How can we make use of water isotopic observations to better evaluate the representation of moist processes in climate models?

Camille Risi

LMD/IPSL/CNRS

Thnaks to: Obbe Tuinenburg, John Worden, Jean-Lionel Lacour, Sandrine Bony, Françoise Vimeux

Ringberg, March 2014

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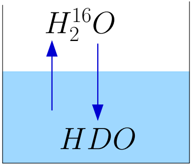
- $H_2^{16}O$, HDO, $H_2^{18}O$ ...
- fractionation during phase changes



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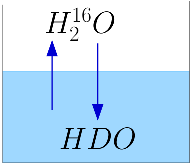

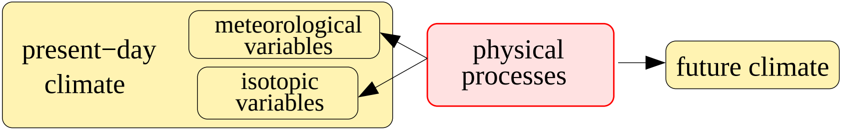

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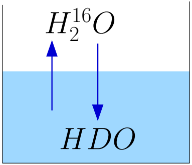

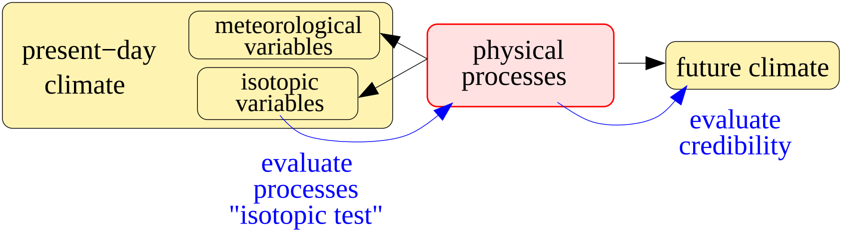

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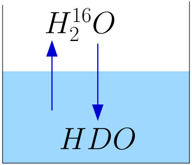

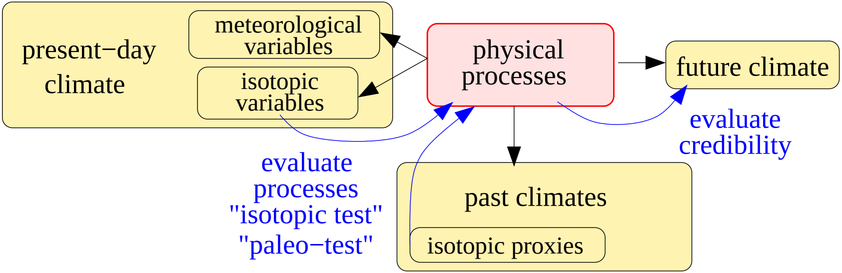

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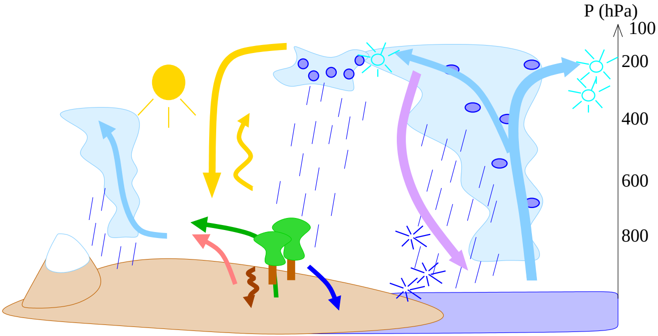

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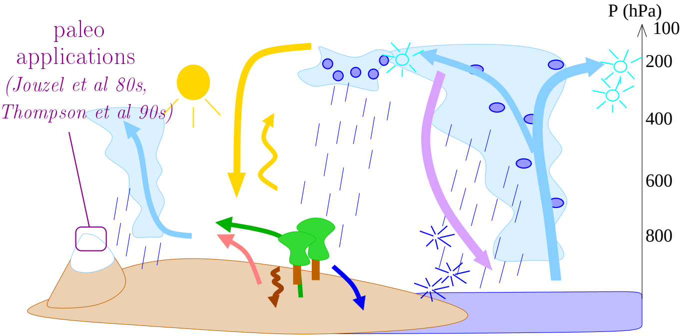

