

On the relationship between Polarimetric Radio Occultation observables and water content for convective systems at different life stages

R. Padullés¹, A. Paz¹, E. Cardellach¹, F.J. Turk², C. O. Ao²,
M. de la Torre², K.-N. Wang², M. Oyola², and K. Schiro³

¹ Institut de Ciències de l'Espai (ICE-CSIC, IEEC)

² Jet Propulsion Laboratory / Caltech, Pasadena, CA, USA

³ University of Virginia, Charlottesville, VA, USA

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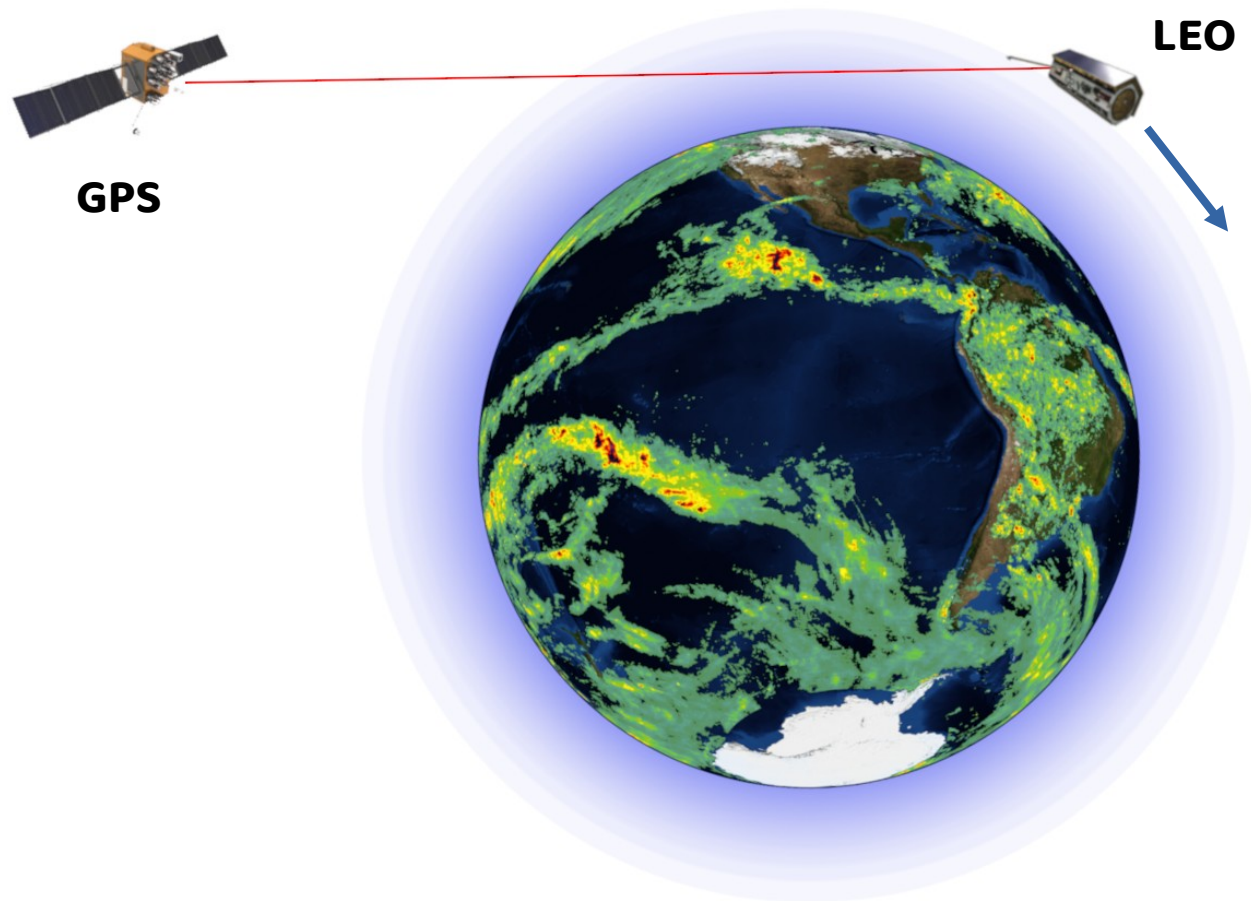
On the relationship between Polarimetric Radio Occultation observables and water content for convective systems at different life stages

- Polarimetric Radio Occultations
 - Enhancement of standard RO for precipitation detection
- Identification of convective systems (current work)
- Preliminary results



