Isotopes dans IPSL-CM

Cécile Agosta, Mohamed Ayache, Aya Bahi, Jean-Claud Dutay, Yann Meurdesoif, Sébastien Nguyen, Camille Risi, Pierre Sepulchre

LMDZiso : news

- Disponible dans la configuration IPSLCM7ISO_work
  - LMDZ-ISO installation/compilation/simulation amip

Chantiers

- Mise en Place d'une simulation de référence (fournie par C. Agosta et N. Dutrievoz) :
  - LMDZ-ISO amip (+ nudging)
  - scripts python pour analyse des sorties
- Convergence physique de phylmdiso avec phylmd
- Fusion du répertoire phylmdiso dans phylmd
  - Utilisation du tableau QX à la place des t_seri xt_seri
  - changement de l'ordre des boucles sur les isotopes
  - supression des #idef ISO
- Remplacement de isoverif par les routines génériques de David Cugnet
- Correction de bugs : explosion de OVAPH218O et OVAPHDO au pôle nord

icoLMDZiso: news

Done:

- Initialization of water isotopes in the icosa driver
- Exchanges of isotopes dyn<->phy in the icosa driver
  Conversion kg/kg ↔ ratio = children / parent
- Advection of isotopic ratios (as for other tracers)

… and some other refactoring later …

It runs and good results! (global nbp40)
But… explosion of H218O and HDO after a few month
→ it comes from the physics, debug ongoing.

Needed for:

- icoLMDZiso LAM, e.g. Antarctica (AWACA, ice core interpretation)
- IPSL-CMiso for paleoclimate studies

Integration of water isotopes into ORCHIDEE

By post-doctoral researcher Aya BAHI

Supervisors

- Camille Risi (SU-LMD)
- Jean Baptiste Ladant (LSCE-CLIM)
- Philippe Peylin (LSCE-MOSAIC)

Contributors

- Josefine Ghattas
- Jerome Ogee
- Matthias Cuntz
- Catherine Ottle

Isotopes in ORCHIDEE

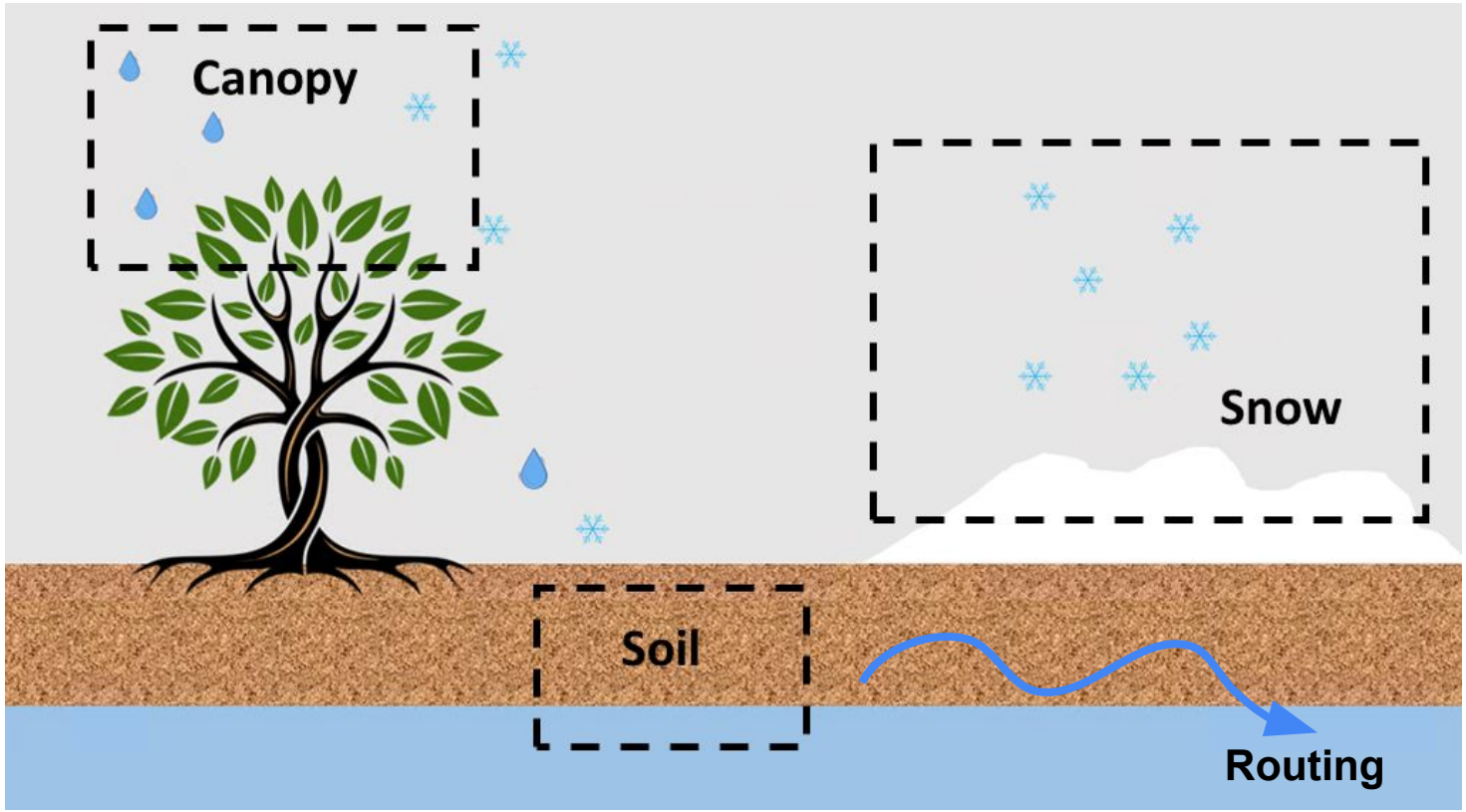
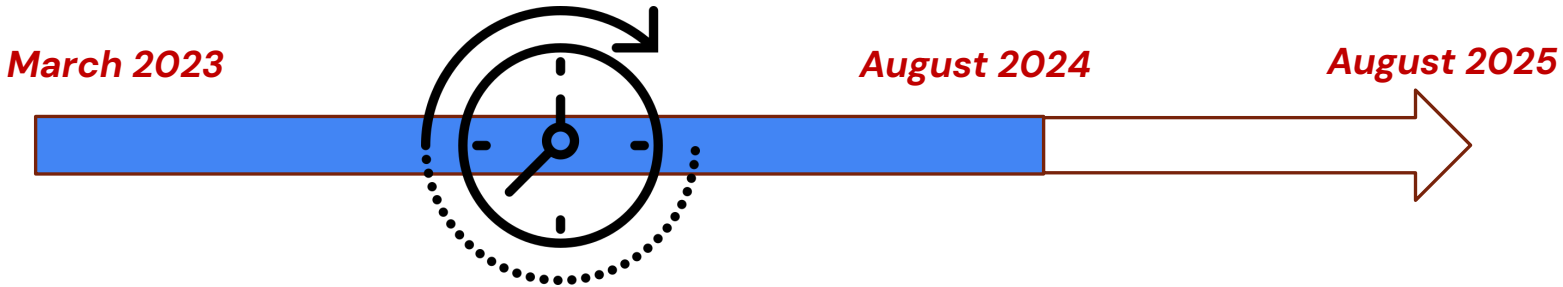


