Ocean Sci. Discuss., 12, C1130–C1132, 2015
www.ocean-sci-discuss.net/12/C1130/2015/

Ocean Science
Discussions

Interactive comment on "Impact of variable sea-water conductivity on motional induction simulated with an OGCM" *by* C. Irrgang et al.

C. Irrgang et al.

irrgang@gfz-potsdam.de

Received and published: 11 November 2015

We are very thankful for the insightful scientific remarks of the reviewer, which helped us to clarify this manuscript.

- "My main issue with the presented approach is that while the authors introduce a detailed, three-dimensional model of the electrical conductivity, based on the temperature and salinity distributions provided by the ocean circulation model, they still use the static, thin-layer simplification of the EM induction equation. For example, the self-induction term (dB/dt) cannot be neglected for tidally induced ocean flows (cf. the different methods used in Tyler et al., J. Geoph. Res. 1997 vs. Tyler, Geophys. Res. Lett. 2005), casting a doubt on the last paragraph of conlusions (p. 1880, l.20-26)."

We agree with the reviewer that self-induction cannot be neglected for magnetic fields that are induced by ocean tides. In the mentioned paragraph (p. 1880, l.20-26), we did not mean to raise the assumption that the results of our study can be simply transferred to, e.g., tidally induced magnetic fields. The thin-layer approximation of the EM induction equation is standardly used (Tyler et al. 1997, Vivier et al. 2004) to model the large-scale ocean circulation induced magnetic fields. It accounts for vertical variations of sea-water conductivity in an integral sense. Indeed, other approaches for solving the EM equation might show a different response (pattern and strength) to a variable conductivity distribution. However, the principal effect of a variable sea-water conductivity should not be neglected in any model configuration. In this sense, the results presented in this manuscript are not confined to the specific model setup or type of water flow, respectively. Nevertheless, we understand that this paragraph might be confusing and we clarified this passage.

- "Although this is probably not critical in the slowly evolving global circulation model, one could still imagine the effects of large vertical conductivity gradients not described by Eq. (1)", "Also, using an insulating Earth's mantle might be a good first-order approach, but wouldn't a conductive mantle affect the generated magnetic signals to a similar degree, as variable seawater conductivity does?"

This is a very interesting research question and might be a suitable subsequent study. As the reviewer already stated, an insulating Earth's mantle is a good first-order approach that was already used in several studies. One of the advantages of our model setup is that we utilize an OGCM to obtain consistent spatially and temporally variable oceanic quantities (e.g., velocities, salt and heat distributions, and conductivity distribution). This setup allows us to asses the pure response of the ocean circulation induced magnetic field to different sea-water conductivity distributions. The contribution of further effects, like interactions and comparisons arising from the Earth's mantle, are beyond the scope of this study. Still, the mentioned ideas are noteworthy and we added them to the conclusion part of the paper, pointing to future related studies.