Update on Isotopic Tracer Development in the CESM

Esther Brady (NCAR)

Outline

- Project Description
- Update on Stable Water Isotopes in POP2+DATM
- Next Steps
- Timeline

A Collaborative Proposal: Development of an Isotope-Enabled CESM for Testing Abrupt Climate Change

PIs: Bette Otto-Bliesner and Zhengyu Liu

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

U.S. DEPARTMENT OF ENERGY | Office of Science

^{14}C, ^{13}C Tracers

$H_2{}^{18}O$, HDO Tracers

CAM5
D. Noone,
C. Bardeen,
A. Gettelman,
J. Nusbaumer

CLM4
W. Riley, J. Tang
C. Koven,
T. Wong,
F. Joos,
A. Bozbiyik

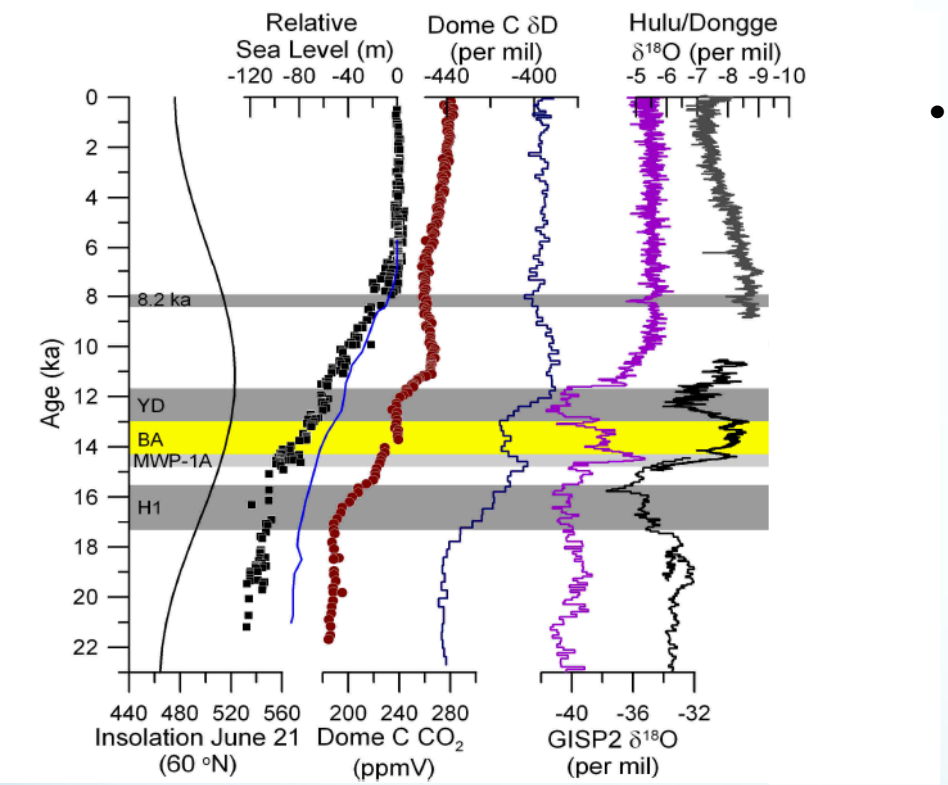
CPL7
M. Vertenstein

CICE
D. Bailey

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

Project Objectives:

