Use of isotopes for process-oriented diagnostics

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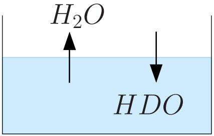
Macao, October 27, 2013

Added value of water isotopes



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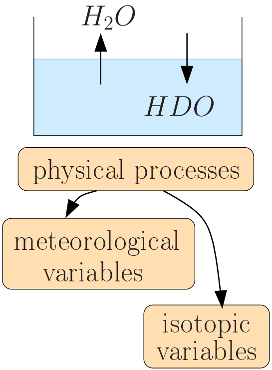

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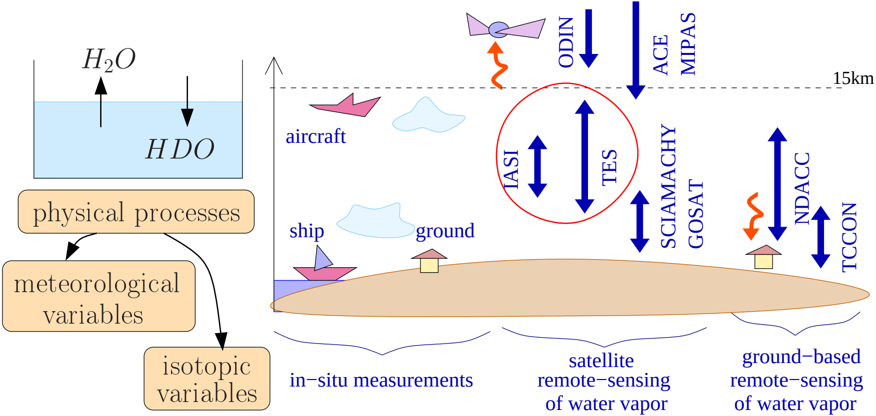
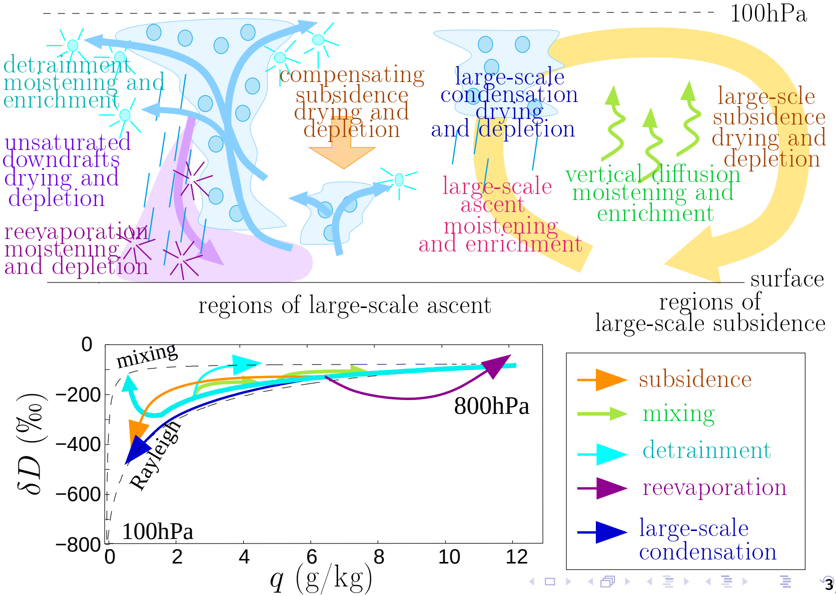


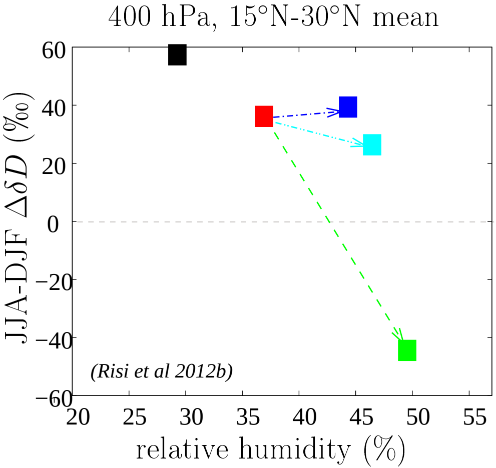
Controls on water vapor isotopic composition



Example: cause of moist bias in GCMs?

