Project Update: Developing Isotopic Tracers in CESM

Esther Brady (NCAR)

A Collaborative Proposal: Development of an Isotope-Enabled CESM. . .

Objective: To enhance the CESM with the capability of simulating key isotopes and geotracers, including $\delta^{18}O$, δD, Pa/Th, $\delta^{14}C$, and $\delta^{13}C$.

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Funded by DOE (SciDAC BER ESM)

CAM5
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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

POP2
J. Zhang,
E. Brady,
K. Lindsay,
S. Peacock,
A. Jahn

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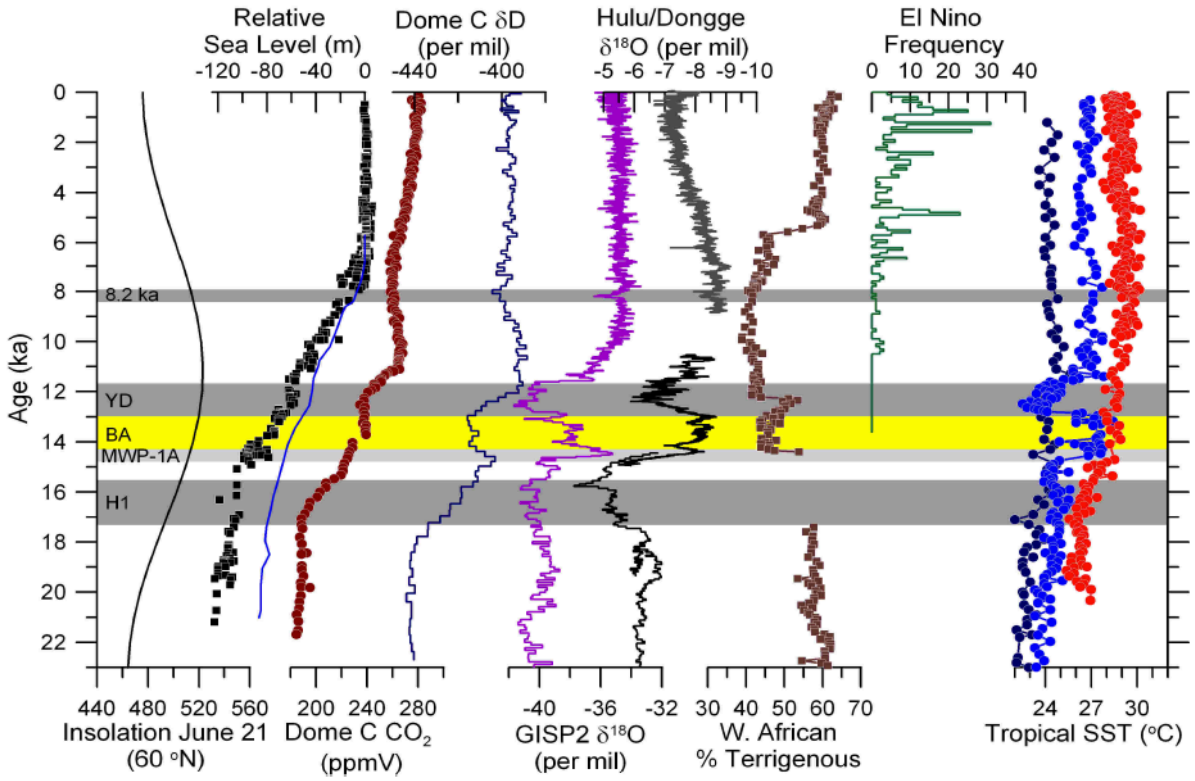
Motivation



Climate proxies:

($\delta^{18}O$, δD, Pa/Th, etc.) are used to infer climate change signals like ΔT, $\Delta precip$, and Circulation changes.

