Evolution of the water stable isotopic composition of the rain sampled along Sahelian squall lines

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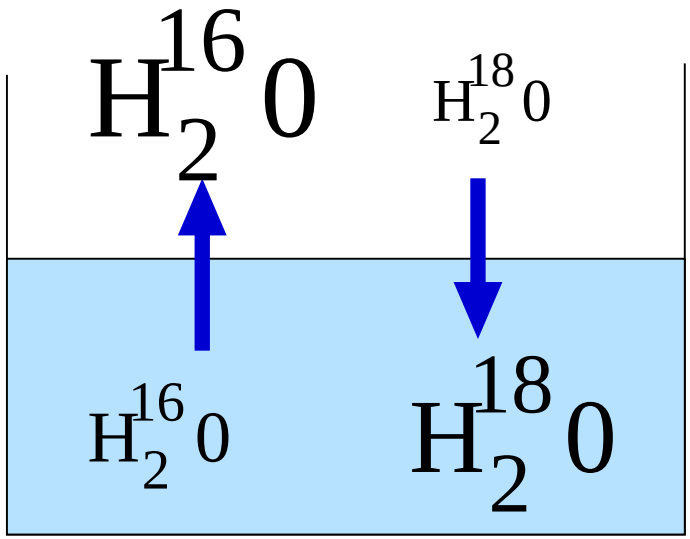
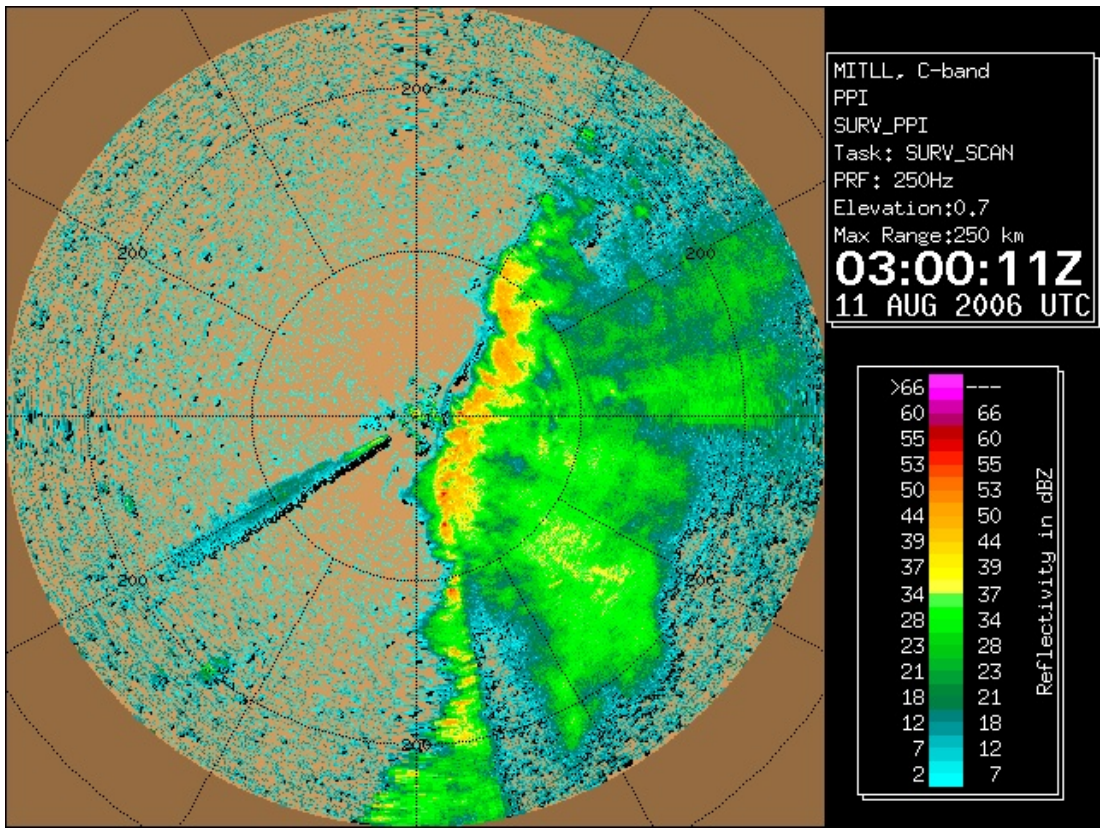
Water stable isotopes



- water=light molecules ($H_2^{16}O$)
  + heavy molecules ($H_2^{18}O$, HDO)
- isotopic fractionation
- applications: past climates, present water cycle
- convective processes: a large uncertainty

Goals

- How does convection influence the isotopic composition of precipitation?
- Collection of water samples along squall lines
- In turn, what information about squall line dynamics and water budgets can be infered from isotopic measurements?



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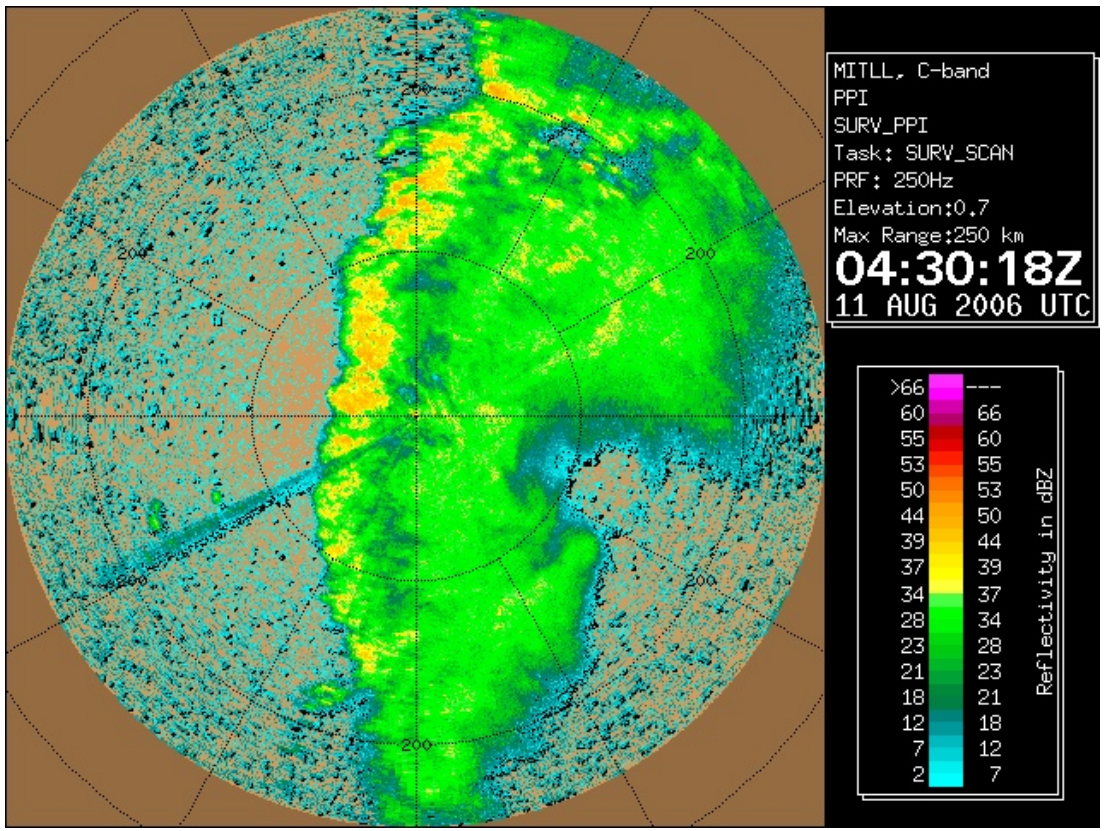

