Inter-hemispheric comparison of the ionosphere-plasmasphere system at mid-latitudes during quiet and disturbed periods

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An increasing demand for a better modelling and understanding of the Ionosphere-Plasmasphere system (I/Ps) is required for both scientific and public practical applications using electromagnetic wave signals reflecting on or passing through this layer. This is the case for the Global Navigation Satellite Systems (GNSS, i.e. GPS, GLONASS, Galileo) and for spacecraft designers and operators who need to have a precise knowledge of the electron density distribution.

Additionally, despite the long-term ionospheric studies that have been on-going for many decades, a number of aspects are still complicated to understand and forecast accurately even in mid-latitude regions during quiet conditions. Performing inter-hemispherical climatological studies in European and South African regions should highlight differences/similarities in I/Ps response during different phases of solar activity and geophysical conditions.

In that frame, the Royal Observatory of Belgium (ROB) and the South African National Space Agency (SANSA) are collaborating in the frame of the “Interhemispheric Comparison of the Ionosphere-Plasmasphere System” (BEZA-COM) project. The goal is to provide inter-hemispheric comparison of the I/Ps implying: (1) a characterization of the climatological behavior of the Total Electron Content (TEC) in the I/Ps, over European, South African, Arctic and Antarctica regions; (2) an identification of the mechanisms that regulate inter-hemispheric differences, asymmetries and commonalities in the I/Ps from low to high-latitudes, (3) study of the different responses of the I/Ps during extreme solar events and induced geomagnetic storms in the two hemispheres.

In this paper, we reprocessed the GNSS data (GPS+GLONASS) of the dense EUREF Permanent GNSS Network (EPN) and South African TRIGNET networks as well as IGS stations for the period 1998-2018. The output consists in vertical Total Electron Content (vTEC), estimated every 15 min., and covering the central European and South African regions. The vTEC is then extracted at two conjugated locations and used to constrain empirical models to highlight the climatological behavior of the ionospheric vTEC over Europe and South Africa. From the results, we will show that the differences are quite significant. To give first answers on these differences, we also compared these models with ionosondes long-term data-based models (for foF2 and hmF2) at two conjugated locations (Grahamstown and Průhonice) as well as long-term NRLMSISE O/N2 ratio (Figure 1).

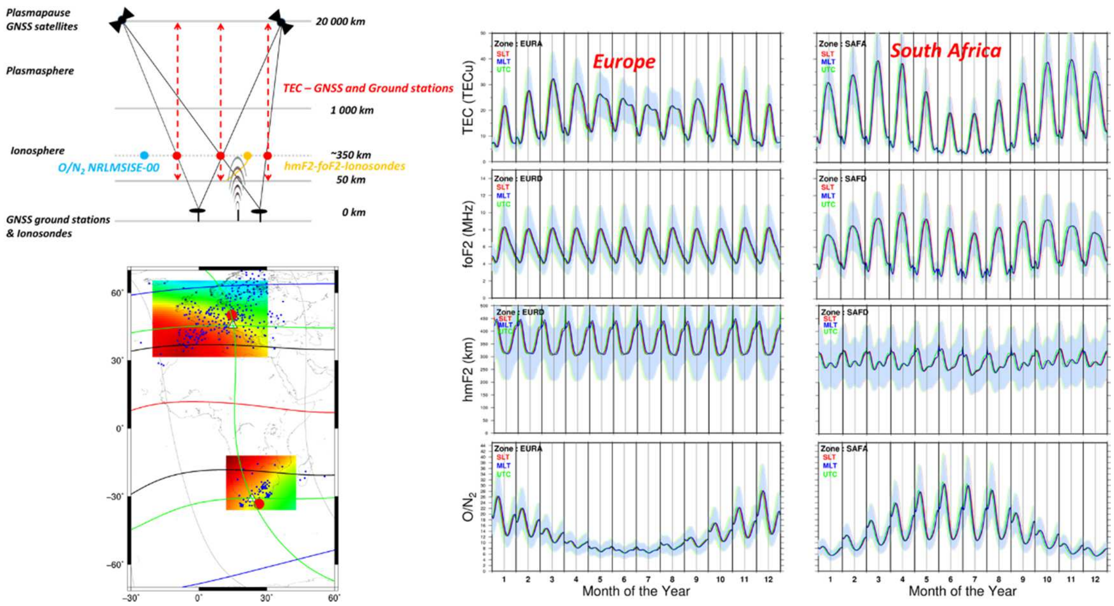

Figure 1. Monthly climatological behavior of the daily ionospheric and thermospeheric parameters for the two hemispheres.

Finally, during the period 2003-2018, 45 intense geomagnetic storms occurred and affected the two hemispheres. We will show first results on the inter-hemispheric comparison of their impact on the vTEC, fof2 and HmF2.