1. Water Isotope Tracers

H_2O, $H_2{}^{18}O$, HDO ---> $\delta^{18}O$, δD, d (deuterium excess)

POP2 (NCAR, U. Wisc)

J. Zhang, E. Brady, K. Lindsay, B. Otto-Bliesner, Z. Liu

CAM5 (CU, NCAR)

D. Noone, A. Gettelman,

J. Nusbaumer, C. Bardeen

CLM4 (CU, LBL)

B. Riley, J. Tang, T. Wong

CICE (NCAR)

D. Bailey

2. Carbon Isotopes: ^{13}C, ^{14}C

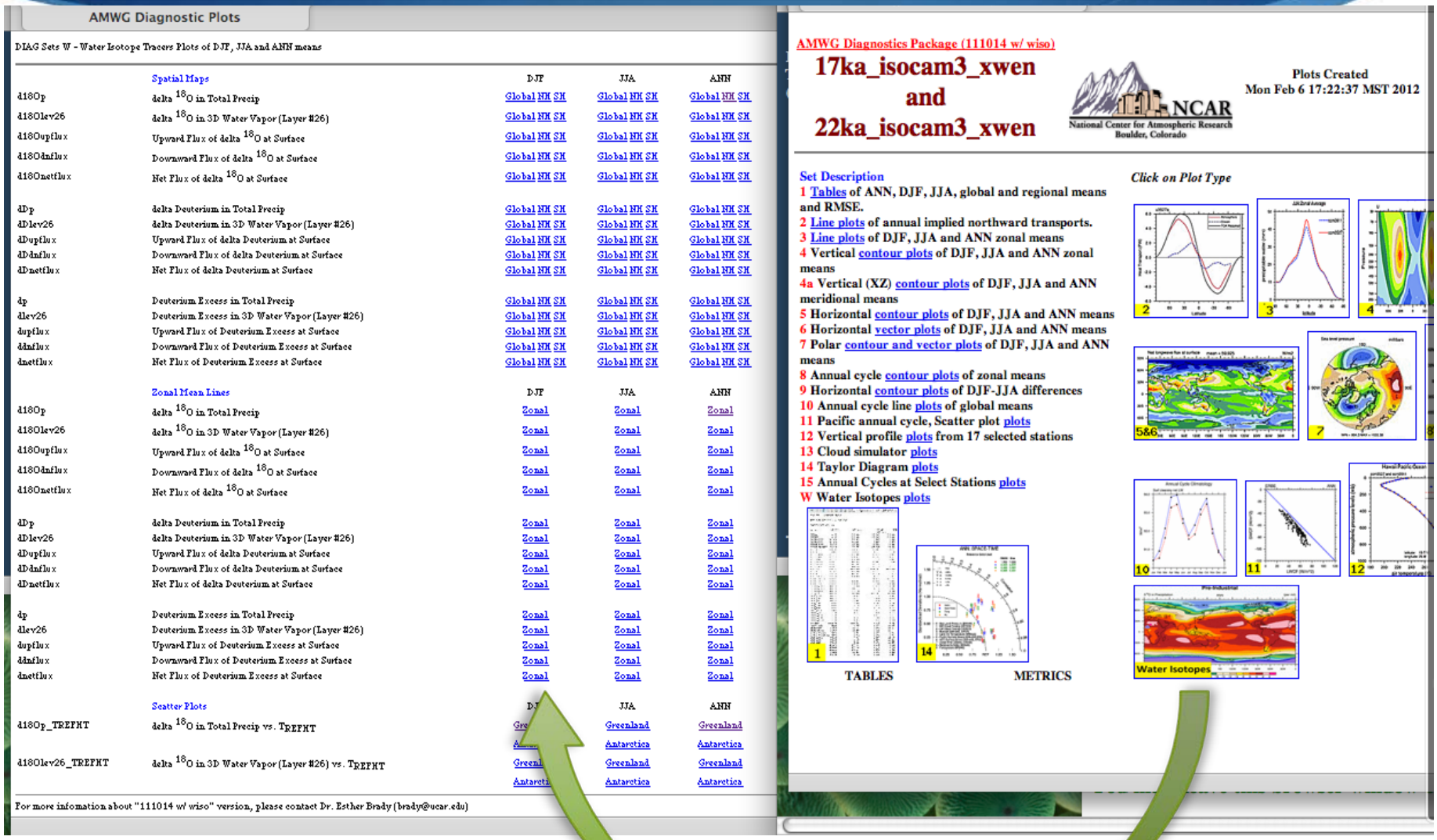
POP2:

A. Jahn, K. Lindsay, S. Peacock (NCAR)
Radiocarbon tracer (14C) as in abiotic OCMIP2 protocols
13C tracer to be built on previous POP1 implementation

CLM4:

