

Induced effects of solar variability on asthmatic crises in adults

Eduardo Del Pozo¹, Gisselle Gil¹, Jorge F. Valiente¹, Mercedes Batule², Herio Toledo³ and Alfredo Triolet¹

¹Institute of Geophysics and Astronomy, Ministry of Sciences, Technology and Environment, La Lisa, Cuba

²National Commission on Asthma, Ministry of Public Health, Calixto García University Hospital, Havana, Cuba

³Institute of Tropical Medicine Pedro Kouri, Havana, Cuba

Received: September 8, 1999; accepted: August 25, 2000.

RESUMEN

Se presenta un análisis de series de tiempo de números de Wolf, frecuencia diaria de explosiones de rayos X de intensidad M y X, valores diarios del índice geomagnético Ap, y número de pacientes tratados con crisis de asma en el Hospital Calixto García de la Habana entre 1987-1990. Se detectan variaciones en la curva de incidencia asmática después del primer evento protónico de bajo nivel en el ciclo 22. La ocurrencia simultánea de periodos de 76 días en las curvas de asma y de rayos X sugiere un efecto complejo y no lineal de la actividad solar.

PALABRAS CLAVE: Actividad solar, asma, efectos solares sobre la biosfera.

ABSTRACT

A time series analysis of the daily values of the Wolf number, the daily rate of X-ray bursts of M and X intensity, the daily values of the Ap geomagnetical index and the daily rate of adult patients receiving treatment for asthma crises at the Calixto García Hospital in Havana City from 1987 to 1990 shows a change in behavior in the asthma index curve immediately after the occurrence of the first low-level proton events of cycle 22. The simultaneous onset of oscillations of 76 day period in asthma and X-ray indexes further indicates a complex non-linear effect of solar variability on asthmatic patients.

KEY WORDS: Solar variability, Sun-biosphere, solar activity, asthma.

Although precipitating factors of asthma crises are well studied, medical practice shows that there are occasional increases in the number of crises for which a known cause cannot be found. Several authors have demonstrated the relationship between asthma crises and meteorological phenomena (Piccolo *et al.*, 1988; May, 1983; Lim *et al.*, 1991), but in a given period of time, they cannot always explain away all variations. Other environmental factors, such as solar activity, have not been considered.

During the last decades, solar variability influence on the biosphere has been studied mainly through statistical analysis, (Druzhinin *et al.*, 1976; Moiseiv and Llubtskii, 1986), but no definite mechanism has been given to account for the correlations found. A possible influence of an increase in solar activity on cardiovascular infarcts, alterations of blood coagulability, and other conditions has been suggested (Novikova and Vnevshev, 1968; Sierra *et al.*, 1982).

The solar activity indicator mainly used in these statistical studies is the Wolf number, but other indicators such as X-ray burst frequency can be more relevant. Solar X-ray or ultraviolet emissions, for example, arrive almost immediately after highly active eruptive phenomena on the Sun, ionizing the Earth's atmosphere and changing the conditions

in it, thus affecting the biosphere and the equilibrium of the environment.

In this paper we present a time series analysis of the daily values of the Wolf number, the daily rate of X-ray bursts of M and X intensity, the Ap geomagnetical index taken from the Solar Geophysical Data Bulletin and the number of patients over 15 years of age receiving treatment for asthma crises at the Calixto García Hospital in Havana from 1987 to 1990 (Asthma National Commission Data Base). The data includes has 71 456 asthma cases and 784 X-ray solar bursts.

The period of 1987-1990 corresponds to the rising limb of the 22-year solar cycle. The activity level in each year can be characterized as follows. 1987 was a year of low activity; during 1988 the Wolf number starts rising, but explosions are few; 1989 is the year of peak solar activity and 1990 still has a very high activity in all solar indexes.

