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Regional Ionospheric Modelling for Single-Frequency Users

Janina Boisits, Nina Joldzic, and Robert Weber
TU Wien, Department of Geodesy and Geoinformation, Vienna, Austria (janina.boisits@tuwien.ac.at)

Ionospheric signal delays are a main error source in GNSS-based positioning. Thus, single-frequency receivers, which are frequently used nowadays, require additional ionospheric information to mitigate these effects. Within the Austrian Research Promotion Agency (FFG) project Regiomontan (Regional Ionospheric Modelling for Single-Frequency Users) a new and as realistic as possible model is used to obtain precise GNSS ionospheric signal delays. These delays will be provided to single-frequency users to significantly increase positioning accuracy.

The computational basis is the Thin-Shell Model. For regional modelling a thin electron layer of the underlying model is approximated by a Taylor series up to degree two. The network used includes 22 GNSS Reference Stations in Austria and nearby.

First results were calculated from smoothed code observations by forming the geometry-free linear combination. Satellite and station DCBs were applied. In a least squares adjustment the model parameters, consisting of the VTEC0 at the origin of the investigated area, as well as the first and the second derivatives of the electron content in longitude and latitude, were obtained with a temporal resolution of 1 hour. The height of the layer was kept fixed. The formal errors of the model parameters suggest an accuracy of the VTEC slightly better than 1TECU for a user location within Austria. In a further step, the model parameters were derived from sole phase observations by using a levelling approach to mitigate common range biases. The formal errors of this model approach suggest an accuracy of about a few tenths of a TECU.

For validation, the Regiomontan VTEC was compared to IGS TEC maps depicting a very good agreement. Further, a comparison of pseudoranges has been performed to calculate the ‘true’ error by forming the ionosphere-free linear combination on the one hand, and by applying the Regiomontan model to L1 pseudoranges on the other hand. The resulting differences are mostly within a +/- 0.5m interval, slightly increasing with decreasing elevation angle. The same comparison utilizing the Klobuchar model delivers considerably larger range differences.

Our aim is to provide precise real-time ionospheric corrections on a regional basis and therefore, to allow a positioning accuracy within a few centimetres for single-frequency users. Thus, a next step will be to improve the robustness of the model algorithm and to establish a reasonable transmission of the parameters via RTCM.