Comparison of D-Region Absorption During Solar Cycle 24

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Earth’s ionosphere is formed mainly due to solar radiation, precipitating particles and cosmic rays. Its behavior is directly dependent on solar variation and the change of solar activity throughout each solar cycle. The solar activity is measured by the number of sunspots and the solar radiation flux expressed by the F10.7 index. The earlier variation in electron density from solar cycle maximum to solar cycle minimum has been noted by Hargreaves (1992). He utilized the F10.7 index as a proxy for Lyman-α radiation flux, which ionizes at D-region heights mainly O₂ and N₂ also NO. Utilizing the IRI model the atmospheric densities of O₂ and N₂ are assumed to be constant, NO density is the unknown. Also, it is known that the ionospheric reflection height depends on, e.g. diurnal variations [Pal & Chakrabarti, 2010] and other sudden ionospheric disturbances. Its longer term variations are not well enough studied.

Utilizing passive VLF ground based measurements with data coverage for almost the entire solar cycle 24, we compare monthly averaged solar quiet absorption curves fitted by a cosine dependence. This cosine dependence includes fixed parameters based on geography and setup of the instrument. The variables are only the solar zenith angle and the D-region absorption. This approach offers an indirect value of NO density change.

For the present study we utilize VLF monitors, which are located in northern Germany and at Czech Republic. The latter station also offers data from ionospheric sounder and continuous Doppler sounding. A simple 1-D ionospheric model is applied to compute ionospheric electron densities for daytime conditions based on solar F10.7 radiation fluxes.

The aim of this study is a comparison of solar quiet VLF curves of the solar cycle 24 maximum and minimum. Beside the change of NO density, also the variation of height of the D-region reflective layer will be discussed.