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About of the Digital Geomagnetic Records Processing with Noice

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ABSTRACT

Digital records of the Total Intensity of the Earth Magnetic Field, realized by means of protonic precession sensors per one minute, shows erratic pulses. The criterions of analysis and filtering of these pulses for magnetically quiet days are studied. The more adequates methods had been the one of comparisson of succesive samples, and the filtered method by means of a windows of the median determination.
In this paper, the results for records with ramdom spikes of the Trelew Magnetic Observatory (φ = 43°2683 S; λ = 294°6183) are analyzed.

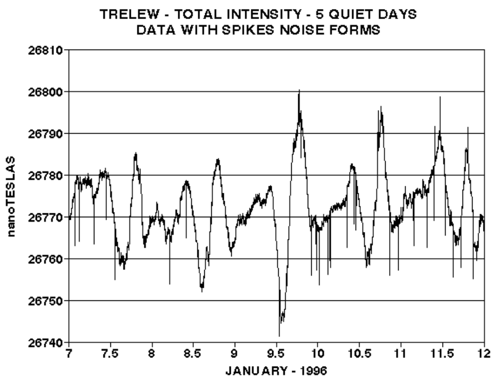
INTRODUCTION

Digital records are a key step in any geomagnetic processing sequence, but one of the most important problems to be resolve is applying adequate filtering techniques to eliminate the random spikes masking the temporal geomagnetic variations with erratic values, not due to natural causes. These spikes can be present individually, but during a day, several times. The pulses are indentified by direct observation on the monitor, but this task is very problematic carrying long time in this process. In this work we will focus on statistical criterions of filtering analysis, and the order for the application of this in a processing sequence to show the adequate software. A reprocessing work was carried out on a geomagnetic total intensity dataset with five magnetically quiet days records at the Trelew magnetic observatory (φ = 43°2683 S; λ = 294°6183), in the period january, 7 to 12 , 1996. The two data filters are: i) median-filter with a move-average window of five points, and ii) cuttoff-filter at 3 nT spike amplitude.
The diurnal variations of the F- total intensity of the Earth´s Magnetic Field represents an important element to correct magnetic surveys on surface (land and ocean) and air surveys. The Worldwide Permanent Magnetic Observatories Net, distribuited non-homogeneously, give this information in ¨rough¨ form, since the protonic precession magnetometer records the absolute value of the Geomagnetic Intensity. These magnetometers are calibrated in different Workshops on Geomagnetic Observatories. Processing calibration is recommended as a tool to minimize amplitude spikes.

DATA ANALYSIS

Figure 1 shows five magnetically quiet days dataset recording at Trelew magnetic observatory (φ = 43°2683 S; λ = 294°6183) in the period 96/1/7-12 (*Rasson et al.*, 1996). Spikes of amplitude about of 30 nT are observed. The corrections for magnetic surveys, that would use this information, will find random pulses or spikes produced by the electronic noise of the instrument, that may become a major problem. The difficulties in detecting such noise emphasizes that a rigorous amplitude and phase preservation scheme must be carried out in the processing stage. In such cases, two methodologies may be able to detect this type of noise. The one produce a cuttoff in k (nT) on the ordinates that satisfy the following relation: (Y (j+1) – Y (j) > k (nT). In this case had been used k = 3 nT, but also it is possible utilize k = 5, 8 or 12 nT when the magnetic activity is major. The lower value of 3 nT had been choosen statistically as the absolute amplitud of the Earth´s Magnetic Field pulsations recorded on magnetograms in analogic form. Therefore, the cuttoff limits are arbitrarily selected. Only after an extensive amplitude calibration work one can gain confidence in this analysis so as to use it as a predictive tool.

FIGURE I SHOWS A FIVE QUIET DAYS DATASET IN TRELEW OBSERVATORY WITH SPIKES NOISE FORMS, WICH OBEY THE RELATION: $|Y_{J+1}\ Y\ J|$ > K(NT), WITH K=3 NT.



The other method consist in using a window of median determination that convolve with the original data series. This method has very good resolution, too. It is possible use windows of 5, 7 or 9 points, but it is better that the points number of the window-filter to be even, forever. (*Bevington*, 1969).