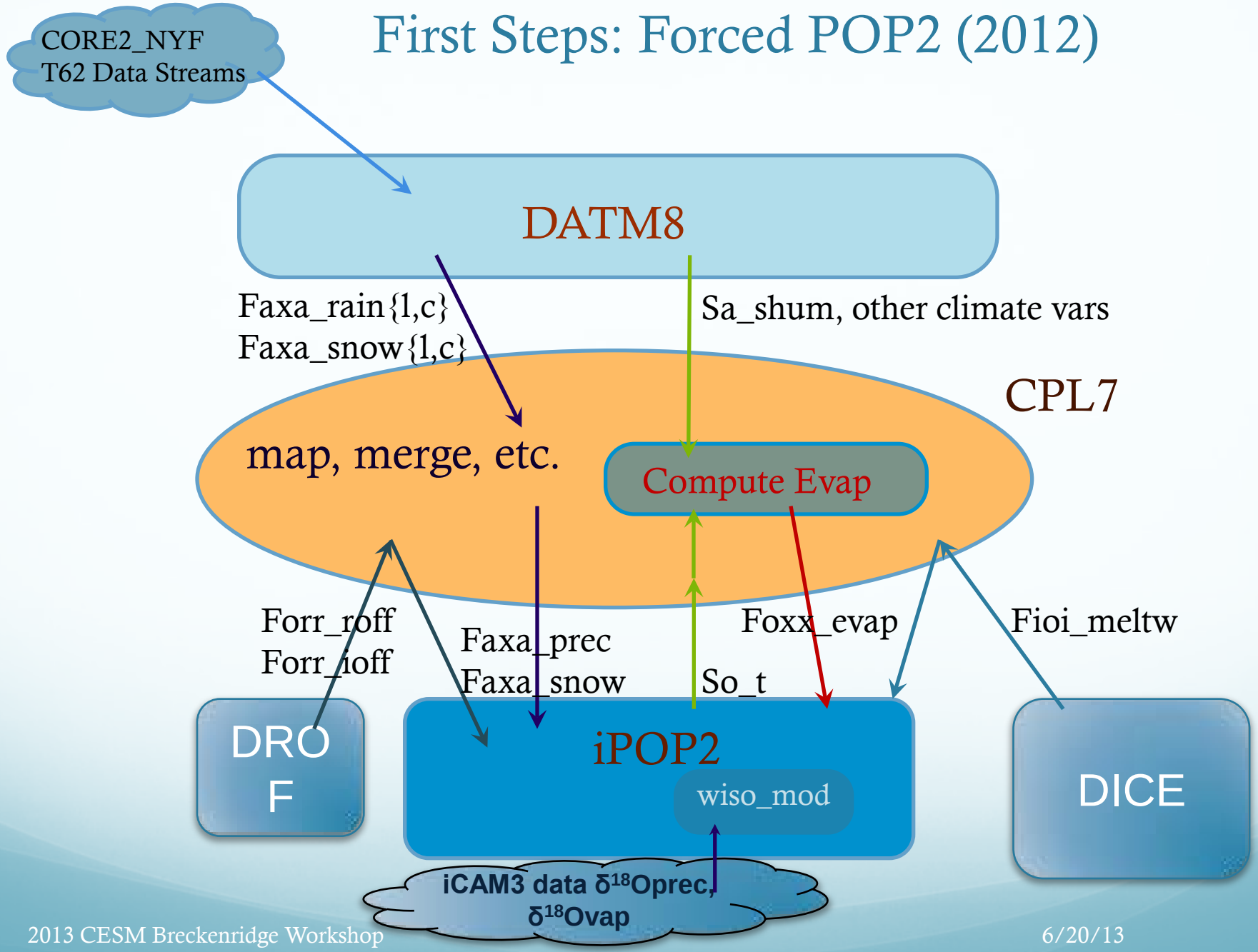
•To enhance the CESM with the capability of simulating key isotopes and geotracers, including $\delta^{18}O$, δD, ^{14}C, ^{13}C, and other geotracers, ie. Pa/Th, Nd.



