

Water stable isotopes in the LMDZ general
circulation model
GNIP-Dynscape workshop

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LMD/IPSL

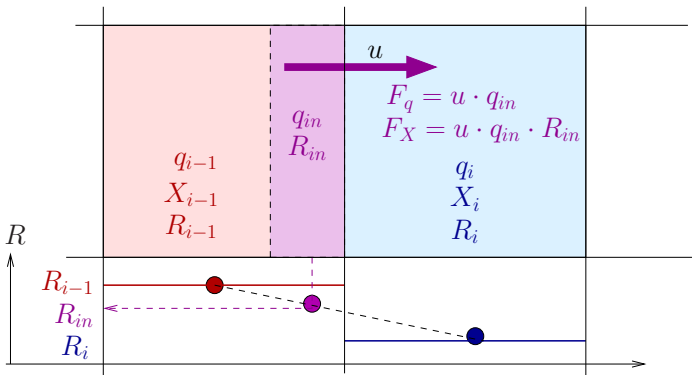
17 november 2008

The LMDZ4 model

- ▶ water stable isotopes in the LMD model (*Joussaume et al 1984*), but got lost
- ▶ LMDZ4:
 - ▶ atmospheric component of the IPSL coupled model
 - ▶ used for AR4 and AR5 IPCC simulations
 - ▶ grid point model, standard resolution $96 \times 72 \times 19$
 - ▶ LMDZoom: stretched grid possible

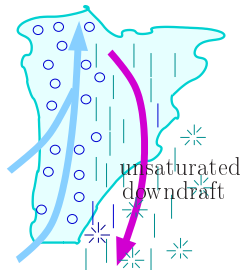
Implementation of water stable isotopes ($H_2^{17}O$, $H_2^{18}O$, HDO) in LMDZ

- ▶ As in most other GCMs
- ▶ assume all soil water is transpired without fractionation
- ▶ advection by the Van Leer scheme: assume R varies linearly

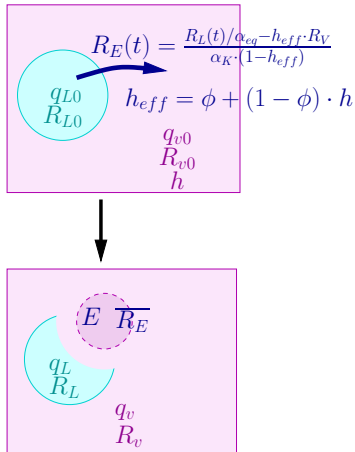
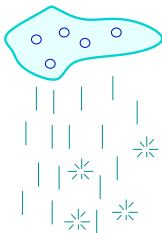


Drop reevaporation

Emanuel convective parametrization



large-scale condensation parametrization



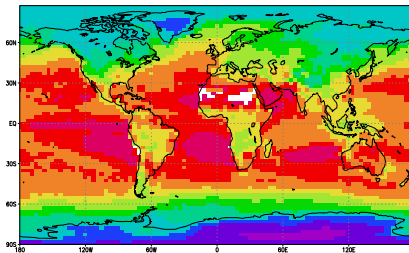
- ▶ during reevaporation, liquid composition varies (*Stewart 1975*)
- ▶ vapor composition varies
- ▶ $h_{eff} > h$

Simulations with LMDZ4-iso

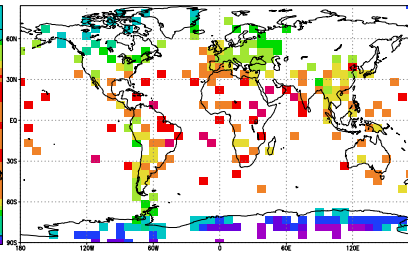
- ▶ short climatological simulations + sensitivity tests to
 - ▶ parameters involved in physical or isotopic processes
 - ▶ uniform SST changes
- ▶ AMIP simulations forced by observed SST from 1979 to 2007, with winds nudged or not by ERA40 reanalysis (still running)
- ▶ LGM simulations with different SST reconstructions