The time sequence plots of these parameters were smoothed with an 361 days window using the formula

$$f(I) = \sum_{j=I-180}^{I+180} f(I+J) / 361 \quad (1)$$

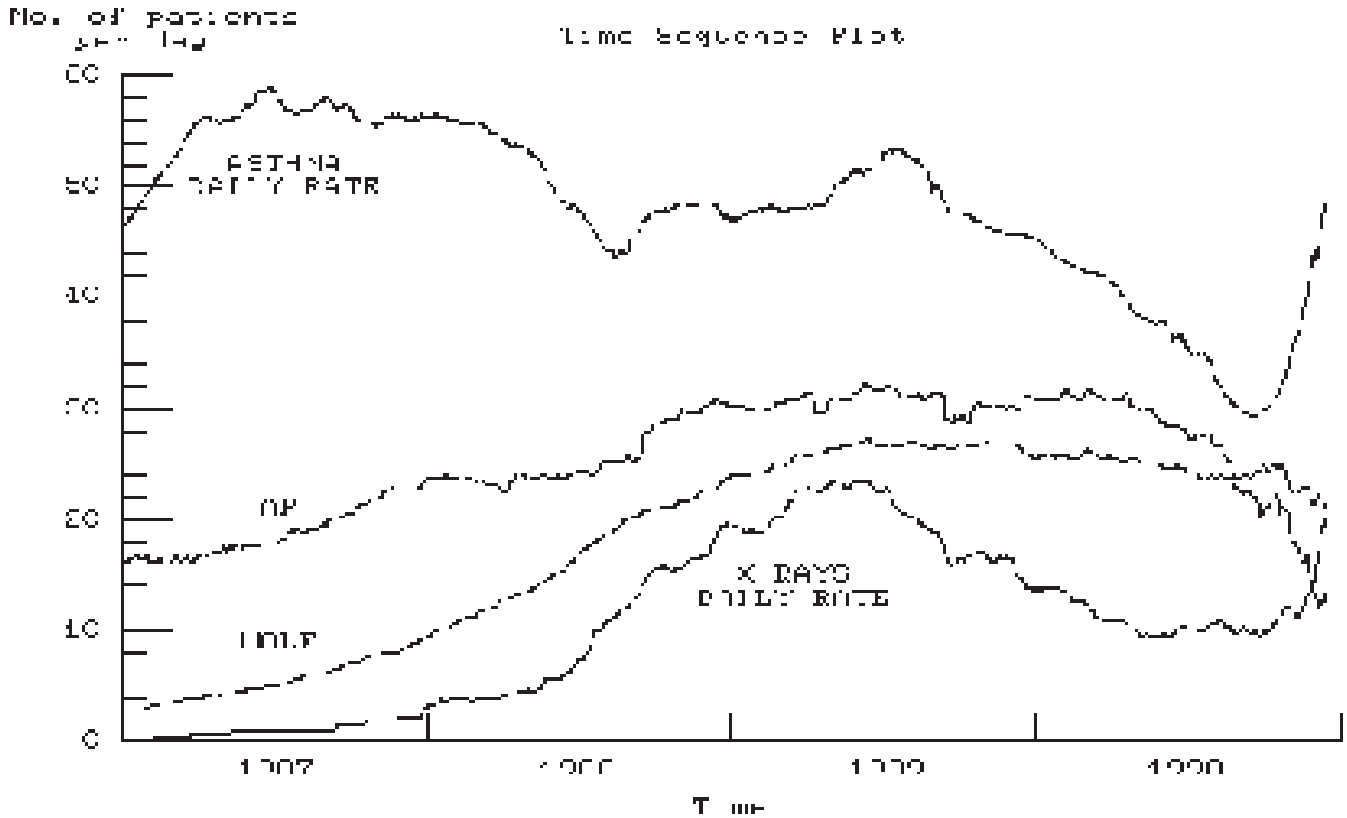


Fig. 1. Daily rate of asthma crises in adults (15-64 years old) from 1987 to 1990. Daily values of the geomagnetic Ap index, Wolf number values and X-ray daily rate (M and X events) values have been converted to plot them on the same scale.

Table.1

Uncertainty per Year in Asthma

ERROR BARS	1987	1988	1989	1990
Variable Asthma	±1.64	±1.40	±1.74	±1.17

Figure 1 shows, in average, a larger number of asthma crises during low solar activity than during high solar activity. The number of crises starts falling around March 1988 reaching a minimum in August 1988. From here on, the number of asthma crises climbs and falls following solar activity. The asthma and X-ray burst frequency curves in 1989 are significantly similar. This behavior might be due to a threshold crossing of a factor hitherto undetected.