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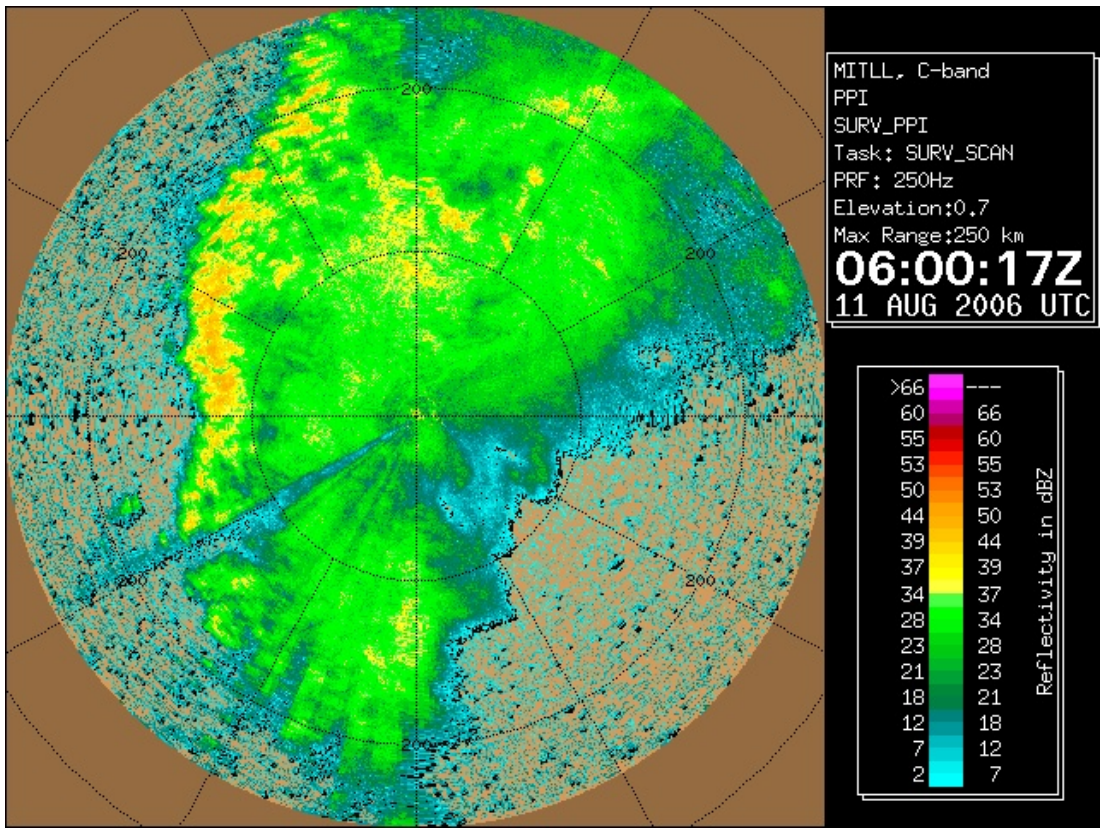
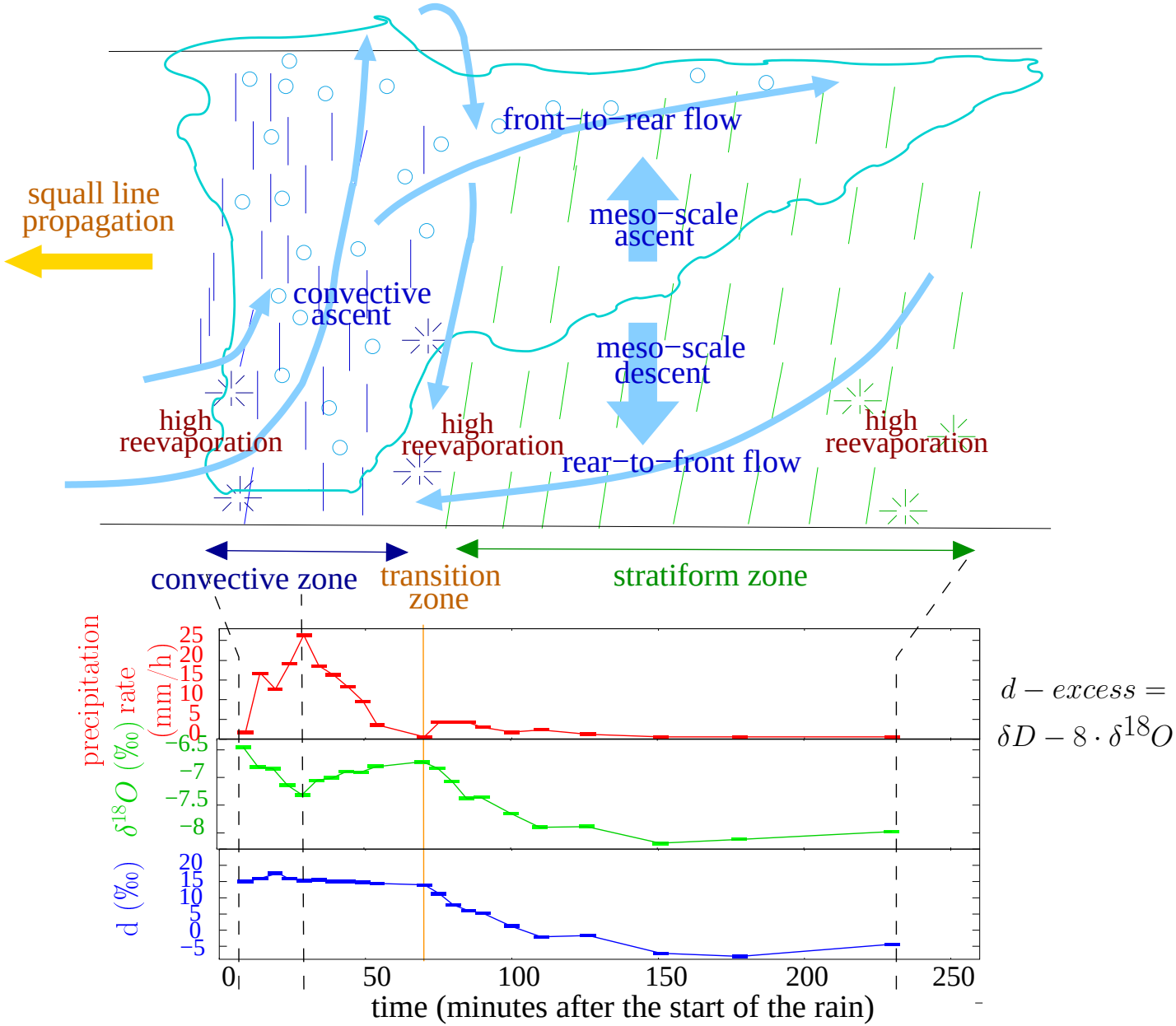
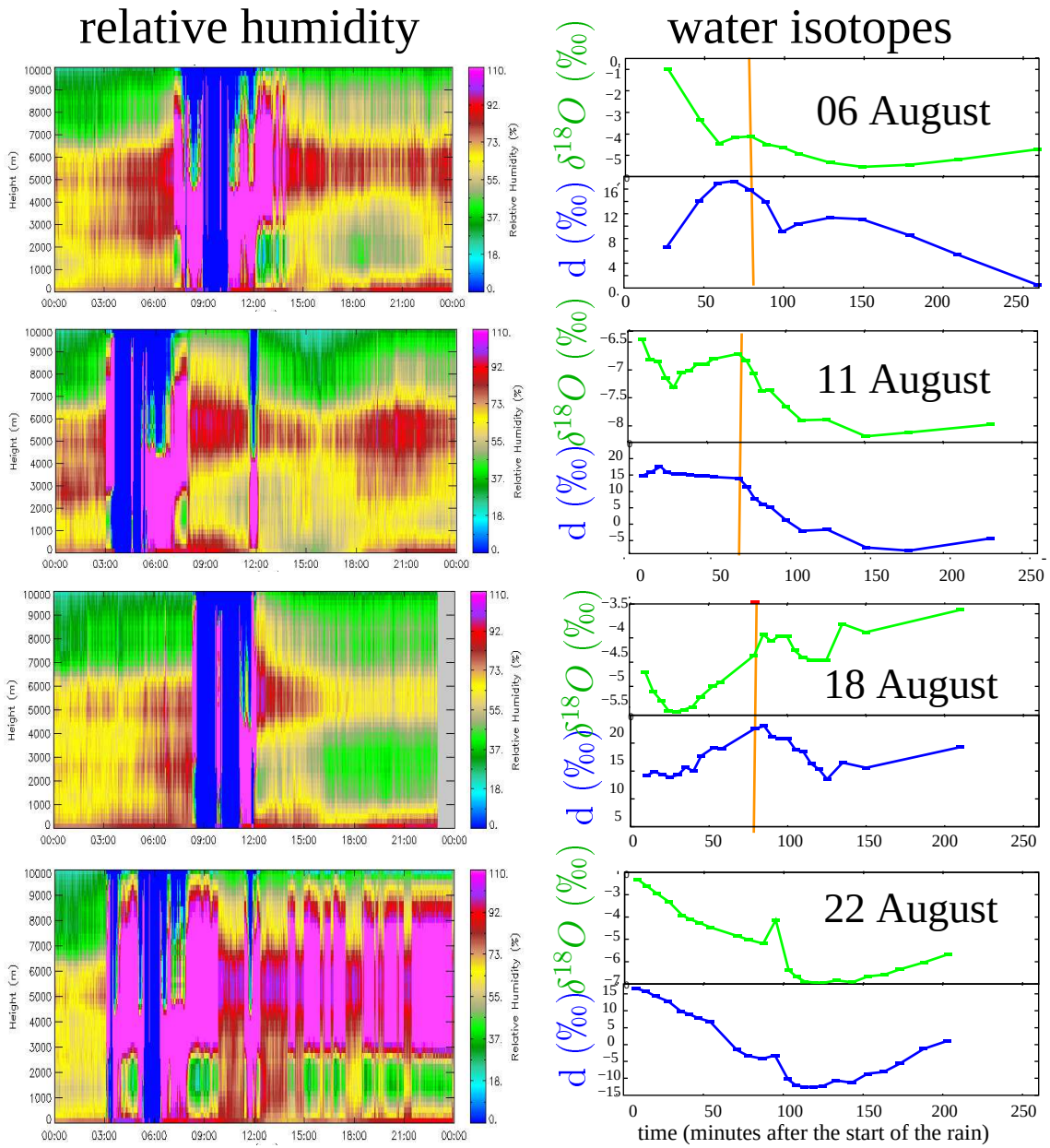


