International Beacon Satellite Symposium BSS-2016
Trieste, Italy

Establishing local TID climatology for Antarctic Peninsula region

V.V. Paznukhov[*1], Y.M. Yampolski[2], V.G.Galushko[2], A.A. Sopin[2], and K.M. Groves[1]

[1] Boston College, Institute for Scientific Research, 140 Commonwealth Ave, Chestnut Hill, MA 02467, USA.
(E-mail: vadym.paznukhov@bc.edu)

[2] Institute of Radio Astronomy of National Academy of Sciences of Ukraine, 4 Chervonopraporna St., Kharkov, UKRAINE.
(E-mail: sopin@rian.kharkov.ua)

Antarctic Peninsula region has been largely devoid of routine TEC measurements because of its harsh environment and geographic al location that makes routine automatic tracking of GPS satellites a difficult task. This area, however, is highly interesting for the study of ionospheric disturbances associated with gravity waves, which are capable of penetrating to very high altitudes. Major sources of ionospheric wave disturbances in this region are cyclones, convective plumes, enhanced zonal winds mountain waves that are produced by the flow over the Antarctic Peninsula.

Three permanent GPS receivers were installed in the region in 2009: VNAD: (65.25º S, 64.25º W), PALM (64.78º S, 64.05º W) and DUPT (64.81º S, 62.82º W), which made it possible continuous monitoring and analysis of local ionospheric dynamics. A number of interferometry methods have been developed recently which allow reconstruction of ionospheric parameters from TEC measurements. One of the most universal methods that is applicable to ionospheric disturbance of an arbitrary shape has been developed by Galushko et al. [1]. This method also allows robust reconstruction of the disturbance parameters by implementing a number of filtering constraints to the data selected for the reconstruction. Application of this method to a year of the data collected at the three Antarctic stations demonstrated a possibility of reconstruction of TID parameters such as velocity, direction of propagation and occurrence probability and showed a great potential of this interferometric approach.

This work presents analysis of almost three years of TEC observations from VNAD, PALM and DUPT stations covering the period from 2009 to 2012. With the application of Galushko et al. [1] method it was possible to establish local climatology of the ionospheric disturbances (primarily associated with travelling ionospheric disturbances, TIDs) in the region. It is shown that the occurrence of the disturbances is controlled by the solar terminator in the winter and by the background ionospheric density in the summer. These results are summarized in Figure 1, which shows statistics of the disturbance observations for the entire period of analysis. During the wintertime (June-August) disturbance statistics is determined by the solar terminator (black and red lines). During the summertime, the presence of the disturbances is largely correlated with the background electron density. Note that in this region a summertime daily trend of the background electron density is inverted because of the so-called "Weddell Sea Anomaly".