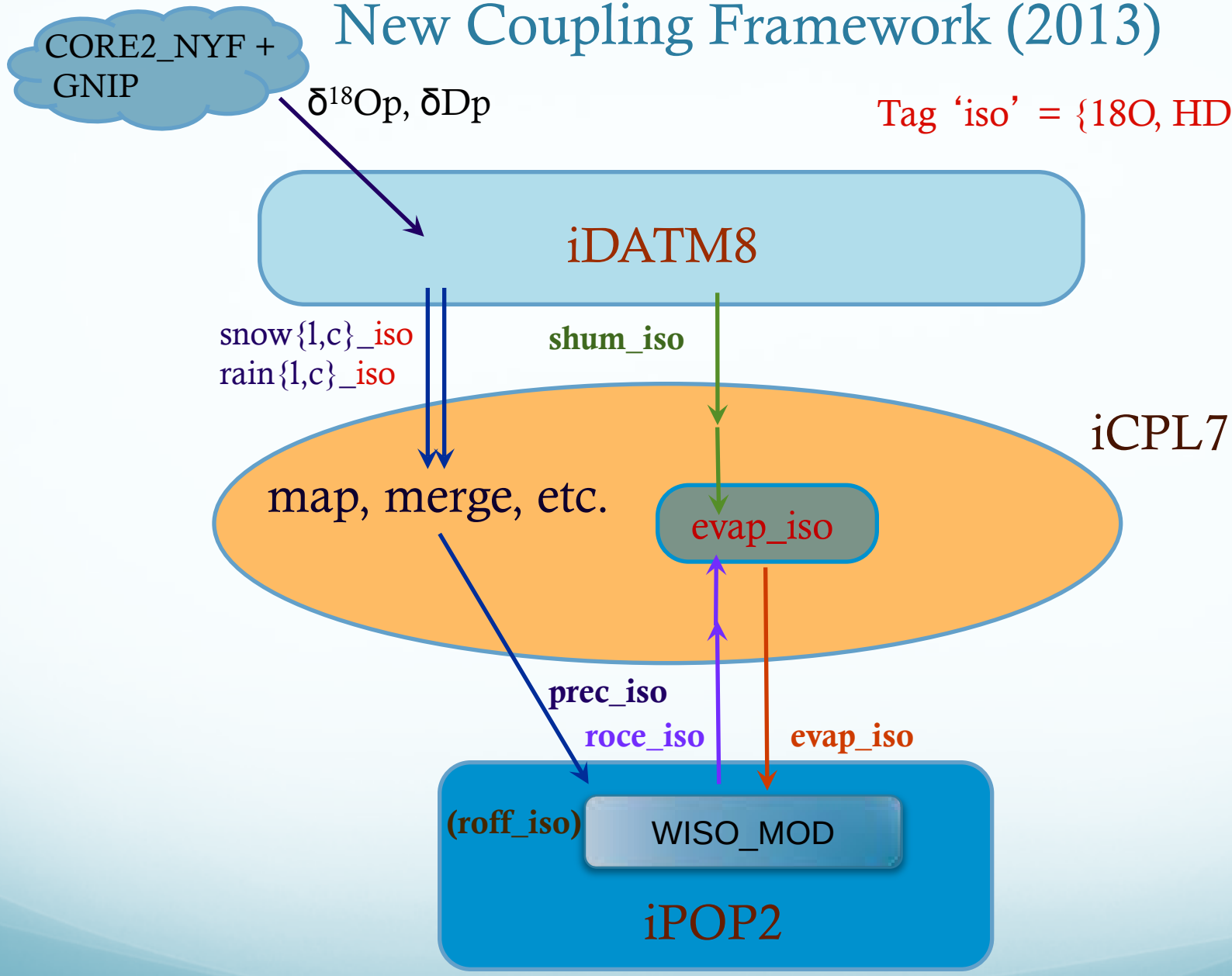
Berger, 1978; Fleming et al., 1998; Clark et al., 2009; Carlson, 2008; Monnin et al., 2001; EPICA, 2004; Grootes et al., 1993; Wang et al., 2001; 2005.

- To perform transient simulations of the last deglaciation, to test iCESM against the proxy record, especially on major abrupt events.

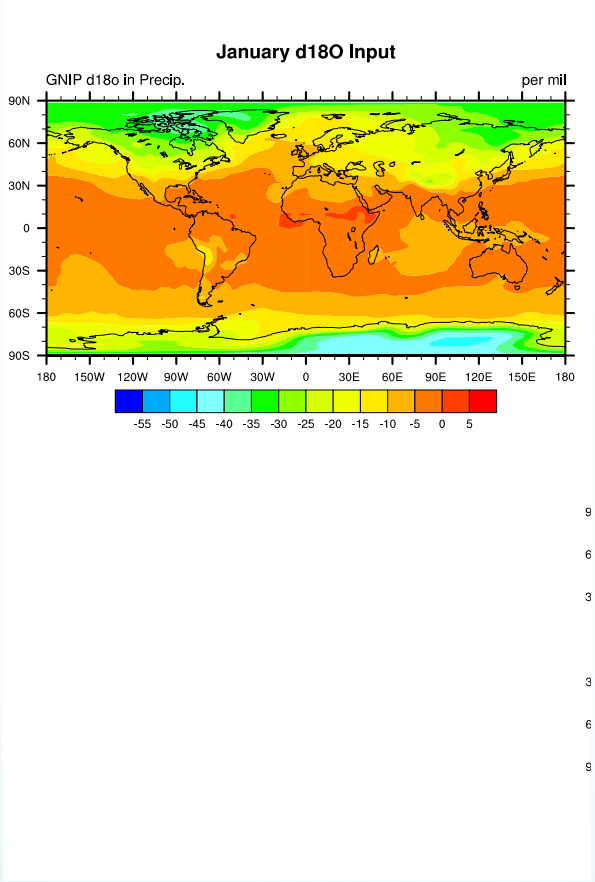
First Steps: Forced POP2 (2012)

