

# ANTARCTIC SCINTILLATION FROM SOLAR CYCLE 24

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## Abstract

This paper presents recent multi-instrument observations in the Antarctic to illustrate the distribution and frequency of scintillation during both quiet and storm-time conditions during solar cycle 24. Scintillation data from multiple GPS receivers in the Antarctic have been incorporated into the Madrigal database, and a statistical study based on this data will be presented. During storm-time conditions, multiple tongue of ionization (TOI) events have been observed that show scintillation associated with large TEC gradients. Scintillation is also clearly associated aurora. To illustrate this correlation, scintillation data from several Antarctic receivers have been overlaid on top of GPS TEC maps, and separately, on top of all-sky camera images showing evidence of aurora. Data from multiple geomagnetic storms in this solar cycle will be presented, incorporating results from numerous other data sources including SuperDARN, COSMIC, and DMSP.

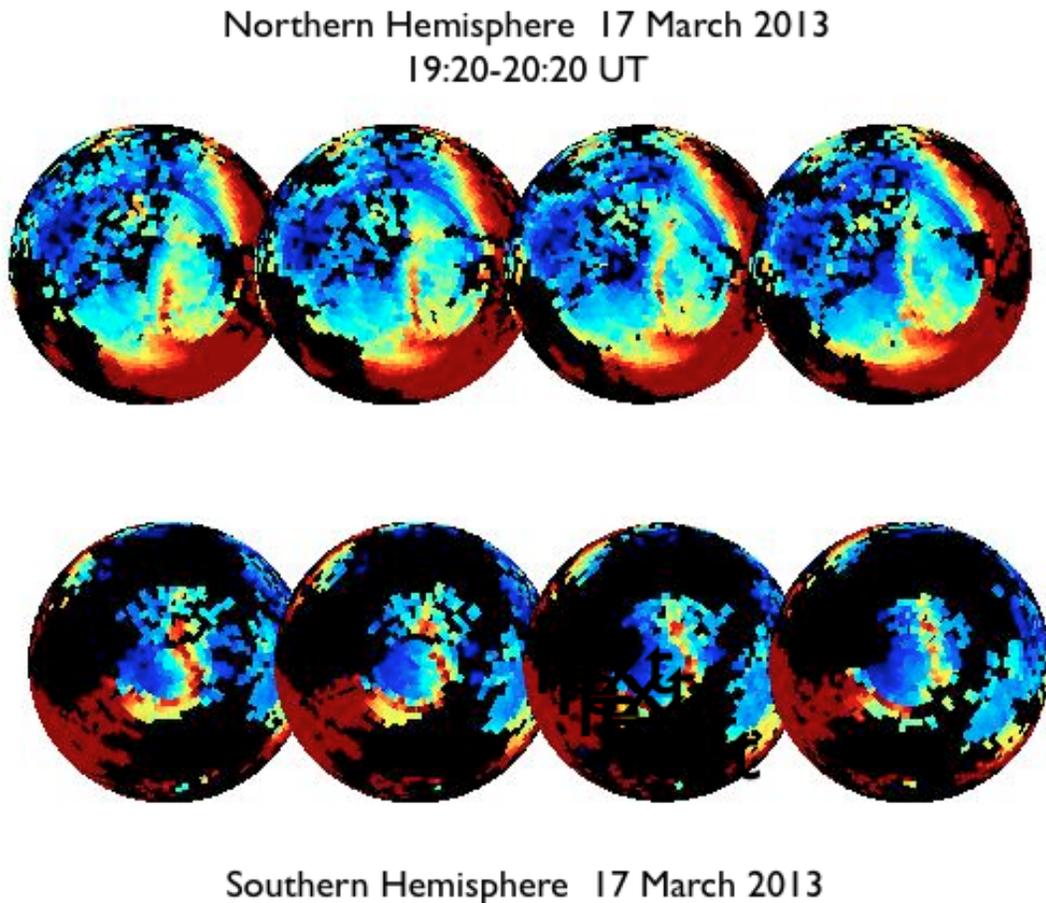
## 1. Introduction

During recent 2011-2013 geomagnetic storms, several tongue of ionization (TOI) events have been observed with polar maps of total electron content (TEC) derived from the global network of GPS receivers. Prior to this solar cycle, GPS receivers were relatively scarce in the Antarctic, and observations of the TOI over the South Pole were lacking. The TOI, as observed by GPS, extends through the dayside cusp, across the polar cap to the nightside, in both hemispheres. The TOI is a source of ionospheric irregularities and its distribution across the high latitude ionosphere is controlled by plasma convection. The focus in this talk is on southern hemisphere, and we will utilize SuperDARN HF radar observations of the high- latitude convection pattern overlaid onto TEC polar plots. SuperDARN HF measurements allow us to measure drifts and velocity shears and to monitor the development of decameter irregularities. We present the locations where HF scatter is observed in the presence of TOI plumes. In addition, we overlay observations of scintillation collected by specially equipped GPS receivers at the South Pole and at McMurdo. We explore the similarities between TOI events observed simultaneously in both hemispheres and also examine the time history of the gradients and irregularities.

