E and F region midlatitude ionospheric drifts observed during geomagnetic storms.

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Introduction.

New digisonde drifts measurements with DPS 4 equipment started at Průhonice observatory in January 2004. The paper reports the results of the ionospheric drifts measurements during 2005 – 2007 years, as were observed at Průhonice observatory during the first years of the operation and compare results for quiet days with the results during days of high solar and geomagnetic activity. In 2004 year Pruhonice station perform F region drift sounding in autodrift mode, two soundings each 15 minutes. In standard autodrifts measurements, the velocity of F region drifts is usually determined near peak of electron concentration profile.From 2005 we measure ionospheric drifts at Průhonice in the height interval 90 – 150 km also. From June 2005 E region drift soundings and F region drift soundings with 15 minutes sampling period for each region started.Interesting changes of the ionospheric drifts during several periods of a suddenly enhanced solar and geomagnetic activity were observed.

1. Ionospheric drifts during quiet conditions.

Modern ionosondes like DPS 4 operates not only as ionospheric sounder, but also as high frequency (HF) Doppler radar systems measuring echo, amplitudes and phase, angle of arrival, polarization and Doppler spectrum. Real time signal processing make it possible to operate as routine ionospheric sounder and HF radar in a variety of modes for ionospheric structure and dynamic research. This methods are described for instance in [1,2].Many results from ionospheric drifts from F region was recently published. We presents at this paper experimental results from midlatitude station Pruhonice (central Europa).
For studiyng of the ionospheric drifts during quiet conditions was computed meam values of the drift velocity during the days with quiet solar and geomagnetic conditions (with Kp < 3). For different seasons (summer, winter and autumn) in 2005 - 2006 years we used different number of quiet days (from 15 for autumn 2005 till 52 during winter 2005 - 2006).
Our experience with data from Pruhonice observatory reveals, however, that the automatic DDA method is rarely applicable for routine drift velocity calculations from the raw of data. The DDA method encounters problems for instance when there are multiple-hop Es or F reflections present on ionogram, range of the measured Doppler frequency shifts is too wide and some other cases. Application of the DDA method to the raw skymaps in such conditions can lead to incorrect results. From this reasons the method for correction of this problems was developed and used. This method will be described and published in [3].

2. Summer conditions.

E and F region drifts velocities was measured and computed for 32 guiet days during June-August 2005. Typical values for vertical component of the E region drift during quiet conditions is very small ~ 5 m/s. Both horizontal components reaches typical values about 20 m/s during quiet conditions. The F region drifts gives different results. Drift velocity in F region is greater during the night in all components. Typical values for vertical, north and east components are Vz ~ 40 m/s, Vn ~ 60 m/s and Ve~ 50 - 150 m

3. Equinox conditions.

Typical E region drift velocity during equinox conditions (for 15 guiet days) is slightly greater than summer results. Typical values for vertical, north and east components of the E region drifts are Vz ~ 10 m/s, Vn ~ 20 m/s and Ve~ 10 m/s and variability both horizontal components are greater then variability of the vertical

component . The F region drifts gives different results. Drift velocity in F region is, like in summer conditions, greater during the night in all components. Observed values for vertical, north and east components are smaller Vz ~ 20 m/s, Vn ~ 50 m/s and Ve~ 50 m/s.

4. Winter conditions.

Drift velocities observed during winter conditions 2005 - 2006 are characterised by increasing drift velocities and greater ionospheric drift activity. Results from 52 quiet winter days shows increasing in all E and F region drift velocity components. Difference between daytime and nighttime activity increased. It is logical consequnce of the different ionospheric conditions during winter, especially increasing role of the meteorologic effects in the winter ionosphere.
Typical E region drift velocity during winter conditions is greater especially in both horizontal components. Typical values for vertical, north and east components of the E region drifts are Vz ~ 20 m/s, Vn ~ 50 m/s and Ve~ 40 m/s. The F region drifts increased in all components also. Observed east west F drift horizontal component reaches value about 350 m/s.