Example of the 11 August squall line

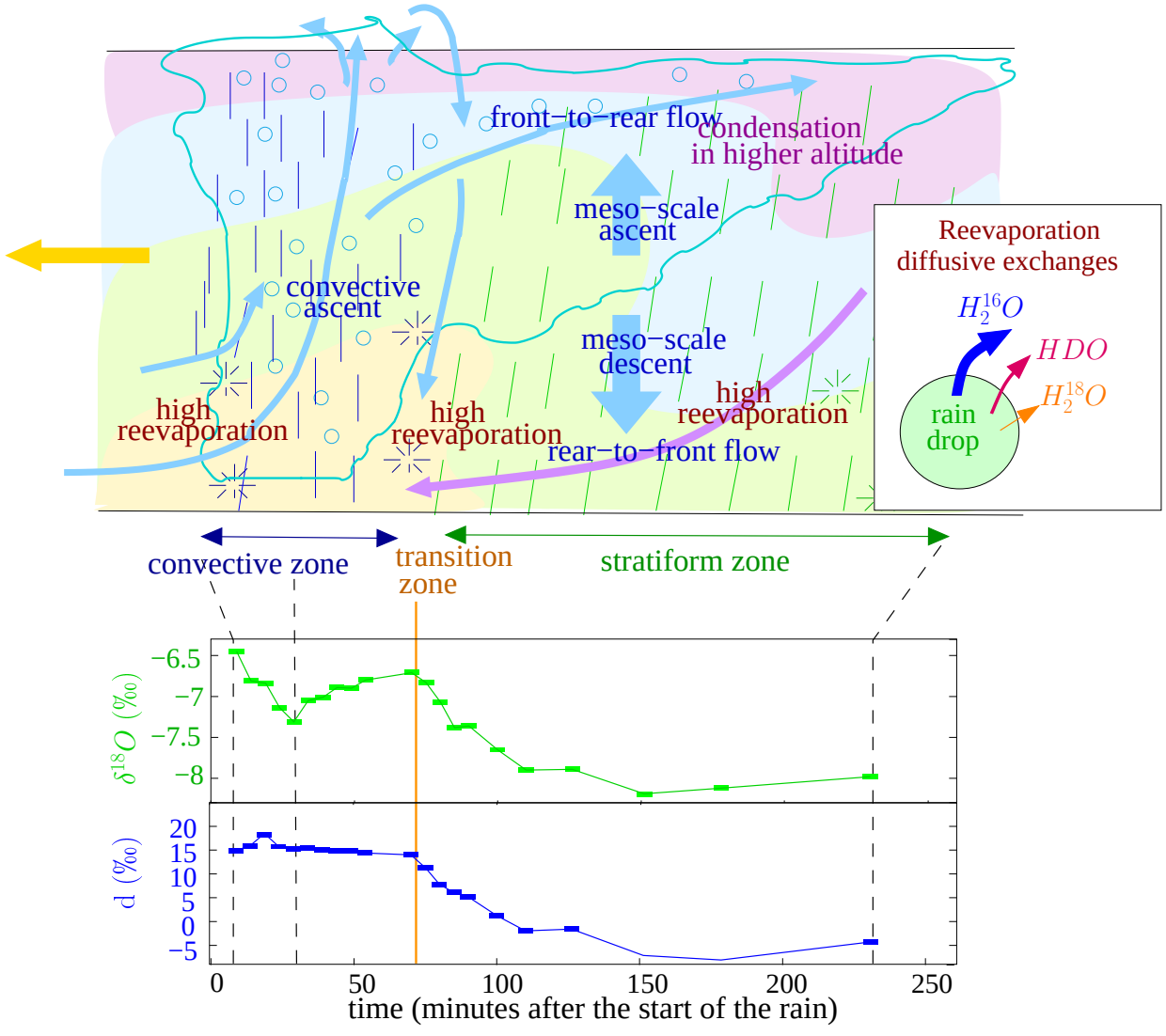


$$d - excess = \delta D - 8 \cdot \delta^{18}O$$

Robust isotopic features for the different lines

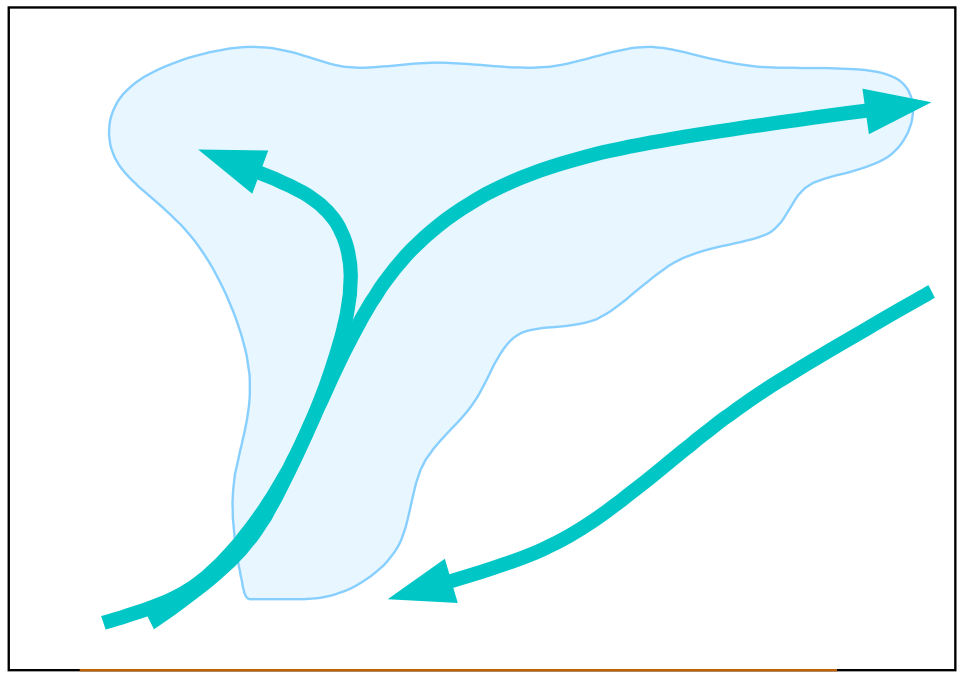


What processes explain this evolution?



