The paper “Width of Plasmaspheric Plumes Related to the Intensity of Geomagnetic Storm” investigates the relationship between the minimum value of dst indice and the plasmaspheric plume width. The dst indice is assumed to be connected to geomagnetic storm intensity. The analysis relies on Van Allen Probes data and it is illustrated with simulations of two plume events. The paper is logically organized, the figures are generally correctly described and the reasoning is clearly explained. However, I have several concerns about the methodology that I would recommend to address before publication.

The Dst is the single proxy for geomagnetic storm intensity considered in the study. Looking back at Gonzales 1994, based on magnetic storms, only min(Dst) lower than -30nT are related to magnetic storms (weak:[-50,-30] and moderate [-50,-100] nT). Intense magnetic storms are not part of this study and conversely the large number of events with min(Dst) larger than -30nT might not be considered as magnetic storms. Your work seems to analyze the relationship between plume width and Dst dip (rather than magnetic storm intensity). This point needs to be clarified (for example, you could either replace the wording “magnetic storm intensity” or exclude the >-30nT events from the study).

Answer:

Thanks for your suggestion. Dst value reflects the level of magnetic storm intensity. According to your suggestion, we replace the wording “magnetic storm intensity” with “level magnetic storm intensity”. Of course, combining the relationship between plume width and Kp or AE indices can better explain the relationship between plume width and “magnetic storm intensity”, which will be done in further work.

The discussion about your suggestion has supplemented in the “Discussion and Conclusion” part of revised manuscript:

On Lines 358-362:

‘This paper analyzes the plume events with Dst value ranging from -90 nT to -15 nT during the recovery phase. In the future study, we will use other geomagnetic activity indices to analyze the relationship between plume width and magnetic storm intensity, such as Kp, and AE, thus studying the correlation between the plume width and substorm activity.’

You claim that you find a relationship a dependence between the plume width only when excluding the events with most negative min(Dst) values. To my opinion it is not fully proven, as you also excluded events that are too large (in MLT and/or R). I would suggest to also try to find a relationship between the plume width and all the dst values when the large plumes are excluded.

Answer:

Thanks for your suggestions. We do not claim that the correlation value arose only after excluding plume events with most negative min (Dst) values. There are few plume events from -90 nT to -209 nT in the range of excessively negative Dst values (less than 12% plume events in the range of 57% Dst values), so analyzing this portion of the plume events would have resulted in a chance result. Therefore, we exclude the events with excessively negative Dst values (less than -90 nT).

I have some concern about your statistical analysis (L204). I do not see any very significant linear relationship in Figure 6, as stated L204. Is it a problem of data distribution, of Spearman correlation understanding, or something else?

Answer:

Thanks for your reminder. We calculate the Pearson coefficient between the P to indicate the size of their linear correlation, and calculate P-value (I'm sorry that P-value was wrongly written as Spearman correlation coefficient in the manuscript. This terrible error has been corrected in the new manuscript.) to test the feasibility of their non correlation. These calculations are realized by the corrcoef function in the MATLAB software.

In order to avoid misunderstanding, the wrong sentence has been changed to:

On Lines 205-206:

'The minimal P-value (~2.890×10-10 and ~4.300 ×10-7, respectively) shows that the linear relationship between them is very reliability.'

Minor comments:

It is striking from your simulation figures that the plume width is smaller at larger R values. How does this affect your analysis?

In the first paragraph a reference to a paper of early explanation/observation of the plasmaspheric plume is missing.

Answer:

Thanks for your reminder. Limited by the method of measuring plume width, we analyze the average plume width instead of each plume width to statistically reduce the impact of different R on plume width. At the same time, it also reflects the importance of our simulation, which can show a more comprehensive process of plume evolution to verify our statistical conclusions.

L63 (1): this is true for outbound crossing only. I guess you identify the plasmapause during inbounds as well.

Answer:

Thanks for your reminder. A complication to the measurement of plume widths is that VAP-A satellite always work anticlockwise, at same time, the plume is still rotating clockwise (mostly) or anticlockwise. This effect can lead the observed plume width wider or narrower than actual one. In a statistical sense, since the entry edge of the plume has similar behavior to the exit edge of the plume, the average width of many plumes is fairly insensitive to such effects (Borovsky et al., 2008).

L83-84: Need some clarification. How did you proceed? Did you search the plumes for the whole rbsp dataset or are you looking for plumes only after Dst minima?

Answer:

Thanks for your reminder. Referring to Halford et al. (2010) and Wang et al. (2016), the onset time of storm is defined as the time when the Dst index slope becomes negative and keeps relatively negative till the minimum of Dst index in our study. In this paper, we search the plumes for the VAP-A dateset (from 2013 to 2018), and think the intensity of magnetic storm is represented by the minimum Dst value from the onset time of nearest storm to the time when plume is identified.

L134: how do you define the main phase? How many plumes are not related to any storm?

Answer:

Thanks for your reminder. Referring to Halford et al. (2010), the main phase is defined as the period from onset of the storm until the Dst reaches minimum value.

We believe that the plume cannot be generated by a too weak magnetic storm, so the plume events with less than -15 nT are considered to be the residual part of the plumes generated by earlier magnetic storm and are finally excluded.

So, the definition of main phase has been added in the revised manuscript:

On Lines 134-137:

'Similar to the standards described in Engebretson et al. (2008), Halford et al. (2010) and Bortnik et al. (2008), we define the main phase is the period from onset of the storm until the Dst reaches its minimum value, and the end of the recovery phase is defined as the fifth day after the main phase finishes.'

L209: describe in few words how the two processes differ.

Answer:

Thanks for your suggestion. By calculating the drift paths of a great quantity of test plasmaspheric particles, the simulation not only provides the evolution of the plasmapause and plasmaspheric plume boundaries, which is similar to the plasmapause test particle (PTP) simulation provided by Goldstein et al. (2004; 2014a; 2014b), but also reveals the evolution of equatorial density in both the plasmasphere and plasmaspheric plume.

So, the sentences have been revised in the new manuscript:

On Lines 210-212:

'In this study, this process differs from the plasmapause test particle (PTP) simulation which only provides the evolution of the plasmapause and plasmaspheric plume boundaries in Goldstein et al. (2004; 2014a; 2014b);'

L223: one can suppose that Maynard and Chen discovered the solar wind electric field.

Is that correct?

Answer:

Thanks for your reminder. I'm sorry we misunderstood you by using references incorrectly. Maynard and Chen (1975) give a formula about the correlation between solar wind electric field and model of convection electric potential (Φ_{VS}). In the new manuscript, we adjust the position of this reference to avoid misunderstanding:

On Line 223:
'the convection electric potential, which is expressed as (Maynard and Chen, 1975): ...'

L223: "IMF" azimuthal angle

Answer:

Thanks for your reminder. φ indicates the azimuthal angle, and the relationship with MLT is MLT = $12(\varphi/\pi + 1)$.

The supplement about azimuthal angle has been added in the revised manuscript:

On Lines 226-227:

'Here, the ESW is the solar wind electric field. φ indicates the azimuthal angle, where MLT = $12(\varphi/\pi + 1)$.'