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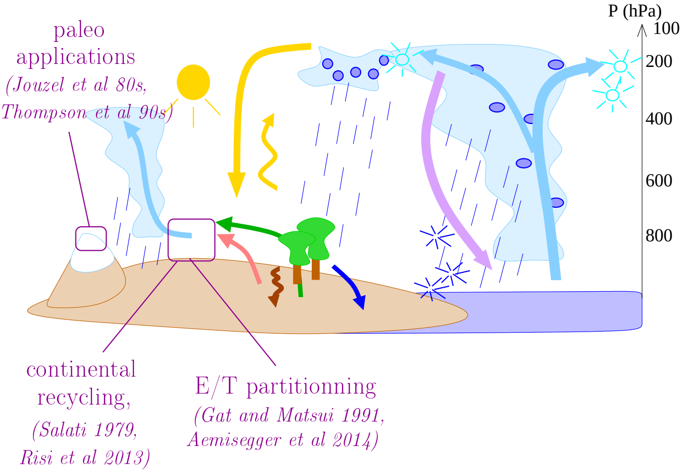

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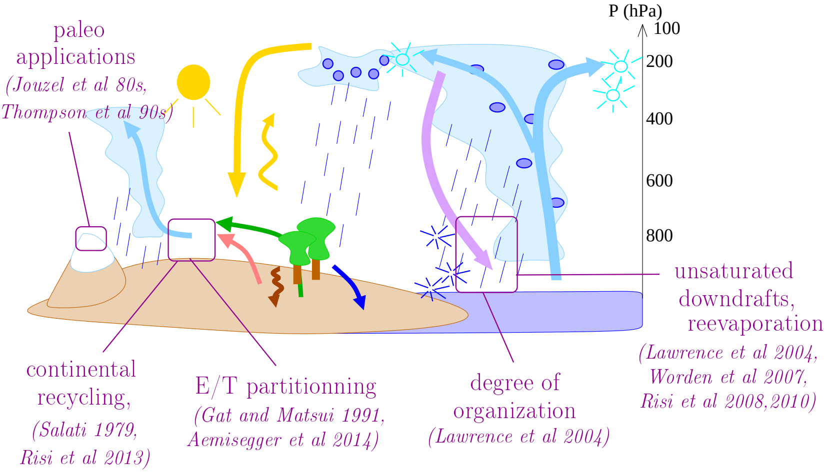

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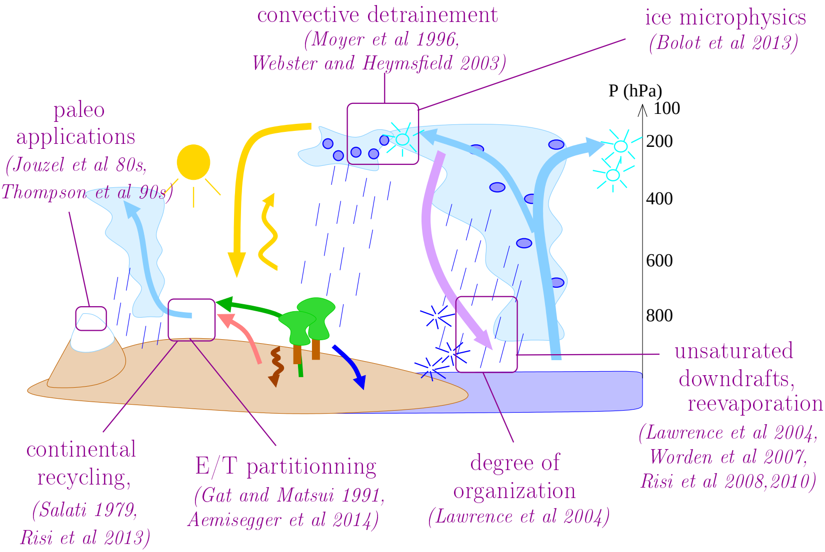


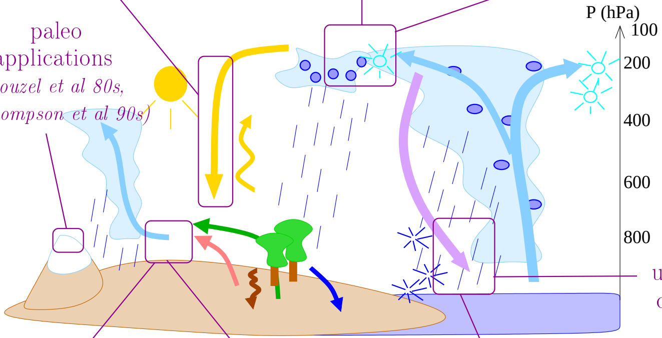
What can we use isotopes for?

