Interactive comment on "Solving the orientation problem for an automatic magnetic observatory" *by* A. Khokhlov et al.

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Short comments on the manuscript "Solving the orientation problem for an automatic observatory" by A. Khokhlov, J.L. Le Mouël and M. Mandea.

The paper is devoted to the actual task of the periodic calibration of magnetometers-variometers at the remote and/or rarely attended automatic geomagnetic observatories. In general, the calibration of the observatory triaxial magnetometer-variometer includes the determination of 3 scale factors, 3 zero offsets and 6 angles for sensitivity axes direction in the selected reference frame. For some types of instruments it is not necessary to determine the zero offset, because this parameter is equal to zero in accordance with the operation principle (for instance, for DIDD or vector 4He pumped

magnetometers). As a rule, such instruments consist of the scalar sensor, which measures intensity of the magnetic field vector with very high accuracy, and the system of deflecting coils, that allows determining components of the vector. Due to the high accuracy of the scalar sensor there is a possibility to perform self calibration of the scale factors and non-orthogonality components.

In the present manuscript the authors attempt to determine the sensitivity axes orientation of the magnetometer-variometer respectively to the geographical reference frame in the assumption, that the six calibration parameters – 3 scale factors and 3 zero offsets – are known a priori. This task is solved by comparison of the magnetometer data and the outcomes of the absolute measurements, usually obtained by means of the DI-theodolite and the proton magnetometer. It has to be noted that the idea to use the absolute measurements for solving orientation problem is not new - the similar approach was used previously to find the orientation of the DIDD magnetometer (Schott and Leroy 2001).

At the beginning of the paper the approach how to find the transformation matrix, which converts data of the calibrated magnetometer-variometer to the proper reference frame, is considered in the error-free case. Then the simulation of the calibration error appeared due to inaccuracy of the absolute measurements performed using the real observatory data. The interesting effect was found - the unexpected weak influence of inaccuracy of the transformation matrix on the final error of the field component determination. However, the low calibration error (approximately few nT) is obtained in assumption that the magnetometer parameters as well as the pillar position are very stable between the calibration campaigns. So, the proposed approach could be hardly applied for solving the orientation problem in the case of ordinal flux-gate magnetometers widely used in the geomagnetic observatories.

In general, my opinion is that the paper is of considerable interest for the observatory practice and may be published after introducing some corrections. The list of small imperfections in the manuscript is given below.

1. At the different places of the paper (p. 340 line2, p. 344 line9, page 349 line 19) there are reference to the Appendix, which is absent in the manuscript.

2. Page 343 lines 9-10. It is stated that the measurement error of the magnetometer-variometer has caused "...neither difficulty nor methodological change ..." In my opinion, it is not true, while the matrix F is poorly conditioned, adding errors to its elements could sufficiently distort the inverse matrix F-1. Should be clarified or commented.

3. Page 343 Eq. (6). It seems the matrix C in Eq. (6) has to be with the hat symbol.

4. Page 345, line 3, page 346 lines 14 and 18, page 350 line 26. The reference to Eq. (8) is marked as "Eq. (9)".

5. Page 345, line15. It is mentioned that the 1-hour means were used for computations, but all results in the Sect. 5.1, 5.2, 5.3 and 5.4 are given for 1-minute data.

6. Page 346, Sect. 5.2. It is not easy to understand how average |ïĄĎV|av and maximum value |ïĄĎV|max were computed. Moreover, there are no expressions for computing |ïĄĎB|av(t) and |ïĄĎB|max(t). Should be explained.

7. Page 347, lines 18-21. "...In Fig. 6 |ïĄĎV|max(t) values are simply ranked versus time t. An examination of this figure in regard of the magnetic situation shows that, as expected, the largest values of |ïĄĎV|max(t) are associated with magnetic storms: ..."

How the reader can know about the presence of magnetic storms looking at Fig. 6?

8. Page 348, line 11-12. "Everywhere $t0 = 7.5$ h for the upper panels, $t0 = 6.0$ h for the lower panels."

Probably it has to be "... left ... right ..."

9. Page 350, line 24. "...In other words, (V 1, V 2, V 3) is close, within b ..."

Probably it has to be "...In other words, (V 1, V 2, V 3) is close, within ïĄěb, ..."

10. Page 351, line 18. The year of the publication is wrong. It has to be 2001 instead

of 1960.

11. Page 353, Fig. 1. My suggestion is to provide captions for the vectors (e1, e2, e3, B1, B2, B3) and to give radius (or diameter) of the balls (ïĄěb,ïĄďb).

References

J.J. Schott, P. Leroy, Orientation of the DIDD magnetometer, Contributions to Geophysics and Geodesy, Vol. 31/1, 2011, p. 43-50.

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