Climatology of ionospheric total electron content over Japan

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A dense GPS receiver network, GEONET (GPS Earth Observation Network) that consists of about 1300 dual frequency receivers was used to derive ionospheric total electron contents (TECs). The TECs were determined by dividing the Japan's area into 32 cells, 2 degree longitude by 2 degree latitude each, with a 15-minute interval. In each cell at a given time, vertical TECs were assumed to be constant. The monthly median value of TEC was evaluated for each cell and each time and was used to derive time-latitude TEC maps by the Legendre polynomial fitting. The analysis covered nearly a whole range of solar activity, from 1998 to 2005. Detailed seasonal and solar flux variations of TECs were analyzed.

During summer seasons, TEC diurnal variations are complicated and show three peaks in general at around morning, midday and evening. The morning peak is prominent in the solar maximum seasons, but the evening peak shows less solar activity dependence compared with the morning one. During winter seasons, the difference between TECs in day and night is largest. The TECs at higher latitudes exhibit a minimum value just after sunset and slightly recover by midnight. Another minimum appears just before sunrise. Through the all seasons, the local time of diurnal peak of TECs is earlier at higher latitudes.

The contribution of electron density to TECs is largest at the F-layer peak height. Thus the TEC climatology should resemble to that of foF2. The above characteristics of TEC morphology are basically incorporated in the empirical ionospheric model, IRI. However there exists quantitative disagreement between the two. A part of the disagreement is due to the change in ionospheric slab thickness, but a part might be owing to the distribution of the data points. TECs evaluated here are based on the continuously distributed data points but foF2 that is observed by ionosondes is at very limited locations.

Some of the features obtained here exhibit evidence of a plasmasphere-ionosphere coupling. The summer-time evening enhancement of TEC could be attributed to a plasma flux from the plasmasphere to the ionosphere by the lowering of the plasma scale height after sunset. The winter-time evening minimum, or midnight recovery, could also be attributed to a plasma flux from the plasmasphere. The seasonal peculiarity of the anomalous peak or dip must be caused by the seasonal changes in the electric field and/or thermospheric circulation.