USGS Experience with the Residual Absolutes Method

by E. W.Worthington & J. Matzka

This paper presents a precise calculation of baseline values (discrete values) from Declination/Inclination measurements by the residual method.

The article is well organized and notations in equations are well described. The six following comments are mainly dealing with the fact that the paper lacks of examples, statistics and evidences onto the improvements of the residuals method. Then, one main outcome would be the possibility to provide estimations of error bars on each punctual absolute measurement.
(That would be possibly used in subsequent baseline calculations -not necessarily smooth ones- with the goal of providing users with estimates of the data error standard deviations. But that very last point is beyond the scope of this paper.)

COMMENTS

A- *Abstract*, page 1, lines 11 and 12:
"The Residual method is also being used at the Deadhorse Magnetic Observatory and will be implemented at the other USGS high latitude geomagnetic observatories in the summer of 2017."
This last sentence appears useless here as only CMO baselines over 14 months are presented.
Moreover, explanations presented page 11, lines 21-22 *("The Residual method has been implemented at both College and Deadhorse observatories. The USGS plans to implement the Residual method at the remaining USGS observatories in Alaska in 2017 and in all observatories by 2019.* ") appear sufficient unless the authors add substantial new graphical and statistical examples with Deadhorse and observatories in Alaska.

B- Section *1 Introduction*, page 2, line 6 to 8:
"*1) At high latitudes, where the geomagnetic field is more active, a good null can be difficult to obtain. 2) The Null method requires the observer to be within arm's reach of the DIM to constantly adjust the theodolite/sensor orientation to achieve a nulled output on the fluxgate*."
Point 3) would be the fact that the residual method is far easier to teach and to be achieved by "observers" who are just on site for a year. Indeed, in some places, magnetic observatory observers are just people that will take care of magnetic measurements without knowing anything about geomagnetism or even about geosciences. Thus, the training has to be fast, easy, efficient and to allow possible clumsiness (as forgotten watch, magnetic glasses, etc).

C- Section *2.0 Computations*, page 5, line 15:

"This iterative process is continued until the change in Imean from one iteration to the next is less than 0.0001 degrees."

It makes sense that the iteration is stopped when reaching the limit of angle reading on the theodolite.

However, how is the iterative calculation (from equations 7 to 11) improving the calculation of Inclination? Please, show the distribution of Inclination values with "usual simple method" and the new exact calculation you propose. Please, convince the reader that the exact calculation is worthwhile.

D- Section 2.2 Declination computations, page 7, line 25:

"Using equation 20 can provide a more precise angular value for declination when converting the value from E."

Same question as for **C**-, Please, show statistical evidence for improvement of declination calculation.

E- Section 2.4 Diagnostic Fluxgate Parameters, page 9 and 10.

Please, compare and show the evolution over time of error parameters for both methods ("commonly used" and new exact calculation).

F- Getting precise discrete baseline values is only worthwhile if the discrete data are subsequently incorporated into a precise and mathematically exact determination of the baselines (rather than spline method on each baseline separately) such as, for example, the one presented during the last IAGA workshop in Dourbes:

> Lesur V., Heumez B., Telali A. and Coïsson P. (2016), "On the accuracy of CLF observatory data", In Proceedings of the XVIIth International Association of Geomagnetism and Aeronomy (IAGA) workshop.
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> Or
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> Lesur V., Heumez B., Telali A., Lalanne X., and Soloviev A. (2017) "Estimating error statistics for Chambon-la-Forêt observatory definitive data" [Paper under review for (probably) the same journal as the present paper].

This raises the issue of obtaining error estimates on observatory measurements.

How the authors may give error bar estimations on each punctual absolute measurement?

(The reviewer precise that he is not co-author or even associated in any sense to the above-mentioned paper.)