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Climatological behavior of the ionospheric total electron content over Europe for the period 1998-2014.

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One of the present challenges of the Space Weather community is to predict the Earth's ionospheric state in response to variations of the solar activity. For that, empirical models based on long-term data sets are relevant tools to better understand the geophysical processes involved in the ionospheric state variations. In this frame, the GNSS-based vertical Total Electron Content (vTEC) maps and the solar activity index F10.7 constitute complete ionospheric-solar data sets useful to constrain such models.

In this paper, the ROB-IONO software is used to reprocess the GPS data of the dense EUREF Permanent GNSS Network (EPN) network for the period 1998-2014. The output consists of IONEX files, estimated every 15 min., and covering the European region with a 0.5° x 0.5° grid. The vTEC is then extracted at three different locations (high-, mid- and low-latitudes) and used to constrain an empirical model to predict the vTEC from only one solar parameter in entrance. Among all the tests, the optimal model to predict the vTEC every 15 min. presents mean differences with observed values of 2.4 ± 2.8 TECu (10.0 ± 25.2 % for the relative differences). To realize this empirical model, a least-square adjustment is used with (1) an eighth-order polynomial function with monthly coefficients between the vTEC and F10.7P; (2) a discretization with respect to the phases of the solar activity.

First investigation of this new model permits to highlight the climatological behavior of the ionospheric vTEC over Europe: (1) two maxima of vTEC at the equinoxes at all latitudes; (2) a predominant semi-annual signal at low- and mid- latitudes due to the seasonal variation of the neutral atmosphere; (3) a double-peak in vTEC at noon observed at mid-latitude during summer months.