Vertical thermodynamic characterization of heavy precipitation using GNSS Radio Occultation observations

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Motivation

ROHP – PAZ will provide, for the first time, joint products of vertical thermodynamic structure of the atmosphere and vertical precipitation information

What can Radio Occultations provide in the study of heavy precipitation and deep convection events?

High vertical resolution	Global distribution	Penetration into clouds and precipitation
(vs Satellite observations)	(vs Radiosondes)	(vs Satellite observations)

Motivation

Penetration into clouds and precipitation

Global distribution

Precipitation transition statistics using co-located RO

- Relationship between water vapor and precipitation ***w – P***
- Observable quantities that can be used to assess the capability of Convective Parameterization schemes in models
- Number of studies using radiosondes (fixed location)

High vertical resolution

Temporal evolution of moisture vertical structure

- How moisture is positioned vertically at the different stages of heavy precipitation events

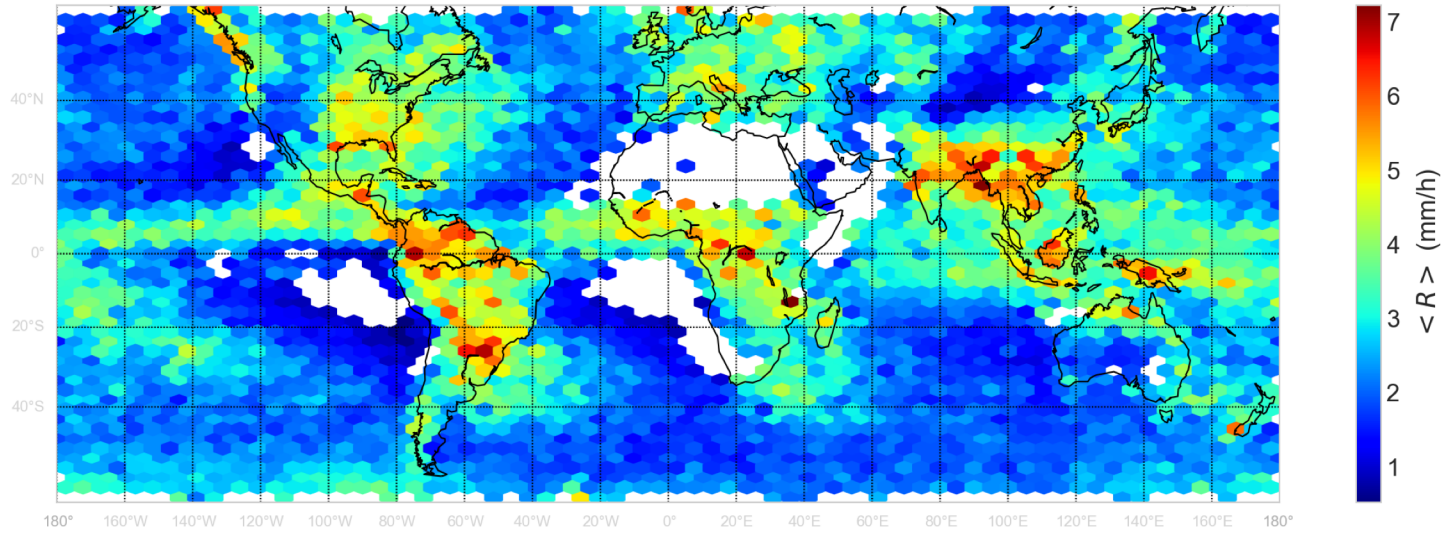
Radio Occultation and Precipitation data

