

Process-evaluation of tropical and subtropical tropospheric humidity simulated by general circulation models using water vapor isotopic measurements

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Thanks to: D Noone, S Bony,
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Uncertainties in humidity change projections

- ▶ tropical and subtropical free tropospheric relative humidity strongly impacts
 - ▶ water vapor feedback (*Soden et al 2008*)
 - ▶ clouds feedbacks (*Sherwood et al 2010*)
 - ▶ deep convection (*Derbyshire 2004*)

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⇒ need process-based evaluation of humidity in climate models

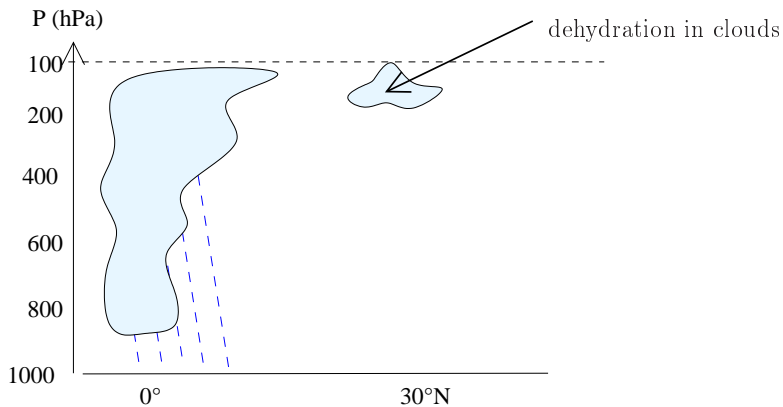
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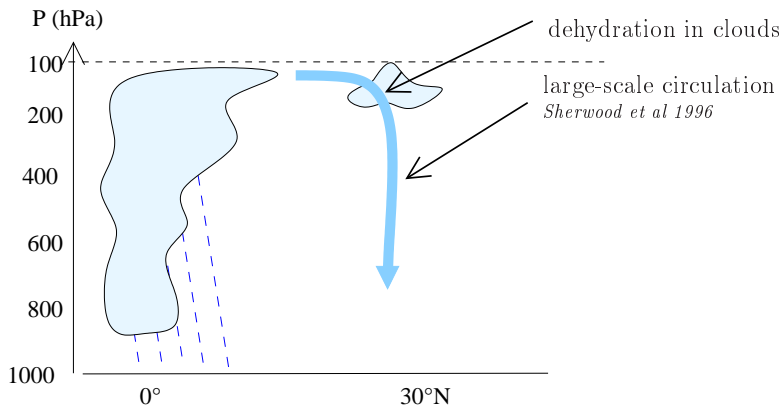
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⇒ Goal: design observational diagnostics to evaluate processes controlling relative humidity, detect and understand biases?

