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Schumann Resonance Monitoring in Hornsund (Spitsbergen) and Suwałki (Poland)

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1. INTRODUCTION

Schumann resonances are resonances of electromagnetic waves in the Earth-ionosphere cavity, and were first predicted and discussed by W.O. Schumann (1952). They are excited by world-wide thunderstorm activity. Maximal amplitudes (modes) can be observed at around 8 Hz, 14 Hz, 21 Hz, and so on. Monitoring of Schumann resonances provides information about properties of the lower ionosphere, world thunderstorm activity, and global climatic change.

2. LOCATIONS AND SITE DESCRIPTION

Locations of Schumann resonance stations maintained by IG PAS are shown in Fig. 1. First Schumann resonance observations by IG PAS were initiated at the Polish Polar Station Hornsund (Spitsbergen) in 2004. This was an outcome of a joined Polish-Hungarian NATO project (2003-2005, EST.CLG.980431). The Hornsund experience led to development of a second set of instruments which was installed in Belsk Observatory (Poland) in 2005. In 2016 this apparatus has been moved to a National Park close to Suwałki because of a significant increase of artificial disturbances in Belsk. The Suwałki station works to date. Basic information about these three stations is listed in Table 1.

3. APPARATUS

Monitoring of Schumann resonances in our three sites is performed by means of induction coil magnetometers and electric ball antennas. Induction magnetometers are used for measurements of the magnetic horizontal components, and the electric antenna (Fig. 2) measures the vertical electric component.

The magnetometer consists of two induction coils, one per horizontal component, and an electronic console for amplification and filtration. Examples of system responses for a magnetic component are shown in Fig. 3.

All apparatus for SR observations was constructed and developed in Central Geophysical Observatory at Belsk in the early 2000s. Measurement of electric component ceased to be continued for Hornsund in 2013 and for Belsk in 2016.

Table 1
Description of three SR sites (Belsk, Hornsund, and Suwałki)

	Belsk	Hornsund	Suwałki
Station code	BEL	HRN	SUW
Latitude [deg]	51.835 N	77.000 N	54.012 N
Longitude [deg]	20.789 E	15.550 E	23.183 E
Elevation [m]	173	15	150
Start date	2005-02-21	2004-09-11	2016-06-19
End date	2016-05-03	---	---
Components	Bx, By, Ez	Bx, By	Bx, By

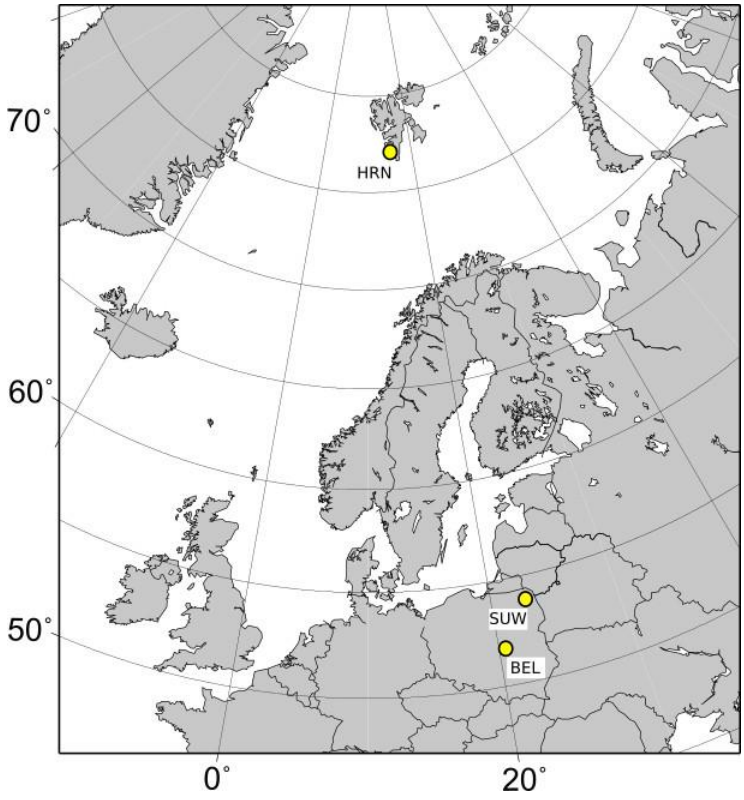

Fig. 1. Locations of SR stations.

Fig. 2. Electric antenna in Hornsund.

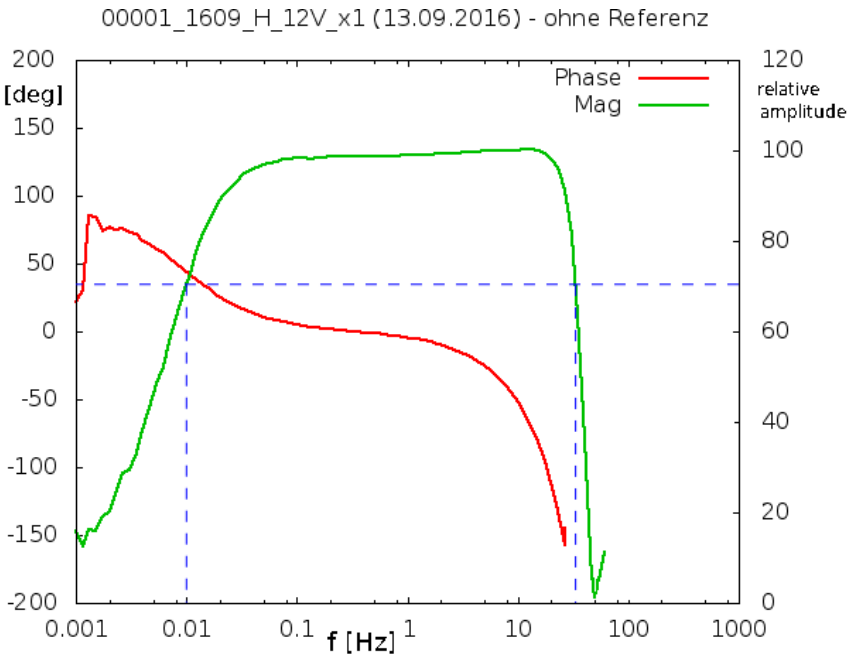

Fig. 3. System response for Bx component (HRN).

