H-COMPONENT ANALYSIS FOR ANNUAL AND SEMIANNUAL GEOMAGNETIC VARIATIONS AT LA QUIACA, PILAR AND TRELEW OBSERVATORIES.

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ABSTRACT

The hourly quiet days and monthly mean values of H geomagnetic component are analyzed for the years 1967 to 1970, corresponding to the 20 th. maximum solar cycle at La Quiaca, Pilar and Trelew observatories. The residual time series were studied by Fourier harmonic analysis and the amplitude and phase of annual and semiannual waves were determined for each hour of universal time. The results obtained were correlated with the maximum solar cycle and the aspect of magnetospheric and ionospheric current systems, paying special attention to the equatorial electrojet effect on the amplitude of annual, semiannual, and daily variations, for the last one, an evaluated method is presented.

INTRODUCTION

The mechanisms that originate the annual and semiannual variations are not obvious enough. Vestine (1954) explained the annual wave in terms of a dynamo mechanism due to southern ionospheric winds blowing always from summer to winter hemisphere. Olson (1970) has proposed that even under constant solar wind conditions, annual and semiannual variations would be present. Bhargava and Rangarajan (1987) have shown that the annual variation is due a composition of effects: the meridional ionospheric winds which were also mentioned by Vestine; the Sq currents which show a great seasonal dependence; and the perturbations. Bhargava (1972) has shown that in low latitude observatories the annual variation during the day is only due to the ionospheric currents, and during the night to magnetospheric oscillations such as seasonal changes in the ring current, this was also observed by Malin and Isikara (1976).

For the semiannual variation there are two hypothesis, the axial and the equinoctial, the first one establishes that there is a geomagnetic activity increase in March and the second one, in September, Cortie (1912), who postulate the axial hypothesis, establish that the most important factor in contribution to semiannual variation is the change of the Earth heliographic latitude. The second one kept out by Bartels (1932) and Mc Intosh (1959), among others, attributes it to the inclination of the Earth magnetic axis with regard to the plane normal to the ecliptic.

For the present study in high solar activity of annual and semiannual variations in South America observatories placing under the equatorial electrojet in South direction, we made use of La Quiaca, Pilar and Trelew observatories. In table 1 we show their geographic and geomagnetic location.

DATA ANALYSIS

OBSERVATORY	Geog. Lat.	Geomag.Lat.	Geog. Long.	Geomag. Long.
LA QUIACA	22.27° S	10.60° S	65.60° W	3.2° E
PILAR	31.67° S	20.20° S	63.88° W	4.0° E
TRELEW	43.25° S	32.00° S	65.32° W	3.0° E

TABLE 1

We used H geomagnetic component time series from La Quiaca, Pilar and Trelew observatories to determine the annual and semiannual variations. The data belong to the years 1967 to 1970 corresponding to the number 20 solar cycle, for what the smoothed number of sunspotsis between 80 and 120 (figure 1). This solar cycle a long maximum activity, similar but with higher intensity at the present in cycles 12 and 16, with 4.5 years extension, but sunspots number between 40 an 80.

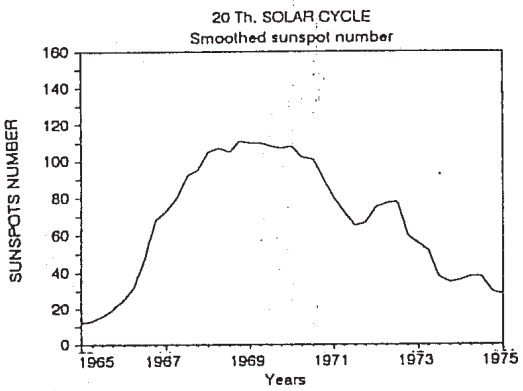

FIGURE. 1

We analyzed hourly mean values for monthly means for every day and monthly means of quiet days, so we obtained 24 time series for each kind of mean and for each observatory. This allow us to make a discrete demodulation for annual and semiannual variations.

La Quiaca and Pilar data were published by the Argentine Meteorological National Service (Servicio Meteorológico Nacional). On the other hand, Trelew data were processed by the terrestrial magnetism department of La Plata University.

