

EUREC⁴A & Water Isotopes

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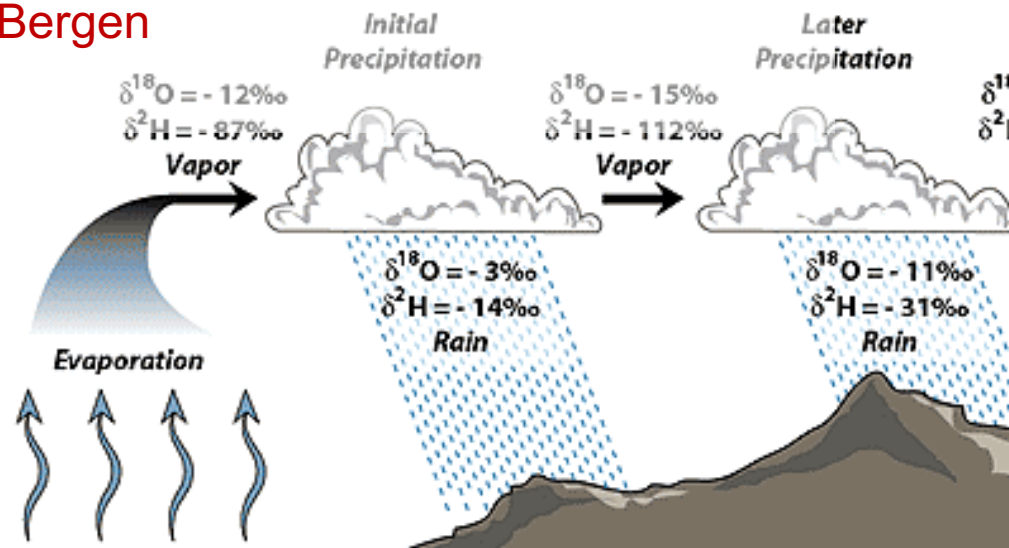
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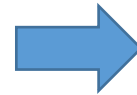
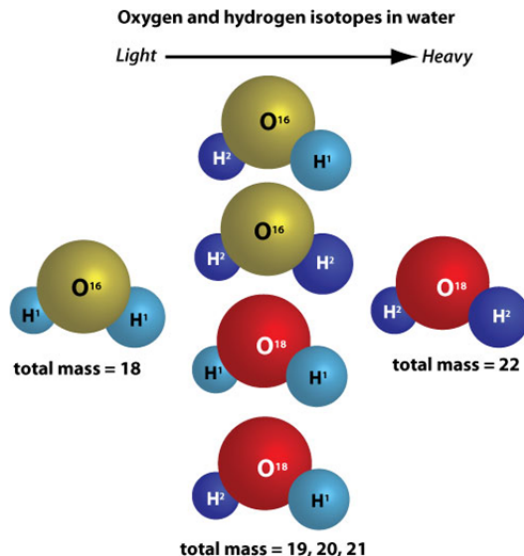
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Water Isotopes

- **Stable water isotopologues** (i.e., isotopes) such as H_2^{18}O and $^1\text{H}_2\text{HO}$ known for their use as **climate proxies** in paleoclimate reconstructions.
- **Isotopes are measurable tracers of moist diabatic processes in the atmosphere** (heavy molecules stay in the liquid phase due to their lower saturation vapor pressure than the lighter H_2^{16}O species – the so-called “equilibrium effect”).
- Also, **heavy molecules have a smaller diffusion velocity** through an unsaturated laminar layer (“non-equilibrium effect”).