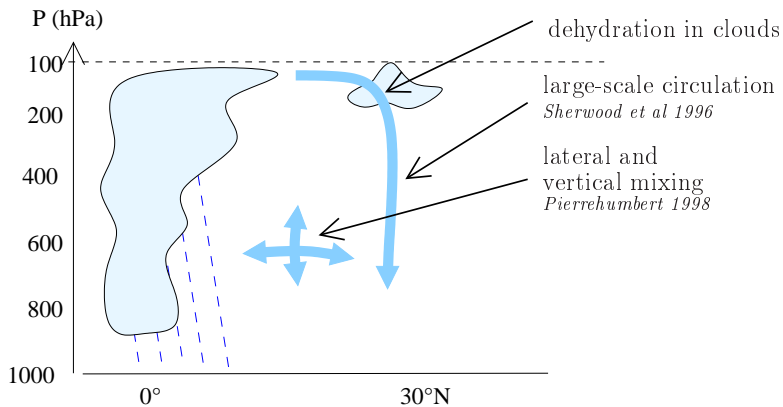
Processes controlling relative humidity



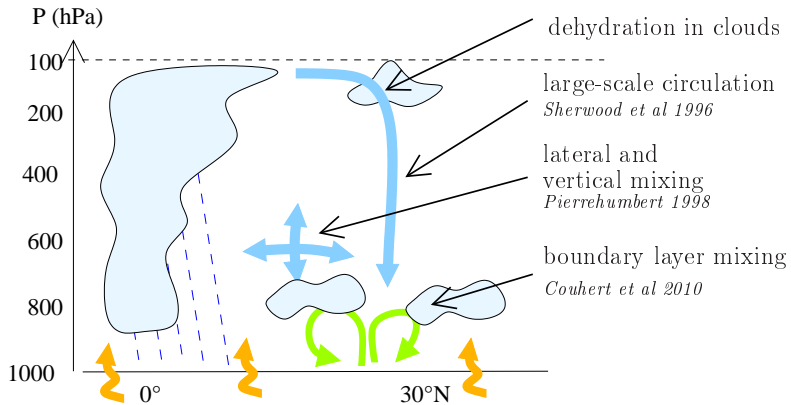
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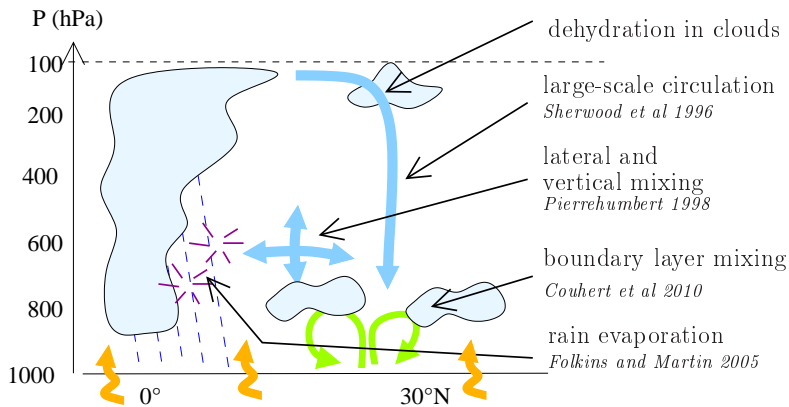
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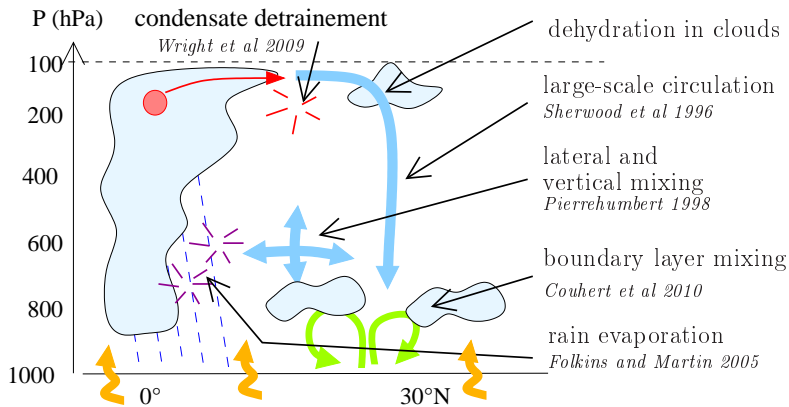
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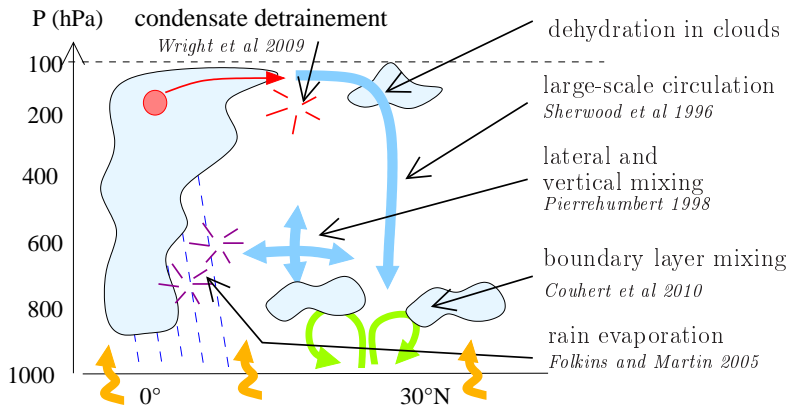
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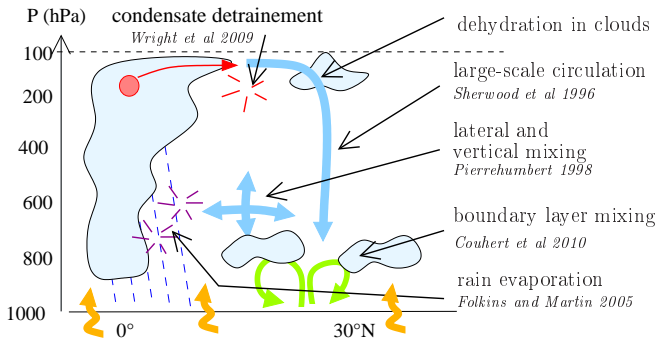
Processes controlling relative humidity



- ▶ Water vapor isotopes are sensitive to these processes

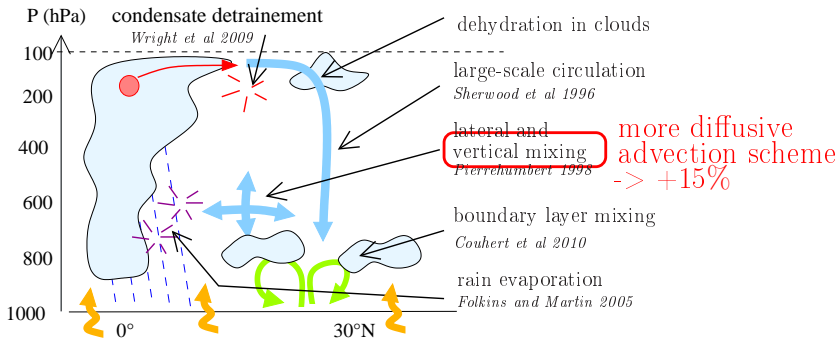
Model simulations

- ▶ LMDZ-iso (*Risi et al 2010*), control simulation = AR4 version
- ▶ 3 possible reasons for moist bias in mid and upper troposphere:



