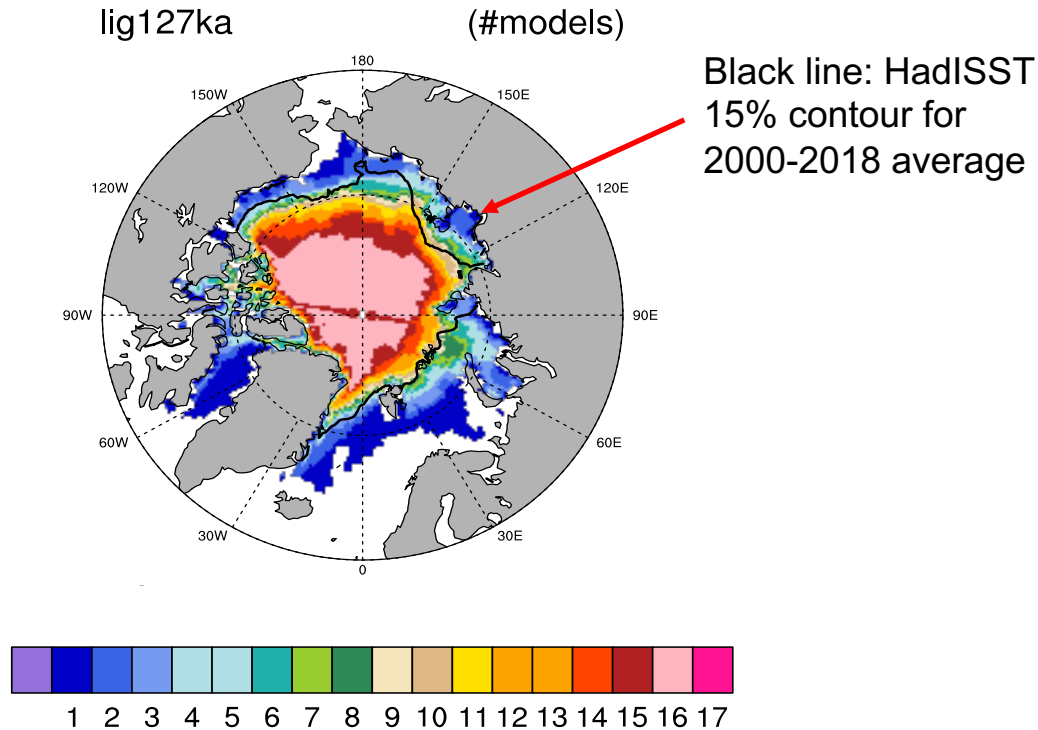*External Co-Chair*

June 15, 2020

→*Otto-Bliesner et al., Paleo&Paleo, submitted, CESM2 Sp. Issue, 2020*

Multi-model ensemble CMIP6/PMIP4
   midHolocene: 12 CMIP6 models
   lig127k: 17 CMIP6 models

Multi-Model Last Interglacial at 127ka
August-September Ave.

lig127ka   (#models)

Black line: HadISST 15% contour for 2000-2018 average

JAS Arctic Sea Ice Area
1pctCO2 vs *lig127k*

# of models with at least 15% sea ice coverage
→*Otto-Bliesner et al., Clim. Past, in review, 2020.*
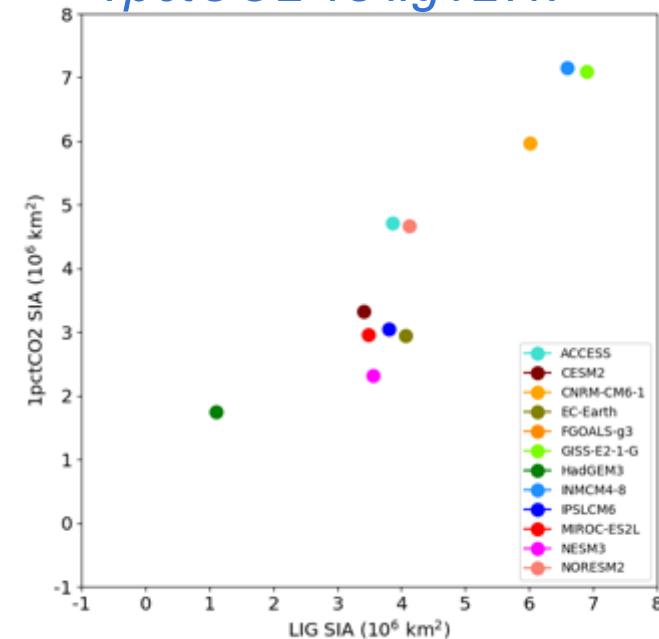
→*Kageyama et al, Clim. Past, in review, 2020*