Polarimetric RO

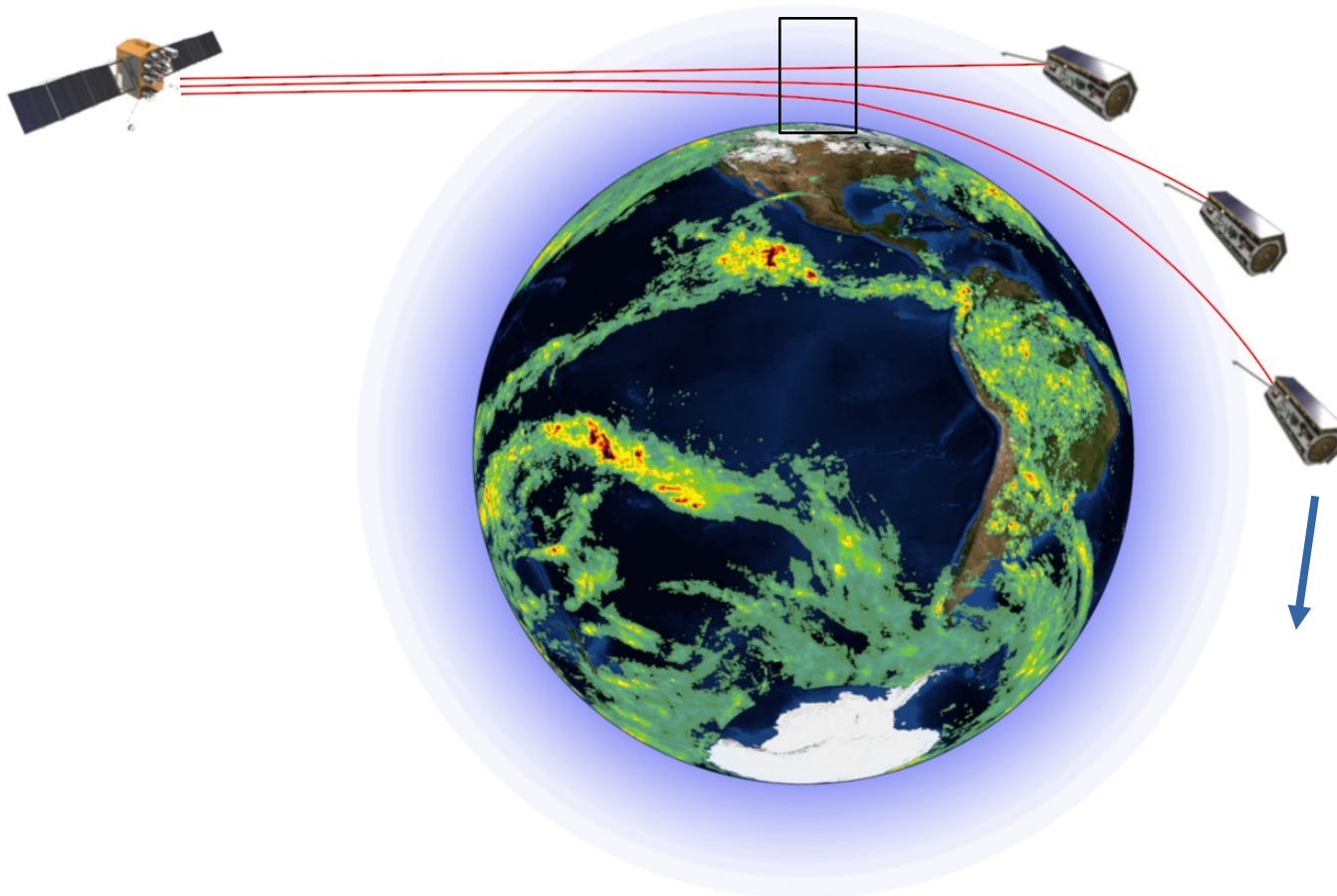
Standard Radio Occultations



- ROs consist on a LEO satellite tracking the signals emitted from a GPS while occulting behind the horizon. The rays cross the atmosphere before reaching the LEO

