Ionospheric response to magnetic disturbances under low solar activity conditions and STORM model corrections for the disturbed periods

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- The period of 2007-2009 was less of strong magnetic storms (with *Dst*< -100nT).

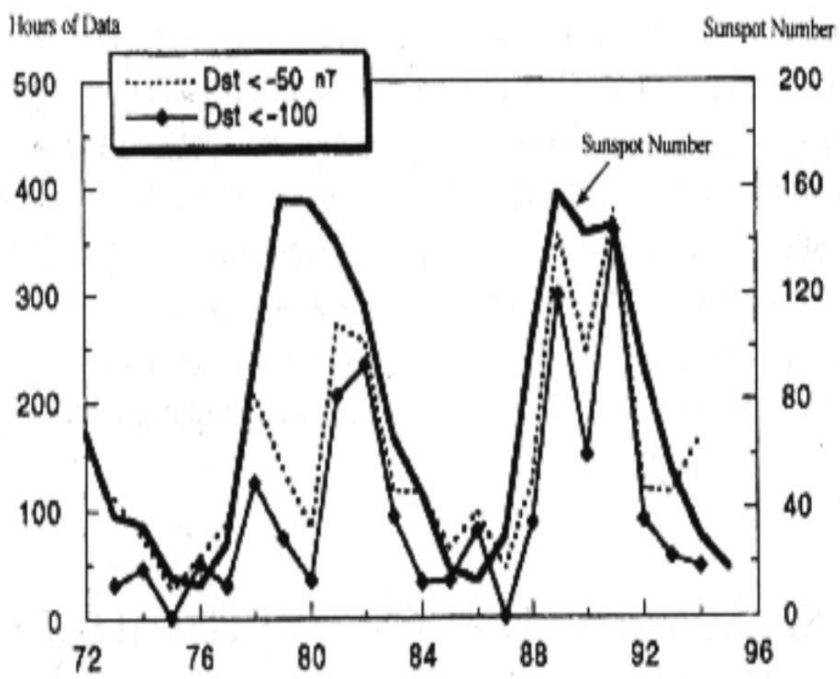
- Number of moderate events (-100 nT< *Dst*<-50 nT) was decreasing (5 events in 2007; 4 events in 2008; 1 event in 2009) till 2010, when it increased again (7 events).

- There were observed numerous cases of minor magnetic storms (*DsT*>-50 nT), which began with well-pronounced rapid increase of positive *Dst*.

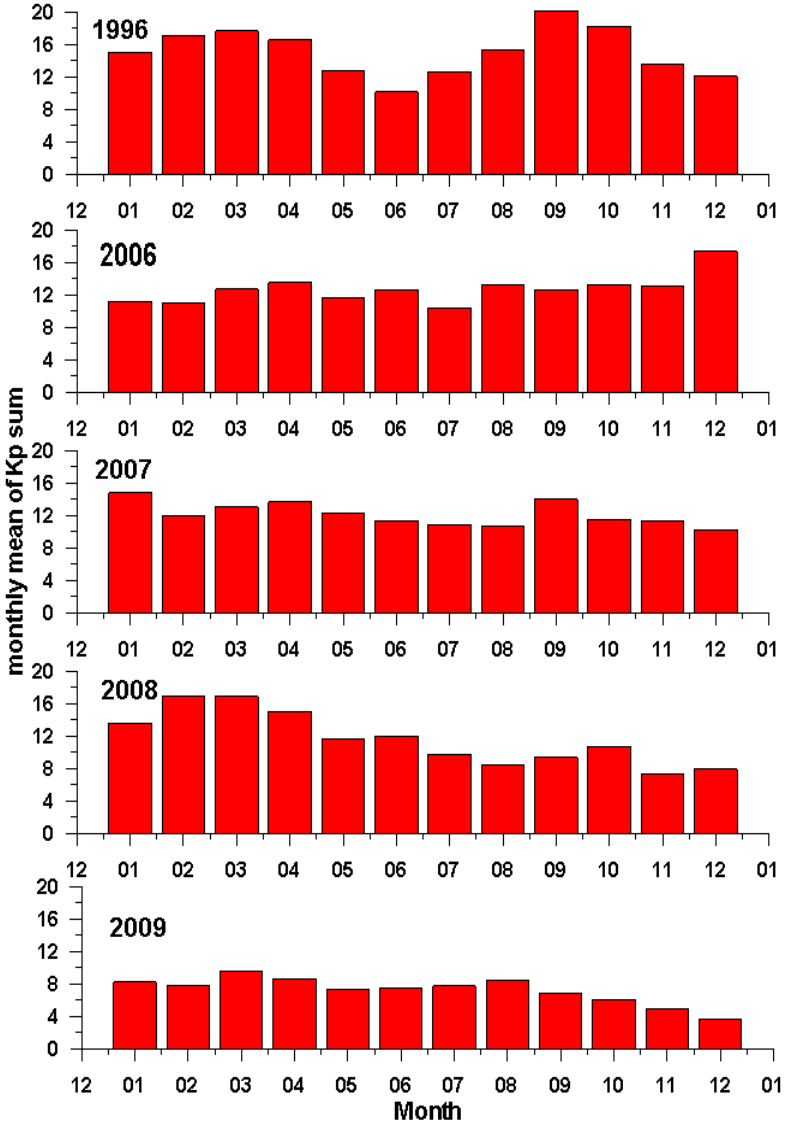
Cander and Halarambous [2011], when analyzing VTEC obtained from European GNSS for the period January 2008 - January 2010, have founded a significant number of events, all with exceptionally large enhancement of TEC over European region during weak geomagnetic disturbances and pointed out still open question about large electron density variations under weak magnetic activity usually assigned particularly to solar minimum years.