Pliocene (3.2Myrs ago) CO_2 ~ 400ppm, Retreat of WAIS, GiS, vegetation, orography and bathymetry changes
CESM2(CAM6) FV1x1--One of 5 CMIP6 models that completed (+ CCSM4 and CESM1.2 completed)

→ *Feng, J., B. Otto-Bliesner, E. Brady, and N. Rosenbloom, 2020: Increasing Earth System Sensitivity in Mid-Pliocene simulations from CCSM4 to CESM2, JAMES, CESM2 Sp. Issue, in revision.*

## Moistening of the Africa and Asian monsoon region during the mid-Pliocene
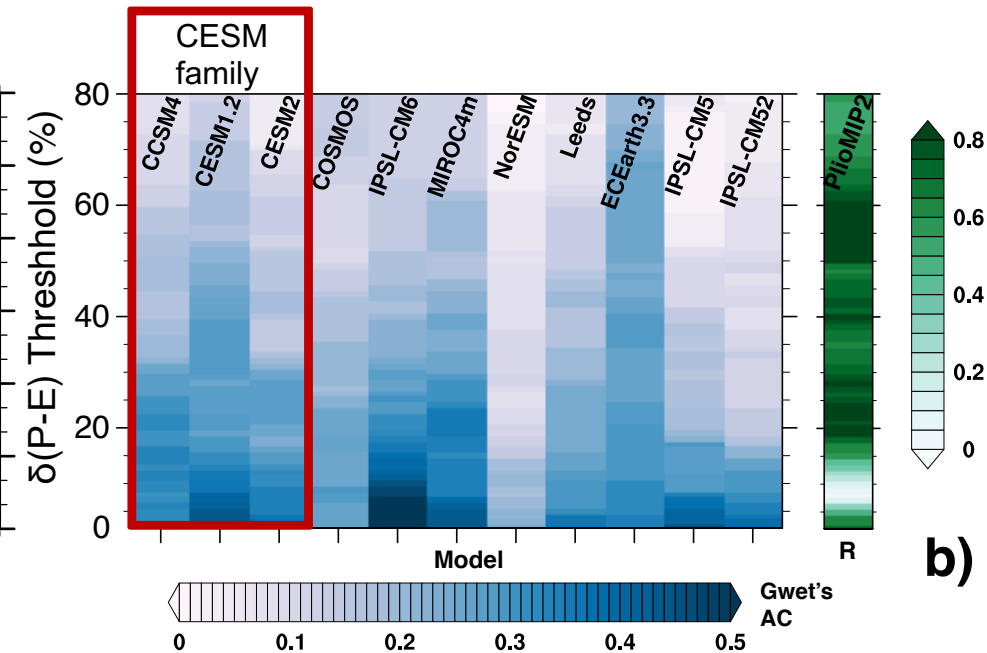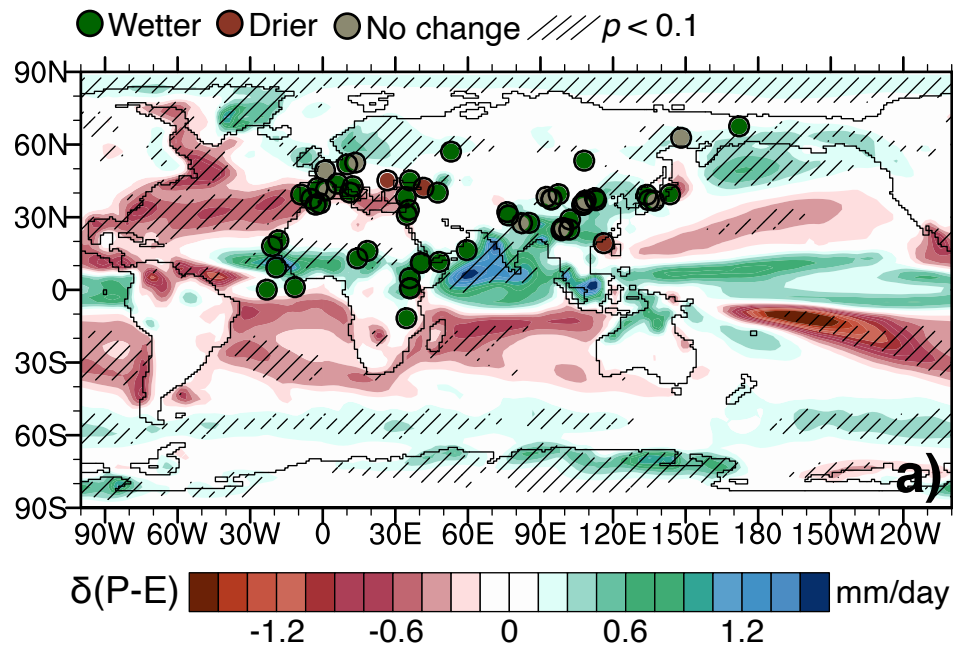
Among three versions of CCSM4, CESM1.2, CESM2, CESM1.2 shows the best pattern correlation with proxy for a wide range of thresholds.