Co-locations between

COSMIC RO
METOP – A/B

1.956.476 cases

IMERG
precipitation data

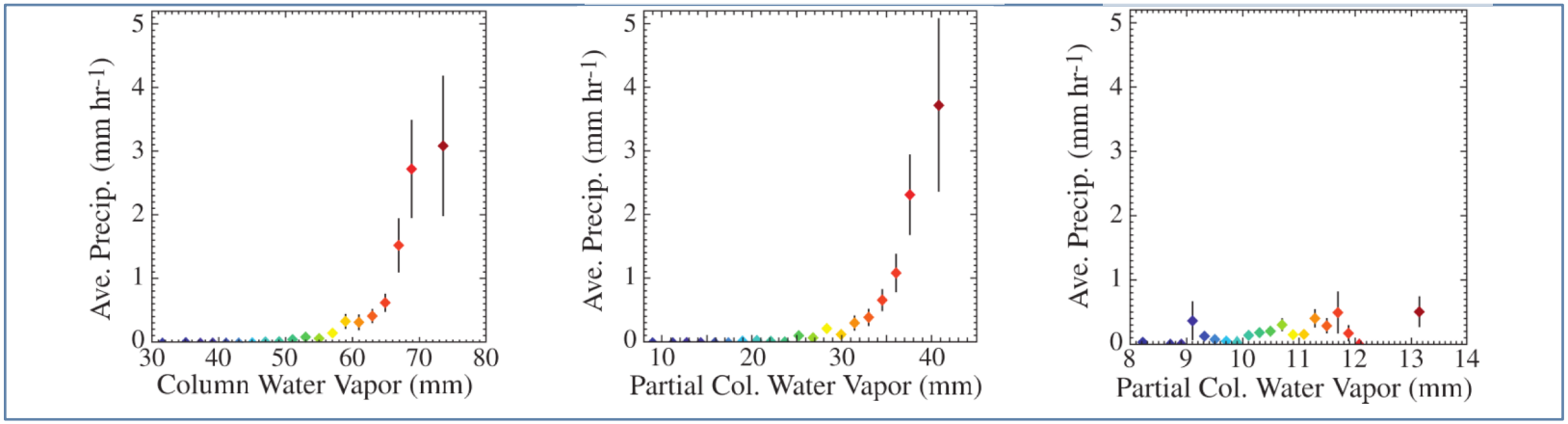


- +-15 min precipitation in the 2x2 deg around RO TP for the +- 6 hours
- Vertical refractivity and Temperature, Pressure, Water Vapor pressure

Precipitation transition statistics

A sharp pick-up in precipitation with increasing Column Water Vapor has been observed, with most influence coming from the free-tropospheric water vapor