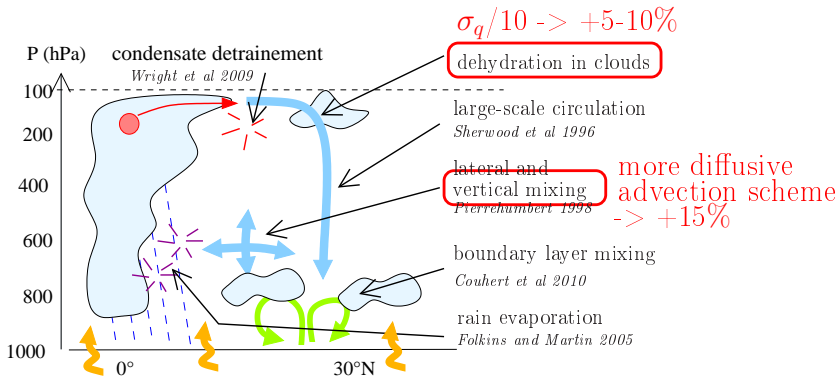
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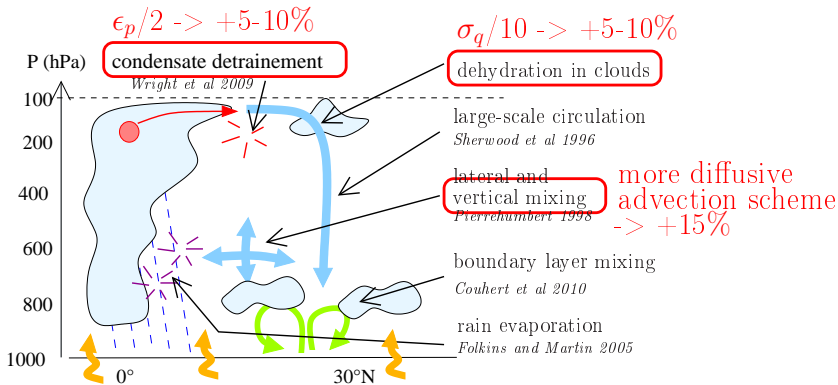
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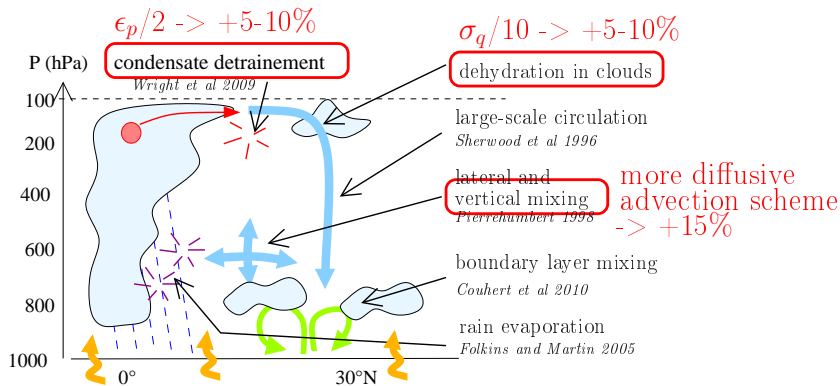
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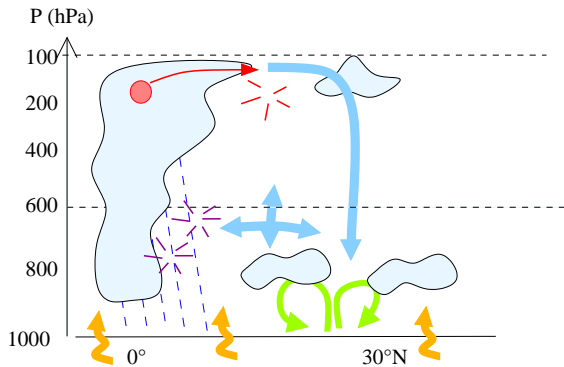
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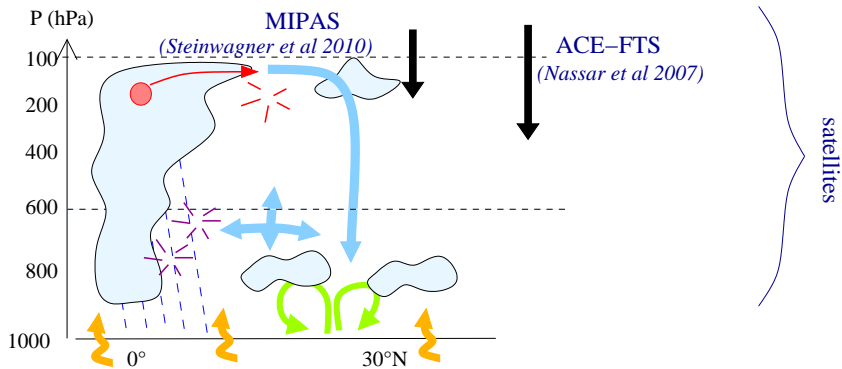


⇒ water isotopes to detect these different reasons for moist bias?