5. Observation of the Ionospheric drifts during disturbed conditions.

The period 2005 - 2007 years are the years of Solar minimum. It means, that disturbed conditions are more rarely, not to often observed. We analysed only 15 weak and strong events from June 2005 till December 2007. Winter 2005 - 2006 was very quiet winter, without disturbed periods.
Good event of increasing solar and geomagnetic activity was observed 24.8.2005. Solar particle event from Kyoto is shown on figure 1.was accompanying strong geomagnetic storm with Kp=9 and Dst - 216. The course of the Dst index

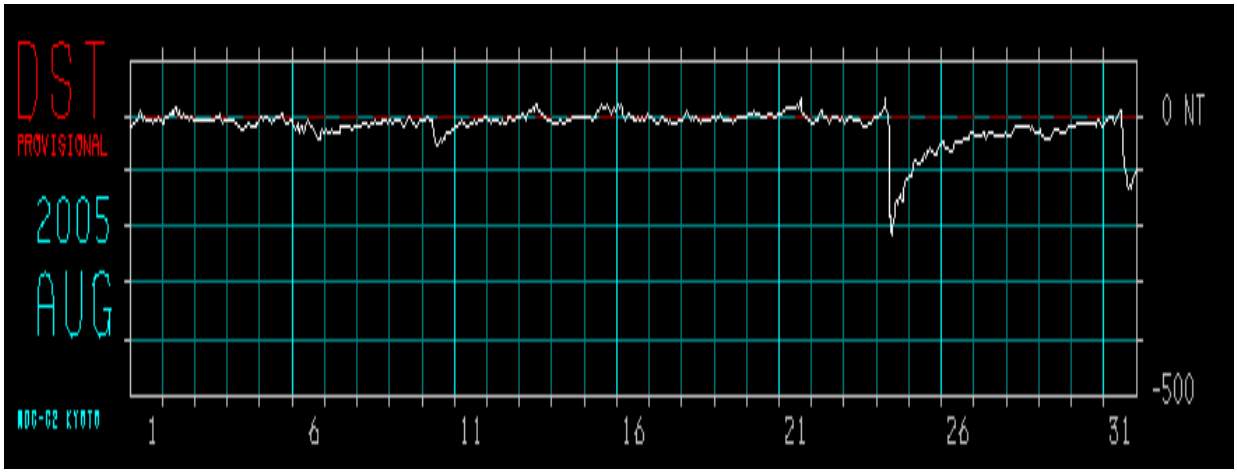

Figure 1. : The course of the Dst index during August 2005. Kp during geomagnetic storm reaches 9 (with SSc 24.8.2005) . Dst index reaches value -216.

The measurements of the ionospheric E region drifts, measured during event 24.8.2005 in comparing with measurements one day before event shows , that vertical E region drift velocity Vz increased from typical value ~5 m/s for quiet summer conditions, up to 20 m/s during disturbed conditions.The variations in both horizontal components are much more greater (especially in comparing with day before event) and north-south component reaches values near 100 m/s (compare with typical values 20 m/s for summer quiet days). Vertical and north-south components of the ionospheric F region drift velocity measured during geomagnetic event are strongly disturbed by storm conditions also. Observed drift velocities of the north-south components reaches during storm values ~ 150 m/s. The variation in the nirth-south component are possibly the result big increasing of TID

activity during storm. The increasing of the F region drifts started started 24.8.2005 04 00 UT. Similar time corse at Dst index shows, that this auroral index is very convenient for monitoring of the F region drifts.

