Documentation of convective processes along squall lines from the isotopic composition of near-surface water vapor in Niamey (Niger) during the 2010 and 2011 West African monsoon periods

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Stable water isotopes and convection

- Different water molecules (mass & symmetry)
- Redistribution during phase changes
- Integrated information on the origin and transport of moisture
- How convective processes control isotopic ratios ?

What record stable water isotopes along squall lines?

- Mesoscale subsidence of depleted air in unsaturated downdrafts
- Admixture of vapor from re-evaporation of falling rain

Risi et al. (2009) (measurements in precipitation)

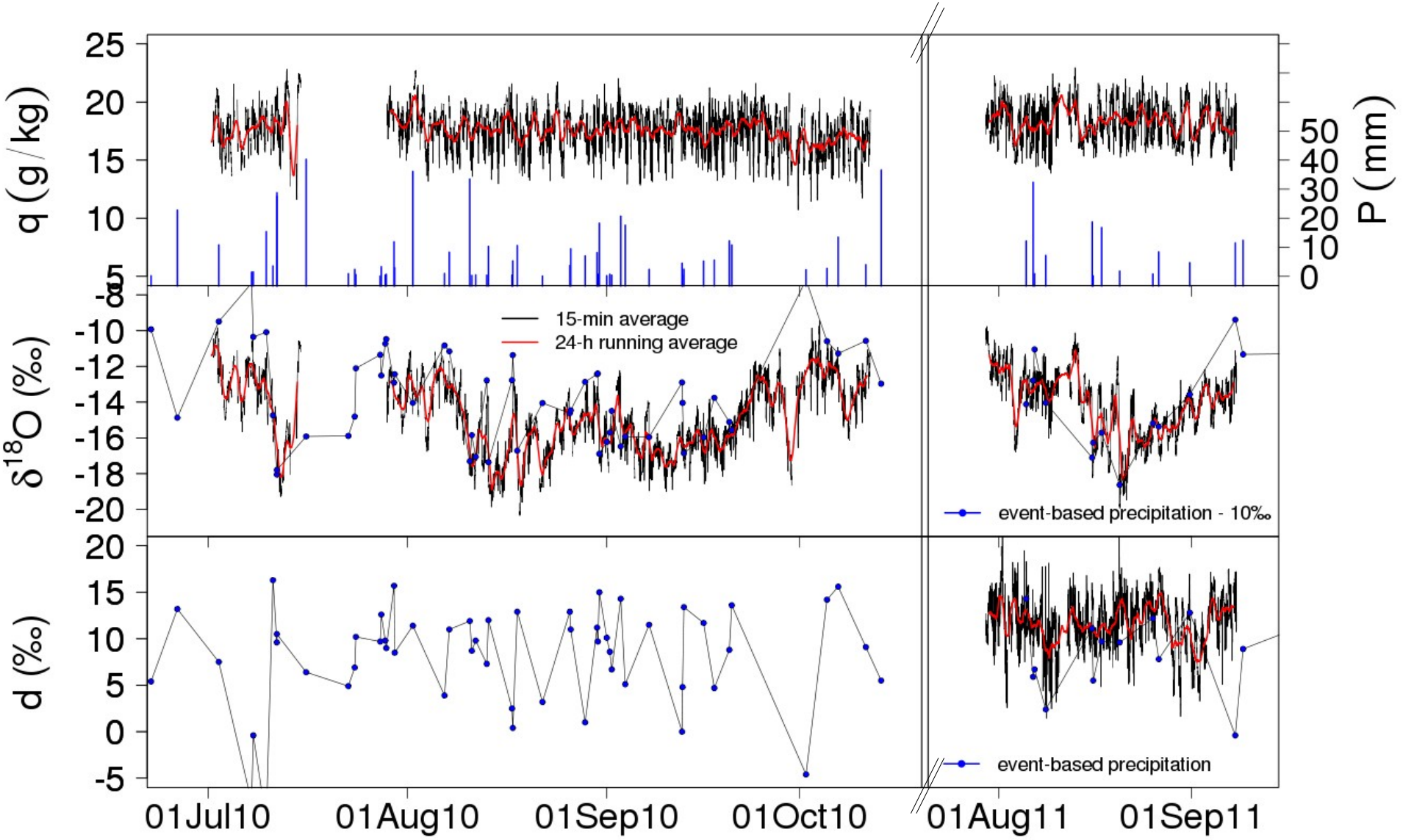
Why do we need **water vapor** isotopic measurements ?

