Solar influence on barometric pressure

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SOLAR INFLUENCE ON BAROMETRIC PRESSURE

During recent years, positive evidence has accumulated to suggest a correlation between upper atmospheric phenomena and weather. Martyn and Pulley (1936) found a significant correlation between ionisation of the E region and barometric pressure at the ground. Gherzi (1950) has reported that the character of ionospheric echoes at a fixed frequency of 6 Mcs sec^{-1} is closely related to the movement of air masses in the China Seas. Abbot (1948) has found that the temperature at Washington is lowered on days of severe magnetic storms. Wulf and Hodge (1950) have observed a relationship between anomalies in the large scale air circulation of the troposphere and those in the upper atmospheric current system that produces the geomagnetic variations. The mechanism by which changes in the upper atmosphere are communicated to the troposphere is far from understood even in a qualitative way.

It is well known that the upper atmosphere is subjected to a marked solar control through changes in the ultraviolet radiation as well as in the corpuscular radiation from the sun. Hence it would be logical to examine whether solar variability could influence the troposphere also through the intermediary of the upper atmosphere.

Duell and Duell (1948) have shown that during the winter season in years of low sunspot activity, sea level barometric pressures at European stations fall to a minimum value 3 to 4 days following magnetically disturbed days, and rise to a maximum 3 to 4 days following magnetically quiet days. They have attempted to explain these relationships as due to the bombardment of the upper atmosphere by the corpuscular radiation emanating from the solar M-regions, and to a resulting chain of complex interactions in the upper atmosphere and the stratosphere.

It is well known, that the solar M-regions have fairly long periods of existence, and as a result of the sun's rotation, geophysical phenomena caused by corpuscular radiation exhibit a tendency for recurrence with a 27-day period. Geomagnetic activity, auroral phenomena and variations in the earth currents may be listed among these. If barometric pressure at the earth's surface were also to be influenced by radiation from the solar M-regions, we should expect it also to exhibit the 27-day recurrence tendency. Such a relation was sought for by the author and has been found. The results of a preliminary investigation in this direction are given below.

The barometric pressure data of many stations in South India for the years 1952 and 1953 (years of low sunspot activity) were examined. The interdiurnal changes of both morning (0300 GMT) and evening (1200 GMT) pressures at several stations showed a tendency for recurrence with a period of about 27 days. In some cases this tendency persisted for a long period covering three consecutive solar rotations. Two such cases are shown in Figs. 1 and 2 in which the 0300 GMT pressures of Madras for the period 13 July to 1 October 1952 and of Tiruchirapalli for the period 1 June to 20 August 1953 ar plotted in rows of 27 days. It will be seen that for the greater part of the 27-day period, the features of the curves undergo well-marked repetitions and these appear, in all probability, to be of solar origin. During these periods chosen, the sunspot activity was low and even this did not exhibit the 27-day recurrence; on the other hand the geomagnetic activity did so thus suggesting that the pressure variations and the magnetic activity were caused by the same solar features, *viz.*, the M-regions. The barometric pressure at Delhi during the winter of 1913-14 (a period of low sunspot activity) was also found to exhibit the recurrence tendency

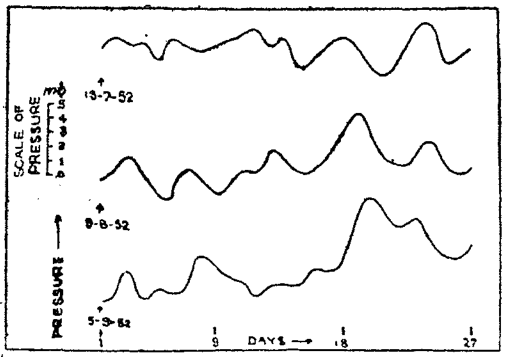

Fig. 1. Variation of 0300 GMT barometric pressure at Madras during the period 13 July to 1 October 1952

This observed solar control of the barometric pressure is in agreement with the statistically deduced findings of Duell and Duell.

Duell and Duell did not find any relationship between solar corpuscular radiation and barometric pressure at European stations during summer. In the present investigation however, using the data of tropical stations, the effect is observed during the summer season as well. This difference in the behaviour of pressure between the high latitudes and the tropics will have to be given due consideration in all attempts at explaining the mechanism by which changes in solar radiation (both corpuscular and ultraviolet) could affect the surface pressure. The possibility of solar M-regions being sources of ultraviolet radiation also, has been suggested by Wulf and Nicholson (1948) and by Das and Bhargava (1953).

During the years 1948 and 1949 when sunspot activity was high, the 27-day recurrence tendency in barometric pressure could not be found. This is what one would probably expect, considering the fact that during such periods the effects caused by the M-regions on the upper atmosphere would be completely masked by those caused by the more active solar phenomena like sunspots, chromospheric eruptions, faculae etc.

The recurrence tendency in barometric pressure seems to hold out some promise

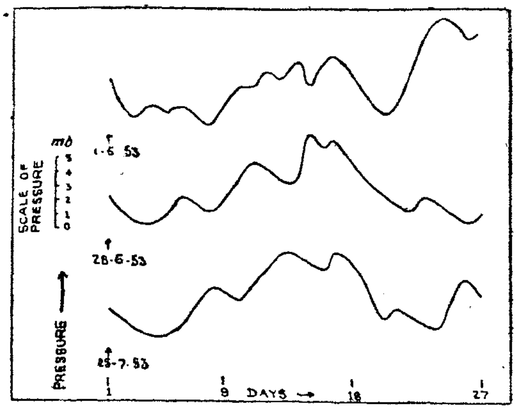

Fig. 2. Variation of 0300 GMT barometric pressure at Tiruchirapalli during the period 1 June to 20 August 1953

in long range weather forecasting during years of low sunspot activity. However before any such attempt is made, an examination of extensive weather data will be necessary with the view of studying the solar control of large scale weather systems.

Further investigation of this type is in progress.

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REFERENCES

Abbot, C.G. (1948). *Smithson. Misc. Collect.*, **110**, 6.

Das, A.K. and Bhargava, B.N. (1953). *Nature*, **172**, p. 855.

Duell, B. and Duell, G. (1948). *Smithson. Misc. Collect*, **110**, 8.

Gherzi, E. (1950). *Nature*, **165**, p. 38.

Martyn, D.F. and Pulley, O.O. (1936). *Proc. R. Soc.*, **154**, p. 458.

Wulf, O.R. and Hodge, Mary W. (1950). *J. geophys., Res.*, **55**, p. 1.

Wulf, O.R. and Nicholson, S.B. (1948). *Pub. Astro, Soc. Pac.*, **60**, p. 37.

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