It was shown by Kamide et al. (1998) and Tsurutani et al. (2006) that CIR (co-rotating interaction region)-related magnetic storms are weak-to-moderate and mostly occur during the declining phase of the solar cycles.

69 such events occurred during the last solar minimum.



After Kamide *et al.*, 1998



Motivation:

- ***to focus on ionospheric F2 layer reaction to occasional magnetic storms above selected ionospheric stations under extremely low solar activity conditions of 2007-2009***

- ***to analyse seasonal and latitudinal dependence of the effects***

- ***to compare IRI model outputs with observed values***

Data sources:

The created database comprises values of *foF2* and *hmF2* for middle latitude stations across European-African and American regions available at DIDBase (UMLCAR,Lowell, Massachusetts, USA)

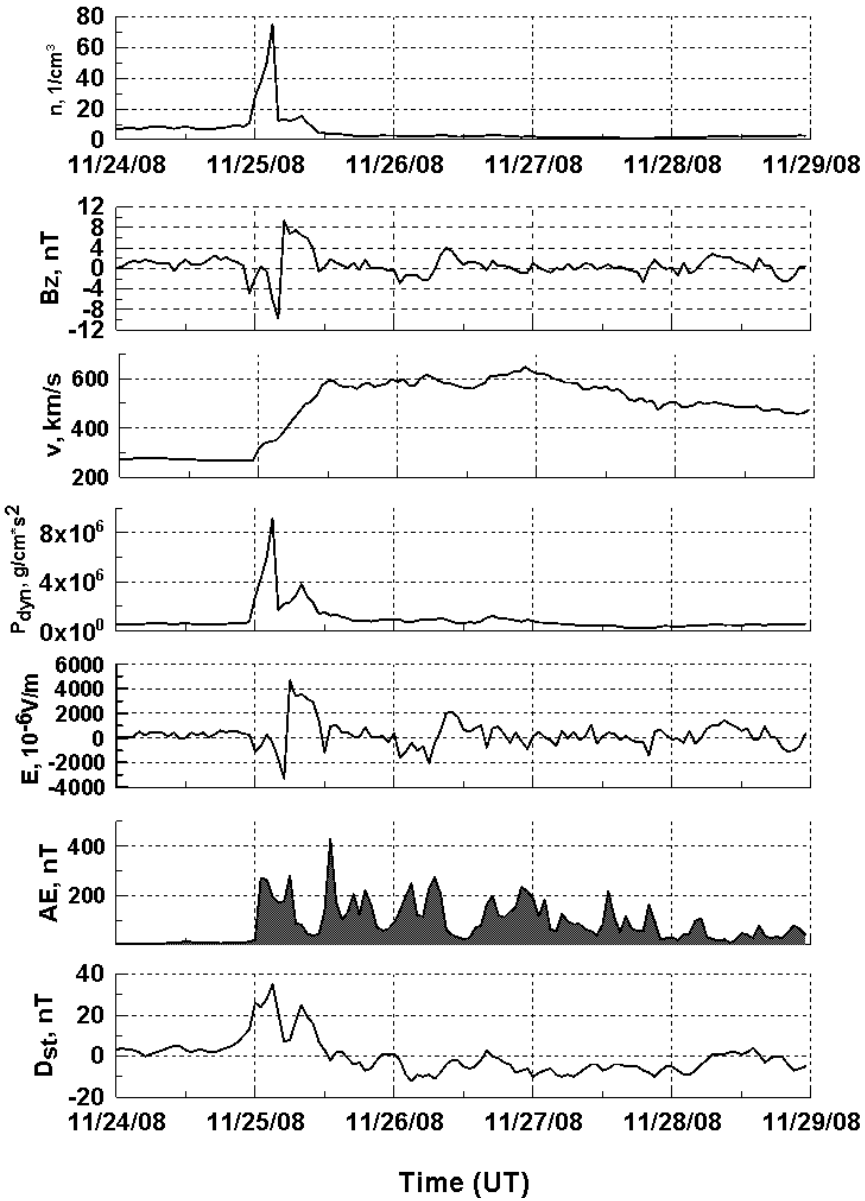
The values of *hmF2* were derived from electron density profiles.