Polarimetric RO

Standard Radio Occultations

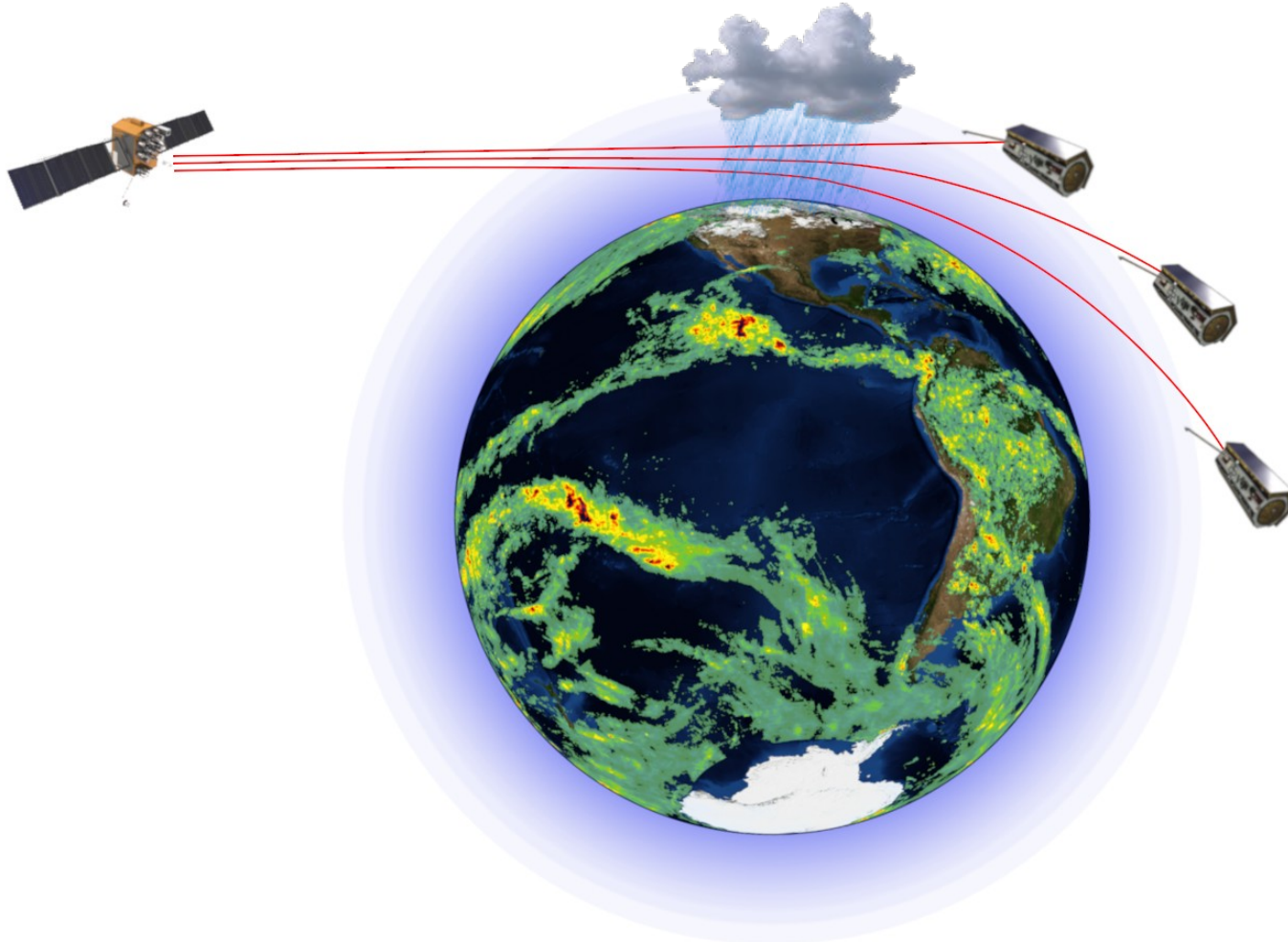


- ROs consist on a LEO satellite tracking the signals emitted from a GPS while occulting behind the horizon. The rays cross the atmosphere before reaching the LEO
- The rays bend due to changes in the refractive index of the atmosphere
- This is a robust and well established technique that allow us to obtain the **thermodynamic state** of the atmosphere in the sensed region

(Refractivity,
temperature, pressure, humidity)