vertical mixing
(Risi et al 2012)

convective detrainement
(Moyer et al 1996, Webster and Heymsfield 2003)

ice microphysics
(Bolot et al 2013)

paleo applications
(Jouzel et al 80s, Thompson et al 90s)



unsaturated downdrafts, reevaporation
(Lawrence et al 2004, Worden et al 2007, Risi et al 2008,2010)

continental recycling,
(Salati 1979, Risi et al 2013)

E/T partitionning
(Gat and Matsui 1991, Aemisegger et al 2014)

degree of organization
(Lawrence et al 2004)

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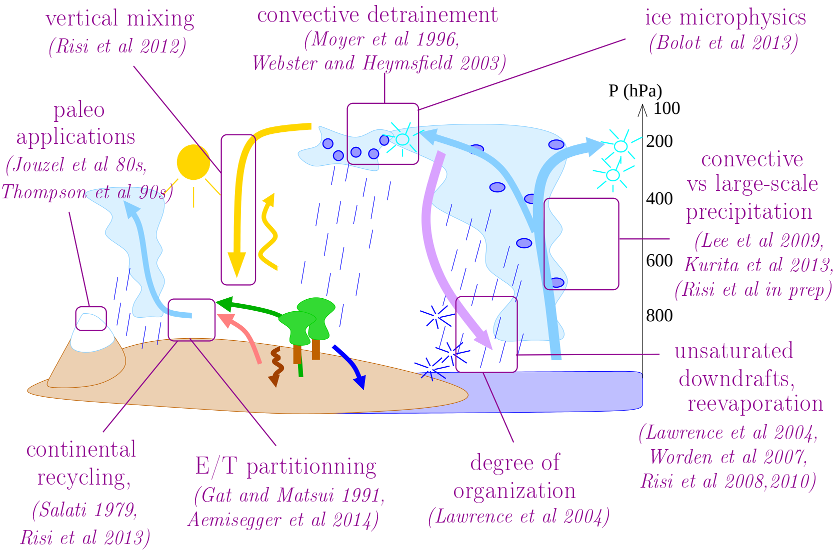
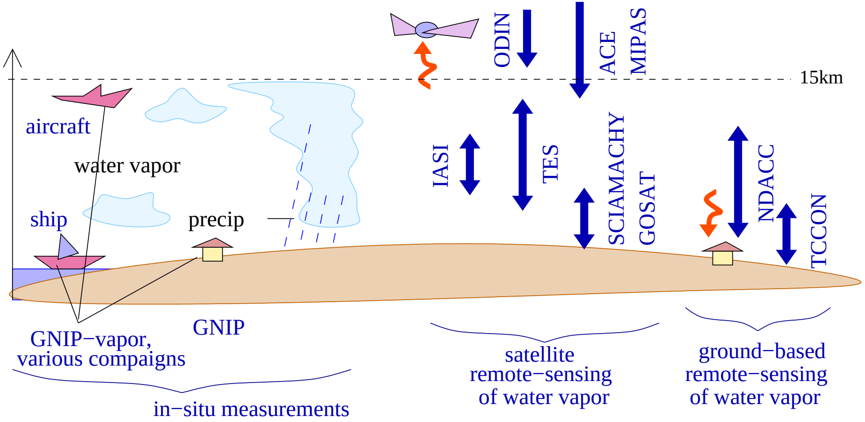