- Subcloud water vapor feeds convective systems
- Changes in δ_v relative to q brings information on the dominant processes
- Origin of moisture
- Diffusive exchanges between precipitation and low-level water vapor (rain evaporation, re-equilibration)
- Evaluation of models

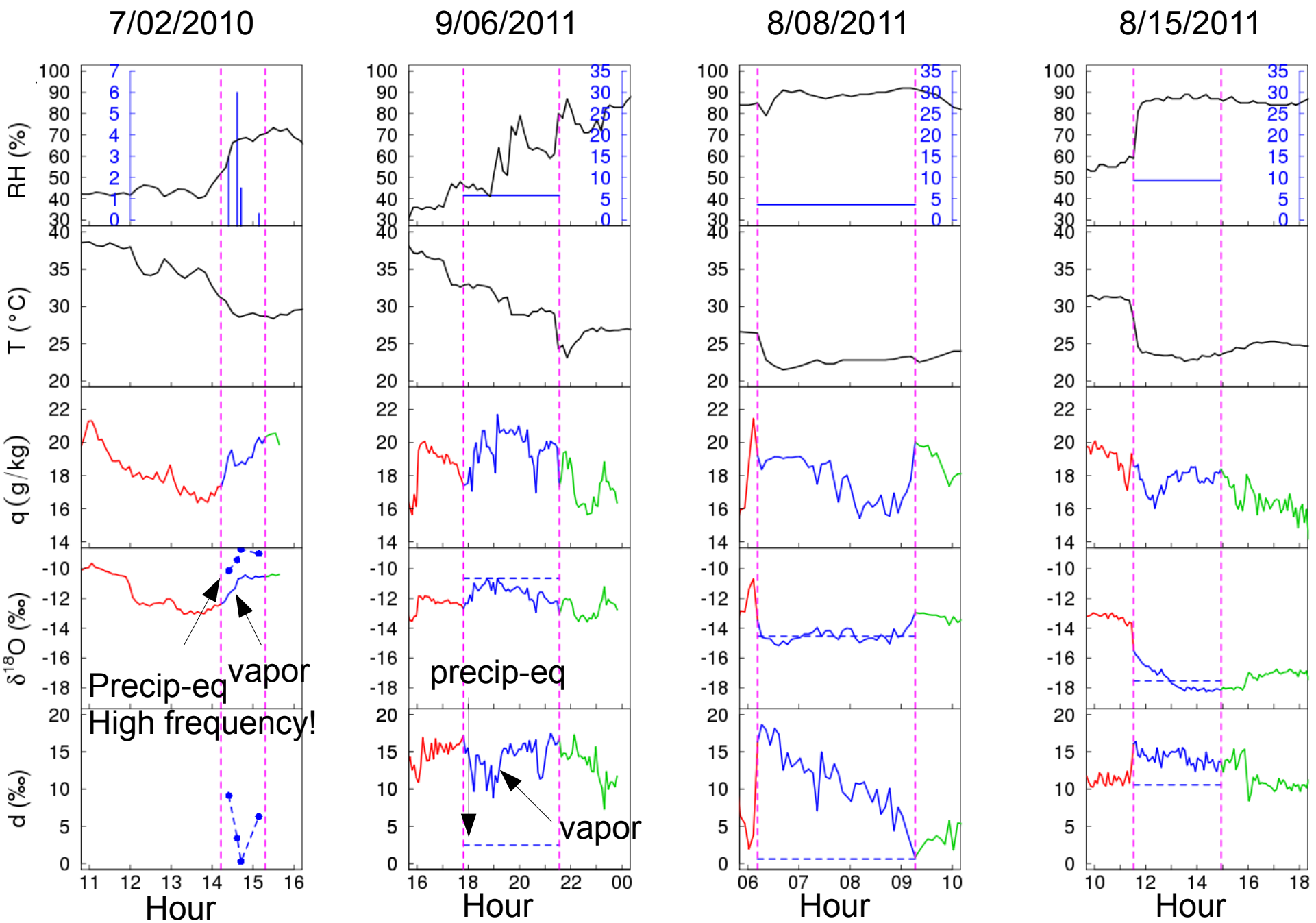
A high frequency information in near-surface air

- Institut des RadioIsotopes (Niamey)
- Precipitation by mass spectrometry
- Atmospheric water vapor by laser spectrometry
  - q, $\delta^{18}O_v$ et δD_v
  - d-excess = $\delta D - 8\ \delta^{18}O$
- ~30 convective systems sampled with both precipitation and water vapor

