Graphical models method - implementation to coupling processes in the atmosphere

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Internal atmospheric waves interact with themselves and/or with the undisturbed atmospheric flow, creating very complicated dynamical system with long-range dependencies. We suspect that regional character of the atmosphere at tropospheric heights may be crucial for explanation of the three different dependencies of foF2 on F10.7cm. We employ multivariate statistic methods applied to daily observational data which were obtained using mid-latitude ionosondes for the investigation of these relationships.

We consider specific and characteristic atmospheric wave generation that correspond to particular climatology of each location “European”, “American” and “Far East”. Specific conditions of each region, involving meteorological phenomena of the location as spectrum of atmospheric wave generation and their propagation. We consider significant difference in low atmosphere climatology as a key explanation of the three classes of ionospheric response to the F10.7cm on long time-scales and suggest that climatology of the troposphere must be taken into account for modelling of the ionospheric response.

Our aim is also to demonstrate that conditional independence graph (CIG) models, representing a robust method of multivariet statistical analysis, are useful for finding a relation between the ionosphere and space weather. This method appears to be more appropriate than correlation analysis between foF2 and geomagnetic and solar indices, especially for longitudinal data for which the characteristics may change over time or time series is interrupted. This method seems more effective to us than correlation analysis or scale analysis.

The final results of our analysis by CIG show that the dependence time shifts were clearly identified, namely +0 day shift in all cases, and +3 / +4 / +5 day shift in the dependence on the solar cycle phase and geographical longitude. Here, we would like to point out that we have analyzed data from ionospheric stations in a rather short span of latitudes, all stations belong to midlatitudes (41.4° N – 54° N) and one would expect either practically same response/dependence of foF2 to F10.7 cm for longitudes and/or geomagnetic dependence as solar and geomagnetic forcing is considered as the most important. However, we have not identified any significant geomagnetically dependence with respect to selected stations and their geomagnetic location. Knowing that ionosphere is strongly coupled with lower-laying atmosphere, we come to the conclusion that climatology of the troposphere may come into play and be responsible for the
difference in time-dependencies and time-lags in ionospheric response to the external solar forcing.