Preliminary Results from Isotope-enabled CAM3 Simulations of the Last Deglaciation*

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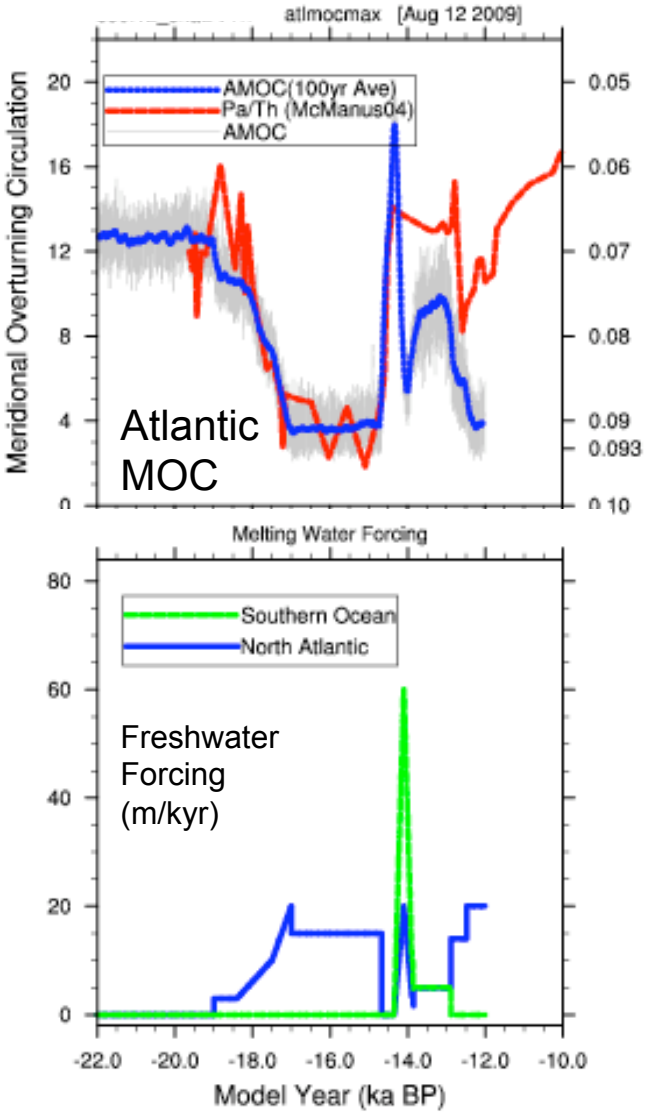
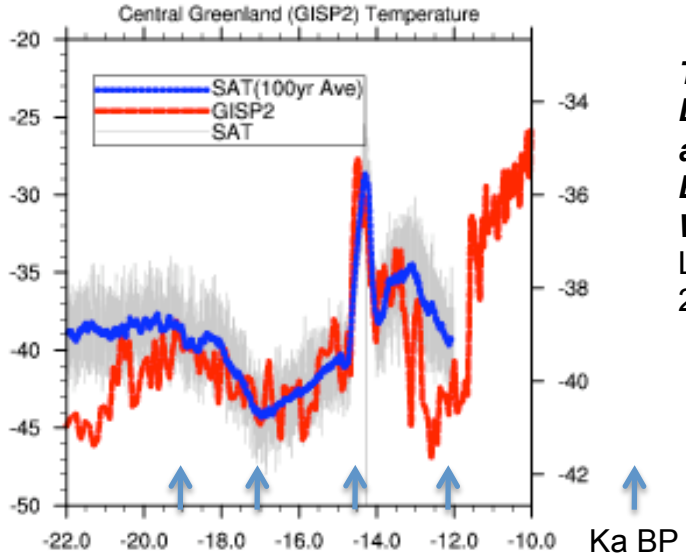
With thanks to
David Noone (CU, IsoCAM3 developer) and David Schneider (CU, NCAR)

*Transient Climate Evolution simulations of the Last Deglaciation accomplished with support from the DOE

NCAR is sponsored by the National Science Foundation

CCSM3 Central Greenland TS vs. GISP2 $\delta^{18}O$





19ka H1 B-A YD PI (control)

Transient Simulation of Last Deglaciation with a New Mechanism for Bølling-Allerød Warming,
Liu et al., Science 325, 2009.

Objective: compare spatial and temporal T-$\delta^{18}O$ relationship over Greenland for different climate states during the Last Deglaciation as simulated by CCSM3 and isoCAM3.