For independent corroboration of a link between these phenomena, periodicities of all these indexes were studied for the whole period and for each year separately using Fast Fourier Transform power spectra (FFT). The X-ray index showed the highest maximum at 76 days in the periodogram for 1989 (Figure 2a). This period had also a significant maximum in the periodogram for the four years. A similar periodicity had been

found by Ichimoto (1985) for H α flares of Importance 1, 2 and 3 for solar cycle 21, and by Özgüç, (1994) for periodicity of the flare index during the solar cycle 22.

In the asthma index periodogram for 1989 we find a distinct peak with significant amplitude at this value (Figure 2b). This same period is also present in Ap and Wolf number periodograms for this year, but with small amplitudes.

Figure 3 shows the time variation of the difference between the 25 and 121 days moving averages on a relative scale of the asthma and X-ray indexes for the whole period using the formula

$$\bar{f}(I)_{25} - \bar{f}(I)_{121} = \left[\sum_{J=-12}^{12} f(I+J)/25 \right] - \left[\sum_{J=-60}^{60} f(I+J)/121 \right] \quad (2)$$

Largest amplitude oscillations appear during 1989. These oscillations correspond to the 76 day peak present in the 1989 periodograms. They appear in November 1988, first in the X-ray index, following the first low-level proton events of this solar cycle. It is interesting to note that these