Polarimetric RO

Polarimetric Radio Occultation technique – Proof of Concept aboard PAZ

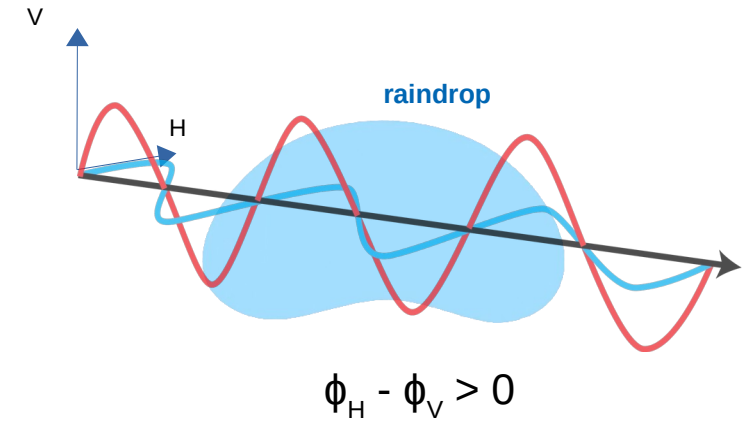
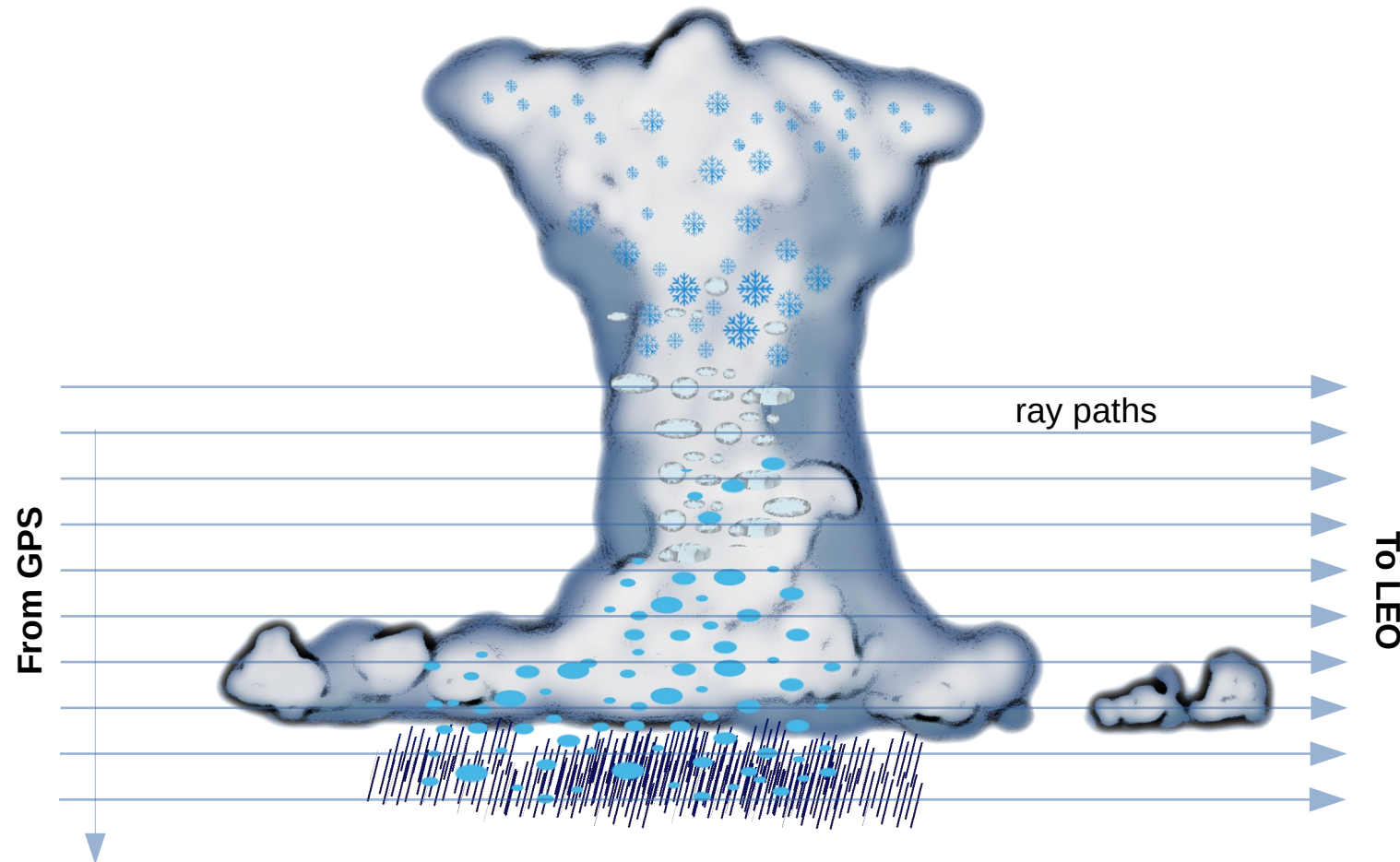


- **The idea** : Minor hardware modification to receive H and V linear polarizations, instead of RHCP (used in the standard RO missions)
- The difference between the phase of the H and V components measured at each port ($\Delta\phi$) can be used to infer precipitation information
- Using same concepts as **polarimetric weather radars**, but in forward scattering geometry and without the range info.

