What do we learn from water isotopes on clouds and convection?

Camille Risi, Caroline Muller, Peter Blossey

LMD/IPSL, Camille.Risi@lmd.ipsl.fr
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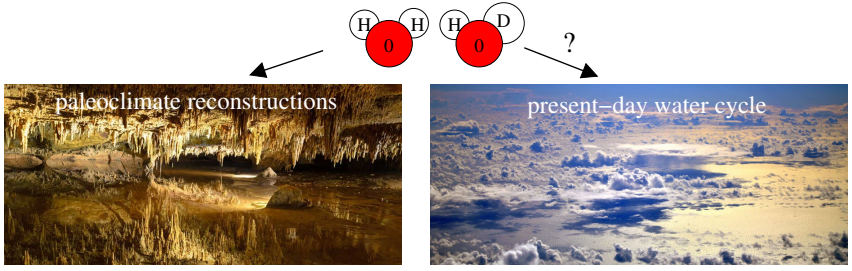
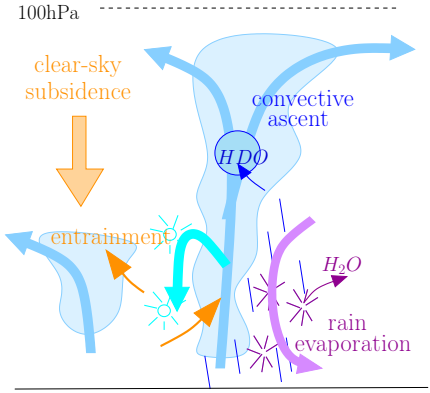
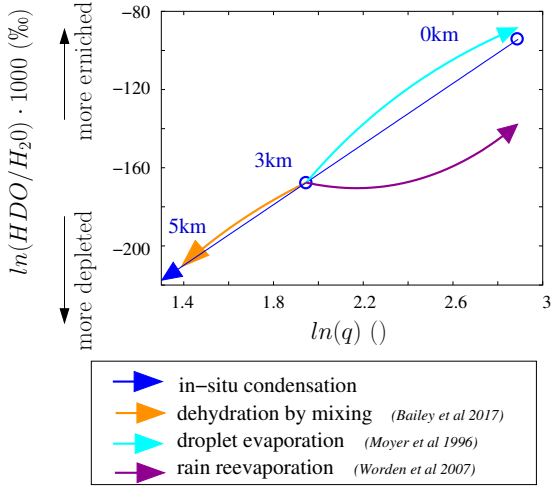


Water isotopes inform us about moistening processes





- In reality, more commplex...

Why do we want isotopes to be useful?

water isotopes

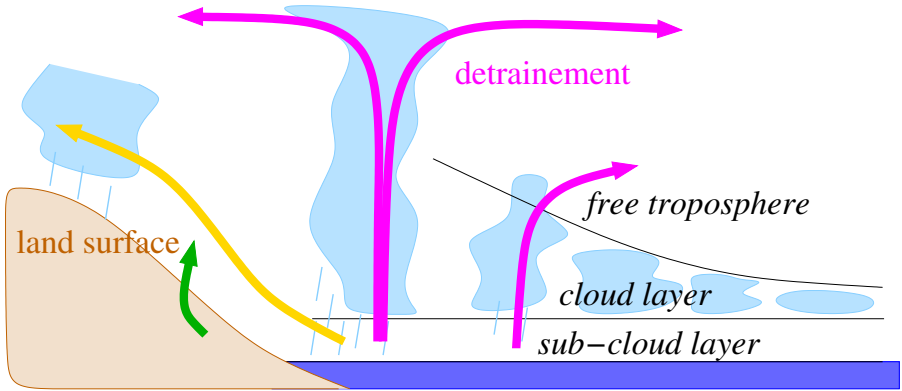
what are isotopes useful for?

what is the most efficient tool?