RESULTS AND CONCLUSIONS

Figure 2 and 3 shows the filtered diurnal variations with a cuttoff- filter of 3 nT amplitude (Fig. 2) and a median- filtter of 5 points (Fig. 3).
Figure 3 shows more satisfactory results stablishing that the median-filter smooths much better the spikes on five Q days dataset in 1996, year of low magnetic activity of the 22- solar cycle.
Figure 4 compares both filters (median- and cuttoff in 3 nT- filters) with its differences. It is possible to see that the mean amplitude of the smoothness is ± 0.5 nT, increasing the uncertainty of the digital values in this quantity.
In conclusion, this work shows that the cuttoff method is more appropiate because the filtered time series only will have lower pulses than this amplitude (3 nT). Therefore, this filtered data series will not contain as selection to the median, that itself constitute a data accommodation.

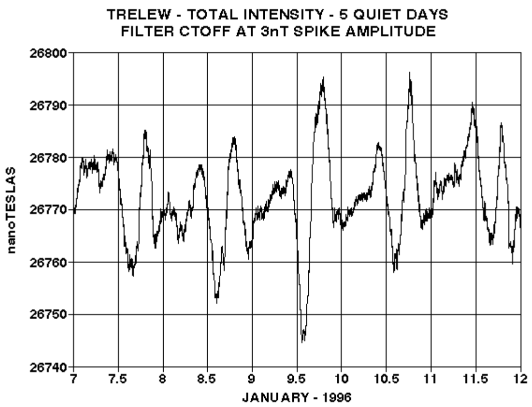


Fig. 2: Cuttoff-Filter in 3 nT spike amplitudes of the Total Intensity of five Q-days dataset recorded at Trelew Magnetic Observatory (96/1/7-12)

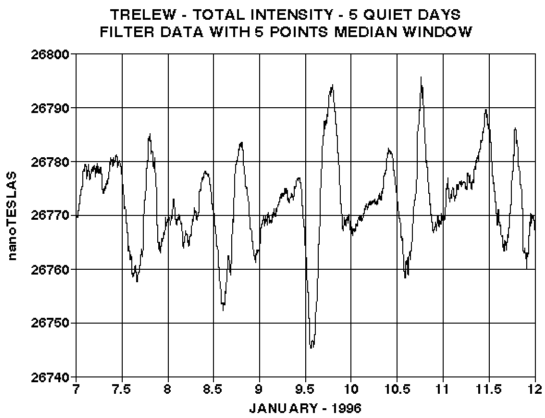


Fig. 3: Median-Filter with 5 points window of the Total Intensity of five Q-days dataset recorded at Trelew Magnetic Observatory (96/1/7-12)

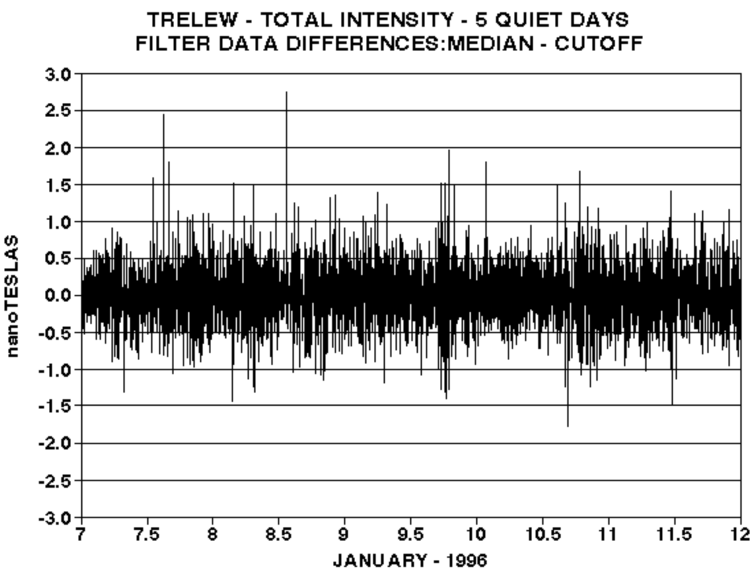


Fig. 4: Differences between the median- and cuttoff- filters

There is a clear dependency between geomagnetic data quality and the processing sequence to be used in order to preserve relative amplitudes. The calibration process is a control tool that allows the definition of the best filtering method.
In spite of this critic, the median-filter is very useful when the noise in spikes form are present in different phases of the development of a magnetic storm.

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