$$\text{e.g. } \Delta\phi = \int K_{dp} dL$$

Polarimetric RO

Polarimetric Radio Occultation technique – Proof of Concept aboard PAZ

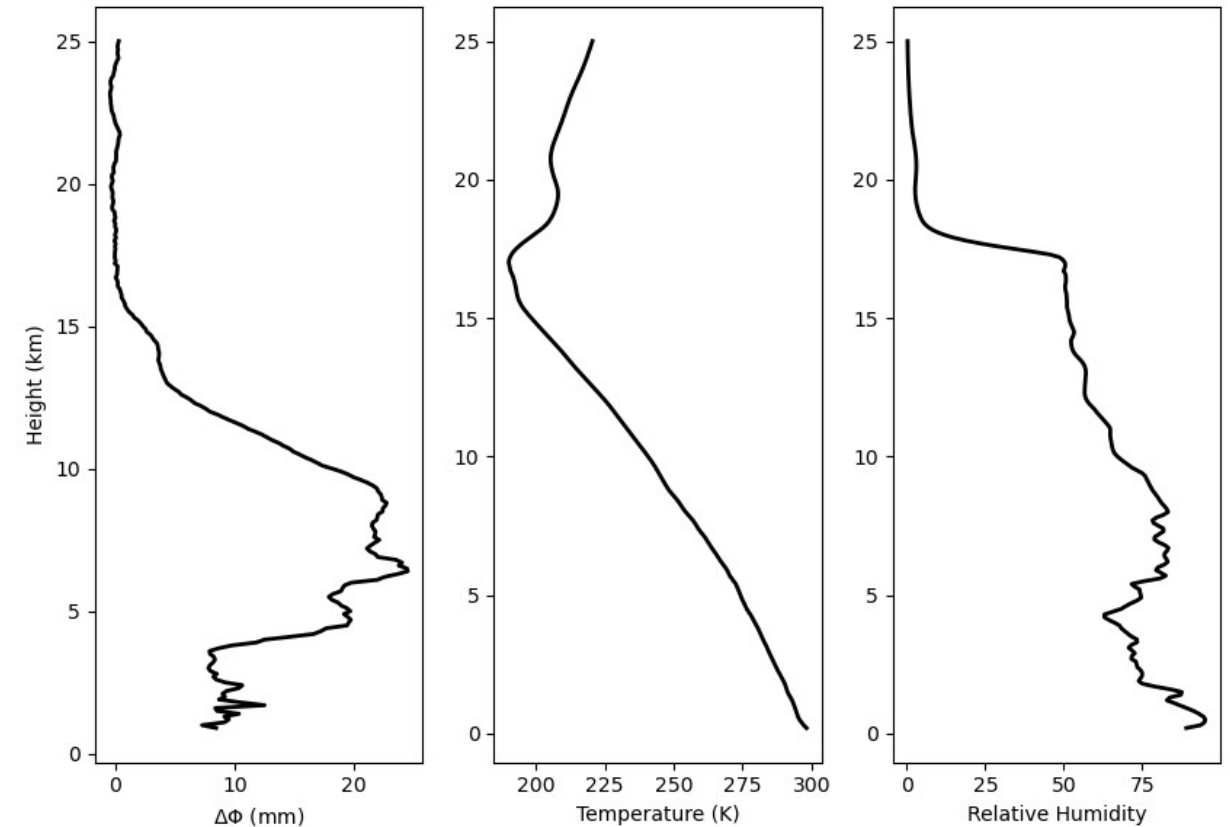
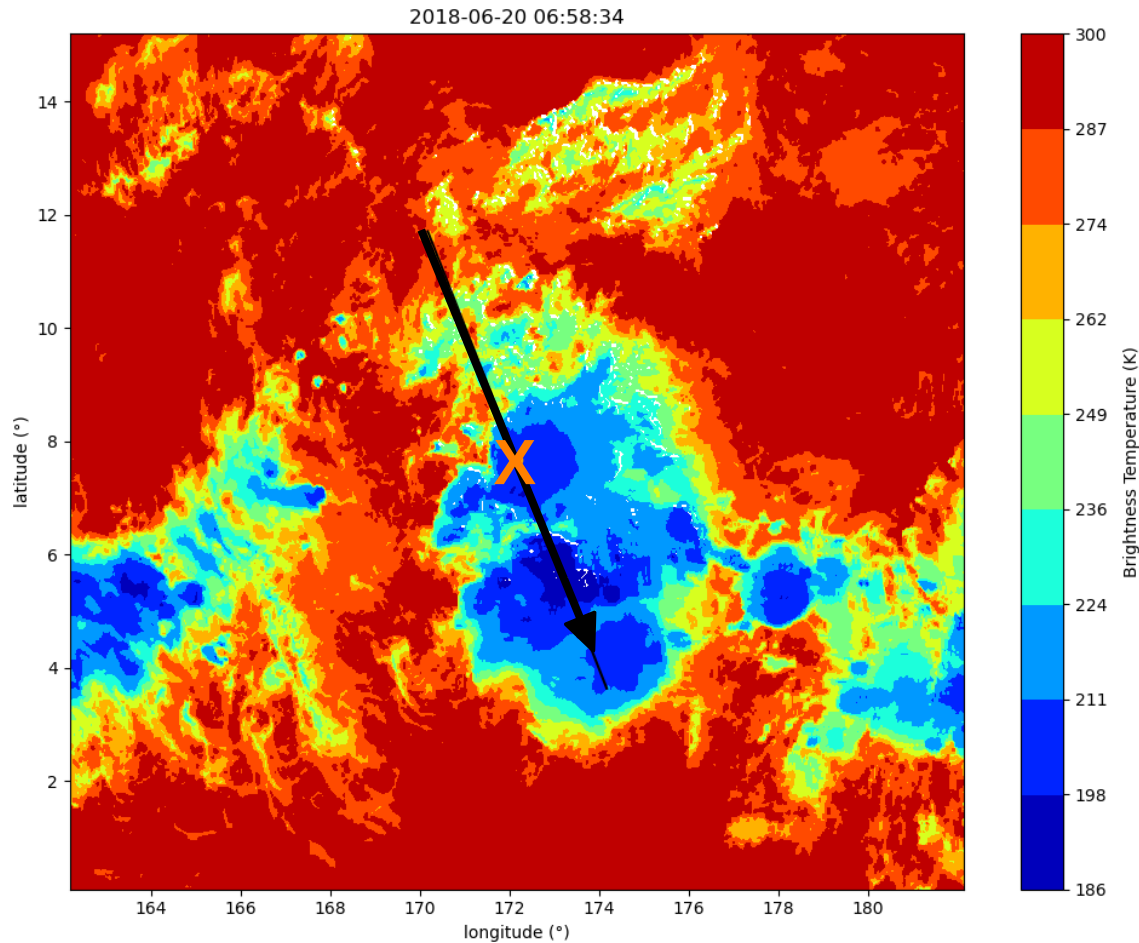


