Water vapor isotopic measurements to evaluate the representation of moist processes in models during Madden-Julian oscillation

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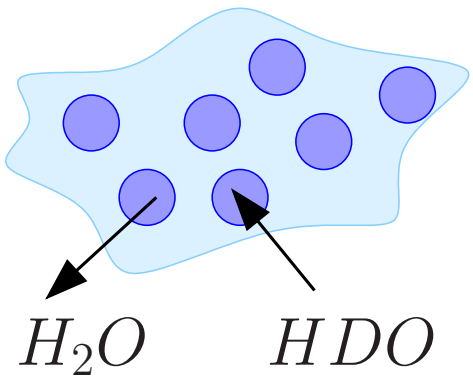
Montreal, August 16, 2014

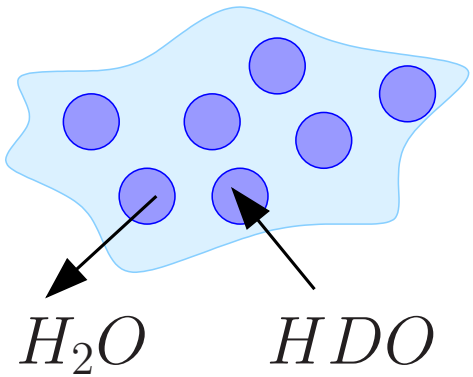
Water isotopes

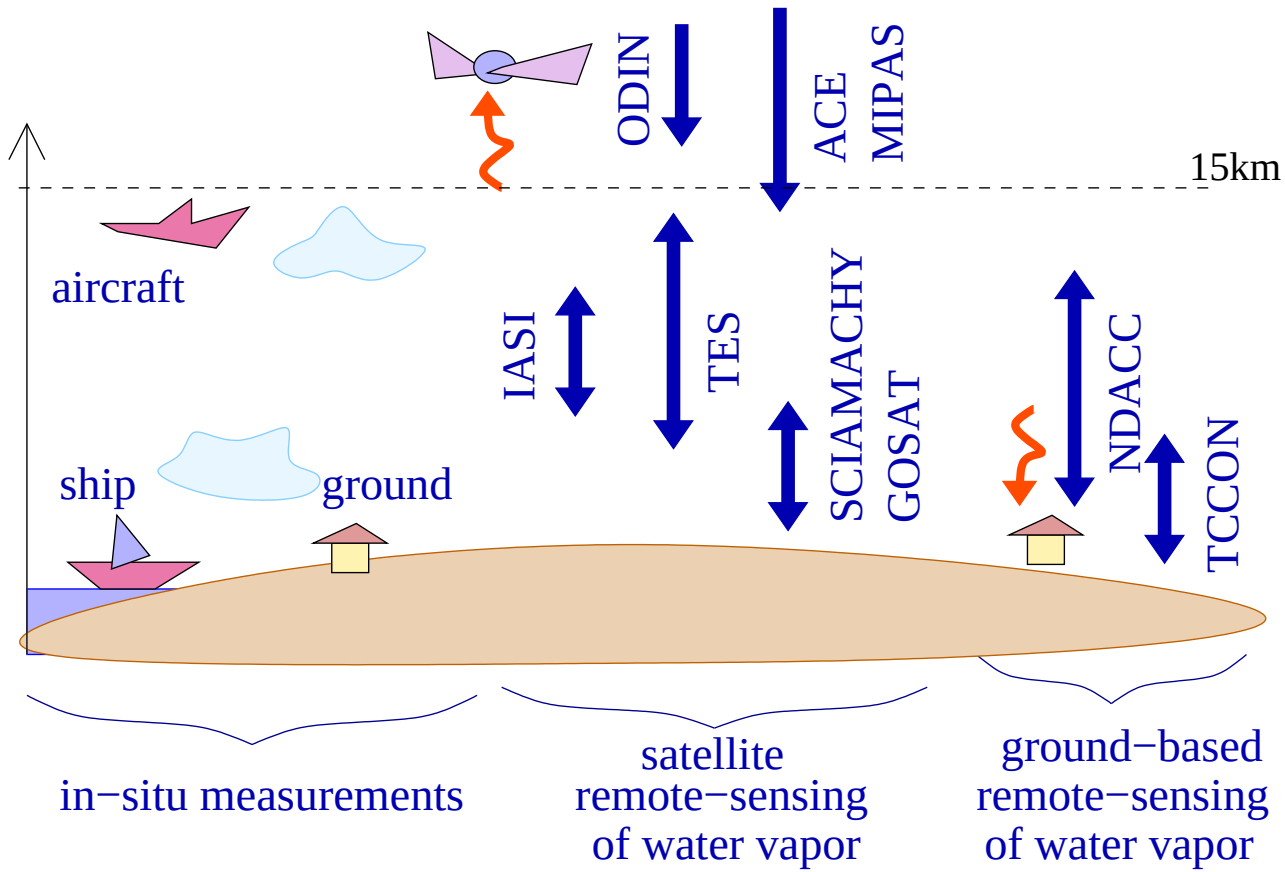


- Water isotopes track cloud processes
- δD in ‰

Water isotopes

- Measuring water vapor δD:





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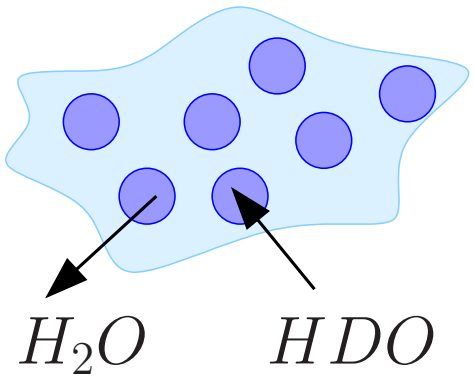

