Solid Earth Discuss., 4, C95–C100, 2012
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Solid Earth Discussions

SED
4, C95–C100, 2012

Interactive Comment

Interactive comment on "Geomagnetic jerks characterization via spectral analysis" *by* B. Duka et al.

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1. It is true that our paper has to report a large amount of exploratory work, and there was more exploratory work that reported here! As the referee said it would be preferable "to condensate the description of the exploration, summarised what combination of filtering and spectral analysis you found most useful, and then given more attention to explaining clearly just what characteristics of the resulting spectra you were using to identify jerks". We think the situation is not the same for all three methods used: STFT, DWT and SHPS. The most problematic is the STFT method, for which we tried to show its drawback for jerk detection and we tried to improve its results by applying it firstly to the SV monthly value series, a de-noising process that uses wavelet decomposition. Maybe, such an approach has not been clearly described, and we have improved

it. Regarding the DWT method, we try to better summarize it by joining the two parts (section 3.2.1 and Appendix B) in the text.

2. Regarding the question: "I really do not know if you are looking for spectral power maxima (or minima?) at a particular frequency, or some other change of pattern"; we realized that we should better explain that in the case of spectrograms (STFT- method), several jerks are identified by clear separations of the pattern, but it is not possible to distinguish the separation between spectrogram pattern representing two very close events. Some local longer-scale jerks correspond to the peaks of large power maxima.

3. Regarding the comment: "I suspect that you have sometimes misled yourselves by working with graphs that join these points by lines. Similarly the resultant spectra are known at only a few frequencies; again this is camouflaged by the smoothing and contouring of the display process", we have not worked with graphs, but we worked with discrete values in time and frequency. The graphs are used only to show time series, that are long series (50 - 100 values for annual mean series and 600 – 1370 values for monthly series). We think that the resultant spectra are known not at only a few frequencies, but at long series of frequencies (see a more detailed discussion in the point 6. of this reply). It is true that the frequency value increases linearly from 0 to Nyquist frequency, but we cannot say the same for the power spectra values (see the graphs of fig.1). Therefore, we think we have not misled for the reason of smoothing and contouring display process.

4. We agree with the referee's suggestion: "It would be much simpler to remove the algebra and to say something like "we obtain 'annual mean' SV values every month, by subtracting the mean of 12 consecutive monthly values from the mean of the next 12 monthly values". It is true we have produced a 12- month running mean every month and we think this kind of SV estimation is not a new one. In a revised version, we remove the algebra and substitute everywhere (in the legend of fig. 4, etc.) "monthly mean" by "12-month SV values taken every month" or shortly "12-month running average SV". We take care of notations to be clearer about the distinctions between the

values and the density of plotted data.

5. Regarding the comment on fig. 4, it is true that we hardly detect the 1901 jerk.

6. Regarding the comment: "With your 12-month time span, presumably there are only power values at 6 frequencies for each time step. I think you should tell the reader that the plots you publish have been contoured by interpolation." As it can be seen in the Appendix A, the STFT provides a matrix B of complex amplitudes of FFT spectra for each section of the data. While the spectrogram plots present power spectra in dB units calculated for each cell of matrix B. This matrix contains rows in the total number of nfft/2 representing the number of frequencies at each time (each position of window). We chose nfft equal to the number of data in the series (in the case of fig. 4, nfft = 1369 values), so the number of frequencies (number of rows of matrix B) at each time step is 685. The number of columns (the total number of window positions) is (1369-10) /(12-10)= 679. According to the output of Matlab specgram function, the frequency value increases linearly in each column of B, from 0 to Nyquist frequency and the time increases linearly from 0 to the end of data across the columns of B, We have checked the variation of the power spectral values in the columns and across the column (fig 1 of this reply, the units of frequency and time are according to the position in the matrix (row number, column number)). The power content variation by the frequency (in a column) is more smoothed than the power content variation by the time (in a row), but in both cases the graph shifts are not regular and linear. We think these plots support the idea of detection of time localized events by the power spectrum pattern separations. By trials, we found the window parameter (length) 12 as the most effective one to detect the geomagnetic jerks. Using the window parameter 12, does not mean that the data sections of the data input to the FFT is a simple 12 full data, but a long set of data, with their weighting tapering towards zero at the ends. As the vast majority of these data are zero, the STFT method produces heavily smoothed plots as it can be seen figures 2, 3, 4 of our paper. We agree with the referee, we should tell this to the reader.

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7. Regarding comment on page 142, line 19, we have to correct the phrase "it is not possible to distinguish the separation between spectrogram lobes representing two very close different slopes" by the phrase: "it is difficult to distinguish the separation between two very close and sharp V-form changes of SV".

8. The referee is right noting " Monthly values of SVy have been estimated at NGK" , should be corrected. To answer this question let us note that the fortran code of gufm1 model calculates at each time and every place not only the geomagnetic field components, but also the SV of these components. Running the calculation with shifting time of one month, we get the series of SV values taken every month.

9. Regarding the comment: "If these oscillations are some sort of noise, increasing the sampling interval has not reduced this noise! You have chosen a particular start time for your 2.5-year sampling; I am pretty sure that another choice would have moved many maxima/minima by a year or more!". We think that such kind of value oscillations are not evident when using 2.5-year sampling. (see the bottom panel of the fig 2 of this reply, where only one term of SHP Spectrum: R43d term is presented). Shifting the start time of the series, would have the same effect on the distances of jerk occurrences and the graph max. We follow the referee's suggestion to "take time interval of 1 year and use the de-noising technique before plotting the results". The results are presented in the upper panel of the following figure, (the R43d term of spectrum). In the graphs of this panel, there are shown the de-noising results obtained by using Daubechies wavelets of different orders (8, 6, 4) of the same level (3) of signal decomposition. We can see that for a very short series (43 values), the de-noised process strongly depends on order of wavelets and on the threshold chosen in each level of signal decomposition. According to these results, we consider that is better to study the 2.5-year sampling series of Rn 3d terms.

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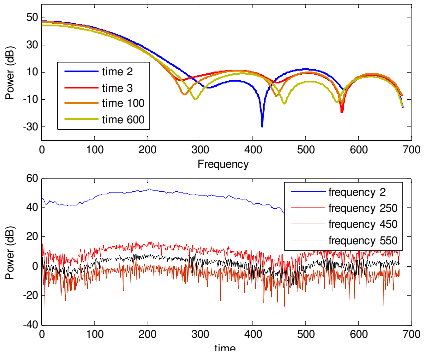

Fig. 1 Power values in dB at 4 different times (upper panel) and at 4 different frequencies (bottom panel)

Fig. 1.

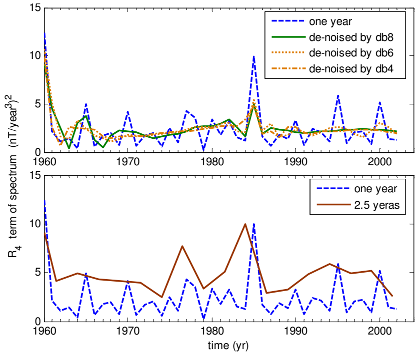

Fig. 2. Spherical power spectral term of degree $n = 4$ at the Earth's surface

Fig. 2.

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