

Rapid mid-latitude magnetic storms recorded by old observatories

Fridrich Valach, Pavel Hejda, Josef Bochníček, Miloš Revallo, Magdaléna Váczyová

Recently, a new insight into the mechanism of the Carrington magnetic storm was published, which identified the field aligned currents as the main cause of this well-known event. The new idea seems to be a promising alternative to the generally accepted theory, in which the ring current is the main cause of the low- and mid-latitude magnetic storms. In our contribution, two records of rapid mid-latitude magnetic storms are discussed which were recorded by historical magnetic observatories (years 1848 and 1872). The profiles of the horizontal component show that, instead of the ring current, some currents related to the auroral oval or field aligned currents (FACs) probably played an important role in the development of these interesting geomagnetic variations.

The classic concept of great mid-latitude geomagnetic disturbances is that they are the magnetic storms and are caused by the ring current. Recently, however, Cid et al. (2015) showed that the immensely large decrease of horizontal intensity (H) that was observed at Colaba during the well-known violent variation on 2/9/1859 was probably caused by the FACs.

Here we present two other profiles of the horizontal component that were observed in the middle of the 19th century. Their "recovery phases" seem to be too rapid to be caused by the decay of the ring current.

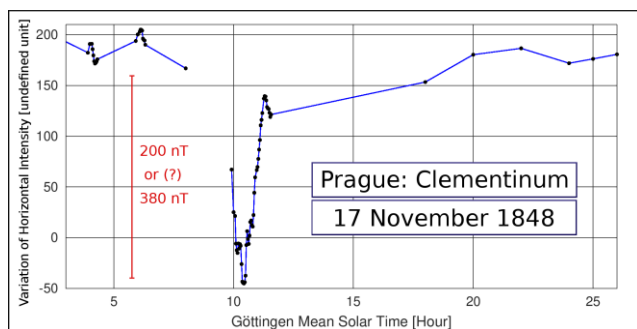


Figure 1: The magnetic variation observed in Prague on 17/11/1848. The vertical scale for the H component has not yet been unambiguously determined.

A pronounced negative variation was observed in Prague (Clementinum) on 17/11/1848 (Fig. 1). This very fast variation with depression more than 200 nT occurred at 23:20 MLT. The most likely interpretation of this event is that it might be caused by the substorm electrojet. Alternatively, its cause might be upward FACs. The magnetic variation was accompanied by an intense aurora, which indicates the presence of auroral oval in mid-latitudes. The GIC effect from this phenomenon affected a telegraph line in Italy.

Author:

- F. Valach¹, P. Hejda², J. Bochníček², M. Revallo³, M. Váczyová¹
 1) Geomagnetic Observatory, Earth Science Institute, Slovak Academy of Sciences, Hurbanovo, Slovakia
 2) Institute of Geophysics, Czech Academy of Sciences, Prague, Czech Republic
 3) Earth Science Institute, Slovak Academy of Sciences, Bratislava, Slovakia

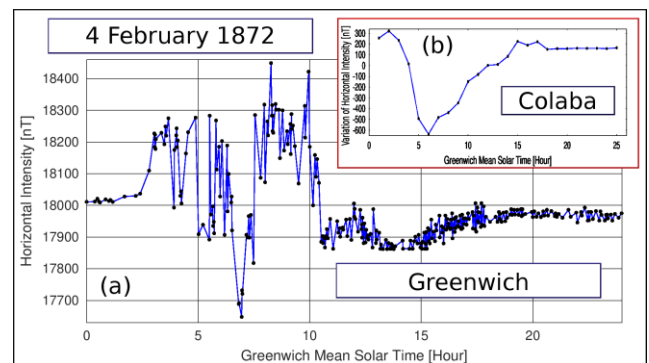


Figure 2: The H-profiles on 4/2/1872 recorded at (a) Greenwich and (b) Colaba.

Very strong auroras accompanied the variations of the H component (Fig. 2a) which were recorded by the Greenwich observatory on 4/2/1872. Maximum depression of H occurred at 19:02 MLT. Interestingly, the 1-hour means of H from Colaba (India) exhibit a profile which well resembles the classic ring-current storm. Provided that the auroral oval reached the location of Greenwich during the storm, the positive variations of H recorded in Greenwich both before and after 19:00 MLT (compared to the H-profile of Colaba) could probably be interpreted as a result of the eastward electrojet.

This study is aimed to support the idea that the non-ring-current magnetic disturbances at mid-latitudes might be much more important than hitherto thought.

Acknowledgments:

This work was supported by VEGA Grants 2/0002/17 and 2/0115/16 of the Scientific Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences.

References:

- C. Cid, E. Saiz, A. Guerrero, J. Palacios, Y. Cerrato, 2015. A Carrington-like geomagnetic storm observed in the 21st century. *J Space Weather Clim* 5: A16, doi: 10.1051/swsc/2015017.

Corresponding author:

Fridrich Valach
 Geomagnetic Observatory, Earth Science Institute, Slovak Academy of Sciences
 Komárňanská 108, 947 01 Hurbanovo, Slovakia
 Tel.: +421 35 760 22 11
 e-mail: fridrich@geomag.sk

