Interactive comment on “Constraining the geotherm beneath the British Isles from Bayesian inversion of Curie depth: Integrated modelling of magnetic, geothermal and seismic data” by Ben Mather and Javier Fullea

Jian Wang (Referee)
wangjianhydz@163.com

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This manuscript presents a new technique to quantify the uncertainty of Curie depths (and heat flow) based on the Bayesian framework. The authors describe the method clearly and perform the numerical synthetic tests on the effects of window sizes, fractal exponent, top and extent depths of magnetic sources. However, my major concern for this manuscript is the evaluation of the uncertainties of both the Curie depths and the predicted heat flow. Before publication it requires some modifications and clarifications. I recommend to better describe the synthetic tests and their parameters and extend the
discussion of the uncertainties. All unclear points are indicated below.

General comments:

1. In the synthetic tests part (section 2.3), the uncertainty ups to $\sim 11$ km using the window size of 200*200 km$^2$ (Fig. 2c) which is usually used to estimate Curie depths in global and regional scales. This indicates that the relative uncertainty is ca. 100% and even 200% when the window size reduces to 100*100 km$^2$. Such uncertainties, for me, are too large to be acceptable. For the real magnetic data, the relative uncertainty of Curie depth is $\sim 50\%$ in the southern North Sea (Fig. 6). Accordingly, the relative uncertainty of the predicted heat flow ups to $\sim 100\%$ (?) in the same region (Fig. 9). How to evaluate these large uncertainties. Recently, Arnaiz-Rodríguez and Orihuela (2013), Speranza et al. (2016) and Wang and Li (2018) estimated that most of the relative errors are less than 15% using various magnetic data. Their error estimation is based on the standard deviation between the spectrum and the linear fit (Okubo and Matsunaga, 1994). Wang and Li (2015, 2018), Li and Wang (2016, 2018), Li et al. (2017) applied the average values of Curie depths estimated by different window sizes to further reduce the uncertainties.

2. What’s the value of beta used for estimating the Curie depth in this study? Does it vary through the study area as the window sizes shown in Fig. 5? If this is the case, the authors should provide a map of various beta for comparing with Curie depths. I noted that a larger $D_z$ can be compensated by a smaller beta (Fig. 3c). If the authors employ variable beta, the large Curie depth/uncertainty may be caused by improper beta.

Specific comments listed as Page No.-Line No.:

1. P4-L15: In the centroid method (Tanaka et al., 1999), the wavenumber range is critical for the centroid depth (and therefore the Curie depth) estimation. Although the wavenumber segment selections vary in different studies, most researches took the wavenumber ranges less than $\sim 0.05$ km$^{-1}$ (See Appendix in Wang and Li, 2018).
2. Eq (2): Please double check the fourth term, beta or beta-1.

3. P4-L22: It is difficult to estimate all the three unknown parameters simultaneously by nonlinear fitting the radial power spectrum. Bouligand et al. (2009) used a constant beta of 3.0 to obtain the Curie depth. I don’t know what the value of beta is used in this study as mentioned in the above General comments. Li et al. (2013) demonstrated that the Maus and Blakely models of radial amplitude spectrum are nearly identical in shapes except for a vertical constant shift, and both are applicable to Curie depth estimation in using the centroid method.

4. Fig. 2b: Please provide the inverted parameters for different window sizes on the figure or in the figure caption.

5. Fig. 5: Please plot the centers of each window on the map.

6. Fig. 7a: Please provide the beta value on the figure and in the caption.

Recommended new references:


Best regards
Dr. Jian Wang