After the obtainment of the time series, the very long period variation or secular variation, was approximated by a first order polynomial which was the best adjustment. Then residual time series were formed and filtered with a gaussian 7 point expression, so we extract lower periodicities out of interest in the present study (Gianibelli and Weisz, 1988). The annual and semiannual amplitudes were obtained by harmonic Fourier analysis.

Another important and novel aspect, is the information contained in the regression adjustment of the time series, which allows us to make a daily variation analysis. This was made by mean of the representation of the distance to the origen of the regression line which give us an estimation of the daily variation mean amplitude in each observatory.

RESULTS AND DISCUSSION

Two kind of results were obtained through the present method of analysis:

- The amplitude and phase of annual and semiannual variations for each hour of universal time (U.T.), and at each observatory.
- The smoothed daily variation given by the origen ordinate of the regression adjustment.

1) Annual variation behaviour.

The greatest amplitude for the annual wave was detected at Pilar observatory, this happened for the monthly means of every day analysis and also for the monthly means of quiet days, but in the last case with higher amplitude. These results are presented in figures 2 and 3 for each day and quiet day monthly means analysis respectively.

The feature of these results and the geomagnetic latitudinal distribution shown clearly the current systems interaction. There we can see that the lower amplitude of the annual wave at La Quiaca is due the interference process between the magnethospheric current systems, those are the magnetopause and the ring currents and the equatorial electrojet, that in high solar activity has a higher intensity in opposite direction, so between 0 and 12 hours of UT, where the ring current is more important in the magnetic equatorial zone, appears a diminution of the annual wave with the greatest effect at La Quiaca, and Lower at Pilar. In the other hand, between 13 and 23 hours of UT the equatorial electrojet has an important effect at La Quiaca and not so at Pilar where the amplitude of the annual wave is similar

to the amplitude obtained for Trelew. A better resolution we reach with the study of the monthly means of the five quiet days.

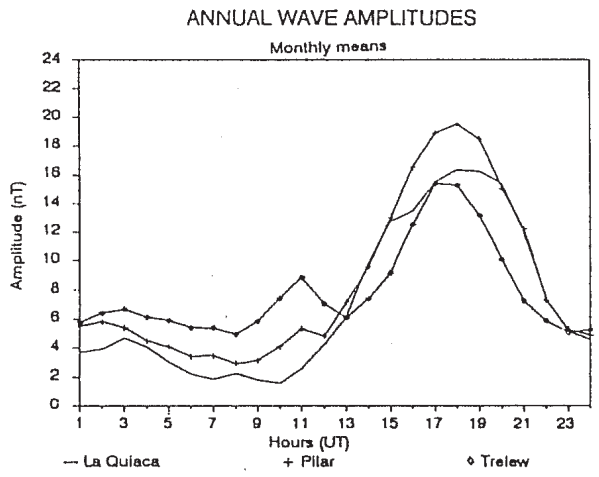

FIGURE 2

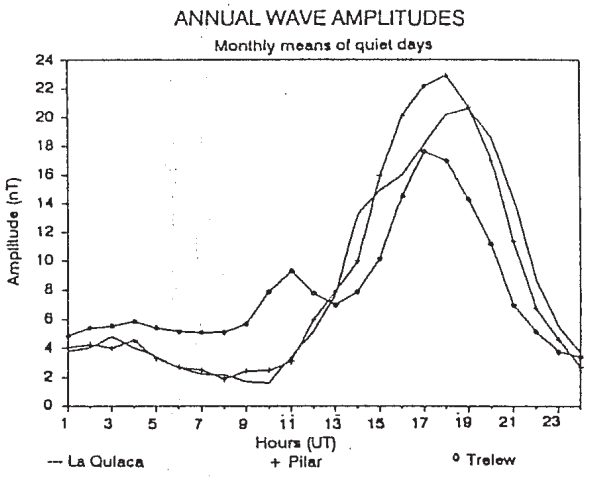

FIGURE 3

2) Semiannual variation behaviour.

