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Comment on angeo-2022-9

Anonymous Referee #1

Referee comment on "Storm time polar cap expansion: interplanetary magnetic field clock angle dependence" by Beket Tulegenov et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2022-9-RC1, 2022

This paper attempts to show that:

- Open GGCM used in the paper does a good job of predicting the location of the open-closed magnetic field boundary (OCB)
- The minimum latitude reached by the polar cap expansion during a storm follows the IMF clock angle during periods of rotation of the IMF
- During times of strongest southward IMF, the polar shifts towards the dayside.

Disappointingly, in my opinion, the paper does not demonstrate these points.

The claim that that the model does a good job of predicting the OCB is not supported by the data shown in the paper. The paper shows histograms of the error of the predicted OCB compared to the observations for each of four storms, and it is readily seen that the histograms and standard deviation are roughly what would be expected for a uniform distribution of error over the range +/-5 degrees in latitude. This indicates to me that the model is essentially giving a random location for the OCB over a 10 degree range of latitudes, a range that is larger than the typical width of the auroral oval. There is some trend for both the model and the data to show the well-known tendency for the OCB to move to lower latitudes with increasingly southward IMF Bz.

The two conclusions about the polar cap location and shape are obtained solely from the model and no attempt is made to consider whether these trends are also seen in the data. It would be interesting if such trends could also be discerned from the data, and perhaps the authors would consider whether they are able make such a determination.

A further point is that the paper does not adequately describe how the OCB was determined from the DMSP data. Many times the DMSP data shows a clean transition from the plasma sheet to polar rain, but this is far from always the case. For example, low-energy (<~1 keV) can extend roughly continuously from the plasma sheet to the mantle on the morning side, and, in the vicinity of the cusp, the OCB can lie at an equatorward boundary of precipitation because cusp precipitation is on open field lines. Enough information needs to be presented so that a knowledgeable person could reproduce the results, Simple saying "spectrograms of ion and electron differential fluxes in a range from 30 eV to 30 keV were inspected to identify the polar cap boundary crossings of the satellites" is not sufficient.

A minor point: I recommend not including statements of fact in a paper's Introduction without a reference. Examples in the current paper are:

"Convection can also change the shape of the OCB without changing the flux contained in the polar cap."

"When the polar cape opens up, that plasma leaves the plasmasphere and convects away. Thus, the OCB shape also controls the shape of the plasmasphere."

"During times of high geomagnetic activity these methods can fail because the precipitation is very intense, clobbering the radars' return signal."