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Annales Geophysicae Discussions

# *Interactive comment on* "MMS observations of energetic oxygen ions at the low-latitude duskside magnetopause during intense substorms" *by* Chen Zeng et al.

**Anonymous Referee #1**

Received and published: 13 August 2019

This manuscript describes statistical analysis of energetic oxygen ion properties at the low-latitude noon-dusk magnetopause. Although the results are of interest to the current space science community, more descriptions and detail are needed to clarify the results and the methods used to derive them. This manuscript may be acceptable for publication in Annales Geophysicae following careful consideration of and adequate responses to the comments given below.

Line 138: The authors should clarify the information on which instrument dataset was used for each data product. Were the moments shown in Figure 2c-2e recalculated from the FPI distribution functions? Or are they the default moments calculated over



the full FPI energy range?

Line 140 (Figure 2f): The calculations performed to derive the >1keV O+ density need to be described to inform the reader how the HPCA energy ranges were specified for those calculations. If a software package was used, then details of the software package and a citation to it should be included. The >1keV H+ density could also be plotted in this figure panel.

Line 158-164: The magnetopause identification criteria are not very convincing. Recommend carefully defining these criteria, as all statistics are derived based on the magnetopause identification. Recommend the authors review identification criteria used in previous works. For example, Haaland et al. (2016) and (2019) describe magnetopause observations by Cluster and THEMIS:

Haaland, S., Reistad, J., Tenfjord, P., Gjerloev, J., Maes, L., DeKeyser, J., Maggiolo, R., Anekallu, C., and Dorville, N. (2014), Characteristics of the flank magnetopause: Cluster observations, J. Geophys. Res. Space Physics, 119, 9019–9037, doi:10.1002/2014JA020539.

Haaland, S., Runov, A., Artemyev, A., & Angelopoulos, V. (2019). Characteristics of the flank magnetopause: THEMIS observations. Journal of Geophysical Research: Space Physics, 124, 3421–3435. https://doi.org/10.1029/2019JA026459.

Paschmann et al. (2018) describe magnetopause identification and observations by MMS:

Paschmann, G., Haaland, S. E., Phan, T. D., Sonnerup, B. U. Ö., Burch, J. L., Torbert, R. B., et al. (2018). Large-scale survey of the structure of the dayside magnetopause by MMS. Journal of Geophysical Research: Space Physics, 123, 2018–2033. https://doi.org/10.1002/2017JA025121.

Line 180: More details are needed to describe how the mean values of the H+ and O+ fluxes and densities were calculated.

Line 184: A more detailed description of how substorm phase (i.e. expansion phase or recovery phase) was defined based on AE index is needed. The authors should use Figure 1 AE index to aid in their description.

Line 202-209: Several narrow energy ranges used for comparing the O+/H+ density ratio are noted. It is important to describe for the reader how these energy ranges were used in the density ratio calculations. In addition, a description of why these energy ranges were chosen should be included. Did the authors consider calculating the density ratio for all energies >1 keV instead of calculating the ratios over individual energy ranges? A comparison of density ratios using both methods may be helpful to decide which method to use. Such procedural information on which analysis methodology was chosen could be included in an appendix.

Line 218-248: Figures 5, 6, 7 all show comparisons of the O+/H+ density ratio. After addressing the previous comment on Line 202-209 on why separate narrow energy ranges were chosen instead of using a broad energy range, the authors may need to revise panel (b) of these three figures. For example on Line 240: Are the O+ and H+ densities referred to in this section calculated from one of the energy ranges discussed in Line 202-209? Greater detail and explanation are needed.

Line 254-256: After addressing the above comments on how the ion densities were calculated, the authors should briefly address whether these comparisons of density across missions are relevant. For example, if the O+ density (calculated over defined HPCA energy range) is higher than seen by Cluster (calculated in what energy range and using which instrument?), what does this mean? Were the instrument energy ranges equivalent or similar? Otherwise, the direct comparison may not be meaningful.

Line 305: Since 31 events is not a large number, recommend the authors produce a table listing the dates and times of each of these events so that others in the space science community can also investigate the events for follow-on studies. Such a table could go in an appendix.



All the references in the manuscript need to be checked. For example, all the MMS instrument papers were referenced but do not appear in the references list. It is likely many other references have been missed.

Line 106: Pollock et al. (2016) is referenced but does not appear in the references list

Line 105: Russell et al. (2016) is referenced but does not appear in the references list

Line 104: Ergun et al. (2016) is referenced but does not appear in the references list

Line 104: Lindqvist et al. (2016) is referenced but does not appear in the references list

Line 107: Young et al. (2016) is referenced but does not appear in the references list

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