Vertical profiles of $\Delta\phi$

- Sensitivity to rain and horizontally oriented frozen hydrometeors

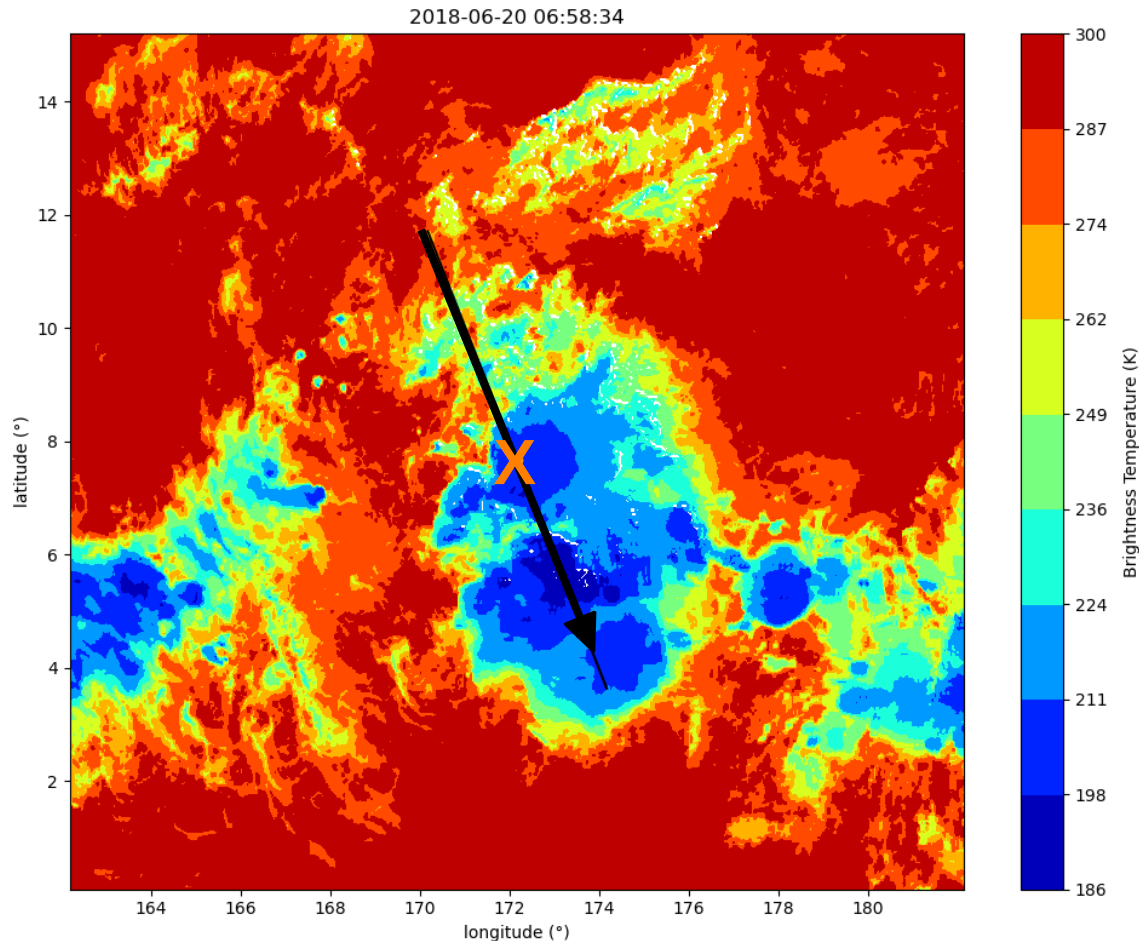
Polarimetric RO

Polarimetric Radio Occultation collocated with 11 μ m IR brightness temperature and the TIMPS database (MCS tracking)



Polarimetric RO

Polarimetric Radio Occultation collocated with 11 μ m IR brightness temperature and the TIMPS database (MCS tracking)