Comparison with GNIP: annual maps

$\delta^{18}\text{O}$ (‰) LMDZ



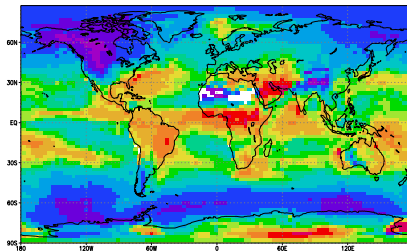
$\delta^{18}\text{O}$ (‰) observations



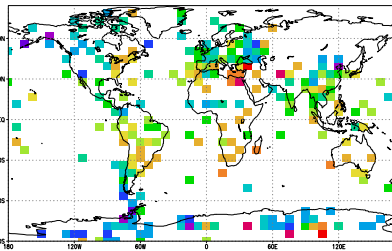
-50 -40 -30 -20 -18 -12 -8 -6 -4 -2

Comparison with GNIP: annual maps

d-excess (‰) LMDZ

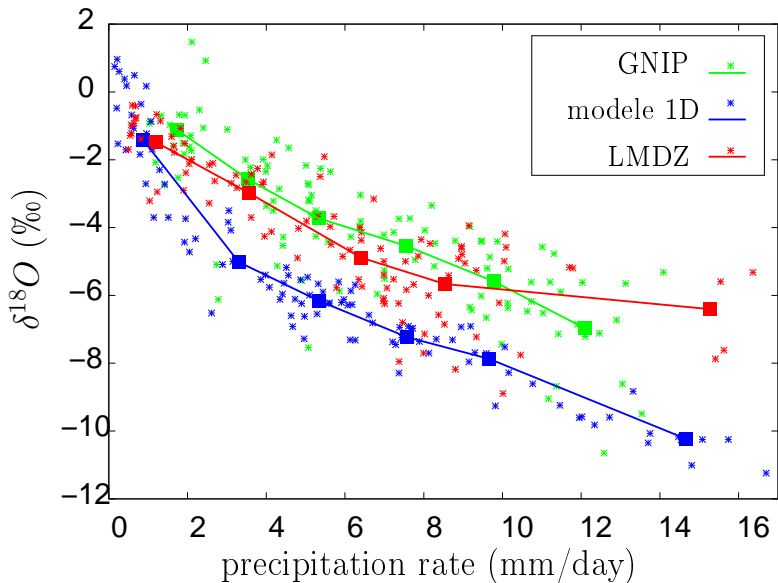


d-excess (‰) observations



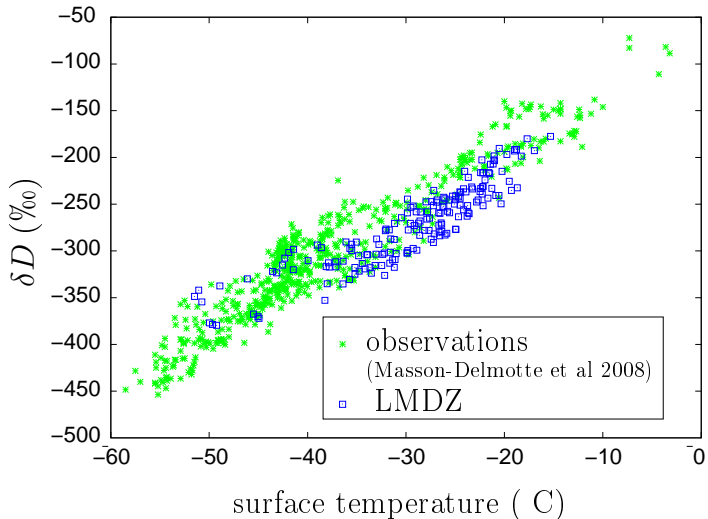
0 2 4 6 8 9 10 11 12 14 16 18

