Statistical and Case Studies of Open Closed Boundaries (OCB) using ULF Wave Observations from Antarctic AGOs, McMurdo Station, and South Pole Station

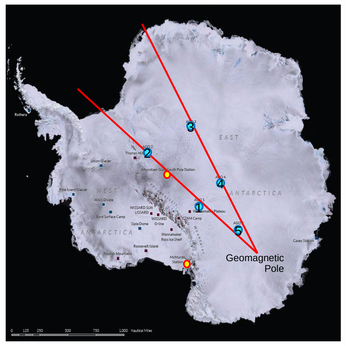
Abstract

We present a statistical study using ground magnetometer data from the Antarctic Automated Geophysical Observatories (AGOs) to characterize open- closed boundary (OCB) behavior during geomagnetically quiet times. Knowledge of the location and dynamics of the magnetic field line OCB provides insight to space physics processes such as sub storms, particle precipitation events, and magnetospheric configuration. Prior studies have shown that determination of the OCB location can be made by examining the ULF wave power in data from a latitudinal chain of ground-based magnetometers extending from the auroral zone into the deep polar cap. In this statistical study, AGOs 1, 2, 3, and 5, along with McMurdo (MCM) and South Pole Station (SPA) were studied. The seasons chosen were centered around the four cardinal dates, March 20th, June 21st, September 22nd, and December 21st.

For each season, 60 days were selected centered around the cardinal date; any days with a planetary Ap greater than 30 were discarded. Using the H- component fluxgate data from South Pole Station, McMurdo Station and the AGO systems, an average daily residual power spectra was calculated. The spectrograms for SPA, MCM, and AGO show signatures of whether the station is located in an open or closed magnetic region. We will present case studies of individual days and a climatology of ULF activity as a function of season.

Station Locations

The Polar Engineering Development Center (PEDC), at NJIT, operates and manages geospace instruments at South Pole Station (SPA), McMurdo Station (MCM), Palmer Station, and at the Automatic Geophysical Observatories.

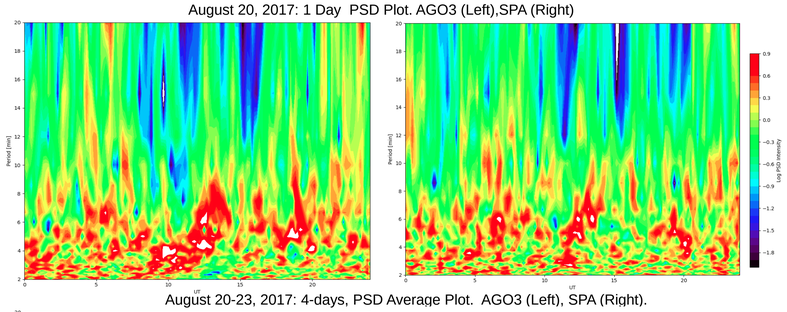


These sites are unique in that they:
- Are located over an expansive region
- Are conjugate w/Northern Hemisphere
- Are the only sites on Earth with coverage into the deep polar cap.

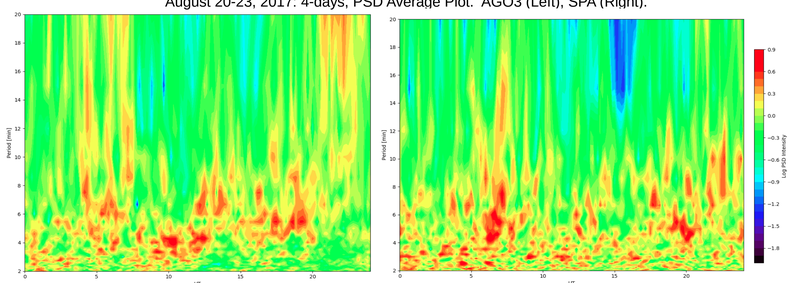
While equipment stationed at the manned locations allows for reliable data transmission, the remote AGO systems must rely on Iridium contacts.

Quiet-time PSDs with various time-scale:

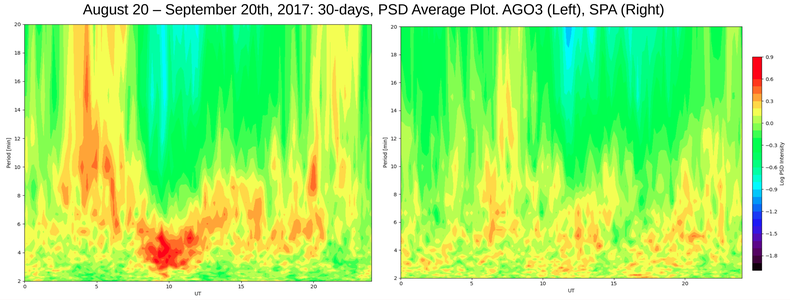
August 20, 2017: 1 Day PSD Plot. AGO3 (Left),SPA (Right)