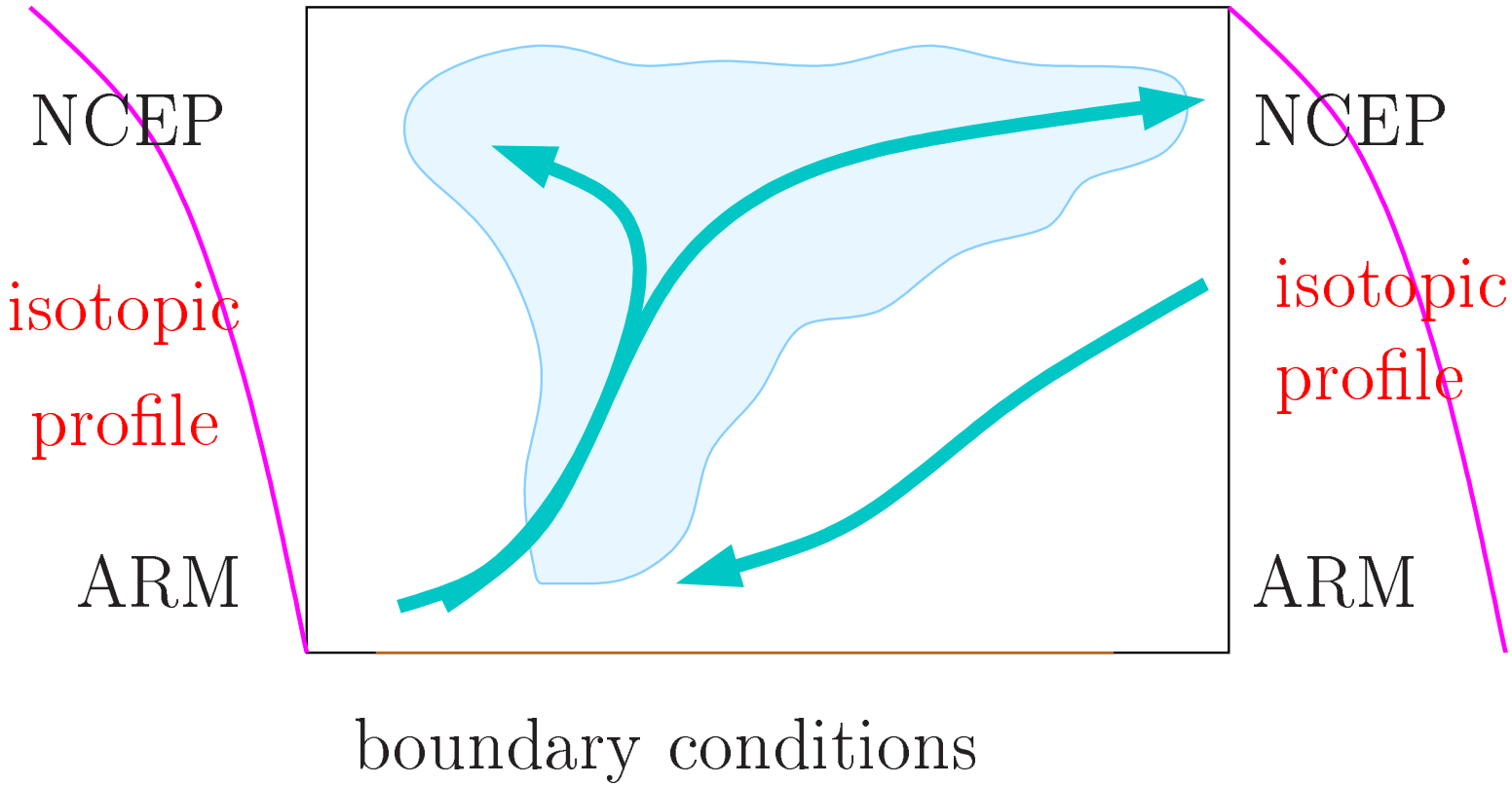
- Hypotheses: rain reevaporation, meso-scale subsidence, condensation altitude... Quantification?

2D isotopic model of transport and microphysics



wind field

2D isotopic model of transport and microphysics



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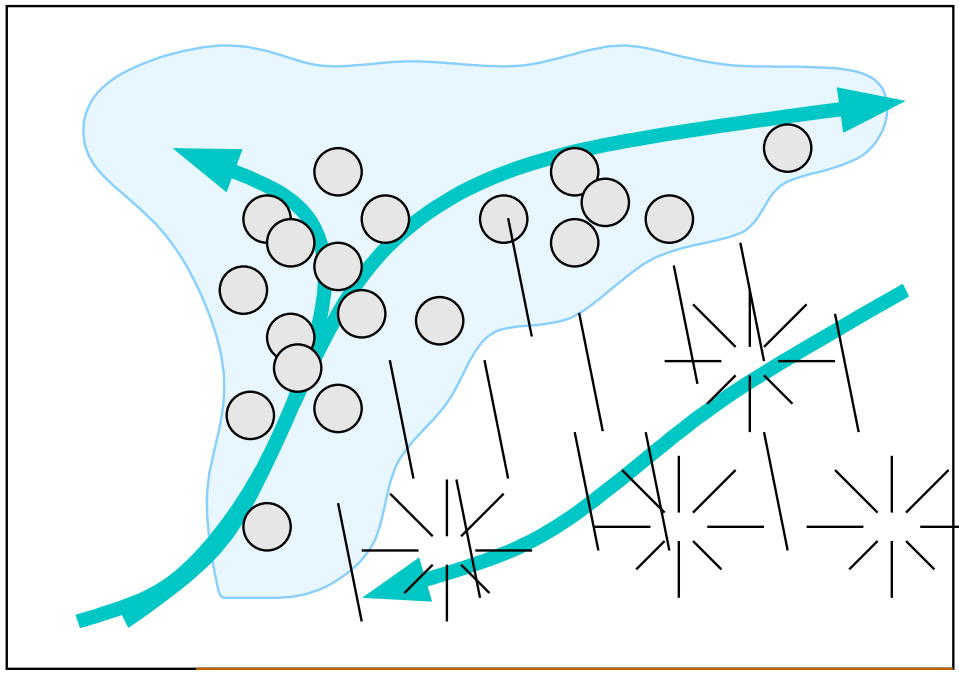
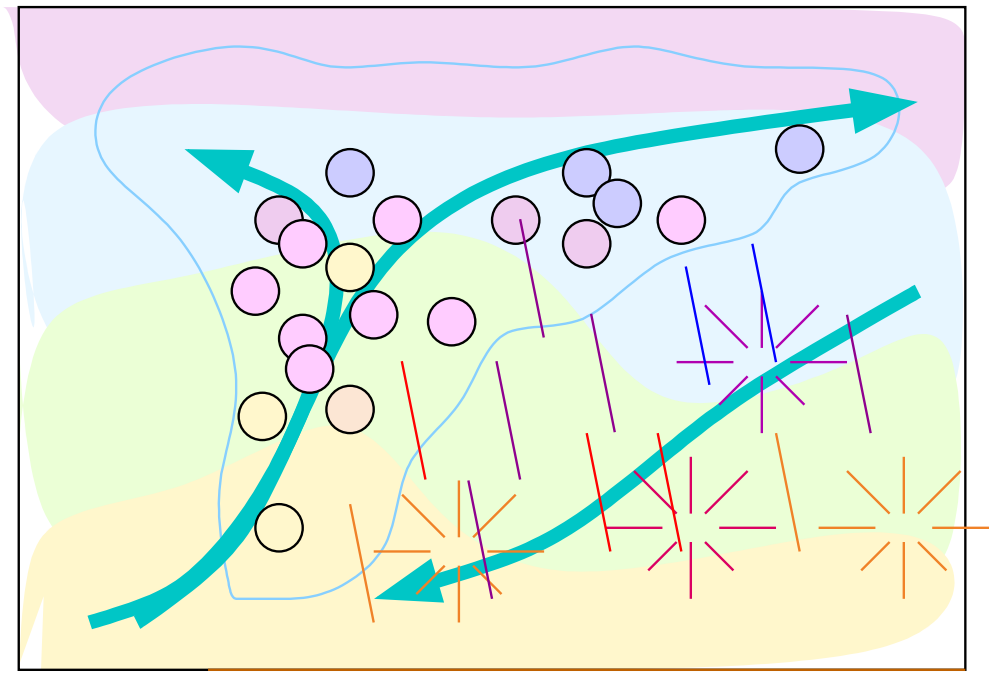