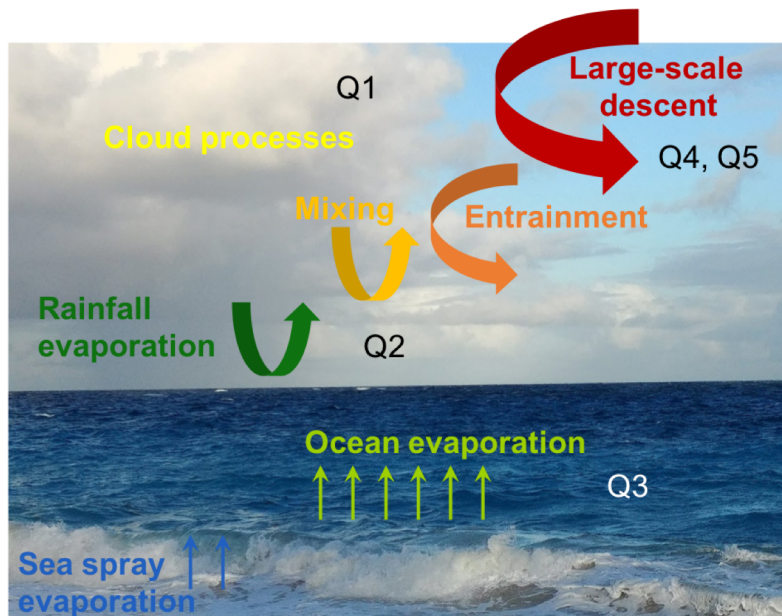


Isotopic composition of a given water sample is determined by the integral of past phase changes that it has experienced.

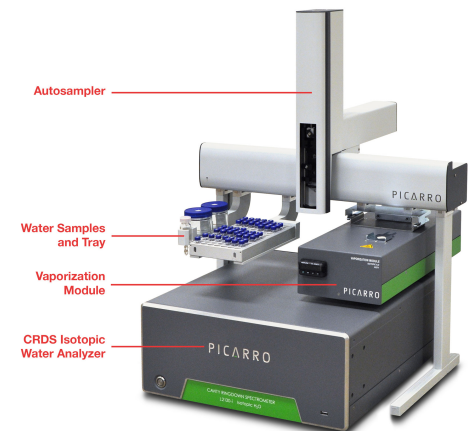
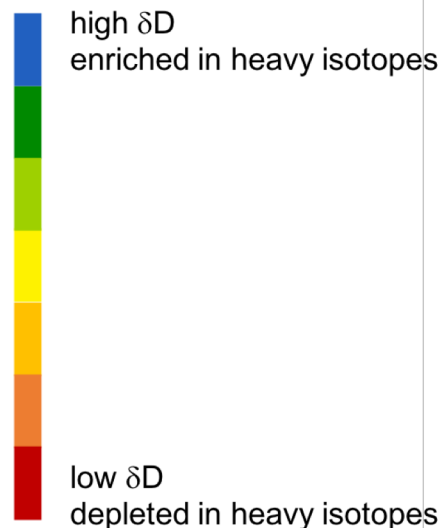
EUREC⁴A & Water Isotopes Rationale

- The strong **contrasts in the isotope signature** of the **very dry descending free tropospheric airmass** (very low amount of heavy molecules), the **freshly evaporated ocean water** (large amount of heavy molecules), and the **below cloud rainfall evaporate** (intermediate amount of heavy or less heavy molecules).
- **These sources of atmospheric moisture can then be mixed in many different ways by turbulent eddies, by convective up- and downdrafts, which leads to important short-term variability in our isotope timelines**

