Retrieval of High Vertical Resolution Atmospheric Profiles from GPS Radio Occultation Measurements

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GPS RO is a novel satellite remote-sensing technique which uses the occulted GPS electromagnetic wave to observe the Earth's atmosphere. Characterized by its advantages of high accuracy, superior vertical resolution and self-calibration, GPS RO is a promising technique in many applications such as atmospheric sciences, meteorology, climate changes, weather prediction, and so on.

Geometric Optics (GO) and Radio Holography (RH) are two kinds of the retrieval methods for GPS-RO. Due to the limitation of Fresnel radius, the vertical resolution of GO is about 1.5 km around the tropopause, while RH methods do not have such limitation. In order to study atmospheric structures with small vertical scale we employ Full Spectrum Inversion (FSI) method, one of the RH methods, to retrieve the GPS-RO profiles from ground to 30 km.

We validate the FSI based results, by comparing them with the radiosonde profiles in Malaysia and North America that are collected nearby the GPS RO events within ±30 minutes time difference. The average discrepancy at 10-30 km altitude is less than 0.5 K. We further analyzed the vertical wave number spectrum of the temperature fluctuation at 20-30 km, which exhibits a good consistency with the model spectra of saturated gravity wave. By investigating the spectral density for the wave number range where the noise floor appears, the substantial vertical resolution of the FSI method is estimated as about 100-200 m at 20-30 km altitude. We have also considered a criterion for the upper limit of the FSI profiles, from the normalized perturbations of the bending angle.

The horizontal resolution of GPS RO for the atmospheric fluctuation is discussed. The horizontal resolution along-ray-track is not improved even though the vertical resolution is improved with FSI. Because of superior height resolution and measurement accuracy, GPS RO is expected to become one of the most important observation techniques of the atmosphere.