



Stable Water Isotopes in the CESM Ocean: Toward Improved Model-Paleodata Comparisons

Esther Brady with Jiang Zhu (UW-Madison)

A Collaborative Proposal: Development of an Isotope-Enabled CESM

PIs: Bette Otto-Bliesner and Zhengyu Liu

Co-PIs: S. Peacock, M. Vertenstein, A. Gettelman

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CAM5

D. Noone
C. Bardeen
A. Gettelman
J. Nusbaumer

CLM4

W. Riley
C. Koven
T. Wong
J. Tang
F. Joos
A. Bozbiyik

CPL7

M.
Vertenstein

CICE

D. Bailey
A. Jahn

POP2

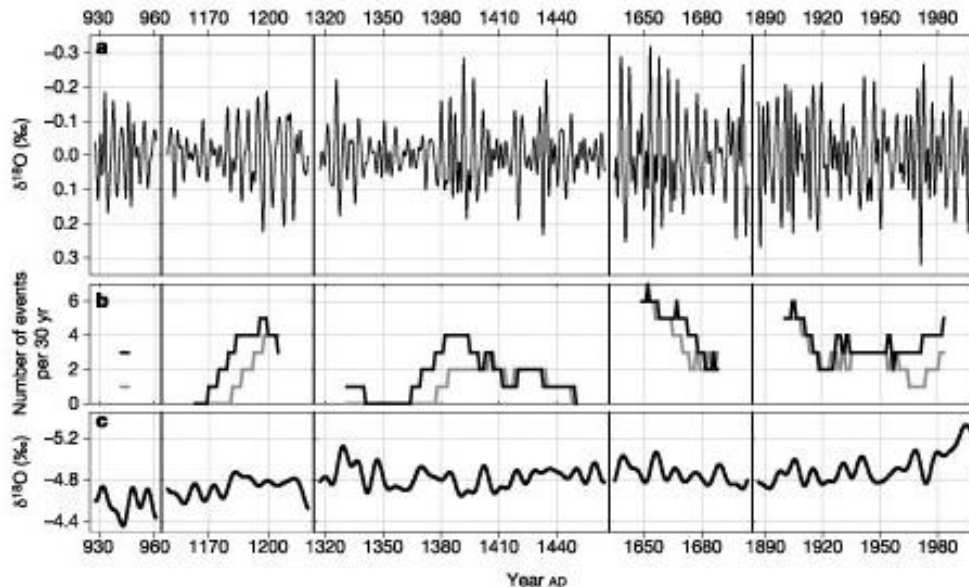
J. Zhang
E. Brady
K. Lindsay
S. Peacock
A. Jahn

RTM

J. Zhu
F. Joos

Objective: Include isotopic water tracers in all aspects of the CESM's hydrologic cycle.

- + To allow more direct Paleodata-Model comparisons for model assessment,
- + To be able to investigate the links between climate variations and isotope tracer responses which underpin paleodata interpretations,
- + To better elucidate the processes underlying changes in the hydrologic cycle induced by past climate change.



**Last millennium ENSO and
Tropical Pacific Climate
Reconstruction
(Cobb et al. Nature, 2003)**

Palmyra Fossil Coral $\delta^{18}\text{O}$
(6N, 162W)

Recent Progress →

Coupled SWI Simulations: H_2^{16}O , H_2^{18}O , HDO

Pre-industrial simulations

CESM1.2: +SWI tracers in CAM5.3 and POP2

- 1) “FV19_gx1v6” ~300 years
- 2) “FV45_gx3v7” ~400 years

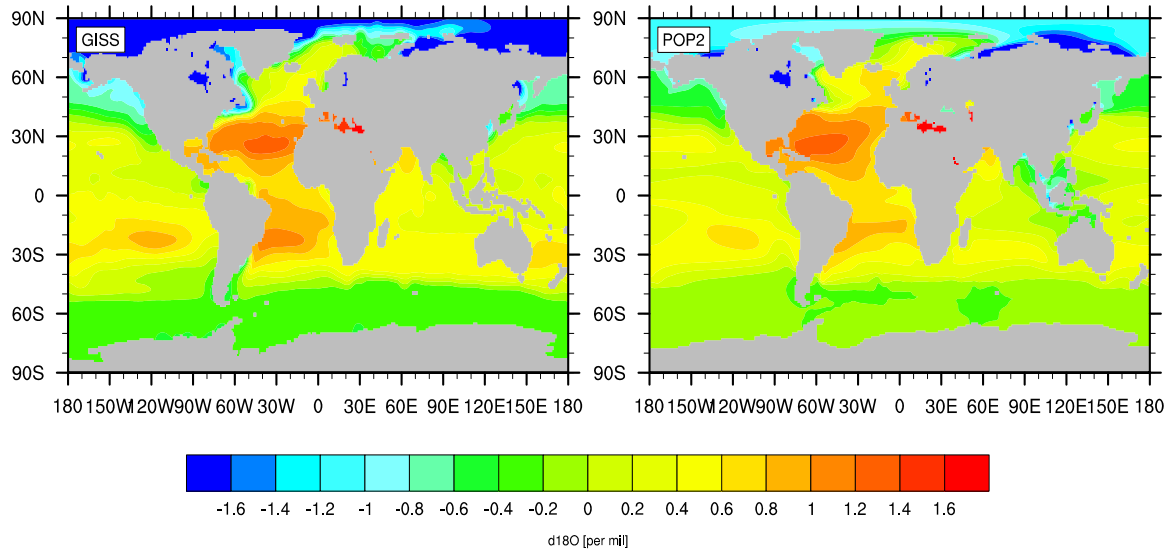
FV45_gx3v7 ~ 1/6 cost of FV19_g1v6 (pe-hrs/myr)