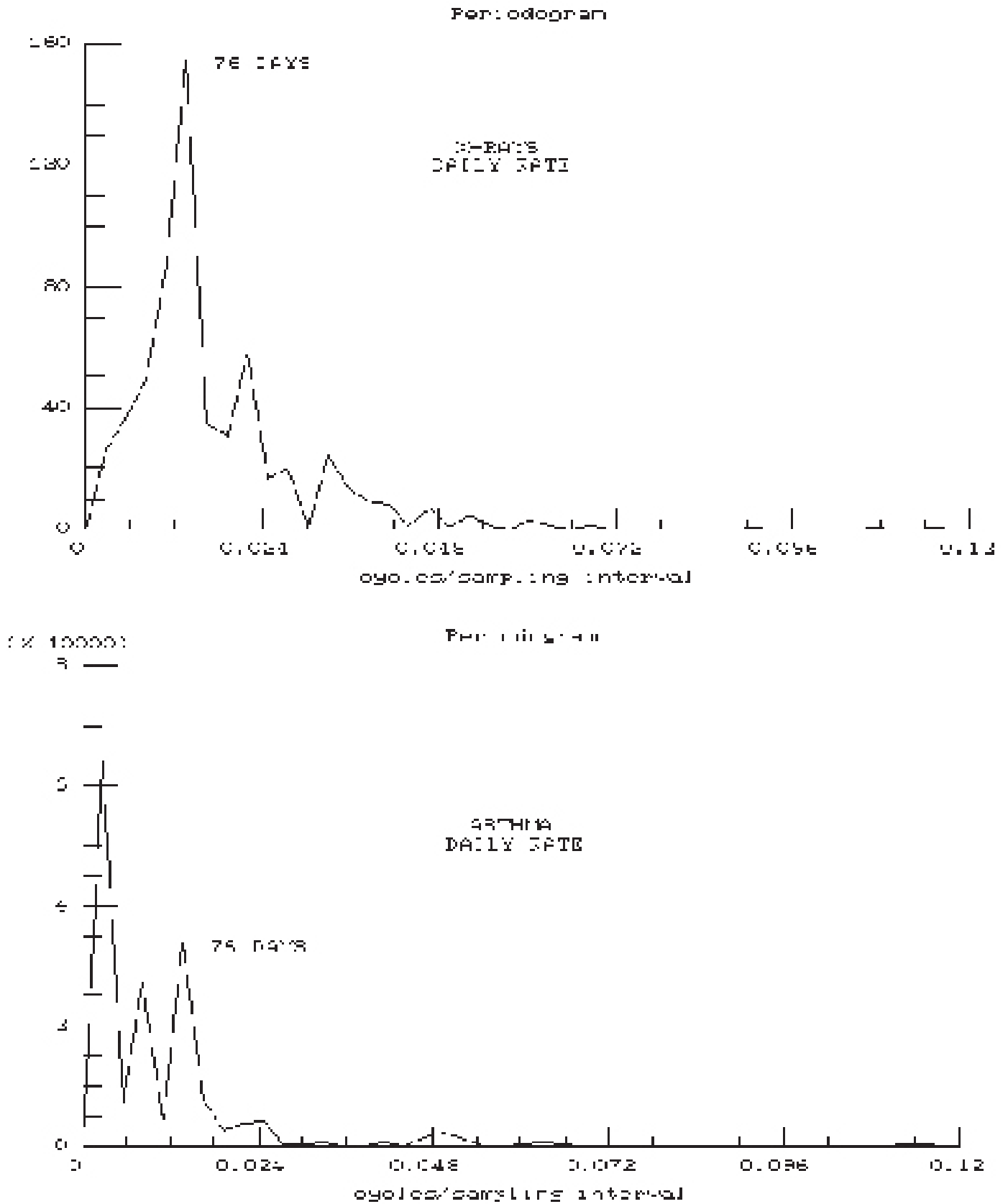


Fig.2 Periodograms for 1989: X-ray daily rate (a), asthma crises daily rate (b).

