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# A joint use of GNSS GEO and MEO satellites for earthquake and tsunami induced TIDs analysis: application to recent relevant events in the Pacific area

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The VARION (Variometric Approach for Real-Time Ionosphere Observation) can be an effective tool to analyse TIDs (Travelling ionospheric disturbances), since it is able to estimate slant TEC (sTEC) variations in real-time [1]. In this work, in order to improve ionospheric monitoring, VARION algorithm was extended to geostationary satellites (GEOs). Indeed, up to now, only GNSS satellites orbiting in Medium Earth Orbits (MEOs) were adopted. The main advantages of applying the VARION algorithm with GEO observations are the possibility to remove all the geometry effects, and to keep the observation noise level as much constant as possible, and to provide continuous time series. These characteristics could improve the effectiveness of TIDs detection and enable a continuous monitoring of the ionosphere activity.
We applied the combined VARION for GEOs and MEOs simultaneously for analysing the TID connected to the MW 7.5 earthquake registered 165 km East-South-East of Tadine, New Caledonia [2]. Tsunami waves were recorded moving out from the epicenter, prompting residents along the coast to flee to high lands and triggering surges as high as 72 cm on the island of Tanna, Vanuatu.
To this aim, GNSS stations belonging both to the regional network of New Caledonia (DIIT [3]) and to IGS network [4] were used, processing in this way a dataset of 27 stations spread all over the territory of New Caledonia.
In order to extract the variations in TEC related to acoustic waves triggered by the earthquake itself, the TEC data were also filtered using passband of 3.3. to 200 mHz (corresponding to wave periods of 300 to 5 seconds). VARION outcomes show that the TEC perturbations are clearly visible for GPS satellite G19 (up to 0.6 TEC units), G02 and G06. This feature is highly evident in hodochrons and space-time TEC variation plots.
Although GNSS stations tracking GEOs are still very few, the preliminary results with VARION-GEO are very promising. Indeed, this analysis shows a good improvement in reducing the observed background noise since geostationary satellites are almost motionless relative to a point on Earth, and as a result the IPPs (ionospheric pierce points where a notional ionosphere intercepts a receiver to satellite line-of-sight) may be assumed to be stationary in the sky. For all these reasons, the introduction of GEO satellite observations in the VARION algorithm may represent a further significant step for the real-time ionosphere monitoring.
In conclusion, the joint application of GNSS GEO and MEO satellites revealed beneficial in detecting TIDs and, hence, it could enhance tsunami early warning system.

References

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