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A Dedicated Software using GNSS Data for Earth Troposphere Path Delay Estimation

Roberto Bertacin, Alberto Graziani, and Paolo Tortora
University of Bologna, Italy (alberto.graziani@unibo.it, +39-0543-374477)

Radiometric signals received from space are affected by delays due to transmission media, which reduce spacecraft orbit determination accuracy or affect the results of radio science experiments. As solar plasma and Earth ionosphere effects are frequency dependant, a multifrequency link can be used in order to remove these contributions. On the other hand the estimation of the Earth troposphere needs a dedicated system such as: meteorological stations, GNSS stations or microwave radiometers. Different precision requirements can be satisfied by selecting the proper technique. For deep space navigation, a GNSS-based troposphere estimation technique can be sufficiently precise. Nevertheless, high radio science experiments results require troposphere calibration obtained by microwave radiometer measurements.

This paper describes the work being carried out at the Radio Science laboratory of the University of Bologna in Forlì for the development of a dedicated GNSS data analysis software (S/W) code aimed at the estimation of the Earth troposphere for deep space navigation. Starting from the nominal GNSS observables, the S/W processes their linear combination: the so-called "iono-free", wide lane and narrow lane. The S/W estimates the error sources affecting the GNSS observables by using the double difference techniques and other dedicated algorithms. The proposed algorithm makes use of an Extended Kalman Filter (EKF) which estimates the troposphere path delay, the baselines length and the phase ambiguities. Once the wet component of the troposphere is obtained through the EKF, the dry part can be obtained too, by using meteorological data and a retrieval model.

Many different tests have been performed so far using the developed S/W, in particular: positioning test result of a non geo-referenced GPS station, direct comparison between the troposphere path delay estimated by using the S/W and the one retrieved by a microwave radiometer, deep space navigation tests by calibrating Doppler data of ESA's S/C Venus Express.