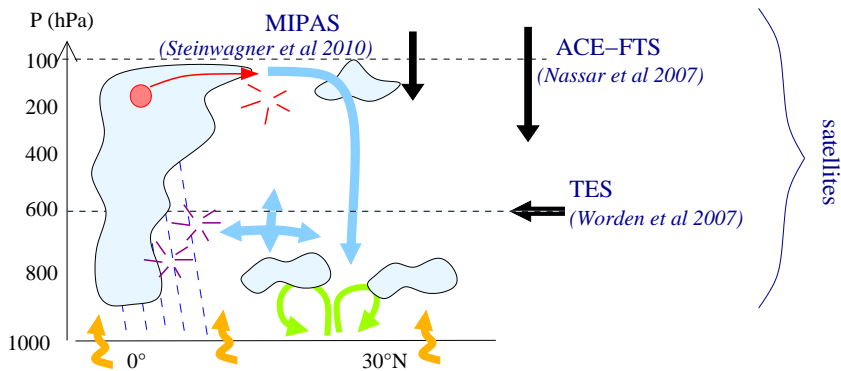
3D isotope measurements



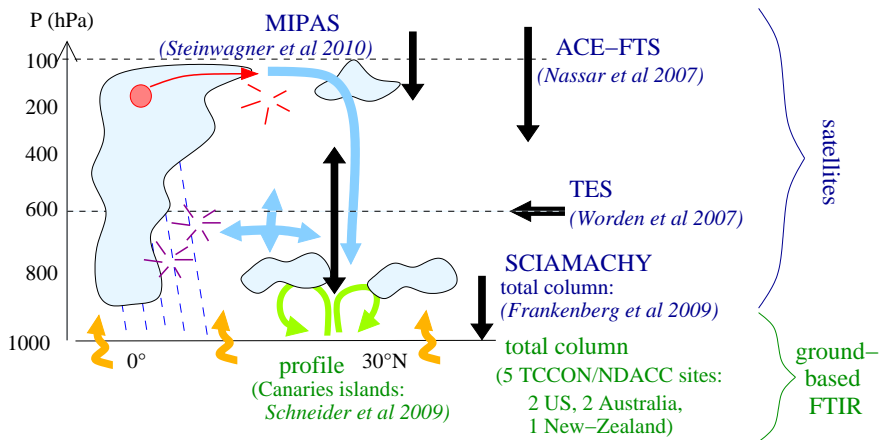
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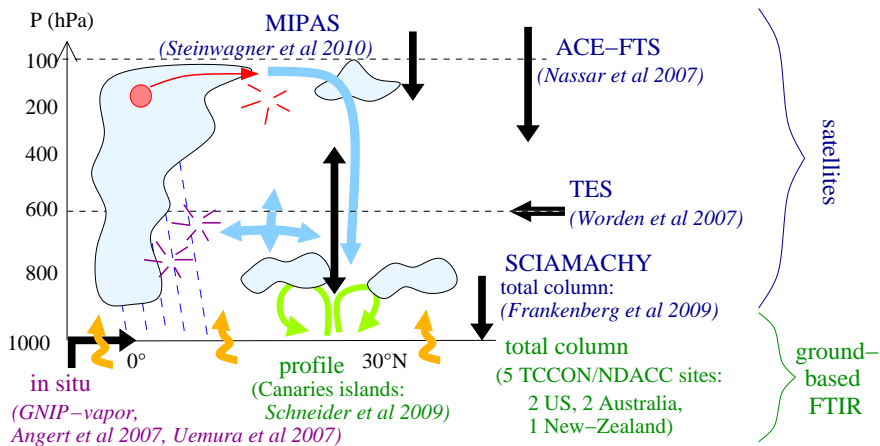
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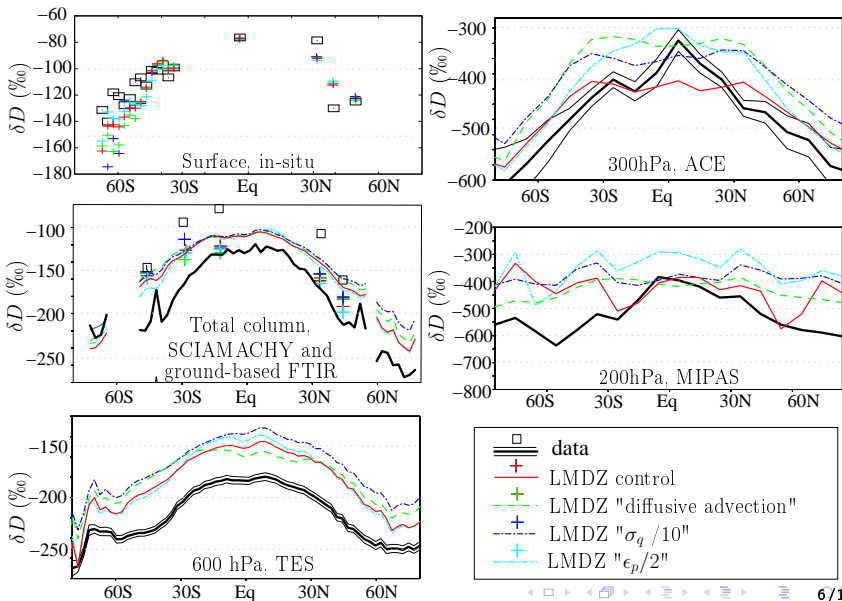
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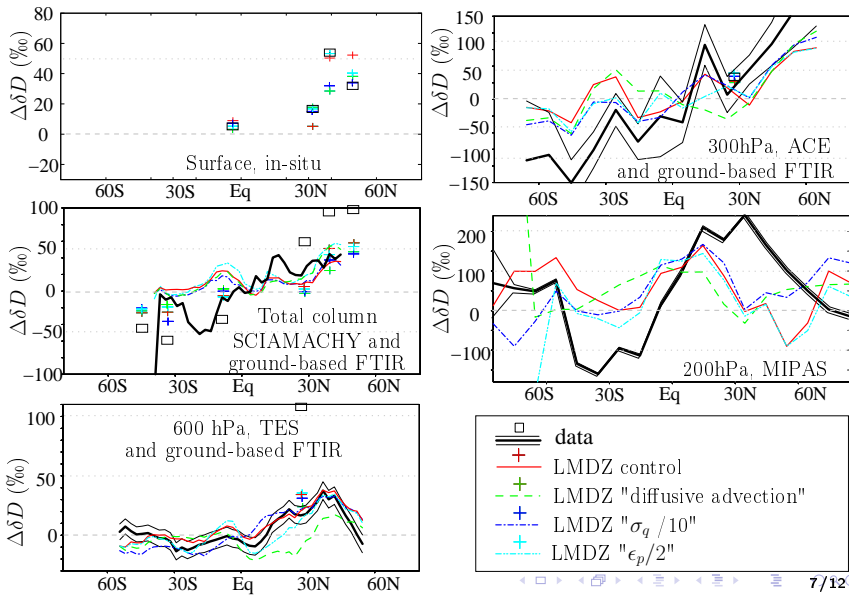
3D isotope measurements



