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Study on the occurrence of planetary waves in the atmosphere-ionosphere system based on ionospheric total electron content data

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The ionosphere has many different variations in time and space. It is mainly influenced by the sun through electromagnetic radiation and particle precipitation. Additionally, upward propagating waves like planetary waves (PW) from the lower and middle atmosphere also contribute to the ionospheric variability. Consequently, planetary wave type oscillations (PWTO) are observed in F2-region parameters as e.g. the maximum electron density NmF2. PW mainly originate in the lower atmosphere and have a large impact on the dynamics of the middle atmosphere at middle and high latitudes during winter. Theoretically PW are not able to directly penetrate into the F2-region. However, an indirect impact on the F2-region variability through PW is expected.
The state of the ionosphere can be estimated with the total electron content (TEC), which can be measured with GNSS. Hemispheric TEC maps for the Northern Polar region are consistently calculated from GNSS measurements by the DLR Neustrelitz since 2002. These maps are analyzed concerning PWTO. The PWTO are compared with parameters estimating the solar influence. Variations of the TEC which correspond to variations of the solar wind, the F10.7cm radio flux and the geomagnetic activity are identified using wavelet analyses. The residual PWTO are compared with PW analyses on stratospheric reanalyses and locally with mesospheric wind measurements from meteor radar Collm. There is a general agreement in the seasonal dependency of PW and PWTO. The modulation of tides is suggested to be a mechanism transporting PW energy into the ionosphere. Good agreements are found between the modulation of the semidiurnal tidal wind in the mesosphere and PWTO in TEC.