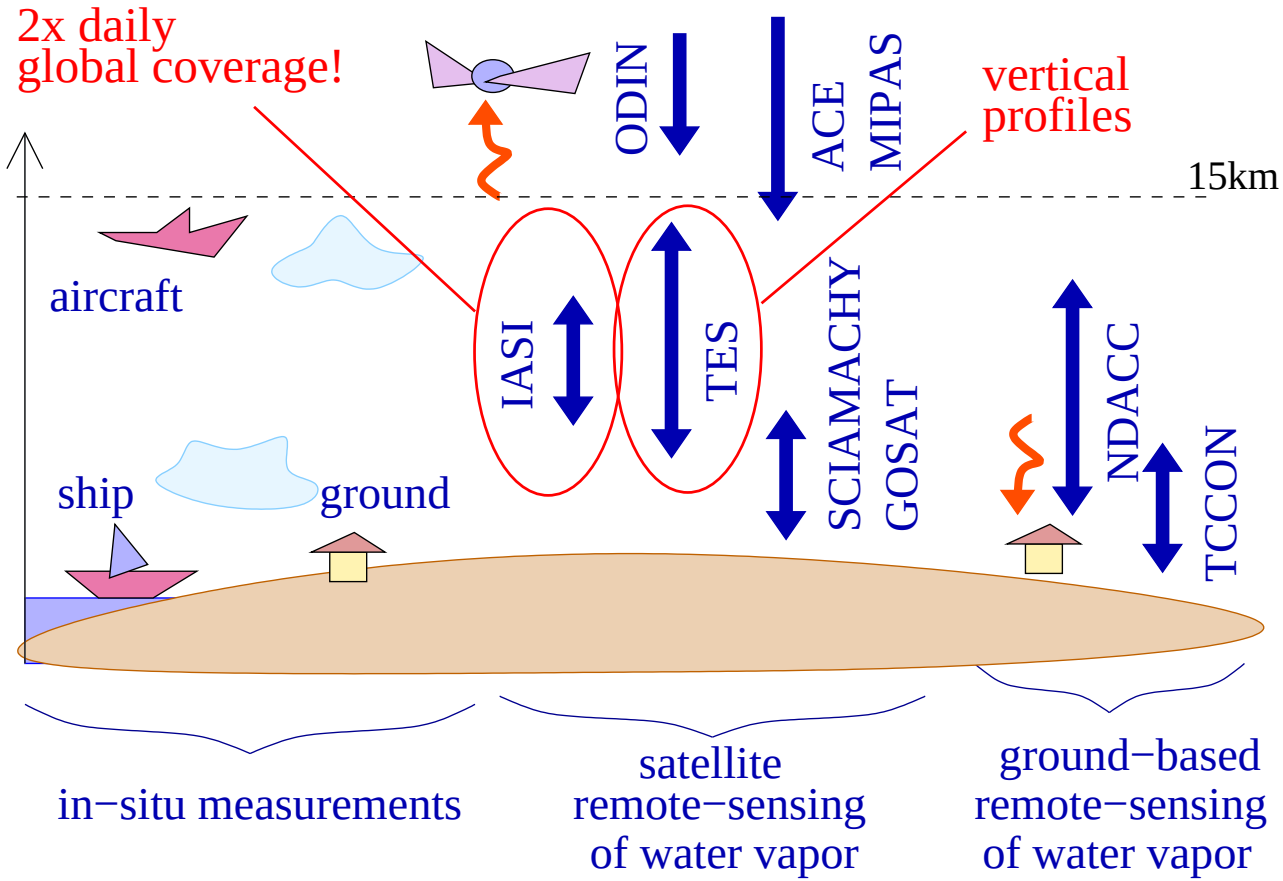

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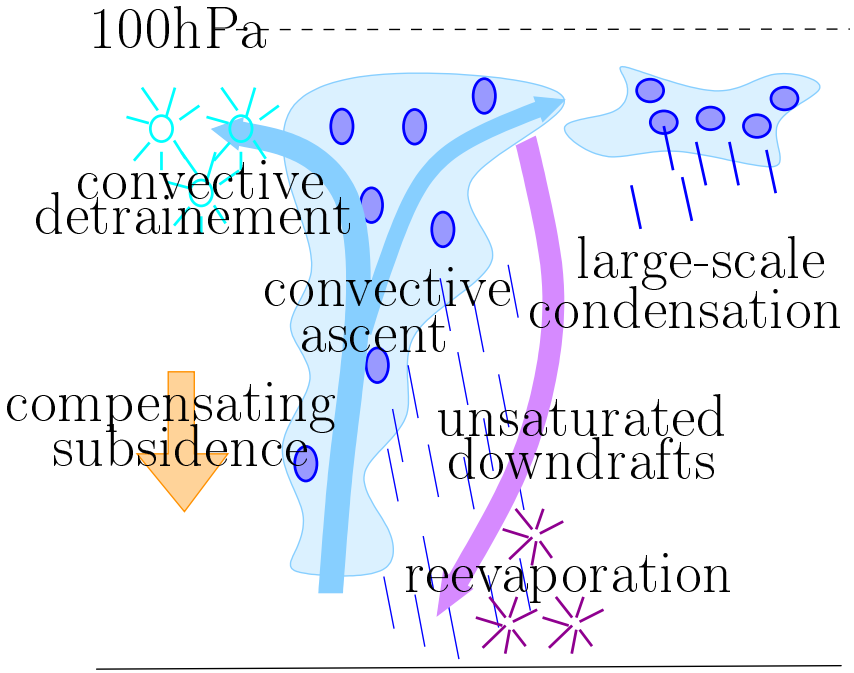
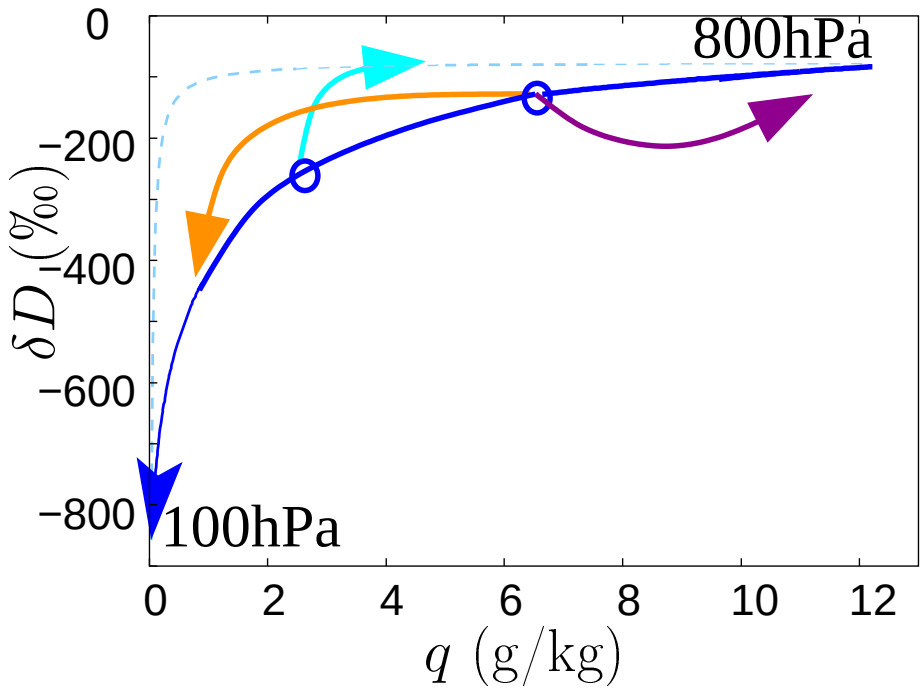
δD signature of moistening and dehydrating processes