Figure 1: The hydrologic components of ORCHIDEE involved in the water isotopes integration

Calendar and perspectives

LSCE

Post-doctoral contract



- To run a simulation on site and compute the isotopic composition of soil water

- To add the frozen fraction of the soil water

- Write a paper about a scientific application/Add isotopes to the snow compartment

Modeling water isotopes with the NEMO Watiso package

The isotopic ratio is transported

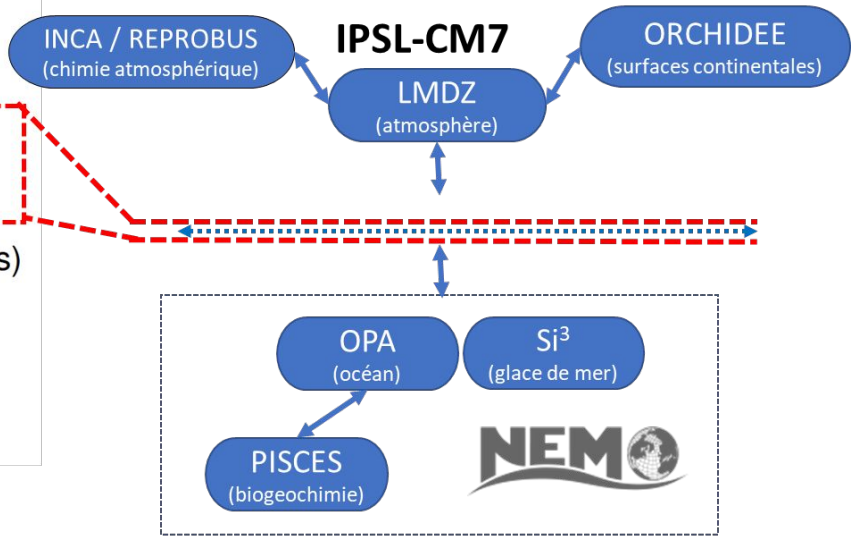
- ${}^{18}\mathrm{R} = {}^{18}\mathrm{O}/\mathrm{O}$ (rel. to the total of all isotopic forms)
- Boundary condition at the sea surface ($z = \eta$)

$$\rho_0 K \bigtriangledown {}^{18}\mathrm{R}|_{z=\eta} = \underbrace{(\mathcal{E} - \mathcal{P} - \mathcal{R})^{18}\mathrm{R}}_{\mathrm{Context-dependent}} - ({}^{18}\mathcal{E} - {}^{18}\mathcal{P} - {}^{18}\mathcal{R})$$