Multidataset evaluation: annual zonal mean



Multidataset evaluation: seasonal (JJA-DJF)



Summary: isotope diagnostics for moist bias

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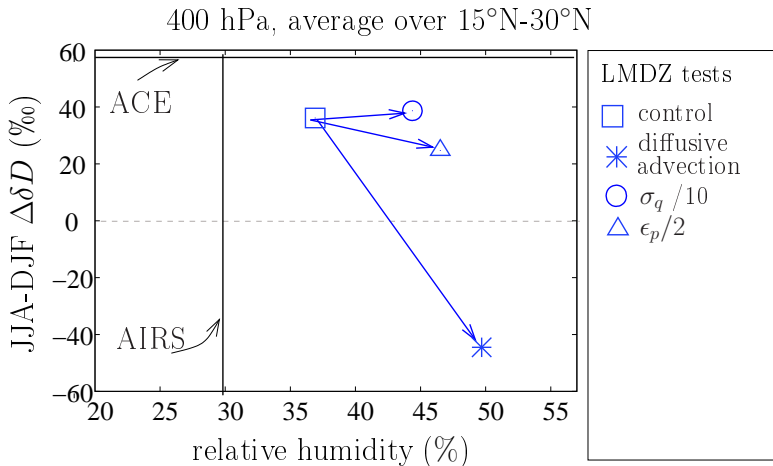
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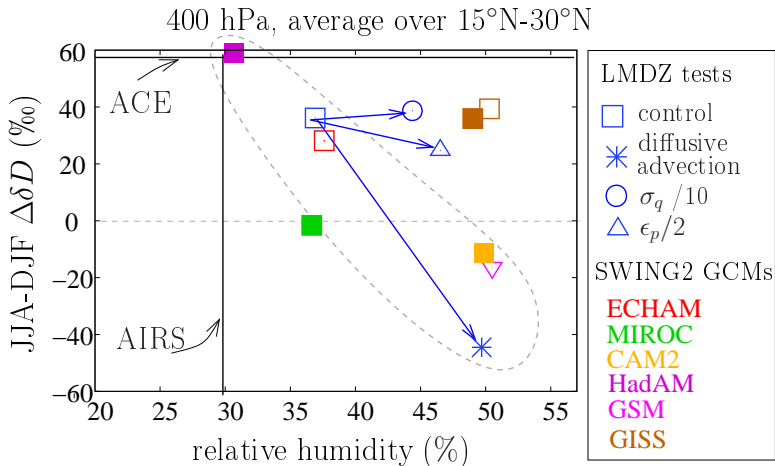
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δD is too high in upper troposphere	condensate detrainment too strong