Recent opportunities

- More and more measurements



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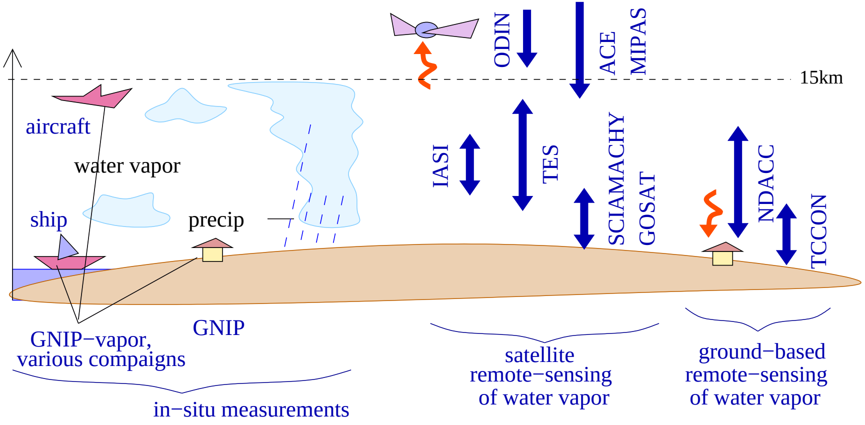
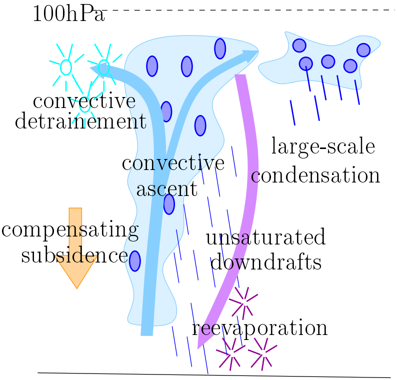
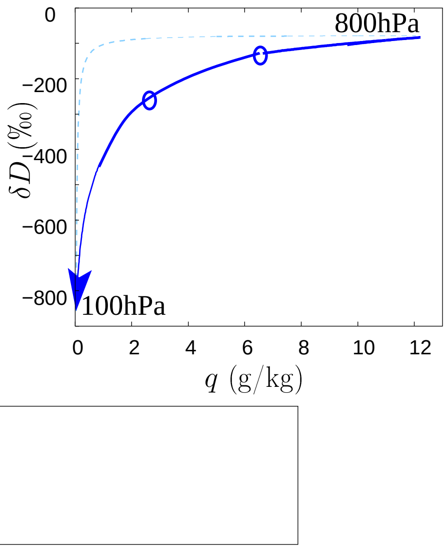


- more and more GCMs have water isotopes ($\simeq$9), SWING2 intercomparison project

q-δD: moistening and dehydrating processes





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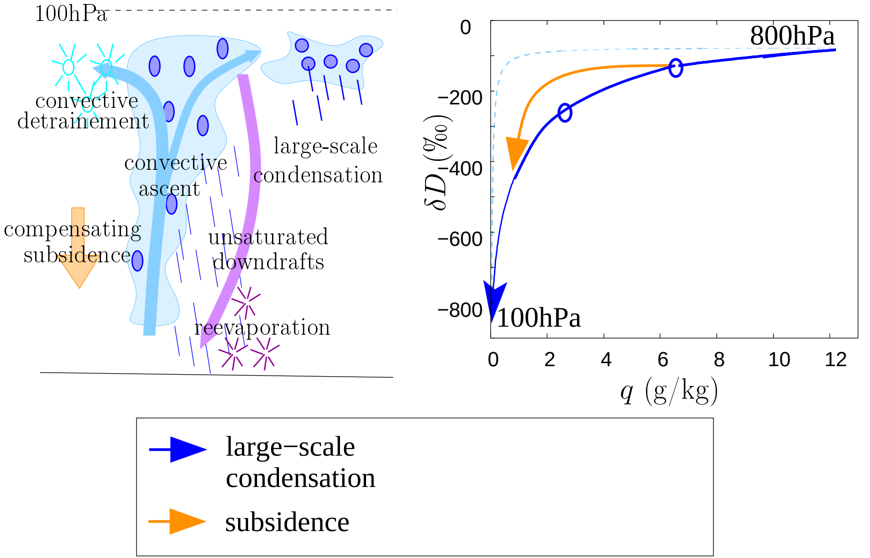

