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Interactive comment on "The linear growth rate of Rayleigh–Taylor instability in ionospheric F layer" *by* Kangkang Liu

Anonymous Referee #2

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General comments:

Presented in this manuscript is a new formulation of the linear growth rate for the Rayleigh-Taylor plasma instability (RTI) that generates Equatorial Plasma Bubbles (EPBs) in the equatorial ionospheric F layer. Different from previous formulations, notably that by Kelley (2009), this formulation uses charge conservation as opposed to current continuity. The author argues that there are issues in applying both the current continuity equation and the perturbation electric fields, as done in previous formulations. This results in a significantly different interpretation of the RTI; in particular, that both the charge accumulation and the perturbation electric fields are not the causes of the RTI, but are the result of it, as argued in this manuscript. The author also concludes that both the background electric field and the neutral wind do not affect the RTI. This

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Discussion paper

manuscript presents an interesting perspective on the RTI formulation and, in the opinion of this reviewer, does constitute an advancement in the theoretical understanding of the RTI. However, there are a few, mostly minor, issues (noted below) that the author should consider prior to being fully accepted for publication.

Specific comments:

1. On the effect of the background electric field and the neutral wind on the RTI: The conclusion that the background electric field and neutral wind do not impact the RTI is not substantiated in my view. Perhaps I did not follow the derivation presented in section 2 well, but it appears to me that the background electric and neutral wind were not considered. In particular, line 94 states that the background electric field was set to zero, and the neutral wind, which is present in equation (1), is no longer present following the linearization in equation (9) and it's not clear to me why this is the case; was there a reference frame change to that of the neutral wind or was it also set to zero? In either case, the author should clarify this point and either justify this conclusion (by better explaining the derivation in section 2) or remove this conclusion from the manuscript.

2. Exponential decay of plasma density with altitude: Equation (18) states that the initial plasma density has an exponential dependence on y. How does this assumption impact the updated description of the RTI shown in figure 5, where the plasma density is represented as a step function from n2=0 to n1? Should this formula for the plasma density be included in this schematic; i.e., should this formula be included for n1 to further complete this description? Further, is this description for L the same as other formulations; i.e., gradient scale length L in Kelley (2009)?

3. General readability of derivation: It is suggested that the author attempt to improve the readability of the derivation in section 2; e.g., in lines 116-120, there are references the "the above relation" and it's not clear to the reader which formula is being discussed, and some of the English is not entirely clear. For example, "the exact relation between

E and V . . . is not simply cE+VxB = 0. . .” yet this relation is used to obtain equation (16). This section needs to be clarified.

4. Local RTI versus flux-tube integrated RTI: It is clear to this reader that the formulation in the current manuscript is focused on the “local” RTI, as opposed to the flux-tube integrated RTI, which was derived by Sultan (1996), which is arguably more “accurate” than any formulation of the local RTI, which includes only a 2-D description of the phenomenon that ignores aspects like interhemispherical asymmetries in physical parameters. While requesting the author to expand their formulation from 2-D to 3-D is clearly outside of the scope of this work, it is suggested to the author to include some mention of this previous work in their introduction and to include some comments on the differences between these approaches in their manuscript. Such additions would help readers better place this work in the context of previous theoretical works.

Technical corrections:

1. Line 14: “calculations” instead of “calculation”

2. Line 24: “this ratio” instead of “the ratio”

3. Lines 25-26: “previous physical description. . . is wrong” is quite strong language. I would suggest that perhaps “is inaccurate” is a better choice.

4. Line 45: Remove second “in”

5. Line 53: I think the author means “From” from “Form”

6. Line 57: “contradicts” not “contradict”

7. Lines 60-61: “equatorial plasma bubble” and “EPB” to plural

8. Line 63: “when the current continuity is applied”

9. Line 65: “growth rate he calculated” I suggest removing personal references from the manuscript

10. Line 71: “RTI are”

11. Line 73: “F layer is depicted”

12. Lines 116 and 118: is “v” supposed to be capitalized?

13. Line 159: “g=10” appears twice here

14. Line 167: This language needs to be smoothened.

15. Line 169: “As k increases..”

16. Line 183: The term “gamma subscript K” for Kelley’s growth rate formula appears for the first time here, but does not appear to be used throughout; e.g., line 232 and 59-60. I suggest making this consistent throughout the manuscript

17. Line 194: “Taking the divergence”

18. Line 199: “field has significant”

19. Line 204: “discussed in section 3.2”

20. Lines 207-208: Should this sentence be two separate sentences? “. . .accumulation. In order. . .”

21. Line 237: “by including the effects”

22. Line 238: Sentence beginning with “He think” needs to be reworded; also the previous sentence needs a period. Further, remove personal references.

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