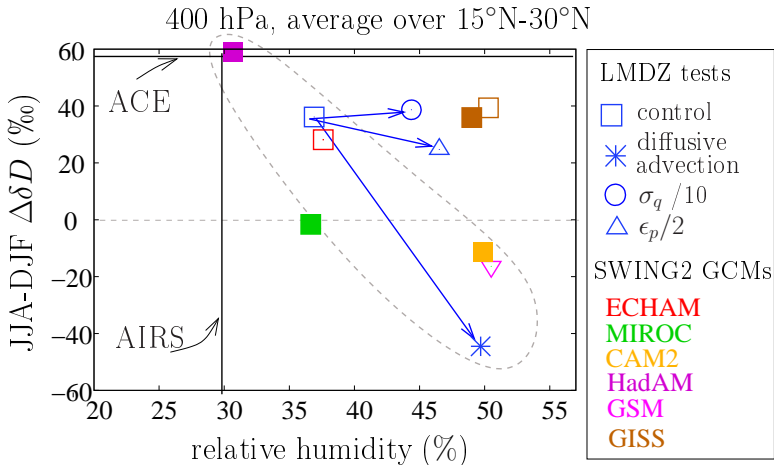
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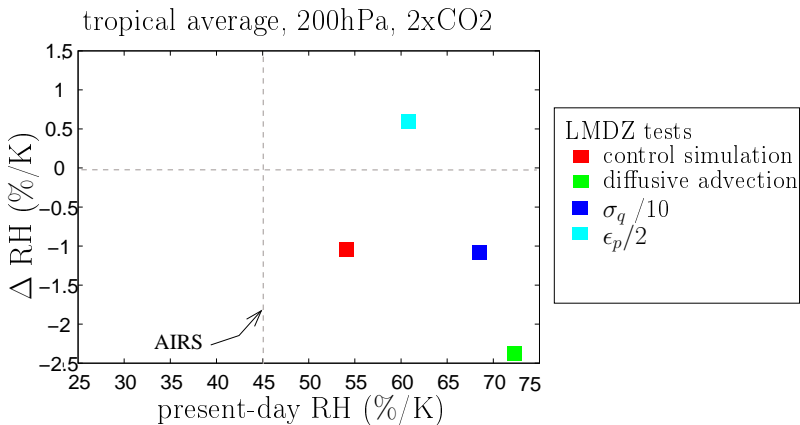


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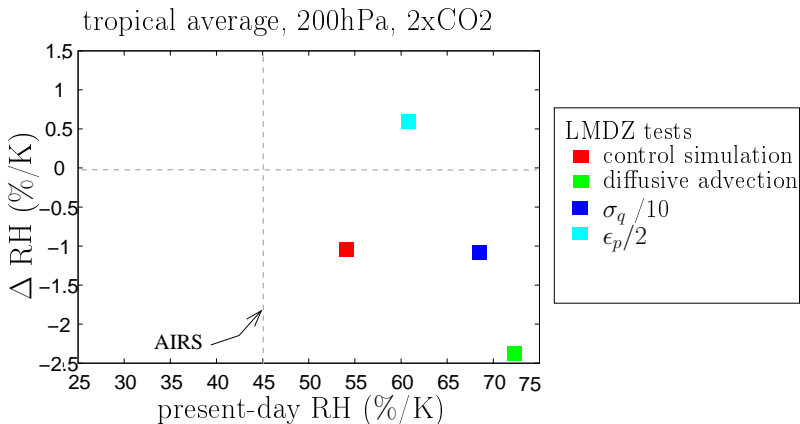


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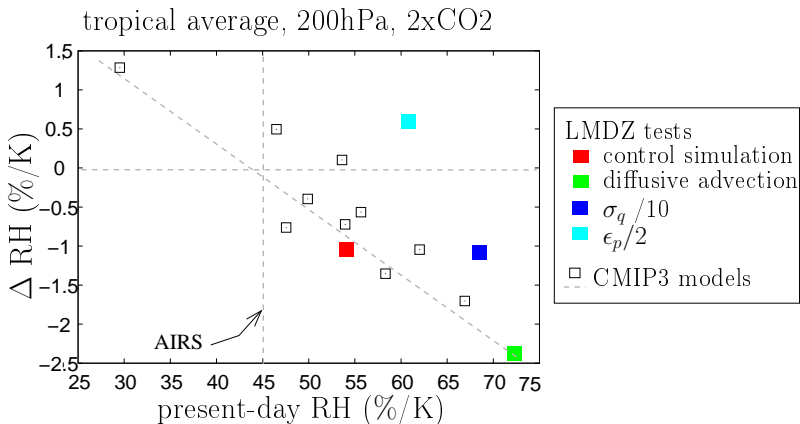


What impact on humidity projections?