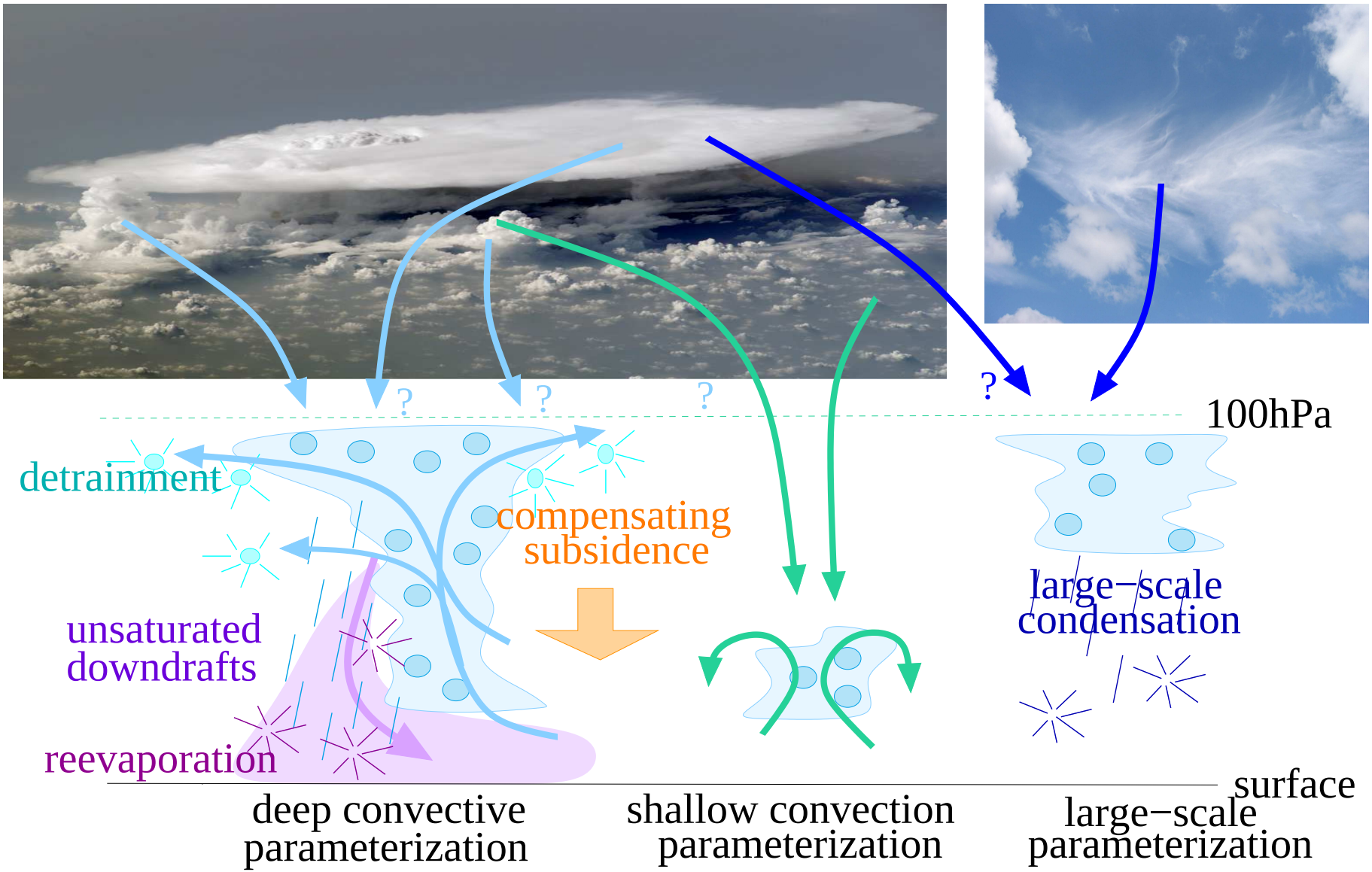




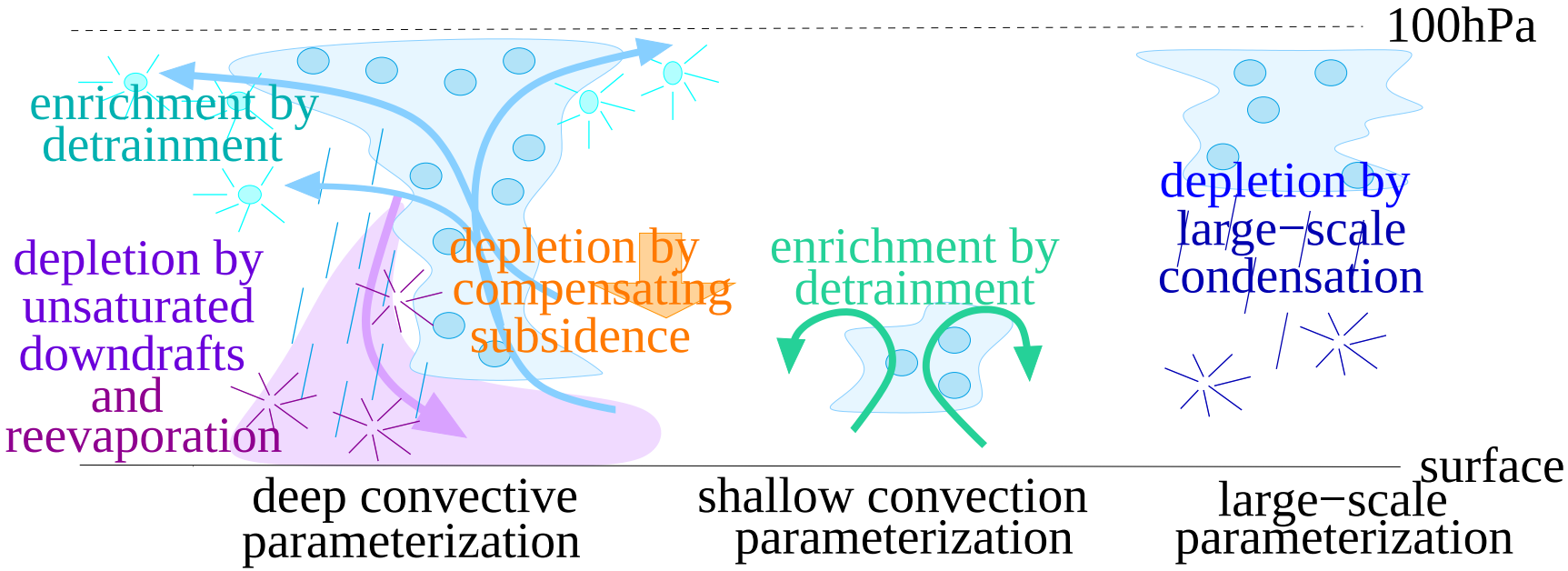
large−scale condensation
detrainment
subsidence
rain reevaporation