science question

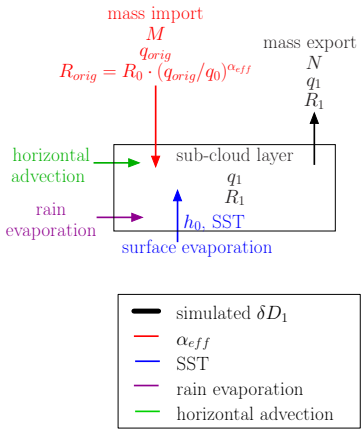
$\Longrightarrow$Before using isotopes, we need to better understand what controls its variations

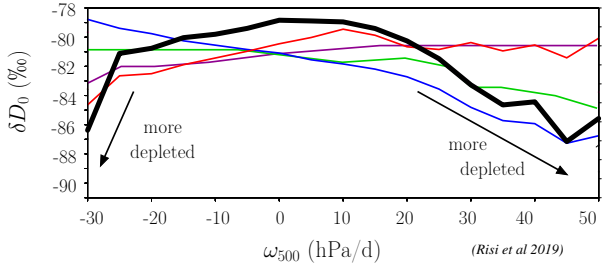
Understanding isotopic variations in the sub-cloud layer of tropical oceans is a first step

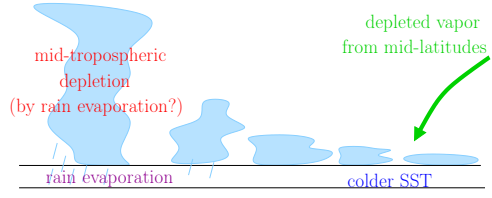


Spatial and seasonal isotopic variations in the tropics

- LMDZ general circulation model (GCM) + simple box model *(Risi et al 2019)*



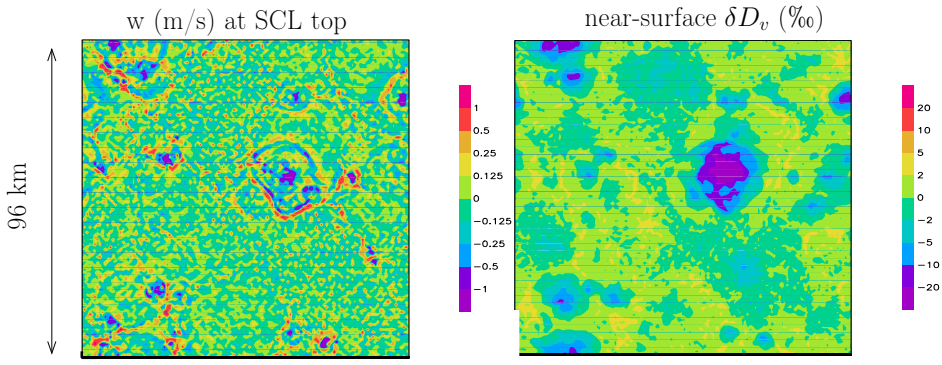




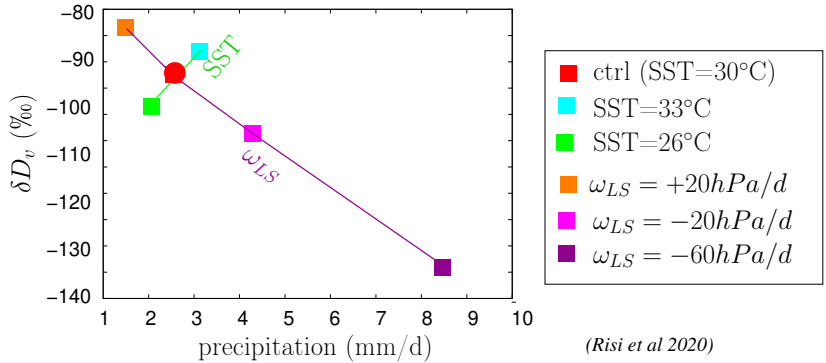
- But limitations associated with parameterizations