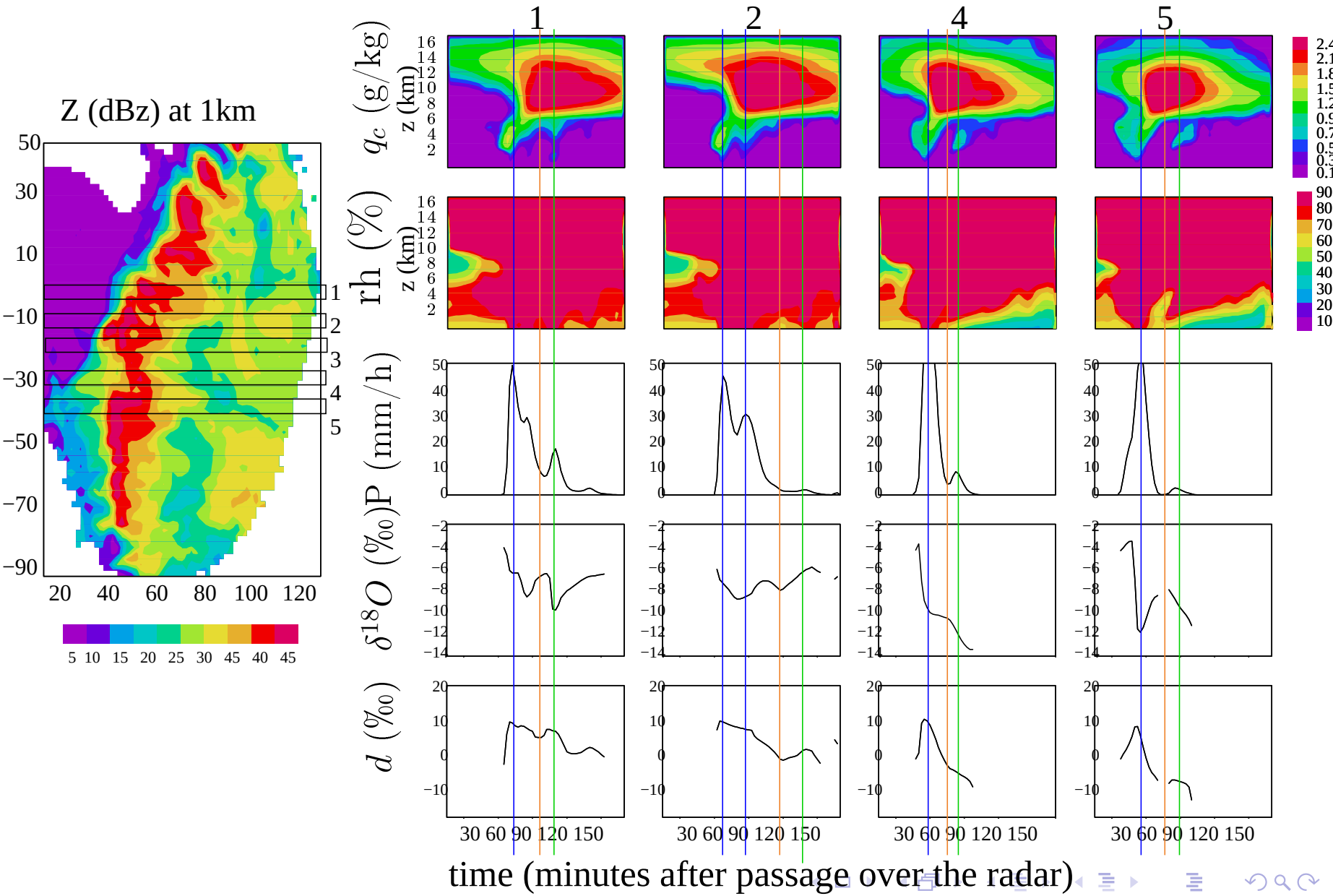
advection and microphysics

2D isotopic model of transport and microphysics

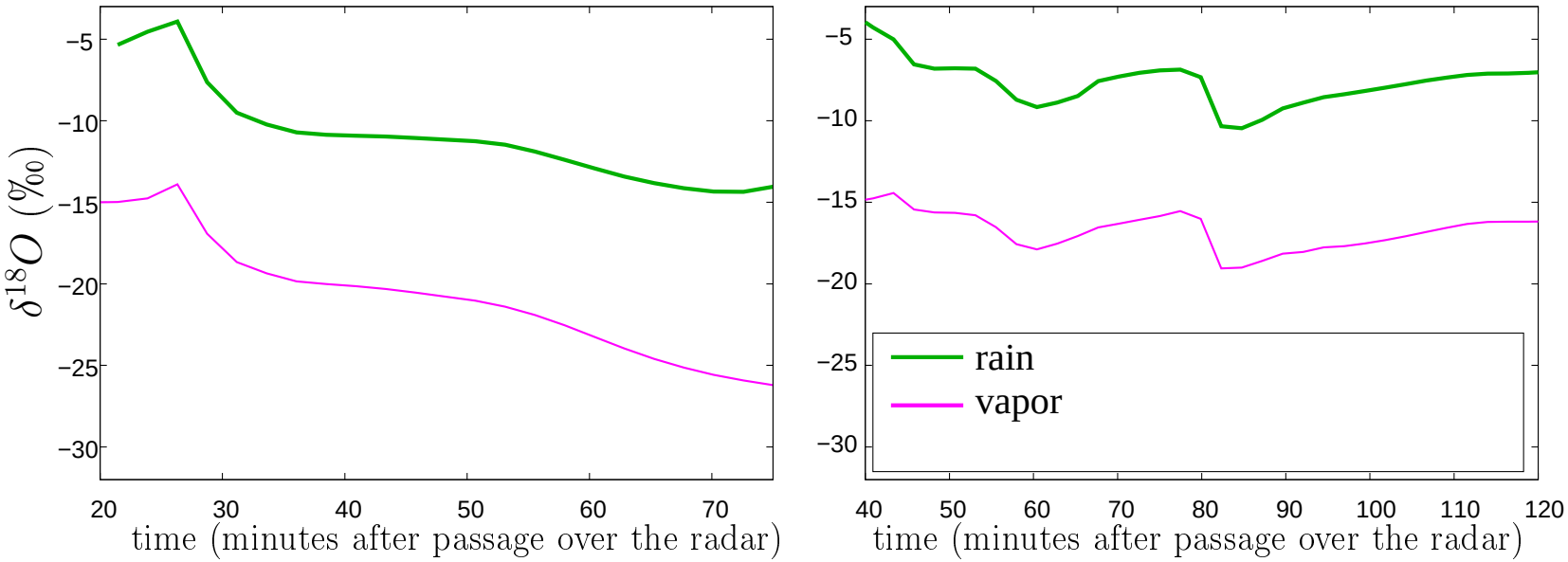


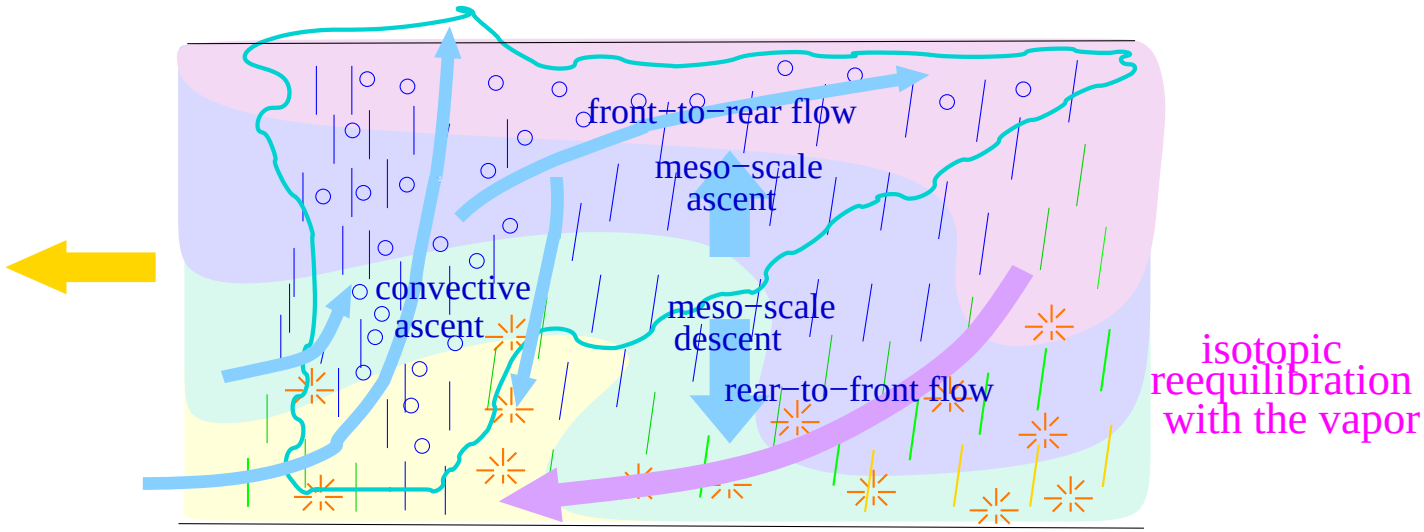
isotopic fields

2D model results



What processes explain the isotopic evolution in the 2D model?