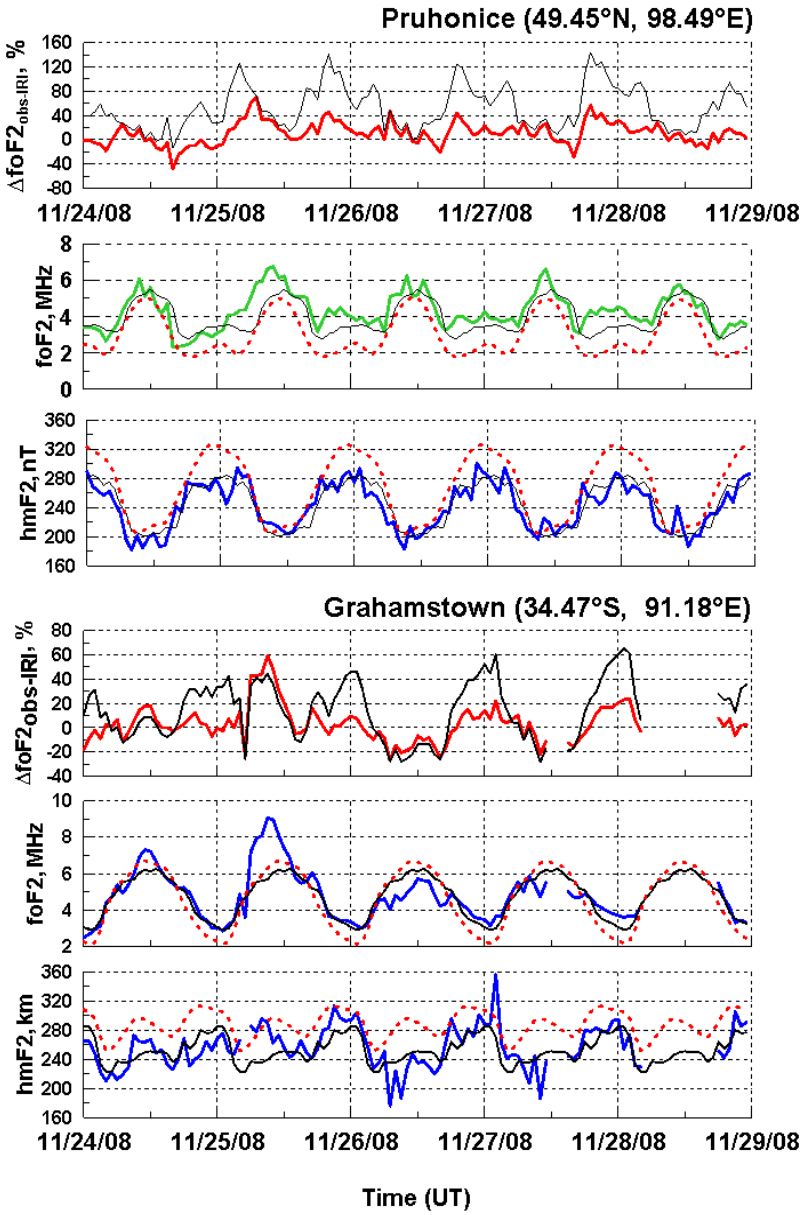
The disturbed periods were analysed using constituently checked data.

To evaluate storm effects on ionospheric *F2* layer we used 27-days running means of *foF2* and *hmF2* centred on storm culmination day.

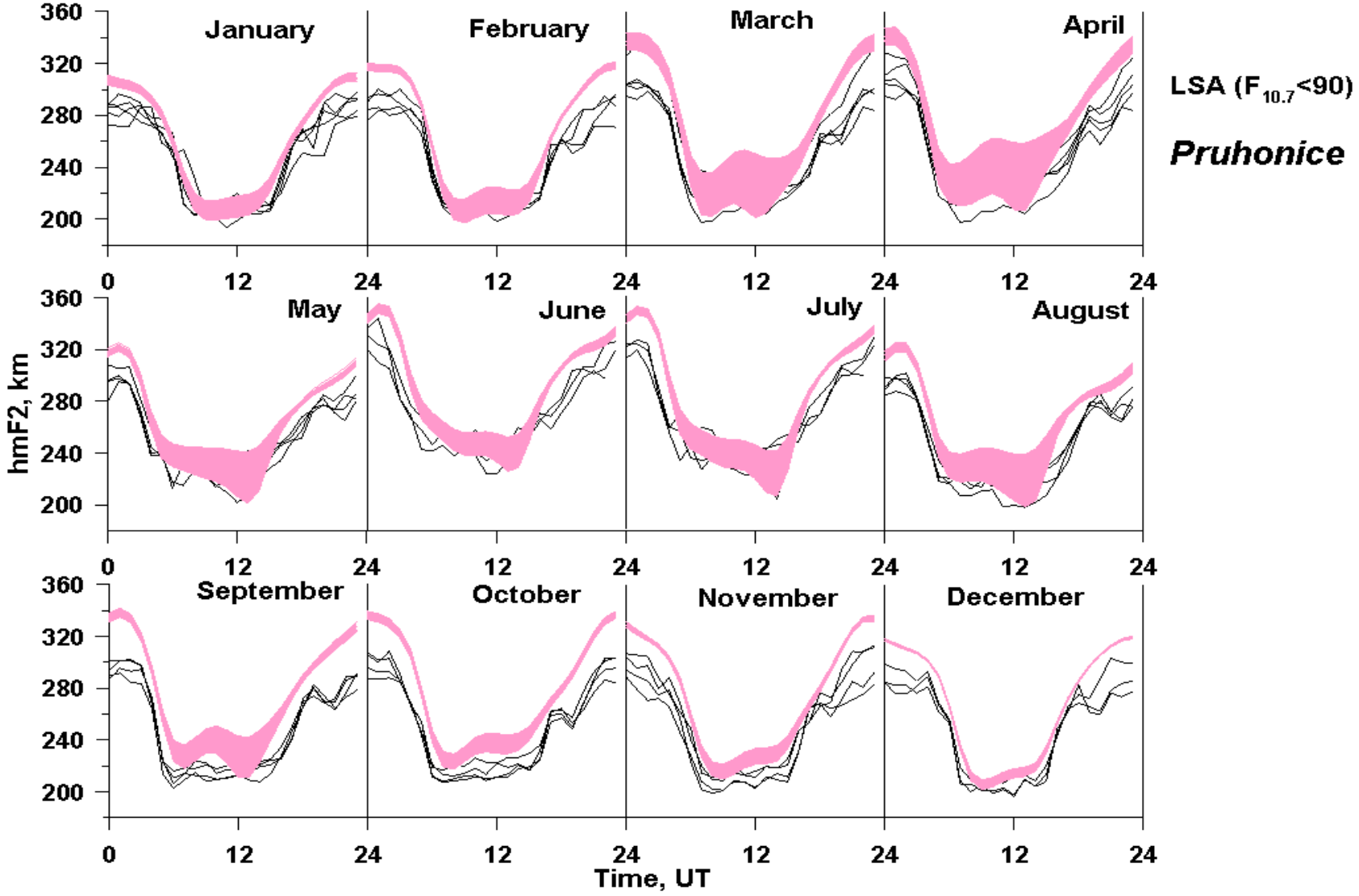
The *Dst, Bz*, *AE* and *Kp* indices were obtained from the World Data Centre for Geomagnetism Kyoto http://wdc.kugi.kyoto-u.ac.jp/ and the Coordinate data Analysis Web of the Goddard Space Flight Centre Space Physics Data Facility, USA http://vspo.gsfc.nasa.gov/websearch/dispatcher

