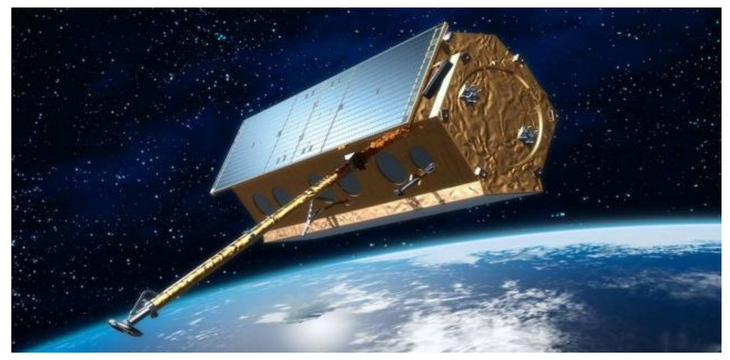
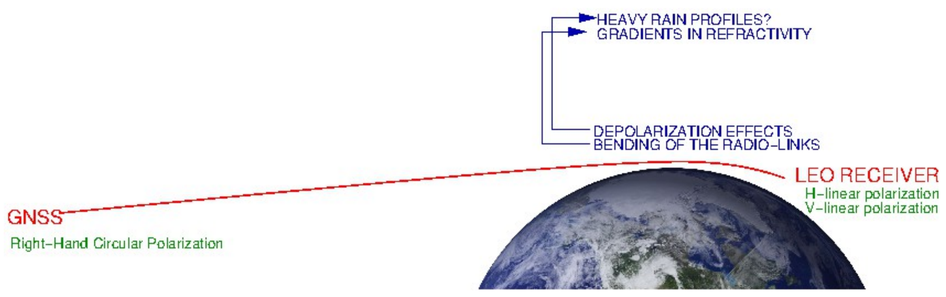
Radio-Occultation and Heavy Precipitation aboard the PAZ orbiter (ROHP-PAZ) and its Ground-Based campaign

R. Padullés, E. Cardellach, S. Tomás [1], M. de la Torre, J. Turk [2]
[1] Institute of Space Sciences (ICE – CSIC / IEEC), Bellaterra, Barcelona, Spain
[2] NASA / Jet Propulsion Laboratory, Pasadena CA, USA

1-ROHP-PAZ is a mission of opportunity: The Spanish Earth Observation PAZ satellite, planned to be launched in Q4 2014, was initially designed to carry a Synthetic Radar Aperture (SAR) as primary and sole scientific payload. It included an IGOR+ advanced Global Navigation Satellite System (GNSS) receiver for precise orbit determination. The design of this particular GNSS receiver allows the tracking of occulting signals, that is, signals transmitted by navigation satellites setting below the horizon of the Earth (or rising above it). The Spanish Ministry for Science and Innovation (MICINN) approved a proposal aimed to modify the original plans of PAZ, by including a polarimetric GNSS Radio-Occultation (RO) payload, the ROHP-PAZ experiment.



Artistic view of PAZ LEO, image provided by HISDESAT



Polarimetric-RO concept: heavy rain and other atmospheric effects (e.g. cloud ice) induce polarimetric effects.

2-ROHP-PAZ is a proof-of-concept experiment: for the first time ever, GNSS RO measurements will be taken at two polarizations, to exploit the potential capabilities of polarimetric radio occultation for detecting and quantifying heavy precipitation events and other de-polarizing atmospheric effects (e.g. cloud ice). If the concept is proved, PAZ will represent a new application of the GNSS Radio-Occultation observations, by providing coincident thermodynamic and precipitation information with high vertical resolution within regions covered by thick clouds.

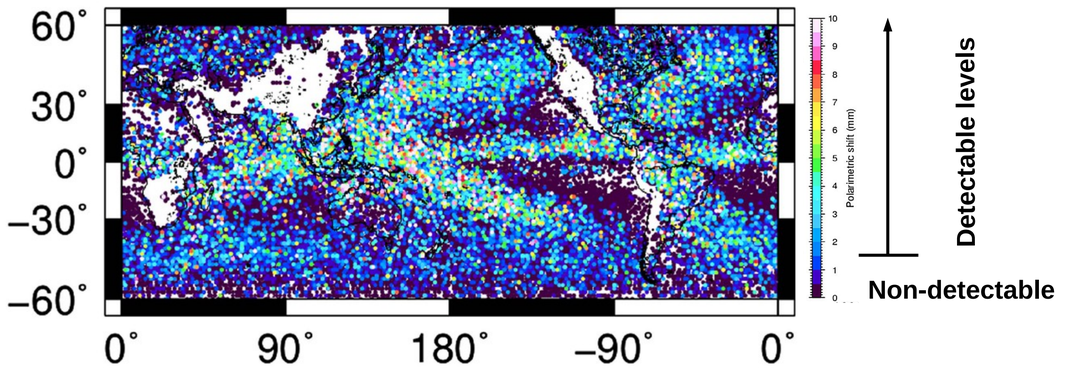
3-ROHP-PAZ potential impact: Coincident thermodynamic and precipitation information with high vertical resolution within regions with thick clouds might help understanding the thermodynamic conditions underlying intense precipitation, which is relevant because these events remain poorly predicted with the current climate and weather model parametrization.
A better understanding of the thermodynamics of heavy precipitation events is necessary towards improving climate models and quantifying the impact of climate variability on precipitation. The particular advantage of GNSS polarimetric RO is that their signals are in the L-band of the microwave spectrum which, unlike infrared or higher microwave frequency band sensing technologies, is little influenced by clouds, not even by the thick clouds that are typically associated with heavy precipitation.

