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Atmospheric Measurement Techniques Discussions

Interactive comment on "Correcting negatively-biased refractivity below ducts in GNSS radio occultation: An optimal estimation approach towards improving planetary boundary layer (PBL) characterization" *by* Kuo-Nung Wang et al.

Anonymous Referee #2

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The manuscript addresses the negative bias that is often found during the retrieval of refractivity, which is known to be related to the occasional presence of superrefractive layers in the low troposphere. The manuscript proposes a procedure to identify the presence of these layers, and to estimate the refractivity within the layer, using external information. This should allow an improved retrieval of the refractivity profile from a bending angle profile.

The subject is interesting, and this exercise may be useful. However, my main concern is that the authors should better explain why it is important to, for instance, try to ad-

dress this negative bias, rather than to accept that the retrieval of refractivity from bending angle presents limitations and is an ill-posed problem below superrefractive layers. As with other underdetermined problems, adding sufficient information eventually provides a closure. The information that best provides this closure is most likely user-dependent. The authors specifically propose the integrated precipitable water (PW) as closure. Although PW may be often available, it is a source external to GNSSRO. The authors should explain why PW is to be preferred over other quantities that may also be equally available, and are also external, or why the retrieval of the refractivity profile is still important, when it can only be carried out requesting external information.

Specific comments:

P1L16: "that couples", to for instance ", and couples"

P1L23: "technique precisely" to "technique that precisely"

P2L14: "transceiver geometry". Current GPSRO does not use transceivers. The transmitter never receives, and the receiver never transmits.

P2L16: "information inside the ducting layer will be missing". It is not really missing. GNSSRO does not provide it.

P2L19: "To mitigate the N-bias". It should be explained why it must be mitigated, rather than accepted.

P2L30: "Measurements of PW". There are very few actual measurements of PW available. Information of PW does exist, but most are retrievals, estimations, or background model information. Given that PW is often not the actual source, why should PW be used, rather than the original measurements?

P3L3: "For a single ray path. . .": This is ok only in a spherically symmetric refractivity field.

P3L5: "n is the refractivity index". It is the refraction index.

P3L6: “assumption of a spherically symmetric”: The assumption is already necessary above.

P3L17: “measured bending angle”. Should be “measured bending angle profile”.

P4L18: “signal with a tangent point inside the trapping layer cannot be received”. I would not say that. There is no signal whose TP is inside the trapping layer, not an existing signal that cannot be received. Tangent points are either above or below.

P4L21: “multiple values”. This is not a numerical problem, and there is nothing unphysical. Eq (2) represents a function that is not defined for all r_t. This is related to, but not caused by, the existence of multiple heights with the same x.

P4L22: “retrieved”. Bending angle is not being retrieved here. It is being evaluated.

P4L23: “bending angle of these rays can still be retrieved through the regular Abel inversion”. The bending angle can be evaluated if we know the refractivity profile. But the Abel inversion (Eq 4) retrieves the refractivity. And this cannot be retrieved once below the superrefractive layer.

P5L3: “Information loss”. It is not lost. It is not being gained. Also later in P13L18.

P5L4: “the most significant negative bias”. Please clarify the sentence.

P5L23: “error parameter” should be “error in the parameter”.

P7L10: “sensitive to the mis-modeling of”. If this is true, then the procedure is weak. The meaning of the rest of the paragraph is unclear. Please rewrite.

P8L4: “PW meaurements”. I understand that the measurements are brightness temperatures related to PW, not PW itself. Also, ground-based GNSS provides ZTD, with PW being derived only through the approximate subtraction of the hydrostatic delay, which must itself be estimated from further measurements or external information.

P13L19: Profiles of retrieved bending and retrieved refractivity still have a 1-1 cor-

respondence. The lost 1-1 is between the atmospheric refractivity and the retrieved bending.

P13L28: “PW measurements”. The measured quantity is a brightness temperature. But given that external information must be used, why PW? Why from AMSR-E? Why not from a background model? Why not some other quantity or quantities from a background model?

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