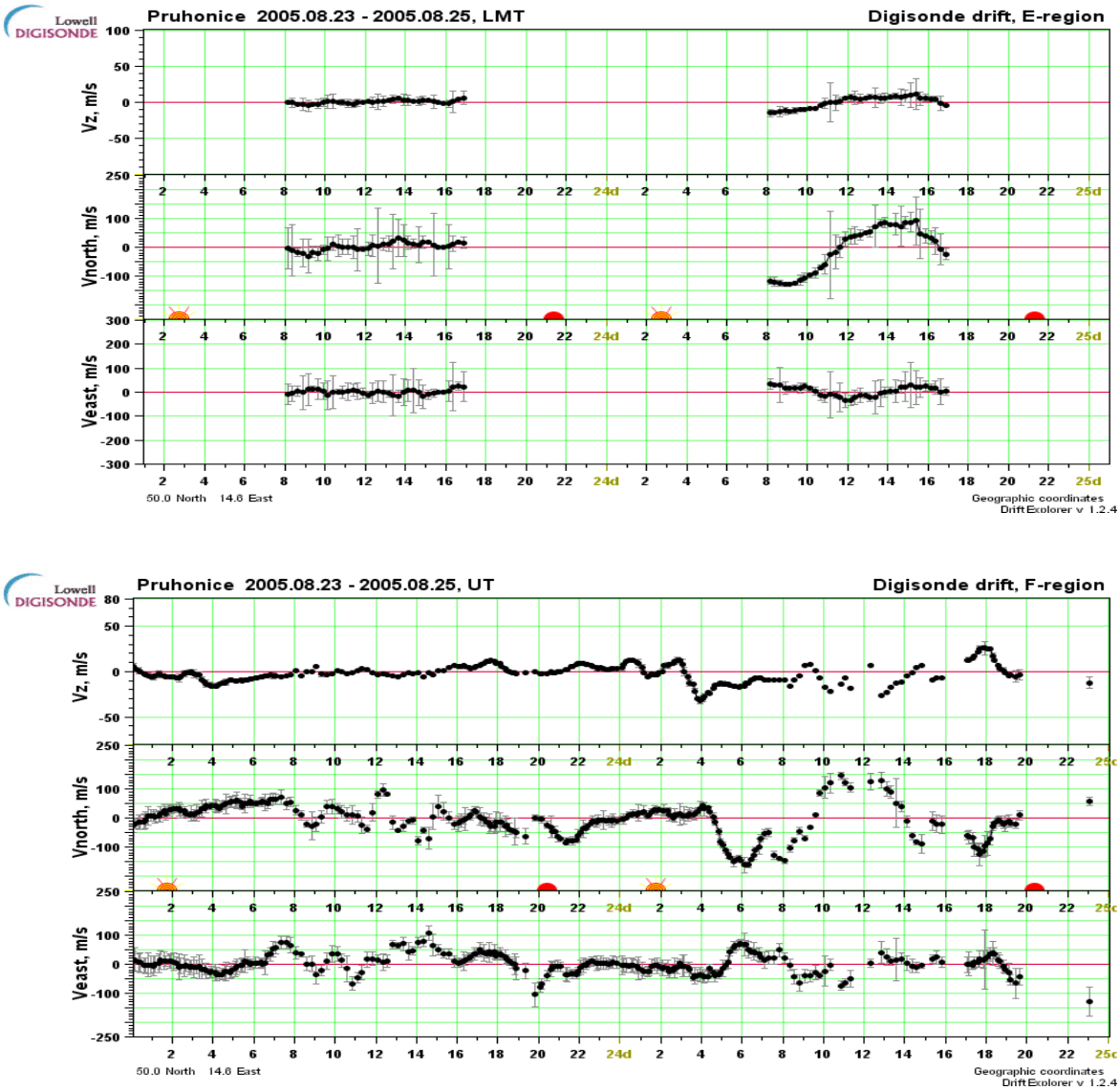

Figure 2. : E and F region drift velocities components measured during geomagnetic storm in August 2005, 23.8.2005 (day before event) and 24.8.2005 (day of the geomagnetic storm).

6. Discussion.

The observation of the ionospheric drifts at Pruhonice observatory during quiet days shows very small variability of the vertical components of the E region drifts during summer and equinox (~5m/s).Variability both horizontal components are larger (~10 - 20 m/s). During winter conditions the increasing of the E region drift activity was observed in all components.

In the F region quiet days drifts significant variability of all drifts components during early morning and late evening (near sunrise and sunset) was observed. Larger variability of the horizontal components during winter and small variability of the vertical component during day time clearly visible during selected quiet days.

During storm event - strong increasing both horizontal components of the E region drift velocity, from typical value 10 -20 m/s till 50 m/s more than 100m/s (during strong storm).

The vertical component of the E region also increased, from quiet value 5m/s till 20 m/s during strong event.

SSC events are directly reflected in drift velocity observations.

All components of the ionospheric F region drift velocity, measured during big geomagnetic event are strongly disturbed by storm conditions. Observed drift velocity components reaches during strong storm values 100- 150 m/s , which were observed at middle latitude station Pruhonice .

The variations in the E and F region drift velocity components are caused by large number of factors: Gravity wave, particle events, TIDs etc., and increasing of their activity during storms.

7. References:

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