Ionospheric TEC disturbance during the Mediterranean tropical-like cyclone occurred on November 2014.

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ABSTRACT

In this work the behavior of the ionosphere over Europe during November 2014 has been analyzed with the objective of analyzing the effect of a tropical storm on total electron content, TEC.

Key words: Medicane, TEC anomalies, Atmosphere-Ionosphere coupling.

1. Introduction:

The upward propagation of internal atmospheric waves (planetary waves, tides and gravity waves) from the troposphere and stratosphere is an essential source of energy and momentum for the thermosphere and ionosphere [1]. Tropical cyclones can generate internal atmospheric waves and their upward propagation can disturb the ionosphere [2].

Mediterranean subtropical cyclones are storm systems sharing properties of tropical cyclones and mid-latitude depressions. These phenomena are often called Medicane (Mediterranean Hurricane) or **Mediterranean tropical-like cyclones**. A Medicane, named Qendresa I by the University of Berlin, originated in the Mediterranean Sea on 7th November 2014 and moved direction west-east across the island of Malta from 03:00 UTC 7th to 12:00 UTC 8th [3].

2. Data and Methodology:

Total electron content (TEC) has been obtained from RINEX files given by more than 150 GNSS stations belonging to International GPS Service, IGS, and EUREF Permanent Network, EPN. All of them were located in Europe. Data were obtained at 1 minute sampling rate in November 2014. The RINEX files have been processed using a technique developed by Prof. Luigi Ciraolo [4]

which assumes the ionospheric thin shell model to obtain vertical total electron content (vTEC).

To analyze the variations of vTEC at every station, we have used the vTEC*Sigma parameter defined by the expression:

$$vTEC * Sigma = \frac{vTEC - vTECmean}{\sigma} \qquad (1)$$

Where vTEC is the observed value in each epoch, vTECmean and σ are, respectively, the mean value and the standard deviation of the vTEC values obtained at the same epoch during the November International Quiet Days (IQD's)

3. **Results:**

Figure 1 displays the vTEC*Sigma series from two stations taken as example of the behaviour of this parameter. As expected, disturbed values appear on the International Disturbed Days (IDD's), corresponding to the month of study: 4, 5, 10, 15 and 16, but another disturbance has been clearly observed at stations nearby the cyclone starting area on 7th November, day in which the cyclone originates.