⇒distinguish between different moistening or dehydrating processes

Relative importance of cloud schemes



δD signature of the different cloud schemes



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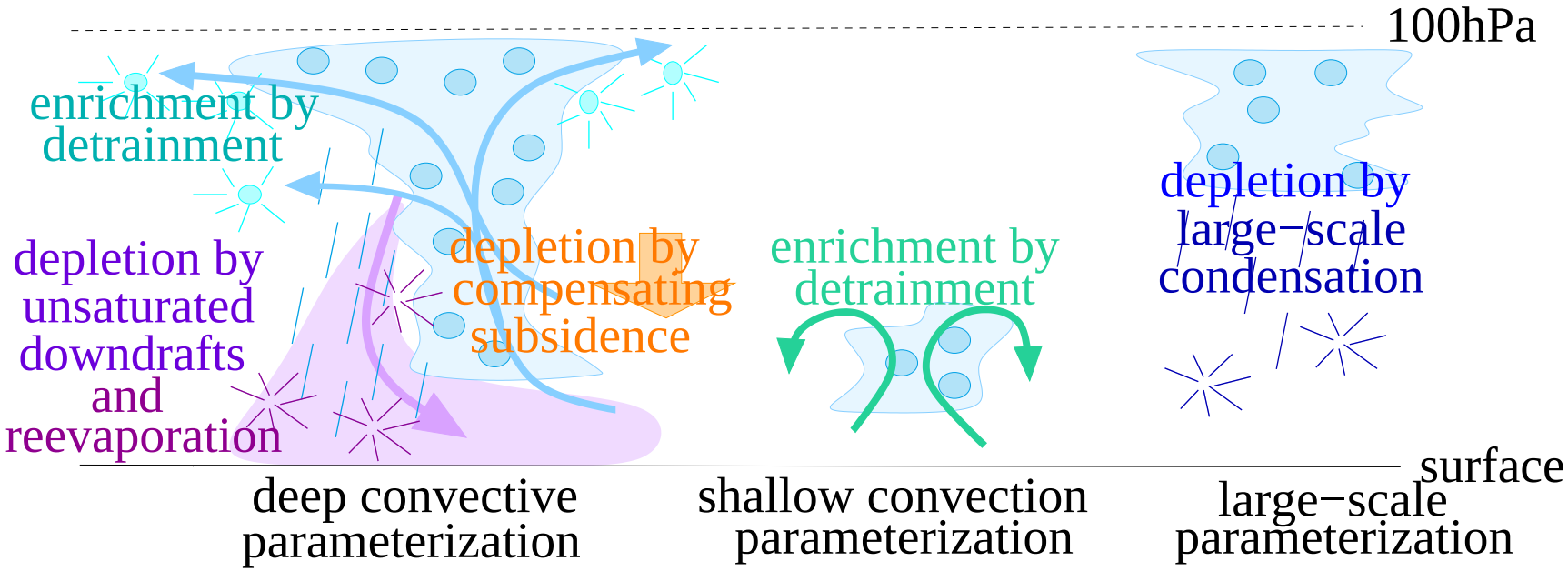

- In LMDZ GCM:
  - In upper trop, precipitating events deplete the vapor more when large-scale precipitation than when convection
  - In lower trop, vapor more enriched when shallow convection.
- IASI ,TES: vapor more depleted when ascent more top heavy

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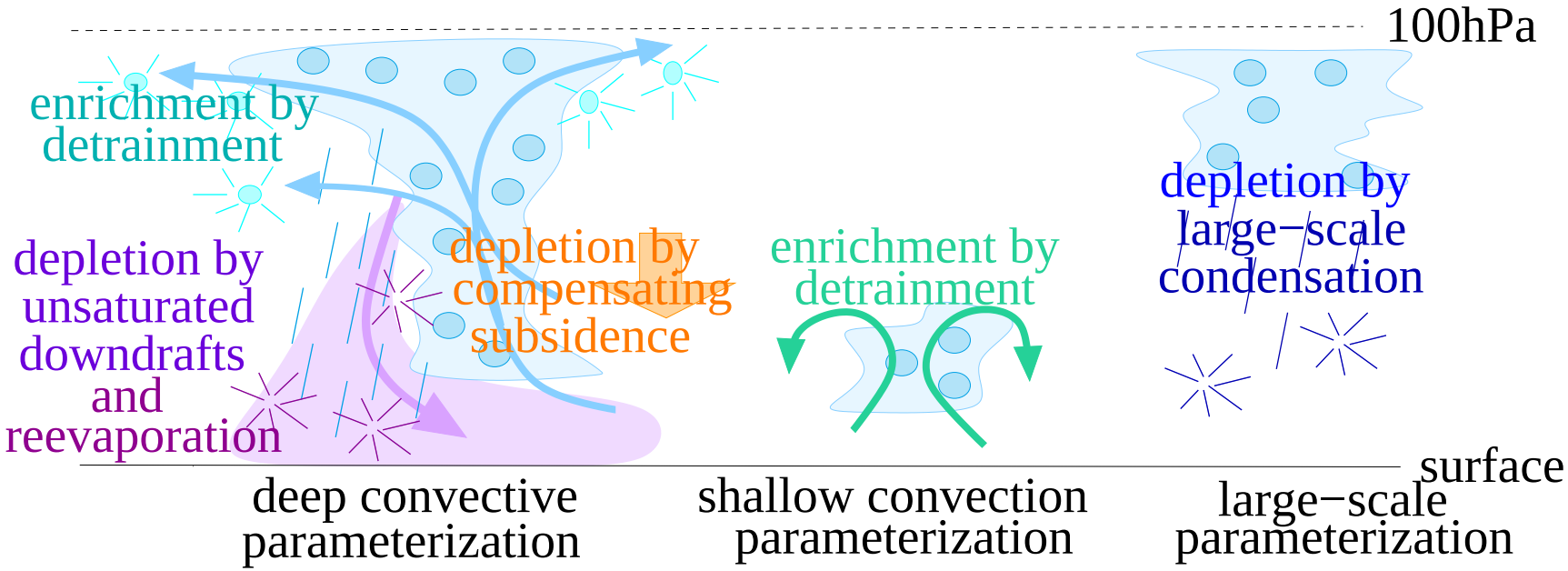