Measurements from the 2010 and 2011 monsoon season



Robust features along squall lines



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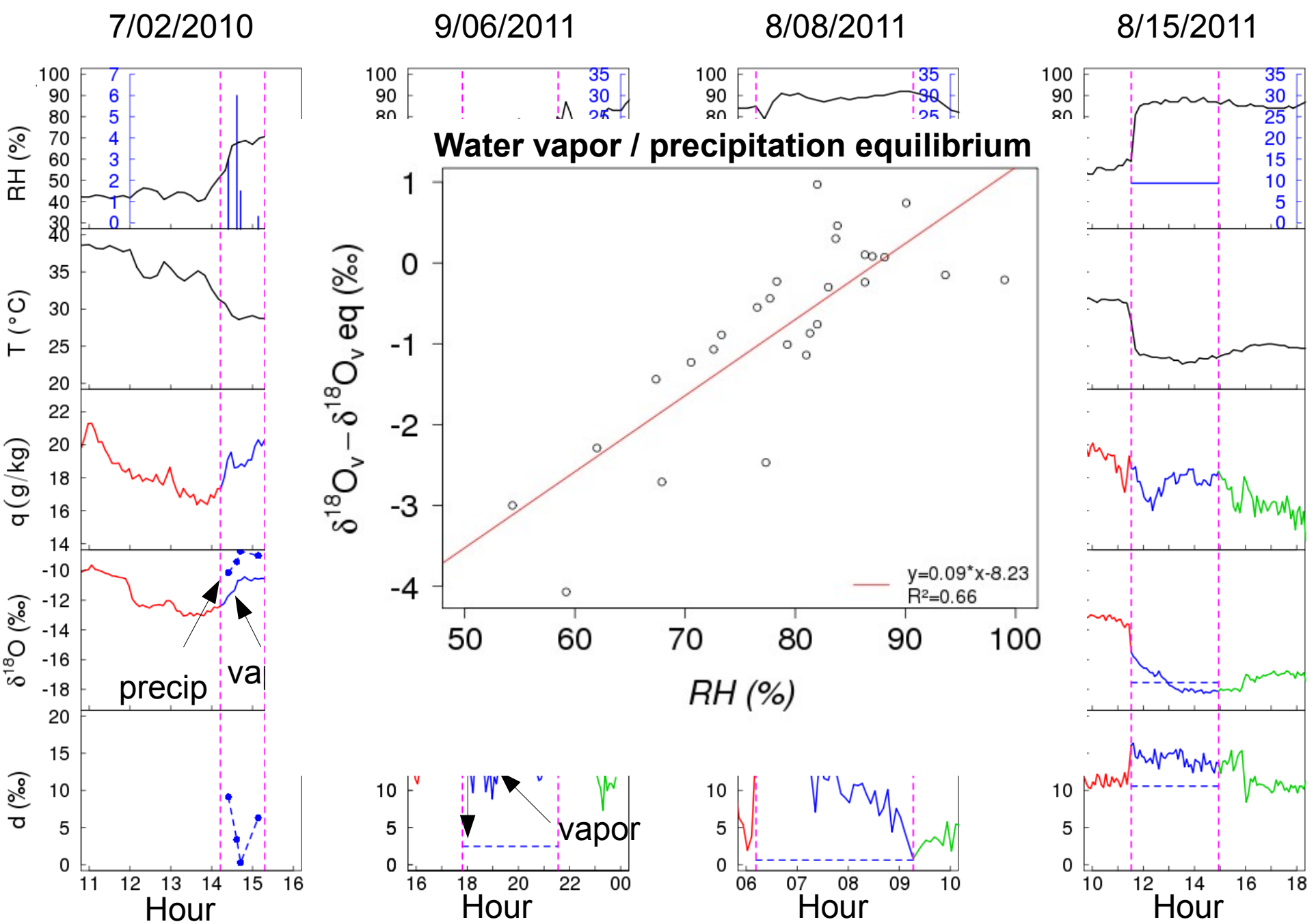