Total column wv | Free tropospheric column wv | Below boundary layer column wv



Holloway and Neelin 2009

RO represents an interesting tool to characterize w-P globally

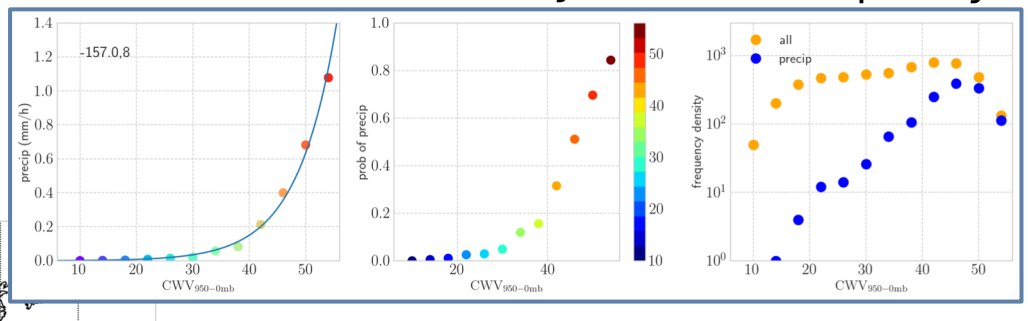
Precipitation transition statistics

Conditionally averaged precipitation

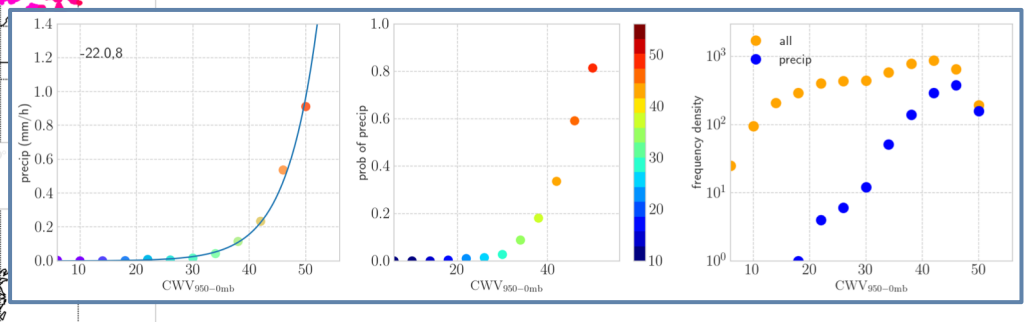
w - P