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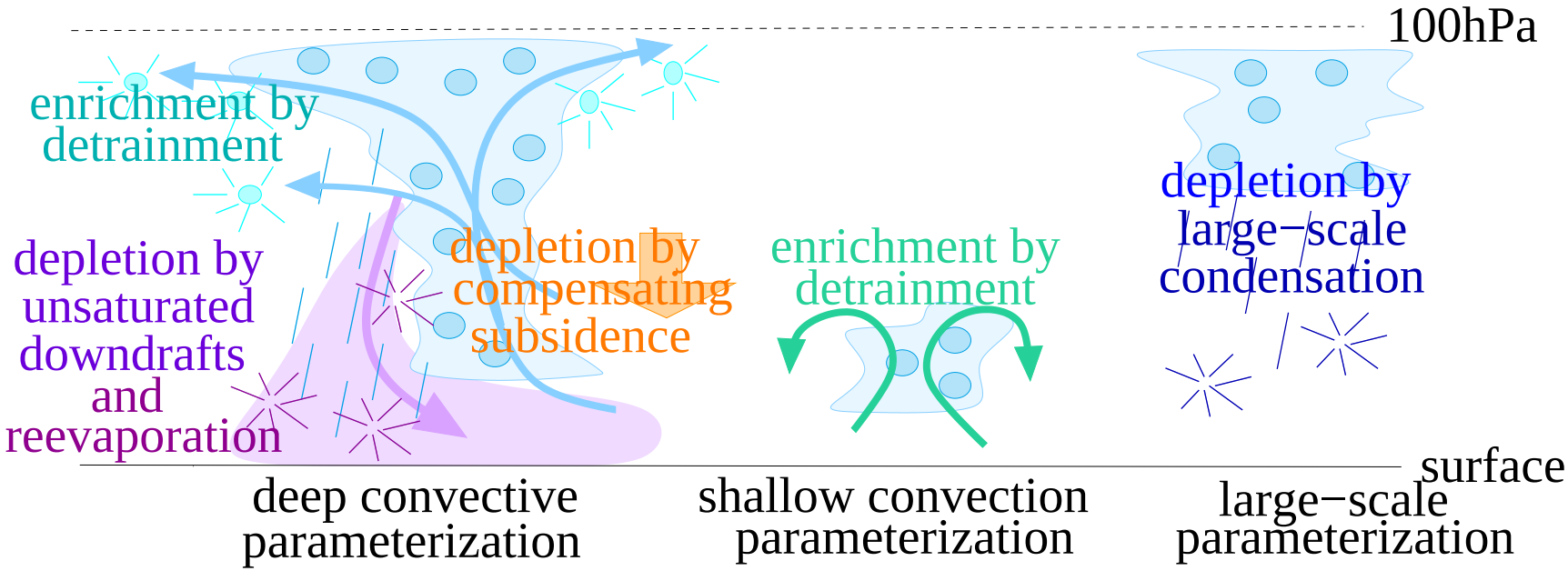

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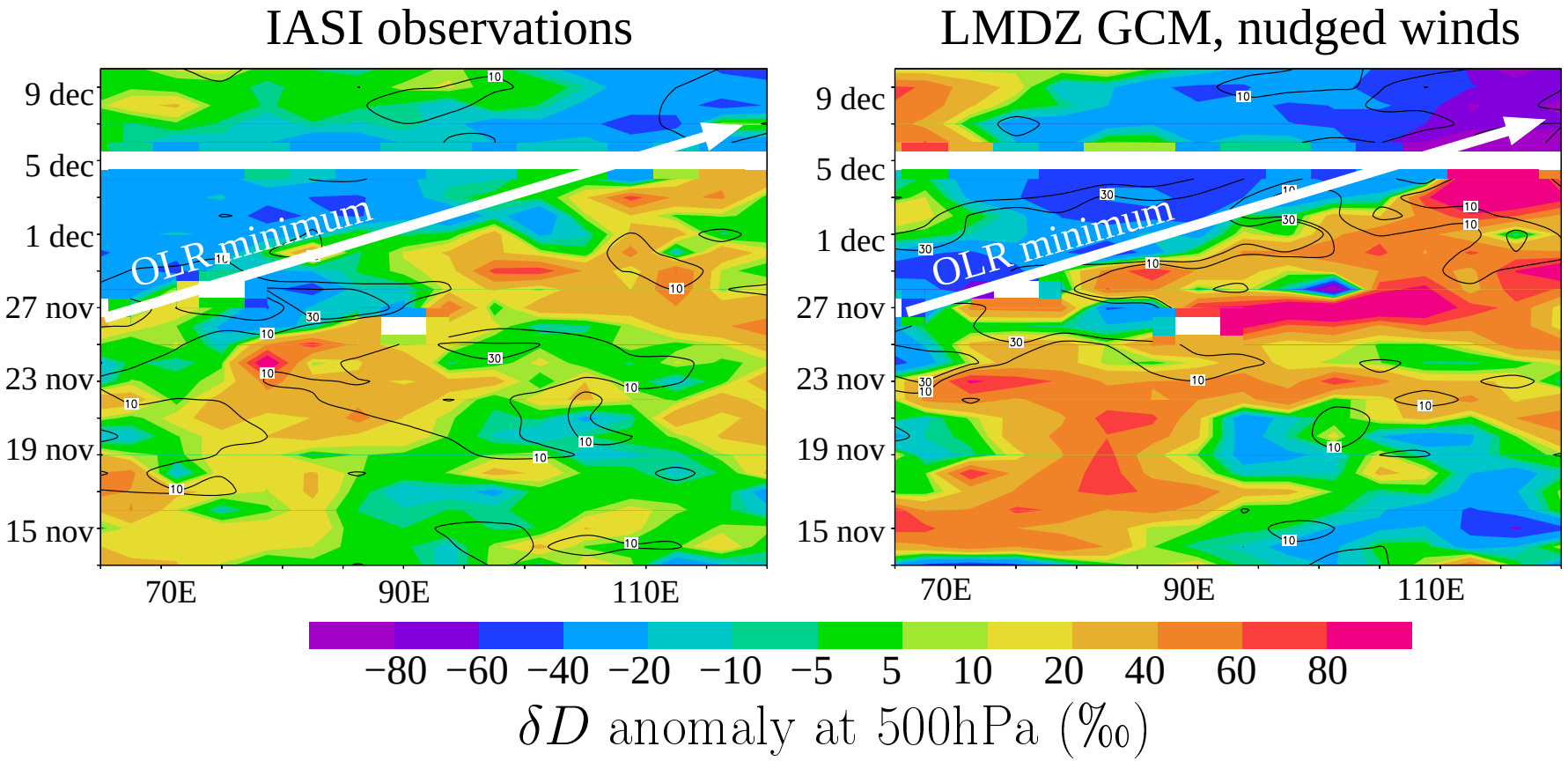
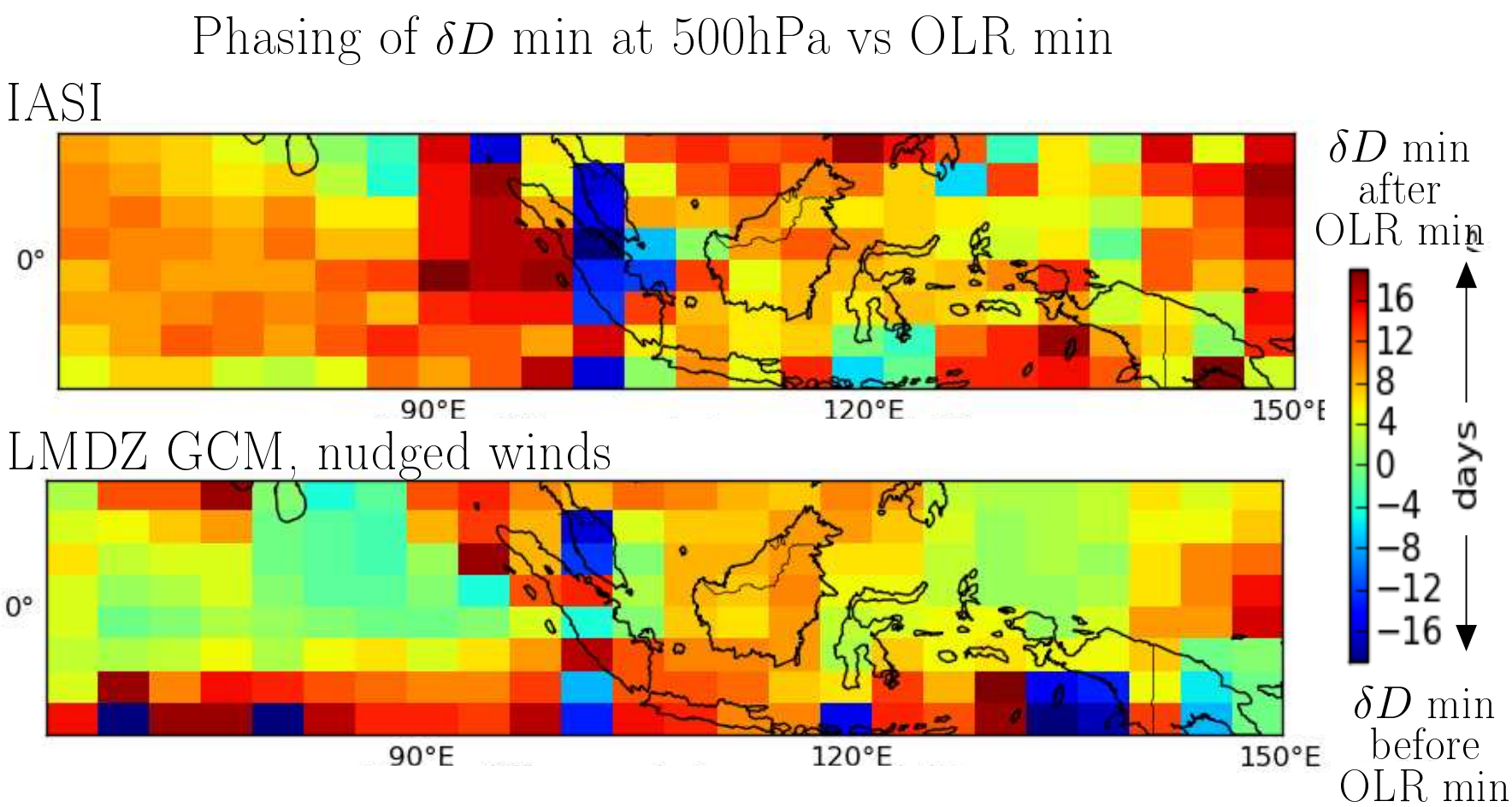
- e.g. during MJO?