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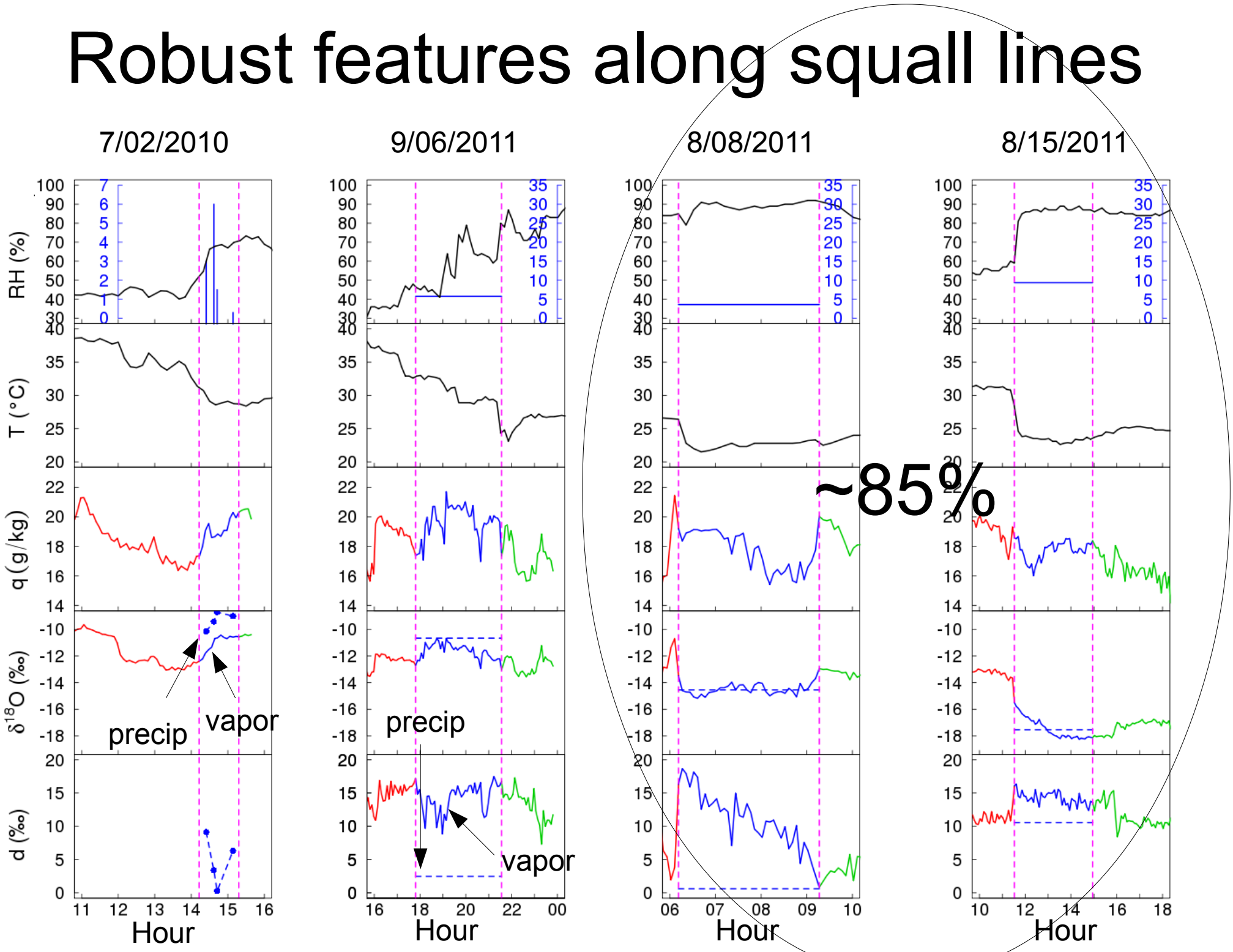
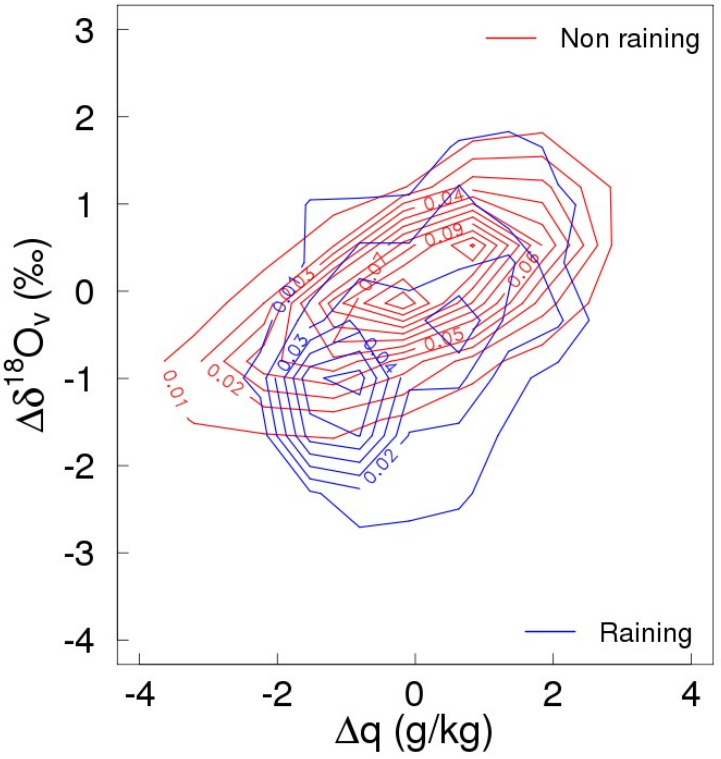
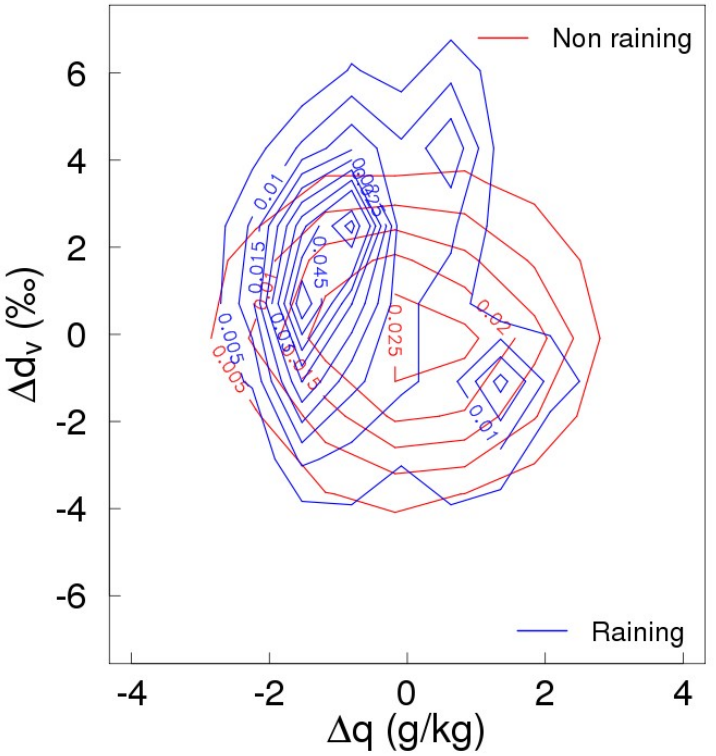


