Apport des mesures isotopiques dans la vapeur d'eau pour évaluer la représentation des processus convectifs dans les modèles de climat

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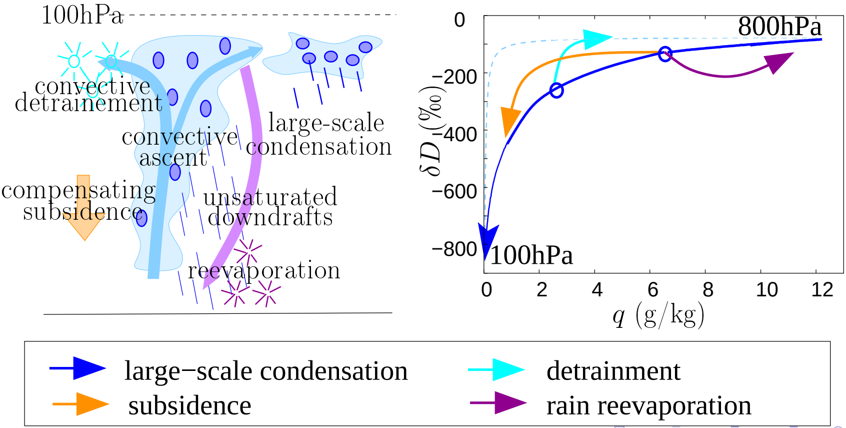
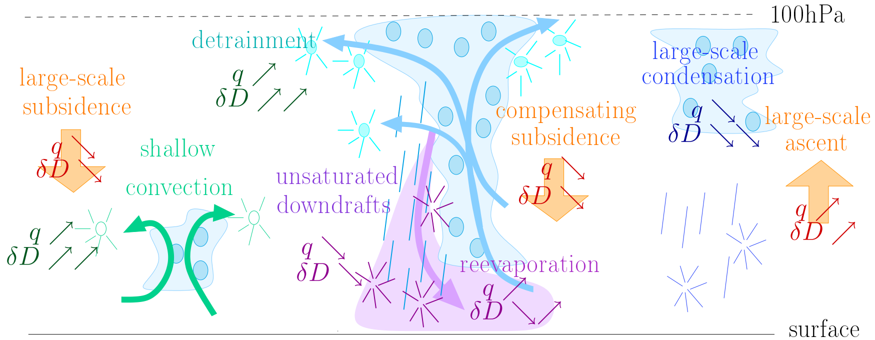
Water vapor isotopes

- $\delta D = ((HDO/H_2O)/R_{oce} - 1) \cdot 1000$ (‰)
- measured from space (TES, IASI, MIPAS, ACE)
- added value compared to q? Theoretical framework -> moistening and dehydrating processes *(Worden et al 2007)*



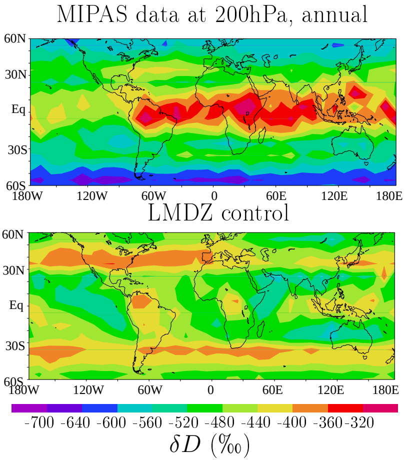
Effect of convective processes on vapor δD

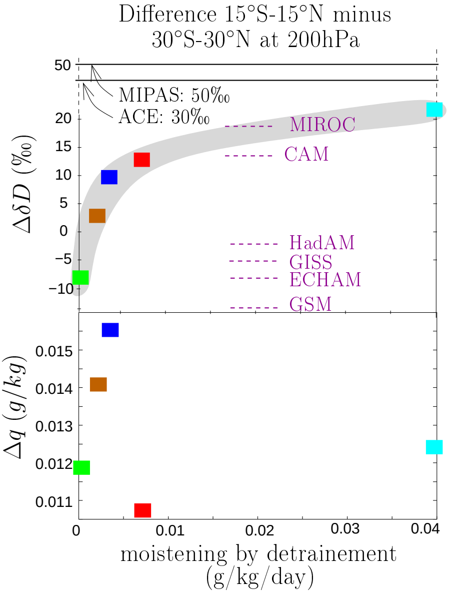


4 examples in this talk:

1. Upper convective detrainment
2. Deep convection/LS condensation
3. Shallow/Deep convection
4. Temporal sequence of convective and cloud processes

