Contribution ID: **270** Type: **Poster**

# Ionospheric response to Mt.Etna eruption

Solid Earth and fluid Earth are two open systems exchanging energy continuously with many geodynamical processes (e.g. earthquakes, volcanic eruptions, tsunami, thermal radiation). Volcanic eruptions belong to these processes because they determine an interaction between lithosphere (or idrosphere) and atmosphere. For example, the evolution of an eruptive column is a coupling process between lithosphere and lower atmosphere but, during an explosive volcanic eruption, other energy releasing occur like acoustic – gravity waves (AGWs) that can reach the upper atmosphere too. The advent of satellite systems in the last 50 years allowed to work out some detection techniques of volcanic activity, for example those based on temperature, pyroclastic or gas concentration.
The ionospheric monitoring in terms of TEC analysis (Total Electron Content) is an application representing a new research field to study volcanic eruptions with satellite technology as Global Navigation Satellite System (GNSS). The GNSS – TEC analysis is based on the electron density oscillations of the ionosphere estimated in terms of TEC Unit (1 TECU = $1{\cdot}10^{16}\ e^{-}{\cdot}m^{-2}$) from GNSS data processing. GNSS data processing algorithm is the Variometric Approach for Real-time Ionosphere Observation (VARION) already applied to detection of TEC signatures by tsunami and volcanic eruptions.
We analyzed fountain activity of Mt.Etna between 2012 – 2021 characterized by Mass Eruption Rate peak $Q_m \geq 1{\cdot}10^{6}\ kg \cdot s^{-1}$. The morning large scale lava fountain (LSLF) of December $4^{th}$ 2015 occurred during clearest TEC signatures characterized by peak $A$ ~ 0.5 TECU, apparent horizontal velocity $v_{HA}$ ~ 170 – 250 $m \cdot s^{-1}$ and frequency $f$ ~ 1 – 1.5 mHz by FFT spectral analysis (Fast Fourier Transform). We applied Empirical Mode Decomposition (EMD) technique to verify TEC signature by physical meaning of its components, namely Intrinsic Mode Functions (IMFs). One IMF characterizes TEC signature with TEC peak $A$ ~ 0.3 TECU and frequency $f$ ~ 0.5 – 1.5 mHz. These results, specially $v_{HA}$ and $f$, agree within literature ones for gravity waves of Co-Volcanic Ionospheric Disturbances (CVIDs).

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