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Comment on angeo-2021-36

Anonymous Referee #2

Referee comment on "Terrestrial exospheric dayside H-density profile at 3–15 R_E from UVIS/HDAC and TWINS Lyman- α data combined" by Jochen H. Zoenchen et al., Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-36-RC2>, 2021

Review of a paper entitled: Terrestrial exospheric dayside H-density profile at 3-15 R_E from UVIS/HDAC and TWINS Lyman- α data combined, submitted by Zoenchen et al. to Annales Geophysicae

General comment:

Although it was difficult for me to follow the contents, I understand that the authors performed the following analysis. (Analysis 1) The Lyman-alpha emissions observed by UVIS/HDAC on Cassini during its Earth flyby were compared with the two independently simulated Lyman-alpha emissions, (a) based on the Geocorona density model derived from the TWINS Lyman-alpha observations published by Zoenchen et al. [2015] and (b) using a radial symmetric model that follows the r^{-3} profile, where r is the geocentric distance. (Analysis 2) Using the difference between the UVIS/HDAC observed emissions and TWINS-based simulated emissions at $r = 3.0-5.5 R_E$, the UVIS/HDAS emissions were corrected. (Analysis 3) Using the corrected UVIS/HDAS emissions, the Geocorona density profile was determined as a new radial symmetric function. (Analysis 4) The density profile was fitted to different functions: one for $3 < r < 8 R_E$ and the other for $r > 8 R_E$. The authors concluded that the results indicate a higher rate of H ionization in the vicinity of the magnetopause and beyond because of increasing charge exchange interactions of exospheric H atoms with solar wind ions outside the magnetosphere.

Since I have major concerns regarding each of the above-listed analyses, I do not recommend this manuscript to be published in Annales Geophysicae until the following major concerns are carefully addressed and the manuscript is accordingly revised.

Major comments:

(A) For the correction of UVIS/HDAS observations, the authors determined the conversion factor, f_c , for the emissions at $r = 3.0-5.5$ Re (overlapping region). The authors used a constant value of f_c (3.285) for Analysis (3) to determine the Geocorona density profile for $r = 3.0-15.0$ Re. However, f_c is not flat at $r = 3.0-5.5$ Re, and f_c is ~ 3.1 at $r > 8$ Re. I suggest the authors use the r -dependent f_c to determine the density profile. The different density profile found in Analysis (4) may be because the constant f_c is applied.

(B) The authors focus on $r = 3.0-5.5$ Re, for Analysis (2), but the TWINS-based model presented by Zoennchen et al. (2015) provides three-dimensional density profile as a function of local time, and latitudes, using harmonics expansion. The validity range of the model is $3 < r < 8$ Re. Why do the authors rely on the TWINS-based model only at $r = 3.0-5.5$ Re? Is the model not valid for $r > 5.5$ Re on the dayside?

(C) The authors used f_c derived from the comparison between UVIS/HDAS and TWINS-based model, but the authors should be able to calculate f_c from the comparison between UVIS/HDAS and the r^{-3} model. I suggest they use the latter f_c as well for Analyses (3) and (4).

(D) The authors assume that the exosphere r profile was similar for both UVIS/HDAS and TWINS cases due to comparable space weather conditions. However; (a) it is not adequately described in the manuscript how comparable the conditions are. I recommend the authors summarize the conditions in a table or something equivalent. (b) What is the advantage of using UVIS/HDAS on Cassini to model the density profile? TWINS observations are enough if the exosphere profile was similar and TWINS observations are better.

(E) For Analysis (3), the fitting procedure/algorithm needs to be described. Also, the authors need to explain why they choose the model function.

(F) It seems to me that the authors use r for two different parameters. One is the geocentric distance (the distance from the Earth center) used for the density models, and the other is the closest distance of the instrument line-of-sight from the Earth center (e.g., Figure 3) used for column brightness/density.

(G) For Analysis (1a), it is not adequately described what values of the coefficients of the TWINS-based model are used.

(H) In addition to line-of-sight information, it is better to describe the field-of-view (FOV)

information of UVIS/HDAS on Cassini. How wide is FOV? What is the pixel resolution (if the instrument can look at more than one direction)?