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Airborne GPS Radio Occultation

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GPS Radio Occultation (GPS RO) techniques use GPS receivers on board LEO satellites, there is another type of GPS RO techniques called the downward-looking (DL) RO. This technique uses a GPS receiver placed inside the Earth's atmosphere such as on an airplane and a mountain top, and provides atmospheric profiles below the altitude of the receiver by the inversion algorithms for GPS DL. DL RO measurements on the top of Mt. Fuji in Japan were carried out in 2001 and succeeded in deriving temperature profiles and water vapor profiles.

We calculate the data distributions of airborne GPS RO measurements with the flights of Garuda Indonesia Airplane between Jakarta and Surabaya in Indonesia on December 1, 2010. There are 11 flights from Jakarta to Surabaya, and 12 flights from Surabaya to Jakarta. Total number of profiles of the flights from Jakarta to Surabaya is 35, from Surabaya to Jakarta is 53. The length of a tangent point trajectory is different between these opposite direction flights. The frequencies of occultations are also different. This may be explained by the characteristics of the orbit of GPS satellites. Because the inclination angle of GPS satellites is 55 and their speed is greater than that of the Earth's rotation, all GPS satellites moves from west to east with respect to the Earth's surface. Therefore, the relative velocity between an airplane and a GPS satellite is low when the airplane flies from west to east, and is high when the airplane flies from east to west. This effect is more marked at low latitudes than at mid or high latitudes.

The effect of the GPS orbit cannot be seen in a GPS RO mission with a LEO satellite. This may be explained by a difference of speed between an airplane and a satellite. While the speed of a normal airplane is approximately 900km/hours, the speed of a satellite at an altitude of 700 km is 22000 km/hours relative to the Earth's surface. Because the speed of GPS satellites is 3000 km/hours, a GPS RO mission with a LEO satellite is not sensitive to this effect.

Next, we compute the airborne GPS RO data distributions over Japan. Here we select nine major airports, and use JAL flights between each selected airports on February 1, 2011. Total number of these flights is 210 and observation data is 1114. For this case the data density near Japan is roughly 5 events/(100 km x 100 km) in a day. This result suggests that airborne GPS RO measurements with commercial flights will produce a number of atmospheric profiles in particular region. So, such measurements are expected to contribute to improve the accuracy of weather forecast around there remarkably.

Keywords: GPS Radio Occultation, LEO, Airborne, downward-looking