EUREC⁴A-iso: process schematic and research questions



Qualitative vapour δD scale



Stable Isotope Analysis of High-Saline Water

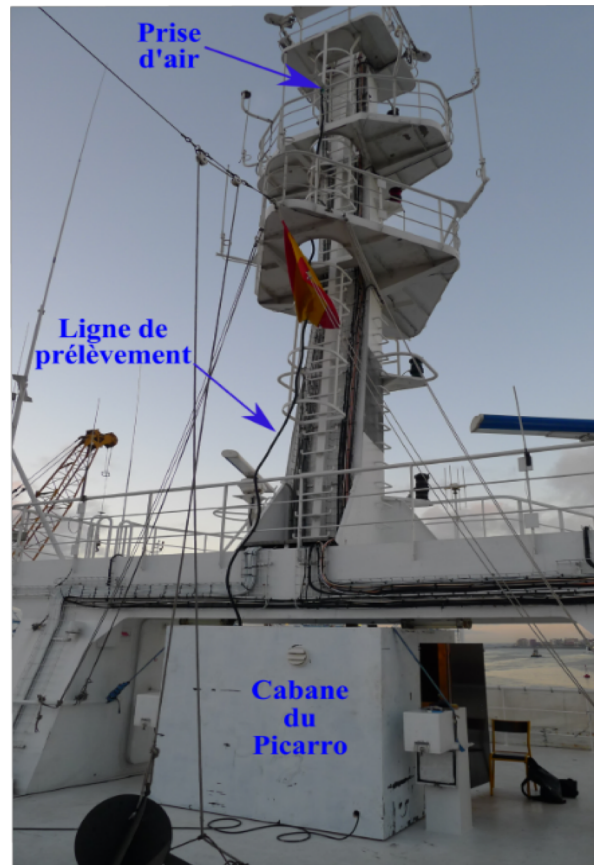
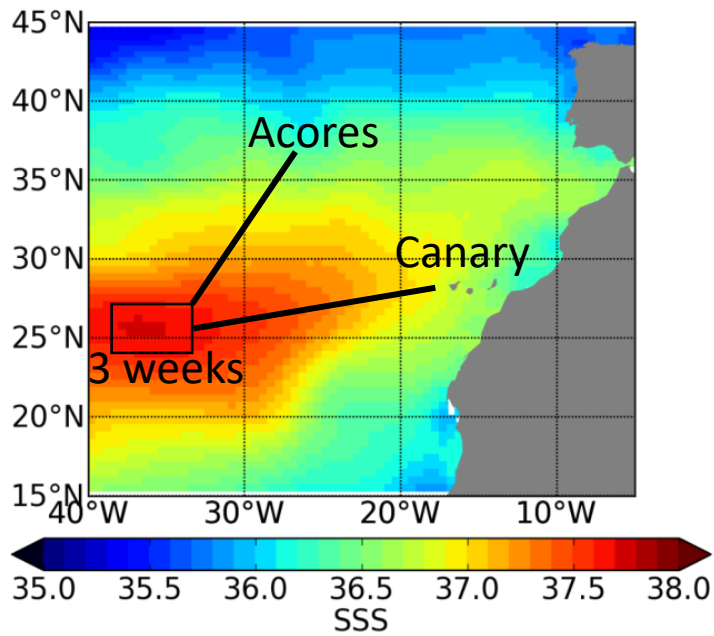
Isotopes group science questions

1. **Isotopes and trade wind cumulus organisation:** Do water isotope signals reflect different types of organisation of low-level trade wind clouds? If yes how?
2. **Boundary layer moisture budget:** Can we obtain a detailed characterization of the sub-cloud layer isotope budget using the EUREC⁴A multiplatform observations combined with isotope-enabled LES simulations?
3. **Coupling to the ocean surface and turbulent fluxes:** How does the ocean surface couple to mixing in the boundary layer and the shallow cumulus clouds structure?
4. **Large-scale circulation coupling:** What is the role of large-scale advection terms in the isotope budgets of the free troposphere and the sub-cloud layer?
5. **Coupling between the tropical and the extratropical water cycles:** What is the role of extratropical dry intrusions and how does the isotope signature of moisture evaporated in the tropics translate into extratropical signals during tropical moisture exports?

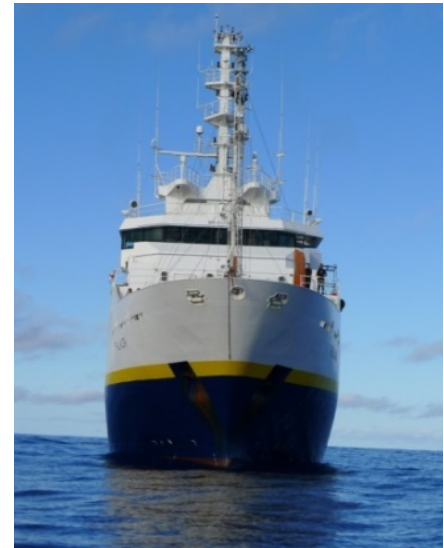
Isotopic water vapor measurements in the tropical Atlantic