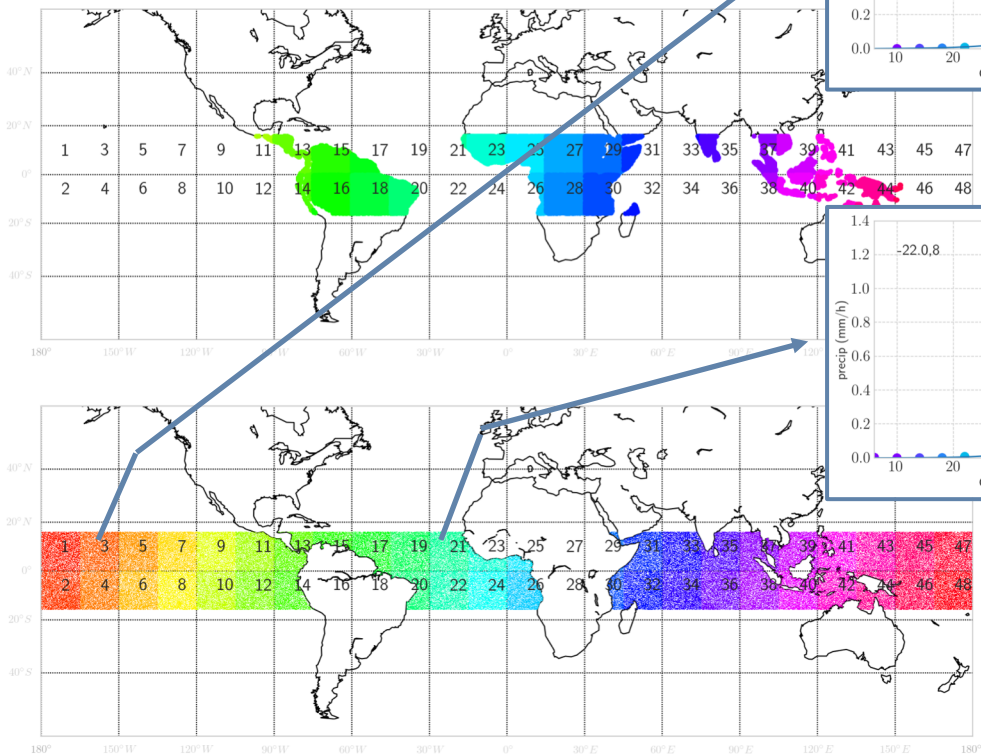
Probability of P

Frequency



Column water vapor above PBL

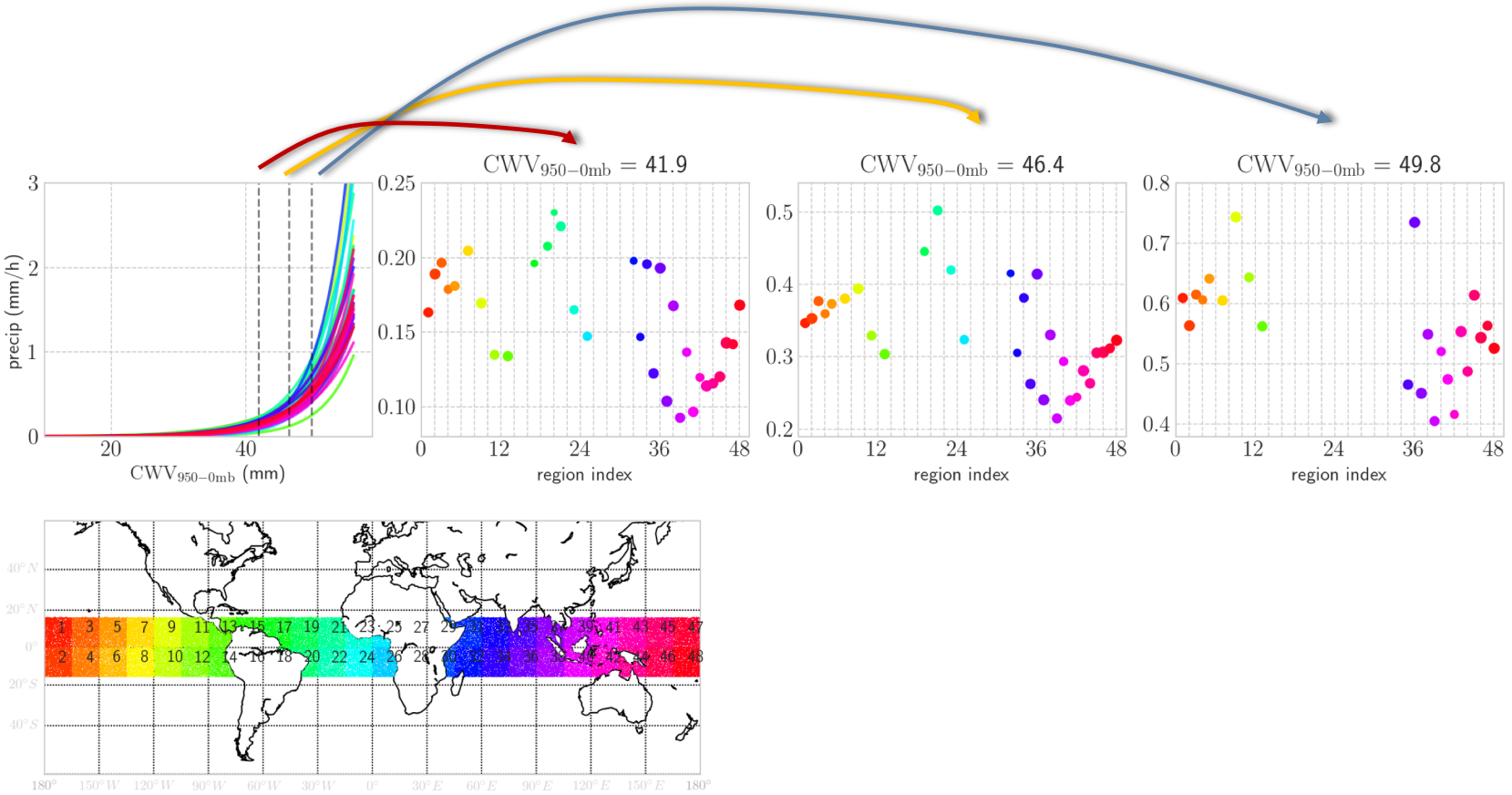




RO observations capture the sharp pick-up, and agree well with previous studies

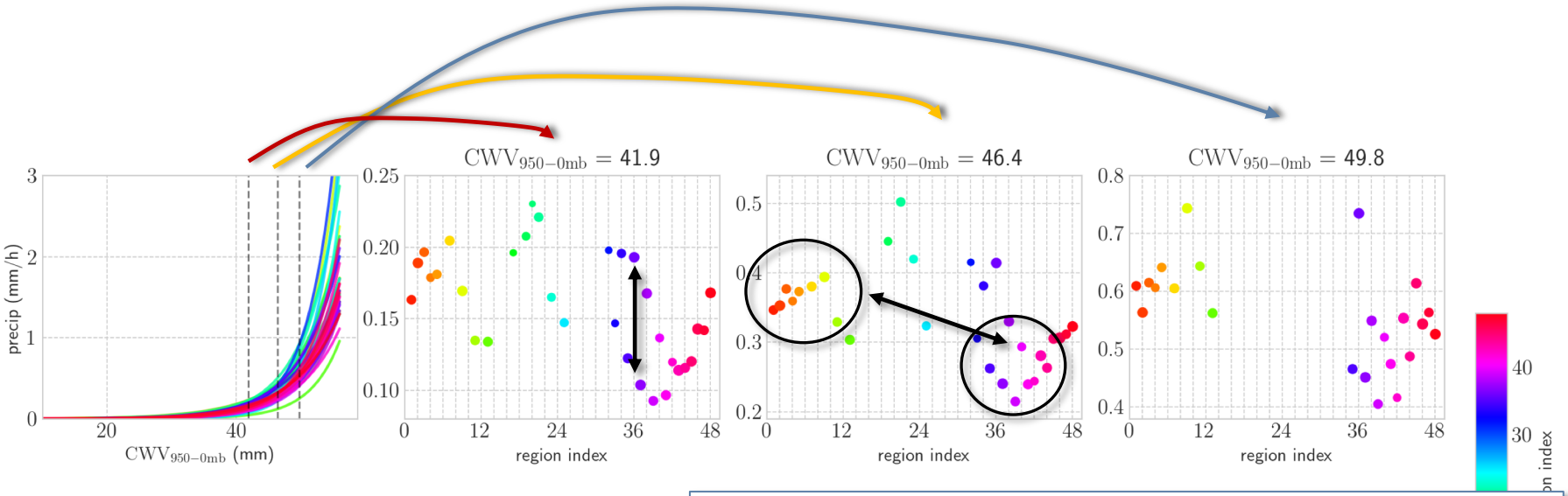
Precipitation transition statistics

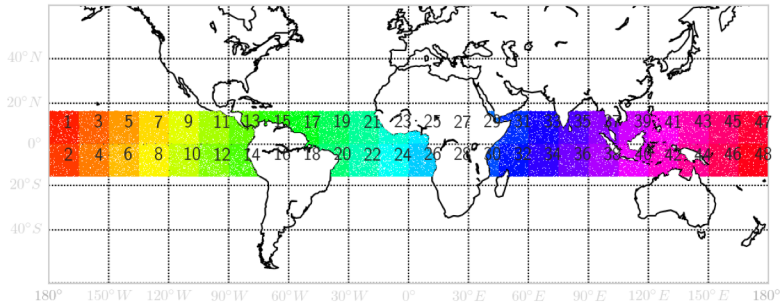
Global comparison of w-P relationship



