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Manuscript Title: **Analysis of ionospheric structure influences on residual ionospheric errors in GNSS radio occultation bending angles based on ray tracing simulations**
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We thank the referee very much for the constructive comments and recommendations and for the overall positive rating that this is considered a useful paper clearly worthy of publication. We thoroughly considered all comments and carefully revised the manuscript accounting for most of them. In addition, we carefully complemented these revisions with a couple of further improvements throughout the manuscript text in the spirit of the comments.
Please find below our point-by-point response (in form of italicized, blue text) to the referees' comments (in form of upright, black text)*, inserted below each comment. Line numbers used in our responses refer to the original AMT Discussions paper and text updates in the revised manuscript are quoted below with yellow highlighting.*

Response to Anonymous Referee #1's Comments

1. General Comments

This paper presents a detailed analysis of residual ionospheric errors (RIE) that have been found in a simulation study of radio occultation measurements. It is, in effect, an extension of [Liu et al., 2015], where the simulation was first reported. In that paper the data with large RIE was excluded from the analysis. In this paper, the large RIE data is re-analysed in order to assess, in detail, how the errors accrue along the raypath. This attention to detail is commendable and provides useful insight into the measurement. The paper is clearly worthy of publication in AMT.

Thank you.

One concern is that the conclusions may not be fully supported by the text. In particular, the authors make the point that the large RIEs can be produced by ionospheric asymmetry or by technical ray-tracing errors that probably arise from discontinuities in NeUoG. The role of ionospheric asymmetry to emphasized by showing that the errors largely disappear when a spherically symmetric ionosphere is used, However, it seems likely that any NeUoG discontinuities will also be removed in the spherically symmetric case; i.e. the two issues cannot by separated by this test. It would be more persuasive if it could be demonstrated that the rest of the dataset (i.e. those with reasonable RIEs) did not exhibit ionospheric asymmetries. Through since no physical reason is presented for the large RIEs to occur in the geographic areas where they are most prevalent, it seems this is unlikely. If ionospheric asymmetries do occur in the other data, the conclusion may be that the large RIEs are caused by the ray-trace problems alone, or by a combination of both the asymmetry and the ray-trace.

Thank you for this important comment; we also got similar questions from the second referee. Based on these comments we carefully re-assessed the 26 cases in terms of their asymmetry, also in the context of the other dataset with the reasonable RIEs, and found re-confirmed that the physical asymmetry and the technical effects inevitably mix up as long as we do not have

an advanced ray tracing based on rigorously smooth 3D ionospheric modeling that reliably keeps the technical effects negligible. (Despite efforts, including talking to other relevant ionospheric experts such as P.Straus/Aerospace Corp. and Stig Syndergaard/DMI, we could not get to such a ray-tracing-using-rigorously-smooth-iono.modeling solution yet.)
We therefore toned down the related discussion a bit now, at several places in the text where found better, including toning down also the conclusion on the role of iono.asymmetry.
We re-checked the abstract first and think in this one we got the right tone already, including that in the last sentence we clearly point to the needed further improvement.
In the conclusions we changed, on p. 17, lines 5-6, from "asymmetric ionospheric conditions play the primary role for anomalously high RIEs," to "strengthening previous results by Mannucci et al. (2010, 2011) we find that asymmetric ionospheric conditions play an important role for anomalously high RIEs," Otherwise we think it looks adequate, again clearly making the point at the end of the section towards the needed further improvement.
In the remainder of the text we changed as follows, at places where we deemed it relevant:
on p. 6, lines 20-21, we rephrased from "main driver of anomalously high RIEs are asymmetric ionospheric conditions as only few events" to "main driver of anomalously high RIEs are asymmetric ionospheric conditions and possibly residual error effects from ray tracing through the 3D ionosphere, since only few events";
on p. 7, line 9, we changed from "some perturbations may also come in from" to "some perturbations also come in from";
on p. 15, line 17, we replaced "dominance of asymmetry effects in driving" by "dominance of asymmetry and 3D ray tracing effects in driving the"; and
on p. 16, line 6, we updated from "play major roles" to "play important roles".

2. Specific Comments

Other issues:

The work of [Danzer et al., 2015] is referenced. In that paper the analysis was limited by "high noise of the simulated bending-angle profiles at mid- to high latitudes". Is this the same problem ray-trace? If so, it is probably worth mentioning it.

Yes, was the same kind of limitation. Ok, we added on p. 9, line 13, a sentence which mentions this: "Danzer et al. (2015) noted that their analysis was somewhat limited by high noise of the simulated bending angle profiles at mid- to high latitudes, which partly reflected the degrading impact of technical ray tracer effects that we also encounter and more explicitly address in this study."

Page 4, line 17. This sentence has become confused and a rogue full stop is present.

We agree this is confusing currently; we thus improved the current p. 4, line 16-19, text part to: "...the RIE biases have a clear negative tendency and a magnitude increasing with solar activity as well as are affected by deviations from ionospheric spherical symmetry (Mannucci et al., 2010) where increasing asymmetries also tend to increase the biases."

Refs

Danzer, J., S. B. Healy, and I. D. Culverwell (2015), A simulation study with a new residual ionospheric error model for GPS radio occultation climatologies, Atmos. Meas. Tech, 8, 3395–3404, doi:10.5194/amt-8-3395-2015.

Liu, C. L., G. Kirchengast, K. Zhang, R. Norman, Y. Li, S. C. Zhang, J. Fritzer, M. Schwaerz, S. Q. Wu, and Z. X. Tan (2015), Quantifying residual ionospheric errors in GNSS radio occultation bending angles based on ensembles of profiles from end-to-end simulations, Atmos. Meas. Tech., 8(7), 2999–3019, doi:10.5194/amt-8-2999-2015.