Sensitivity tests:
with LMDZ:

- Control
- Excessively diffusive vertical advection
- Excessive condensate detrainement
- Insufficient in-situ condensation
- AIRS/ACE data



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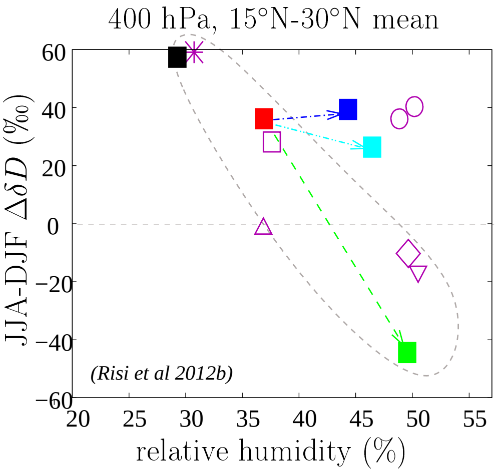
SWING2 models:

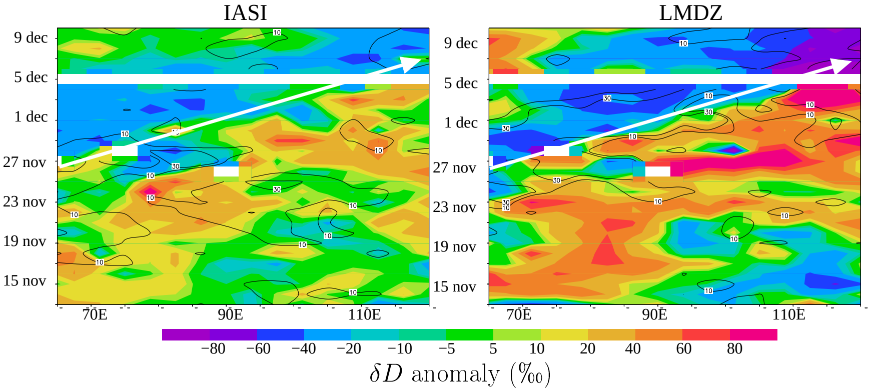
- ECHAM
- MIROC
- HadAM
- CAM2
- GISS
- GSM



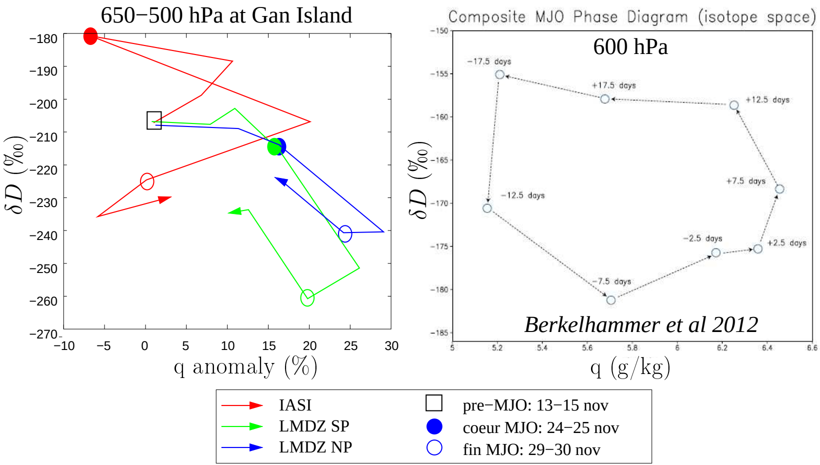
- frequent reason for moist bias=excessively diffusive advection

Water isotopes during Cindy Dynamo

- Hovmuller diagrams at 500hPa, 10°S-10°N average



Cycles q-δD



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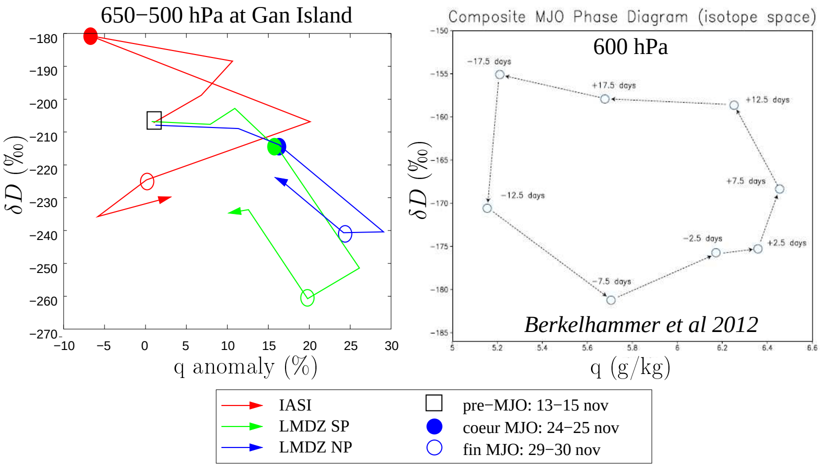

