Reply to Referee #2

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Dear Referee #2,

thank you for very useful and constructive comments. Please, see below for our point-by-point replies. The original review is written in *black* and our replies in blue.

The authors describe a new set of techniques to model the geoelectric field using curl free as well as the divergence free geomagnetic field. They work through a series of simplification of Maxwell's equations to derive the relationships and point out interesting insights into the induced geoelectric field properties. The model does require a good representation of the ground conductivity which can be a limitation for many other locations. Overall this is an excellent contribution to the research area and will be interesting to apply in locations outside the Scandinavian region.

Minor comments:

Abstract: I would not have a citation embedded in the abstract ((Kruglyakov & Kuvshinov, 2018)

We will remove the citation.

Line 9: coefficients

Will be corrected.

Line 17: with orders of magnitude

Will be corrected.

Line 24: , a solid understanding

Will be corrected.

Line 25: scarce

Will be corrected.

Line 28: A couple of more linking sentences would be useful. E.g. To achieve an intercomparison of results we ... "do things ..."

We suggest to add: "We will approach the modelling problem by separating the different contributions to the geoelectric field."

Line 52: surface

Will be corrected.

Line 150: You make an excellent point about the induced fields tending to cancel each other out.

Thank you!

Line 188: geoelectric

Will be corrected.

Line 300: It is not entirely clear at this point that the SMAP model with PGIEM2G is a prerequisite for the modelling to work to compute CF from DF. Can you clarify that here?

We suggest to modify the original sentence

"In principle, it should be enough to to determine the time-independent coefficients from a single active interval."

by adding the clarification at the end of it:

"In principle, it should be enough to to determine the time-independent coefficients from a single active interval modelled using SMAP and PGIEM2G."

Line 347: good data are available

Will be corrected.

Figure 3 caption: Last sentence says Bx, By, Bz but that is -B_theta, B_phi, -B_r rather than r, theta, phi as written.

Will be corrected.

Figure 5: Conductivity is in a diverging blue-white-red color scale - could you change it to a linear one (i.e. no white in the middle). This applies to other figures or plots with linear increasing rather than positive/negative variations

If it is acceptable, we would like to keep the current color scale. The diverging scale makes it easy to separate small and large values, which is important for the electric field amplitude and conductances. Furthermore, the combination of red and blue should be suitable for the colorblind, whereas many other color scales are not.

Figure 10: similar comment about linearly increasing colors. Also there doesn't seem to be any red in the plots.

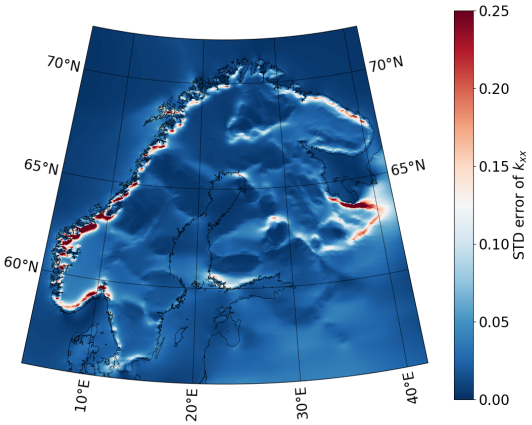
There are very small areas of red, mainly at some coast lines. However, as this is not clear, we suggest to saturate the plots further, as shown in the attached Figure 1.

Figure 18: the label on the colorbars are not legible

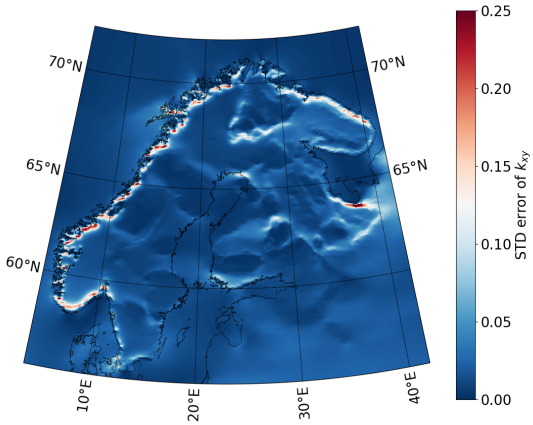
We will make them larger as shown in the attached Figure 2.

In addition, we will remove some extra ϵ_0 from Eq. 22 and Eq. 24. This is just a typo and does not affect the results.