Changes in δ_v relative to q

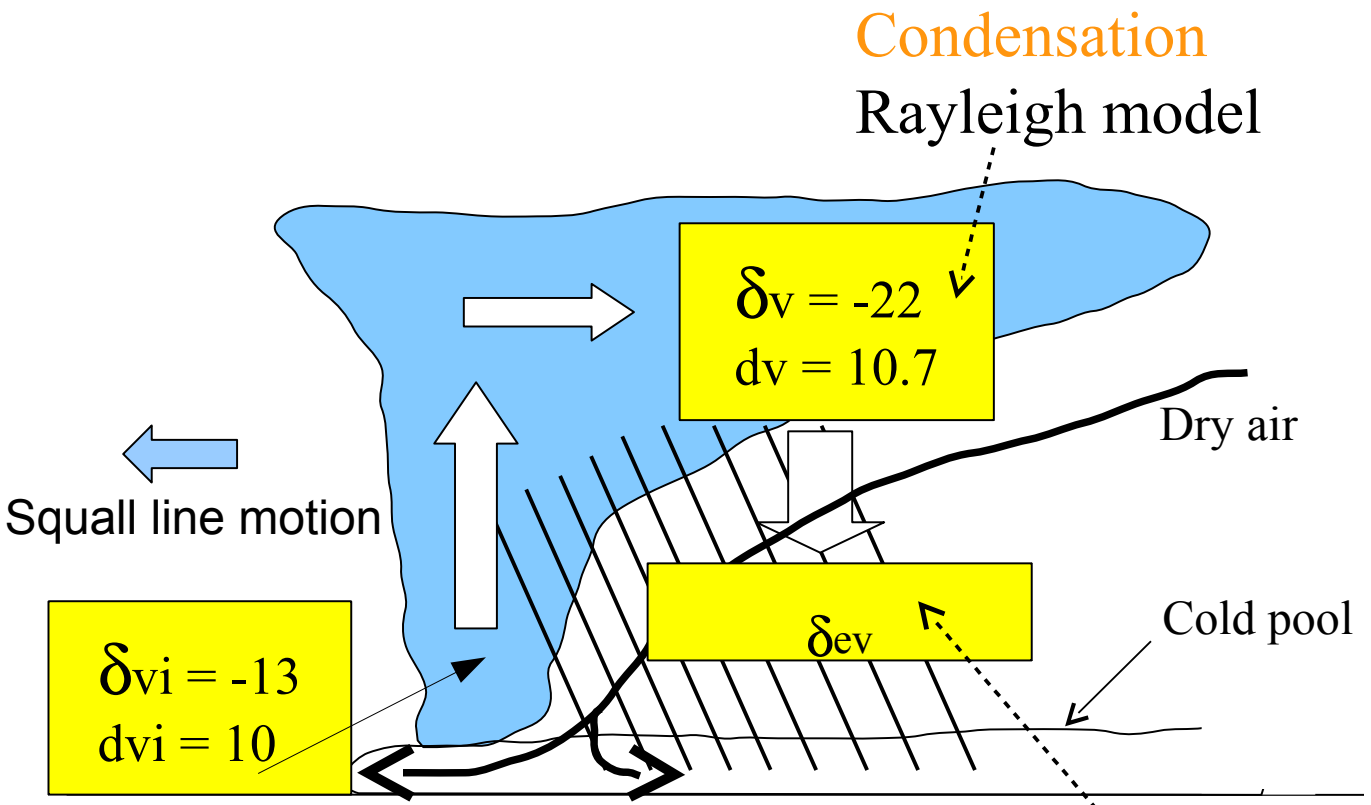
Joint Probability Distribution

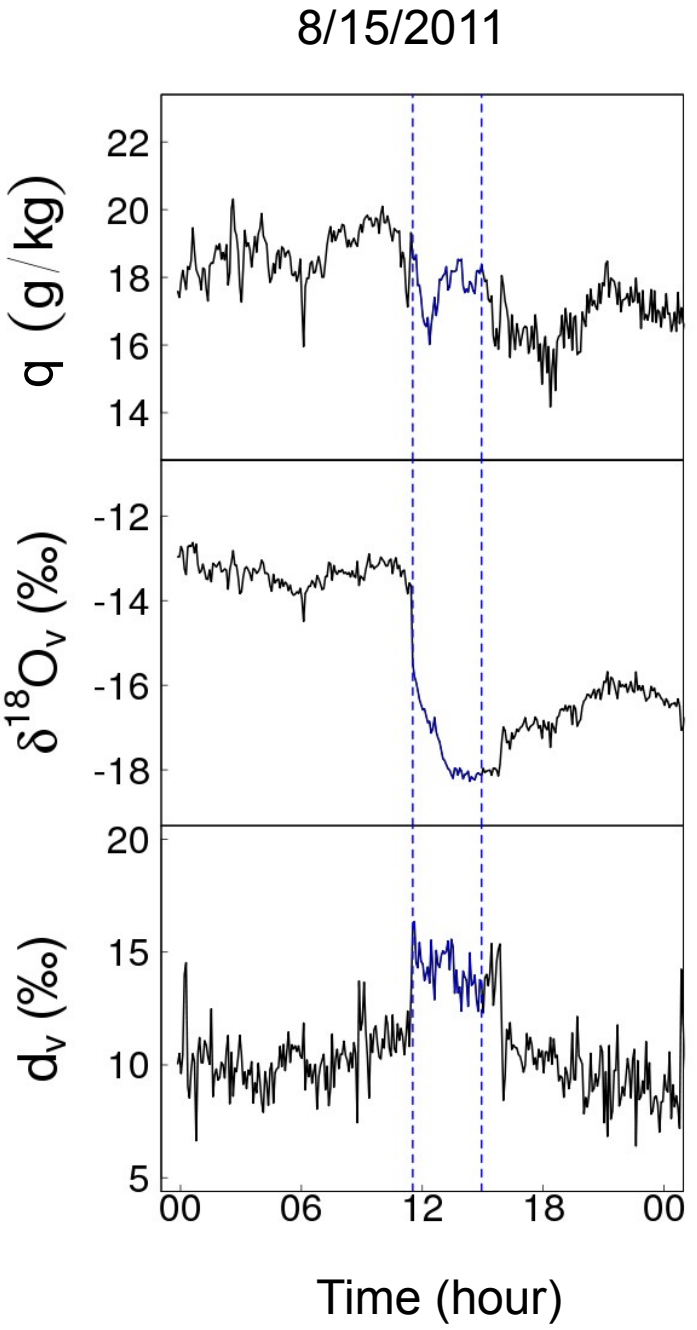




A simple box model for squall line