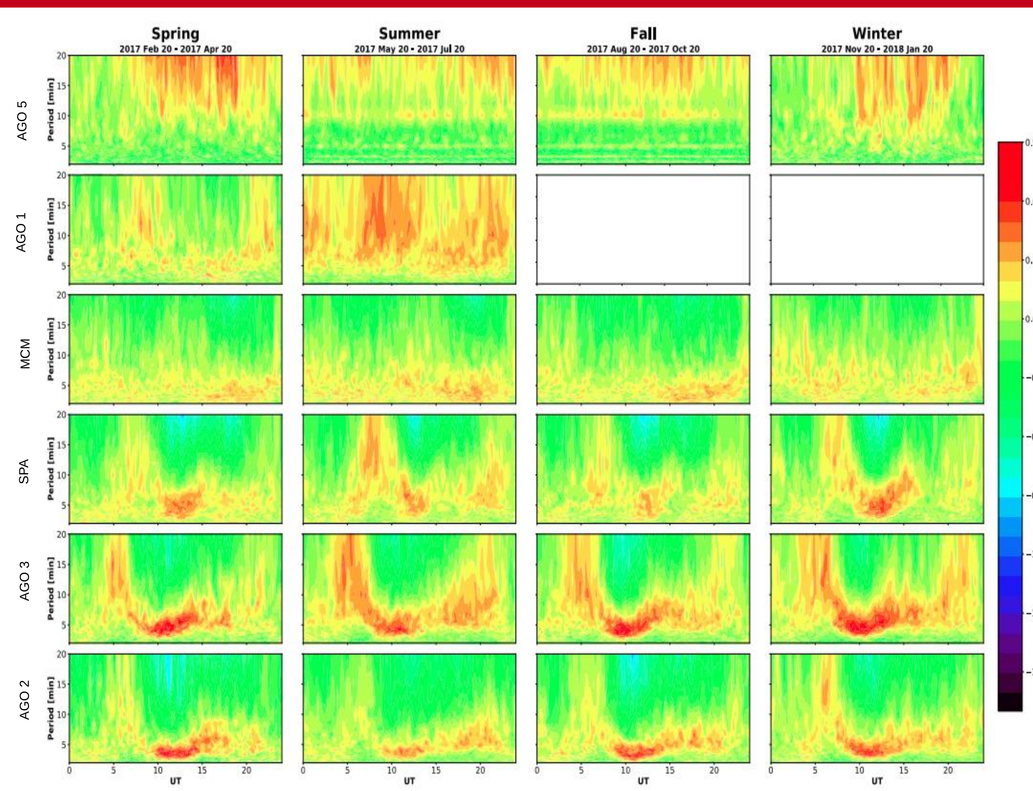


August 20-23, 2017: 4-days, PSD Average Plot. AGO3 (Left), SPA (Right).



August 20 – September 20th, 2017: 30-days, PSD Average Plot. AGO3 (Left), SPA (Right)

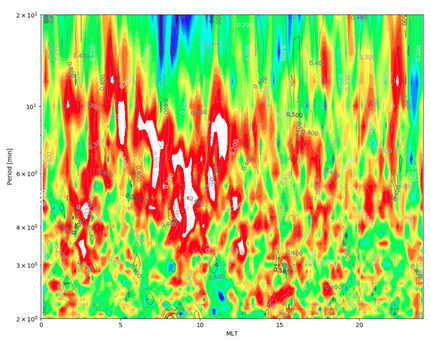




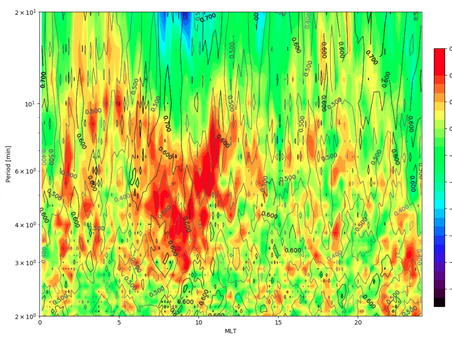
(Left) A selection of climatology data for the South Pole Station and AGO 3 during Fall 2017. The plots show how averaging the quiet time days influence the spectrograms. Data is presented for 1 day, 4-day average, and 30-day average.

(Top) The climatology during quiet time for AGO2, AGO3, SPA, MCM, AGO 1, and AGO2.