1) Upper convective detrainment

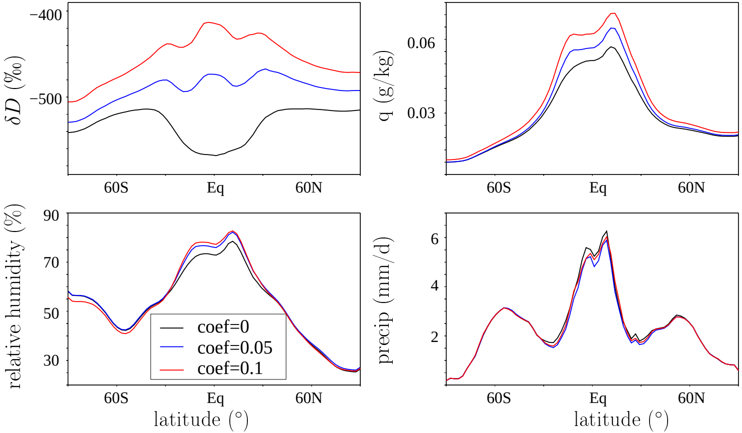




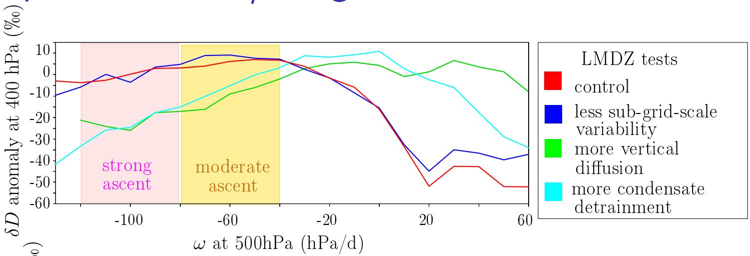
- control
- vertical advection more diffusive
- stronger condensate detrainment
- less large-scale condensation
- less large-scale precipitation

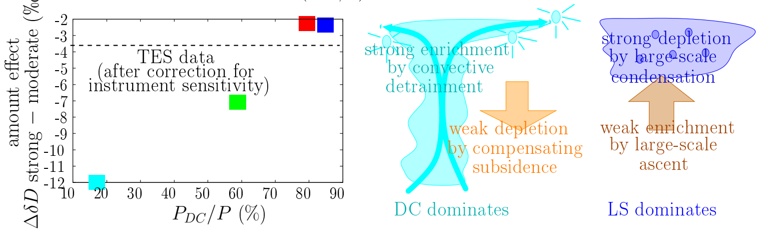
Variable convective precipitation efficiency?

- Preliminary test with LMDZ: $\epsilon_p^{max,eff} = \epsilon_p^{max} - coef \cdot \sqrt{CAPE}$



2) Deep convection/ large-scale condensation

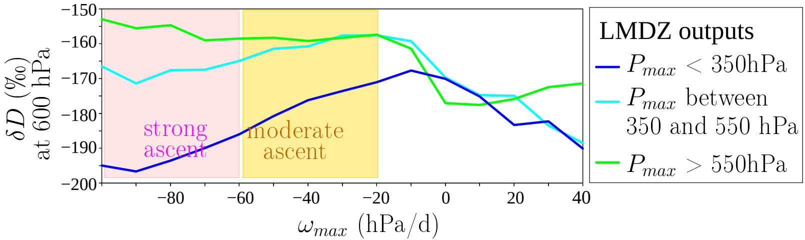


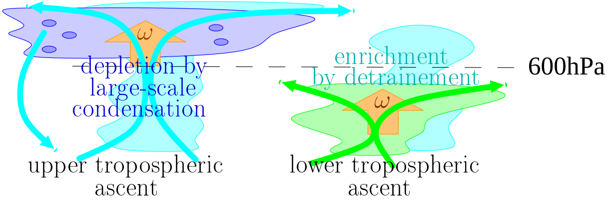


- conv vs LS precipitation= arbitrary, model-specific choice, but consequences on latent heating profiles, transport, cloudiness...

⇒use water isotopes to evaluate conv vs LS precip partitionning?