Simple bucket models for iso-evaporation over land, and sea-ice
Iso-runoff to POP2 has same delta as local Precip.,
No fractionation due to sea-ice formation.

Preliminary results for $\delta^{18}\text{O}_w$

Surface (5m)

Surface $\delta^{18}\text{O}(\text{o}/\text{o})$ FV2_gx1_290-298



300 year CESM1.2 spin-up;

iPOP2 + iCAM5.3
FV19_gx1v6

Biases:

High Latitude too enriched →
No seaice processes
Insufficient depletion in High
Latitude Precipitation

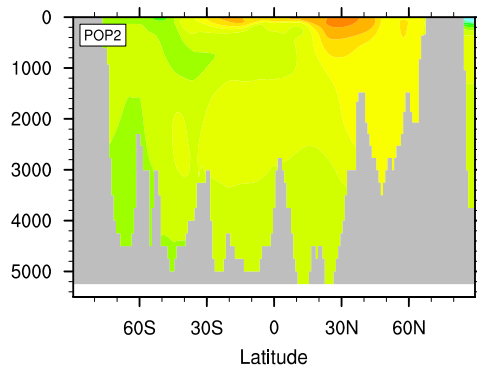
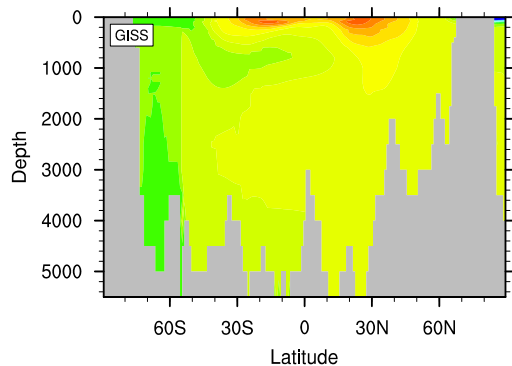
NASA-GISS
Global Seawater ^{18}O Database
(LeGrande and Schmidt, 2006)

Ave: Yrs 290-298

Preliminary Coupled POP2 results for $\delta^{18}\text{O}_w$

Atlantic

Atlantic along 30.5 W, $\delta^{18}\text{O}(\text{o}/\text{o})$ FV2_gx1_290-298



300 year CESM1.2 spin-up;

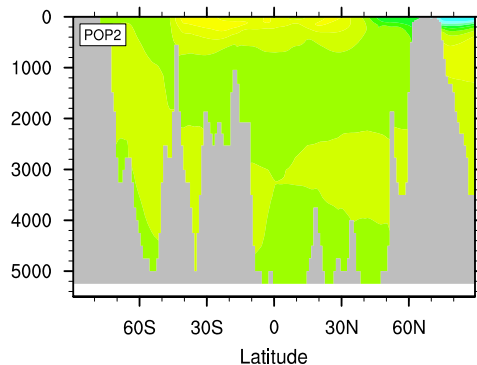
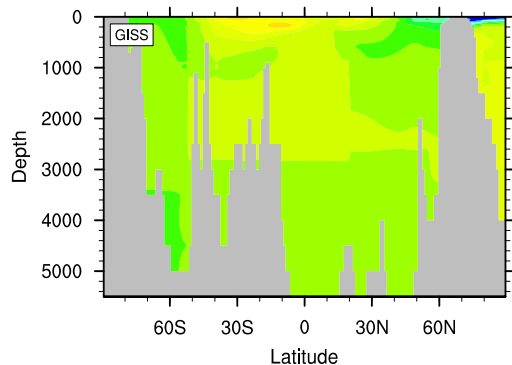
iPOP2 +iCAM5.3 (FV2_gx1v6)

Biases:

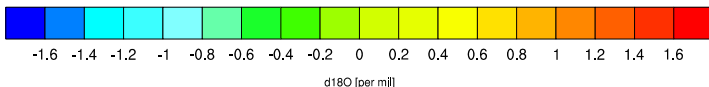
Too depleted Deep Ocean → spin-up not at equilibrium.

