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Comment on angeo-2021-55

Anonymous Referee #1

Referee comment on "Statistical study and corresponding evolution of plasmaspheric plumes under different levels of geomagnetic storms" by Haimeng Li et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-55-RC1>, 2021

General comments :

The preprint is dealing with plasmaspheric plumes in the Earth's magnetosphere and their occurrence rate dependence to geomagnetic storms intensity. The study is based on observations and simulations. The study is based on Van Allen Probe A observations of plasmaspheric plumes. Results are compared in detailed to the output of a previous study (Lee et al., 2016) that focused on the observations of plumes close to the magnetopause. Simulations of plume evolution are presented for two geomagnetic storms of different intensities to explain the different results between the present study and Lee et al. study. The overall impression of the study is positive: the paper is well-organized, the reasoning is logical, figures support the interpretation, and considering simulations to explain observations make the conclusion stronger.

Specific comments:

1. Only VAP-A observations are used (and not VAP-B), which make sense for the occurrence rate calculations. It is therefore surprising that only VAP-B orbit is overplotted on the simulation output with the indication "the black curves indicate the observed plasmaspheric plume" (Figure 5 and Figure 7). Why is that plume observation made by VAP-B? one could expect observations from VAP-A or, even better from both probes.
2. The main finding of the study is that the occurrence rate of plumes at lower L-shell is higher during large geomagnetic storms and higher at large L-shell during low geomagnetic storms. As shown in your simulations a given plume plume is larger close to the plasmapause (at low-shell) that farther from the plasmapause (at larger L-shell). The plume criteria detection is however the same for every L-shells. How can this affect the occurrence rate estimation, and hence the conclusion?
3. The two simulated events correspond to geomagnetic storm of still relatively moderate intensity. Is there any reason for not choosing a $Dst < -100$ nT storm for the second event?

L45: for EMIC the situation is a bit more complicated: EMIC are not preferentially observed in the high-density plumes (Usanova) excepted maybe for triggered emission (Grison)

L146: Is there any discontinuity in the density or the Sheeley model states a density of 5 at $L=7$?

Figure 4.c: It would be good to extend the time range to the stop time of the simulation (figure 5)

Technical corrections:

L25: A torus

L30: plasmaspheric particles: the convection given by the formula is sign-charge dependent

L72: deleted artificially: "discarded" might sound better

L94: define the "non storm" period

L101: dusk side: looking at the figure, you could even give a precise range 15-21MLT