November 2008 geomagnetic storm

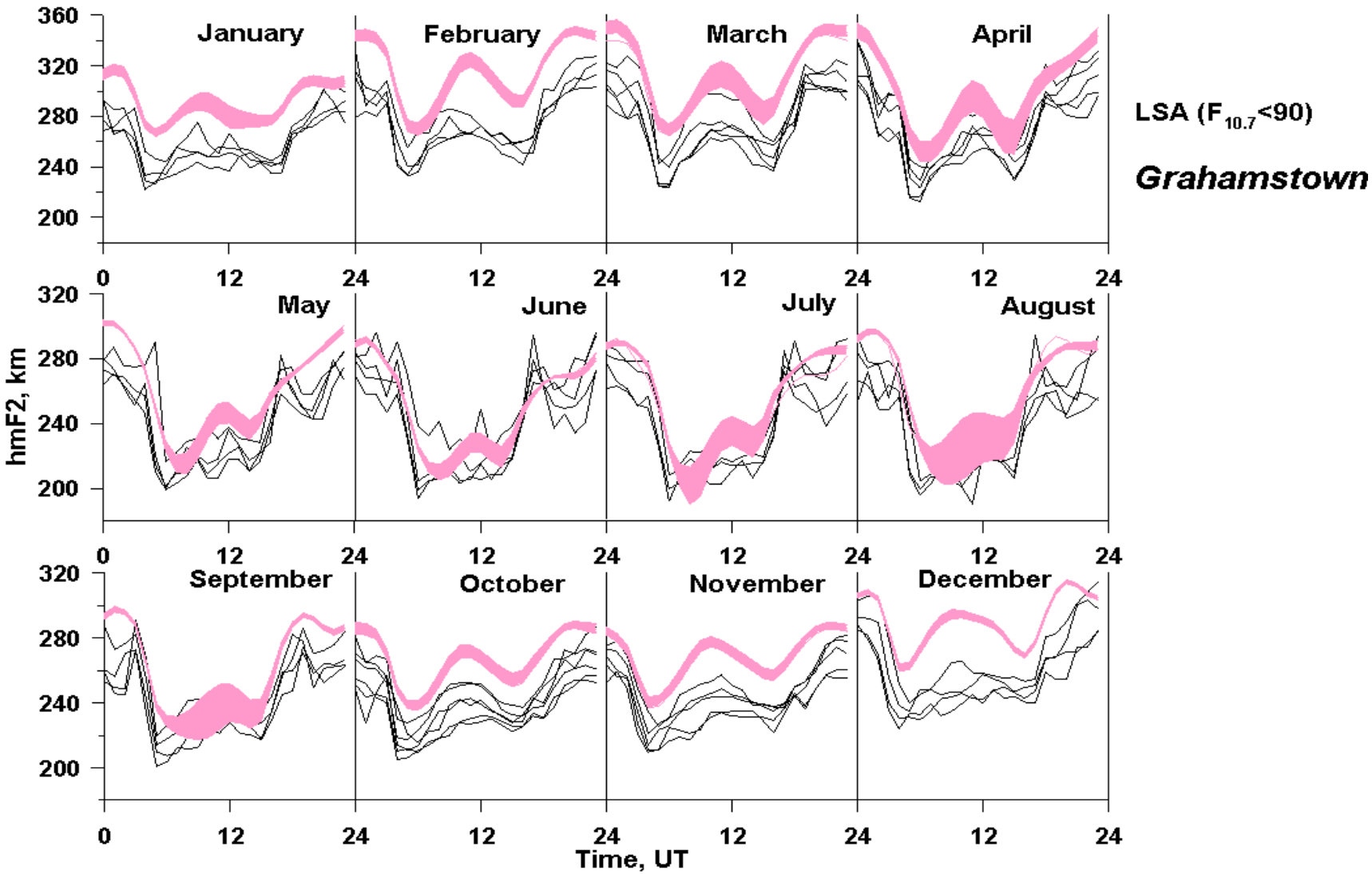




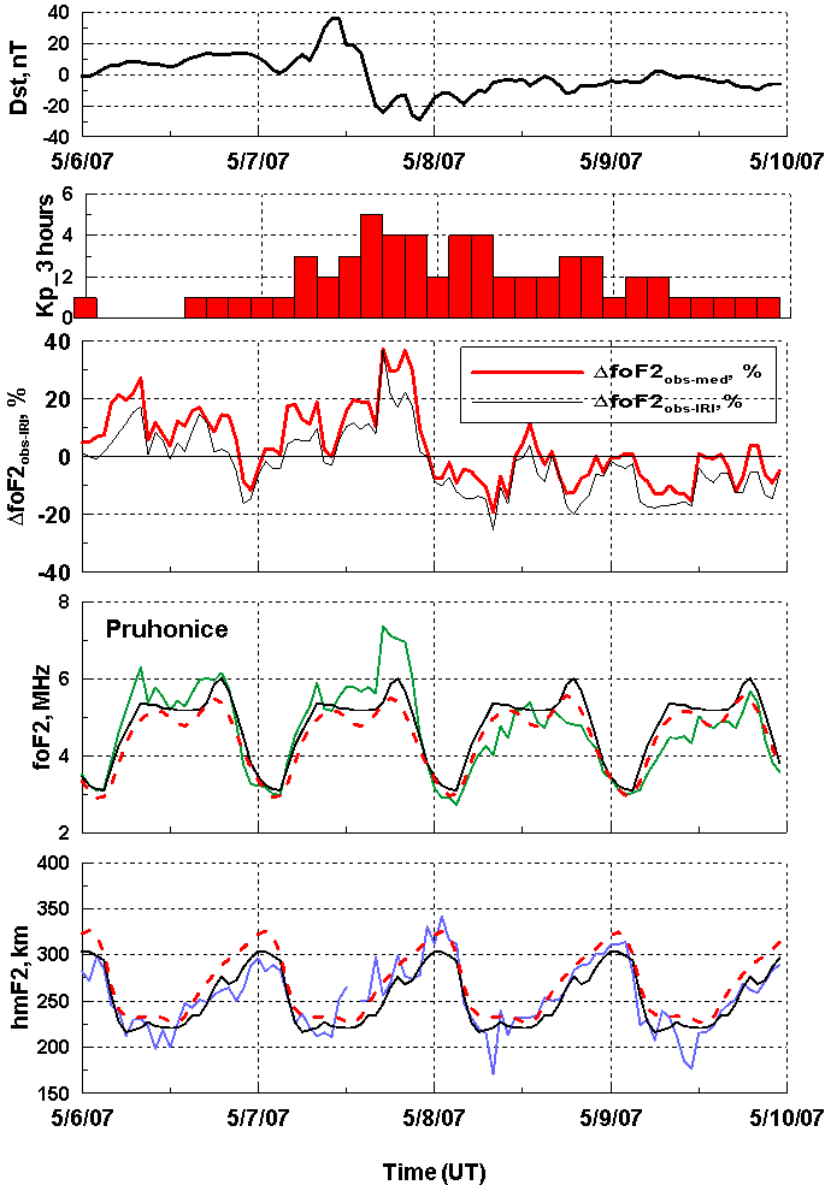
Observed and IRI calculated hmF2



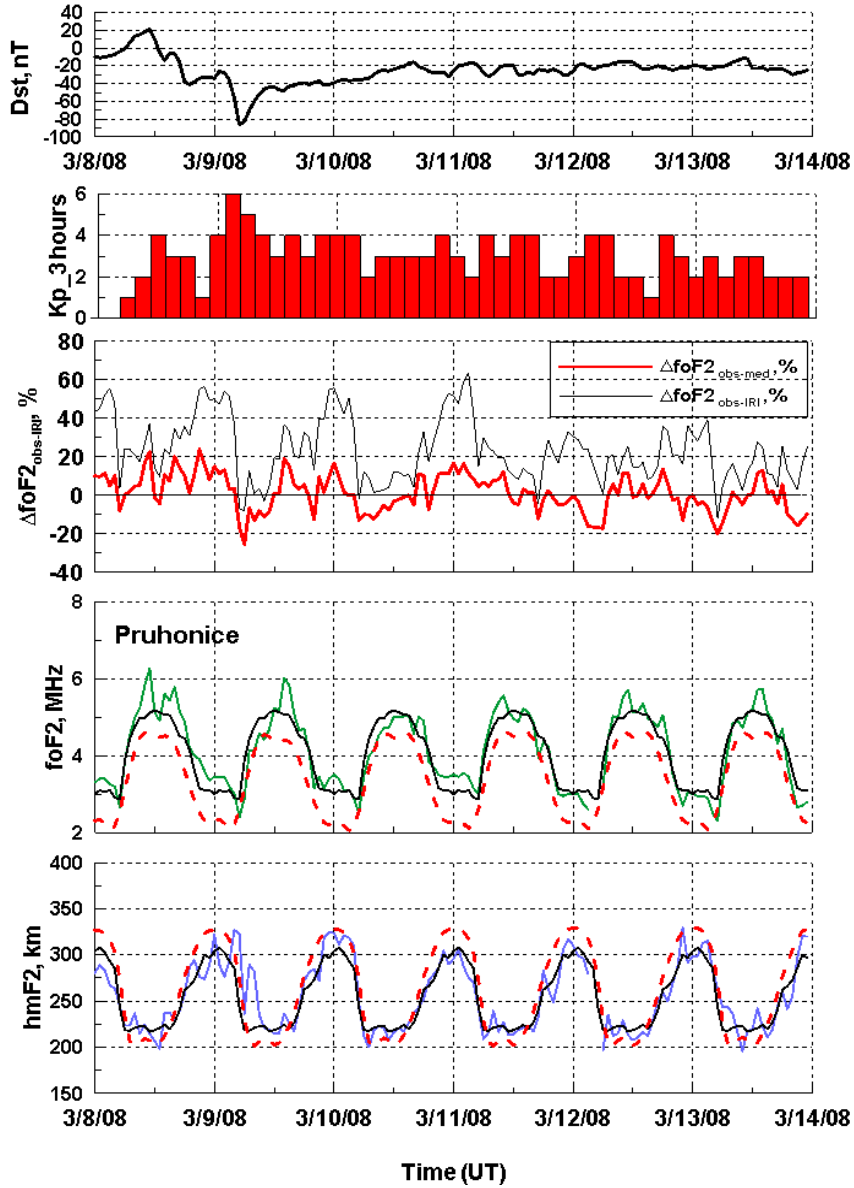
Observed and IRI calculated hmF2



May 2007 geomagnetic storm

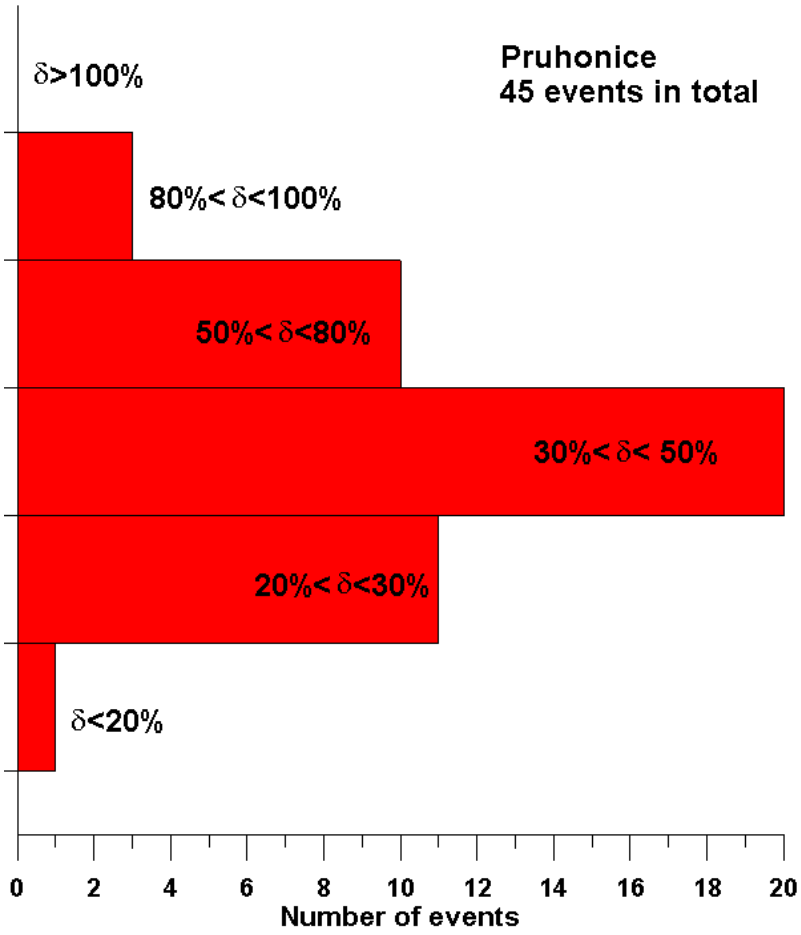


