Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-136-RC1, 2019

Annales Geophysicae Discussions
Open Access
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Interactive comment on "Ionospheric Plasma Density Measurements by Swarm Langmuir Probes: Limitations and possible Corrections" *by* Piero Diego et al.

Anonymous Referee #1

Received and published: 19 September 2019

Overall appreciation

This paper discusses two corrections that should be applied to the Swarm Langmuir probe measurements for ionospheric electron density. The paper presents an assessment of the quality improvement of the obtained results by comparing Swarm and CSES data. The results reported here constitute an important advance in using Langmuir probe data to build a consistent observation set of in situ ionospheric densities. The paper is well-structured. There is an excellent introduction to Langmuir probe theory, which allows the reader to appreciate the relevance of both proposed corrections. The paper also puts the work properly into context. The conclusions are clear. I have a

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Discussion paper

few suggestions for improving the presentation of the material. In particular, there are many small language and typographical issues in the manuscript. The paper will likely be suitable for publication after minor revision.

Questions and remarks

The section “Langmuir probe: general theory” is very instructive. Perhaps it would be good to somewhere state that it is written from the point of view of spherical Lps. Note that some ionospheric Lps have been cylindrical (e.g. Hoang et al. 2017, https://doi.org/10.1088/1361-6501/aa87e1; Ranvier et al. 2017, https://doi.org/10.1109/TPS.2017.2700211). It might therefore be interesting to explain how the conclusions from this section would be modified for the case of cylindrical probes.

In the Swarm-CSES comparison, the authors find that – after applying the corrections – the agreement becomes much better, but that there is a difference between the dayside and the nightside situation. A major difference between the dayside and nightside ionosphere is in the electron temperature. This therefore prompts questions about the Te that the authors have used in the correction. How has it been obtained? On lines 214-215 the authors refer to the difficulty that this correction requires a good value for Ne and Te up front. It would be useful to provide at least an estimate of the sensitivity of the correction factor to uncertainties on the given Te.

Figures 4, 6 and 7 compare the original densities to the corrected ones. There is no way to separate the respective roles of both corrections separately, while this would give valuable information about the usefulness of each correction individually. This could easily be provided, for instance, by expanding the histogram plots of figure 7.

The paper very strongly focuses on Ne as the prime result of the Lp measurements, and how it can be improved. But what about Te? Some comments would be appreciated.

Minor issues

Title: drop “possible”

17: the concept “voltage ripple” might be familiar only to a limited public; reformulating this to avoid this technical terminology could make the abstract more accessible for a broader audience

27: represents -> represent

29: mounting -> carrying

30: 470 km : I presume that this is the orbit altitude? What about the spacecraft separation between the pair?

35: in -> by

36: Lpbased -> Lp-based

37-38: The references given here focus on ionospheric density applications and compare the Lp data with remote sensing data. It could be worthwhile to also mention comparisons done in other domains between Lps and in situ plasma data (from plasma spectrometers or wave analysers), such as the one by Pedersen et al. 2008, https://doi.org/10.1029/2007JA012636.

56: mounts -> carries

66: Importantly, the conjunction is also in altitude. Perhaps it is sufficient here to just say “in conjunction with . . .”

75: drop the superfluous hyphen

85: with respect to -> with respect to the

111: thin sheath condition -> the thin sheath condition

111: thick sheath regime -> the thick sheath regime

170: Can you provide an order of magnitude error due to ignoring H+?

180: particles -> “particle’s” or “particles”’

185: compensation -> Compensation

198: unmatched parenthesis? Also, this expression does not contain S_h which you explain on the next line

213: something is wrong with the construction of the sentence. Replace “results” by “is”?

228: Due to thermal velocity -> Due to the thermal velocity

228: compared to plasma potential -> compared to the plasma potential

238-255: It would clarify the explanation given here by adding a figure that sketches the configuration and a typical ion trajectory.

255: Oxigen -> Oxygen

255: Could you indicate how big the correction term is relative to Rp?

294: algorithm for sheath effect -> algorithm for the sheath effect

297: with respect to fixed probe potential -> with respect to the fixed probe potential

300: explains -> explain

300: The argument presented here focuses on the extent to which both spacecraft are at the same geographic longitudes. As the problem involves plasma density, wouldn’t one rather have to make the argument for geomagnetic longitudes?

336: a strong electric field -> a strong probe-spacecraft electric field

339: are -> is

Varia:

Please be consistent, sometimes you use “in-situ”, sometimes “in situ”.

Idem for V_s/c and V_S/C.

Note that different citation styles are used throughout the text: sometimes as (. . .), sometimes as [. . .], sometimes with author first name initials and sometimes without, . . .

There is a typesetting problem with variable left text margin width.

There is also a problem with the symbol for the Debye length.

Section numbering is missing in the submitted manuscript (although such section numbers are sometimes referred to).

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