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VTEC modelling using multi-technique observations with different latencies: a parallel filtering approach

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The focus of this contribution is the development of an operational tool, called OPTIMAP, for the mapping and prediction of the ionospheric Vertical Total Electron Content (VTEC) from the combination of different space geodetic observation techniques, namely GNSS (e.g. GPS, GLONASS), satellite altimetry (e.g. Jason 2/3), DORIS (e.g. Jason-2, Saral and HY-2A) and radio-occultation measurements of LEO missions (e.g. FORMOSAT-3/COSMIC).

Since all input data sets are available with individual latencies, a procedure was developed which consists of a certain number of parallel running Kalman filters. Hereby, the core of the procedure - the main filter - is driven by GNSS hourly observations and is running in near real-time with a latency of about two hours. The output of the main filter includes a set of B-spline coefficients representing the global GNSS VTEC variations. The second parallel filter utilizes observations with an about four hour latency from satellite altimetry as well as the results from the main filter. Consequently, the second parallel filter combines the two techniques GNSS and satellite altimetry by considering their individual latencies. Continuing in the same manner with the other observation techniques we finally end up with results not only for the combination of all available techniques but also of a reduced number of techniques. Since all results, i.e. all VTEC maps, are based on the GNSS observations, comparisons with other VTEC products are always possible.

Our mathematical approach for a global representation of VTEC is based on a series expansion in terms of two-dimensional basis functions defined as tensor products of trigonometric and polynomial B-spline functions. The main advantage of B-spline functions is their compact support. To be more specific, each basis function is different from zero only in a well-defined finite interval. In practice, this property allows for an appropriate local handling of the data distribution and their quality, etc.

In this contribution we will present the concept of the parallel filtering approach supported by B-spline functions to deal with the individual latencies of different space geodetic observation techniques; in addition numerical results of the procedure will be presented.