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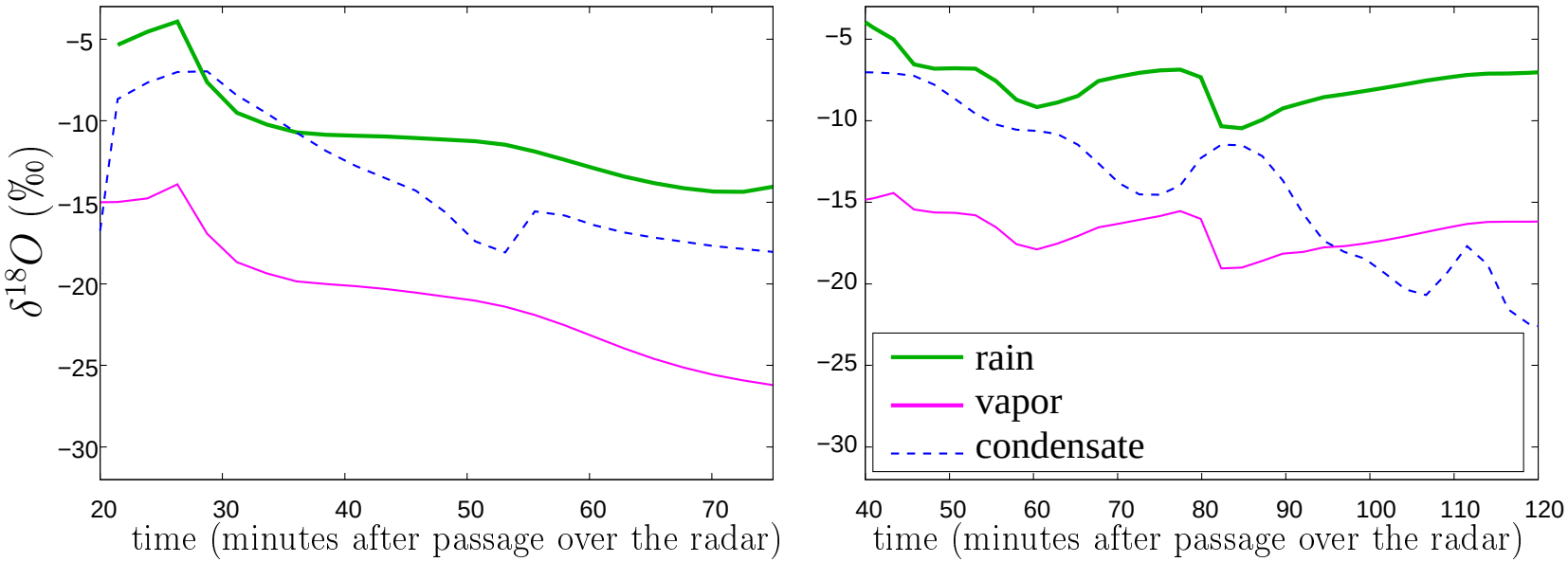

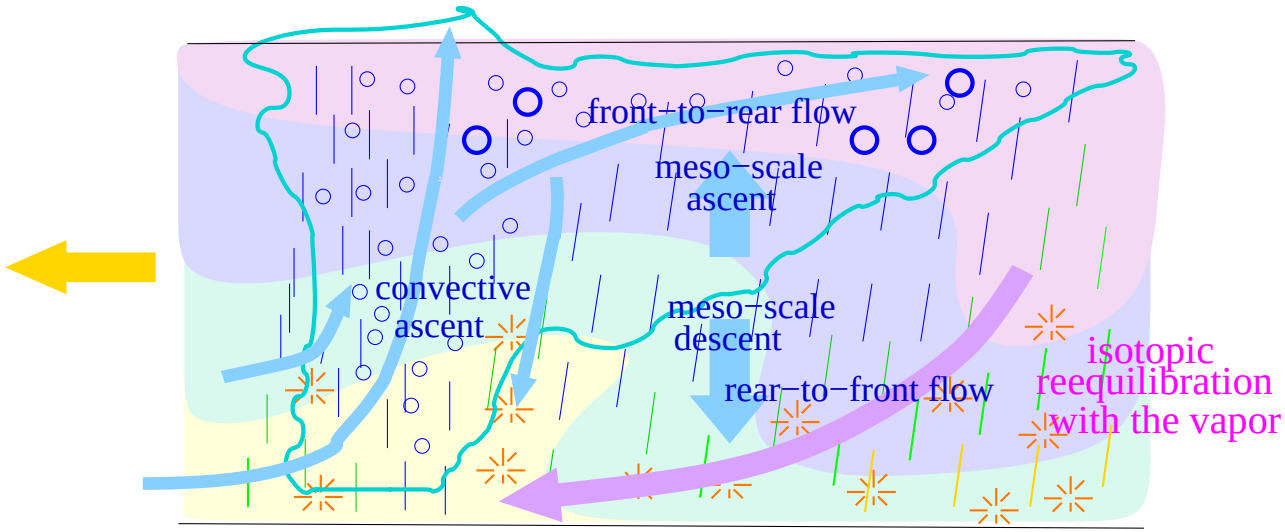

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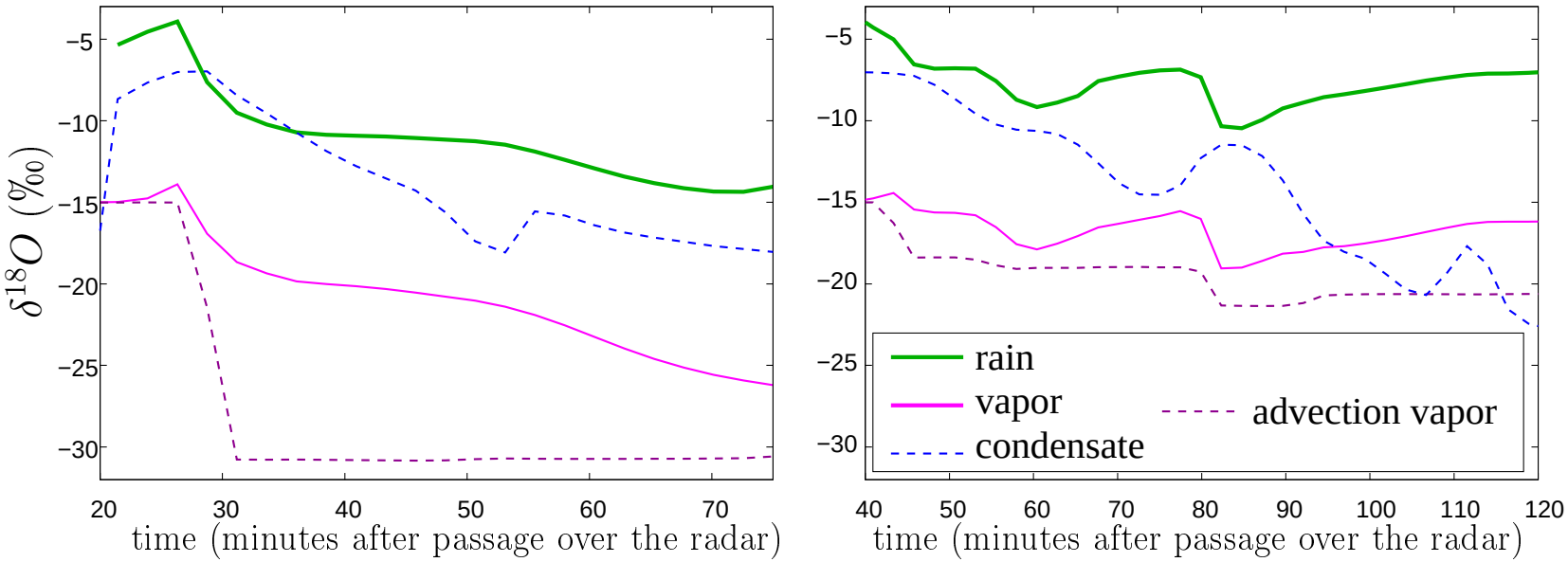