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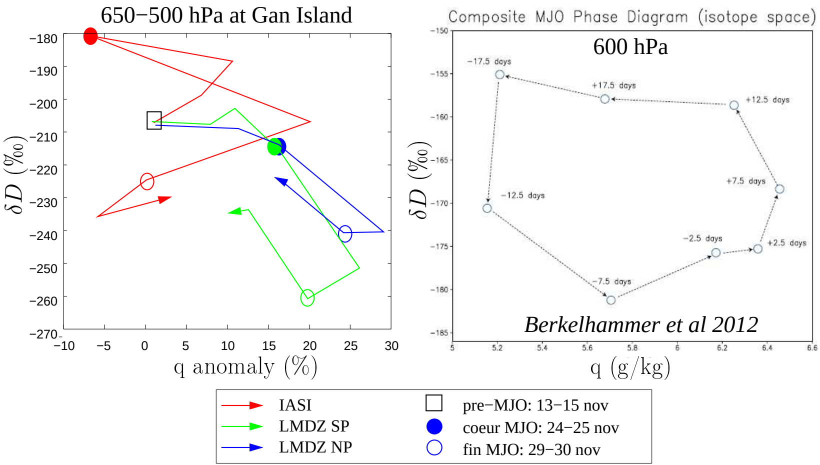
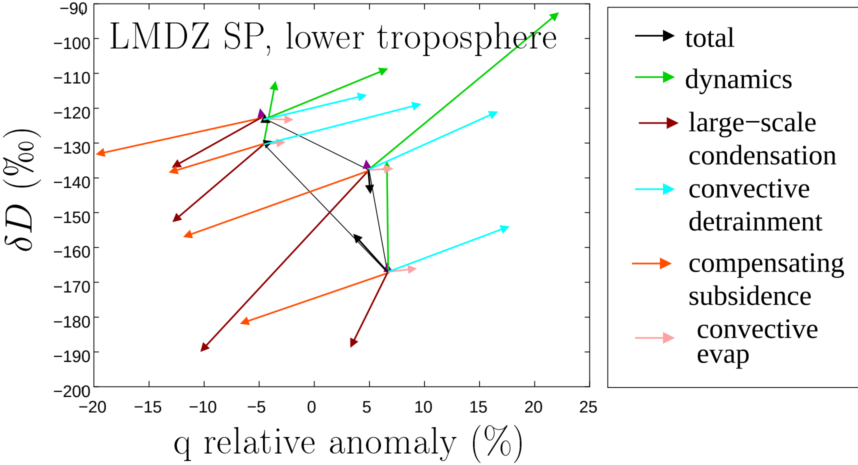
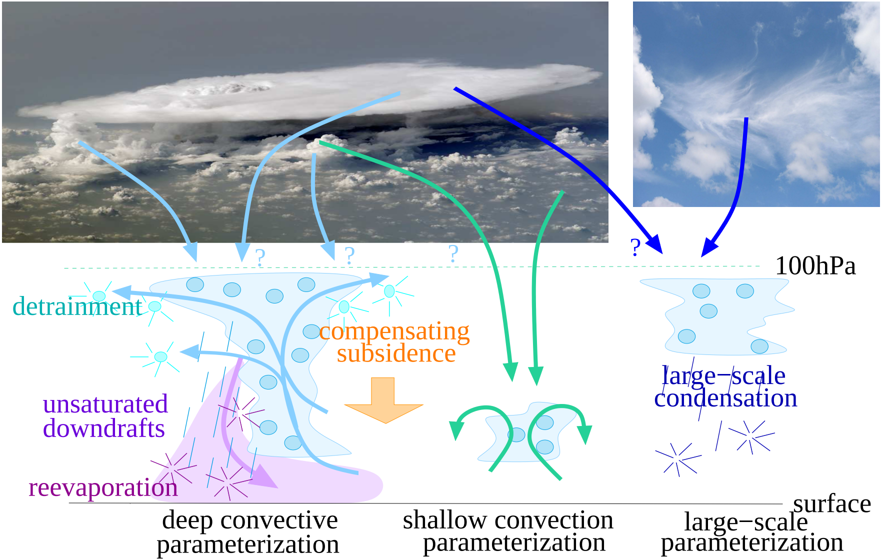


- depends on location/season? altitude? type of event?
- use sign/shape as a process-oriented diagnostic?