These waves does not show a good modulation with the local time. We only can say

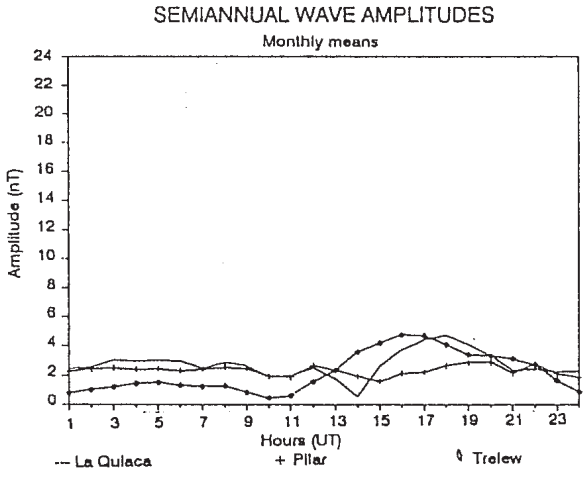

FIGURE 4

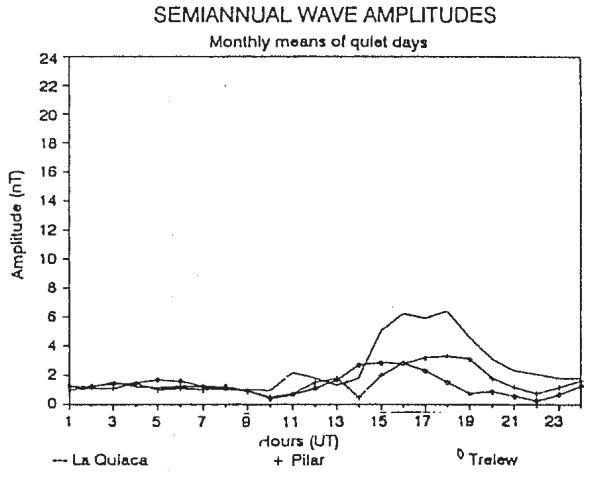

FIGURE 5

that, from figures 4 and 5, the electrojet effect is more important than the magnetospheric currents.

3) Daily variation behaviour.

In this variation we observed the same as Affolter H. (1968) with respect to the amplitude of daily variation in the observatories studied. (Figures 6 and 7). We must notice that at Trelew observatory it is presents the ionospheric currents focus movement generating a ma-

ximum in the daily variation at 8 hours of local time and decreasing towards midday.

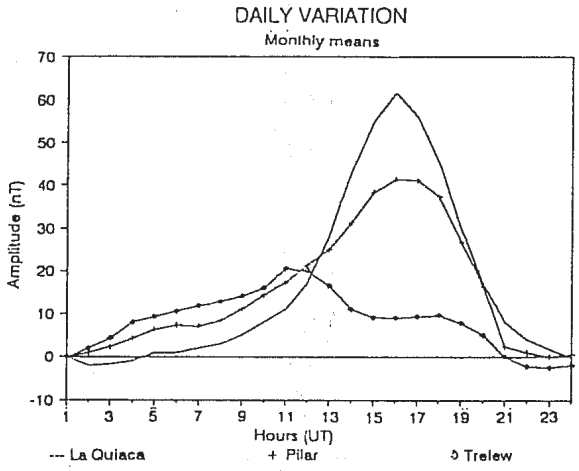

FIGURE 6

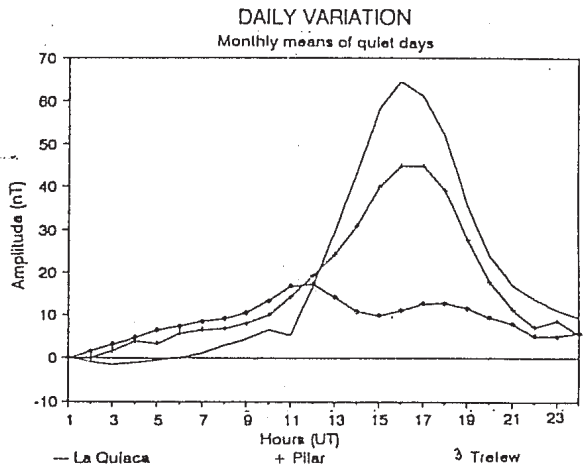

FIGURE 7

CONCLUSIONS

The methodology we used, was the appropiate to observe the evolution of annual and semiannual variations with the universal time and geomagnetic latitude.

Another observed aspect was the interaction at daily hours of the three most important current systems: the magnetopause current, the ring current and the ionospheric current systems with the equatorial electrojet effect. This interaction produce at the earth surface, a diminution in the annual variation in the magnetic equator zone (Figures 2 and 3). In the other hand, the semiannual variation does not show this decreasing effect.

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