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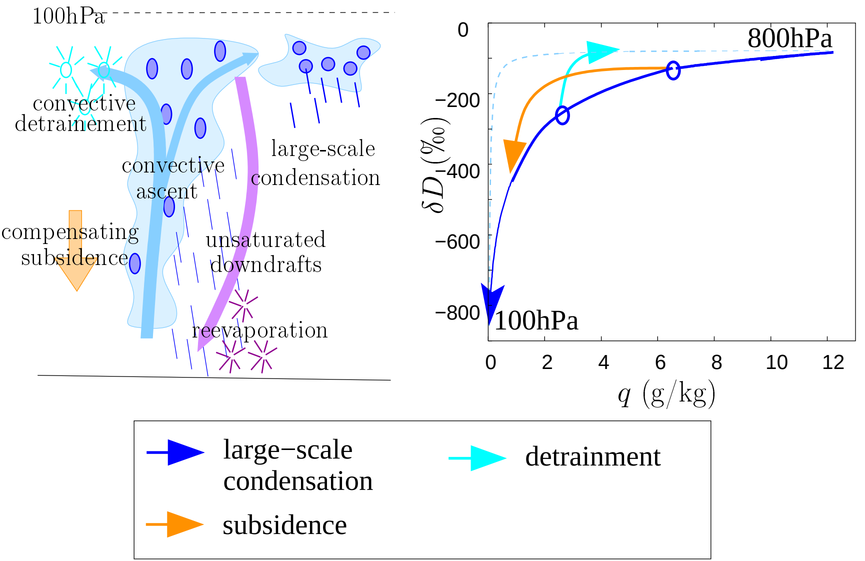

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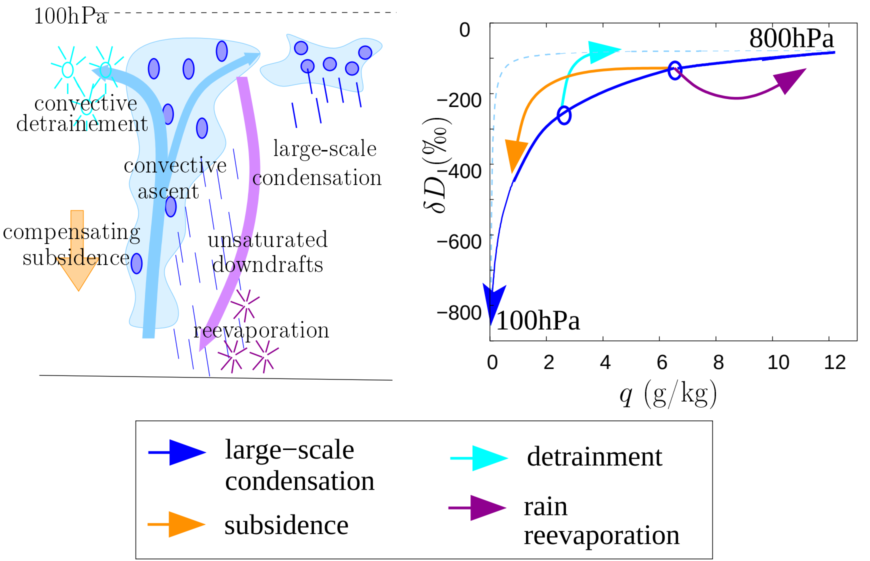
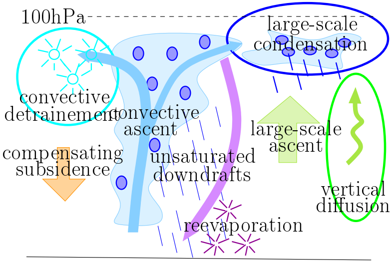
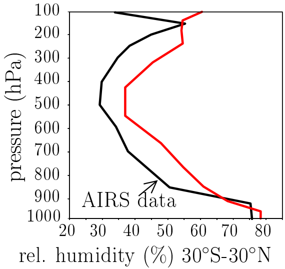


What causes the moist bias in GCMs?





LMDZ:

- Control

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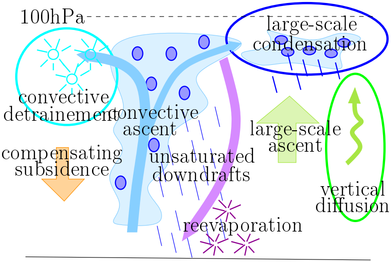

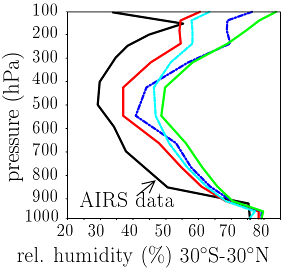

LMDZ sensitivity tests:

- Control
- Excessively diffusive vertical advection
- Excessive condensate detrainement
- Insufficient in-situ condensation

