Some Aspects on the Relationship of Dst Index and Sunspot Number

Julio C. Gianibelli*, E. A. Suarez*, L. Barrio**, I. R. Cabassi* and P. Sallago*

*Departamento de Magnetismo Terrestre y Electricidad Atmosférica. Facultad de Ciencias Astronómicas y Geofísicas. Paseo del Bosque s/n. (1900) La Plata. Argentina.

**CONICET.

ABSTRACT

The response of the coherence function applied to Dst index and R sunspot number data in the period 1957.0 - 1982.0 is studied.
The results show that the Dst index may be expressed as at least a linear function of R in the spectrum with periods near to 10.1 yr.

1. Introduction.

The hourly Dst index records the variations of the ring current and it is measured with great accuracy due to the symmetry characteristics of this current and to the relative simplicity of the magnetic variations. In determining the Dst index had been taken into account the elimination of the transient variations which are not caused by the ring current and the reference levels in which the secular variation and base lines produced interference *[Mayaud P. N., 1980]*.
The net of stations to determine the Dst index are as follows: Honolulu, San Juan, Hermanus and Kakioka, thus showing that the geomagnetic effects at the ground level comprise a zone of ∓30° of geomagnetic latitude. Otherwise, the R sunspot number shows the solar activity and it is known since 1700 on.
Several methods, especially autoregressive ones *[Marple L. R. 1987]*, to analyze time series applied to the sunspot number had been recently developed.
The purpose of this paper is to find out the frequency bands where a relation between Dst and R is present.

2. Methodology and Data Analysis.

It was used the method of direct compute of coherency function through the determination of the Dst and R indexes discret autospectra, which we call $D(\omega_j)$ and $R(\omega_j)$ and the cross spectrum $DR(\omega_j)$. The coherency function is descripted by *[Kanasewich E. R. 1981]*:

$$C(\omega_j) = [(Re(DR(\omega_j)))^2 + (Im(DR(\omega_j)))^2] / [(Re(D(\omega_j))) * (Re(R(\omega_j)))]$$

where Re and Im are the real and imaginary parts of the autospectra and cross spectrum.
The response of the coherency function in each ferquency ω_j will shows at their maximums that the related variables may be expressed by means of a function which is linear in the simplest cases..
The analysis of Dst *[IAGA 1982]* and the R sunspot number *[Waldmeier M. 1961, 1977]* embraced the period 1957.Ø - 1983.Ø in which not smoothed monthly means had been used (Fig. 1).

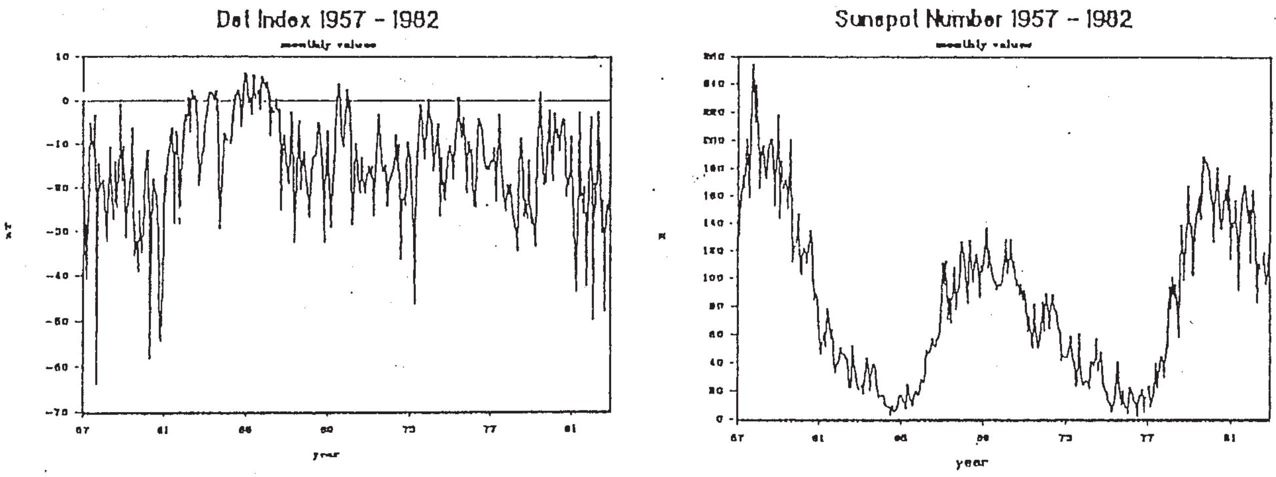

Figure 1.