How do local atmospheric parameters such as humidity and wind speed control the kinetic fractionation during evaporation ?
Context of Eurec4A similar to other 'trade wind' experiments

STRASSE
(summer 2012)

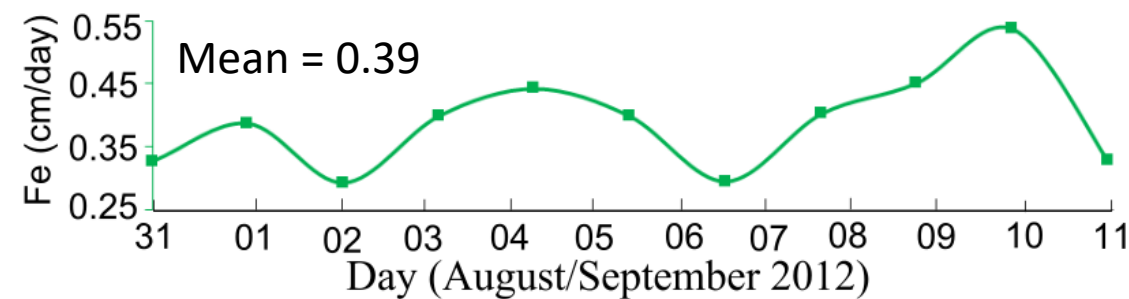
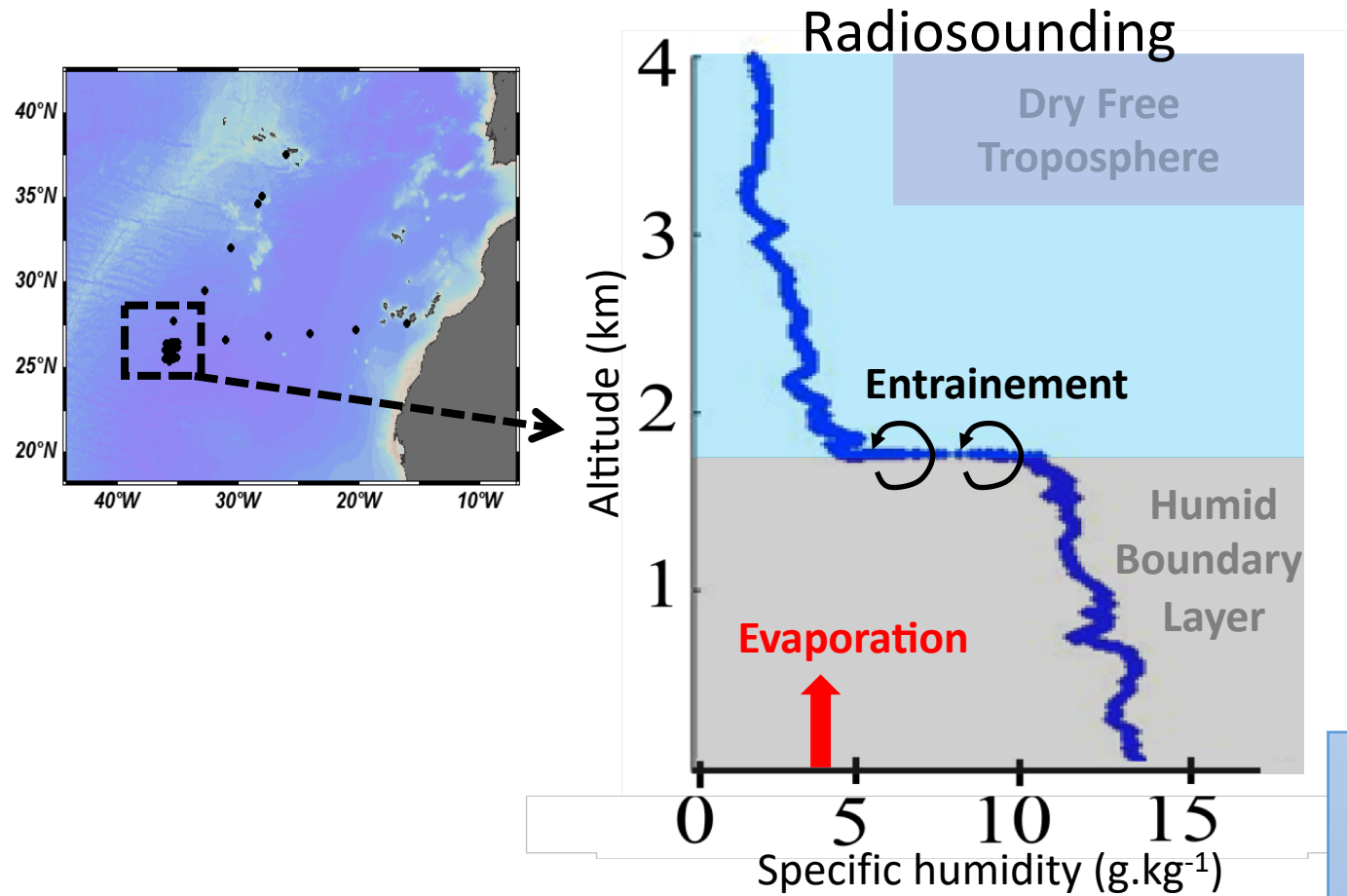