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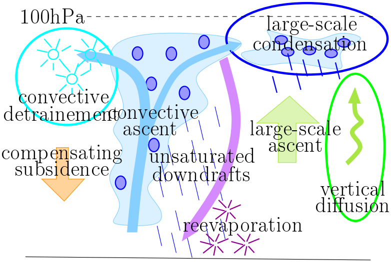

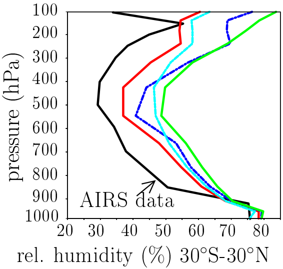

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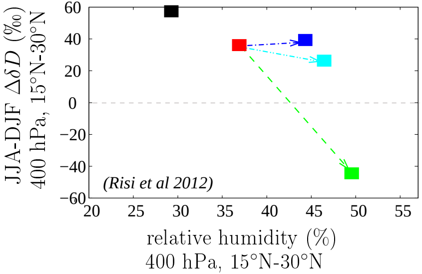

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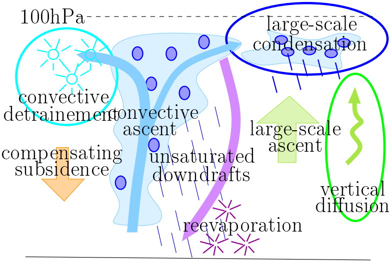

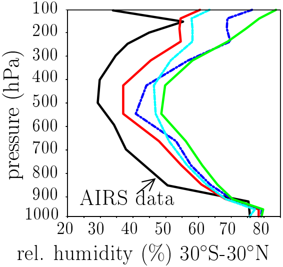

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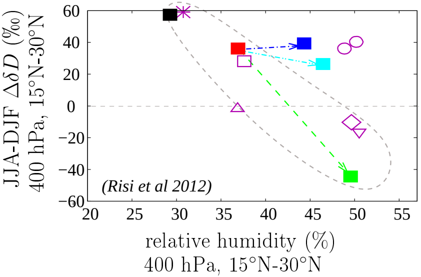

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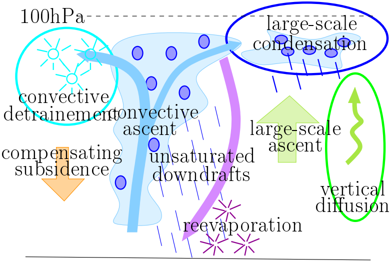

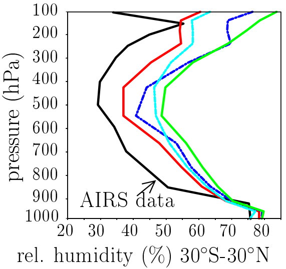

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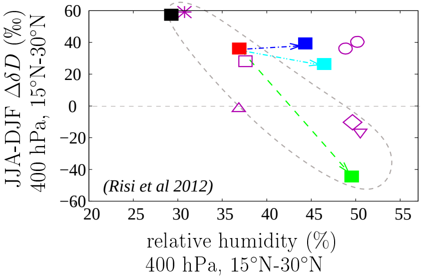
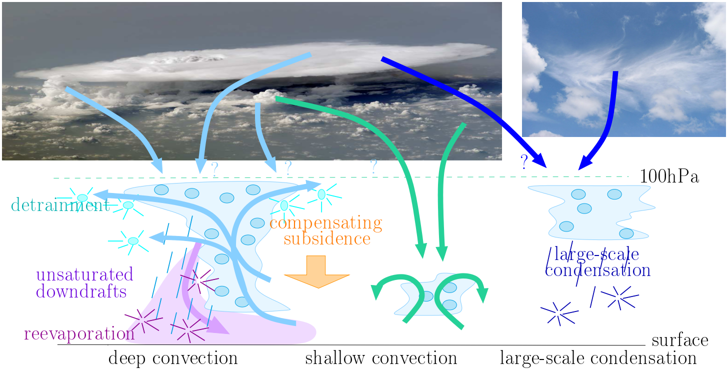