Comparison with GNIP: amount effect

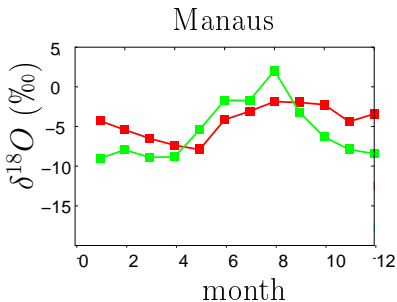
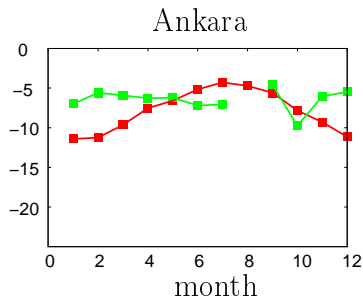
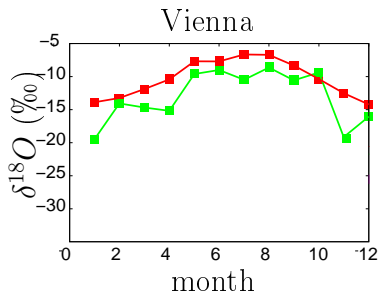


Comparison with GNIP: temperature effect

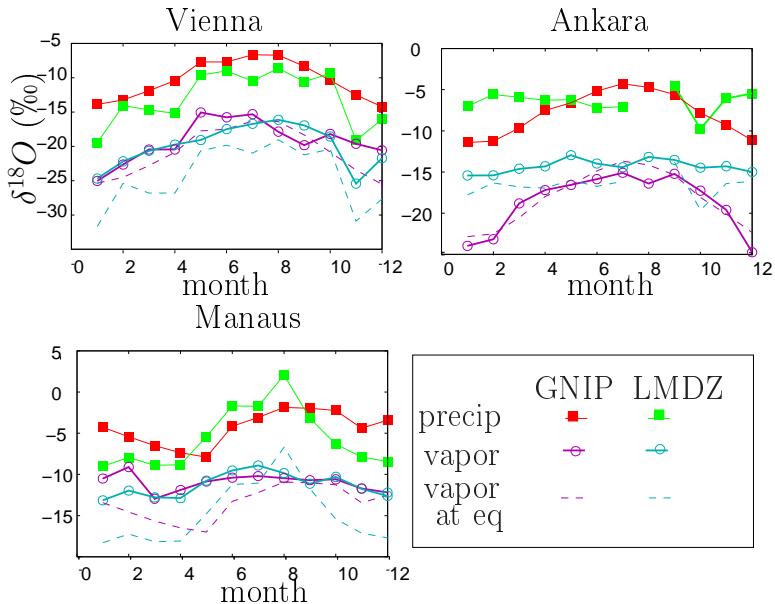
Temperature effect in Antarctica



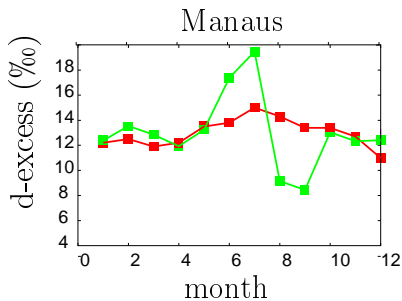
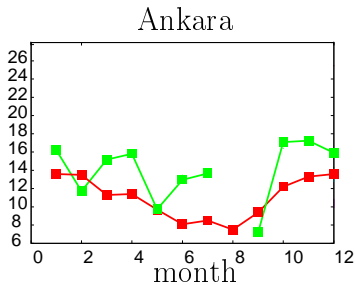
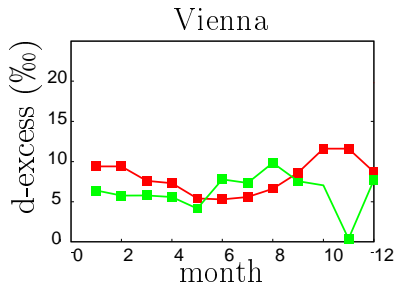
Comparison with GNIP: seasonal cycles