Cindy Dynamo campaign case



- Observed q max 0-1 days before OLR min
- Observed δD min 3 days after OLR min
- LMDZ captures this lag for this case

Statistical analysis for 2006-2007



- Observed δD min lags OLR min in Indian Ocean
- More complicated over Maritime Continent
- LMDZ δD to in phase with OLR

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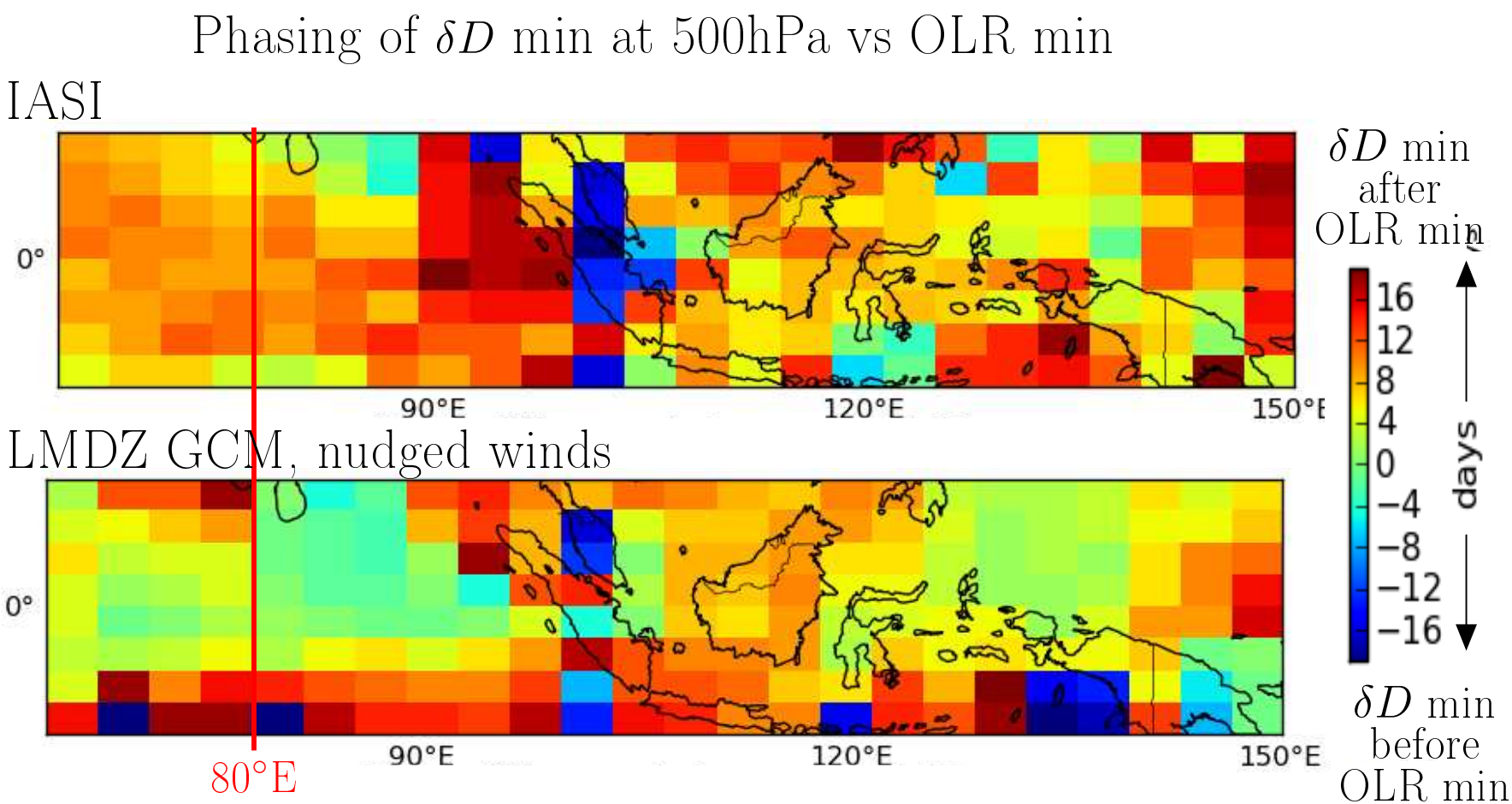