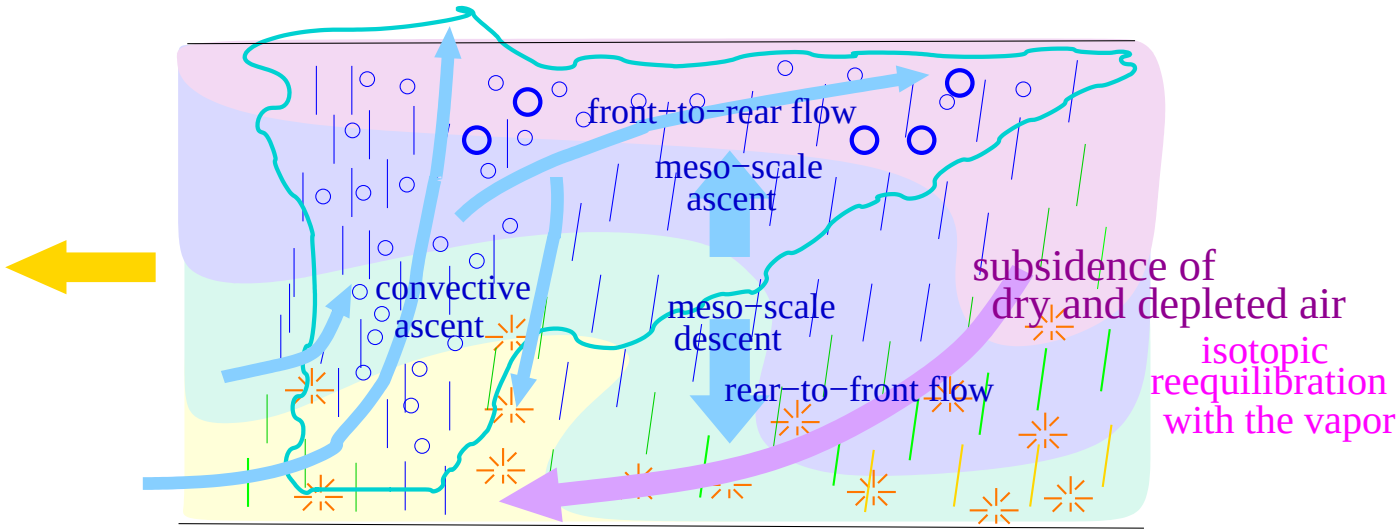

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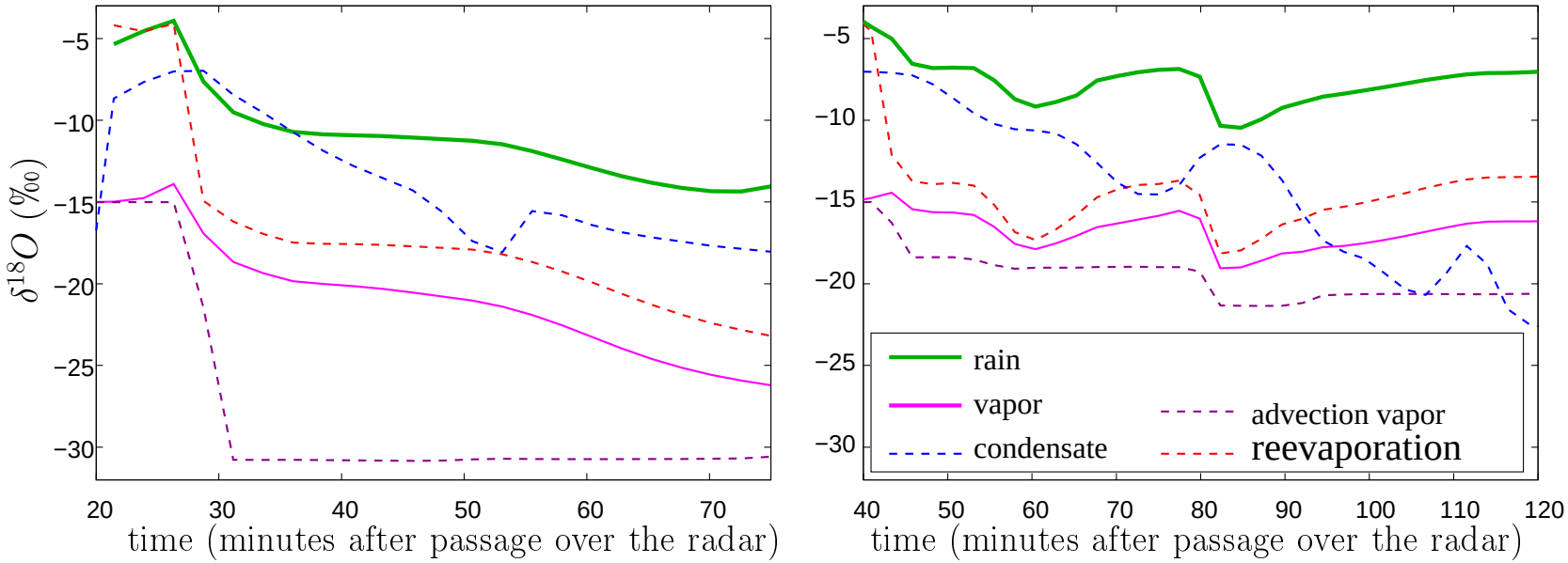
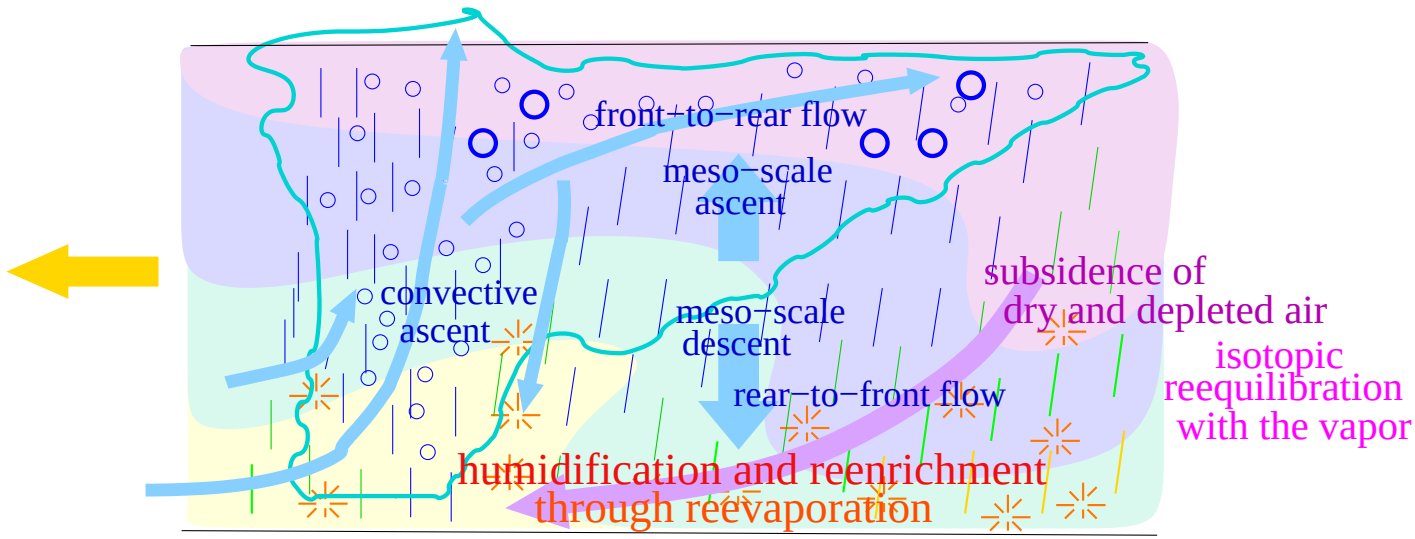
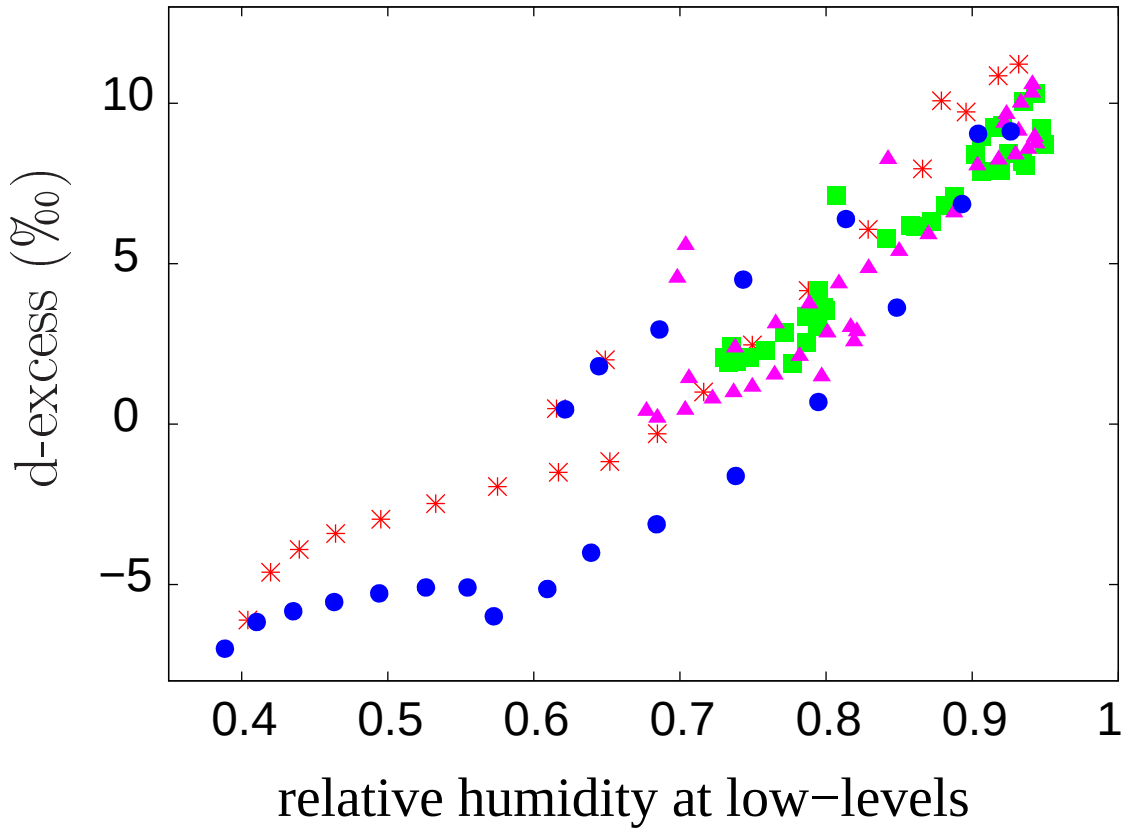
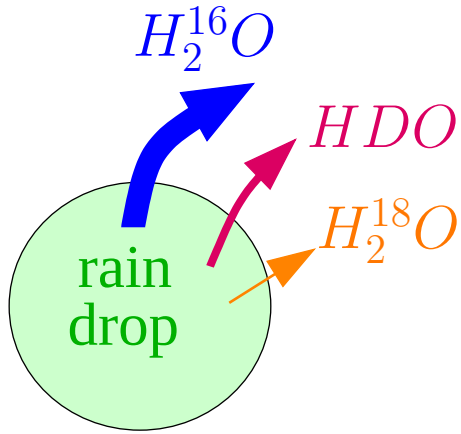




