Response to Major Comment 3) by Reviewer 3.

3) New L2 extrapolation

The reviewer makes a number of important points, which we will respond to more fully at a later date. However, we believe that the main comments, regarding the questionable physical-mathematical basis of the new L2 extrapolation method, are incorrect. They are probably a result of a lack of clarity in the submitted manuscript, regarding the key assumptions.

In the neutral atmosphere, the contribution of the ionospheric bending to the total bending falls in a fractional sense, because the neutral bending increases exponentially towards the surface. However, the ionospheric bending is not "negligible", and it cannot be ignored in NWP applications.

An assumption made in most GPS-RO ionospheric correction bending (e.g., Vorob'ev and Krasil'nikova, 1994) and extrapolation routines (e.g., Zeng et al, 2016) is that the total bending angle for frequency k, α_k, can be written as the sum of the neutral bending, α_n, plus a frequency dependent ionospheric term, $\alpha_{i,k}$, which scales with frequency as, $1/f^2$. Hence,

$$\alpha_k = \alpha_n + \alpha_{i,k}$$

where $k = (1,2)$ for the f_1 and f_2 frequency, respectively. This decomposition is the basis of the standard linear ionospheric correction (for a common impact parameter),

$$\alpha_n = \alpha_1 + \frac{f_2^2}{f_1^2 - f_2^2}(\alpha_1 - \alpha_2)$$

used to estimate the neutral bending (e.g., Vorob'ev and Krasil'nikova, 1994). Note that the difference $\alpha_1 - \alpha_2$ should be independent of the neutral atmosphere, $\alpha_{i,1} - \alpha_{i,2}$, and it will only vary slowly with height (e.g., see Figures 2 and 3, Zeng et al, 2016). "Residual" ionospheric errors caused by non-linear terms can also be accounted for (e.g., Healy and Culverwell, 2015), but they are typically a few tenths of a microradian, and they are not of importance here.

In this paper, we also assume that the total bending can be approximated by the sum of the neutral and ionospheric terms, and then we use a simple ionospheric model to fit the *neutral free* bending angle differences, $\alpha_1 - \alpha_2$, over a 20 km vertical interval. These fitting parameters are then used to extrapolate the $\alpha_1 - \alpha_2$ values where the L2 signals are lost or significantly degraded.

Therefore, assumptions made are entirely consistent with the standard ionospheric correction, but we accept that this could be made clearer in the original manuscript.

References

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Zeng, Z., Sokolovskiy, S., Schreiner, W., Hunt, D., Lin, J., and Kuo, Y.-H.: Ionospheric correction of GPS radio occultation data in the troposphere, Atmos. Meas. Tech., 9, 335-346, https://doi.org/10.5194/amt-9-335-2016, 2016.