Neural Networks for Tropospheric Profiling from GPS-LEO Radio Occultation

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Global Positioning System (GPS) receivers placed on a Low-Earth Orbit (LEO) satellite allow the sounding of the Earth's troposphere and ionosphere evaluating the additional delay, due to the refractivity index, of a radio signal when passing through the atmosphere.

This radio occultation technique in recent years has been exploited to obtain profiles of refractivity, temperature, pressure and humidity in the troposphere, and several investigations have demonstrated that the retrieval accuracies are comparable with traditional atmospheric sensing techniques. Even though the atmospheric refractivity profiling by radio occultation is a well-defined problem, care must be taken to analyse factors affecting the occulted signal (multipath, satellite motion etc.) and to compute the temperature, pressure and humidity profiles from the refractivity profile. The accuracy of tropospheric profile estimation is affected by the use of proper boundary conditions and by the presence of water vapour in the atmosphere, that complicates the interpretation of refractivity. In fact the recovery of tropospheric profiles in wet conditions requires knowledge of temperature derived from independent observations (i.e. radiosoundings or ECMWF data).

In this work a retrieval method based on neural networks is proposed to overcome the constraint of temperature profile availability at each GPS occultation. We have trained a neural network with refractivity profiles as input computed from the geometrical occultation parameters of the CHAMP satellite provided by the Information System and Data Center (ISDC) of GeoForschungsZendrum (GFZ) (Potsdam).

The outputs are the dry and wet refractivity profiles obtained from the contemporary ECMWF data. We have considered a feedforward neural networks with the Levenberg-Marquardt algorithm for a fast training. The output decomposition of the wet and dry refractivity allow to obtain temperature, pressure and humidity profiles without the knowledge of the temperature ones as independent source of information.