3.Results.

To compute the auto spectra and the cross spectrum were previously determined the normalized auto correlation of each index and the cross correlation. The results are shown on Fig.2.
Later the cross and auto spectra were computed by means of Fourier´s Fast Transform. The results are present on Fig.3.
For the power spectra of the Dst index have been pointed out the differents peaks that surpass the estimate noise level of $\sqrt{2}$ nT determined by the maximum peaks at the very high frequencies.
The R power spectrum shows a main lobule going from 7.76 to 14.22 yr. It is also present in the cross spectrum. The secundary lobules between 5.Ø and 7.76 yr are present at the R and cross spectra, but it is not well define at the Dst spectrum.
On the other hand at low frequency R shows only one lobule of period with maximum near to the double solar cycle (19.Ø yr). It is also observed at the Dst spectrum while at the cross spectrum two lobules are present.
Fig.4 shows the coherency function where the frequency band around the solar cycle is the one representing the periods where a funtional relationship Dst with R may be possible, while it is negligible in the

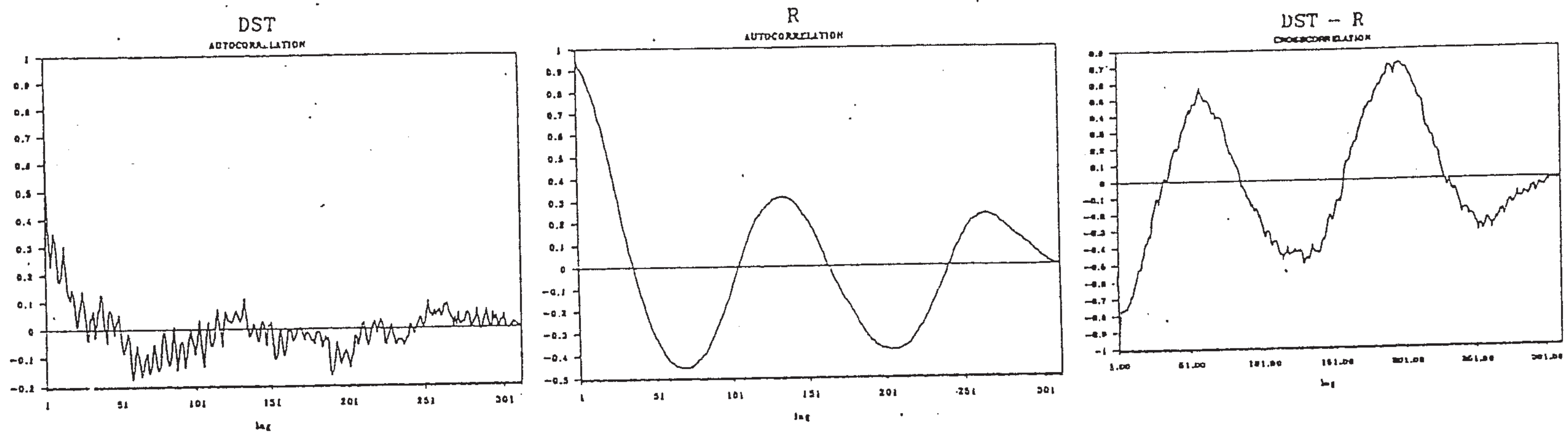

Figure 2

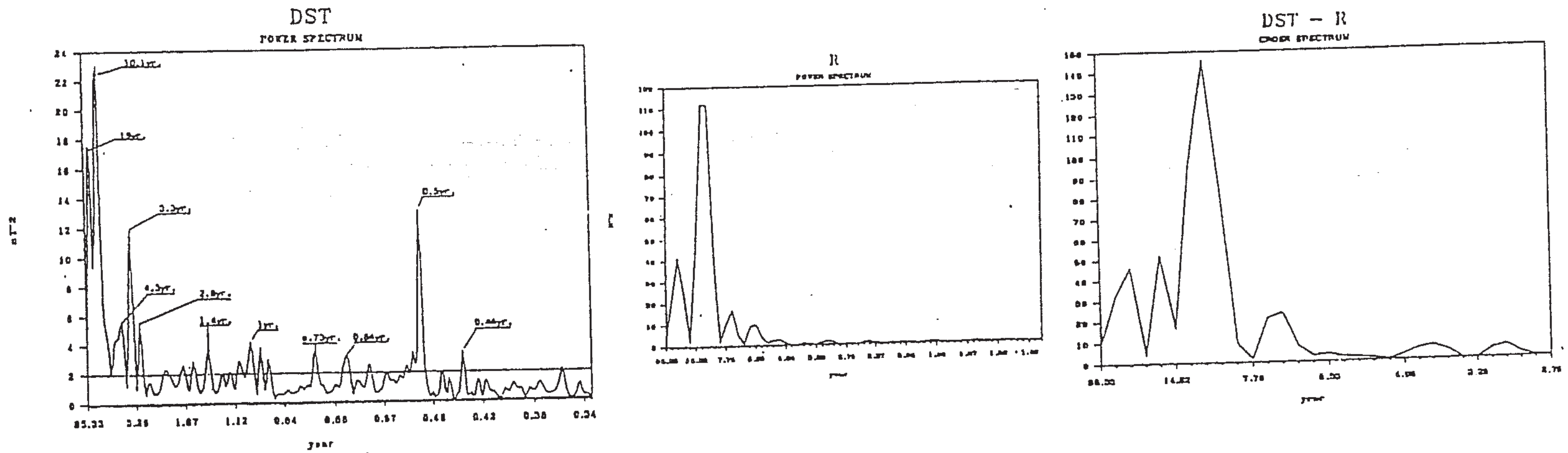

Figure 3

rest of the periods. The short periods smaller than the solar cycle come from an interaction between the magnetosphere and the solar wind. There it is easily observed a predominant wave of 3.3 yr as well as the semiannual, while the annual variation is inside a lobule with period near to it, producing interferences.