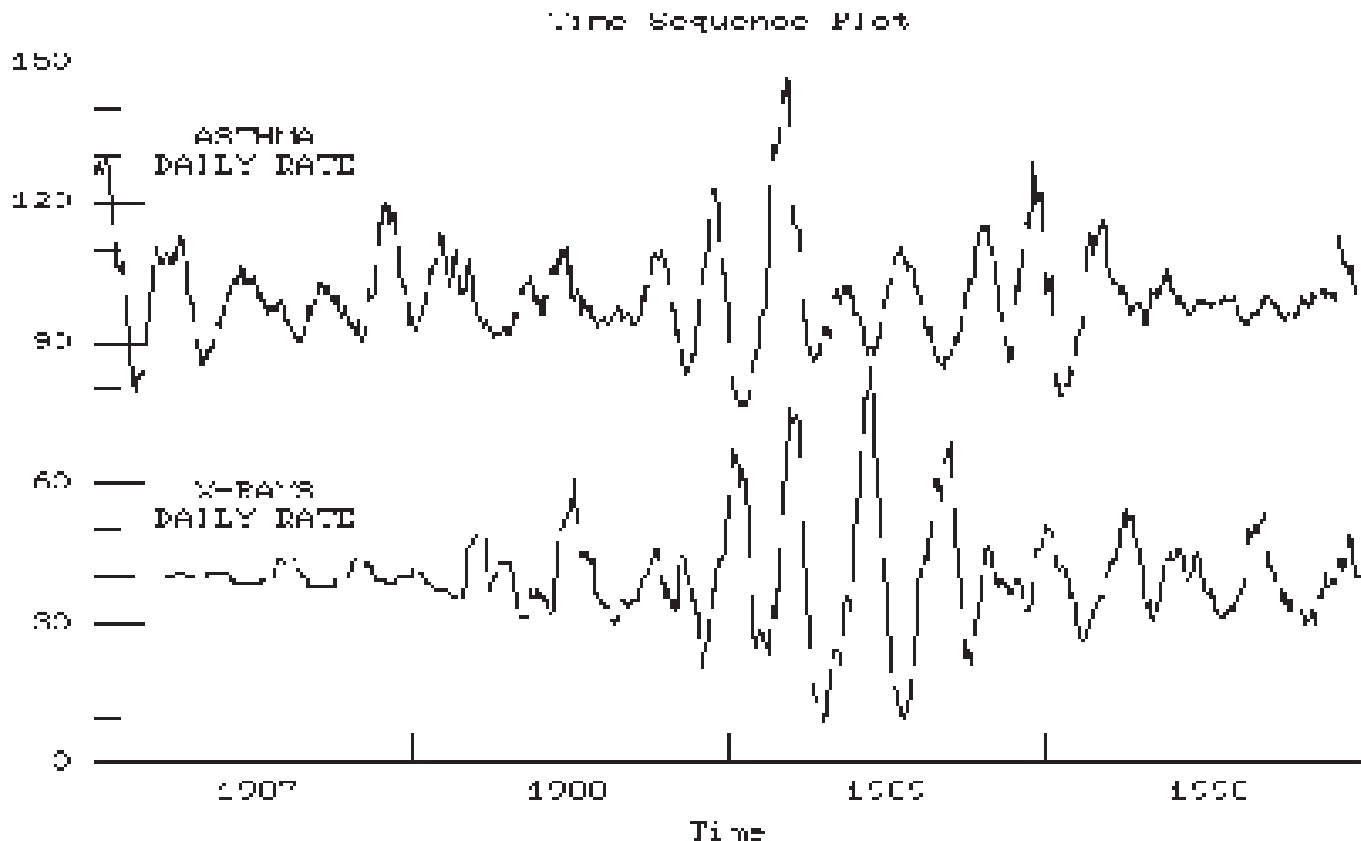


Fig. 3 Time variation of the difference between the 25 and 121 day moving averages of the asthma and X-ray index in relative scale.

oscillations are shorter lived in the asthma index, having two distinct increments in amplitude starting at the end of 1988 and middle of 1989, respectively.

These two effects (i.e. the change in tendency and the onset of oscillations of the same period) are present simultaneously in the time sequence plot of the 25-day moving average (Figure 4), using the formula

$$\bar{f}(I) = \sum_{J=-12}^{12} f(I+J)/25 \quad (2)$$

Note that the first peaks in the X-ray index curve (second half of 1988) immediately precede the change in tendency and onset of large amplitude oscillations in the asthma index curve.

It is common to look for solar activity effects on the biosphere only after very large energetic processes in the solar atmosphere. In our case, we find a highly discernible effect in the time sequence plots simultaneous with the first low-level proton events, and the onset of oscillations of a definite period in the X-ray and asthma crises indexes, long

before the appearance of the very large active regions of March 1989 on the Sun.

This effect is complex and possibly non-linear, suggesting an influence of the variation of the solar activity on asthmatic patients. It would be advisable in future studies to investigate not only the peaks of solar activity, but also its variability. Combined studies of meteorological and solar indexes might also shed light on the possible mechanism for the interaction between environmental factors and the biosphere.

