



Climatology of vTEC at midnight over mid-latitude regions using PCA

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At night the content of the electron density at mid-latitude is mainly controlled by loss processes, recombination and electron movement, which are related by the continuity equation. The vertical wind plays an important role in these processes.

Global vertical Total Electron Content (vTEC) maps produced by the International Global Navigation Satellite System (GNSS) Service, the Horizontal Wind Model 2007 (HWM07) and the International Reference Ionosphere (IRI) 2012 model are used to describe the climatology at midnight over mid-latitude regions during 2000-2002. In particular, four regions were selected. They are approximately centered in zero magnetic declination, two in the northern hemisphere and two in southern hemisphere. They are located near and far from geomagnetic poles respectively. Principal Components Analysis (PCA) technique highlights the spatial-temporal variations to the overall vTEC variability which can be well represented by an orthogonal base. Indeed, we show for the four selected regions the contributions of the first three modes account for more than 95% of its variability.

PCA results show that vTEC variability respond to vertical wind variation with decreasing values of about 10% -15% with the action of a vertical wind lasting for two hours. The Mid-latitude Summer Night Anomaly (MSNA), which is directly related with vertical wind, is present in regions far from geomagnetic poles. A remnant effect of the winter anomaly is also observed, in regions near geomagnetic poles. A longitudinal variation for mid-latitude ionospheric vTEC with maximum values in equinoxes, associated with negative and positive magnetic declination in all regions is observed.

For the IRI model, PCA results, are quite similar but the mean values are lower than the obtained with the Global vTEC Maps. These data show the MSNA but not the remnant of the winter anomaly. In all regions the longitudinal variation is present with the same seasonal variation as Global vTEC Maps.