RV La Thalassa



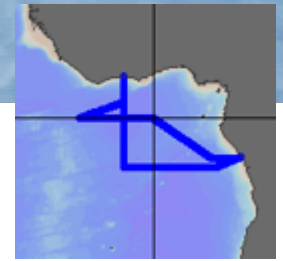
But, more frequently PICARRO CRDS installed close to bridge

Meteorological conditions - Typical of the GST in Summer



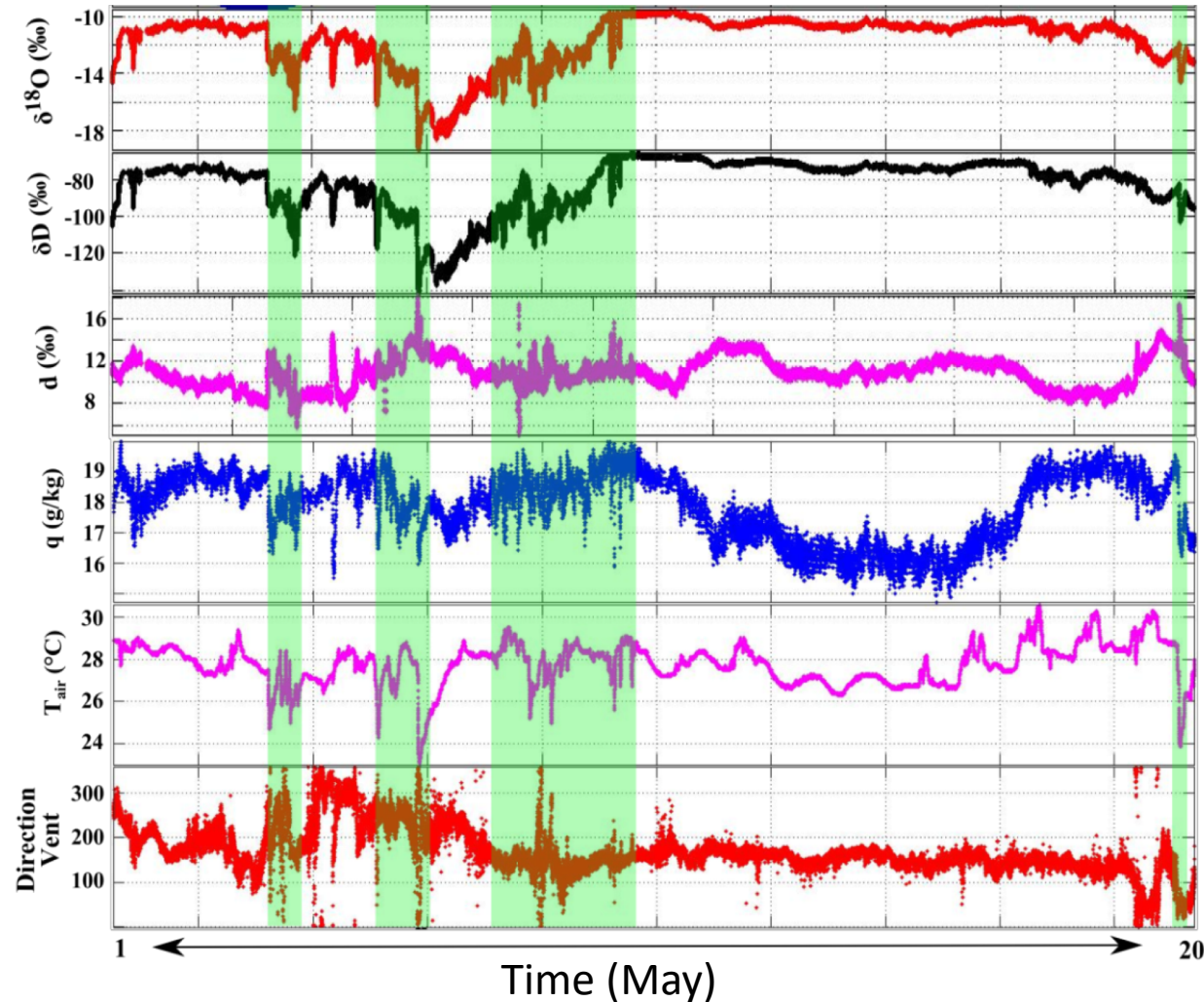
We expect a strong influence of the evaporation flux on the humidity at the sea surface.

