Geophysical Research Abstracts
Vol. 21, EGU2019-16563, 2019
EGU General Assembly 2019

Study on frequency selection of independent inversion water vapor profile via LEO-LEO occultation probing technique

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LEO-LEO microwave occultation (LMO) measurements is an advancement of GPS radio occultation (GRO) using centimeter and millimeter wave signals between low Earth orbit (LEO) satellites, exploiting both refraction and absorption of signals, to deal with the temperature-humidity ambiguity in the troposphere where humidity cannot be neglected. GRO initially chose the L-band to avoid atmospheric effects as much as possible, thus it is less sensitive to atmospheric information. Frequency near 22 GHz water vapor absorption line was proposed by researchers to independently retrieve humidity. Microwave signals of LMO from the transmitter satellites reaching the receiver satellites through the atmosphere. The amplitude and phase of the signal will change due to the atmospheric attenuation. Using the differential transmission method, water vapor and temperature profiles can be simultaneously obtained without auxiliary background information. LMO has properties of high accuracy and vertical resolution, long-term stability, nearly all-weather capability and global coverage. In addition, the frequencies higher than L-band of GRO can reduce ionospheric sensitivity and extend profiles to much higher altitudes. Selecting the proper probing pairs of frequencies is a crucial important part of the LMO occultation. In this paper, we focus on the frequency channels selection and assessment, simulate LEO-LEO radio occultation based on frequencies near the X band (8.0, 9.7 GHz), K band (17.25 GHz, 20.2, 22.6 GHz) and M band (179, 181.95, 183.3 GHz). We implement the simulations from the near surface to mesosphere for the performance analysis and assess the accuracy of pressure, temperature, and water vapor profiles retrieved from LMO. The results show that inversion accuracy can meet NWP and climate monitoring requirements. Comparing the result of K band with the X+K+M band, the retrieval performance is not significantly different for pressure and temperature, because the refractive information plays a dominant role for these two variables. As for water vapor, M band extend accurate retrievals from near 12km up to near 24 km, X band from near 7 km down to near 2km, especially for the tropical low troposphere. The results are encouraging for further development LEO-LEO occultation exploration plan.