March 2008 geomagnetic storm

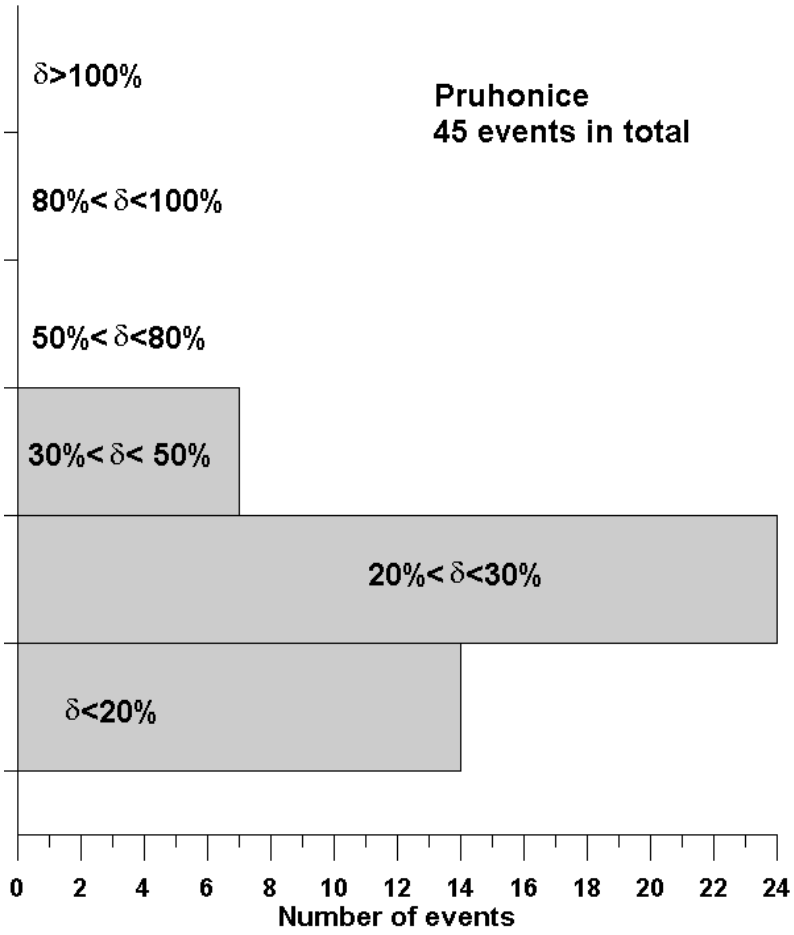


Effects of minor geomagnetic storms on foF2

11-summer; 13-equinoxes; 21- winter

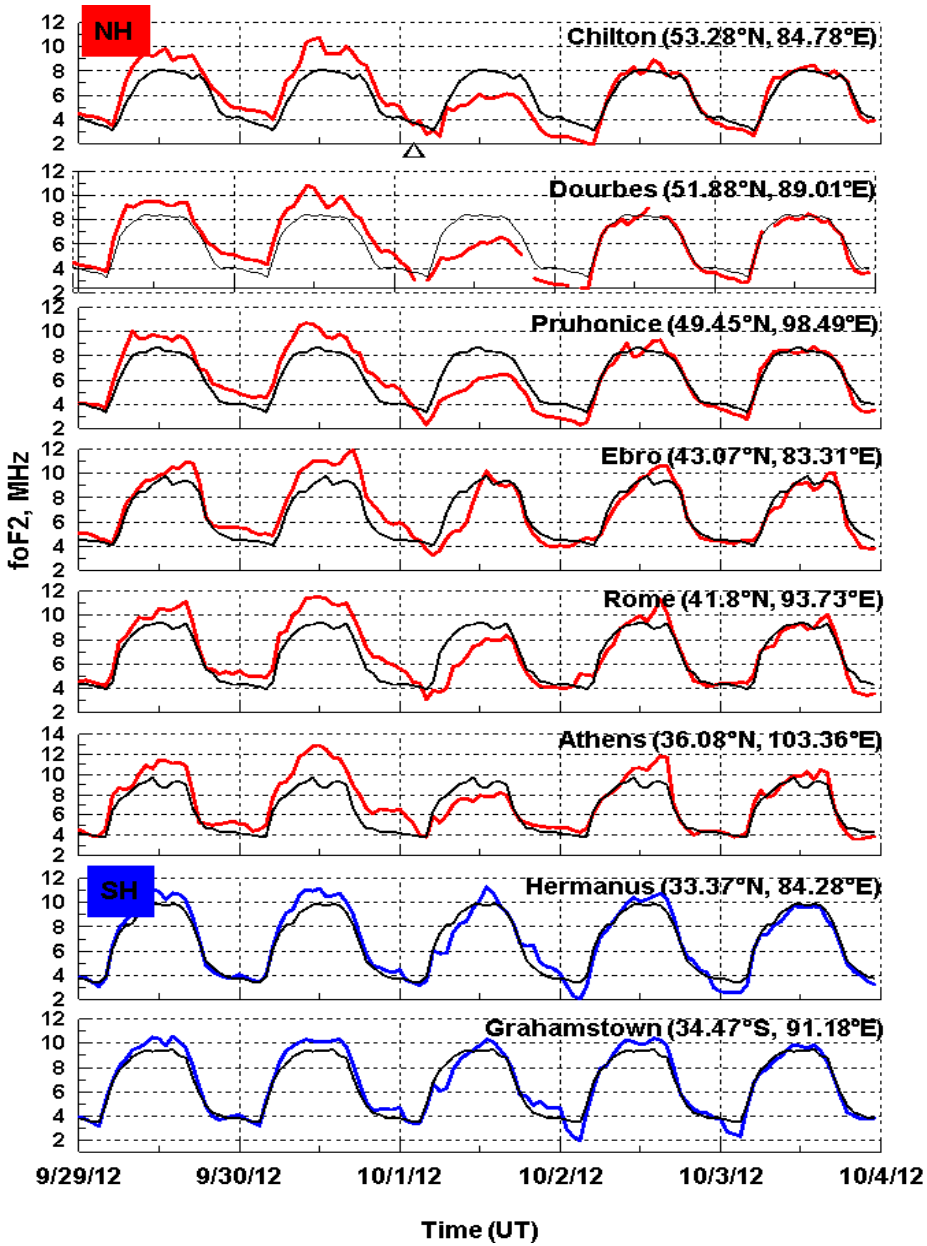


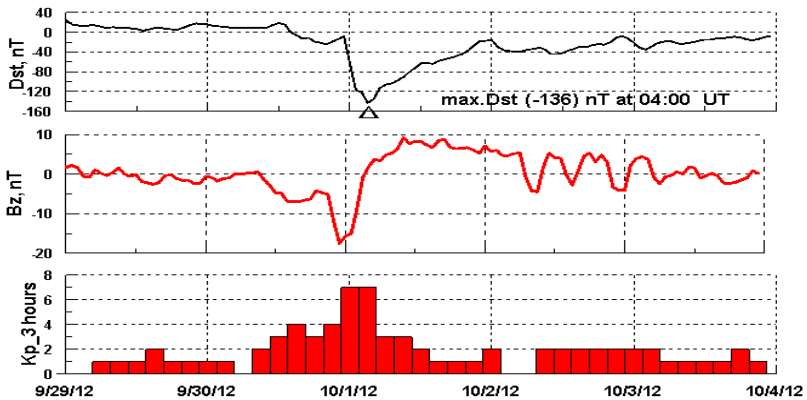
Positive effect

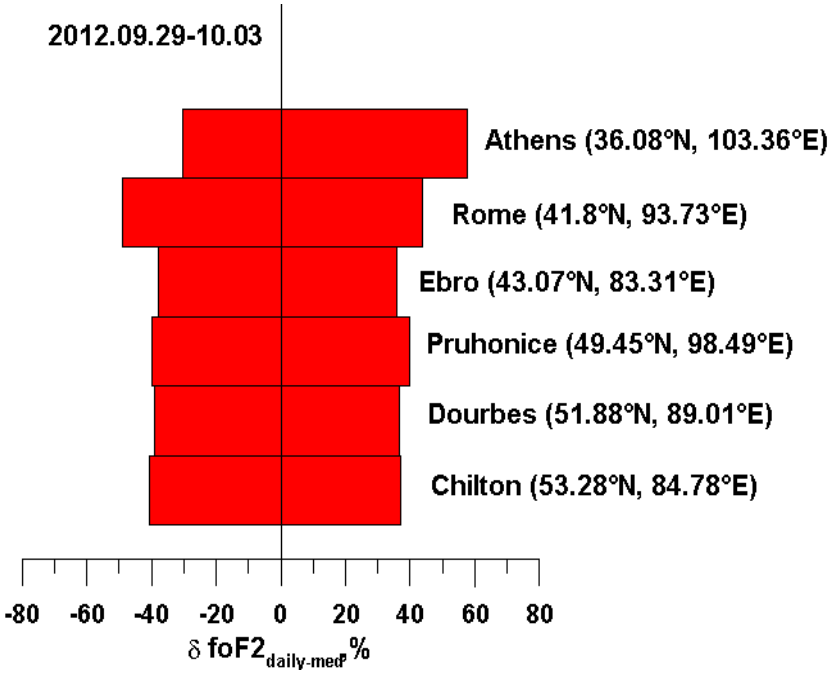