Host Satellite:	PAZ (Spain)
Launch:	Q4 2014
Orbit Type:	Sun-synchronous
Orbital Nominal Height:	514 km (LEO)
Orbit Eccentricity:	1.1e-3 to 1.2e-3
Orbit Inclination:	97.4 degree
RO GNSS Receiver:	IGOR+
RO Antenna:	Aft-direction 5-element array 2-polarizations (H/V) > 12.5 dB peak each port 2-freq. (L1/L2)

4-Sensitivity analysis

Cardellach et al. (2014)

- ***GNSS pol-RO observable: phase-shift between received H- and V-polarized fields.***
- ***Expected precision of PAZ's polarimetric phase-shift, given in units of length: <=1.5 mm delay in 1 second integration.***
- ***Simulations based on ~120,000 COSMIC RO events collocated with precipitation TRMM mission show:***



Precipitation intensity $< R >$:	Percentage of detectable cases
> 0.5 mm/h	24 %
> 1 mm/h	41 %
> 2 mm/h	72 %
> 3 mm/h	83 %
> 4 mm/h	88 %
> 5 mm/h	90 %
> 10 mm/h	95 %

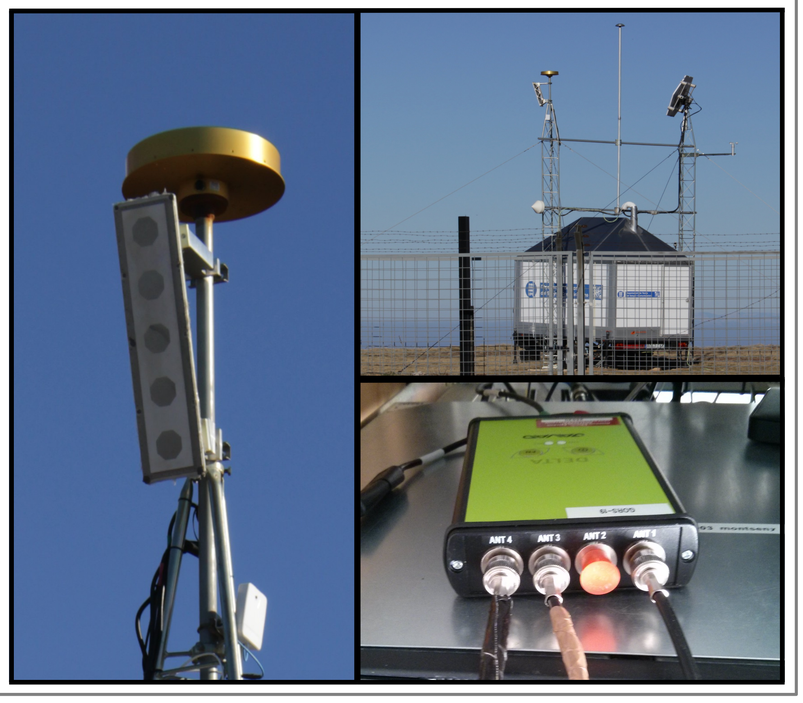
Cardellach, E.; Tomas, S.; Oliveras, S.; Padulles, R.; Rius, A.; de la Torre-Juarez, M.; Turk, F.J.; Ao, C.O.; Kursinski, E.R.; Schreiner, B.; Ector, D.; and Cucurull, L., Sensitivity of PAZ LEO Polarimetric GNSS Radio-Occultation Experiment to Precipitation Events, IEEE-TGRS, 2014, doi:10.1109/TGRS.2014.2320309.

5-Ground-Based Campaign

Aim: To identify and understand the factors that affect the polarimetric RO signal before the launch of the satellite, by collecting heavy rain together with free-rain data from ground.

The selected site is the top of a 1700m. mountain peak (Puigsesolles). The site has clear views over the horizon to the south (east to west) direction, an area in which intense precipitation tends to occur several times per year.

Experimental set-up:
- PAZ's engineering model antenna
- JAVAD commercial receiver (provided by the German research center for geosciences GFZ), locked inside a shelter



More information and data acces: **http://www.ice.csic.es/paz**