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- ▶ Improving/extending isotope diagnostics

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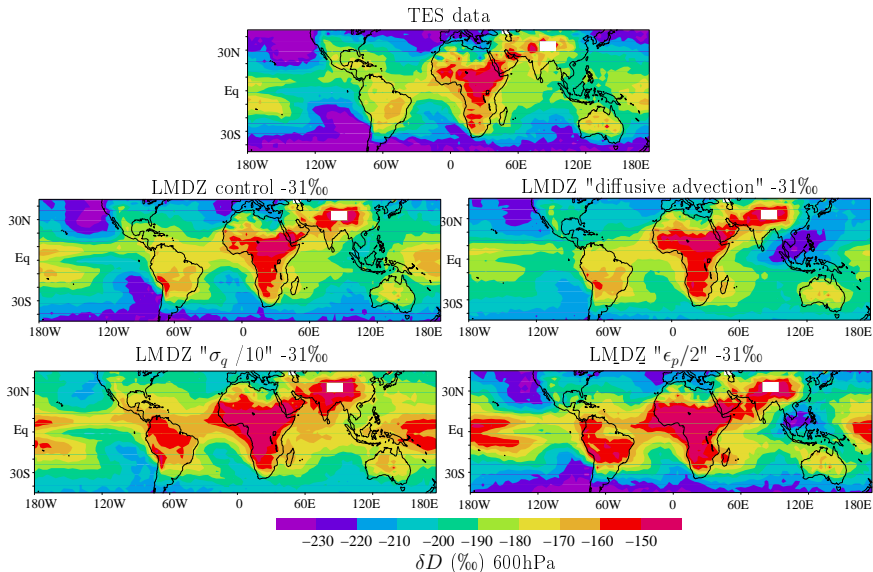
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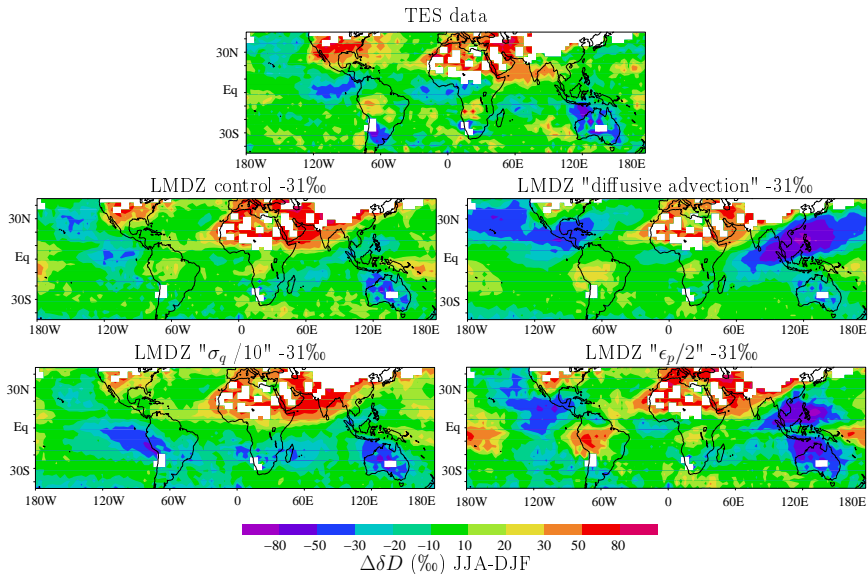
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 - ▶ Water isotopes in CMIP?

Supplementary material

Annual mean δD in TES at 600hPa

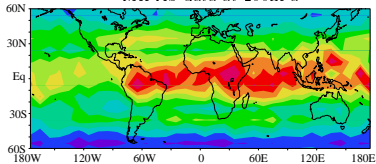


Seasonal variations in TES

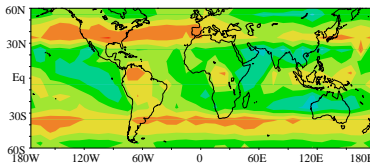


Annual mean in MIPAS

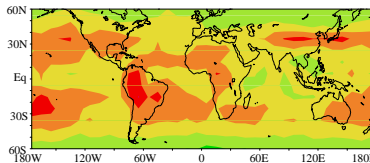
MIPAS data at 200hPa



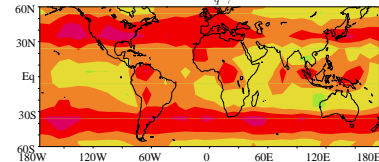
LMDZ control



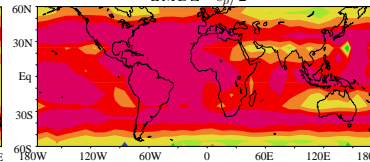
LMDZ "diffusive advection"



LMDZ " $\sigma_q / 10$ "



