

Severe magnetic storms and surface pressure variations

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ABSTRACT. Association of surface pressure variation with magnetic activity is studied, using the superposed epoch method. A steady fall in pressure upto about 4 days prior to the day of onset of severe magnetic storm is noticed.

1. The effect of the state of geomagnetic field on the lower atmosphere has been of abiding interest to many investigators (Craig 1952, Shapiro 1956, Macdonald and Roberts 1960, Shapiro and Ward 1962, Twitchell 1963, Jacchia *et al.* 1967, Plam 1967, Beynon and Winstanley 1969). Craig (1952), using superposed epoch method, studied average surface pressure at locations between 30° and 70°N latitude for ten days following geomagnetically disturbed and quiet conditions and concluded that some sort of a link between surface pressure and ionospheric condition existed. Shapiro (1956) observed that the persistence correlation of surface pressure distribution over a location to be the lowest for the day 14 after the day of large and rapid increase of geomagnetic activity. Twitchell (1963) noted an increase in the 500 mb trough index, obtained from the intensity of moving 500 mb troughs, approximately 7 and 14 days after SCs. In this note a study is made of the surface pressure changes at Bombay in relation to SC magnetic storm, using the superposed epoch method.

2. Magnetic storms with range $\geq 300 \gamma$ in the horizontal component of the geomagnetic field at the Alibag Observatory (geomag. Lat. 9·5°N) are considered severe. The local day on which the sudden commencement of the storm occurs has been taken as the key day. Selection of the storms is restricted to single storms *i.e.*, those with no disturbance 5 days before as well as after the occurrence of SC. 39 storms of this type occurred during the period 1924 to 1967. Three individual cases of the pressure variation around the day of SC are presented in Fig. 1. Daily mean barometric pressure values 10 days before and after the day were considered. The mean pressure values are presented in Fig. 2(a). Taking the alternate storms, 39 storms were divided into two groups of 20 and 19 and the mean pressure values were calculated. The patterns for both the groups were

fairly similar to Fig. 2(a), suggesting that the association of pressure with magnetic activity is real.

An interesting feature of Fig. 2(a) is the steady fall in the surface pressure upto about 4 days prior to the SC. Stagg (1928) in his study of time

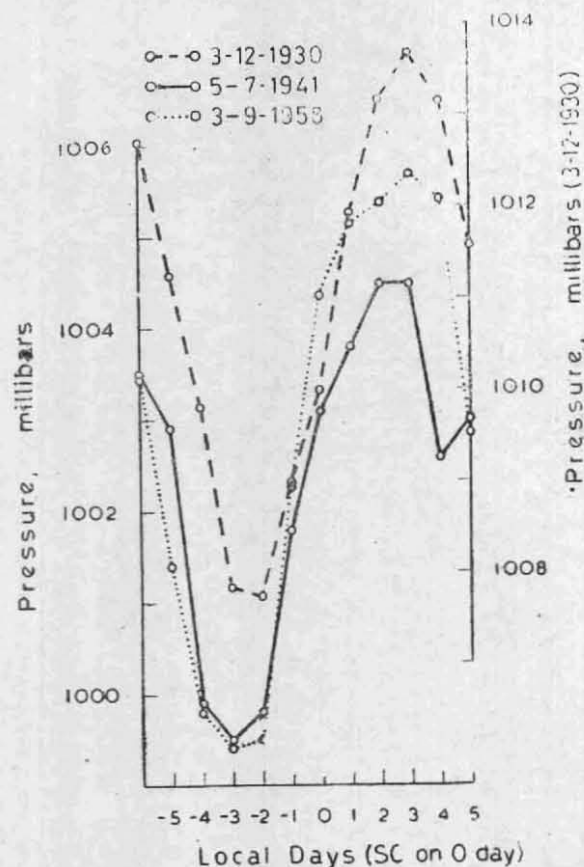


Fig. 1

Three individual cases of surface pressure variation around the day of sudden commencement of severe magnetic storm with range in H at Alibag $\geq 300 \gamma$

