TOTAL ELECTRON CONTENT OBTAINED WITH THE USE OF SELECTED GPS SATELLITES

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ABSTRACT

Total electron content obtained with the use of different GPS satellites is calculated. The data sets are specifying according to different ionospheric and magnetic conditions. The influence of elevation angle is discussed regarding the TEC spatial anisotropy.

1. INTRODUCTION

The Global Positioning System (GPS) provides useful ionospheric information about an electron concentration between the satellites and the considered receiver – total electron content (TEC). The accuracy of the TEC values obtained is the crucial point in ionospheric analysis. The uncertainties depend on the ionospheric delays and errors. Unfortunately, the number of visible satellites is different in different moment of time. Some of them are located at low elevation angels, just above the horizon. The signal from these may pass the ionosphere relatively far from the receiver site. In this case the disturbed ionospheric conditions influence the signal much more than the signal coming from other directions. Spatial variability of the ionosphere becomes important [1]. Special corrections for ionospheric delay were proposed by [2]. However for the correct TEC obtaining in particular receiver's site during wide spread ionospheric storms the signals from different GPS satellites should be analysed separately.

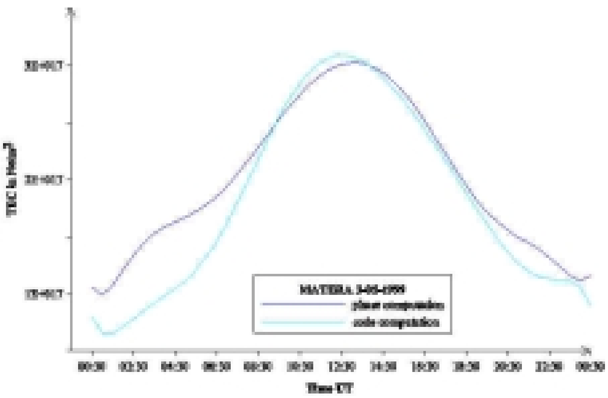

Fig. 1. TEC calculated in two manners: using code or phase observations.

In this paper TEC obtained with the use of different GPS satellites is calculated. The data sets are specifying according to different ionospheric and magnetic conditions. The influence of elevation angle is discussed regarding the TEC spatial anisotropy.

2. DATA ANALYSIS

The rough data from Matera IGU station (16.7^{o}E, 40.6^{o}N) for the 3rd May 1999 was used for present analysis. TEC is calculated in two manners: using code or phase observations (Fig. 1). Computations were done with the so-called geometry-free linear combination of two frequencies L1 and L2 – L4, which contains ionospheric information only. TEC obtained from code is more smoothed than phase measurements. For phase measurements, as the exact determination of the initial phase ambiguity is needed, the number of unknown parameters is enlarged.

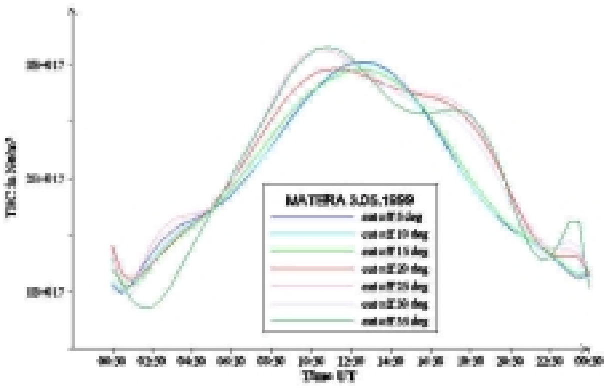

Fig. 2. TEC obtained when the number of satellites observed is diminished by taking into account only these, which are visible above the elevation angle: 5^o-35^o with 5^o step.

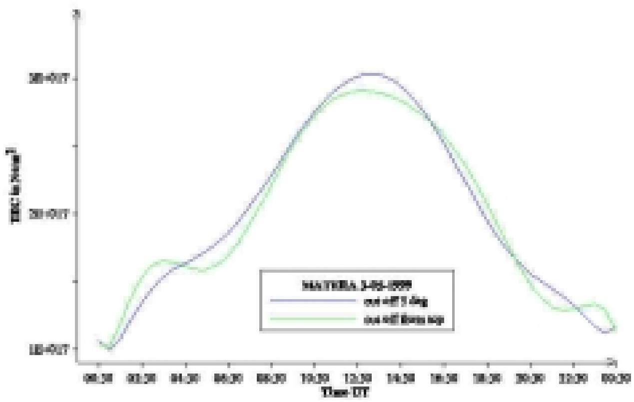

Fig. 3. TEC values obtained from the satellites that are seen between elevation angle 60^o and 5^o and above 5^o.

