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Comment on gi-2021-25

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Referee comment on "On the determination of ionospheric electron density profiles using multi-frequency riometry" by Derek McKay et al., Geosci. Instrum. Method. Data Syst. Discuss., https://doi.org/10.5194/gi-2021-25-RC2, 2021

This study examined derivation of the electron density height profile from measurements with the multi-frequency riometer, and concluded that the profile cannot be estimated uniquely from the measurement alone. I agree with the conclusion and the mathematical process. However, to improve the article, I think that the text had better clearly write unique points different from previous works in this field.

Estimation of the electron density profile has been conducted by several researchers in this field for more than half century. They also suggested difficulty in estimating unique profile close to the real one. Then some of the previous works proposed model functions to assume the height profile. Since authors also have worked in this field for many years, I think that you know well, but you can refer to, for example, Parthasarathy et al. (JGR, 1963), Hultqvist (PSS, 1968), Stoker (JGR, 1987), McKay-Bukowski et al. (IEEE Trans. Geosci. Remote Sens., 2015), Cheng et al. (JGR, 2006). Comparing with these previous works, an advantage of this work would be the mathematical approach, which presents difficulty in an objective manner. Section 1 (Introduction) should mention this point.

There are some minor comments.

- L66-68: There are two comments on these lines. (1-1) Can the neutral density change be significant for the collision frequency? It is generally hard to measure the density, so

we used to apply the model value, but it is likely different from the true value. (1-2) The electron temperature may significantly increase around 105-110 km with large electric fields or Farley-Buneman instability, although it is not often occurred. So I agree that we can ignore such a special situation, but it may be good to mention in the text.

- L86: “where i is the height array index for a given height, h” Redundant. Already written at L85.

- L100: Probably “Figure 3”.

- L119: This may be better to say "why many riometers used to be operated in the 30-40 MHz range".

- L158: Probably “eleventh” instead of “tenth”.

- L162-163: “As a result, it can be hypothesized that any number of model solutions could be formulated that would result in a superficial fit of the data.” Does this suggest that a model reproduced by some lower terms may be acceptable to fit the data?

- No solid black line in Figure 8.

- L195: (8-1) There are two curves in Figure 9. The text should mention each line. (8-2) My understanding is that the absorption residual, shown in Fig. 9, was derived from Fig. 8 as differences between values with solid and dashed lines. A simple calculation may provide noisy results but curves in Fig. 9 are very smooth. Why?

- L200 “The two profiles bear no resemblance.” The SVD may not give unique solution. Is there any possibility that there is/are other answer(s)? It might be closer to the true data. If this is the case, you do not need to pick up the m_est curve as the representative one.

- L213 “s is the shape function parameter.” I cannot find "s" in the equation (21). Since the last sentence of this paragraph says "s" is a scalar, do you assume s = 1 so invisible in the equation?

- Eq.(22): I cannot follow derivation of the equation 22, in particular, about the relation with the equation 21. What relations are there between G_s and G?

- Caption of Figure 11: “The residuals are shown in the two top panels.” Redundant.

- L265: “which is that” Should remove.