→*R. Feng, Battachaya T., et al, Moist continental climate driven by elevated CO_2, afforestation and loss of Greenland ice sheet during the Pliocene, in prep,2020.*

Past warm climates like the Early Eocene provide unique constraints on the model behaviors under the GHG forcing.
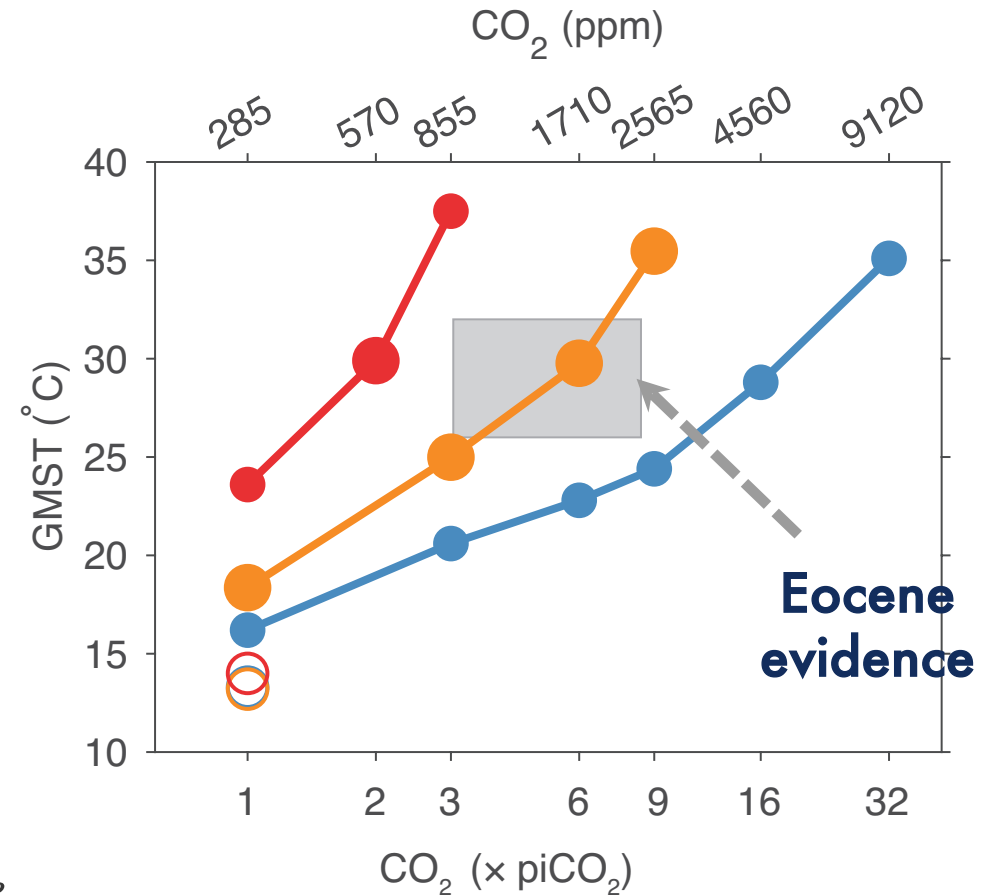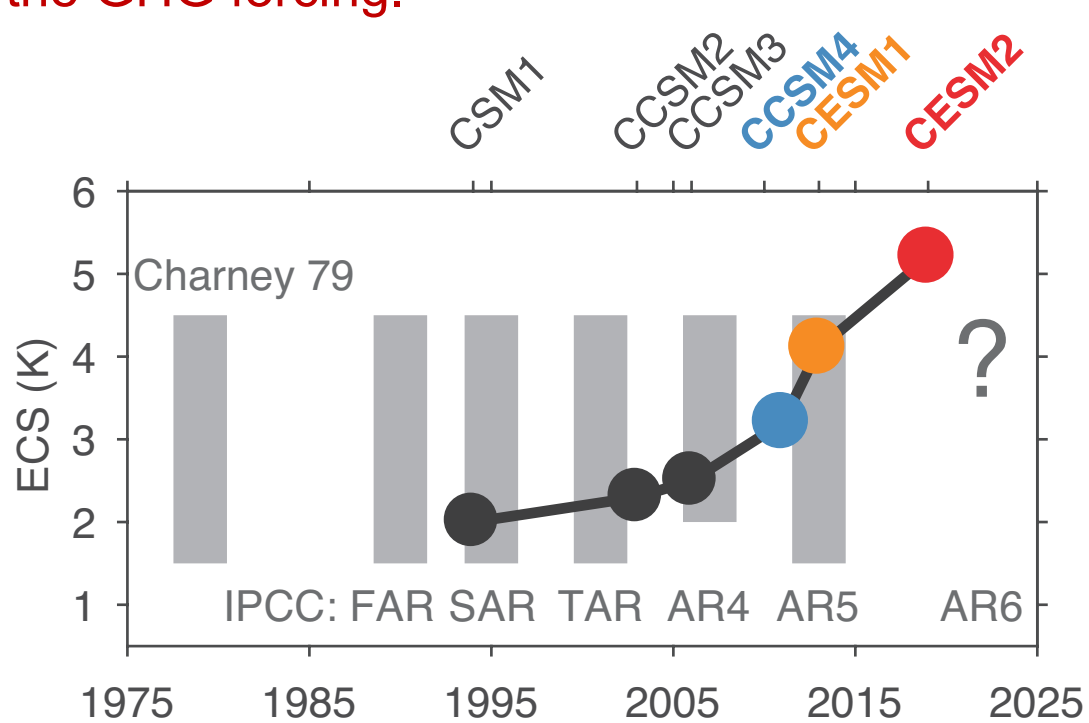
Zhu, Poulsen, & Tierney, 2019, *Science Advances*
Zhu, Poulsen, & Otto-Bliesner, 2020, *Nature Climate Change*

Best model-data match in Eocene simulations using CESM1.2 with CESM2 being too warm and CCSM being too cold.

