SSC DETECTION USING WAVELET ANALYSIS.

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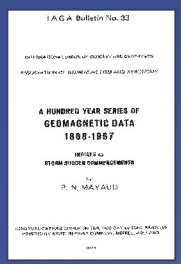
ABSTRACT

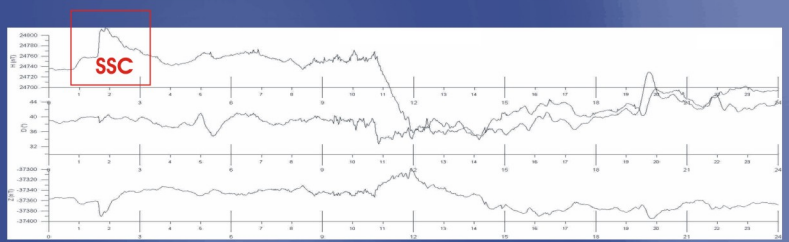
For Sudden Storm Commencements, several methods aiming automatic detection of the events have been proposed. Most of them are based in the analysis of digital geomagnetic field data using some morphological aspects of these events. Here we present a method using a wavelet analysis on the derivative of H component which is related with the steepness of the rising time. Wavelet analysis is very precise tool for time and frequency determination. A comparative of the results from the detection lists is shown.



"SSC's, sudden commencements followed by a magnetic storm or by an increase in activity lasting at least one hour"

P.N. Mayaud in 1973 introduced changes in the SSC definition and criteria for its identification (IAGA bulletin No. 33, "A hundred year series of Geomagnetic Data 1868-1967. Indices aa, Storm Sudden Comencements").

It was the first time that a list included SSC's, no matter what storm amplitude was reached. In this new definition more importance was given to the change of rhythm in the magnetic



1.

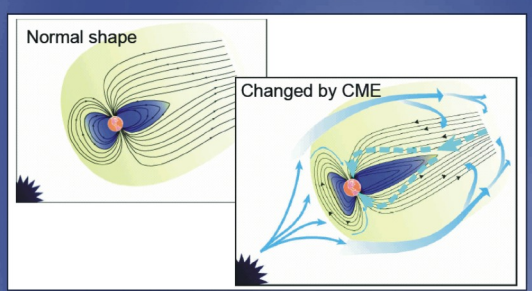
An SSC is due to an increase in the pressure of solar wind that causes a compression in the magnetosphere. This is observed like a sudden increase in H component of geomagnetic field.

Since 1975, Ebro Observatory is the International Service on Rapid Magnetic Variations and his task is to publish all SSC according to last definition. This work presents every day more difficulties:

The discrepancy in the criteria of the collaborating magnetic observatories

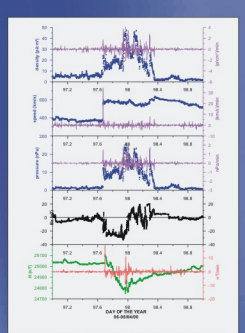
Slow communication between them and the Service.

For these and more reasons, it is proposed a new method of SSC detection based in the automatic analysis of digital geomagnetic field data. It detects them from analyzing morphological parameters of sudden variations in the H component and performing a wavelet analysis on the derivative of this component. Using this last method, noise is neglected, allowing a rapid detection of these variations. Finally results can be confirmed with solar wind pressure data. We obtained good results, especially for SSC's A and B types because of their sudden and clear variation.



SSC Detection

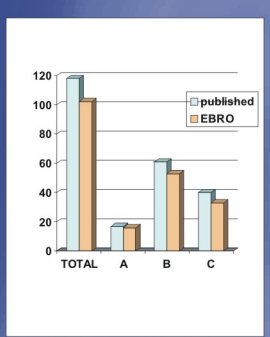
1) Analyzing morphological parameters of the magnetic field and solar wind pressure data.



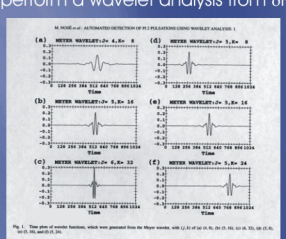
Analysing simultaneously the parameters involved (solar wind pressure, speed and density) with H variation one can decide if an event is a SSC or not. This method has been tested for Ebro geomagnetic data (1999-2002) producing satisfactory results:

A events 94%
B events 87%
C events 82%

TOTAL 86.4 %



2. wavelet analysis
A step function in the component H maps as a pulse on its derivate. Then, we can perform a wavelet analysis from δH variation.



We use Meyer wavelet analysis to detect SSC's, localizing the event and rejecting the noise.

J parameter (j=1,...,9) controls the wideness of the filter and therefore the frequency of the signal.
Noise and artificial spikes result a limit for short period events detection.
With 1 minute geomagnetic data, we use Meyer wavelet j parameter:

j	Time resolution (min)
5	=> 32
6	=> 16
7	=> 8

K parameter controls the temporal position of the event.

Conclusions:

Performing a wavelet analysis with only Ebro data, we obtain a 49.5% of success. But if the analysis is complemented with others low latitude observatories (ABG, HON, MBO, KAK, SJG) data, success increases to more than 72%.

In this case - with more than one observatory data - wavelet analysis gives good results, and again "A" and "B" events score better.