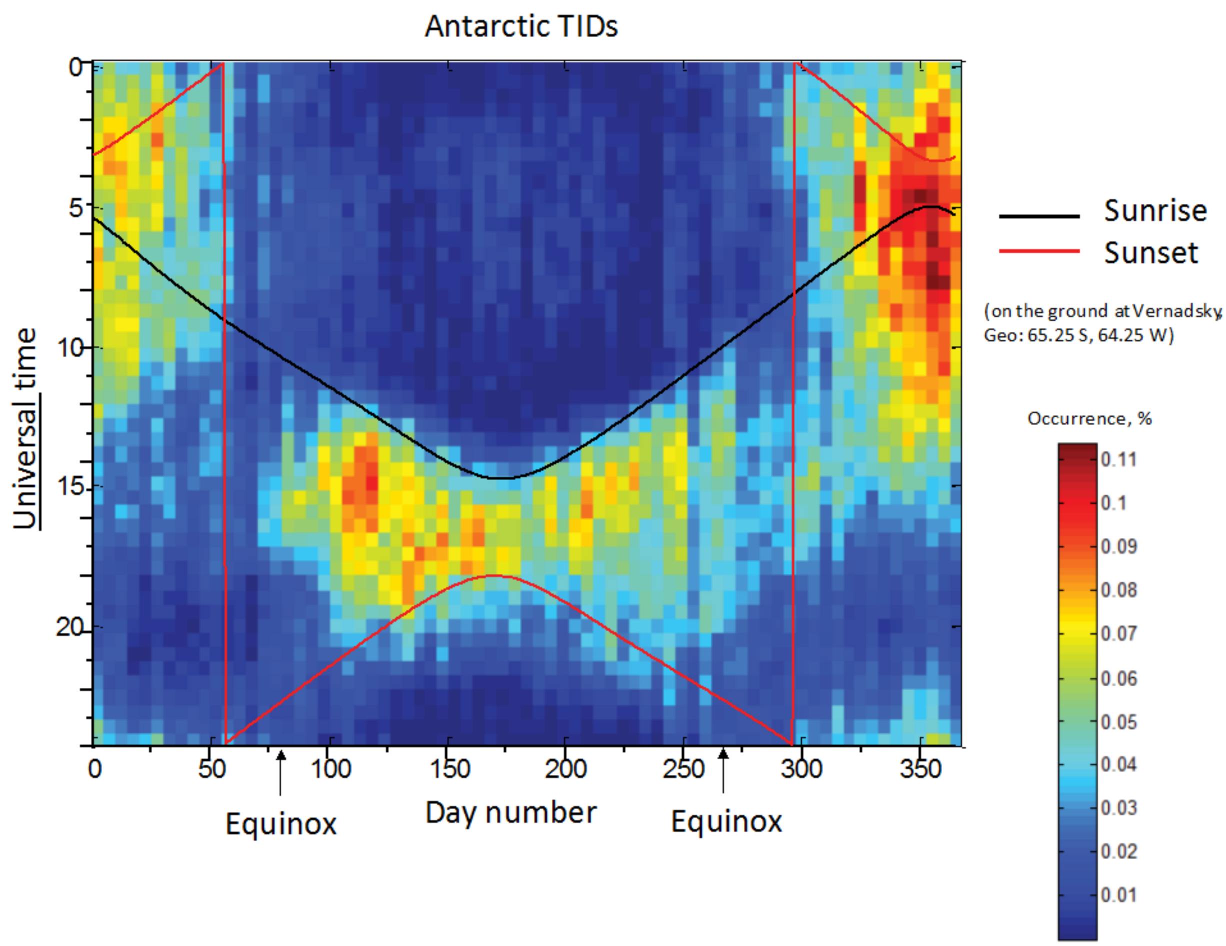

Figure 1. Statistic of TID occurrence in the Antarctic Peninsula region. During the wintertime (June-August) disturbance statistics is determined by the solar terminator (black and red lines). During the summertime, the presence of the disturbances is largely correlated with the background electron density.

Analysis of the direction of propagation of TIDs also revealed a surprisingly regular behavior, for example, under quiet geomagnetic conditions, TID direction is strongly controlled by the neutral wind direction, which displays a very repetitive pattern from day to day throughout the entire year. This can possibly be explained by the neutral wind filtering effect in the lower ionosphere, which is demonstrated by the near perfect correlation of the measured TID direction and direction of the neutral wind flow modelled with the TIEGCM model.

Results of this study suggested further investigation into the disturbance characterization in the Antarctic Peninsula region. With that objective, a bistatic HF system was installed in 2015 at Vernadsky and Palmer stations. In addition, an advanced GNSS receiver, Septentrio PolaRx Pro equipped with interference-suppression Choke ring antenna was installed in June 2015 at Palmer station. A significant advantage offered by this system is ability to monitor Glonass and Galileo satellites, which makes it possible to greatly improve the regional coverage at this location thanks to the higher inclination of those satellites. Also, availability of the raw data and control of the operational modes makes it possible to achieve an accurate calibration of TEC data and allows reconstruction of the absolute TEC values which are important for the analysis of the changes in background ionosphere during the period of observations. Another benefit provided by the new system is possibility of measuring the intensity of the ionospheric scintillations. The first light results collected by Septentrio system are presented and contrasted with other simultaneous measurements.

Key words: GNSS diagnostics, travelling ionospheric disturbances, gravity waves.

References:

[1] Galushko, V.G., Sopin, A.A., Yampolski, Y.M., (2014). Diurnal variations of the parameters of ionospheric disturbances as derived from TEC measurements over the Antarctic Peninsula, Telecommunications and Radio Engineering, Volume 73, Issue 4, Pages 353-373, doi: 10.1615/TelecomRadEng.v73.i4.50