F. Joos, A. Bozbiyik (U. Bern)
B. Riley, C. Koven, J. Tang (LBNL)

Extending the AMWG diagnostics



AMWG Diagnostic Plots

DIAG Sets W - Water Isotope Tracers Plots of DJF, JJA and ANN means

	Spatial Maps	DJF	JJA	ANN
d18Op	delta ^{18}O in Total Precip	Global NH SH	Global NH SH	Global NH SH
d18Olev26	delta ^{18}O in 3D Water Vapor (Layer #26)	Global NH SH	Global NH SH	Global NH SH
d18Oupflux	Upward Flux of delta ^{18}O at Surface	Global NH SH	Global NH SH	Global NH SH
d18Odnflux	Downward Flux of delta ^{18}O at Surface	Global NH SH	Global NH SH	Global NH SH
d18Onetflux	Net Flux of delta ^{18}O at Surface	Global NH SH	Global NH SH	Global NH SH
dDp	delta Deuterium in Total Precip	Global NH SH	Global NH SH	Global NH SH
dDlev26	delta Deuterium in 3D Water Vapor (Layer #26)	Global NH SH	Global NH SH	Global NH SH
dDupflux	Upward Flux of delta Deuterium at Surface	Global NH SH	Global NH SH	Global NH SH
dDdnflux	Downward Flux of delta Deuterium at Surface	Global NH SH	Global NH SH	Global NH SH
dDnetflux	Net Flux of delta Deuterium at Surface	Global NH SH	Global NH SH	Global NH SH
dp	Deuterium Excess in Total Precip	Global NH SH	Global NH SH	Global NH SH
dlev26	Deuterium Excess in 3D Water Vapor (Layer #26)	Global NH SH	Global NH SH	Global NH SH
dupflux	Upward Flux of Deuterium Excess at Surface	Global NH SH	Global NH SH	Global NH SH
ddnflux	Downward Flux of Deuterium Excess at Surface	Global NH SH	Global NH SH	Global NH SH
dnetflux	Net Flux of Deuterium Excess at Surface	Global NH SH	Global NH SH	Global NH SH
	Zonal Mean Lines	DJF	JJA	ANN
d18Op	delta ^{18}O in Total Precip	Zonal	Zonal	Zonal
d18Olev26	delta ^{18}O in 3D Water Vapor (Layer #26)	Zonal	Zonal	Zonal
d18Oupflux	Upward Flux of delta ^{18}O at Surface	Zonal	Zonal	Zonal
d18Odnflux	Downward Flux of delta ^{18}O at Surface	Zonal	Zonal	Zonal
d18Onetflux	Net Flux of delta ^{18}O at Surface	Zonal	Zonal	Zonal
dDp	delta Deuterium in Total Precip	Zonal	Zonal	Zonal
dDlev26	delta Deuterium in 3D Water Vapor (Layer #26)	Zonal	Zonal	Zonal
dDupflux	Upward Flux of delta Deuterium at Surface	Zonal	Zonal	Zonal
dDdnflux	Downward Flux of delta Deuterium at Surface	Zonal	Zonal	Zonal
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ddnflux	Downward Flux of Deuterium Excess at Surface	Zonal	Zonal	Zonal
dnetflux	Net Flux of Deuterium Excess at Surface	Zonal	Zonal	Zonal
	Scatter Plots	DJ	JJA	ANN
d18Op_TREFHT	delta ^{18}O in Total Precip vs. TREFHT	Gre...	Greenland	Greenland
		A...	Antarctica	Antarctica
d18Olev26_TREFHT	delta ^{18}O in 3D Water Vapor (Layer #26) vs. TREFHT	Greenl...	Greenland	Greenland
		Antarcti...	Antarctica	Antarctica

For more infomation about "111014 w/ wiso" version, please contact Dr. Esther Brady (brady@ucar.edu)

AMWG Diagnostics Package (111014 w/ wiso)

17ka_isocam3_xwen and 22ka_isocam3_xwen

NCAR National Center for Atmospheric Research Boulder, Colorado

Plots Created Mon Feb 6 17:22:37 MST 2012

Set Description

1 Tables of ANN, DJF, JJA, global and regional means and RMSE.
2 Line plots of annual implied northward transports.
3 Line plots of DJF, JJA and ANN zonal means
4 Vertical contour plots of DJF, JJA and ANN zonal means
4a Vertical (XZ) contour plots of DJF, JJA and ANN meridional means
5 Horizontal contour plots of DJF, JJA and ANN means
6 Horizontal vector plots of DJF, JJA and ANN means
7 Polar contour and vector plots of DJF, JJA and ANN means
8 Annual cycle contour plots of zonal means
9 Horizontal contour plots of DJF-JJA differences
10 Annual cycle line plots of global means
11 Pacific annual cycle, Scatter plot plots
12 Vertical profile plots from 17 selected stations
13 Cloud simulator plots
14 Taylor Diagram plots
15 Annual Cycles at Select Stations plots
W Water Isotopes plots

