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The GNSS polarimetric radio-occultation technique to sense precipitation events: a new concept to be tested aboard PAZ Low Earth Satellite

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The Radio Occultation and Heavy Precipitation (ROHP) experiment, to be conducted aboard the Spanish PAZ satellite, consists of a radio occultation (RO) mission provided with dual-polarization capabilities. The research with polarimetric RO data has the goal of assessing the capabilities and limitations of this technique to infer profiles of heavy precipitation. The technique aims to provide vertical profiles of precipitation simultaneously to the vertical profiles of thermodynamic parameters (standard RO products) perfectly collocated both in space and time. If successful, the polarimetric RO will represent the first technique able to provide these complementary information on precipitation. This is a relevant input for studies on heavy and violent rainfall events, which being poorly represented by the current-generation of Numerical Weather Prediction and General Circulation Models appear to be difficult to forecast on all time-scales. The Low Earth Orbiter hosting this experiment, to be launched in 2013, will orbit at 500 km altitude in a near-Polar orbit. The Radio Occulation payload includes a RO GNSS receiver and a dual polarization (H/V) limb oriented antenna to capture the signals of setting GNSS transmitters. NOAA and UCAR participate in the ground-segment of the radiometric experiment to enable near-real time dissemination of the level-1 standard RO products.

The space-based GNSS RO technique scans the atmosphere vertically at fine resolution (close to 300 meter in the troposphere) by precisely measure the delay between a GNSS transmitter and a GNSS receiver aboard a Low Earth Orbiter, when the former is setting below or rising above the Earth limb. The standard, thermodynamical, products are extracted from the excess delay induced by the atmosphere at different layers. This presentation will not focus on this well-established application, but a novel concept using polarimetry to also retrieve rain information.

The precipitation-measurement principle is based on the asymmetry between the vertical and horizontal axis of the rain droplets, especially when intense rates of precipitation occur. As a first approximation, the RO signals propagate across the precipitation-volume tangentially, that is, along the local horizontal axis of the droplets. Forward scattering models have been implemented to quantify the sensitivity of L-band signals to different rain rates and precipitation extension being crossed by the signals. The observable considered so far is the polarimetric phase shift: difference between the phase delay suffered by the H- and V-polarizations.

Real RO events have been collocated with TRMM precipitation data. The path traveled by the RO signal under a given altitude has been projected on the TRMM grid of observations, to obtain a profile of the precipitation being crossed by the RO link at a given moment of the occultation event. This mechanism has been used to feed the propagation models and thus estimate the polarimetric phase shift that each precipitation event would have induced into the occultation observation. This simulation exercise permits to determine the detectability thresholds and the expected statistics of such collocated events. Methodology and results will be presented.