Geophysical Research Abstracts
Vol. 16, EGU2014-3435, 2014
EGU General Assembly 2014

Arrival of a tongue of ionization in the nightside polar ionosphere and effects on GPS scintillation

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In this case study we present findings of Global Positioning System (GPS) scintillation in relation to the arriving front of a tongue of ionization in the nightside polar cap over Svalbard. We find almost no amplitude and some phase scintillation in relation to the leading density gradient, which is interpreted as "false" refractive scintillation due to suboptimal data detrending, as opposed to diffractive scintillation from decametre-to-kilometre-scale irregularities.

During active geomagnetic conditions, high-density plasma may convect into and across the polar cap. The plasma may be segmented into F region polar cap patches upon entry in the cusp/cleft region, or it may form a continuous tongue of ionization when no such segmentation occurs.

Large-scale ionospheric plasma structures such as polar cap patches may contain decametre- to kilometre-scale irregularities, particularly at the edges. Irregularities of these scale sizes cause problems for global navigation satellite system (GNSS) signals, causing amplitude and phase variations known as scintillations. A drawback of most high-latitude GNSS scintillation studies is the use of a 0.1 Hz detrending filter cutoff frequency, which in the literature has been shown to cause "false" phase scintillation.

In the literature, much of the high-latitude scintillation research is statistically oriented and concerns polar cap patches. Scintillation directly in relation to ionization tongues is far less studied. We present findings of GPS scintillation in relation to the arriving front of a tongue of ionization on 31 October 2011 in the nightside polar cap over Svalbard, using GPS scintillation and total electron content (TEC) monitors, the EISCAT Svalbard Radar (ESR), and an optical all-sky airglow imager. To our knowledge, this is the first study presenting such detailed multi-instrument data of scintillation in the Svalbard region as well as taking into account the problems of a 0.1 Hz detrending cutoff filter.