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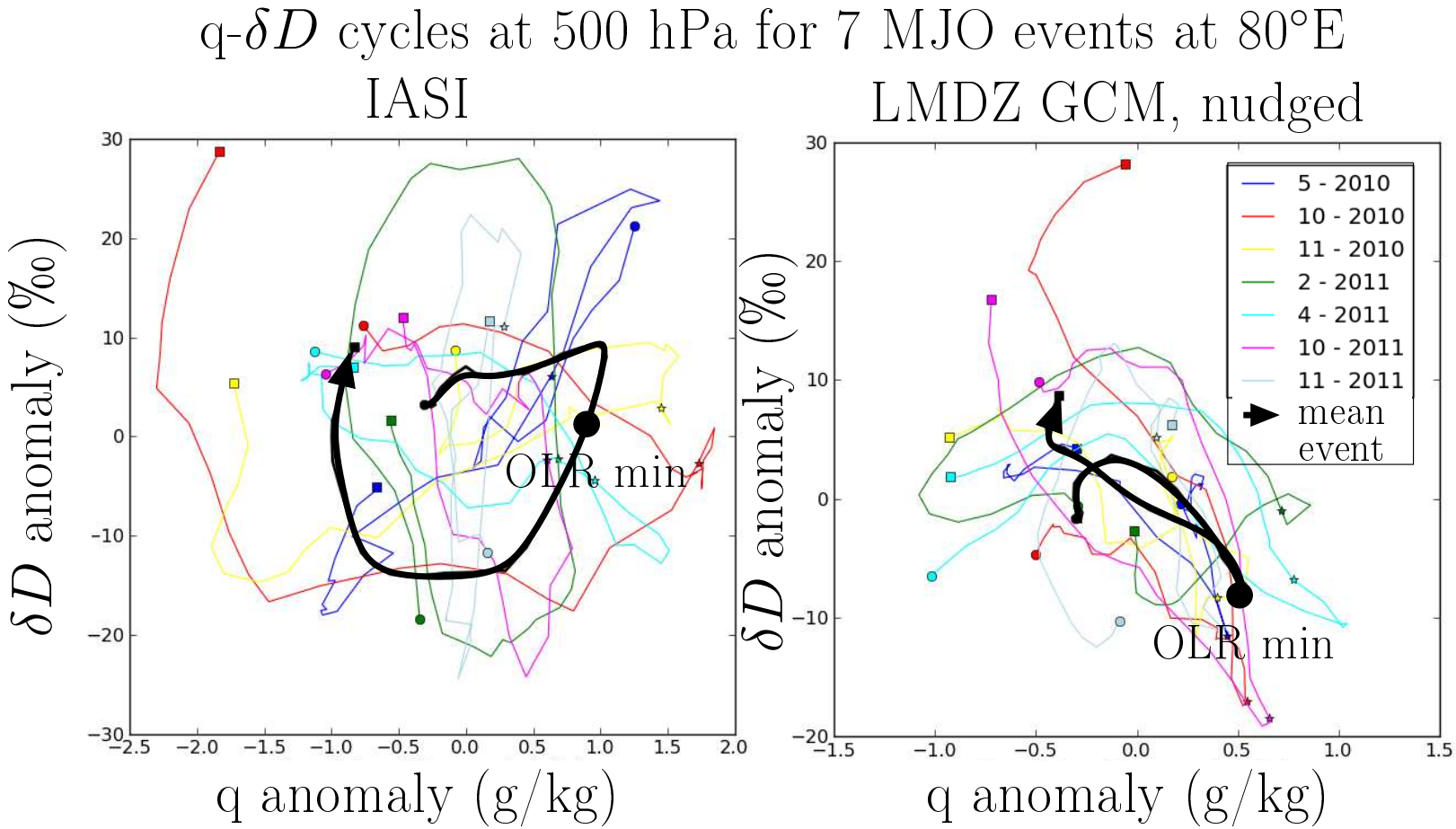
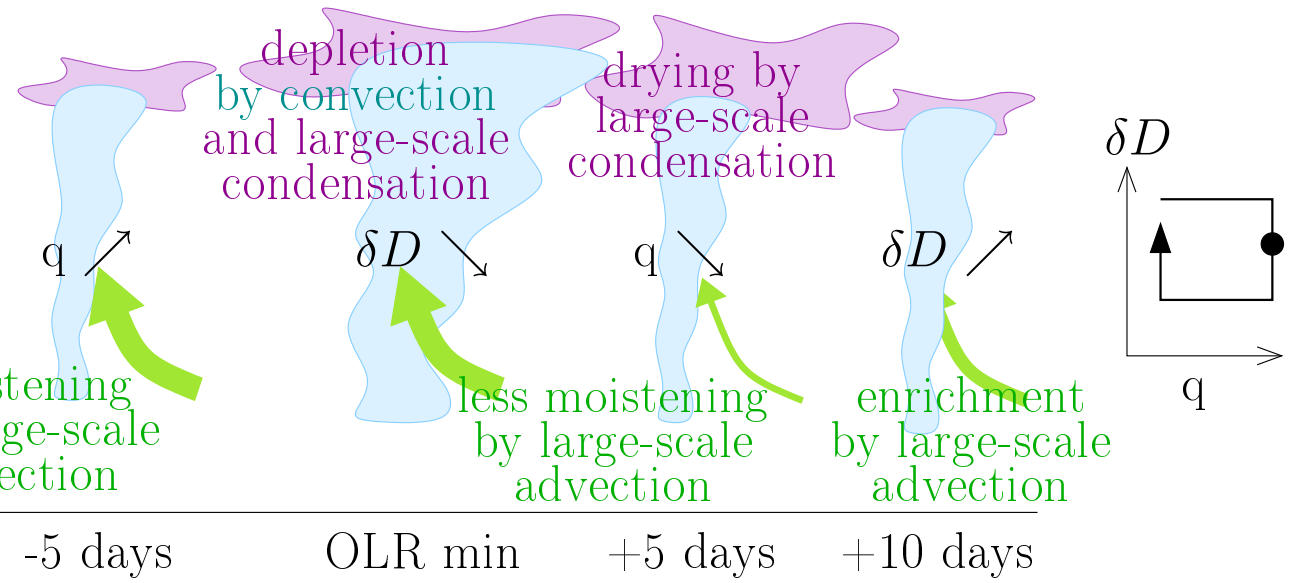
q-δD cycles in Indian Ocean