Paleo + Land Ice WG Collaboration: Greenland Ice Sheet evolution 127 ka → 119 ka

Transient forcing: Orbital & Vegetation forcing

CESM2(CAM6) FV1x1   CISM2: 4km GrIS
Same as for CESM2-CISM2
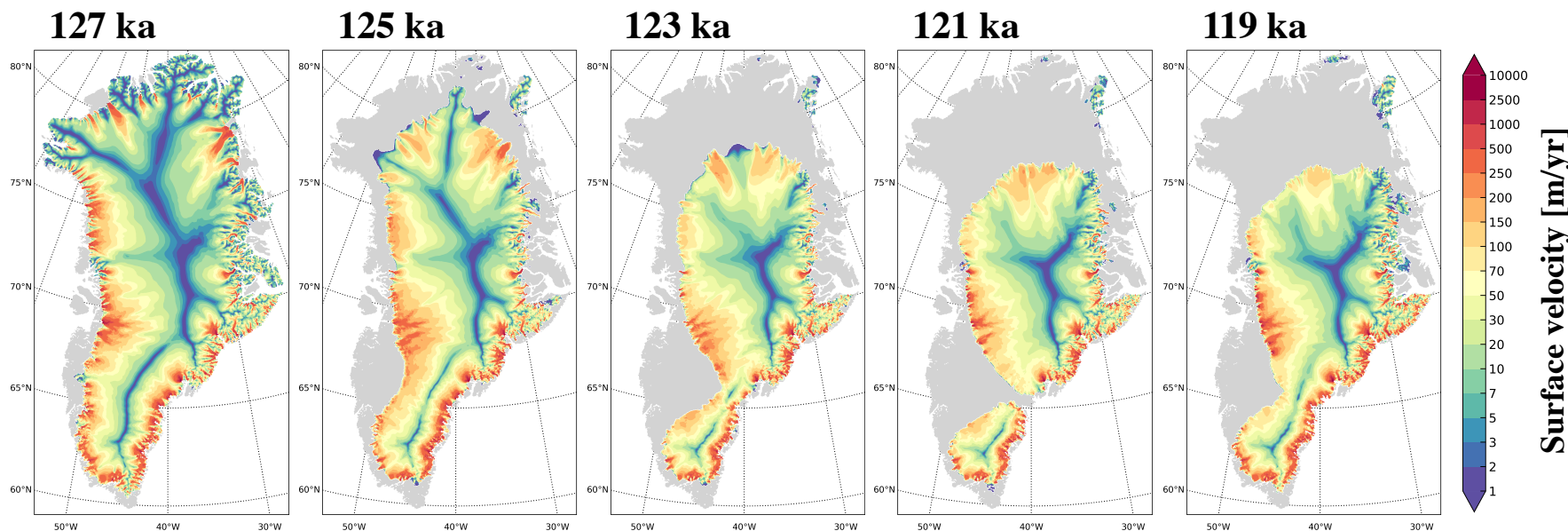 future scenario simulations
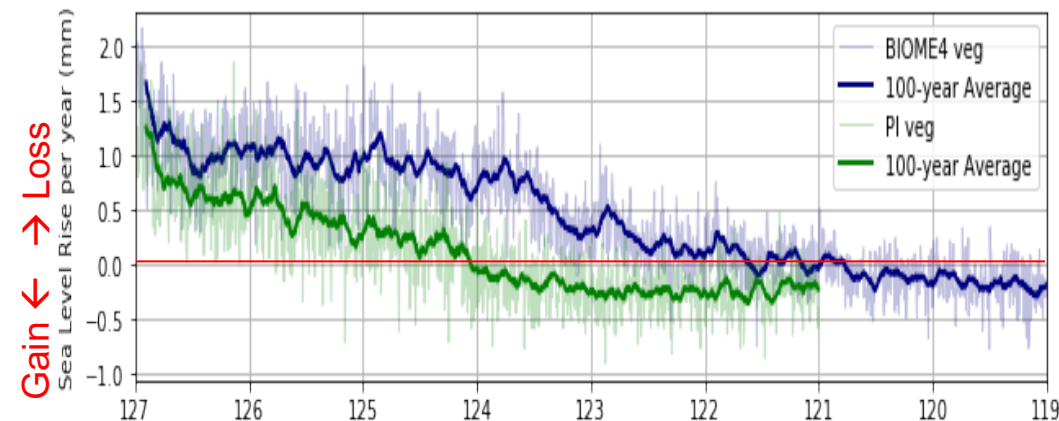
Key Results:

GrIS retreats to a minimum extent at 121 ka, followed by regrowth. GMSLR~4.2m

Good agreement with ice core records

Vegetation distribution has a strong influence on ice sheet behavior.

Sommers, et al., in prep.