Tendances from different processes



Convection vs large-scale schemes



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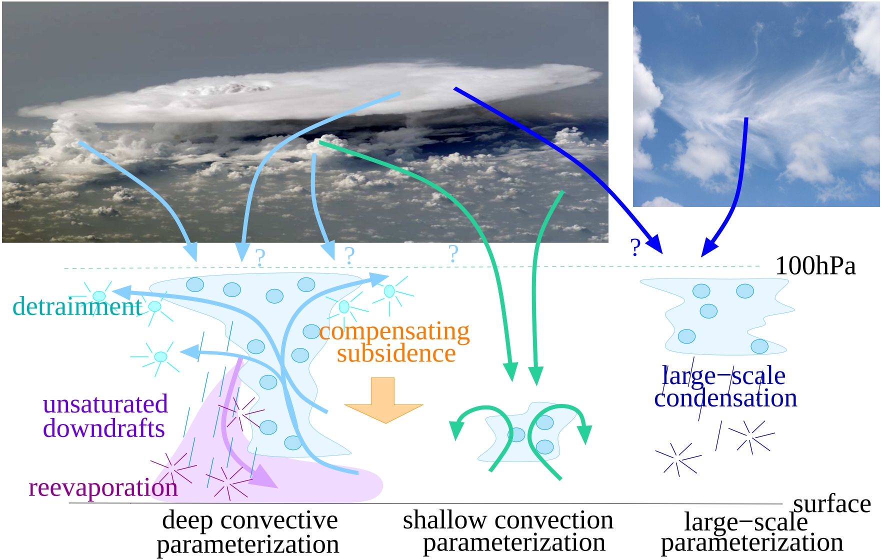

- conv vs large-scale precip arbitray

Why is the conv vs LS partitioning important?

arbitrary but affects:

- simulated climate and variability
  - heating rate large-scale circulation
  - cloudiness radiative effects
  - intra-seasonnal variability (Kim et al)
  - humidity transport

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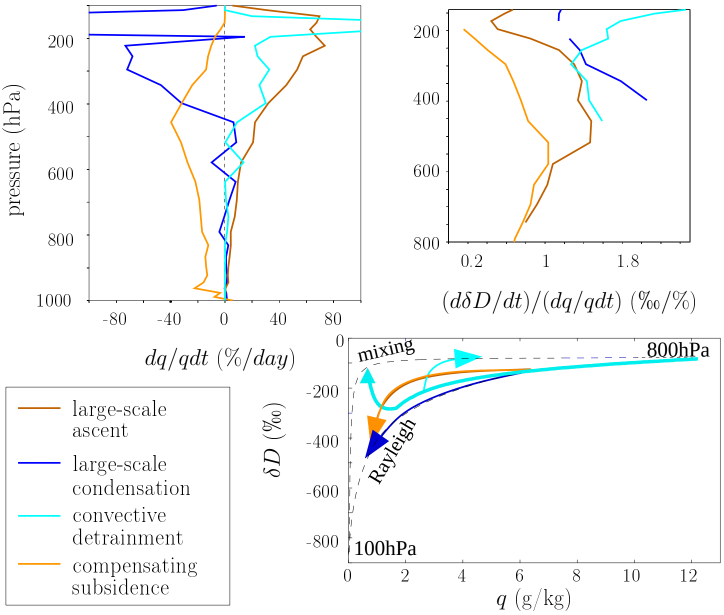
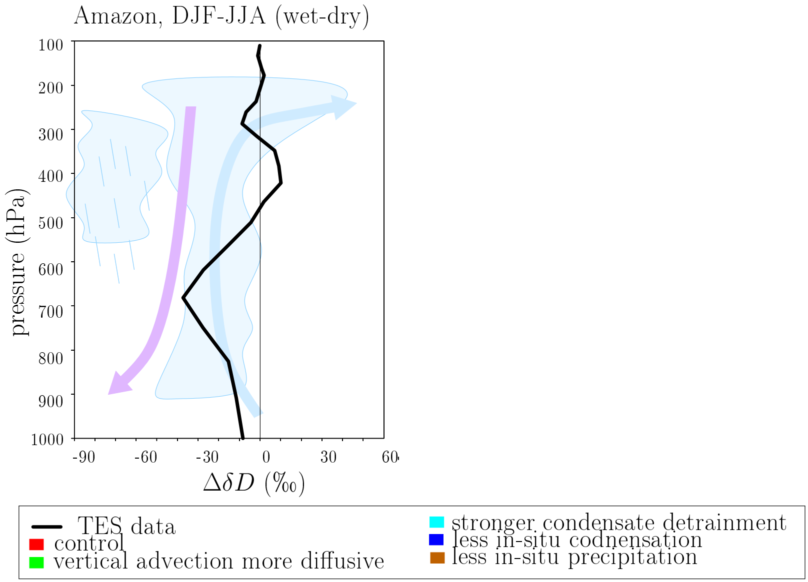
- things that can be used for model evaluation
  - chemical tracor transport
  - water isotopes