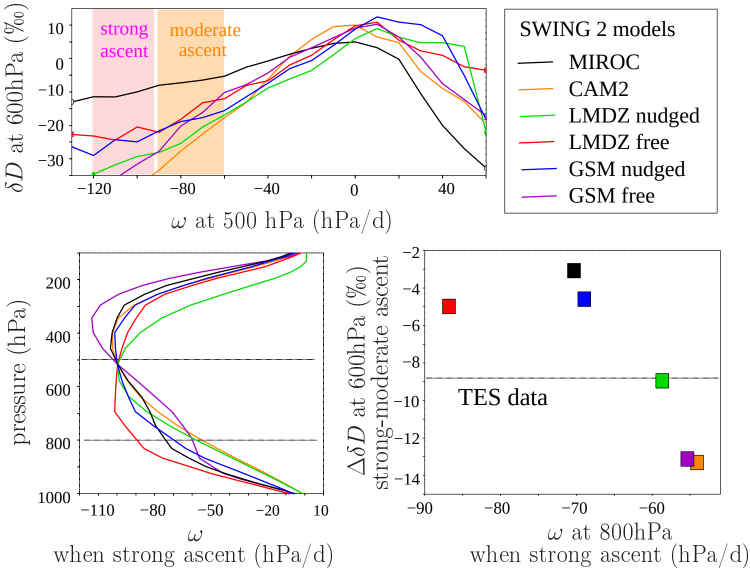
3) Shallow/deep convection





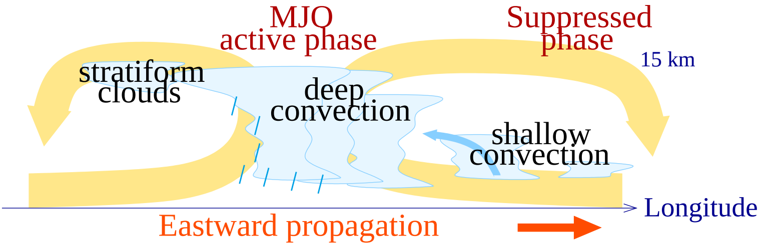
- Precipitation depletes the vapor more if top-heavy ascent
- Consistent with TES and IASI
- Evaluate deep/shallow and associated LS circulation?
- Implication: link with cloud feedbacks (*Sherwood et al 2014*)?

Multi-model comparison



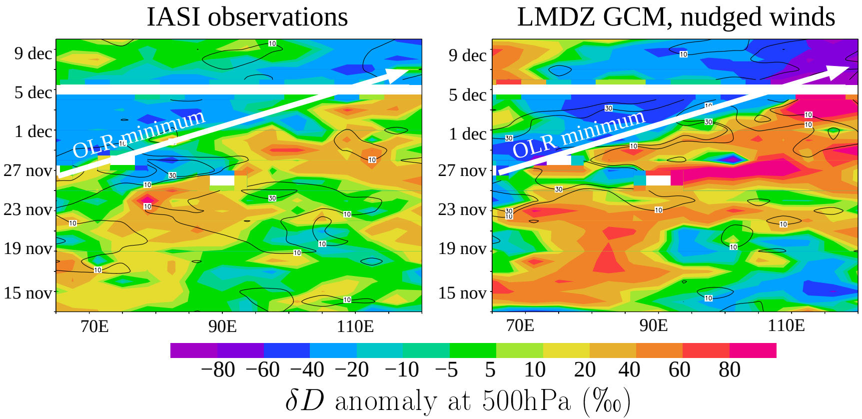
4) Temporal sequence of convective and cloud processes

- during convective life cycle (on-going using MCS tracking, *Fiolleau and Roca 2013*)
- during MJO events



- GCMs have difficulties to simulate the MJO (*Hung et al 2013*)

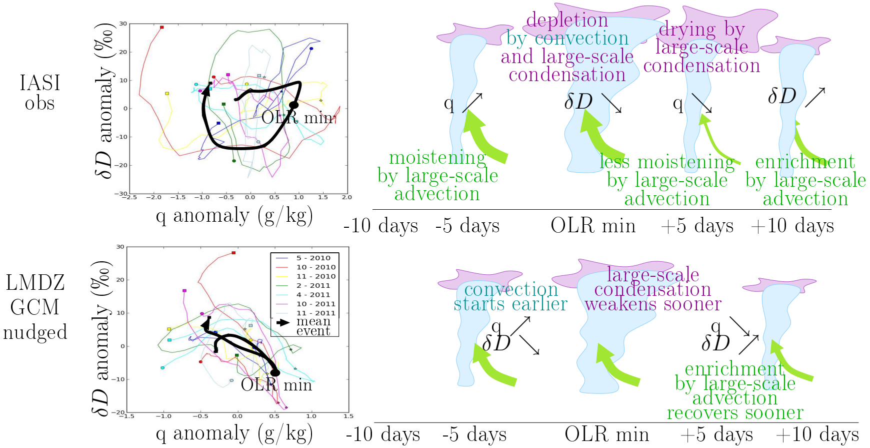
Cindy Dynamo campaign case



- Observed q max 0-1 days before OLR min
- Observed δD min 3 days after OLR min
- LMDZ, when nudged, captures these features for this case

q-δD cycles in Indian Ocean

q-δD cycles at 500 hPa for 7 MJO events at 80°E



Tuinenburg et al 2015

-> on-going: sensitivity tests, link with MJO simulation?

Conclusion

- In upper troposphere: $\delta D \nearrow$ with condensate detrainment constrain on convective detrainement
  -> precipitation efficiency cannot be constant?
- In mid-troposphere, $\delta D \nearrow$ with deep convection and $\searrow$ with LS condensation
  -> constrain this proportion and associated latent heat profiles?
- In lower troposphere: $\delta D \nearrow$ with shallow convection and $\searrow$ with deep convection
  -> constrain this proportion, associated latent heat profiles and large-scale circulation?
- Application during the MJO, $q - \delta D$ suggests that convection triggers too soon and large-scale condensation is not maintained long enough? -> understand why models have difficulties to simulate the MJO, discriminate between different model versions?