## 2 DATA EXAMPLES

Data from one of the large geomagnetic storms in this solar cycle, 17 March 2013, is shown here. There were two periods of significant activity. The first period was relatively early in the day. Between 6 and 8 UT, the KP was 6.7, and at 10 UT, the DST

index dropped to -89. Later, between 18 and 20 UT, the KP was again 6.7, and the DST index dropped to -116. Figure 1 shows the total electron content (TEC) derived from the network of ground-based GPS receivers over both the north and south pole on this day, starting during the second period of geomagnetic activity, between 19:20 and 20:40. Each plot represents a 20 minute average. As can be seen in GPS TEC maps shown, TOIs are observed in both hemispheres with very similar structure. The base of the TOI plume however remains fixed in geographical longitude. This is most evident in the last southern hemisphere plot where the base of the plume remains fixed over Argentina. The significance of this semi-fixed position to the local geomagnetic field will be discussed.

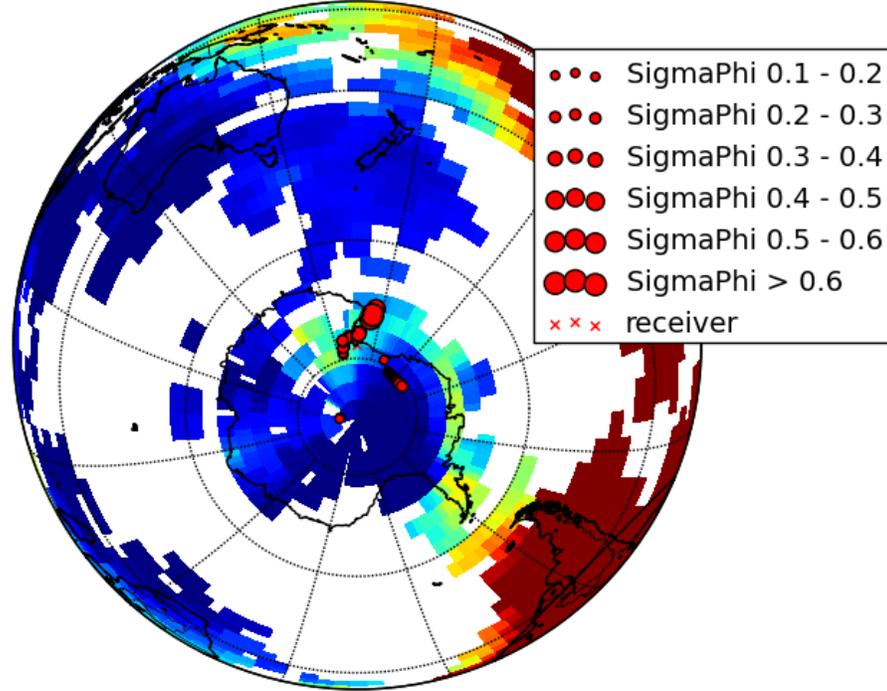


***Figure 1. GPS TEC data merged to produce images of the Tongue of Ionization (left) and polar cap patches (right) over both the North and South Poles during the recent 17 March 2013 geomagnetic storm.***

Figure 2 shows the observed GPS phase scintillation from special scintillation receivers

in the presence of the TOI on 17 March 2013. There is a strong correlation with the TOI and the measured phase scintillation.

Phase scintillation/TEC map for 2013-03-17 21:21:46 - 2013-03-17 21:41:46



*Figure 2. Merged GPS scintillation and GPS TEC TOI observations*

### 3 SUMMARY

We will provide an in-depth analysis of Antarctic scintillation during specific storm-time periods during this solar cycle. We will also describe the scintillation database that we have incorporated into the Madrigal database, and the new tools available for merging the SuperDARN, GPS TEC data, and GPS scintillation observations. A statistical summary of all observed scintillation will be presented.