Tendencies from conv. vs large-sc. precip



Sensitivity tests in LMDZ



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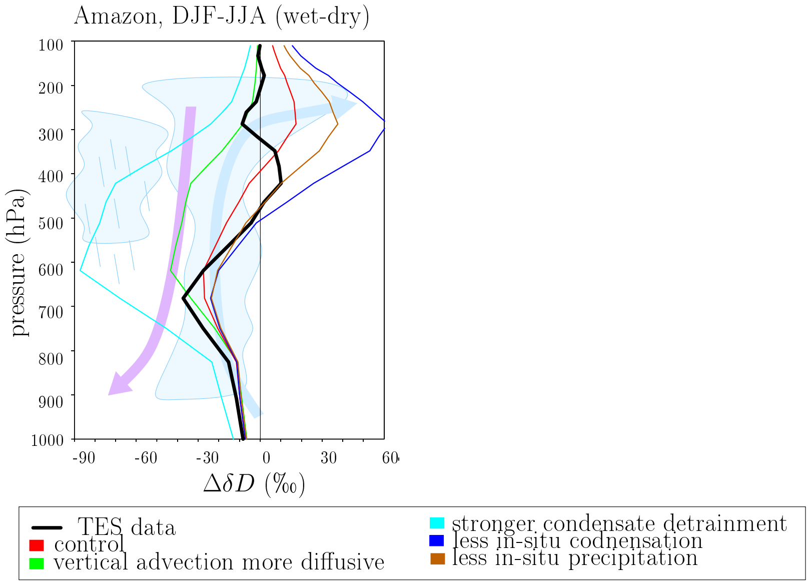

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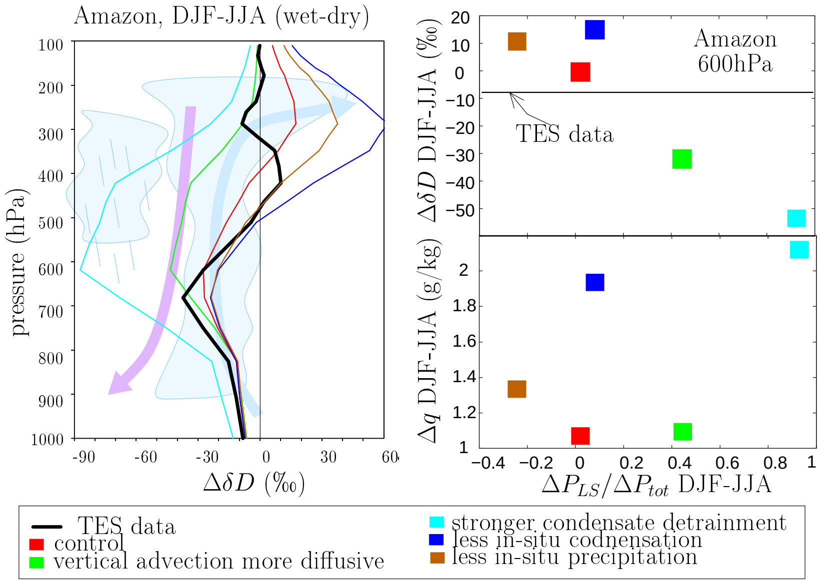

Conclusion

Summary

- δD informs about moistening and dehydrating processes
- $q - \delta D$ during MJO informs about relative timing of processes
- precipitating events deplete the tropospheric vapor all the more as it is associated with large-scale precipitation
  $\Rightarrow$use it more quantitatively to evaluate conv vs large-scale precip partitionning and underlying heating profiles

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More generally

- lots of measurements exist but are still under-exploited
- progress in understanding what controls tropospheric isotopic composition, but still work before we can reverse this understanding to use isotopic measurements quantitatively

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Perspectives

- Link with degree of organization?
- Combine q, δD + cloud $\Rightarrow$ better constrain large-scale precip
- Combine q, δD + chemical tracers: CO, O_3, ^{10}Be $\Rightarrow$ fluxes
- Comparisons with CRMs