Geophysical Research Abstracts
Vol. 20, EGU2018-10013, 2018
EGU General Assembly 2018

A joint variometric approach for real-time analysis of earthquake driven ionospheric disturbances using a Stand-Alone GNSS Receiver: the 2015 Chile earthquake case study

Michela Ravanelli (1), Giorgio Savastano (1,2), Attila Komjathy (2), Olga Verkhoglyadova (2), Esayas B. Shume (2), and Mattia Crespi (1)

(1) Geodesy and Geomatics Division, DICEA, Sapienza University of Rome, Rome, Italy , (2) Ionospheric and Atmospheric Remote Sensing Group, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

It is well established that earthquakes can trigger atmospheric waves able to propagate right up to the ionosphere as Coseismic Ionospheric Disturbances (CIDs). They are due to the acoustic waves both produced in the proximity of the epicenter (within 500 km) and by those triggered by Rayleigh waves propagating far from it. Numerous studies demonstrated that GNSS (Global Navigation Satellite System) is a mean to detect ionosphere alterations through computing the total electron content (TEC) value.
Our work finds itself in this context, but in the meantime, it extends its fields of application. The aim of this paper is, therefore, to apply two different algorithms, which both leverage the variometric approach, in order to analyse earthquake driven ionospheric perturbations. In this background, VARION (Variometric Approach for Real-Time Ionosphere Observation) and VADASE (Variometric Approach for Displacement Analysis Stand-alone Engine) algorithms were applied on the real-time scenario of an 8.3 magnitude earthquake that occurred in Chile on September 16, 2015. The former one is able to detect sTEC (slant TEC, TEC on the satellite-receiver line of sight) variations in realtime using observations coming from a stand-alone GNSS receiver. The latter is, instead, able to characterize ground velocities and displacements, also by using a stand-alone GNSS receiver in realtime; they are, hence, connected to the ionospheric disturbances.
The results obtained demonstrate how effective the joint application of the two algorithms is. Indeed, VARION well shows up the sTEC variations connected to the CID: such variation is evident especially in the regions located north of the epicenter, thus highlighting a north-south asymmetry in the perturbation.
On this point, a dedicated procedure, employing VADASE algorithm, proves that such CID directivity is caused by the different energy released by the earthquake in both directions. Indeed, the high correlation between the ground vertical displacements and the CID indicates that the ionospheric disturbance is mainly the result of the vertical ground motion at the solid Earth. Nevertheless, other factors, such as the geologic structure of the crust, play an important role in the CID and should be considered as the subject of further studies.
In conclusion, it can be said that the dual variometric approach, represented by the joint application of VARION and VADASE algorithms, could effectively help the comprehension of this kind of phenomena, by constituting a new way in GNSS ionospheric seismology.