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Modeling Ionospheric Effects for High Accuracy GNSS Applications

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Ionospheric effects are one of the main barriers to achieve high accuracy GNSS positioning and navigation, including precise point positioning (PPP), relative carrier phase based positioning and Differential GNSS (DGNSS), as well as Satellite Based Augmentation System (SBAS). Measurements made on two different frequencies allow the correction of the first order ionospheric effects by means of the widely used ionospheric-free linear combination. However, through this process, the second and third order ionospheric effects, which may cause errors of the order of centimeters in the GNSS measurements, still remain unmodeled. Furthermore, effects such as ionospheric scintillations, caused by time-varying electron density irregularities in the ionosphere that occur more often at equatorial and high latitudes, in particular during solar maxima, also degrade the quality of positioning and navigation. Several approaches have been proposed to mitigate ionospheric effects on GNSS, which in general involve improvements to the functional and/or stochastic models of the Least Squares Adjustment used to estimate position. In this contribution we present techniques recently developed that combine both functional and stochastic models, in order to reduce such effects and their propagation on positioning quality. We present results of the application of these developments on GNSS PPP and relative positioning.