Set-Up for IsoCAM3 'Time Slice' Simulations for Last Deglaciation

Use CCSM3 Fully coupled (Atm+SeaIce+Ocn+Lnd+DGVM) TraCE simulations to force water isotope enabled CAM3 standalone model (Noone.) $H_2{}^{16}O$, HDO, $H_2{}^{18}O$, $H_2{}^{17}O$, HTO

Inputs to isoCAM3:

BC: Orography, land surface

Fixed GHG, orbital parameters, S_o, taken from transient TraCE Simulations

Forcing: monthly TS and ocn, ice fractions from CCSM3 TraCE simulations

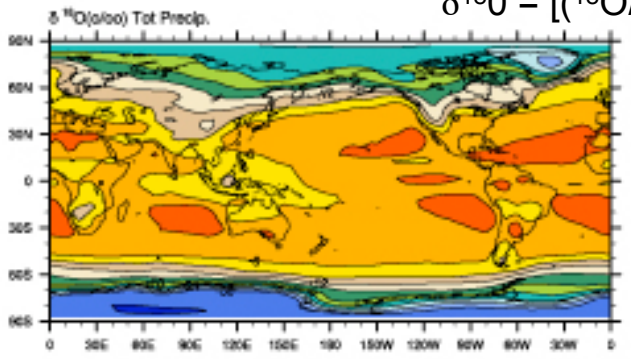
Run IsoCAM3 50 Years, --analyze 30 years following a spin-up period

Time Slices:

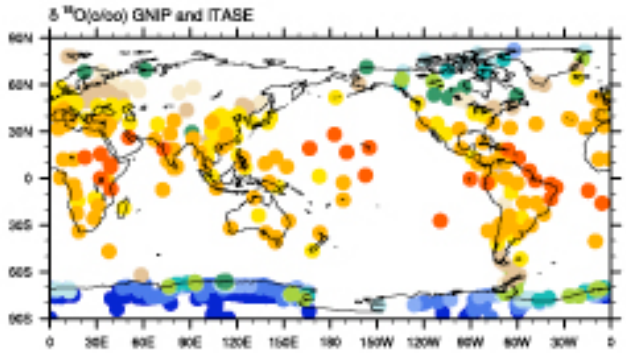
Preindustrial	(PI)	$d^{18}O_{sw}$ = 0.5°/oo	Control	TOPO=PD
Younger Dryas	(YD)	$d^{18}O_{sw}$ = 0.84°/oo	12.1ka	ICE5G@12.5
Bolling-Allerod	(BA)	$d^{18}O_{sw}$ = 1.25°/oo	14.5ka	ICE5G@15.0
Heinrich Event 1	(H1)	$d^{18}O_{sw}$ = 1.57°/oo	17ka	ICE5G@17.0
19ka	(LGM)	$d^{18}O_{sw}$ = 1.7°/oo (Lee et al. 2008)	19ka	ICE5G@21ka

$\delta^{18}0 = [(^{18}O/^{16}O)/(^{18}O/^{16}O)_{SMOW} - 1.0]*1000^{o}/_{oo}$

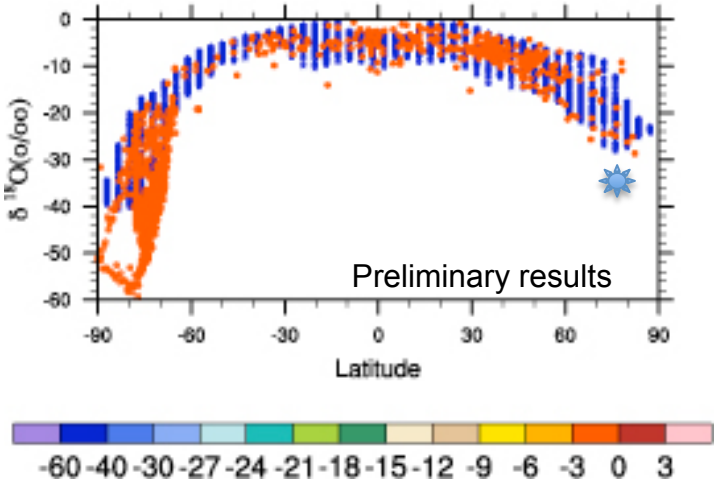
Preindustrial Simulated Annual $\delta^{18}O_{ppt}$



Present Day Observed $\delta^{18}O_{ppt}$
GNIP + Masson-Delmotte et al. (2008)



Negative $\delta^{18}O$ indicates PPT is depleted of heavier isotopes relative to standard.



