Search for Correlation between the Annual Rate of Change of Gemagnetic Horizontal Intensity and Surface Air Temperature at Alibag-Colaba, Bombay

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1. Introduction

WOLLIN *et al.* (1981) found that the annual rate of change values of magnetic horizontal intensity and the annual mean temperature data (1935–1975) from 25 out of 29 pairs of magnetic observatories and nearby weather stations in the northern hemisphere, gave a very good inverse correlation, with a lag of 1, 2 or 3 years in the temperature data. They also discussed two mechanisms for the observed relationship. In the case of Alibag-Colaba, Bombay, pair from India, they correlated the annual H -change data for the period 1937–1967 with the temperature data with a lag of 3 years (1940–1970) and obtained a significant correlation coefficient ($r = -0.54$).

In the present investigation, we have re-examined the geomagnetic and temperature data of Alibag and Colaba, Bombay, respectively, for the same 31-year period as studied by WOLLIN *et al.* (1981), as well as for a much longer period of 103 years (1875–1977) of the magnetic data. The earlier Colaba magnetic data for the period 1875–1905 were first reduced to the Alibag site and then used. We, however, do not obtain any significant correlation coefficient in the case of the Alibag-Bombay pair.

2. Data

The annual mean values of the horizontal component H for the period 1875–1946 were taken from PRAMANIK (1952) and 1947–1958 from the year-book for 1957–1958, Part I (GOVERNMENT OF INDIA METEOROLOGICAL DEPARTMENT, 1957–1958), of the Alibag Magnetic Observatory (Geograph. Coords: $18^{\circ}38'N$, $72^{\circ}52'E$. Geomag. Coords: $+9.5^{\circ}$, 143.6°), and for the period 1959–1977 from the Indian Magnetic Data Volumes (INDIAN INSTITUTE OF GEOMAGNETISM, 1969–1977) and the year-to-year differences were computed, which formed the data set for the annual rate of change of H at Alibag. The surface air temperature data were taken from the nearby weather observatory at Colaba, Bombay (Geograph. Coords: $18^{\circ}54'N$, $72^{\circ}49'E$), as given in the *Annual Summaries* published by the Indian Meteorological Department. The annual

Fig. 1 Rate of change in the annual means of H at Alibag (1875–1977) along with the annual mean surface air temperature values at Colaba, Bombay, plotted with a 3-year lag (1878–1980), showing the absence of correlation. The data within the two vertical lines refer to the period studied by WOLLIN *et al.* (1981).

mean temperature data were derived from the daily values based on the mean of daily maximum and minimum temperatures at Colaba. A considerable amount of these temperature data were supplied by the Deputy Director-General of Meteorology (Climatology and Geophysics), India Meteorological Department, Pune. Additional temperature data for Colaba for the period 1945–1980 were obtained from the Director, Regional Meteorological Centre, Colaba, Bombay, based on the relevant *Annual Summaries*.

3. Analysis and Results

Figure 1 gives a plot of the rate of change in the annual means of H at Alibag from 1875 to 1977, along with the annual mean surface air temperature values at Colaba, Bombay, plotted with a lag of 3 years from 1878 to 1980. The data studied by WOLLIN *et al.* (1981) are also shown bounded by two vertical lines for the period of 1937–1967.

An examination of the different peaks and valleys in the plots of the two parameters does not readily suggest any meaningful association either for the whole period of 103 years or for the period of 31 years. Nor is there any apparent association between the simultaneous data or the temperature data with a lag of 1 or 2 years. The correlation coefficients with the temperature data lagging behind by 3 years of the magnetic data, as well as simultaneous data, have also been computed for the two sets of data and are given in Table 1 along with their standard errors.

These results are not at all statistically significant.

4. Discussion

SRIVASTAVA *et al.* (1979) studied the annual mean values of geomagnetic and meteorological data for the period 1848–1967 from the Colaba and Alibag Observatories, Bombay, situated on the sea-coast in the tropics and under the strong influence of the Indian monsoon, and found that the increasing secular trend of the geomagnetic total intensity at Alibag (as seen from 10-year means of annual mean values) was directly related to the air temperature trend at Colaba. This result was found to be contrary to the inverse relationship between the two parameters (10-year mean values) reported for several magnetic obser-

Table 1. The correlation coefficients.

Period	Lag of temperature data (years)	Correlation coefficient
1875–1977	3	$+0.14 \pm 0.10$
1937–1967	3	-0.15 ± 0.18
1878–1979	0	$+0.15 \pm 0.10$
1937–1967	0	-0.22 ± 0.18

vatories around the world by WOLLIN *et al.* (1973). Subsequently, STERNBERG and DAMON (1979) concluded after extensive investigations for 85 stations that there is no globally valid inverse relationship between geomagnetic intensity and temperature for the period covered by observatory records. PITTOCK (1978) has critically discussed the weakness of these sun-weather relationships. Now, again, we are unable to confirm the results of WOLLIN *et al.* (1981) in the case of Alibag-Colaba, Bombay, about a possible inverse correlation between the annual H -changes and the air temperature with a lag of 3 years in the temperature data. Our present results are statistically insignificant. An examination of Fig. 1 of WOLLIN *et al.* (1981) pertaining to Alibag and Bombay, has revealed certain inaccuracies in the magnetic secular change data plotted for the years 1944 to 1948, as can be compared and seen with Fig. 1 of this paper.

We are, therefore, inclined to believe that geomagnetic-meteorological correlations with the surface data in the Indian region, which comes under the strong influence of the monsoon, and rather weak and insignificant.

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REFERENCES

- GOVT. OF INDIA MET. DEPT., *Magnetic, meteorological and atmospheric electric observations made at the Govt. observatories at Bombay, Alibag, Annamalaiagar and Trivandrum, 1957–1958*, Part I, 1963.
- INDIAN INSTITUTE OF GEOMAGNETISM, *Indian Magnetic Data*, Bombay, 1969–1977.
- PITTOCK, A. B., A critical look at long-term sun-weather relationships, *Rev. Geophys. Space Phys.*, **16**, 400–420, 1978.
- PRAMANIK, S. K., Secular variation of the magnetic field at Colaba and Alibag, *J. Geophys. Res.*, **57**, 339–355, 1952.
- SRIVASTAVA, B. J., H. ABBAS, and S. SAXENA, Solar-geomagnetic-climatic relationships at Bombay, *Indian J. Radio Space Physics*, **8**, 148–151, 1979.
- STERNBERG, R. S. and P. E. DAMON, Re-evaluation of possible historical relationship between magnetic intensity and climate, *Nature*, **278**, 36–38, 1979.
- WOLLIN, G., G. J. KUKLA, D. B. ERICSON, W. B. F. RYAN, and J. WOLLIN, Magnetic intensity and climatic changes 1925–1970, *Nature*, **242**, 34–37, 1973.
- WOLLIN, G., W. B. F. RYAN, and D. B. ERICSON, Relationship between annual variations in the rate of change of magnetic intensity and those of surface air temperature, *J. Geomag. Geoelectr.*, **33**, 545–567, 1981.