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Interactive comment on "Ionospheric correction of GPS radio occultation data in the troposphere" *by* Z. Zeng et al.

Anonymous Referee #2

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This paper considers the ionospheric correction of GPS radio occultation in the troposphere, and how to extrapolate the (alpha_l1-alpha_l2) differences. The information in the paper will be of interest to other GPS-RO data providers, and NWP users who may wish assimilate the data. However, I recommend publish after major revision, because often the results are explained on the basis of simulations that are not presented in any detail. For example, the "ionosphere induced vertical shifts" noted in the abstract, are similar to shifts seen in wave optics modeling. But this modeling is only mentioned, and not presented in any meaningful detail. Hence, it is difficult for the reader to understand how the electron density at the LEO can produce this result (particularly when the ray tracing results differ).

I recommend that the simulation results mentioned in the text be described and pre-

sented in more detail before publication. Please see specific comments below.

Specific comments

Page 7785, line 13: Typo, "and *the* multiple ..."

Page 7785, line 21. How do you know the structure in the observed bending angle profile is caused by moist convection? If statement this based on simulations at the observation location (as suggested on line 1, 7786), please provide more detail, like for example the NWP information used. Source, resolution, forecast-range etc.

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Page 7786, Paragraph 2, line 7-27. The paragraph is difficult to understand physically. The bending angle profiles in Fig 1c and 1d have sharp vertical gradients near 3.5 km and 2.8 km, respectively. Presumably, the signal to noise is lowest for L1CA and L2C bending angles near these heights, because of atmospheric defocusing. What role does atmospheric defocusing and reduced signal to noise have on the increased (corrected) bending angle errors in these vertical intervals?

The role of the electron density at the LEO is unclear. Why should the electron density at the LEO produce larger bending angle errors when the vertical bending angle gradients are largest?

Based on Schreiner et al (Appendix A, 1999) and also noted in the text, the electron density at the LEO should not significantly affect the retrieved impact parameters. This fact is confirmed by ray tracing, but not in wave optics simulations. Firstly, why would the modeling approaches differ when assessing the impact of the electron density of the LEO? Secondly, the reader needs more details about the simulations mentioned in the text. EG:

*What orbits are used in the simulations? Do they differ in the ray tracing and wave optics simulation?

*What is the neutral atmosphere model? Horizontal gradients included?

*What ionosphere model is used? Are horizontal gradients included in the ionosphere model and used to compute the ray path?

*Can the \Delta h_{1,2} be related to the horizontal refractivity gradients integrated along the ray path?

*In addition, quantify \Delta h_{1,2} provided by both the ray tracing and wave optics approaches, and note the values in the text. How do they vary with impact height?

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Page 7788, Line 20. Please provide more detail about why the first two terms in equ.7 are needed for "modeling of the effects of horizontal inhomogeneity of the ionosphere". Again, this appears to rely on simulations that are not presented in any detail, and therefore would be difficult to for a reader to reproduce. What effects of horizontal inhomogeneity are we talking about here? Why is (A+B*h) better in these situations than say D/(300-h)**1.5?

Page 7789: Eq. 8 and Figure 2.

When performing the least square fitting, is it a weighted least square fit, where the assumed (alpha_1-alpha_2) error statistics vary with height? Please confirm that the (alpha_1-alpha_2) differences below 20 km are not used in the least squares fit.

The removal of term 4 clearly improves the pink line (213.02). However, I am surprised that the inclusion of a term D/(300-h)**1.5 produces the unwanted curvature below $\sim$ 35 km, given that C/(100-h)**1.5 does not appear to. Surely the third term would produce greater curvature in the final solution than the fourth term? What happens if you remove term 3, but keep term 4?

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Page 7791, line 15. The use of ECMWF analyses. Given that COSMIC bending an-

gle profiles have been assimilated into the ECMWF analyses, can it be assumed that error arising from uncorrected ionospheric effects are uncorrelated with "the model" (ECMWF analysis?) errors? A short-range ECMWF forecast might be a better comparison.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 7781, 2015.