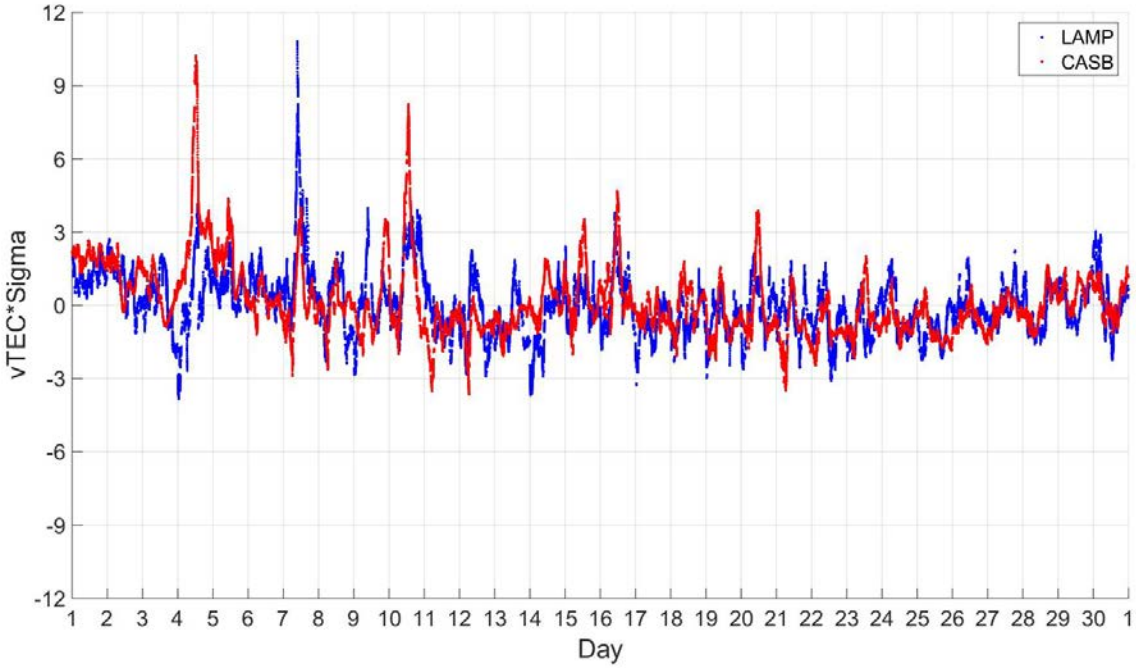

Figure 1 vTEC*Sigma time series of two stations: LAMP (blue) in Lampedusa, Italy, close to the tropical-like cyclone and CASB (red) in Ireland. Note that the peaks observed for CASB station on days 4, 10 and 16 correspond to international geomagnetically disturbed days.

Maps of vTEC*Sigma isolines have been drawn to display the spatial distribution of the vTEC*Sigma anomaly (Figure 2) by applying Delaunay triangulation method to values of vTEC*Sigma over each station. The largest ionospheric disturbance occurred at 10:00 during the formation of the Medicane (Figure 2 left). The peak intensity of the Medicane happened at 12:00 when the disturbance remained on the ionosphere (Figure 2 right) reaching a value of 10.8. The

absence of other causes of ionospheric disturbance and the spatial distribution of the anomalous values of vTEC*Sigma indicate a possible connection with the Medicane.

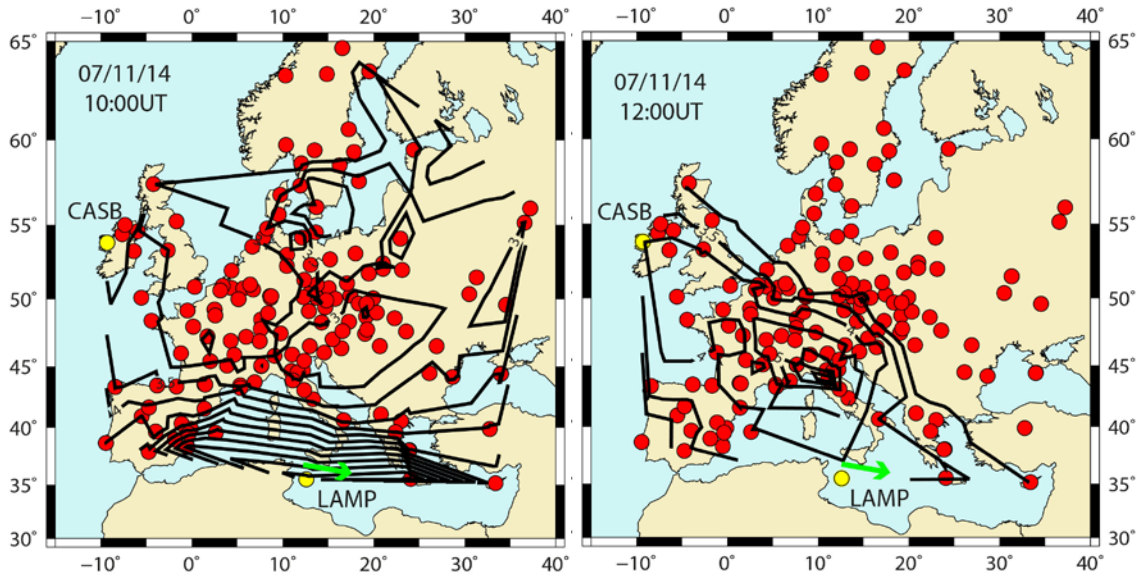

Figure 2. Maps of anomalous values of vTEC*Sigma (isolines represent vTEC*Sigma values equal or greater than 3 with the highest value of 10.5) on the maximum disturbance (10:00-12:00) on 7th November. The circles represent all the GNSS stations (in yellow the two stations selected in Figure 1) and the green line represent an approximation of the itinerary of the tropical cyclone.

4. References:

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[3] A Medicane (MEDIterranean hurriCANE) or Tropical-Like Cyclone (TLC) brought severe weather to parts of the Mediterranean in early November. http://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_2412479.html

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