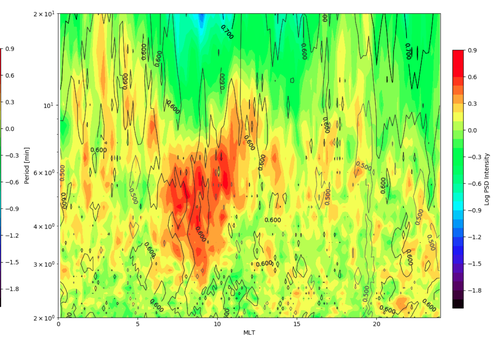
Quiet Time PSDs with Standard Deviations



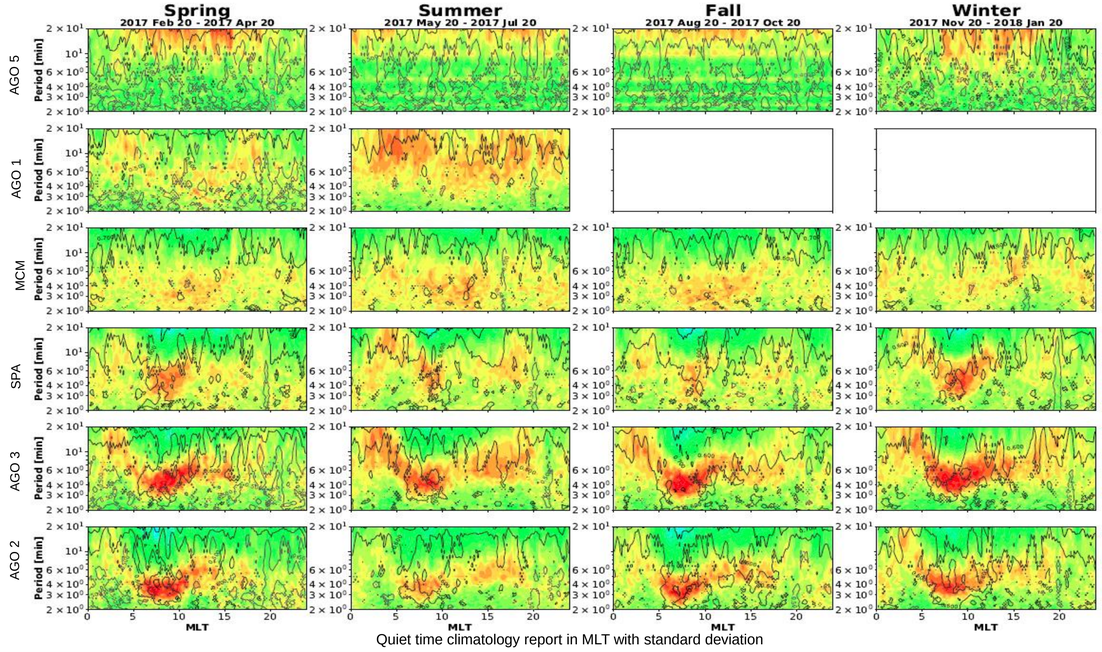
Quiet time averages for 1-day PSD plot for South Pole Station in Spring 2017 with standard deviation lines.



Quiet time averages for 7-days PSD average plots for South Pole Station in Spring 2017 with standard deviation lines.



Quiet time averages for 30-days PSD average plots for South Pole Station in Spring 2017 with standard deviation lines.



Quiet time climatology report in MLT with standard deviation

CONCLUSIONS: As per *Urban et al.* [2011], synoptic fluxgate data can be used to identify the location of the OCB in a particular magnetic sector, which is most prevalently seen at AGO2, AGO3, and SPA. We are currently quantifying these OCB locations with band integrated data, with thresholding from AGO5 to account for the influence of solar wind ULFs. There is seen to be greater variability in ULF data on the dusk-midnight section, likely due to ULFs as per *Cooper et al.* [2018]. Barring Iridium transmission issues and AGO power system concerns, the technique shows great potential for locating the OCB all year long, with an array of relatively simple instruments. Inclusion of other fluxgate magnetometers would further constrain the OCB location.

Time Conversions: Universal Time (UT) – Magnetic Local Time (MLT)

Station	UT-MLT
AGO5	2:52
AGO1	3:44
MCM	6:57
SPA	3:35
AGO3	2:02
AGO2	3:29

THE UNIVERSITY OF SCRANTON A JESUIT UNIVERSITY

Rachel Frissell, Andrew Gerrard (gerrard@njit.edu), Hyomin Kim, and Nathaniel Frissell

University of Scranton, Scranton, PA and Center for Solar-Terrestrial Research, New Jersey Institute of Technology, Newark, NJ, USA.

Acknowledgement: The work presented here was supported by the National Science Foundation Office of Polar Programs (PLR-1247975 and PLR-1443507) which partially supports AGO field operations on the Antarctic plateau.