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Interactive comment on "Non-singular spherical harmonic expressions of geomagnetic vector and gradient tensor fields in the local north-oriented reference frame" *by* J. Du et al.

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General comments

The paper deals with non-singular formulation of the elements of the vector and tensor of the Earth's magnetic field similar to the works done by Petrovskaya and Vershkov (2006) and Eshagh (2008, 2009). The main difference is related to the normalisation factor as in the geomagnetism the semi-normalised associated Legendre functions (ALFs) are used, but in the gravity field studies the fully-normalised ones. The developments are very trivial, but can be useful. In addition, the authors provide the non-singular formulae for the third-order derivatives of the geomagnetic field. The pa-

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per is recommended for publication in Geosciences Model Development after a major revision. The following general and specific comments are provided for improving the paper.

Specific comments

1. The authors are asked to write some words about the differences between the works done by Petrovskaya and Vershkov (2006) and Eshagh (2008, 2009) and to explain why semi-normalised ALFs are used for the geomagnetic field.

2. In the abstract, it is written higher-order derivatives, whilst the paper considers the third-order ones. It should be revised.

3. According to the reference system theory, the local north-oriented frame is defined as a frame whose z-axis is radially upward and the system is left handed. The equations that e.g. Eshagh (2009) has used are based on such a frame. Please explain why this frame is defined differently in the paper.

4. The paper presents the mathematical derivations in 7 subsections, but the problem is that the reader cannot find the connection with these mathematical proofs and the traditional expressions. It is recommended that the authors start with the traditional expressions of the vector and tensor of the geomagnetic field as well as the third-order derivatives, and discuss about their importance and roles in geomagnetic studies, and in the mathematical derivations they refer to the traditional formulae so that the reader can see the connections between the new and old formulae. For example, see the Eshagh (2009) that you have referred to.

5. The appendix repeats the things that have been already presented in the paper. Please remove it! Those coefficients related to the third-order derivatives can simply be move into the text.

6. The purpose of the numerical investigation is not clear. If the goal is just to present the maps of the vector and tensor quantities based on the new formulae, then what will

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be the role of considering two geomagnetic models? One of them should be enough, otherwise the author should discuss about the discrepancies between the models. In addition, the maps of the third-order derivatives are missing, this could be a good contribution, which the paper deals with improperly.

Technical comments

1. All abbreviations should be defined properly in the introduction even if they are well-known and they should be given some reference, e.g. ESA, GOCE, CHAMP, SAC-C, ST-5,Örsted. . .

2. The abbreviation 'SHA' has been defined but never used. Please remove it!

3. In Section 2, above Eq. (1), it is written that '.. at point P' whilst P will be introduced later as the ALF. Simply write any point with the geocentric distance r, co-latitude teta and longitude lambda. The same holds for the text above Eq. (2a).

4. Below Eq. (44), the abbreviation SH has not be defined already. Please write the full name!

5. The sentence above '2-derivation of . . .' write: 'the Kronecker delta'.

6. The article 'the' should not be used when an equation is referred by its number. For example, write: Eq. (1) and NOT 'the Eq. (1)'. The same holds for 'Lemma 3'.

Conclusion of Review

The paper can be published after a major revision and hopefully the authors will find the comments constructive and useful for improving their manuscript.

Interactive comment on Geosci. Model Dev. Discuss., 7, 8477, 2014.