Abstract

Signatures of planetary waves in the electron density in the ionosphere (usually named planetary wave type oscillations, PWTO) are the object of investigation in this work. These PWTO are periodic variations with periods between 2 und 30 days and a horizontal extension which can exceed 10.000km. Because their properties often agree with atmospheric planetary waves (PW) in the lower and middle atmosphere, they are suggested to be correlated.

The PWTO are described on the basis of maps of the total electron content (TEC), which cover the northern hemisphere from 50°N to the polar cap and are operationally produced in the DLR with a temporal resolution of 1 hour. The calculation of relative differences to a running 27-day median (ΔTEC_{rel}) is used as a band pass filter to avoid variations beyond the period range of PW. Appropriate spectral analysis methods are used to decompose the data set into the wave components of standing and propagating waves. Furthermore, a new filter method based on the wavelet transformation is used to minimize solar forced variations in the signal as good as possible.

The comparison of the power of the filtered signal $\Delta TEC_{rel,filter}$ and the relative TEC ΔTEC_{rel} shows a difference of up to 50%. Thus, a major part of the power of the PWTO in the ionosphere occur due to variations of the solar radiation, the solar wind and the corresponding geomagnetic perturbations. A significant correlation to the solar activity cycle cannot be found.

The spectral analyses of $\Delta TEC_{rel,filter}$ show a number of similarities as well as some differences in the characteristic properties of PWTO and PW. Quite characteristic is the dominance of the zonal mean oscillation and the strength of PWTO with periods below 10 days in the ionosphere. However, these differences do not exclude a correlation to PW.

A few suggestions for the coupling of the lower and middle atmosphere with the ionosphere mentioned in the literature are addressed empirically in this work. The achieved results indicate that the nonlinear interaction of atmospheric waves is a possible part of the mechanism coupling the atmosphere and ionosphere. It is assumed that the resulting secondary waves reach the lower thermosphere, where they influence the thermospheric composition or the winds and the dynamo induced electric field by what their signatures become visible in the ionosphere. Against this, the analysis results indicate that the modulation of atmospheric gravity waves is unlikely to take part in the coupling of the atmosphere and ionosphere.