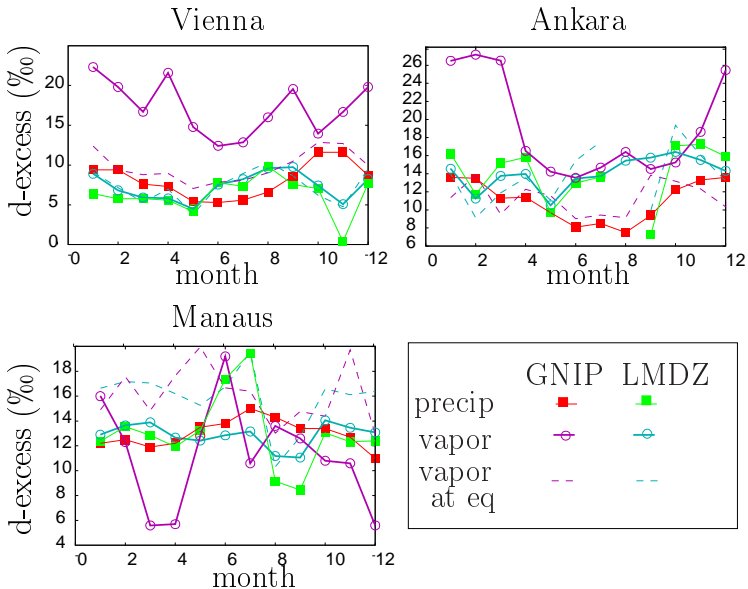
Comparison with GNIP: seasonal cycles



Comparison with GNIP: seasonal cycles

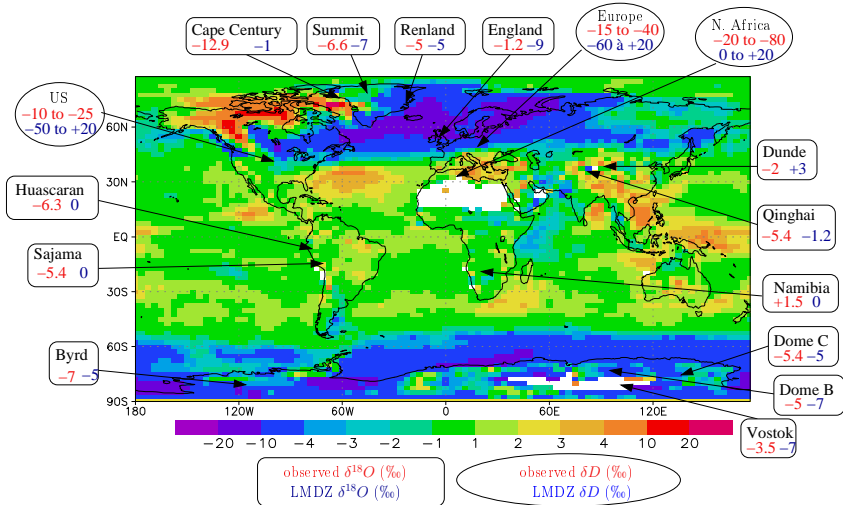


Comparison with GNIP: seasonal cycles



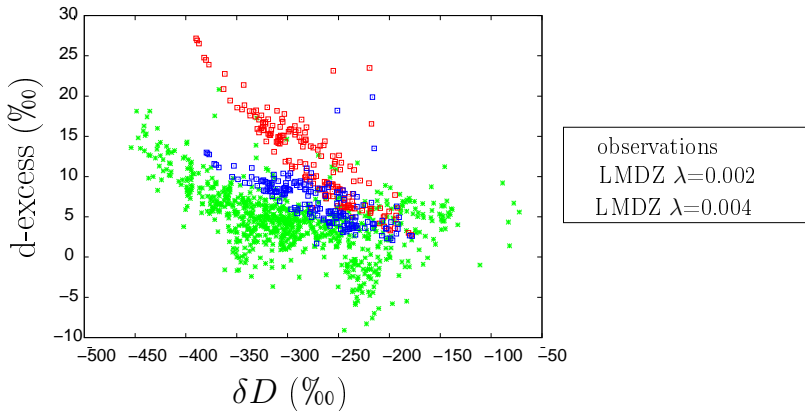
LGM simulation

$\delta^{18}O$ LGM - present day change (‰) simulated by LMDZ



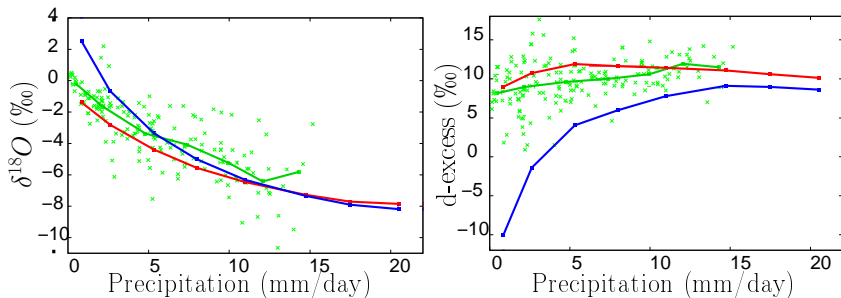
Sensitivity tests

- ▶ kinetic fractionation during snow formation → d-excess in Antarctica



Sensitivity tests

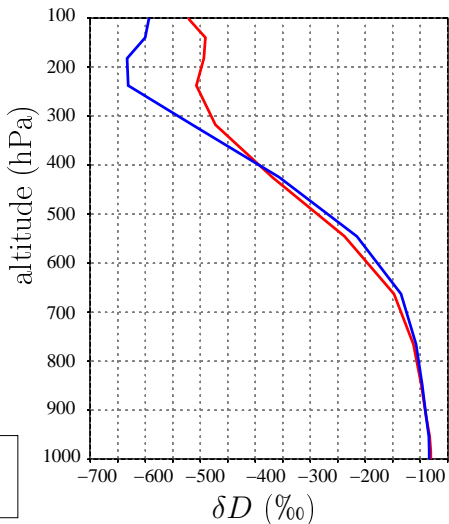
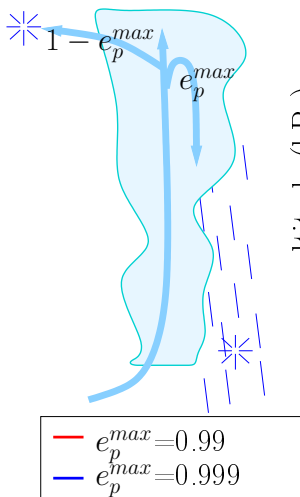
- ▶ humidity during reevaporation → amount effect



- * GNIIP data over tropical islands
