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Comment on amt-2022-57

Anonymous Referee #1

Referee comment on "Detection and Localization of F-layer Ionospheric Irregularities with Back Propagation Method Along Radio Occultation Ray Path" by Vinícius Ludwig-Barbosa et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-57-RC1>, 2022

1st Review of "Detection and localization of F-layer ionospheric irregularities with back propagation method along radio occultation ray path" by Ludwig-Barbosa et al.

I am afraid that I don't think this is an interesting paper and it is not appropriate to be published because:

- The authors seem to have contradictory understanding about the use of back propagation methods to localize the ionospheric irregularities. On one hand, the authors, as titled, studied the back propagation method to localize F-layer ionospheric irregularities in this manuscript. On the other hand, the authors seem to have deep suspicion about this method. For example, in L137-140, the authors mentioned that "BP method has been used to detect irregularities in F-region in studies using both simulations and real occultation measurements. However, there is a lack of RO events combined with collocated data provided by different systems where the true location of the irregularity region is precisely known". So can the back propagation method localize the irregularities or not? Clearly there are only rare chances we can find RO events collocated with other observations. Also if other observations can provide true location of irregularity, why do we need RO data for this purpose then?

The study took an RO case used in Carrano et al. (2011) as a starting point to perform their simulations. The authors thought the location of the plasma bubble in this case can be well estimated because it collocates with observations from a radar and a ground-based VHF receiver. I agree that from different observation platforms you can derive more

physical parameters related to the irregularity. But one reason why Carrano et al. (2011) didn't use the back propagation method to infer the location of irregularity was the phase data (which is required to back propagate the signal) was not available for this case.

In my opinion, the back propagation method is not something new. It has been used to localize the ionospheric irregularities in simulation study and real RO measurements.

- The simulation of the single bubble case in this study was similar/same to the modeling described in Carrano et al. (2011). What is new in the study is that more cases with different sizes, fluctuation intensities and placements were designed to test the impact on the estimation accuracy. But I am not sure how applicable of those designed simple cases is to represent the real ionospheric irregularities, and not very convinced by the conclusions made through such simple analysis. The authors claimed that the location estimation accuracy of the back propagation method was ~ 10 km based on idealized single plasma bubble setting. In this study, the space between each BP phase screen is 50 km. If shorten the distance between phase screens, would the estimation accuracy be enhanced? Also the authors mentioned that "in multiple bubble scenarios only the strongest disturbance would be resolved properly". How good would it be considered as "resolved properly"? If there're several local minima in the standard deviation curve, wouldn't different local minima correspond to locations of multiple irregularity regions?
- The writing is poor, unclear and redundant. For instance,

L47-48: "the location of irregularities patches is not self-reliant": what does "self-reliant" mean herein?

L111-113: "the excess path due to ionospheric ... which ... which ... due to slightly different propagation paths": please rephrase this sentence.

L118-120: "Such regions ..., which specifically corresponds to sizes up to the Fresnel scale": I can't tell what you are trying to express here, especially the clause.

L131-132: "The high-order bias ... by Kappa or Bi-local correction": This sentence is not needed.

I would stop addressing the remaining ones here, and suggest the authors read the whole manuscript carefully and try to make each statement clearer and more concise.

Specific comments:

L14: "Fresnel-Huygens" Huygens-Fresnel

L39: "RF" first time to mention. No abbreviations

L52: "parametrization" parameterization

L128-129: the authors introduced the "inbound" and "outbound" herein, but also used other terms such as "first" and "second", "left" and "right" to describe the same meaning. It would be better to just use one set of such terms.

L149: "in the propagation and vertical direction": vertical direction is not clear to me, vertical to what? Do you mean "along- and across- propagation directions"?

L149: "outer scale": what does this "outer scale" indicate?

L154: "a envelope" "an envelope"

L166-167: Could the authors please give a simple explanation of your WOP or tell me where in the text you introduced your "WOP"?

L192: "SLTA" No abbreviation here since it is mentioned for the first time.

L208: "left side"?

L219-220: Please explain where the threshold value comes from. There's no Figure A.

L294-295: "In reality, ...by BP method estimation": what do you mean by "slightly farther away from the LEO"? Why not "closer to the LEO"?

A18: fs,WOP \square fs,wop

L378: 80 km?

L381: horizontal direction?

L382: 2×10^{18} \square 2^{18}