THE STANDARD TROPOSPHERIC CORRECTION MODEL FOR THE EUROPEAN SATELLITE NAVIGATION SYSTEM GALILEO

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ABSTRACT

Microwave signals as used by global navigation satellite systems (GNSS) suffer from atmospheric propagation delays in transit, namely ionospheric and tropospheric delays. The frequency-dependent ionospheric delays can be easily eliminated by simultaneous measurements on two frequencies whereas the tropospheric delays - that reach a magnitude of about 2.5 m in zenith direction and up to 25 m at low elevations - cannot be compensated that easily. Since the tropospheric propagation delay mainly depends on atmospheric pressure, temperature and relative humidity, the GNSS-user needs information about these parameters for calculating and eliminating this error source. The total tropospheric delay can be separated into a hydrostatic and a wet component. The first can be computed accurately by surface pressure measurements. The latter is dependent on the wet refractivity profile of the troposphere which can be highly variable.

A new default tropospheric correction model - the so-called "blind model" - was developed for the future GNSS-user by the Institute of Geodesy and Navigation in cooperation with ESTEC/ESA and shows a clearly improved accuracy in comparison to the currently widely used MOPS RTCA model [4]. This blind model employs climatological input data and is based on physical principles; the needed meteorological input data are stored in a database. The difference and improvement compared to the current stand-alone correction model - the standard MOPS-model - can be seen in the modelling of these meteorological parameters and the resolution. Whereas the meteorological parameters depend only on the latitude for the MOPS-model (zones with 15° spacing and no distinction between the northern and southern hemisphere), the meteorological parameters of the new blind model are stored in a gridded database (i.e. an 1° x 1° grid - called TropGrid - which could be stored in a GNSS-receiver). Furthermore these parameters are modelled now by harmonical functions representing diurnal and seasonal variations - in contrast to constant values for all parameters in the region of ±15° around the equator. The coefficients of these harmonical functions were derived by a least-squares adjustment over a time period of about three years using data of a world-wide numerical weather field (NWM) as input data, resp. 15 years using ECMWF ERA 15 in a second approach conducted at ESTEC. With the knowledge of the position of the GNSS-user and the time, the needed meteorological parameters can be interpolated and the current tropospheric propagation delay can be calculated.

It should be mentioned that, if GNSS-users needed tropospheric propagation delays with high accuracy, the numerical weather fields could directly be used by integrating the refractivity profile. Furthermore for more or less static users, the above mentioned coefficients of the harmonic functions can be tuned to individual stations, this yields the co-called site-specific database TropSite.

The paper describes this new correction approach for the future global satellite navigation system GALILEO in more detail. The presented validation results show a clear improvement in accuracy of about 25% in global average in comparison to the MOPS-model.