



EGUsphere, referee comment RC2
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Comment on egusphere-2022-850

Anonymous Referee #2

Referee comment on "Drivers of rapid geomagnetic variations at high latitudes" by Liisa Juusola et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-850-RC2>, 2022

I am sceptical of the authors' measures of internal and external geomagnetic field variation.

I am happy to be corrected on this, but I see no reason why the variational data could not, in principle, be fitted with a geomagnetic field model that are entirely generated by external current systems. When I say this, of course, I am not referring to the internal field generated in the Earth's core. That part of the field is essentially steady over the course of a magnetic storm. To emphasize, I'm referring to the storm-time variation in the geomagnetic field. I see no reason why that part of the field can't be entirely modelled by external sources.

In this context, recall that a spherical-harmonic description of a global field has both internal and external parts (the division between the two comes with different radial functions), and this dichotomy is consistent with potential-field theory. That sort of internal-external division is rigorous, but such a division is not, to my knowledge, available for spherical elementary currents, where one starts off assuming that internal currents reside on a shell at an arbitrarily chosen depth.

Therefore, I would be extremely careful in making physical interpretations of the *internal* field while relying on an unrealistic assumption about the source of the internal field. The danger of circular reasoning, here, should be clear.

I note that the authors seem to admit most this on lines 248-250: "However, separation and interpolation of the geomagnetic field between the stations are not perfect and are affected by the density of the magnetometers as well as boundary conditions, as discussed by Juusola et al. (2020)." One wonders, then, how much the separation can be affected by the boundary conditions. This big issue is not addressed anywhere as far as I know.

My understanding is that the boundary conditions used in spherical elementary current systems are just mathematical conveniences. As such, they allow construction of specific field models, but these field models are only examples from the large set of models that can fit the data. In other words, the models are non-unique. Some of the possible models (with different chosen boundary conditions) might have lots of internal contribution, but others might have very little.

This sort of non-uniqueness is why spherical elementary currents are often described as "equivalent".

As long as such non-uniqueness exists, I don't know how the authors can come to any conclusions about the relative portions of internal and external fields.

Please consider these issues.