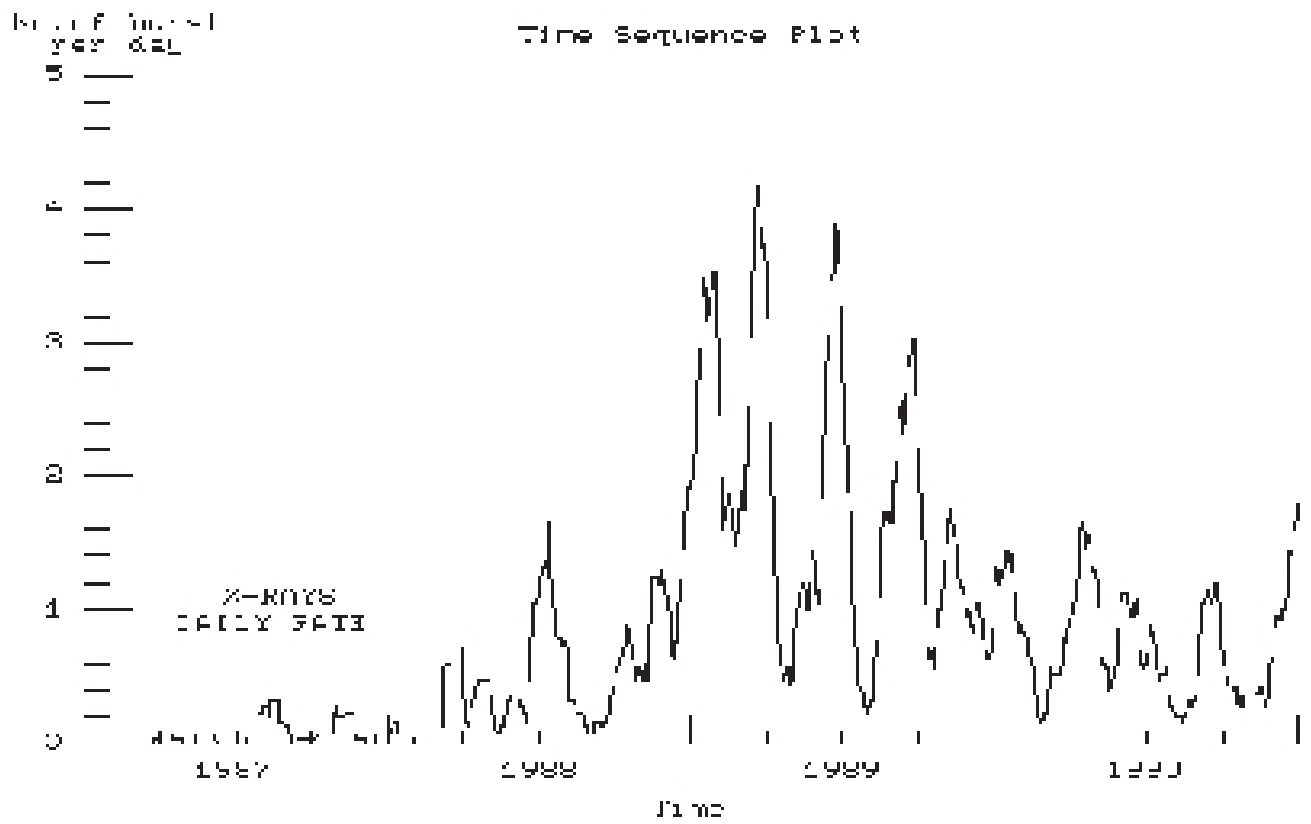
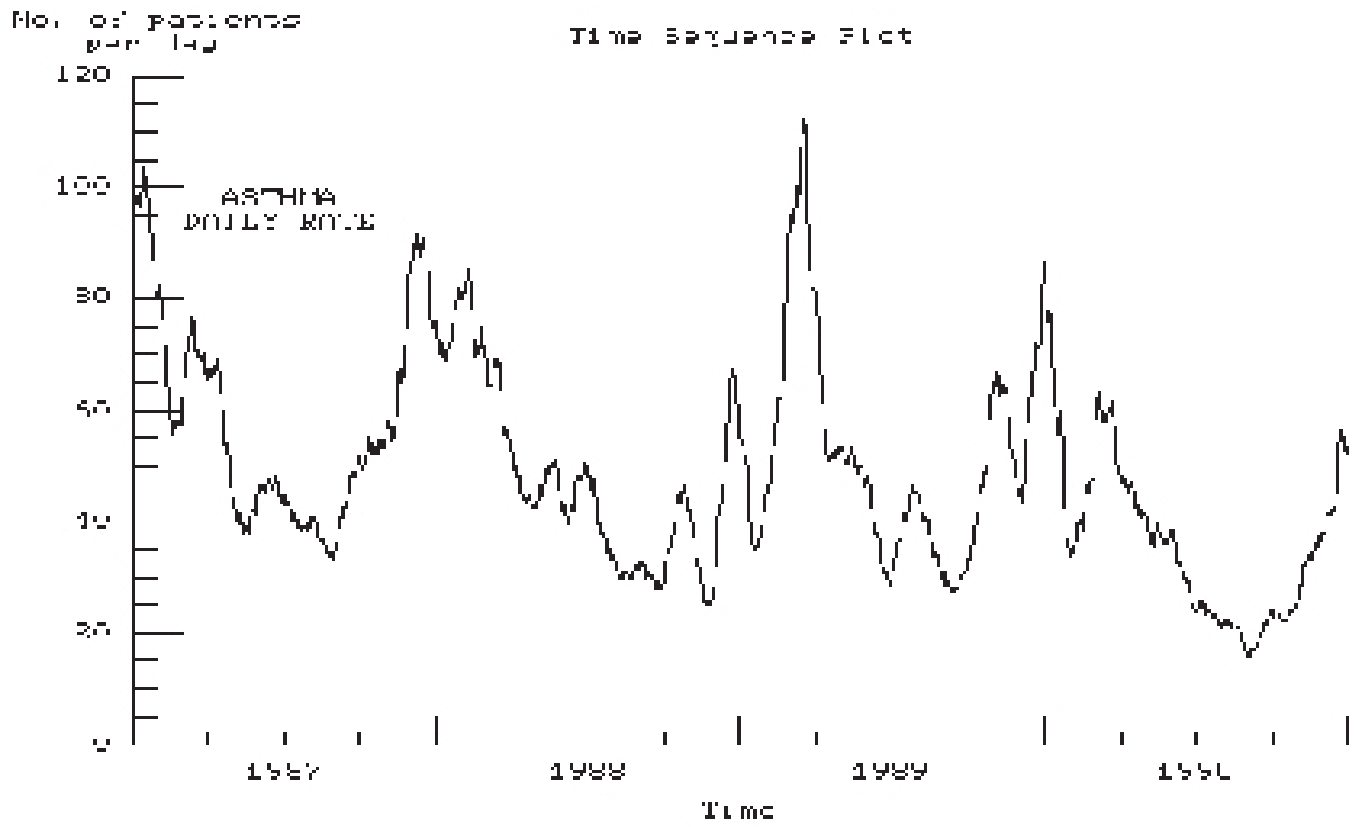


