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Regional Densification of a Global VTEC Model Based on B-Spline Representations

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The project OPTIMAP is a joint initiative of the Bundeswehr GeoInformation Centre (BGIC), the German Space Situational Awareness Centre (GSSAC), the German Geodetic Research Institute of the Technical University Munich (DGFI-TUM) and the Institute for Astrophysics at the University of Göttingen (IAG). The main goal of the project is the development of an operational tool for ionospheric mapping and prediction (OPTIMAP). Two key features of the project are the combination of different satellite observation techniques (GNSS, satellite altimetry, radio occultations and DORIS) and the regional densification as a remedy against problems encountered with the inhomogeneous data distribution.

Since the data from space-geoscientific mission which can be used for modeling ionospheric parameters, such as the Vertical Total Electron Content (VTEC) or the electron density, are distributed rather unevenly over the globe at different altitudes, appropriate modeling approaches have to be developed to handle this inhomogeneity. Our approach is based on a two-level strategy. To be more specific, in the first level we compute a global VTEC model with a moderate regional and spectral resolution which will be complemented in the second level by a regional model in a densification area. The latter is a region characterized by a dense data distribution to obtain a high spatial and spectral resolution VTEC product. Additionally, the global representation means a background model for the regional one to avoid edge effects at the boundaries of the densification area. The presented approach based on a global and a regional model part, i.e. the consideration of a regional densification is called the Two-Level VTEC Model (TLVM).

The global VTEC model part is based on a series expansion in terms of polynomial B-Splines in latitude direction and trigonometric B-Splines in longitude direction. The additional regional model part is set up by a series expansion in terms of polynomial B-splines for both directions. The spectral resolution of both model parts is defined by the number of B-spline basis functions introduced for longitude and latitude directions related to appropriate coordinate systems.

Furthermore, the TLVM has to be developed under the postulation that the global model part will be computed continuously in near real-time (NRT) and routinely predicted into the future by an algorithm based on deterministic and statistical forecast models. Thus, the additional regional densification model part, which will be computed also in NRT, but possibly only for a specified time duration, must be estimated independently from the global one. For that purpose a data separation procedure has to be developed in order to estimate the unknown series coefficients of both model parts independently. This procedure must also consider additional technique-dependent unknowns such as the Differential Code Biases (DCBs) within GNSS and intersystem biases. In this contribution we will present the concept to set up the TLVM including the data combination and the Kalman filtering procedure; first numerical results will be presented.