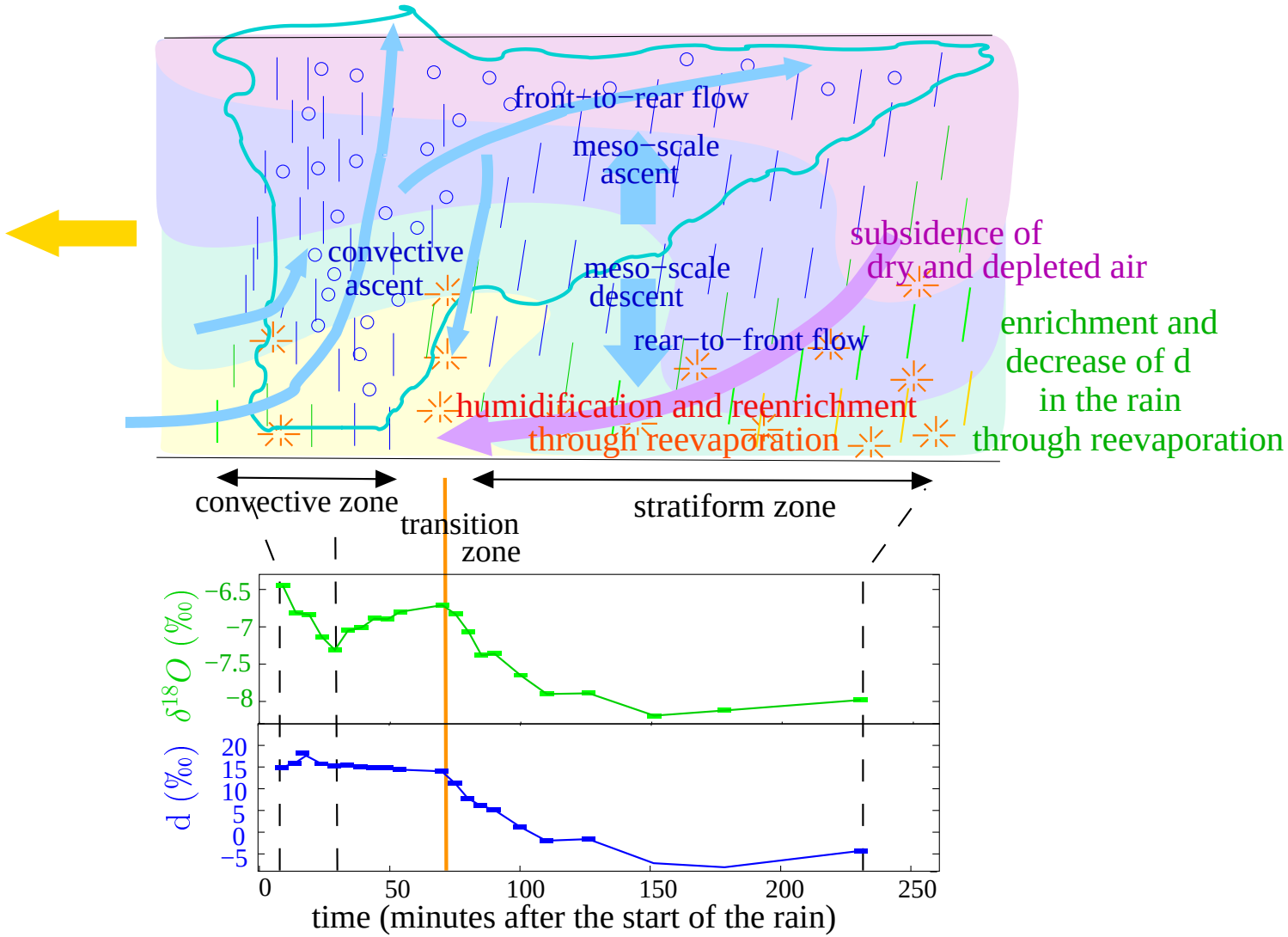
What controls d-excess in the 2D model?





- d-excess depends mainly on relative humidity at low-levels

Interpretation of the data using the 2D model



- $\delta^{18}O$: dynamics and low-level humidification by reevaporation
- d-excess: low-level relative humidity

Conclusion and perspectives

- Both data and 2D model suggest that rain reevaporation and meso-scale subsidence are key processes.
- 2D model limits and uncertainties
  - vapor sampling?
- use of water stable isotopes to better constrain the water budget in squall line and their representation in models?