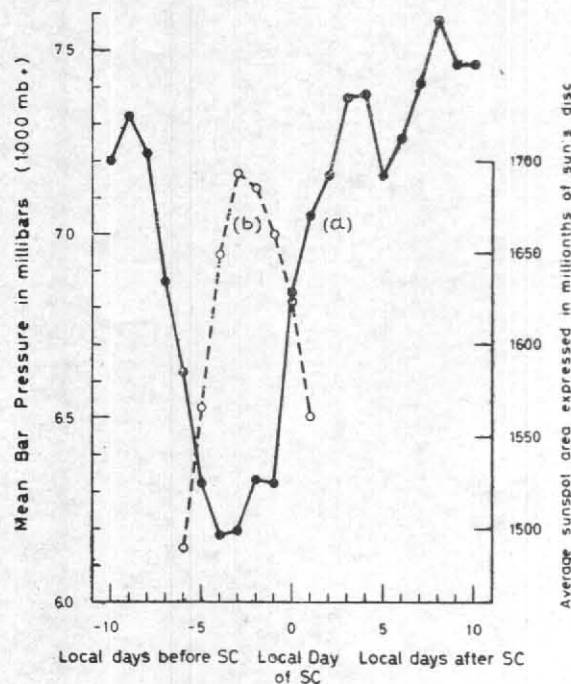


Fig. 2

- (a). Mean barometric pressure (m.b) 10 days before and 10 days after the day of sudden commencement of severe magnetic storm with range in H at Alibag $\leq 300\gamma$ during 1924-1967
Number of storms : 39
- (b). Mean sunspot projected area in millionths of Sun's disc on days associated with magnetic disturbance ($C_i > 1.5$) for high sunspot numbers during 1906-1925. Mean values are taken from Table XI on page 15 of J.M. Stagg's paper in *Geophys. Mem.*, V. 42 (1928)

interval between magnetic disturbances and associated sunspot changes remarks that the 4th day prior to the commencement of magnetic disturbance is the day about which there is the greatest tendency to increase of sunspot area. Fig. 2(b) is the mean sunspot projected area on days associated with magnetic disturbance, $C_i > 1.5$, for high sunspot numbers in the period 1906-1925, taken from Table XI on page 15 of his paper. The pressure decrease appears related to the increase in the projected sunspot area, computed from a different period.

3. Pressure variations similarly computed for 89 moderate storms, with range in H between 150 γ and 300 γ and with no disturbance in the preceding and succeeding 5 days are presented in Fig. 3 (a).

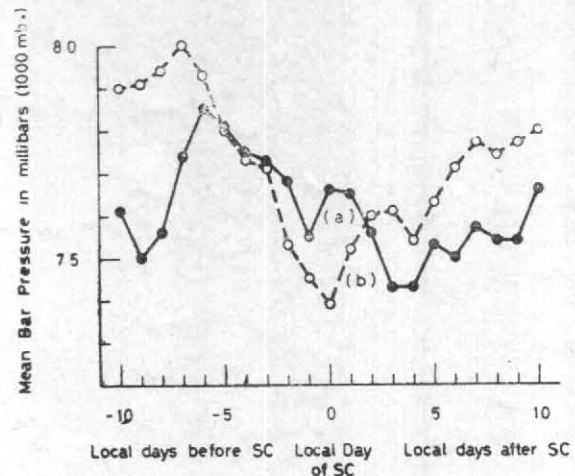


Fig. 3

- (a) Mean barometric pressure (mb) 10 days before and 10 days after the day of sudden commencement of moderate magnetic storm with range in H at Alibag between 150 γ and 300 γ during 1925-1967
Number of storms : 89
- (b) Mean barometric pressure (mb) 10 days before and 10 days after the day chosen at random during 1939-1967
Number of days chosen at random : 90

Pressure variations for 90 sequences of days with key day chosen at random are presented in Fig. 3 (b). In Fig. 3 it is seen that curve (a) is not much different from curve (b). This leads to the conclusion that the association of surface pressure with magnetic activity is evident only under conditions of intense magnetic disturbance. The study by Macdonald and Roberts (1960) also indicates that certain troughs in the 300 mb circulation are amplified subsequent to the onset of severe magnetic storm.

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REFERENCES

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| Beynon, W. J. G. and Winstanley, E. H. | 1969 | <i>Nature</i> , 222, 1262. |
| Craig, R. A. | 1952 | <i>J. Met.</i> , 9, 126. |
| Jacchia, L. G. Slowey, J. and Verniani, F. | 1967 | <i>J. geophys. Res.</i> 72, 1423. |
| Macdonald, N. J. and Roberts, W. O. | 1960 | <i>Ibid.</i> , 65, 529. |
| Palm, A. | 1967 | <i>Ibid.</i> , 72, 5569. |
| Shapiro, R. | 1956 | <i>J. Met.</i> , 13, 335. |
| Shapiro, R. and Ward, F. | 1962 | <i>J. Atmos. Sci.</i> , 19, 60. |
| Stagg, J. M. | 1928 | <i>Geophys. Mem.</i> V., 42, 1-16. |
| Twitchell, P. F. | 1963 | <i>Bull. geophys.</i> , 13, 69. |