Higher order ionospheric effects on GNSS positioning in the European Region

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In addition to the common practice of eliminating the (first order) ionospheric effect, for instance, by the ionosphere-free observable, this work shows a method of accounting for the remaining (higher order) ionosperic effects, which lead to residual range errors (RREs) in GNSS positioning. An investigation on the higher (second and third) order ionospheric effects (Ion2 and Ion3) in the European region during the high and low periods of the solar cycle is presented in this work. Days are selected for analysis in terms of the planetary K index (measure of disturbances in the geomagnetic field), Kp, which provides a reasonable threshold to include and exclude the effect of geomagnetic storms on the state of the ionosphere. The stations analyzed in this work are selected from the International GNSS Service (IGS) network in Europe, with a geographical distribution in terms of latitude (mid and high latitudes, including the auroral region) and longitude. This work investigates RREs due to Ion2 and Ion3 by using the program Rinex_HO (Marques et al. 2007) which estimates these errors and the total electron content (TEC) along line of sight for each receiver/satellite link. It also creates new GPS observation files that are corrected for these higher order ionospheric effects. Thereby it is possible to assess the effect of correcting the GPS observations for the higher order ionospheric terms in the station coordinates estimation. In this paper the precise point positioning (PPP) approach was used for analysis.