Cross-Working Group Projects –On Going

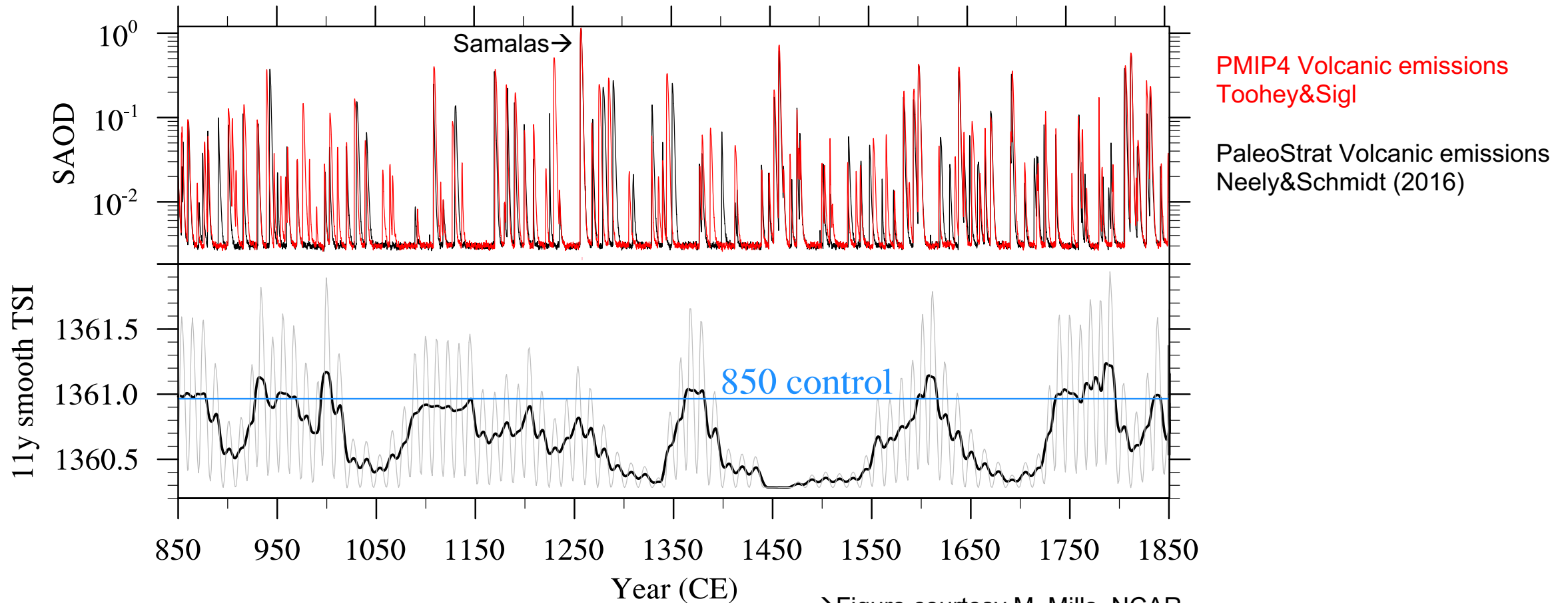1) CMIP6 Tier 1 *past1000*
   CESM2-WACCM6ma FV2x1
   Ensemble with 2 different volcanic emissions
   + Solar variability, LULC, GHG, Orbital

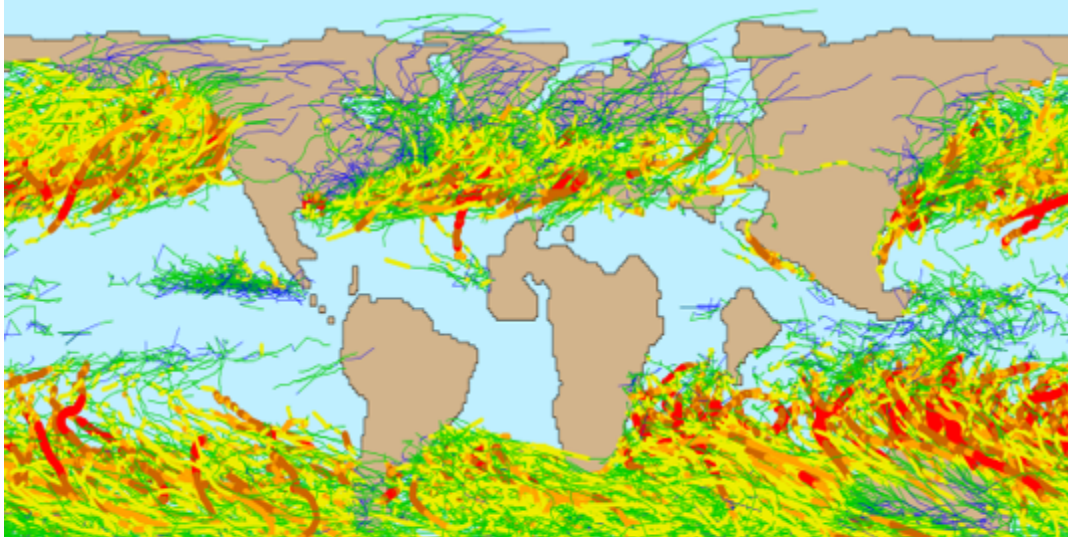2) Transient Holocene (6050BCE to 850CE)
   CESM2(CAM6-Chem) FV2x1
   Also volcanic emissions, solar variability,
   LULC, GHG, Orbital