Observables

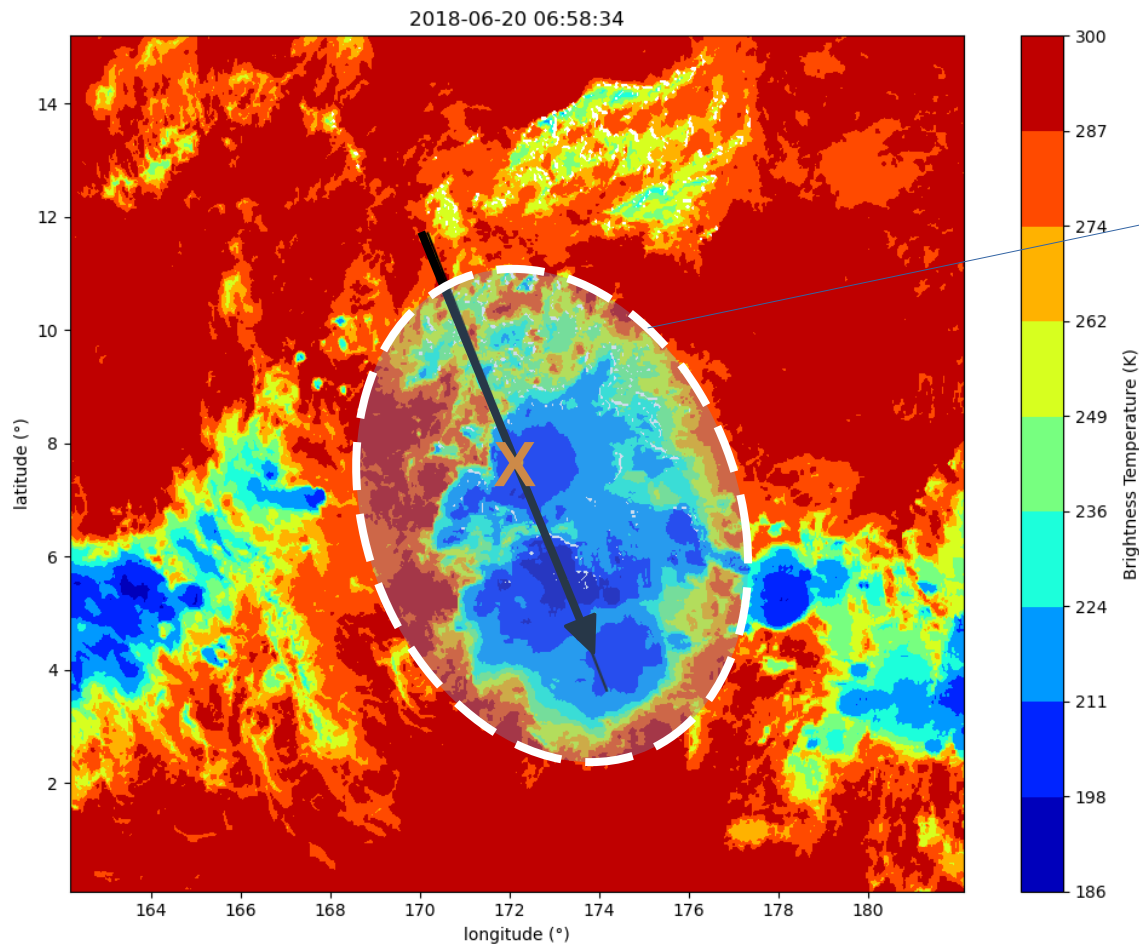
- **Vertical profiles of $\Delta\phi$** , providing information of precipitation and the whole cloud structure
- **Temperature and Moisture** vertical profiles

Unique observational dataset that provides precipitation and thermodynamics information **simultaneously** within heavy precipitation environments

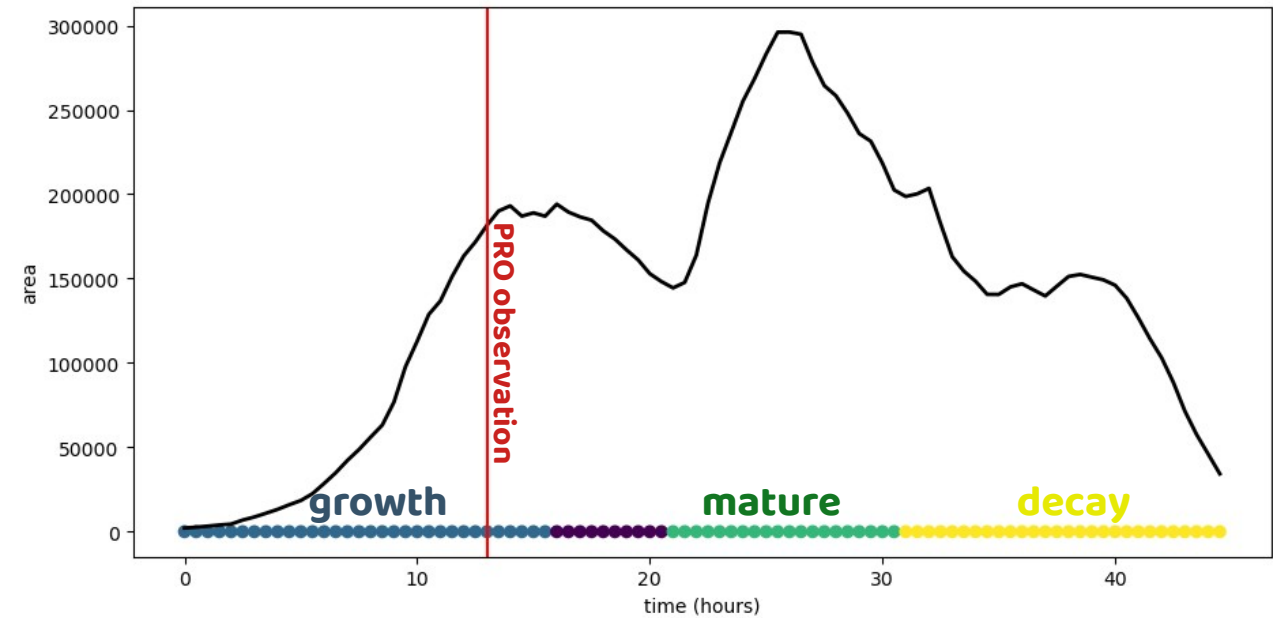
$\Delta\phi$ (mm) Temperature (K) Relative Humidity