Precipitation transition statistics

Global comparison of w-P relationship

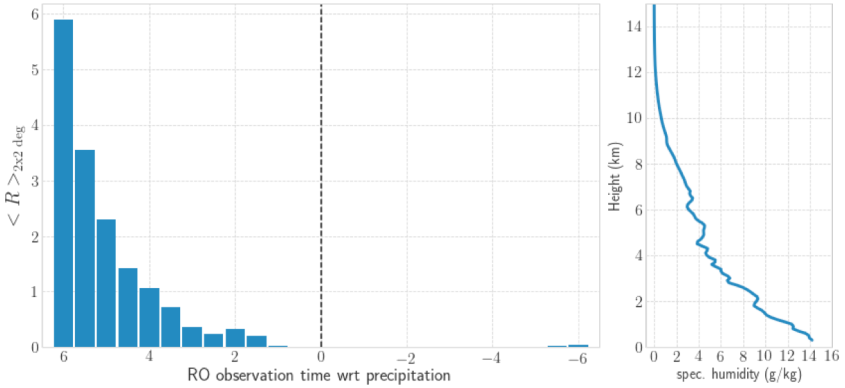




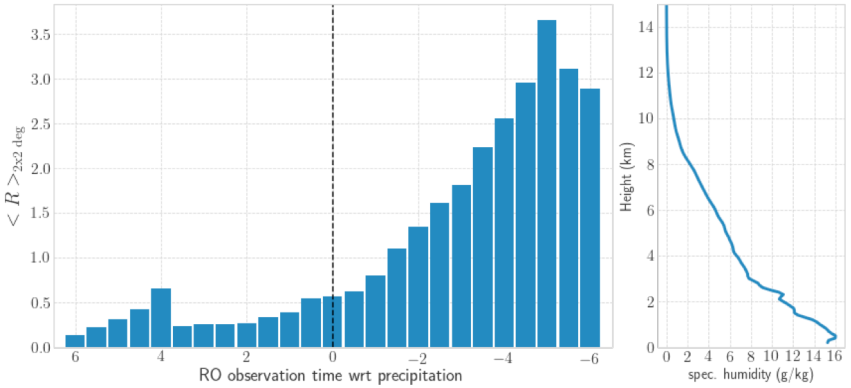
- Relationship holds globally
- Differences among regions
- Differences between northern and southern regions
- Probably, these differences are associated to temperature differences

