Solid Earth Discussions

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General comments on se-2021-117

Anonymous Referee #1

Referee comment on "Interpolation of magnetic anomalies over an oceanic ridge region using an equivalent source technique and crust age model constraint" by Duan Li et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-117-RC1, 2021

General comments

The manuscript proposes a space-domain method that uses a pair of equivalent layers for interpolating sparse total-field anomaly data on the oceanic crust by using an age model as a constraint. Although not clearly specified in the manuscript, the method is developed in a topocentric Cartesian Coordinate system with x, y, and z axes pointing, respectively, to North, East, and down. The method consists in solving a constrained-linear inverse problem for simultaneously estimating the physical property distribution on the two layers that yields an acceptable total-field anomaly data fit. The method imposes smoothness along isochrons of oceanic crust only on the physical property distribution of the shallow layer with the purpose of filling the gaps of total-field anomaly data. For me, the manuscript needs to be significantly improved before being considered for publication. The main problems are listed below:

- The equivalent-layer technique is offered as a better alternative to kriging, minimum curvature, cubic spline interpolation, and inverse distance weighting methods for interpolating sparse total-field anomaly data on oceanic crust because “these methods might not be optimal for the data prediction in areas with insufficient data” (page 4). The problem here is that the equivalent-layer technique is also negatively affected by insufficient data.
- At the end of page 4, beginning of page 5, it is written that the equivalent-layer technique may provide a more accurate magnetic field because it is possible to improve its structure and distribution. In my opinion, this justification should be considerably improved. It is not clear how the structure and distribution of the equivalent layer can be modified to produce a more accurate field at the interpolating points. I understand that, by increasing the number of sources composing the equivalent layer, it is possible to obtain an exact data fit at the observation points because the inverse problem becomes underdetermined.
- The proposed method uses the crustal age model of Müller et al. (2008) as a priori

information for constraining the linear inversion of total-field anomaly data on oceanic crust. This model, in turn, was obtained on the basis of marine magnetic anomaly identifications. It seems that there is a circular reasoning problem here. Because the age model depends on the magnetic data, it does not necessarily introduce new information into the inverse problem and apparently cannot be used as a constraint.

- Matrices Wx and Wy (eq. 3) impose smoothness along x and y directions. However, the isochrons are not necessarily aligned with x or y directions. So, it is important to clearly explain how the proposed method deals with isochrons that are not aligned with the x or y directions.
- The simulated crust (Figure 1) has isochrons that are perfectly aligned with the North-South direction (x-axis). In this case, matrix Wx (eq. 3) can be used to impose a strong smoothness along the x-direction. However, this model represents a very ideal situation. The simulated survey lines (Figure 2) are perfectly orthogonal to the simulated isochrons. This is also a very ideal situation. For me, the test with synthetic data presented in Section 3 should be used as an initial validation test. The conclusions obtained from this test cannot fully support the interpretation of real data. In my opinion, additional tests with synthetic data produced by models reproducing or at least approximating the complexity of a real magnetic survey on oceanic crust should be included in the manuscript.