Using large-eddy simulations

- SAM *(Khairoutdinov and Randall 2003)* with isotopes *(Blossey et al 2010)*
- RCE, fixed SST, 750 m resolution, doubly periodic,



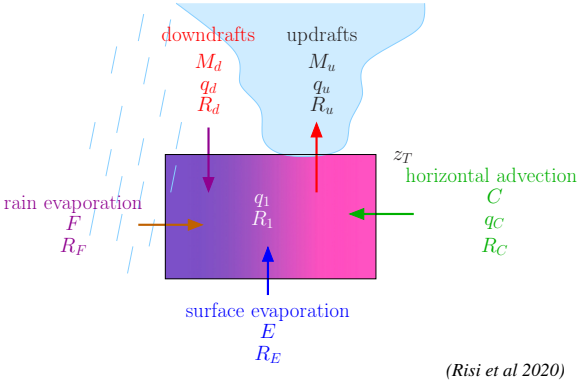
The response of water isotopes to precipitation depends on its thermodynamical or dynamical origin



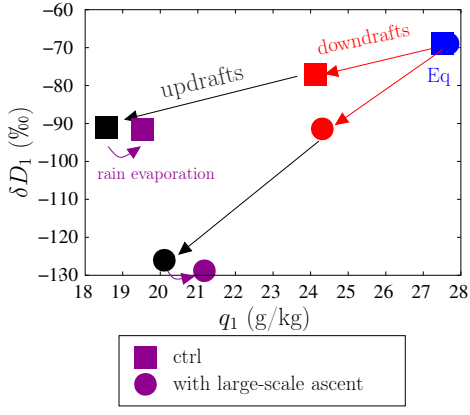
(Risi et al 2020)

- Could isotopic observations/records inform thermodynamical or dynamical origin of current/past precipitation changes? *(Bailey et al 2016, Dee et al 2017)*
  ⇒ Preliminary results in a GCM are disappointing

What controls the sub-cloud layer δD_v?



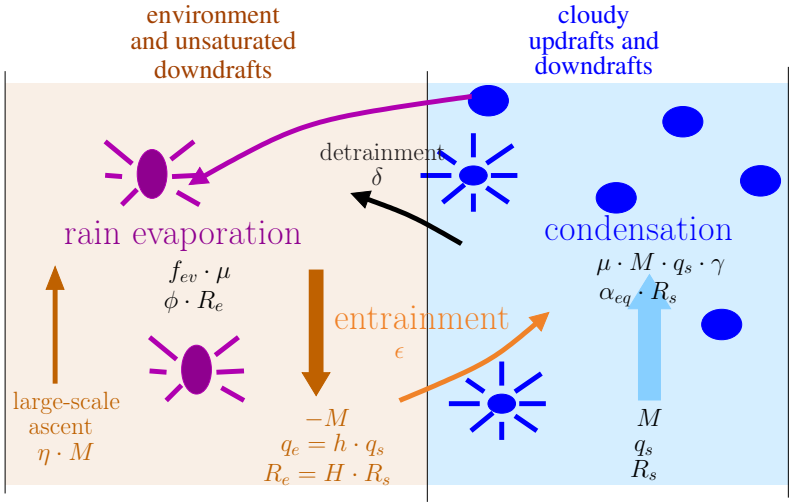
(Risi et al 2020)



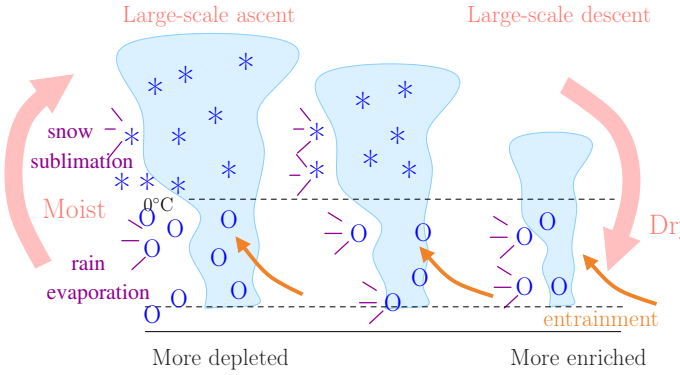
- Updrafts have the largest effect on drying and depleting the sub-cloud layer
  $\Rightarrow$ a missing component in climate models?
- Enhanced depletion with large-scale ascent due to steeper $q - \delta D$ vertical gradient