PIRATA FR24 – The Guinea Gulf



Strong convection

Trade-winds regime



Rain

Two main atmospheric regimes

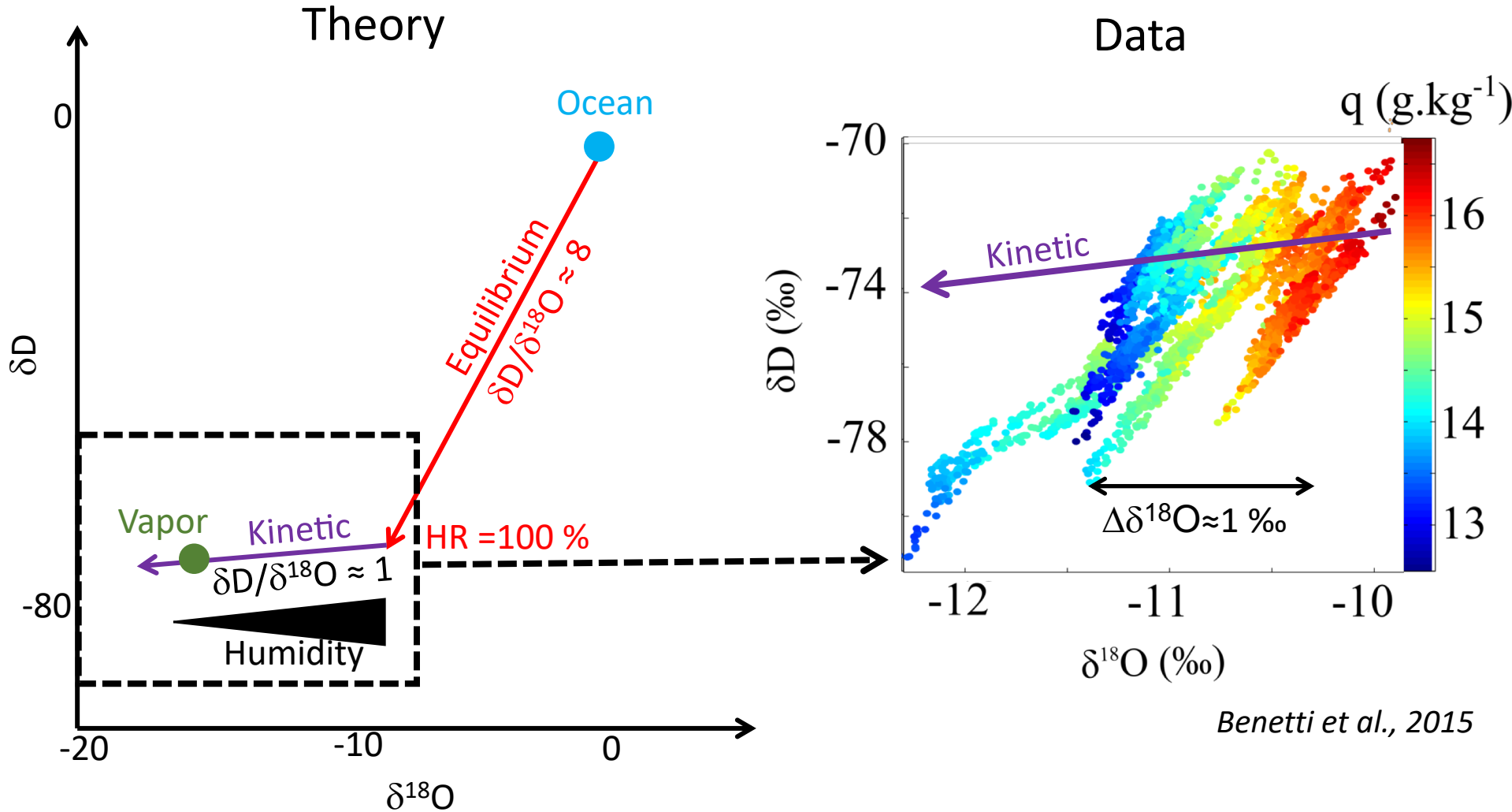
- Deep convection around the ITCZ
- A period of limited vertical mixing within the trade-winds regime

Specific question

Characterisation of the convective system (eg. comparison with LMDZ-iso, reevaporation of the rain)



How does evaporation affect the isotopic composition of the water vapor at 17 m?