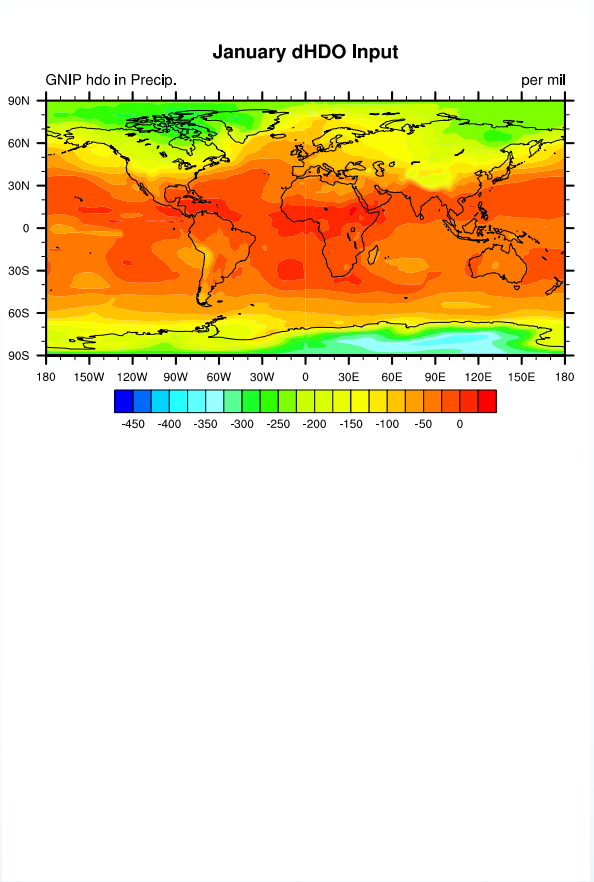


New Coupling Framework (2013)



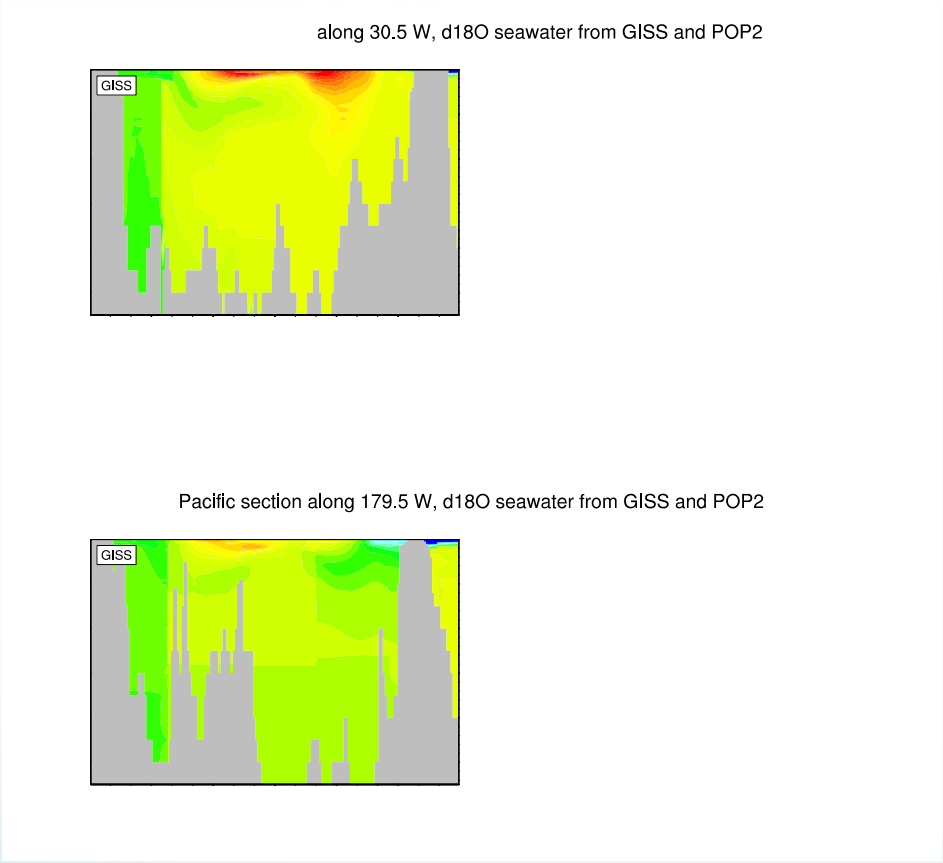
New monthly data sets added to CORE2_NYF climatological data streams





