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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

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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

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Discussion paper

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 ∼11 km using the window size of 200*200 km2 (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 km2. Such uncertainties, for me, are too large to be acceptable. For the real magnetic data, the relative uncertainty of Curie depth is ∼ 50% in the southern North Sea (Fig. 6). Accordingly, the relative uncertainty of the predicted heat flow ups to ∼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 Dz 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 ∼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:

1. Arnaiz-Rodríguez, M.S., Orihuela, N., 2013. Curie point depth in Venezuela and the Eastern Caribbean. Tectonophysics 590, 38-51.

2. Speranza, F., Minelli, L., Pignatelli, A., Gilardi, M., 2016. Curie temperature depths in the Alps and the Po Plain (northern Italy): Comparison with heat flow and seismic tomography data. J Geodyn 98, 19-30.

3. Okubo, Y., Matsunaga, T., 1994. Curie point depth in northeast Japan and its correlation with regional thermal structure and seismicity. Journal of Geophysical Research: Solid Earth 99, 22363-22371.

4. Jian Wang, Chun-Feng Li. 2015. Crustal magmatism and lithospheric geothermal state of western North America and their implications for a magnetic mantle. Tectonophysics, 638: 112-125.

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geothermal implications for the Songliao Basin. Journal of Asian Earth Sciences, 163: 177-193.

6. Chun-Feng Li, Jian Wang. 2018. Thermal structures of the Pacific lithosphere from magnetic anomaly inversion. Earth and Planetary Physics, 2: 52-66.

7. Chun-Feng Li, Jian Wang. 2016. Variations in Moho and Curie depths and heat flow in Eastern and Southeastern Asia. Marine Geophysical Research, 37 (1): 1-20.

8. Chun-Feng Li, Jian Wang, Jian Lin, Tingting Wang. 2013. Thermal evolution of the North Atlantic lithosphere: New constraints from magnetic anomaly inversion with a fractal magnetization model. Geochemistry Geophysics Geosystems, 14 (12): 5078-5105.

Best regards

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