Subsidence & rain evaporation





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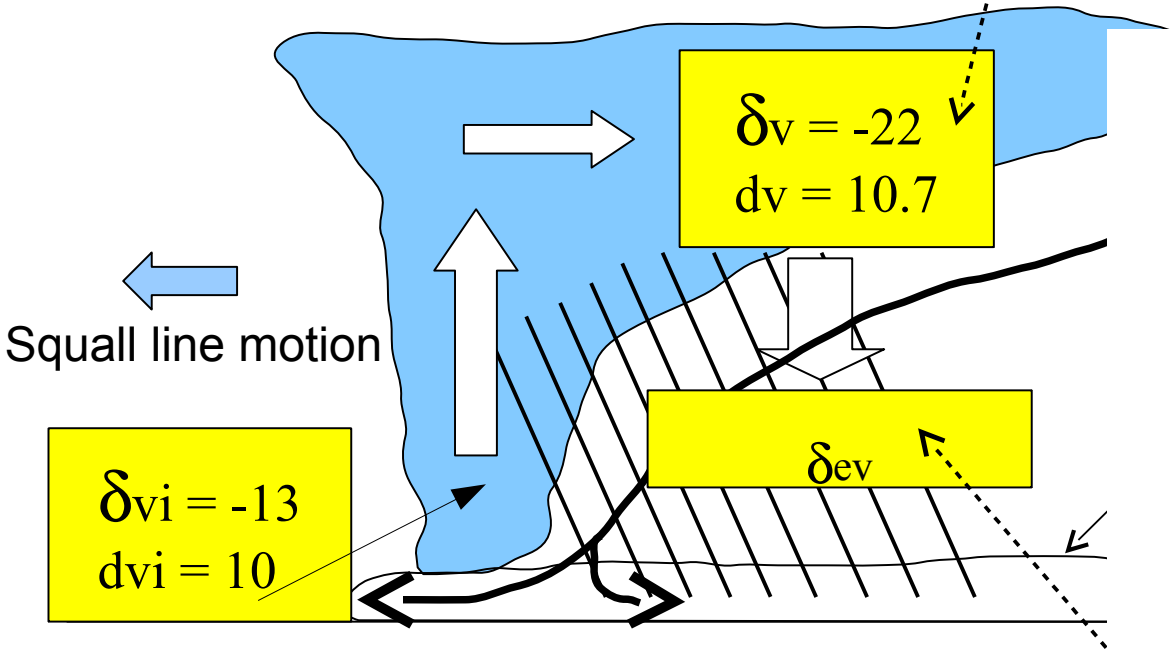
Subsidence & rain evaporation