For every hour the number of visible satellites is changed dynamically. For some particular hours the number of remaining visible satellites is too small and it is not possible to calculate the reasonable value of TEC. To study the TEC dependence on the configuration of visible satellites the number of satellites observed is diminished by taking into account only these, which are visible for the elevation angle: 5^o-35^o with 5^o step (Fig. 2). Additionally, for particular moment the satellites that are seen above 60^o are cut off, also and compared to situation when only these that are located above 5^o elevation angle are considered (Fig. 3). The differences of TEC obtained for all conditions are negligible.

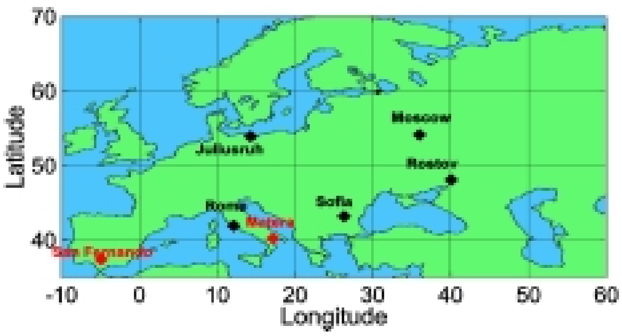

Fig. 4. European area showing locations with GPS receiver at Matera and San Fernando stations (red squares) and ionospheric VI stations (black squares).

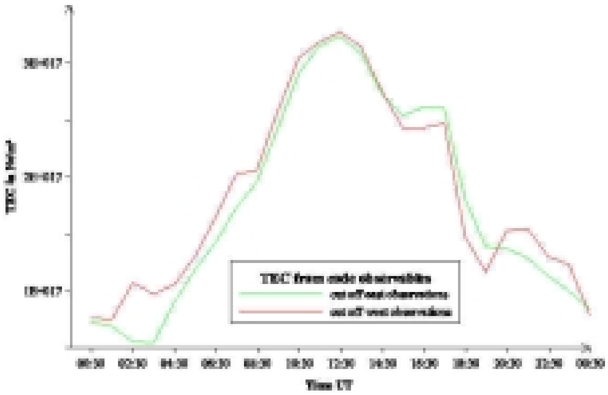

Fig. 5. TEC values obtained from the satellites observed east and west side of Matera station

The ionospheric conditions were analysed according to the disturbances observed at VI stations from European area (Fig. 4). For the analysis all European VI stations were considered, but the disturbance appeared only at the stations listed in Table 1. The disturbance is obtained from the catalogue of disturbances from the Ionospheric Despatch Centre in Europe [3] defined according to the algorithm by [4]. To provide TEC values without ionospheric storm dependence the data sets are specifying according to different ionospheric conditions, by cutting off the observed satellites from east or west side of Matera station (Fig. 5 and 6). The strong negative disturbance observed in lower ionosphere at five ionospheric stations located east from Matera is remarkably marked, while at San Fernando located west from Matera this disturbance is not recognizable.

Table 1. The disturbances considered at European VI stations at 3rd May 1999.

Station	Start(UT)	Maximum(UT)	Disturbance	End(UT)
Sofia	2	6	-50%	9
Rome	2	3	-46%	5
Moscow	18	2	-45%	11
Rostov	2	3	-44%	5
Juliusruh	21	2	-52%	4

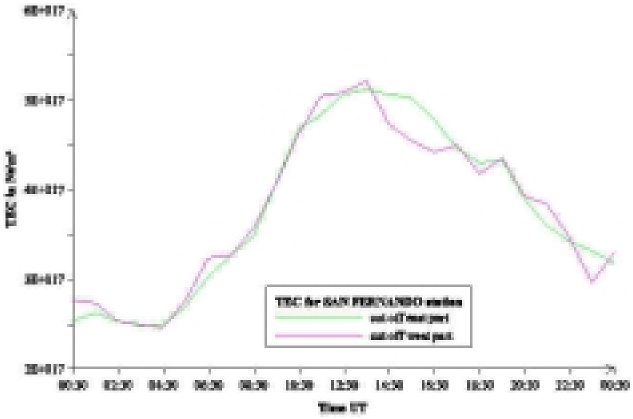

Fig. 6. TEC values obtained from the satellites observed east and west side of San Fernando station.

3. CONCLUSIONS

All presented figures confirm that the application of frequency combination L4 for TEC obtaining with the use of code observations, as well as phase observations with reasonable accuracy, show remarkable spatial TEC anisotropy during ionospheric storms. Preliminary results show some evidence for this fact. However, more studies are needed. Only the careful analysis in satellites choosing for TEC computations allows making independent the results from the localization of the ionospheric disturbance, as well as from the elevation angle of considered satellites.

4. ACKNOWLEDGMENTS.

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5. REFERENCES

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