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Observations with the GISMOS Airborne Radio Occultation System

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The spatial sample density of temperature and moisture profiles derived from the current spaceborne GPS radio occultation (RO) constellation is limited by the number of occultation satellites in operation. With the current RO satellite configuration, only one RO profile per day is typically available in a 160,000 square kilometer area in the mid-latitude and tropics and slightly more in high latitudes. The airborne RO technique, which has the GPS receiver onboard an airplane, offers flexibility and much denser sampling for targeted observation within 400 km of the aircraft, and provides comparable high vertical resolution to that of the spaceborne case. With an airborne system, targeted measurements can be planned in an optimal geometry to study the accuracy of RO measurements in the lower troposphere where strong vertical gradients in moisture might lead to disruption of signal tracking. These dense measurements can also be used to test assimilation techniques of refractivity and lower tropospheric moisture derived from RO data.

In February 2008, the GNSS Instrument System for Multistatic and Occultation Sensing (GISMOS), developed at Purdue University, was successfully deployed on the NSF HIAPER aircraft for series of research flights in the Gulf of Mexico coastal region to validate the airborne observing system. During this campaign, occultation observations were collected in conjunction with supplemental radiosonde and dropsonde soundings. RO signals were recorded using side-looking GPS antennas and dual frequency GPS receivers. However, these conventional phase-locked-loop GPS receivers cannot always track the signal in the lower troposphere, where there are rapid phase accelerations caused by highly variable moisture structures. To extend the observations deeper into the atmosphere, the raw signal from occulting satellites is recorded at 10MHz sampling interval by a GPS recording system (GRS). Open-loop (OL) tracking, which replaces the traditional GPS receiver feedback loop using an a priori estimate of Doppler frequency, was implemented in a software receiver and the data was post-processed after the flight. Such an extensive dataset can be of importance in studies aimed at improving signal processing performance for spaceborne as well as airborne RO measurements.

We present data from the February 2008 campaign, and show several examples of occultations with clear atmospheric signals in the excess phase and Doppler. Many recordings that were made with conventional receivers descend below 5 km in the atmosphere. With an OL tracking procedure using the data recorded by the GRS, the measurements extended deeper into the atmosphere ($\sim$ 2km above surface). Raytracing was used to simulate the atmospheric excess phase profile from a nearby radiosonde sounding. The excess phase profiles acquired with both closed-loop and open-loop tracking show consistent patterns compared to the radiosonde observations.