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

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Dear Dr. Forster, Thanks for the detailed comments that may help us to substantially improve our analysis. The aim of our work is not to bend Swarm Ne to that of CSES, but is to find the reasons why the two instruments show such a high discrepancy in the absolute values while they track each other in the shape of the time series along the orbit (reaching a very good agreement when at almost same LT). Of course, the expected difference due to the different altitude (about 35% from IRI values) and orbits have been taken into account, as reported in Sect. 4 (Fig.5 and relevant comment). The results obtained by Lomidze et al. are not a matter of discussion for us, because, even

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if they show consistent agreement between the measurements and the models used, we think that in-situ observations should be treated separately since these are obtained with similar procedures, and these are quite different from those used for the calibration made by Lomidze et al. The agreement in Lp measurements could be a simpler matter once the actual value of collected current is determined. For this reason, we consider very important to find a way to match in-situ measurements in order to provide the proper reference values for ionospheric plasma models. Of course, also CSES Lp data may need a calibration review, especially for what concern the plasma potential detection (e.g. Rui Yan et al., The Langmuir probe onboard CSES: data inversion analysis method and first results, EEP, 479-488, 2018, doi:10.26464/epp2018046). However, it is our feeling that the harmonic mode of Swarm Lp, and in particular its negative bias, could produce more important interferences in the ion collection described in OML theory. With reference to the shape and effect of a sheath around the probe, we appreciate your suggestion and the one of Dr. Buchert (private communication) which warn to consider the Chen reference and the sheath presence itself in case of fast moving objects in the plasma (i.e. S/C velocity). Still we believe in the sheath presence and in its effect on ion collection but we would rather suggest the specific results of Whipple (Potential of surface in space, 1981) for a revised evaluation of the actual current collection. To examine in depth your warnings, we have chosen Whipple (1981) results that summarize the condition in which the sheath effect on ion collection is applicable. In fact, if the relative velocity between S/C and plasma is much greater wrt the thermal velocity, this effect becomes very small with respect to the static scenario we suggested. The increase in current collection, therefore, should be within a few tens of % more than that collected by the probe disk area. The magnitude of this current enhancement is also in agreement with that suggested by Buchert. About the “electric field effect” induced by the S/C-Lp potential difference, we thank you for the information about the reference GND that we misinterpreted. If we understand well, such potential difference is fixed at -2.5V along the orbit. In our paper, the word “unbalanced” means that the cross-section grows only toward the S/C but not in the outer direction. We

estimate the ToF to identify how long the electric field acts pushing down towards the probe the ions that are travelling in the space between S/C and Lp. This path can be roughly considered to start at the edge of the S/C sheath and to finish while crossing the stub of the Lp.

Anyway, as the sheath is the charge layer that shields electric fields around a polarized body, the electric field is confined inside the sheath. This means that, as long as the sheath is small, the probe polarization effects are localized very close to the probe and, in addition, they are already described by OML theory. In such cases corrections are not applicable. Nevertheless, when the plasma density becomes lower (e.g. at higher latitudes or inside plasma bubbles or Travelling Ionospheric Disturbances,. . .) and the Debye length consequently increases, the probe and the S/C sheaths could melt and the electric field between them is no longer shielded, giving rise to saturation effects due to ions amount inside the enlarged global sheath. Unfortunately, this scenario appears to be very hard to describe with a simplified model and so the relevant current collection enhancement. All those issue imply that the paper cannot be corrected in its current version but it needs a complete revision. We aim to carry such study out in cooperation with the Swarm Lp developer team in order to improve the feedback rate and the quality of the analysis. We decided therefore to withdraw the paper in its current form. Best regards. Piero Diego

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