Wavelet-Based ULF Pulsation Index for Studying Conjugate ULF ~~Pulsation~~ at High Latitudes and Its Applications to Space Weather

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AGU FALL MEETING San Francisco | 12–16 December 2016

GP31C-1316: 08:00-12:20, December 14, 2016
Moscone South Poster Hall, San Francisco, CA

Abstract

A wavelet-based index is described in this study and applied to present geomagnetic Ultra Low Frequency (ULF) pulsations observed in Antarctica and their magnetically conjugate locations in West Greenland. The index is effective for identification of pulsation events in the Pc4-5 frequency range, which is related to ~~the~~ Geomagnetically Induced Currents (GICs) ~~shown by many researchers~~, and measures important characteristics of ULF pulsations in both the temporal and frequency domains. We discuss how the wavelet indices can be used to monitor geomagnetic pulsations in both hemispheres simultaneously. The wavelet analysis shows valuable information for GIC- related studies, including the spectrum, correlation, and magnitude of the geomagnetic pulsations. The comparison between conjugate locations reveals the similarities and differences of ULF pulsations in both hemispheres. Also, since the Greenland chains are located near the coastal area, while the Antarctic chains are over thousands meters of the ice-sheet on the East Antarctic plateau, inter-hemispheric comparisons of vertical magnetic field perturbations can be used to reveal how sensitive ULF pulsations are to ground conductivity.

I. Introduction

Geomagnetic pulsations:

Ultra-low-frequency (ULF), ~~lower than the natural frequencies of the plasma, like plasma frequency and the ion gyrofrequency,~~

Typical classification scheme (Jacobs et al., 1964):

Pulsation Classes							
	Continuous pulsations					Irregular pulsations	
	Pc1	Pc2	Pc3	Pc4	Pc5	Pi1	Pi2
T	0.2-5s	5-10s	10-45s	45-150s	150-600s	1-40s	40-150s
f	0.2-5Hz	0.1-0.2Hz	22-100mHz	7-22mHz	2-7mHz	0.025-1Hz	2-25mHz

Geomagnetically-induced currents (GICs)

GICs are produced by a naturally induced geo-electric field during geomagnetic disturbances. which ~~flowing~~ along electric power-transmission ~~systems~~ and other electrically-conducting infrastructure. ~~AS~~ an extreme example, during the great magnetic storm of March 1989, these currents caused wide-spread blackouts across the Canadian Hydro-Quebec power grid, resulting in the loss of electric power to more than 6 million people (Allen, 1989, Thomson, 2010).

II. Data and Method

Fluxgate Magnetometer DATA

Autonomous Adaptive Low-Power Instrument Platform (AAL-PIP), operated by Magnetosphere - Ionosphere Science Team (MIST) Group at SPACE@VT (http://mist.nianet.org/).

West-Coast Greenland ground network. Operated by DTU Space (http://www.space.dtu.dk/English/Research/Scientific_data_and_models/Magnetic_Ground_Stations.aspx)

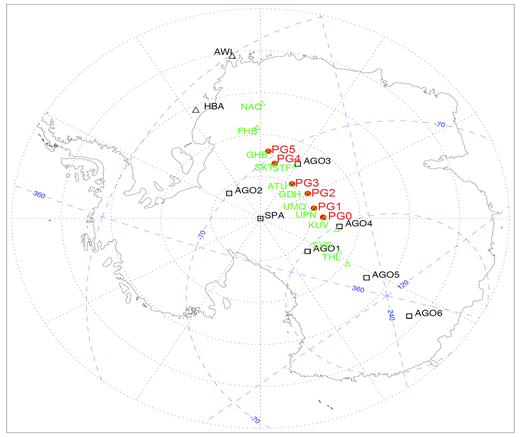

Fig 1. Antarctic 40 Degree Magnetic Meridian Chain (AAL-PIP） Operational sites are shown in red. Magnetic conjugate locations in Greenland are marked in green.

Wavelet Analysis

~~It allows decomposing the~~ geomagnetic data into ~~the~~ different frequency bands ~~which~~ still ~~keep~~ localized time-varying features. This ~~provides the possibility~~ to separate the variations according to the frequency bands of their drivers which ~~are from the current systems in ionosphere and magnetosphere.~~