PMIP4 Volcanic emissions
Toohey&Sigl

PaleoStrat Volcanic emissions
Neely&Schmidt (2016)

→Figure courtesy M. Mills, NCAR

NCAR Deep Time Activities (HSF Projects)

PETM (~56Ma) Tropical Cyclone Track (FV0.25 CAM5)

The lack of TC in the subtropical bands can be linked to the increased wind shear, figure courtesy of C. Zarzycki.

- ❏ *Intensification of the hydrologic cycle along the North Atlantic during the PETM: A data /model comparison (Rush et al., in prep).*
- ❏ *Extreme weather in the PETM (Kiehl et al, in prep).*
- ❏ *Moisture transport in the PETM through atmospheric rivers, Shields et al, in prep).*
- ❏ *Global change in continental climate during the Paleocene- Eocene Thermal Maximum: a view through the window of terrestrial palynology, Koradis et al, in prep).*

Transient Climate through the last Deglacial (iCESM1.2)
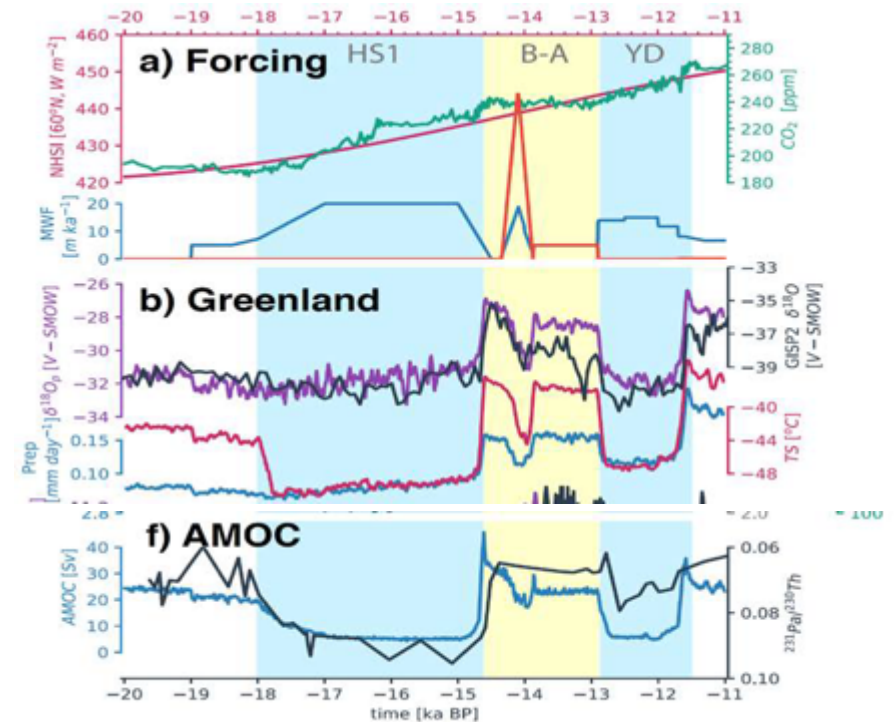
- ❏ *Hydroclimate Footprint Accompanying Pan-Asian Monsoon Water Isotope Evolution during the Last Deglaciation, C. He, Liu, Z. et al, submitted to Science, 2020.*

Paleo Tools and Documentation are stored on Github and can be found through Paleo Working Group "Resources" link.

https://github.com/CESM-Development/paleoToolkit/wiki/Paleoclimate-Resources-for-CESM

Output from many of our CESM paleoclimate simulations is available (or soon will be) On the CMIP6 ESGF or NCAR CDG.

For more CESM Paleoclimate science talks, discussion, and lunch chats:

Joint Session: Polar, Land Ice and Paleoclimate Working Groups

Wednesday, June 17, 2020 830-1230