GISP2 (Modern)

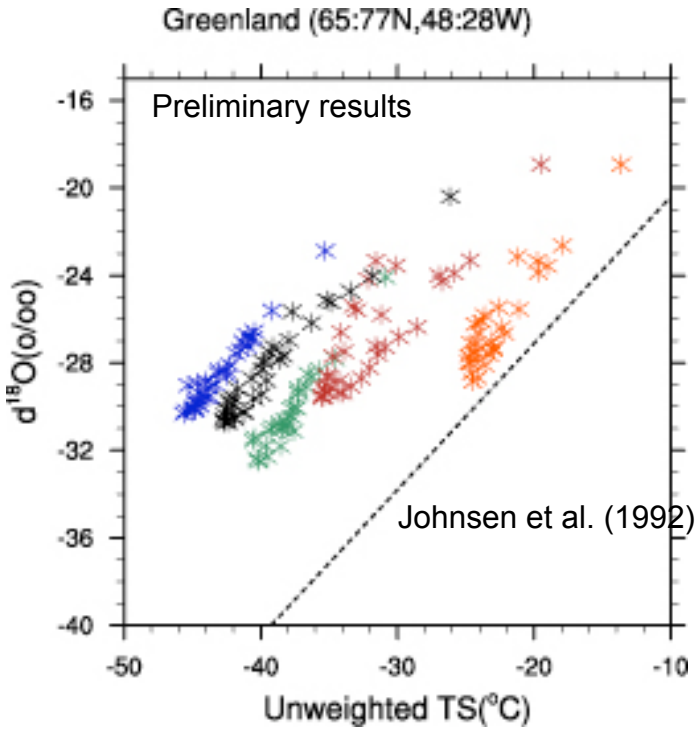
Model

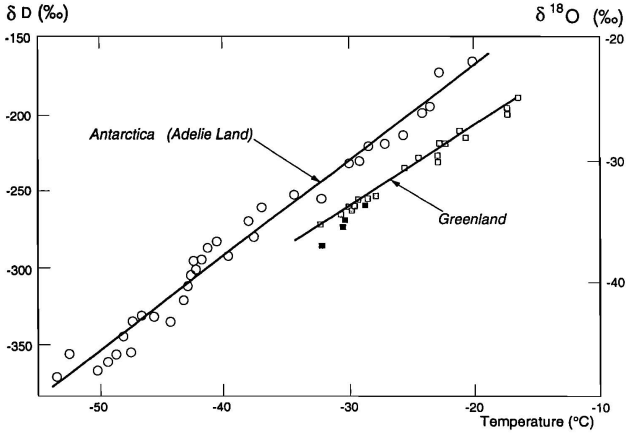
Observations

$\delta^{18}O_{ppt}$ vs. TS Spatial Relationship over Greenland

PD (OBS) $\delta^{18}O = 0.67\ T - 13.7^{o}/_{oo}$ (Johnsen et al. 1992)

PI
YD
BA
H1
LGM





From Jouzel et al. (1997)
Greenland $\delta^{18}O$ data from Johnsen et al. 1989.

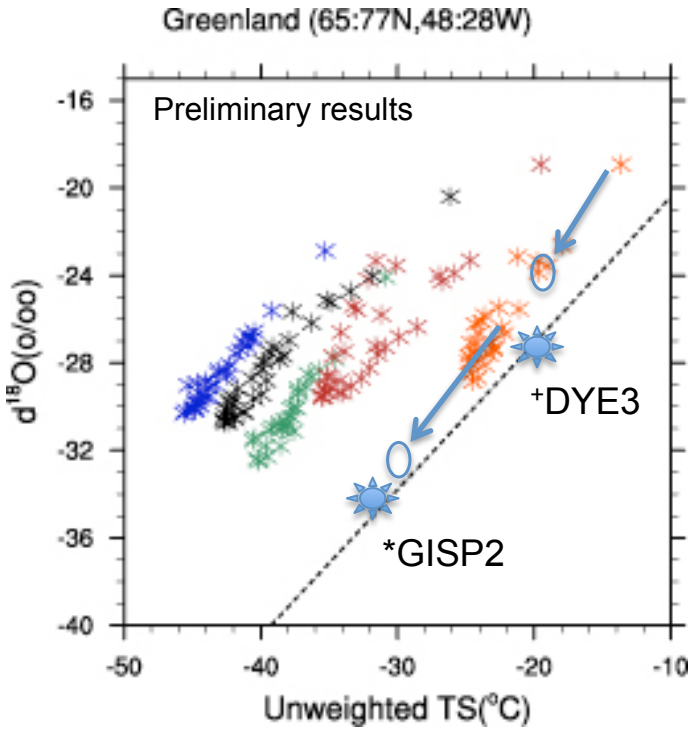
δ^{18}Oppt vs. T Spatial Relationship over Greenland

Greenland IceCore Comparison…

*Carrie Morrill, pers. comm.
+Johnsen et al. 1992.