Fig. 4 Time sequence plots of the 25 day moving averages: asthma daily rate (a), X-ray daily rate (b).

BIBLIOGRAPHY

- DRUZHININ, I. P., B. I. SAZONOV and V. N. LAGODIN-SKII, 1976. Influencia de los factores cósmicos sobre el organismo humano. *Cosmos, Tierra, Pronóstico*.
- ICHIMOTO, K. and J. KUBOTA, 1985. Periodic behaviour of solar flare activity. *Nature*, 316.
- LIM, To, H. W. LOOI and K. HARUM, 1991. Asthma and climate conditions, experience from Kuantan, Malaysia. *Med. J. Malaya*. 46, 3, 23-4.
- MAY, K. L., 1983. Meteorological and climatic factors in bronchial asthma. A clinical dilemma. *Allergol Immunopathol* 11 (6), 465- 472.
- MOISEIV, H. I. and R. E. LLUBTSKII, 1986. Acción de los factores heliogeofísicos sobre el organismo del hombre. *Problemas de Biología Cósmica*. Ed. Nauka. Len.
- NOVIKOVA, K. F. and M. N. BNEVYSHEV, 1968. Influencia de la actividad solar sobre el surgimiento de las afecciones por infarto del miocardio y sobre la mortalidad debido al mismo. *Cardiología*, 4, 109-112.
- ÖZGÜC A. and T. ATAC, 1994. The 73-Day Periodicity of the Flare Index during the Current Solar Cycle 22. *Solar Physics*, 152, 319.
- PICCOLO, M. C., C. G. PERILLO and C. G. RAMON, 1988. Outbreaks of asthma attacks and meteorologic parameters in Bahía Blanca, Argentina. *Ann. Allergy*. 60, 9, 107-109.
- SCIENTIFIC COMMITTEE ON SOLAR-TERRESTRIAL PHYSICS, Solar Terrestrial Energy Program 1990-1995. Initial Research Projects, Project 5.5 Solar Variability Effects on Technological Systems and the Biosphere.
- SCOSTEP Bureau Meeting; STP NEWSLETTER SCOSTP; December 1994.
- SIERRA, P., O. ALVAREZ and A. ESTUPIANAN, 1982. Influencia de la actividad solar en la morbilidad del Infarto del Miocardio registrada en cuatro hospitales de Ciudad de La Habana. *Rev. Cubana de Medicina*., 21, 3.
- SOLAR GEOPHYSICAL DATA, 1987-1990. National Geophysical and Solar Data Center A, Boulder Colorado. USA.
-

Eduardo Del Pozo¹, Gissele Gil¹, Jorge F. Valiente¹, Mercedes Batule², Herio Toledo³ and Alfredo Triolet²

¹Institute of Geophysics and Astronomy, Ministry of Sciences, Technology and Environment

Av. 212, No 2902 % 29 y 31 La Lisa, Cuba, Fax 5(37) 33 9497.

²National Commission on Asthma, Ministry of Public Health, Calixto Garcia University Hospital, Havana, Cuba

³Institute of Tropical Medicine Pedro Kouri, Havana, Cuba