CODE Ionosphere Products

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Abstract

The list of ionosphere products as regularly generated at CODE includes final, rapid, as well as predicted products. The vertical total electron content (VTEC) is modeled in a solar-geomagnetic reference frame primarily using a spherical harmonics (SH) expansion up to degree and order 15. To convert line-of-sight TEC into vertical TEC, a modified single-layer model mapping function approximating the JPL extended slab model mapping function is adopted (to retrieve VTEC consistent to TOPEX-derived TEC). No external ionosphere model is used.

The global ionosphere map (GIM) information is made available generally in three different forms: (1) Bernese ionosphere files containing the originally estimated SH coefficients, (2) IONEX (IONosphere map EXchange) files containing VTEC grid maps at 2-hour intervals, and (3) content-reduced RINEX navigation data files containing daily Klobuchar-style ionospheric (alpha and beta) coefficients best fitting the (corresponding) IONEX information. In the CODE data archive, time series of all these products are accessible without any gaps back to 1995 (see www.aiub.unibe.ch/ionosphere.html for details). Solely the final product in IONEX format is delivered to the IGS. For comparison purposes, also our final Klobuchar-style model and the ionospheric model broadcast by the GPS system are supplied by CODE in form of IGS-compatible IONEX files. It is worth mentioning that, starting with GPS week 1158, our final ionosphere results are no longer results from a 24-hour analysis but results for the middle day of a 72-hour combination analysis done on the normal equation level. In this way, discontinuities at day boundaries can be minimized and a time-invariant quality level is achieved.

The new possibility to stack and manipulate GIM-related normal equations takes us a lot further towards producing a GPS/TOPEX-combined ionosphere product. The IGS policy with respect to "combined" products, specifically combinations with non-GPS/GLONASS data, has to be reviewed.

IGS IONEX files contain 12 VTEC maps for times 01:00, 03:00, 05:00, ..., 23:00 UT. This circumstance makes the interpolation between 23:00 and 01:00 UT difficult, especially for users interested in TEC information without discontinuities at day boundaries. Consequently, we propose to start to include 13 maps in IONEX files, referring to epochs 00:00, 02:00, 04:00, ..., 24:00 UT.

Instrumental biases, so-called differential P1–P2 code biases (DCB), for all GPS satellites and ground stations are an important by-product of the ionospheric analysis. They are estimated at CODE as constant values for each day, simultaneously with the parameters used to represent the global VTEC distribution. The DCB datum is defined by a zero-mean condition imposed on the satellite bias estimates. P1–C1 bias corrections are taken into account if needed. Latter corrections are routinely generated at CODE in the global satellite and station clock estimation procedure and newly as part of the final widelane ambiguity resolution step (on the basis of ambiguity-fixed double differences related to the Melbourne-Wübbena linear combination of code and phase measurements). Sliding 30-day averages of both P1–P2 and P1–C1 DCB retrievals are computed every day. At the end of each month, month-specific averages are produced and stored in our DCB data base. P1–C1 DCB files specific to the CC2NONCC utility program are offered.

For global ionosphere mapping in particular, a good GPS tracking station coverage is indispensable. Against this background, we could show that there is still much potential in improving the IGS data availability and latency, respectively. These problems actually concern final and principally rapid and ultra-rapid applications. Moreover, data from very remote stations (typically tide gauge stations) not yet meeting the few-day delay requirement might be utmost useful, not only for IGS ionosphere mapping but also for global orbit and clock determination.