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GNSS VTEC calibration using satellite altimetry and LEO data

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Among different systems remote sensing the ionosphere, space geodetic techniques have turned into a promising tool for monitoring and modeling the ionospheric parameters. Due to the fact that ionosphere is a dispersive medium, the signals travelling through this medium provide information about the parameters of the ionosphere in terms of Total Electron Content (TEC) or electron density along the ray path. The classical input data for development of Global Ionosphere Maps (GIM) of the Vertical Total Electron Content (VTEC) is obtained from the dual-frequency Global Navigation Satellite Systems (GNSS) ground-based observations. Nevertheless due to the fact that GNSS ground stations are in-homogeneously distributed with poor coverage over the oceans (namely southern Pacific and southern Atlantic) and also parts of Africa, the precision of VTEC maps are rather low in these areas. From long term analyses it is believed that the International GNSS Service (IGS) VTEC maps have an accuracy of 1-2 TECU in areas well covered with GNSS receivers; conversely, in areas with poor coverage the accuracy can be degraded by a factor of up to five. On the other hand dual-frequency satellite altimetry missions (such as Jason-1&2) provide direct VTEC values exactly over the oceans, and furthermore the Low Earth Orbiting (LEO) satellites such as the Formosat-3/COSMIC (F/C) provide about a great number of globally distributed occultation measurements per day, which can be used to obtain VTEC values. Combining these data with the ground-based data improves the accuracy and reliability of the VTEC maps by closing of observation gaps that arise when using ground-based data only. In this approach an essential step is the evaluation and calibration of the different data sources used for the combination procedure.
This study investigates the compatibility of calibrated TEC observables derived from GNSS dual-frequency data, recorded at global ground-based station networks, with space-based TEC values from satellite altimetry and F/C observations. In the current procedure the ground-based GNSS observations have been used to develop a GNSS-only GIM, using the parameter estimation technique. The VTEC values extracted from these models have been quantified and calibrated with the raw altimetry and LEO measurements. The calibrated values have been consequently used for developing the combined GIMs of the VTEC.