- excessively diffusive advection=most frequent bias

Convection/ large-scale partitionning



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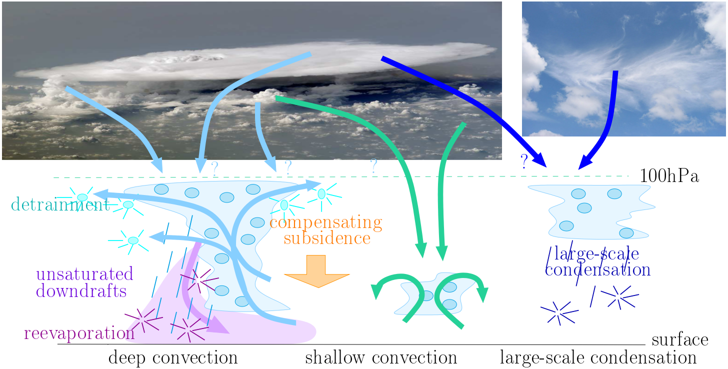
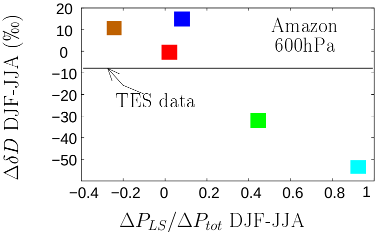


LMDZ sensitivity tests

- control
- vertical advection more diffusive
- stronger condensate detrainment
- less in-situ condensation
- less in-situ precipitation



Water isotopes during the MJO

Hoevmuller diagram at 500hPa
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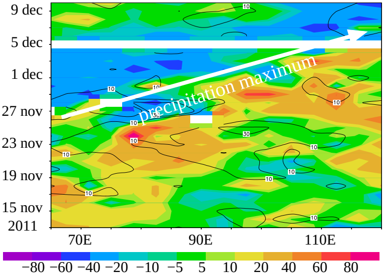

δD anomaly (‰)
q anomaly (contours, %)

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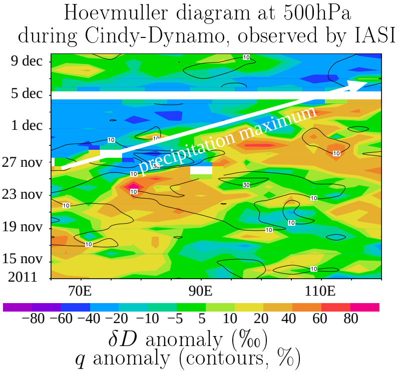

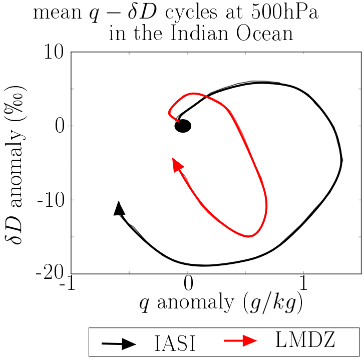

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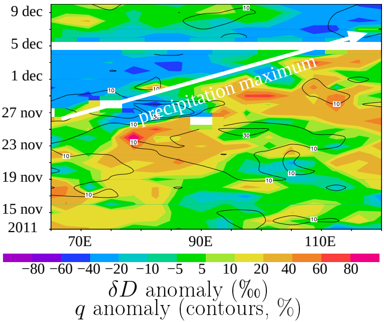
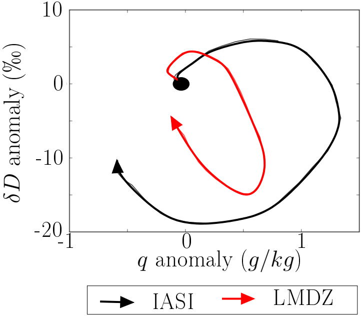


mean $q - \delta D$ cycles at 500hPa
in the Indian Ocean



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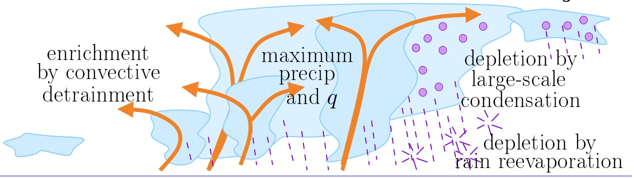

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- isotopic CRMs to study processes
  - e.g. SAM (Blossey et al 2010, Moore et al 2014)
  - compare with SCMs? e.g. RCE simulations, campaign cases, conditional sampling (e.g. Couvreux et al 2010)