TEMPORAL AND SPATIAL VARIATIONS OF DISCRETE MAGNETOSPHERIC OSCILLATIONS DETECTED BELOW 1mHz

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ABSTRACT

Low frequency geomagnetic pulsations are detected below 2 mHz, using the underground ultra low-noise 3D superconducting magnetometer system [SQUID]² (SQUID with Shielding QUalified for Ionosphere Detection) in the Laboratoire Souterrain Bas Bruit in Rustrel (LSBB - France). The detection of the Earth's eigen modes in the magnetic quiet background of the ionosphere has been established [1] but other ultralow-frequency waves in the magnetosphere have been also observed below 1 mHz.

Independently of the nature and the origin of these waves, analysis of the magnetograms has been performed using 3 techniques: the Fast Fourier Transform (FFT) and Discrete Fourier Transform (DFT) and the Stockwell Transform (ST), extension of the short time Fourier Transform and a variant of the continuous wavelet transform. The analysis is made for 72 consecutive hours in absence of major earthquakes and magnetic storms.

The results show that the FFT and DFT analyses provide a global signature of these discrete waves; the ST analysis clearly shows that oscillations of modes occur at different times and that the duration of their excitation period is daily dependent. A good agreement of the results is obtained by these techniques showing this complementary approach is interesting to evidence the spatial and temporal variations of magnetospheric oscillations.

Figure 1 shows the Stockwell results for the NS component. The coloured zones correspond to the excited frequencies in this time period, more (red) or less (blue). Among the set of frequencies, some of them can be attributed to the Earth's modes: in this range, the 0T2 mode at 0.379 mHz (green line) and the 1S2 mode at 0.679 mHz (red line) are well separated. For these 2 modes, the time-variations of the amplitude of the Stockwell transform is detailed in panels c) and d).

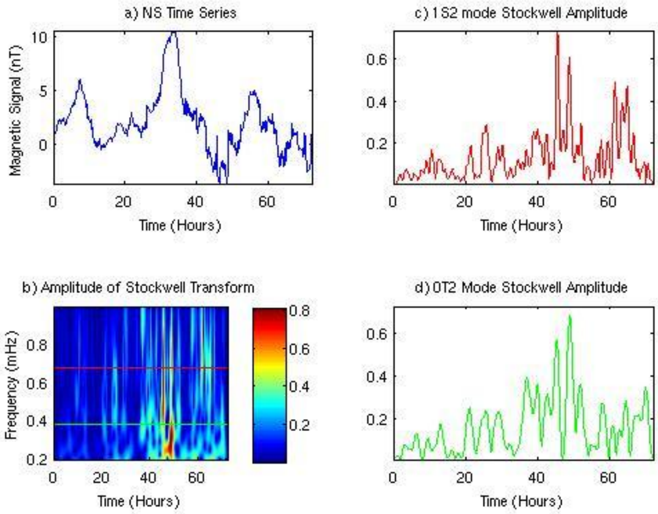

Fig. 1: Stockwell results for the NS component
(a) shows the variations of the NS geomagnetic field amplitude during 72 consecutive hours ;
(b) is the amplitude of the Stockwell transform showing the set of excited frequencies in the range 0.2 to 1 mHz ;
(c) shows the amplitude of the Stockwell transform of the 1S2 mode at 0.679mHz (red line in Fig. 7b) and its time variation;
(d) shows the amplitude of the Stockwell transform of the 0T2 mode at 0.379 mHz (green line in Fig. 7b) and its time variation.

The peaks of the plots (c and d panels) clearly indicate the excitation time and duration of each mode, with its associated intensity. The maximal excitation of these 2 modes occurs at different times and the duration of their excitation period is different. Similar analysis can be performed for other dominant modes for each magnetic field component, showing a possible time-detection of the Earth's modes during a quiet seismic and magnetic period.

The origin of the resonances lower than the Earth modes remain unclear but several hypotheses can be evoked as for example atmospheric pressure effects or tide influence. Besides, it is not excluded that some influence of the internal metallic (Fe and Ni) Earth inner core fluctuations can be detected by [SQUID]². However, beat frequencies can be speculated as resulting from free mode interference and characterized by the simple difference between two close frequencies that can be easily identified from the calculated PREM values. Implicitly, interference exists if the waves present similar amplitude and frequencies. Following this hypothesis, the free oscillation modes detected on each component can produce interference which can be recorded by [SQUID]² on the same component.

REFERENCES

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