Pacific

Pacific along 179.5 W, $\delta^{18}\text{O}(\text{o}/\text{o})$ FV2_gx1_290-298



Too enriched deep SH → Precipitation not sufficiently depleted in high latitudes.



NASA-GISS

Global Seawater ^{18}O Database
(LeGrande and Schmidt, 2006)

Towards Improved Model-Paleodata Comparisons

→ Tropical Variability

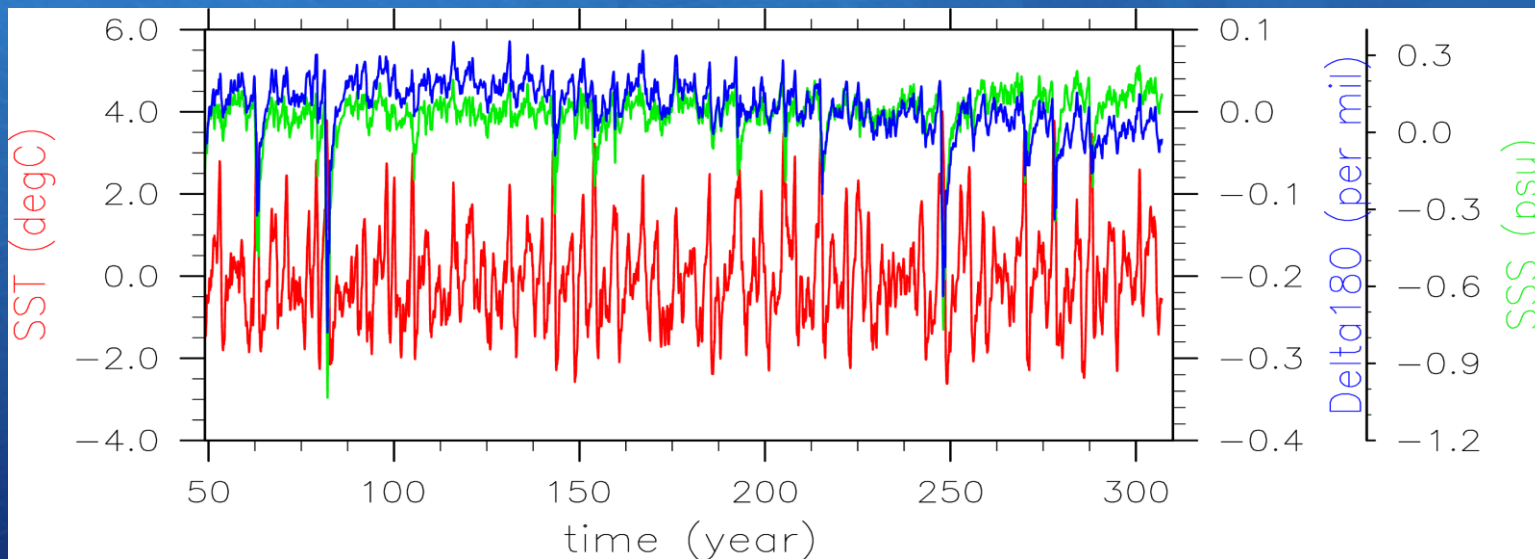
e.g. Corals: $\delta^{18}\text{O}_c = R(\text{SST} - C) + \delta^{18}\text{O}_{\text{sw}}$

$R \sim -0.22 \text{ } ^\circ / \text{oo} / ^\circ \text{ C}$ (Grotoli and Eakin, 2007)

$\delta^{18}\text{O}_{\text{sw}} \sim f(\text{SSS})$ (Craig and Gordon, 1965; Fairbanks, et al. 1992)

Nino3.4 Anomalies

(mean monthly ann. cycle removed)



Some large warm events are associated with large negative $\delta^{18}\text{O}_{\text{w}}$ and SSS anomalies.

Outlook...

Near term:

Finish up iCAM5+ and iPOP2, merge with trunk.

Finish CLM4 (T. Wong, CU) and test coupled.

Test, and couple CICE4 (D. Bailey, A. Jahn)

Implement in RTM (J. Zhu, UWisc.)

Long Term:

Transient Coupled Simulations—(w/Carbon isotopes)

- 20th Century

- Last Millennium

- Holocene

- Deglacial