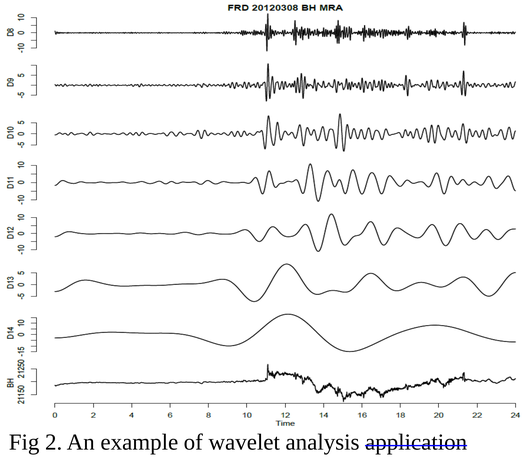

Fig 2. An example of wavelet analysis ~~application magnetometer data.~~

III. Results: examples of wavelet-based indices on conjugate ULF pulsations caused during SI events on 20130119

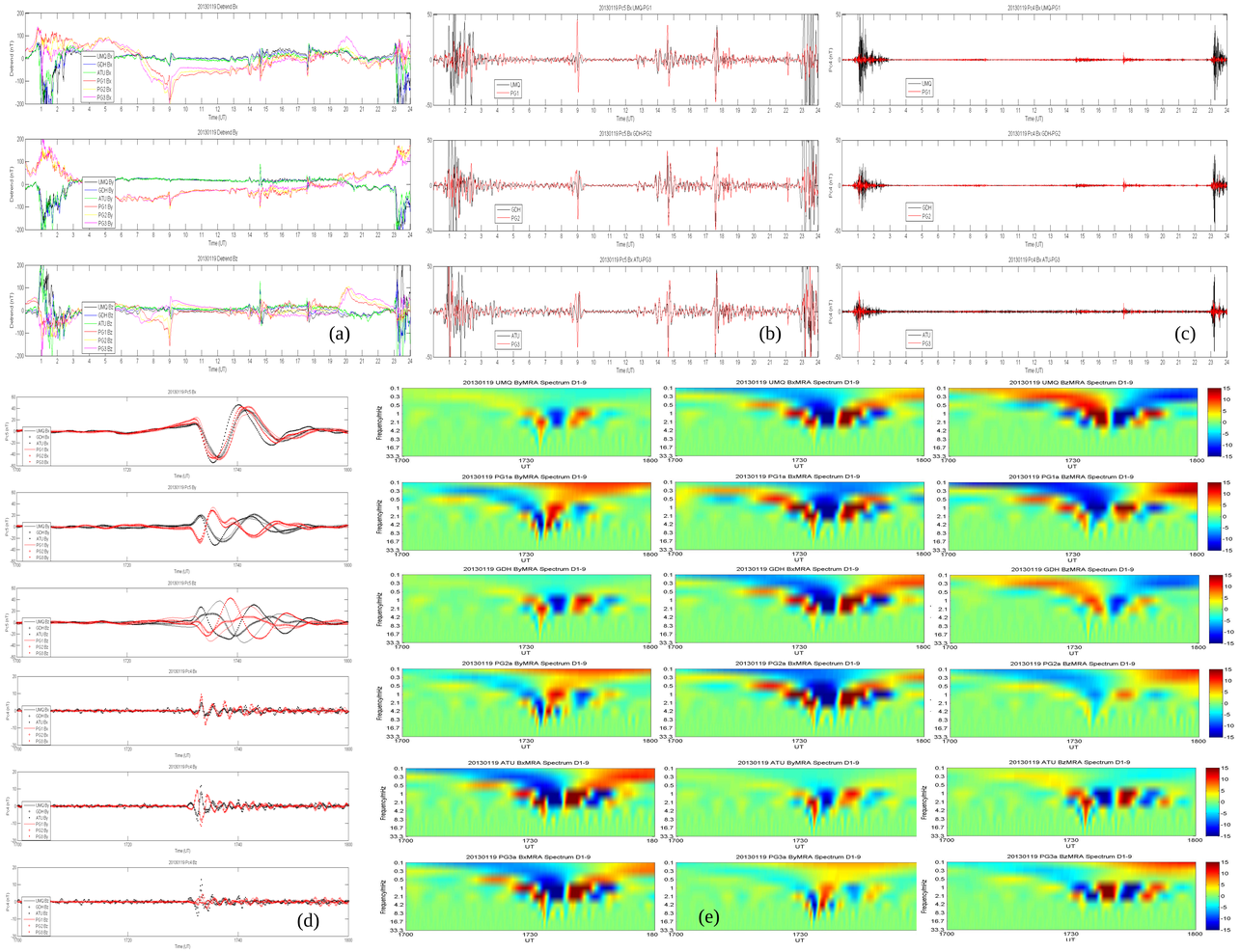

Fig 4. (a) original magnetic fields; (b) PC5 frequency range pulsations; (c) PC4 frequency range pulsations; (d) Zoom-in for the SI event periods from 1700-1800UT; (e) Details of spectra comparisons.

IV. Discussion and conclusion

1. The results indicate that the wavelet-based index of (ULF) pulsations is effective for identification of pulsation events in the Pc4-5 frequency range in both hemispheres. It presents important characteristics of ULF pulsations in both the temporal and frequency domains for inter-hemispheric comparisons at conjugate locations.
2. The comparison of geomagnetic pulsations in both hemispheres simultaneously reveals the similarities and differences of ULF pulsations in both hemispheres. ~~Especially, vertical magnetic field (Bz) perturbations were observed more evidently,~~ since the Greenland chains are located near the coastal area, while the Antarctic chains are over thousands meters of the ice-sheet on the East Antarctic plateau.
3. Using additional observations and simulations, ~~,~~inter-hemispheric comparisons can be used to reveal how sensitive ULF pulsations are to ground conductivity, further more, applied to space weather monitoring.

V. Acknowledgement

This research is supported by the National Science Foundation through the following awards: ANT-0839858 and EAR-1520864. The Antarctic instrumentation for this research has been supported by the National Science Foundation through a Major Research Infrastructure (MRI) grant ATM-922979 and grant PLR-1243398 has supported the stations operations and the research. Thanks to DTU Space for the geomagnetic data from West Greenland Chains.