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Study of global behavior of ionosphere effects of moderate geomagnetic storms using high time resolution global ionosphere maps (GIMs)

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It is well known that Global Ionosphere Maps (GIMs) of vertical total electron content (vTEC) are a very important tool to study ionosphere behavior on a global scale, particularly to detect specific ionosphere variabilities both in time and space. Recently, it has been also proved that the accuracy of such maps increases by using high time resolution (15-minutes interval) GIMs [1]. In order to detect lower atmosphere effects on the ionosphere as those caused by dust storms or volcano eruptions, a differential GIMs technique has been recently introduced [2]. In the present study the same technique has been applied to high resolution GIMs produced by the Universitat Politecnica de Catalunya (Spain) to analyse the global effects of moderate geomagnetic storms occurring in northern hemisphere winter. The selected events have a minimum value of Dst geomagnetic index near midnight and similar F10.7 solar flux monthly mean (around 100 units). The differential GIMs technique consists in computing and mapping the differences using the mean TEC values of the 15 previous values at a specific UTC. The results obtained show that this method allows to detect the time and space evolution of the effects of geomagnetic storms. Figure 1 displays, as an example, the original GIM and the differential one for the 00:00 UT of the storm that occurred on 27-28 February 2014. This disrupting effect on the ionosphere is localized in the geographical area from Western European-African region and the Eastern Pacific Ocean region. This area covers from global sunlit area to local midnight hours and lasts about 4 hours around the time of minimum Dst value. A detailed evolution of the ionosphere effects is described and discussed for the events analyzed and those results are complemented with the observed evolution of the TEC rate of change index ROTI and geomagnetic field H component at given locations in different areas of the globe.

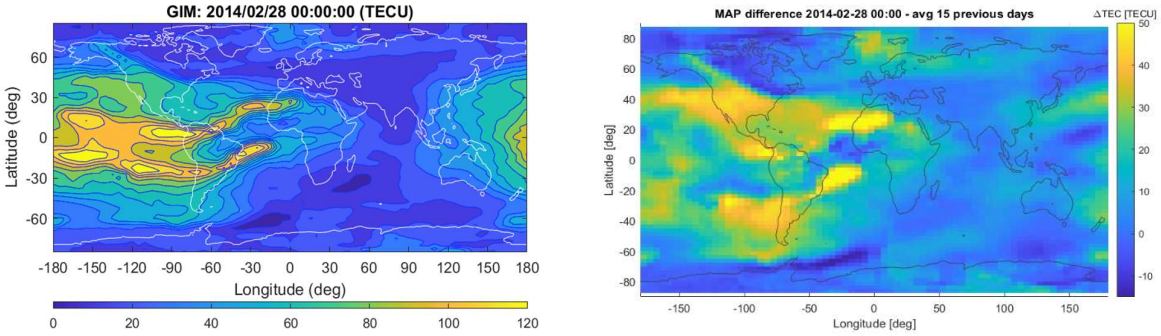

Figure 1. GIM corresponding to the day of the storm 28/02/2014 at 0 UT (left) and map of the differences at the same hour between the GIM of the left and the average of 15 previous days (right).

References

[1] Milanowska, B.;Wielgosz, P.; Krypiak-Gregorczyk, A.; Jarmołowski,W. "Accuracy of Global Ionosphere Maps in Relation to Their Time Interval". Remote Sens. 2021, 13, 3552. https://doi.org/10.3390/rs1318355.

[2] Pulinets, S., Davidenko, D., and Pulinets, M., "Atmosphere-ionosphere coupling induced by volcanoes eruption and dust storms and role of GEC as the agent of geospheres interaction", Advances in Space Research, vol. 69, no. 12, pp. 4319–4334, 2022. doi:10.1016/j.asr.2022.03.031.