Another interesting feature of the Dst spectrum is the 1.4 yr peak that could belong to the variation of 17.0 months of the sunspot numbers.
The method applied to determine the coherency function is irresolute concerning this point.

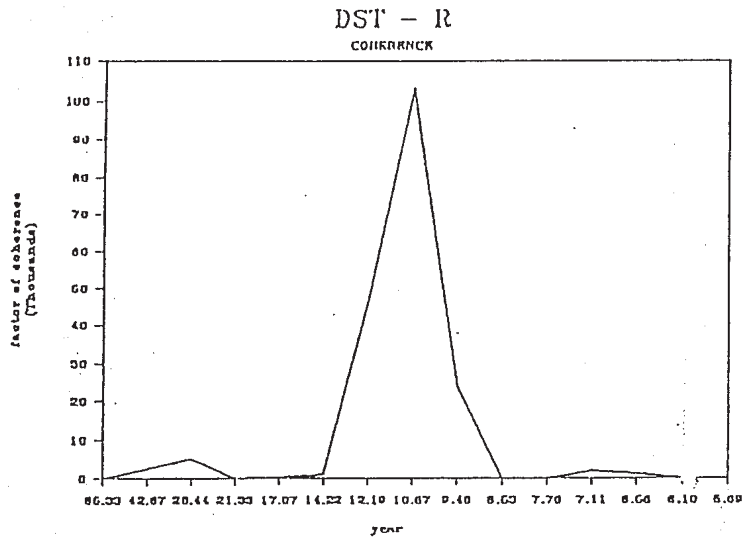

Figure.4

4.Conclusion.

The methodology used allows to stablish with accuracity that there is a functional relation between Dst and R indexes in low frequency. This implies variations in Dst in correspondence with a mean field electrodynamics of the variation period of 10.1 yr, thus suggesting that the interaction and coupling of the solar wind with the magnetosphere present oscilations at the high period band but it does not clearly shown a modulation double of the solar cycle as it is observed at the R and Dst spectra.

5.Reference

IAGA Bull. N°32 (1982) Geomagnetic Data.
Kanasewich E. R. (1981) Time sequence analysis in geophysics (3th ed.) Univ. of Alberta Press, Canada.
Marple L. R. (1987) Digital spectral analysis. Prentice Hall, New Jersey USA.

Mayaud P. N. (1980) Derivation, meaning and uses of geomagnetic indixes. Am. Geoph. Union, Monograph 22, USA. 22, USA.
Waldmeier M. (1961) The sunspot activity. Zürich Schulthess and Co.
(1977) The sunspot activity 1961 - 1975 Astronomische Mitteilungen Eidgenössischen Sternwarte Zürich, Nr 346