Moisture evolution across vertical layers

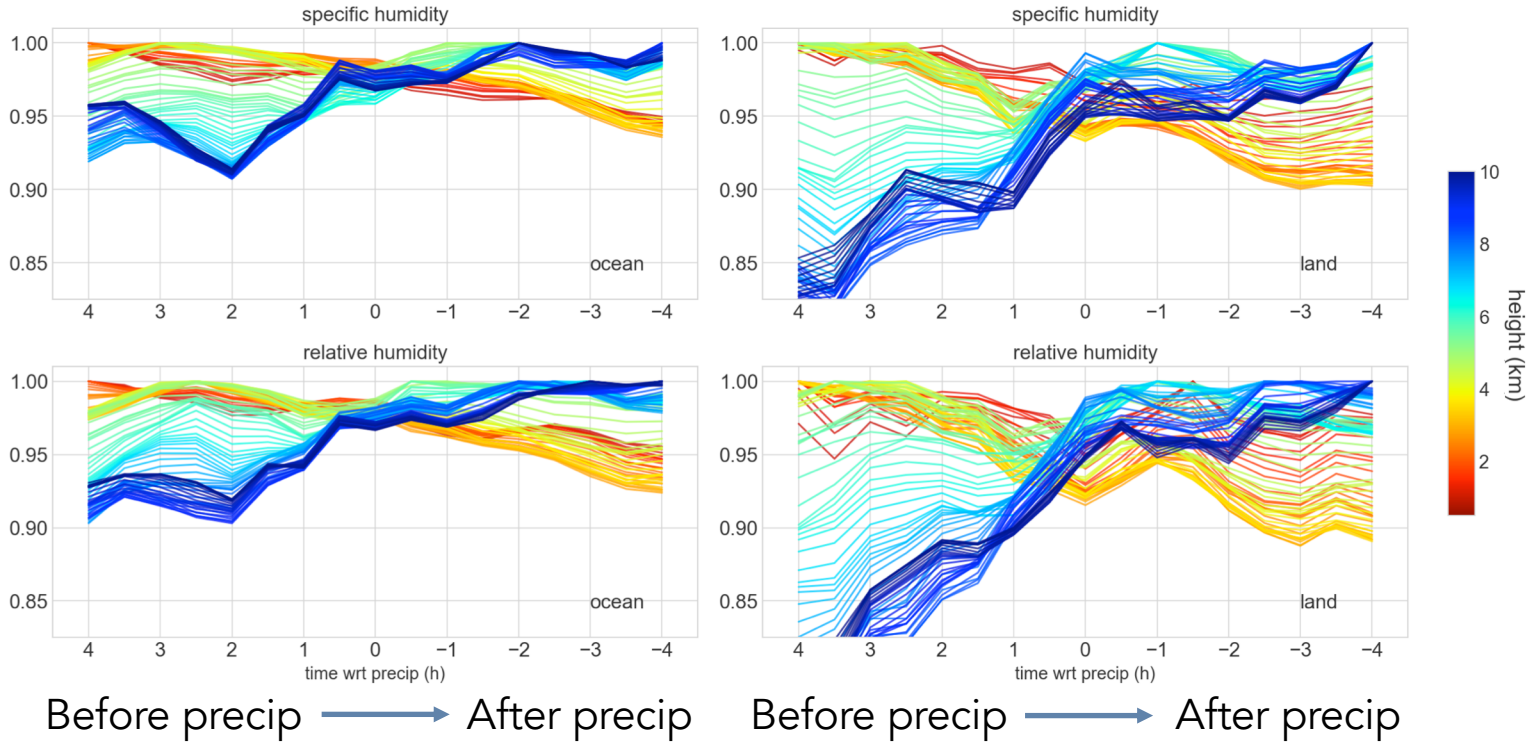
Observation 6 h after maximum precip



Observation 5 h before maximum precip



Moisture evolution across vertical layers



Prior precipitation: *Low tropospheric humidity supports deep convective initiation*
During precipitation: *Moist air is lifted updrafts, while drier air from downdrafts dilutes moisture content*
After precipitation: *Upper troposphere increases moisture content -> large-scale ascent induced by convective heating*

Conclusions

- Radio Occultations represent a good tool to characterize the water vapor structure positioned above the boundary layer, shown to be important in the study of deep convection

- With Polarimetric Radio Occultations, we expect to be able to improve and advance in the w – P relationships globally, and as a function of height

- The high vertical resolution of RO allow us to follow the evolution of moisture across the different vertical layers

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