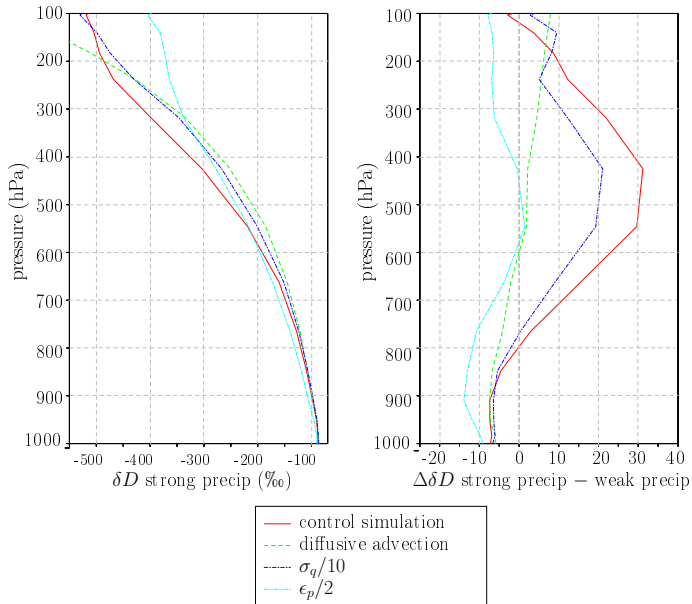
LMDZ " $\epsilon_p / 2$ "



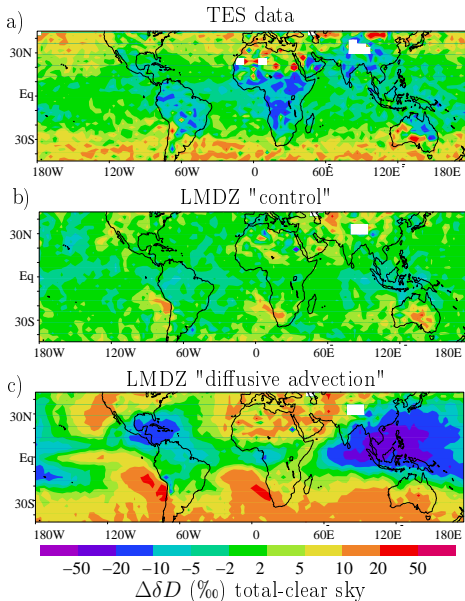
-700 -640 -600 -560 -520 -480 -440 -400 -360 -320

δD (‰) total column

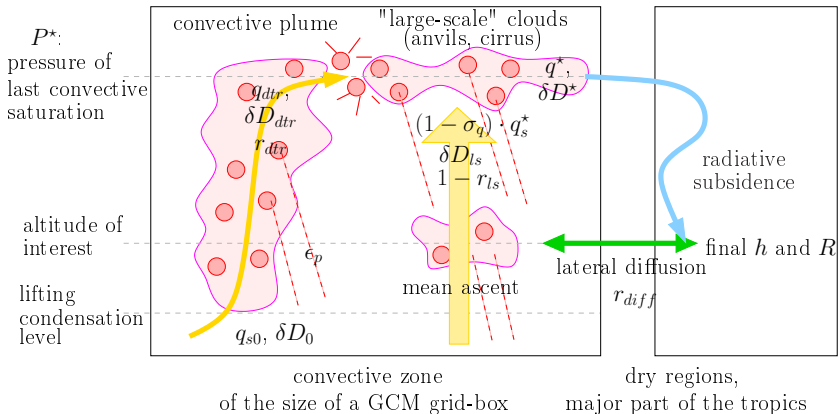
Effect of convection on isotopic profiles



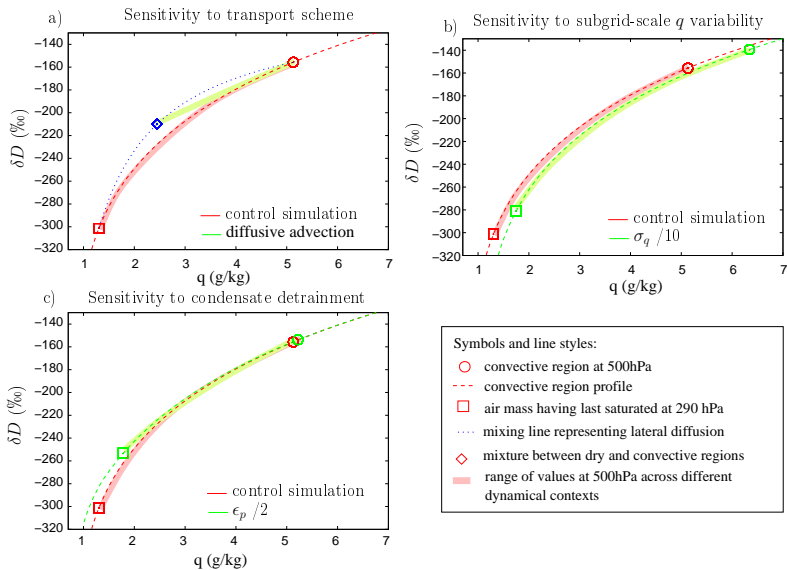
Evaluation of the link δD -cloud cover in TES



Theoretical framework



Interpretation of the sensitivity tests



Validation of the theoretical framework