Monthly mean δ18O and δD in Precipitation
GNIP Station data + model spatial regressions
Buenning and Noone, Pers. Comm.

POP2 results for $\delta^{18}Ow$



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

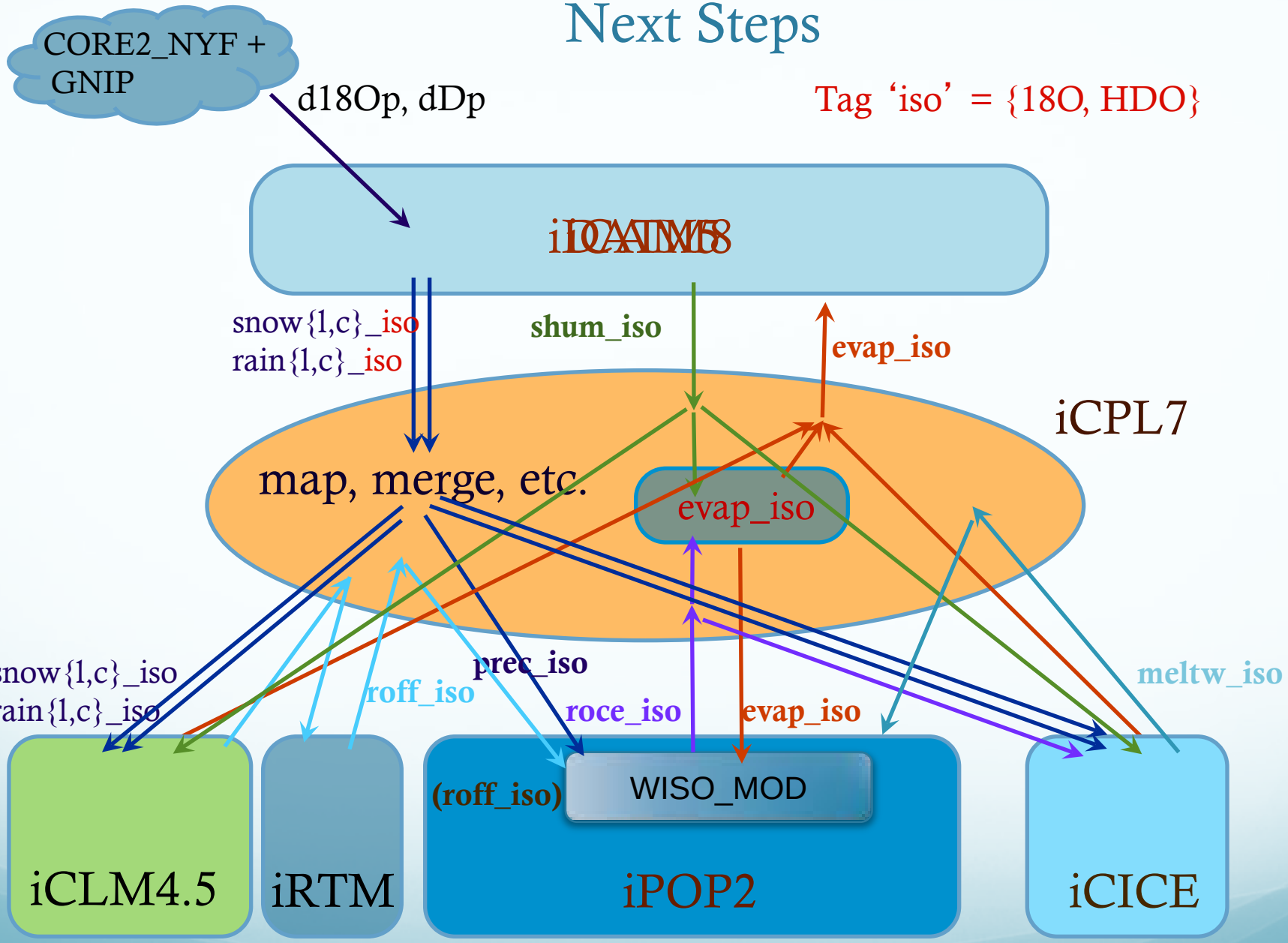
Year 500

500 year spin-up; 3° Forced POP2 CORE2 NYF (Large and Yeager, 2009) (T62, repeat monthly mean)

3° ocean: gx3v7 grid

Biases:
Too depleted in SH and Deep Ocean
>Iso-Evaporation bias
Too depleted deep N. Atl:
>Weak AMOC

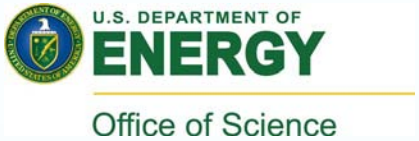
Next Steps


CORE2_NYF + GNIP
d18Op, dDp
Tag 'iso' = {18O, HDO}
snow{l,c}_iso
rain{l,c}_iso
shum_iso
evap_iso
iCPL7
map, merge, etc.
evap_iso
snow{l,c}_iso
rain{l,c}_iso
roff_iso
prec_iso
roce_iso
evap_iso
meltw_iso
(roff_iso)
WISO_MOD
iCLM4.5
iRTM
iPOP2
iCICE

Status and Timeline

- Started Sept. 2011
  - Yr 1
    - Individual SWI development in CAM5, CLM4 and POP2 is underway
    - POP2: 14C tracer (abiotic radiocarbon based on OCMIP2 protocols) by A. Jahn
    - CLM4+: Testing+Dev. Carbon Isotopes (U. Bern, LBNL)
  - Yr 2
    - Iso-CAM5 Stable Water Isotopologue development continued
    - Implementation of SWI tracers in CICE by D. Bailey
    - Added 'coupling' for SWI fluxes and states passed between POP2, CAM5, CICE, other components
    - Implementation of Biotic 14C and 13C in POP2 by A. Jahn, K. Lindsay, M. Levy
