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Discussions

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Interactive comment on "Testing the Electrodynamic Method to Derive Height-Integrated Ionospheric Conductances" *by* Daniel Weimer and Thom Edwards

Anonymous Referee #2

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Daniel Weimer and Thom Edwards, Testing the Electrodynamic Method to Derive Height-Integrated Ionospheric Conductances, MS No.: angeo-2020-60

First and foremost I apologize to the authors and editor for the slow reply. I simply got swamped with work.

The paper applies three, separate empirical models to the formulas proposed by Amm (2001) to calculate the distributions of the ionospheric Pedersen and Hall conductivities for various conditions.

The paper is, with some exceptions, well written, figures are of publication quality, the technique is well explained and the paper is logically organized. I do, however, suggest

the authors address my major weaknesses. In particular the methodology needs to be critically discussed. Please view my many comments and concerns as an attempt to be helpful. Based on this is recommend publication after minor revisions.

Major concerns.

Methodology 1. While the technical approach is largely (see below) well explained the methodology is questionable. When the authors organize their data by IMF, dipole tilt angle, F10.7 and so on the assumption is that these parameters are indeed controlling the ionospheric electrodynamics. There is a causality implied in the approach which opens two fundamental questions: is there a cause-and-effect and if so what is the delay?. I think this may work on the dayside where delays between SW conditions and the response of the ionospheric electrodynamics are likely on the order of minutes and thus within the 5-min binning. I, however, object to the approach on the nightside. Here the plasma-sheet is involved and the FACs, particle precipitation, convection and thus conductances and ionospheric currents are due to processes within the plasma sheet. These are only probabilistic related to the SW conditions and the delays are largely unknown and certainly much larger than the 5-min binning. An example is in L338 "IMF clock angles influences the conductivity values". I do not think the word 'influences' is right. Another example is in L203. Is the previous 20 used or is it the center of the window? If centered the ionospheric conditions can hardly be associated with future SW conditions? A discussion of this methodology and arguments for why this is appropriate is required. 1) Methodology 2. I worry that the paper uses a circular argument. The SuperDARN convection distributions use a fill-in model which is IMF driven. Thus, the convection has embedded an IMF dependence which will obviously will be seen in the derived distributions. 2) Technique 1. Please provide an argument for why AMPERE and SuperMAG was not used. These have been carefully validated and provide more comprehensive datasets than those used here. 3) Technique 2. I worry that the ground level perturbations are assumed to be due to an overhead current. This is not the case in the polar cap and equatorward of the auroral oval.

Please comment/discuss. Also see L254-255. 4) Technique 3. Clearly the solutions are problematic in regions of low E but I also worry about regions in which the direction of E varies sharply. Maintaining the relative alignment of the various parameters in such regions is very difficult and mis-alignments result in erroneous conductances since these essentially are fudge-factors. 5) Technique 4. The authors allude in L435 to the Hall vs DF. Can you include a brief discussion on this widely used assumption? Also see L85-86. 6) Energy transfer (e.g. L371). How is energy transported over these long distances? L359 states: "their gradients act to transport energy flux" but I don't understand how this actually works. 7) L437-455. Please change from 'scale sizes' to something like 'small- and meso-scale'. Also, I don't know where the 20%-50% comes from. The contribution from these processes is very much a topic of discussion.

Minor concerns.

Remove L75-77. I disagree, considering all the other complications. L150. "after accounting for solar wind propagation delays". Please elaborate. Which technique is used and I assume this is from L1. L293. "a wrong result again, but useful to include." Can you please add an argument "a wrong result again, but useful to include, because..." L319. The Green el al paper was a proof of concept or technical paper. L339: See Ohtani, S., Gjerloev, J. W., Johnsen, M. G., Yamauchi, M., Brändström, U., & Lewis, A. M. (2019). Solar illumination dependence of the auroral electrojet intensity: Interplay between the solar zenith angle and dipole tilt. Journal of Geophysical Research: Space Physics, 124, 6636– 6653. https://doi.org/10.1029/2019JA026707.

Clean up language. For example: "atmosphere with a high level of precision" what does this mean? "that cause the derived conductivity to seem negative", why seem? "gradients act to transport energy flux from", transport flux? "and potentially useful conductivity values are lost." to who and how?