Strong influence of the evaporation on the water vapor at 17 m

The closure assumption

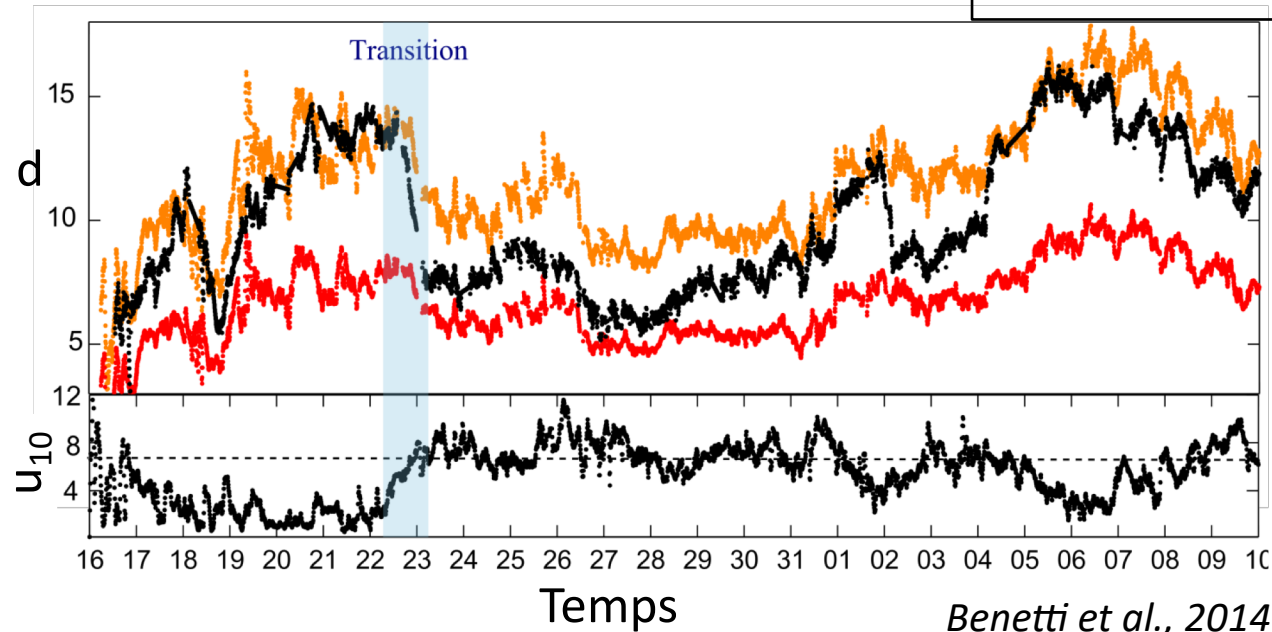
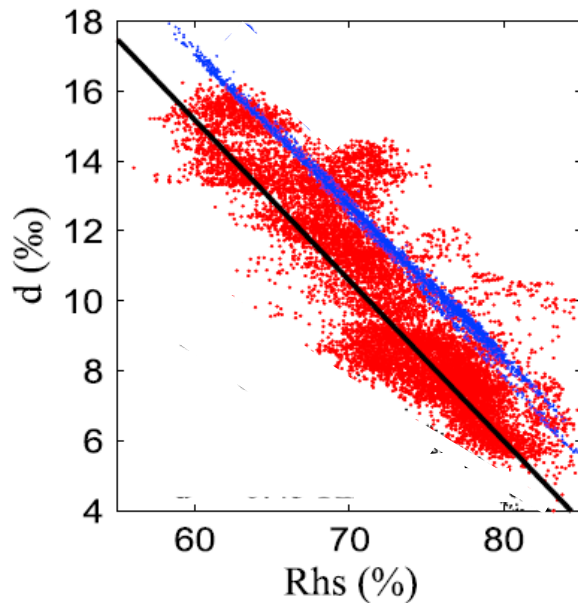
(Merlivat and Jouzel, 1979)

Dependency of deuterium excess to

Humidity

Wind speed

Weak wind
Strong Wind
Data



Benetti et al., 2014

Dependency of d-excess to surface conditions
Humidity / Wind speed

RARA AVIS 2015 – The sub/tropical North Atlantic Ocean



January – June 2015