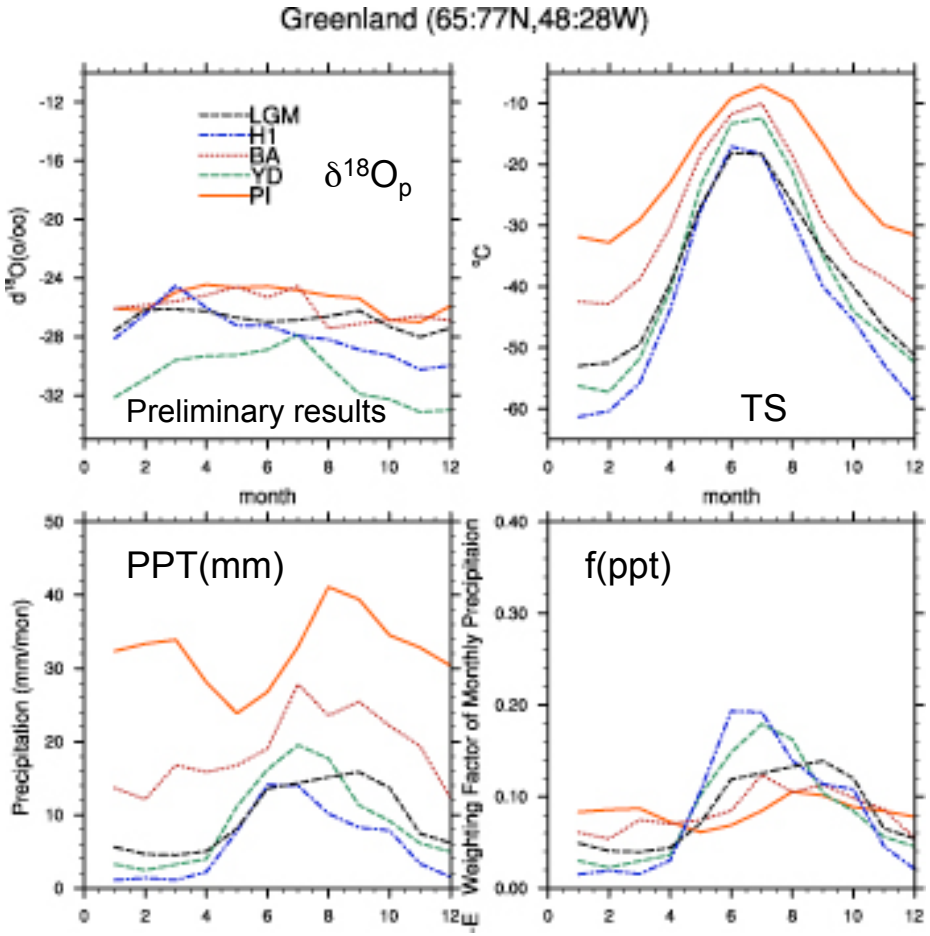
Correct for elevation bias using lapse rate: -6.5°C/1000m to correct T bias, then use spatial T - $d^{18}O$ slope to correct for $d^{18}O$.

~1150m -> -7.5°C -> -5 to -6.5 °/oo



With elevation correction, closer to ice core values, but retain small positive biases of 0-2°C and 2-4°/oo

Is there a shift in the seasonal distribution of PPT?



Cold climates (Hosing and LGM)
• have larger annual cycle of TS due to greater expansion of winter sea ice.

•show more seasonality in PPT with greater summer PPT and hence could bias $\delta^{18}O$ toward less depletion.

•show weaker $\delta^{18}O$ seasonality than Jouzel et al. (1994).

Summary of Preliminary Results

We have simulated water isotope distributions using David Noone's water isotope enabled version of CAM3 for 5 climate states during the last 19,000 years BP.

These preliminary results suggest isoCAM3 has positive biases of $\delta^{18}O$ and surface T than observations over Central Greenland. These may be related to the lower elevations of T31-resolved high latitude ice sheets.

Spatial Temperature – $\delta^{18}O$ relationship is strong over Greenland with slightly different slopes and intercepts for different climate regimes.

Temporal Temperature – $\delta^{18}O$ relationship over Central Greenland varies with time but is generally comparable to the temporal slope determined by Cuffey and Clow (1997).

NCAR is sponsored by the National Science Foundation