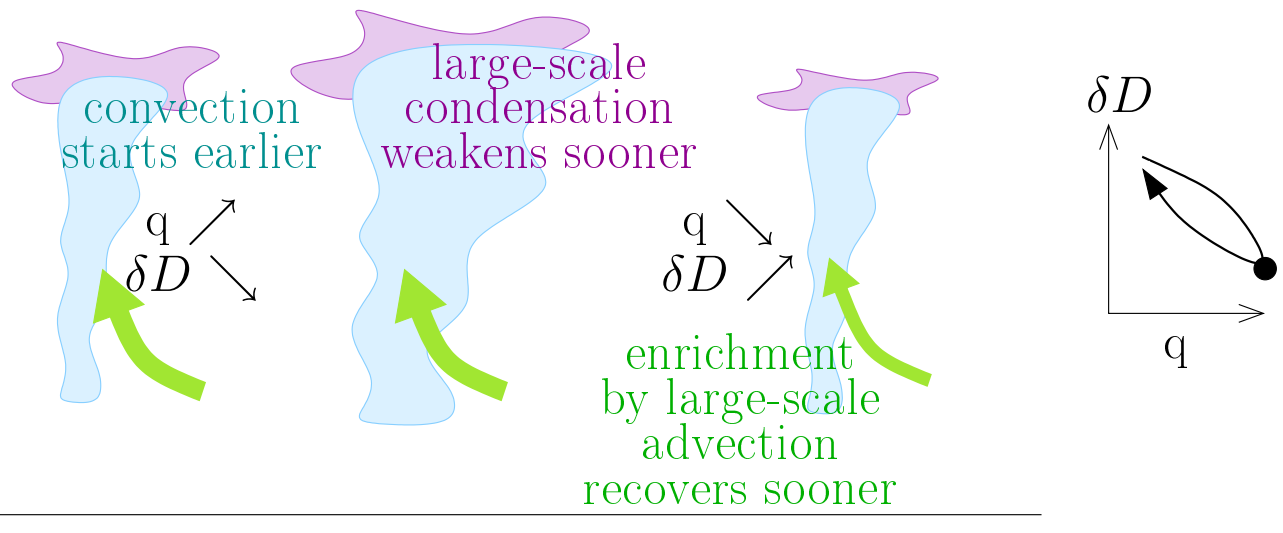
- Observations: “circular”, clockwise shape
- LMDZ: sometimes circular, too often “linear”: why?

What determines $q - \delta D$ shape in LMDZ?

events with "circular shape" in q-δD diagram



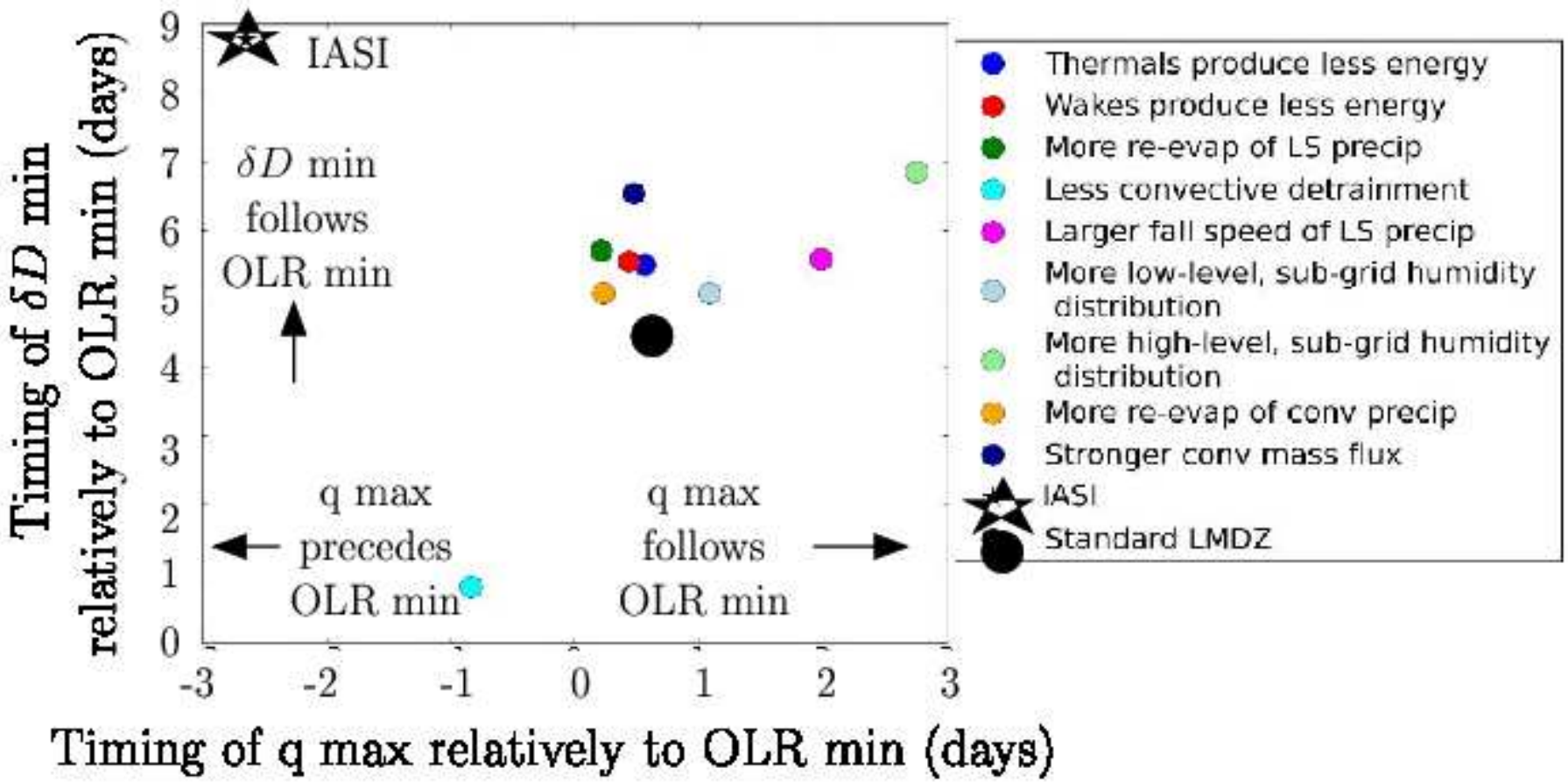
events with "linear shape" in q-δD diagram



Preliminary summary on $q - \delta D$ cycles

- Observed "circular shape" over Indian Ocean consistent with cloud evolution shallow $\longrightarrow$ deep $\longrightarrow$ stratiform
- What happens over the Maritime Continent?
- LMDZ too in phase: convection triggers too soon? Large-scale condensation not maintained long enough? Large-scale advective enrichment recovers too soon?
- $q - \delta D$ useful for model evaluation?

Sensitivity tests with LMDZ



- $q - \delta D$ shape sensitive to convection/cloud parameters
- How to get closer to observations?

Summary and perspectives

- $q - \delta D$ cycles during MJO: informs about the relative timing of shallow convection, deep convection, large-scale condensation and large-scale advection
- Potentially useful for model evaluation
- Still lot of work to fully understand both data and model behavior
- Help from CRMs?
- Exploit better the Cindy Dynamo campaign data?