Collaboration with AJD (French association)

35 m

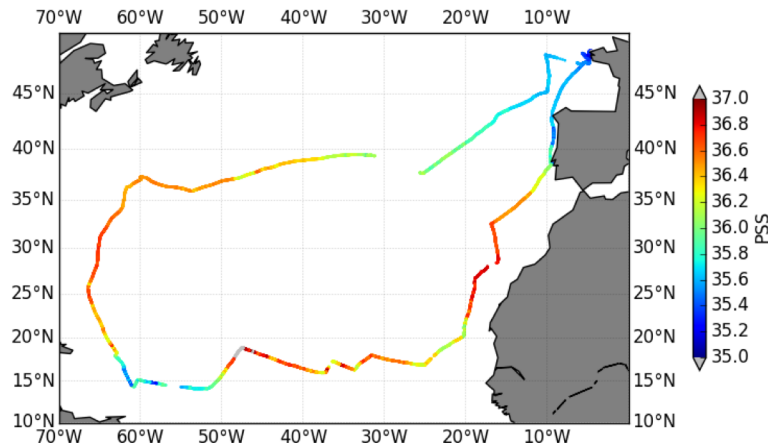
Installation of the scientific material on a sailing boat (eg. limited power supply) – Success of the protocole

Specific questions

Seasonal variability of δe in the trade winds region (comparison with the summer cruise STRASSE)

Bermudes Island – Comparison with the land station measurement.

Raravis - Salinity



Potential cold pool (and depletion)
under rain...

