GPS and Ionosonde Measurements at the Pruhonice Observatory

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Introduction

The Pruhonice ionospheric station (50°N, 14.5°) has measured the ionosphere since 1957. The Topcon NET-G3 receiver has operated since 2011 in Pruhonice station to give additional information about ionospheric dynamics. The combination of the digisonde and the GPS/GNSS receiver in one place is relatively unique and it brings new possibility to study ionospheric processes.

Topcon NET-G3

Signals Tracked: GPS (L1, L2, L5 carrier, CA, L1 P, L2 P, L2C), GLONASS (L1, L2, L5 carrier, L1CA, L2CA, L1, P, L2, P), *GALILEO (E2-L1-E1, E5)

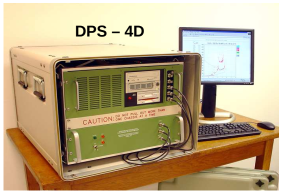
Antenna Type: CR-G3 Choke ring

Digital ionosonde DPS-4D (Lowell, Massachusetts)

Transmitting antenna: two crossed double delta antennas, 36 m height

Receiving antenna field: four crossed aerial loops

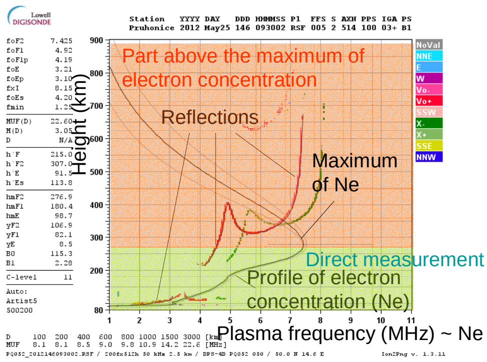
Standard measurement settings: one ionogram each 15 min with 0.05 MHz resolution, two drift measurements (E and F2 region) each 15 min



Dynamics of the ionosphere

The ionosphere is highly variable system with a wide range of periods. Its state depends on the solar and geomagnetic activity, daytime and season and it is influenced by the neutral atmosphere. In the ionogram (right) the reflections from layers E, F1 and F2 are present (red) and the profile of electron concentration is computed (black line). While the lower part of the electron concentration profile is computed directly using digisonde measurement (green area) the upper part (the topside ionosphere, orange area) is estimated indirectly using a model. Drift measurement estimates horizontal and vertical velocity of the plasma in chosen height window using Doppler shift of the reflected signal (right bottom panels) and thus it gives us information about the plasma movement.

Pruhonice ionogram



TOPCON NET G-3

+ high time resolution

+ "real'/measured TEC value

- integral value of the electron content rather than profile of electron concentration

DPS-4D

+ electron concentration profile (especially lower part below maximum of electron concentration)

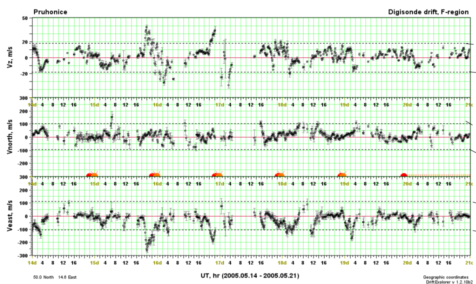
+ dynamics of the ionosphere (velocity of the plasma)

+ Doppler shift (drift) measurement

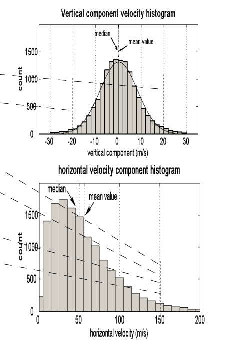
- Uncertainty in topside ionosphere (considerable part of the TEC) which is computed using a model

- regular time resolution 15 min for standard measurement

Drift meausurements during disturbed day (14 Apr – 21 Apr 2005)



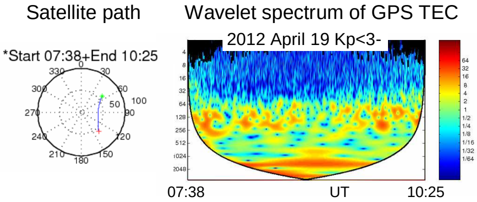
Extreme drift velocity components measured for Pruhonice at 14-20 May 2005.

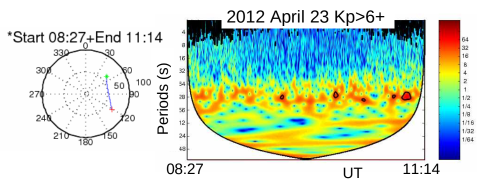


Histograms of the vertical and horizontal components of F region drift velocitys for Pruhonice during 2006.

Satellite path

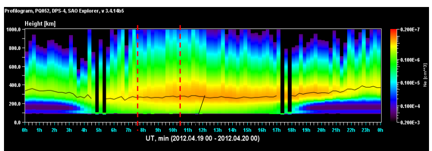
Wavelet spectrum of GPS TEC

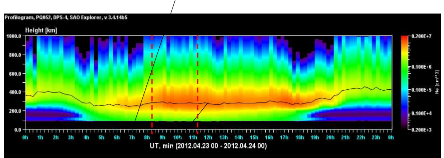




Increase in wave activity at periods>~60s. Stable behavior for all spectra (night vs. day; disturbed vs. quiet; different satellites and zenith angles) was observed.

Digisonde derived electron concentration





Increased TEC in disturbed day compared to quiet day

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Conclusion and future work

GPS ionospheric measurement is a convenient complement to "classical" iono/digisonde observation and vice versa. High temporal resolution of the GPS enables us to analyze short-term variation in the ionosphere (e.g. the Es layer observations, changes in TEC compared to state of the neutral atmosphere etc.). On the other hand, the digisonde is capable to estimate the part of TEC below the maximum of electron concentration with a high accuracy and describe the dynamics of the ionosphere and thus give additional information which may help in TEC measurement and modeling.

Long-term TEC datasets will be used to analyze wider range of periods of ionospheric variations (e.g. TIDs, planetary or gravity waves).