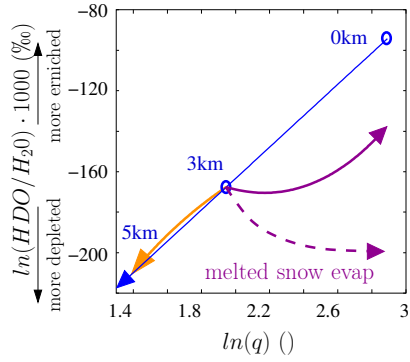
What controls δD_v vertical profiles?

- Simple 2-column model *(Risi et al submitted*, inspired by *Romps 2014)*



What controls δD_v vertical profiles?



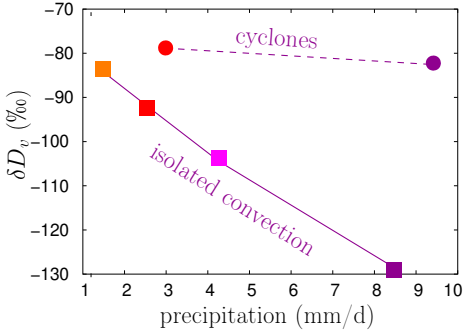


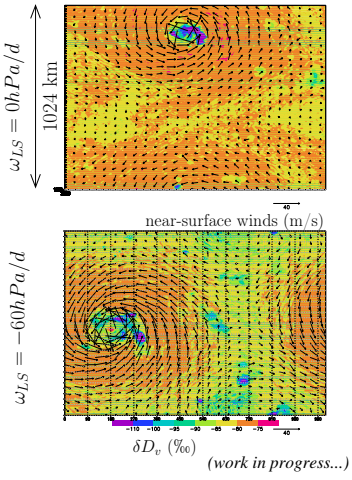
(Risi et al submitted)

- Large-scale ascent: less rain evaporation and snow sublimation
- Large-scale descent: entrainment of drier air

What role for convective organization?

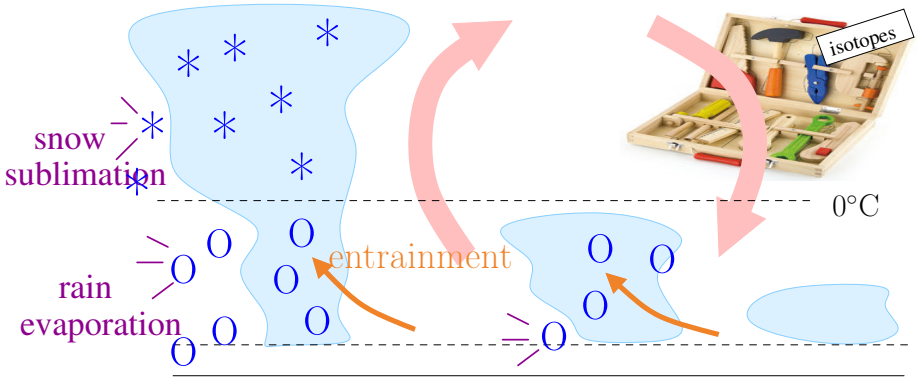
- more depleted vapor in more organized convection? *(Lawrence et al 2004)*





- Large-eddy simulation results at odds with expectations...

Conclusion



(Risi et al submitted)

- isotopes relevant to test hypotheses involving rain evaporation, snow sublimation, entrainment?
- processes controlling water isotopes still need to be better understood.

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