Statistical analyzing the effect of ionospheric irregularity on GNSS radio occultation atmospheric measurement

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AMT-Review

General comment:

The submitted manuscript quantifies the impact of ionospheric irregularities on failed radio occultation (RO) inverted events and bending angle oscillations, due to the contribution of sporadic E occurrences and the F1-layer. The manuscript provides a very interesting contribution on assessing the impact of small-scall residual ionospheric errors (RIEs) on RO data profiles. Except of a few minor revisions, I recommend the manuscript for publication.

Specific comments:

Literature research (Introduction): Some of the older and newer published literature on assessing RIEs is missing. Regarding older literature the study of Danzer et al. 2013 is very interesting, since it applies a very similar approach to assess the impact of the RIE. The study analyzed the bending angle bias as a difference of the observed bending angle to the MSIS reference climatology, to obtain an estimate of the RIE. This similarity in the approaches should be mentioned. More recent literature is the work by Danzer et al. 2020 and Liu et al. 2020, where the former assesses the climatological impact of the RIE and the latter applies a profile-to-profile study which calculates the RIE through applying four terms (electron density, geomagnetic field, raypath inbound, and raypath outbound effects). Please have a look into it and discuss it in your manuscript. Maybe it could be also relevant to the calculation of small-scale scintillations (kappa and bi-local correction).

Line 114: Please provide information about the settings for the NCAR climatology model. How was the setting for the solar activity? Danzer et al. 2013 uses for example a constant solar flux value, in order to assess the solar variations of the RO bending angle to the climatology.

Line 118: Please provide a more detailed introduction of the S4 index, to aid readability and understanding.

Lines 193-196, Figure 2: I am curious, what is the statistics within a bin? I know it varies with latitude, however, just on average, from low to high latitudes, so that I get an idea of the numbers behind the percentage shown in Figure 2. Please also replot Figure 2, fix the range of the colorbar, e.g. column 2, the range moves from 0 to 20, and from 0 to something like 25. Furthermore, a colorbar needs a unit and a label of what is shown, the manuscript always includes this information in the title.

Lines 322-329: I really appreciated the summary, but I think the implication and discussion part could be extended. What are the next best steps to include the ruled-out events in the processing? Bending angle oscillations at high altitudes are usually handled via the high-altitude initialization, to remove such effects. Is the bi-local correction (Liu et al. 2020) an option for correcting such small-scall ionospheric scintillations?

Technical comments:

Figures: Please *improve readability of the Figures* 1,2,5,6 for the reader. For example, Figure 1 misses the information of label and unit on the y-axis (altitude, km). In the third column, the y-axis extent is not constant (it jumps a bit). Provide ticks in-between (third and fourth column, x- and y-axis). And so on … Figures 5 and 6: Include a unit and label information for the colorbar (r.h.s.), include a larger space between the colorbar and the plots.