Polarimetric RO

Polarimetric Radio Occultation collocated with 11 μ m IR brightness temperature and the TIMPS database (MCS tracking)

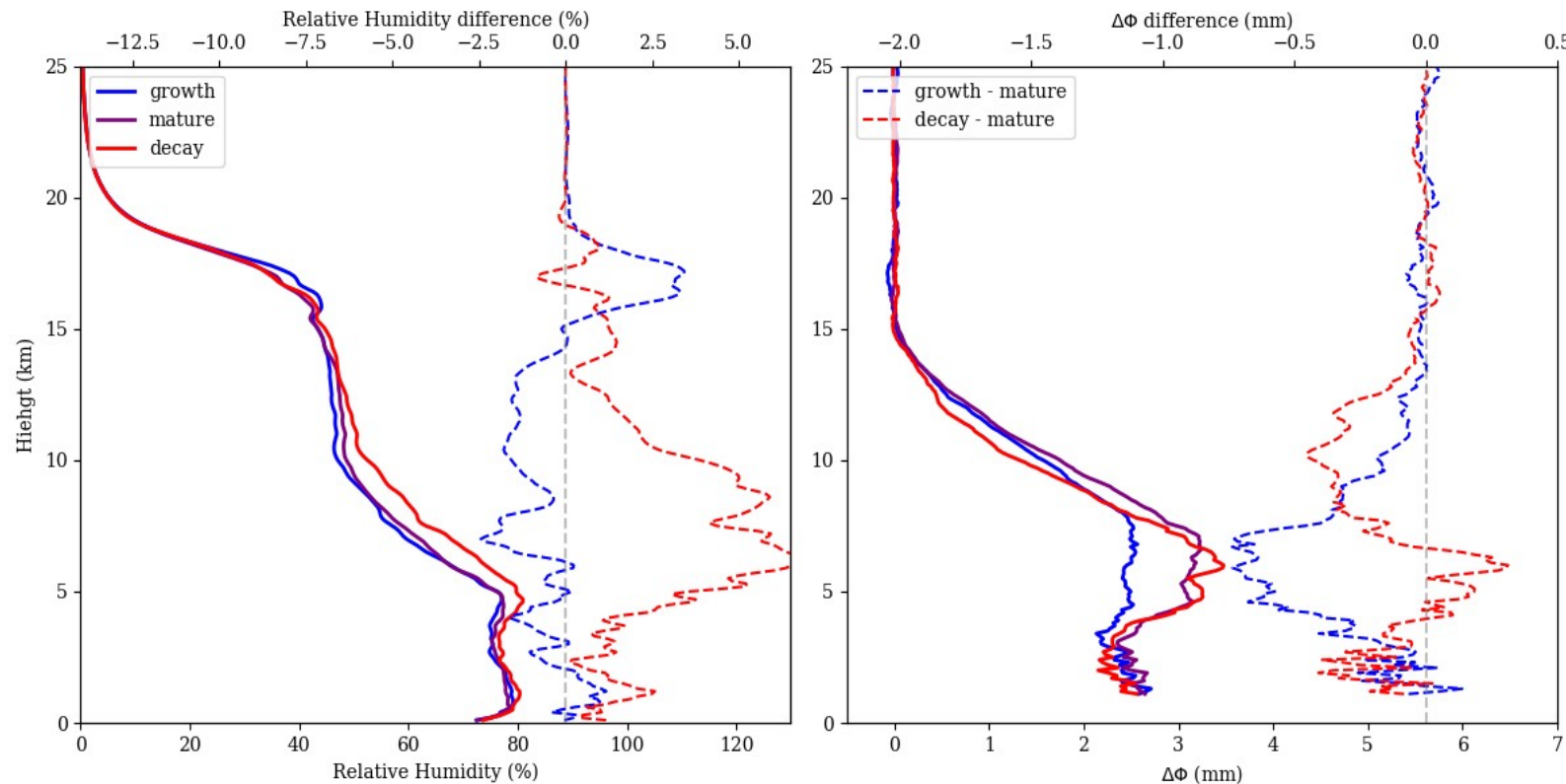


Mesoscale Convective System



Polarimetric RO

Polarimetric Radio Occultation observations grouped by MCS development stage



VERY PRELIMINARY RESULTS

- During the decay stage, humidity increases in the upper free troposphere, possibly indicating moistening of these layers happens due to convection
- $\Delta\phi$ is systematically larger during the mature and the decay stages, and smaller during the growth.
Hypothesis: more turbulent environment prevent hydrometeors to orient in the upper layers?

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- Global tropical precipitation relationships to free tropospheric water vapor using Radio Occultations, **Padullés et al. 2022**, Journal of the Atmospheric Sciences. Doi: 10.1175/JAS-D-21-0052.1
- TIMPS database: <https://jrusell.chpc.utah.edu/timps/>

More references and data available for download in the ROHP-PAZ mission website: <https://paz.ice.csic.es>

Thank you

padulles@ice.csic.es

paz.ice.csic.es

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