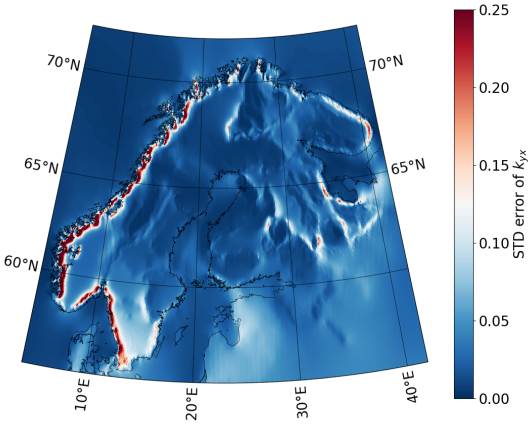
(a) STD error of k_{xx}



(b) STD error of k_{xy}



(c) STD error of k_{yx}



(d) STD error of k_{yy}

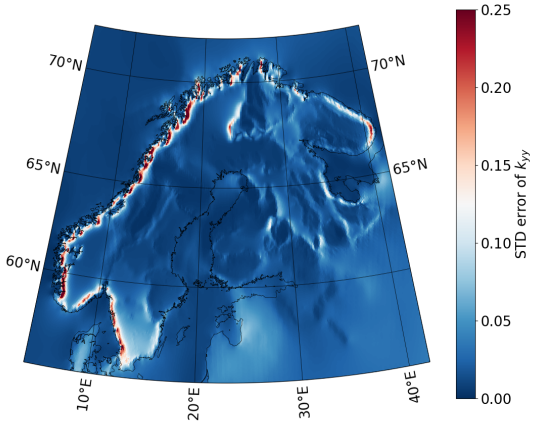
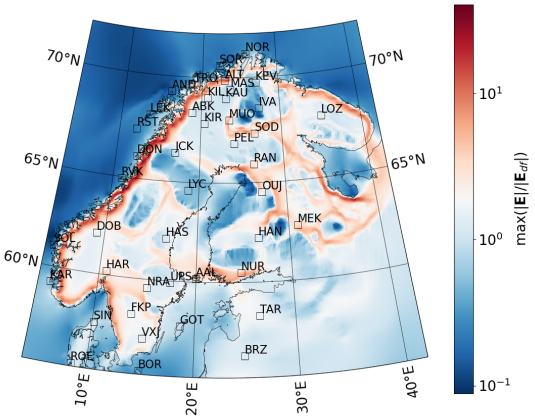
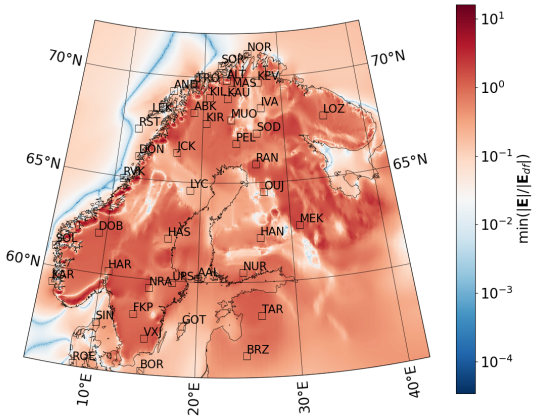


Figure 1.

(a) Maximum $|\boldsymbol{E}|/|\boldsymbol{E}_{DF}|$



(b) Minimum $|\boldsymbol{E}|/|\boldsymbol{E}_{DF}|$



(c) $\boldsymbol{E}_{DF}$ direction for maximum $|\boldsymbol{E}|/|\boldsymbol{E}_{DF}|$

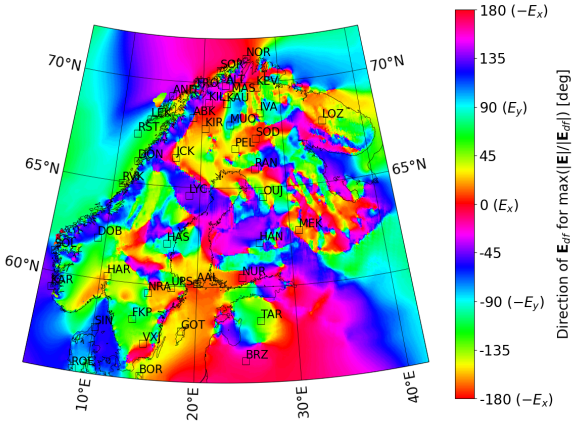


Figure 2.