$\mathcal{E}$, $\mathcal{P}$, $\mathcal{R}$ = evaporation, precipitation, run-off ($\exists$ice-shelves)

${}^{18}\mathcal{E}$, ${}^{18}\mathcal{P}$, ${}^{18}\mathcal{R}$ = associated isotope fluxes

- Assumption: ${}^{18}\mathrm{R}_{\mathrm{sea-ice}} = {}^{18}\mathrm{R}|_{z=\eta}$
- No-flux condition on solid boundaries



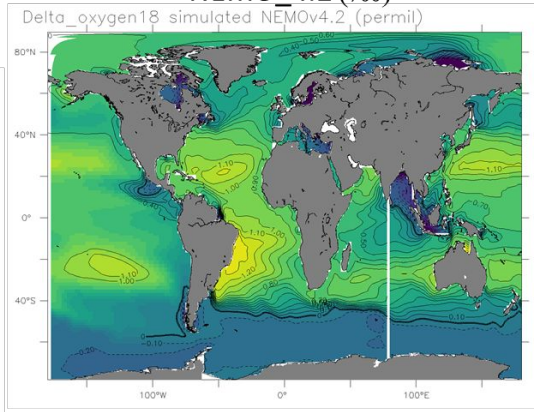
Implementation

Two cases implemented

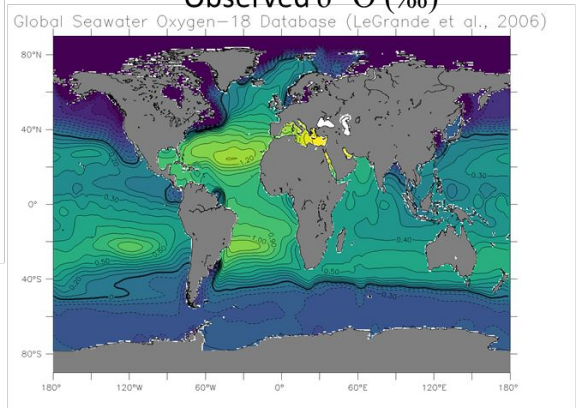
1. *ln_linssh*=.false.
   - on-line or coupled
   - full consistency between salinity and isotopic ratios
2. OFF-line
   - additional tracer S_w
   - *ln_linssh*=.true.
   - equilibrium state

Cases *ln_linssh*=.false. in on-line or coupled modes theoretically possible; but adds complexity

NEMO_4.2 (‰)



Observed $\delta^{18}O$ (‰)



Implementation and Next Steps

Current Status:

•Package Implementation:

- Code writing and compilation: **Completed**

•OFFLINE Coupling:

- Implemented and tested with **long runs** using ORCA2 grid
- Experiments prepared:
  - **Control**, **Mid-Holocene**, and **LGM** simulations
- External forcing:
  - Fluxes from **LMDZiso bucket** model
  - No impact of **sea ice** on the isotopic composition of seawater

Next Steps:

•Asynchronous Coupling:

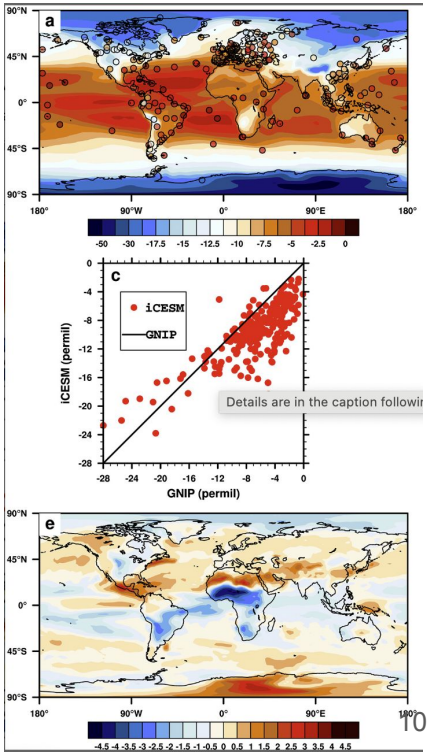
- Test asynchronous coupling (LMDZiso-NEMOv4.2), M2 internship (P. Sepulchre)

•Toward Fully Coupled Model:

- Integration of water isotopes into the IPSL-CM coupled model …

M2 internship funded by EUR-IPSL (Sepulchre/Nguyen/Risi et al.)

- Target : Asynchronous coupling LMDZiso - NEMOiso global
- Preindustrial validation and warm paleoclimate simulation
- PhD project submitted to CEA. Results in January ‘25



Example of validation with iCESM (Brady et al., JAMES, 2019)