- LMDZ, $\phi = 0.9$ (standard)
- LMDZ, $\phi = 0$

Sensitivity tests

- precipitation efficiency → upper tropospheric profiles



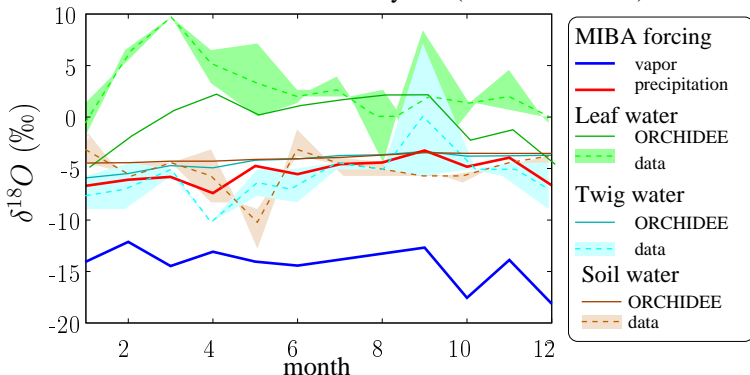
Perspectives: developpement in LMDZ

- ▶ $H_2^{17}O$ still problematic (advection scheme?)
- ▶ isotopes in the “New Physics” of LMDZ

Perspectives: ORCHIDEE

- ▶ isotopes in the land surface model ORCHIDEE
- ▶ coupled simulations
- ▶ evaluation with GNIP, MIBA and GNIR

Seasonal cycle simulated by ORCHIDEE offline
and observed on the Bray site (Southern France)



Perspectives

- ▶ coupled LMDZ-ORCHIDEE zoomed simulation over West Africa, Amazonia, Tibet
- ▶ isotopes in the fully coupled IPSL model