The sampling frequency is 100 Hz for all stations. For recording we use a 24-bit NDL data logger equipped with GPS module and Ethernet interface. The NDL logger has been developed in IG PAS, too.

4. DATA TRANSFER AND QUALITY CONTROL

Data from all three stations are automatically transferred (every 5 minutes) via Internet (VPN connection) to IG PAS servers located in Belsk and Warsaw. Then (also automatically) raw data are converted to daily DDF files. Binary DDF format is used for geomagnetic and magnetotelluric data in our institute. We have a lot of tools for edition, visualization, filtration, rotation and other operations on data in DDF format. Every day we check spectrograms for SR stations on our internal web pages. Examples of power spectra are shown in Fig. 4.

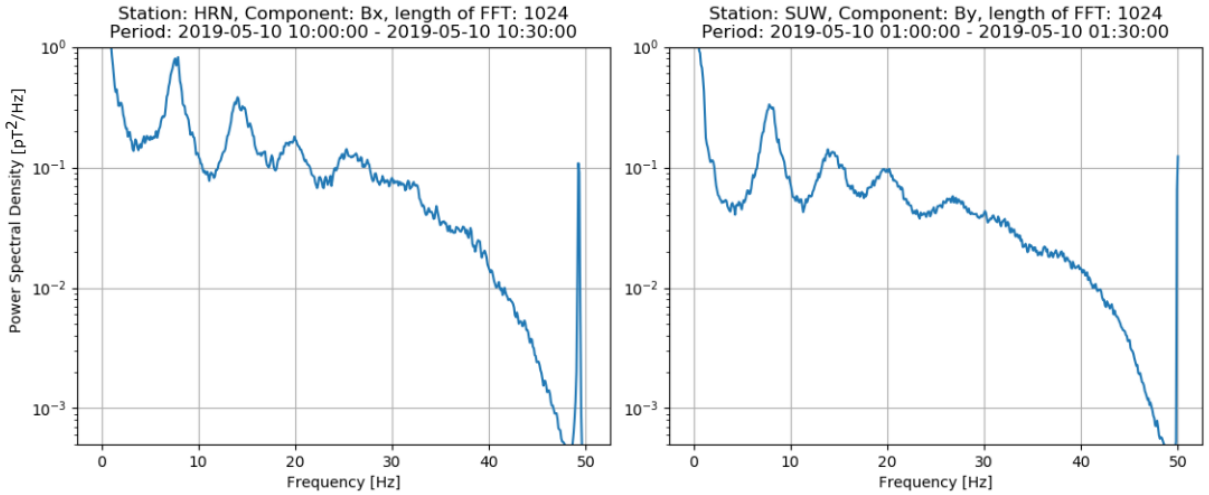

Fig. 4. Example power spectra for Hornsund and Suwałki.

5. USAGE OF SCHUMANN RESONANCE DATA FROM IG PAS STATIONS

First observations of the Schumann resonance phenomenon in Belsk and Hornsund were described by Neska and Sátori (2006). Various applications including data from our Schumann resonance stations can be found in Neska (2007), Sátori *et al.* (2007), Sátori *et al.* (2012), Nickolaenko *et al.* (2014), and Williams *et al.* (2014).

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OBSERWACJE REZONANSU SCHUMANNA W HORNSUNDZIE (SPITSBERGEN) I W SUWAŁKACH (POLSKA)

Streszczenie

Rezonans Schumanna jest to zjawisko rezonansowe fal częstotliwości ELF propagujących się w naturalnej wnęce rezonansowej uformowanej między powierzchnią Ziemi a dolną jonosferą. Źródłem rezonansu Schumanna jest globalna aktywność burzowa. Pierwsze obserwacje zjawiska rezonansu Schumanna w IGF PAN rozpoczęto w roku 2004 w Polskiej Stacji Polarnej w Hornsundzie w ramach wspólnego, polsko-węgierskiego projektu NATO (2003-2005, EST.CLG.980431). Doświadczenia z Hornsundu zaowocowały wykonaniem drugiego zestawu aparatury, który został zainstalowany w 2005 r. w obserwatorium w Belsku. Z powodu znacznego wzrostu sztu-cznych zakłóceń w paśmie ELF w roku 2016 zdecydowano się przenieść aparaturę z Belska do stacji w Suwałkach, która znajduje się na terenie Wigierskiego Parku Narodowego. Aparatura do obserwacji zjawiska rezonansu Schumanna została w całości opracowana i wykonana w IGF PAN. Składa się ona z magnetometru indukcyjnego mierzącego składowe poziome ziemskiego pola magnetycznego oraz anteny elektrycznej do pomiaru składowej pionowej pola ele-ktrycznego. Dane pomiarowe z Belska, Hornsundu i Suwałk wykorzystywane są w licznych pracach naukowych dotyczących m.in. badania zmian klimatycznych na Ziemi, wyznaczaniu parametrów dolnej jonosfery oraz obserwacji globalnej aktywności burzowej.