Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-105-RC1, 2017

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 #1

Received and published: 24 May 2017

General Comments

This paper sets out a new retrieval method for GPS-RO refractivity below a ducting layer. This problem is known to be ill-posed, and therefore a-priori information is required to provide a solution. The new approach uses ECMWF analyses and AMSR-E preciptable water retrievals (not measurements!) to make the problem well-posed. The authors present simulated retrievals errors and apply the new approach to COSMIC profiles. As might be expected, the errors with real COSMIC data are larger when verified against radiosonde observations. The paper requires major revision before

publication.

There is no discussion on the impact of horizontal refractivity gradients errors on the retrieval performance. It would be useful for the authors to consider the recent Zeng et al (2016, Appendix A) paper (http://www.atmos-meas-tech.net/9/335/2016/) that show that horizontal gradients in the ionosphere can lead to features being assigned the wrong height. More generally, if atmospheric and ionospheric horizontal gradients are causing an impact parameter error, da, the resulting radius or height error, dr, is

dr = da/(n+r.(dn/dr))

where n is the refractive index, and r is the radius. The key point here is that impact parameter errors are amplified when mapped to radius, and this is particularly problematic for ducting conditions where r.(dn/dr)$\sim$1. How does this affect your interpretation?

Secondly, in the context of NWP assimilation, if an NWP system is assimilating refractivity/bending angles down close to the ducting later, and is also assimilating other radiances like AMSR-E and, would the retrieved refractivity profiles below the ducting layer provide any extra information? If the authors argue that the retrieved refractivity is not intended for NWP assimilation, that is reasonable but it should be stated in the text.

Specific comments

Page 4, Line 28, "Able" should be "Abel".

Page 8, The AMSR-E PW values are not "measurements". They are retrieved quantities that will depend on a-priori information. Please correct this throughout the paper. What a-priori is used in the AMSR-E retrievals? EG, do they have to assume a temperature profile?

Page 8, ECMWF analysis information. Are you using the 137 vertical levels, horizontal reolution, etc? Please give details.

Page 8, equation 9. The temperatures in this equation should be virtual temperatures? Typo or bug in the retrieval? More generally, are you using virtual temperatures when you compute the height of the ECMWF levels?

Page 9, C_y in equation should include a forward model error term. EG, caused by assuming ECMWF tmperatures are "true" in eq.8, assuming the q(z) is constant etc. Have you estimated it?

Section 3.

When generating the observed bending angle from the raob, I assume you integrate eq.2 or 3? Please state this, and give more details. It should be emphasised that horizontal gradient errors are neglected in simulations in this section. Have the raobs been assimilated at ECMWF - ie, the raobs and analysis could be correlated? It might be interesting to see if the ECMWF forecasts at the raob locations look very different.

Section 4

Page 12. Line 19. "no double or complex structure inside the trapping layer". Please explain what is being screened out here, and how often it happens.

Page 12, last line: I suggest that the 200 m difference between estimated x_b and the corresponding radiosonde information could be caused by the variation of n.r.sin(phi)(=a) along the ray path. This a well known consequence of horizontal gradients. Have you investigated this by looking at gradients in the analysis fields along the ray paths?

Figure 12. Suggest rename it Fig. A1, because its ony referenced in the appendix.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-105, 2017.