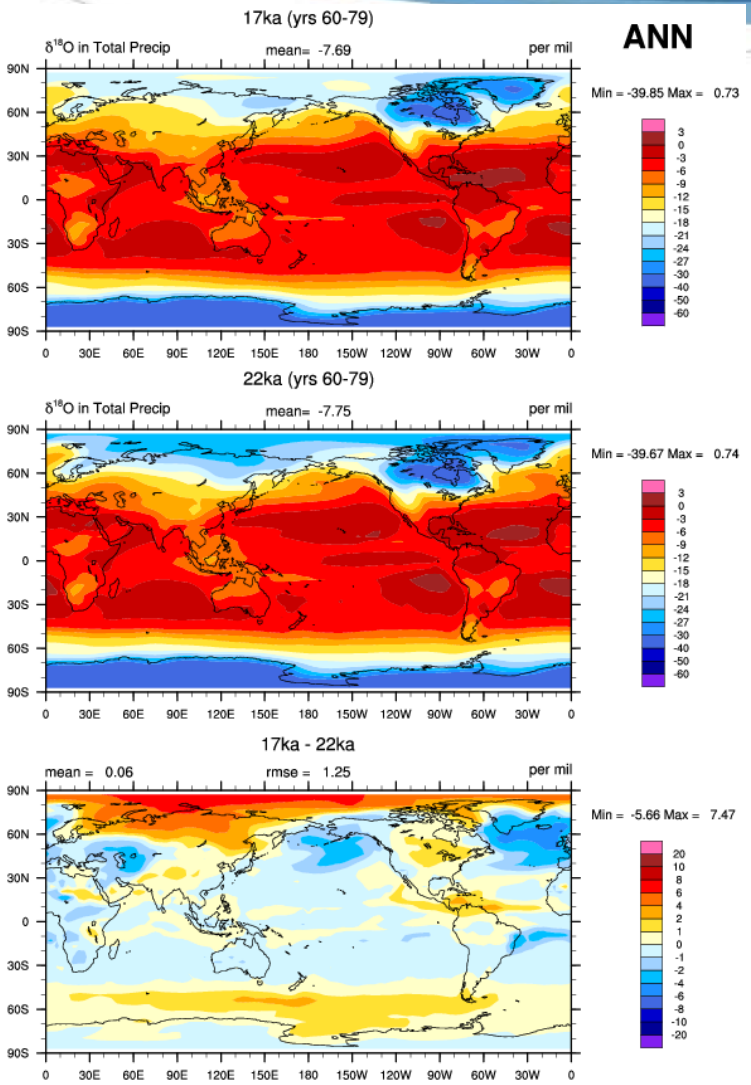
TABLES METRICS

Click on Plot Type

Water Isotopes

E. Brady and X. Wen (Z. Liu, U. Wisc.)

Extending the AMWG diagnostics



Example: d18O in Total Precipitation

Next Steps

Water Isotopes

- Complete separate development of water isotope tracers in components.
- Add CPL7 MCT infrastructure for coupling to data models as a first step toward the full coupling process

Carbon Isotopes

- Continue development of Carbon isotope tracers in POP2
- ^{14}C tracer is good candidate for testing fast Newton-Krylov spin-up technique (K. Lindsay).
- Integrate efforts between U. Bern and LBL on CLM4 carbon isotopes.

Status and Timeline …

- Collaborative Proposal started Sept. 2011
- Water Isotope Tracer development in CAM5, CLM4 and POP2 underway in separate configurations, not yet fully coupled.
  - Progress updates today with next few talks
- Carbon Isotope Tracers
  - Continue development in CLM4;
  - Continue testing radiocarbon in POP2
  - Develop 13C tracer in POP2 based on POP1 implementation.
- Other Ocean Circulation tracers (ex. Pa/Th) intended for Year 3