Condensation

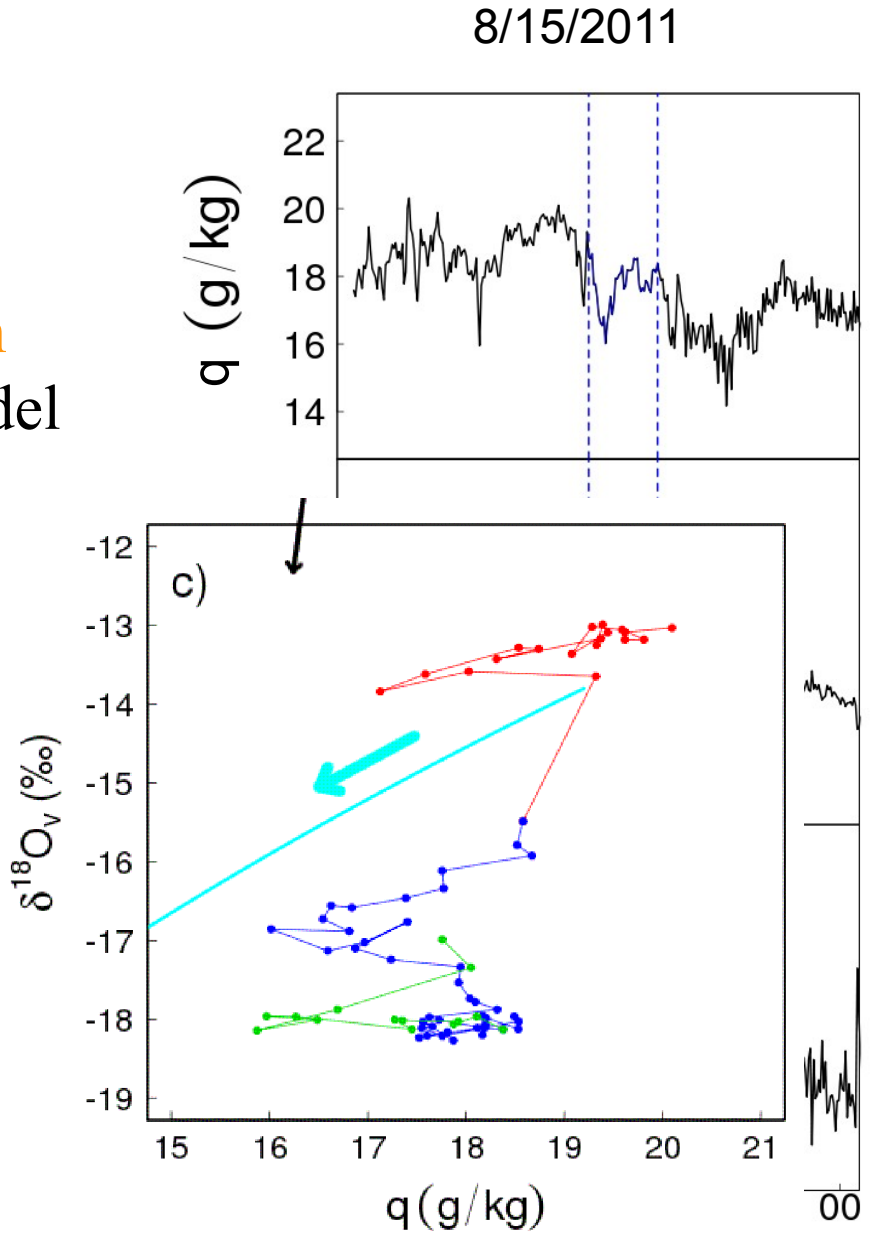
Rayleigh model



Rain eva

Stewart, 1

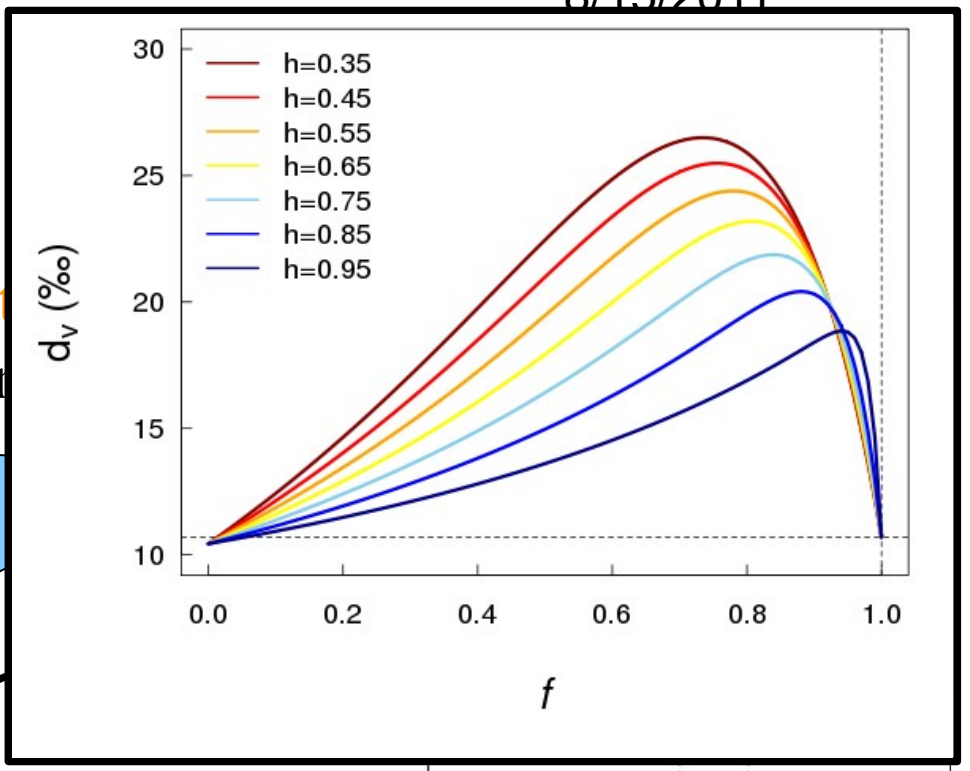
Bony et al., 2008



A simple box model for squall line

8/15/2011

Subsidence & rain evaporation



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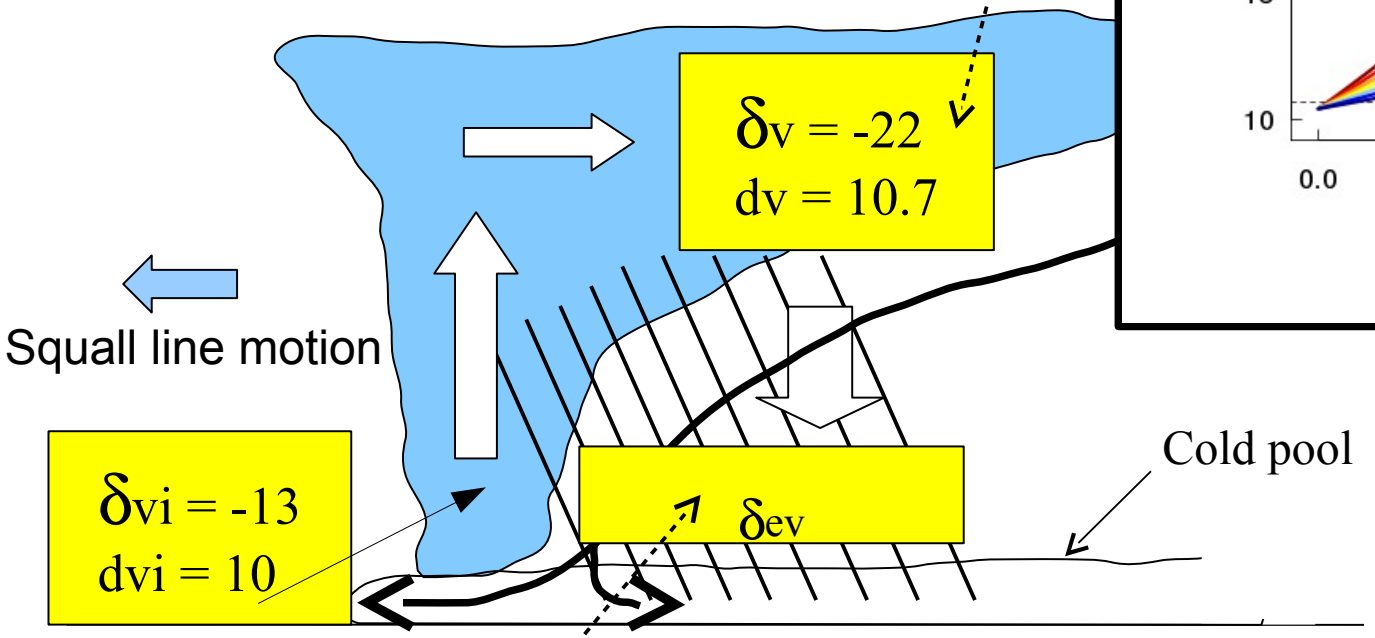

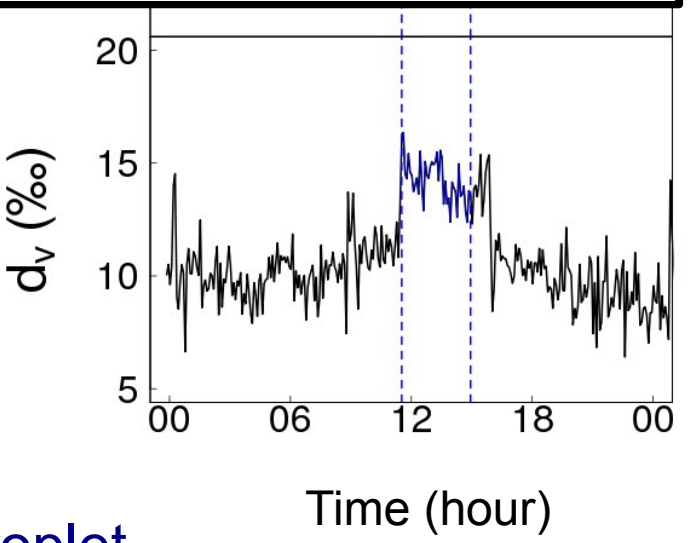

Rain evaporation

Stewart, 1975;
Bony et al., 2008

f = fraction of remaining liquid droplet

Take home messages

- Isotopic measurements both in precipitation and water vapor
- Robust evolutions for well organized systems
- Balance between subsidence and re-evaporation processes
- Useful data for evaluate models equipped with water isotopes