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MULTI-SCALE REPRESENTATION OF THE IONOSPHERE FROM THE COMBINATION OF SPACE-GEODETIC OBSERVATIONS

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Abstract. In this contribution we present a multi-scale ionosphere model calculated from the combination of measurements from various space-geodetic observation techniques. A multiscale representation means basically the approximation of a signal under different resolution levels. Thus, we decompose the target function, e.g., the electron density or the vertical total electron content of the ionosphere into a system of detail signals each related to a specific geographical region and a specific frequency band. Whereas the modeling of coarse structures needs generally only a small number of observations, finer structures, however, require a considerably larger number of observations. Consequently, the computation of the detail signals depends on the data distribution.

Our approach consists of the International Reference Ionosphere (IRI) as the reference (background) model and an additional unknown term represented by a series expansion in terms of multi-dimensional B-spline (scaling) functions. Since different kinds of B-splines - namely trigonometric and endpoint-interpolating B-splines - are selectable, our approach can be applied to both global and regional data sets. Since the input data are heterogeneously sampled in space and time due to the specific orbit and instrumental characteristics, finer structures of the target function are modelable just in regions with a sufficient number of observation sites.

The series coefficients of the chosen B-spline expansion are calculated from space-geodetic observation techniques by parameter estimation. To take adavantage of the different characteristics of the various techniques a combined adjustment of terrestrial GNSS measurements, GNSS observations from LEO satellites, observations from VLBI, and measurements from dual-frequency altimetry missions is performed. The weights of the different techniques including the reference model IRI are estimated by variance component estimation.

B-splines are characterized by the favorable feature to generate a multi-scale representation of the target function by creating a family of B-spline wavelet functions. The corresponding series coefficients are calculable via the so-called two-scale relations. Multiscale representations are used for a long time in digital image processing for data compression or reduction, respectively. All these favorable properties can be transferred from the twodimensional to the multi-dimensional case. In this contribution we outline these aspects and discuss how a wavelet-based Kalman filter can be constructed for near real time applications.