Negative effect

October 2012 geomagnetic storm



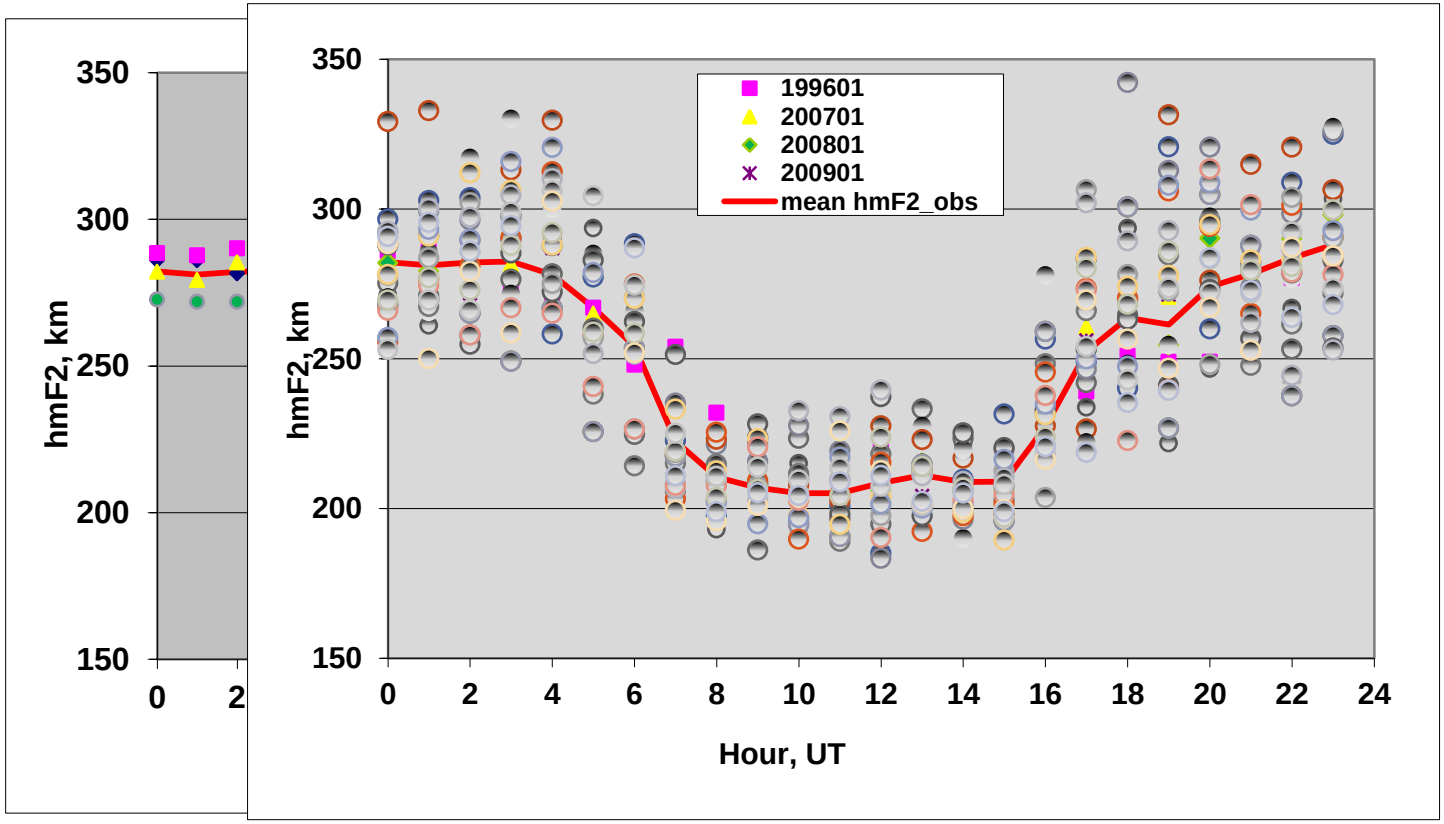




Effects on hmF2

δ hmF2$_{max}$, km	Positive (number of events)	Negative (number of events)
50<δ<80	2	15
30<δ<50	23	22
20<δ<30	20	8

Pruhonice



Conclusions:

The presented results show that:

- the effects on the middle latitude ionosphere of weak-to-moderate CIR-related magnetic storms, which mostly occur during the declining phase of the solar cycle, could be comparable with the effects of strong magnetic storms.

- in general, both positive and negative deviations of *foF2* and *hmF2* from their 27-days running means have been observed independent on season and location.

- Positive effects on *foF2* prevail and are more significant.

- the IRI STORM model gives no corrections of *foF2* for analysed events.

ACKNOWLEDGEMENTS

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