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Comparison between empirical and physical models of the topside ionospheric-plasmaspheric electron content above Antarctica

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As the polar regions are Earth's windows to outer space, the Antarctic continent provides a unique opportunity for scientific research that cannot be performed at mid- and low-latitude regions. Moreover, the polar ionosphere-plasmasphere system, especially over Antarctica, is not well understood as compared to other regions due to a lack of experimental observations. Consequently, one of the present challenges of the Space Weather community is to better characterize the climatological behavior of the polar ionosphere and plasmasphere separately in response to variations in the solar activity at high latitudes.

In this paper, we characterize the differences in the ionosphere-plasmasphere total electron content (IPTEC) climatological patterns over Antarctica. We reprocessed the GNSS (GPS + GLONASS) data available since 1999 up to now for stations situated at latitudes below S50° using the ROB-IONO software [1]. The estimated IPTEC data set is then employed to constrain an empirical model to predict the IPTEC from F10.7P solar index as input using a least-square adjustment. The resulting model permits to estimate the IPTEC at a given location and specific time in Coordinated Universal Time (UTC), Solar Local Time (SLT) and Magnetic Local Time (MLT) in each zone. From the output of this model we discuss the different climatological behaviors identified in the IPTEC at these polar latitudes.

We also used the radio occultation data from the COSMIC (Constellation Observing System for Meteorology, Ionosphere, and Climate, www.cosmic.ucar.edu) program, from the University Corporation for Atmospheric Research (UCAR) and the UCAR Community Programs (UCP). This data set consists in different sets of ionospheric parameters since 2001 up to now from Low Earth Orbits (LEO) satellites such as CHAMP, GRACE and FORMOSAT-3. This data set is employed to assess the climatological behavior of the Ionospheric Electron Content (IEC) for different levels of solar activity. Subtracting the IEC to the IPTEC, we highlight and discuss the contribution of the topside Ionospheric-Plasmaspheric Electron Content (topIPEC) in the polar region.

These new data sets and models are compared to in-situ measurements of the plasmaspheric electron density from the Cluster spacecraft launched in 2000 and still orbiting around the Earth. Finally, the comparison with a 3D physical dynamic model of the plasmasphere [2] will be presented.

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