    - Refinement/testing of 13C and 14C in CLM4.5 by A. Bozbiyik and F. Joos
    - HERE → Couple SWI iPOP2 to iCICE then iCAM5
  - Yr 3
    - Update SWI in CLM4 to CESM1.2; implement in RTM; Couple.
    - Implement 13CO2 and 14CO2 tracers in CAM5
    - Couple iso-CO2 components (CAM5+CLM+POP2)
    - Other ocean circulation tracers (ex. Pa/Th, εNd)
    - iTraCE simulation: Last 21,000 years with Geotracers for better comparisons to Proxy archives
- Targeted for 'Developers' CESM release in 2014

Thank You



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News for Paleo-Developers

New SSC Directive:

- Paleo WG Code Development Guidelines

CESM Forums: bb.cgd.ucar.edu

- Paleoclimate Modeling→ Nan Rosenbloom, liaison
  - Announcements
  - Input and Output Data requirements
  - Software, Runtime, and Science Issues

Next Steps

Water Isotopes

- Start coupling iPOP2 + iCICE, then add iCAM5
- Further development in CLM4+, RTM, and in CPL7 required to diagnose and close global heavy water budget.
- Test resolution dependence of iCAM5 water isotope tracers (CSL) and tags?.

Carbon Isotopes (Alex)

- Continue testing and validation of Carbon isotope tracers in POP2
- Explore the use of 'Fast' spin-up techniques (K. Lindsay).
- Develop isotopic CO_2 tracers in CAM5.
- Couple iCLM4.5, iPOP2, iCAM5, for full coupled isotopic carbon cycle.