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Atmospheric Measurement Techniques Discussions

Interactive comment on "Wave-optics uncertainty propagation and regression-based bias model in GNSS radio occultation bending angle retrievals" *by* Michael Gorbunov and Gottfried Kirchengast

Anonymous Referee #1

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The authors present a new method for bias correcting GPS radio occultation (GPS-RO) measurements in the boundary layer. The boundary layer bias (BLB) model corrects a negative bending angle and refractivity bias in the boundary layer. The source of this bias is thought to be small scale fluctuations in the refractivity field. These are included in some simulations to demonstrate the effect. It is shown that the new bias model removes most of the BLB.

Given that one reasons GPS-RO has had an impact in operational NWP and climate reanalyses is that it can be assimilated without bias correction, introducing a bias correction scheme for this data is a significant step. I believe more is required to demonstrate

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that the small scale fluctuations are the *main source of the bias*, and some discussion of the operational monitoring statistics from the NWP centres is also required.

The following questions should be considered before publication.

Is the proposed bias correction model aimed at NWP or other applications?

Please provide spatial maps of the bending angle and refractivity biases, related to the profile information shown in Figures 1 and 2. How do the spatial maps of the simulated data in Figure 1 compare with "observed" COSMIC minus ECMWF bias maps? How do the observed bias maps correlate with parameters such as low cloud cover, and total column water? Can we be sure that the small-scale fluctuations are the main source of the bias?

Figure 2. This is not consistent with standard operational monitoring at NWP centres. See, for example. http://www.romsaf.org/monitoring/index.php.

EG, GRAS measurements are biased positive with respect to both the ECMWF and Met Office models in the lower troposphere, and there are also differences for rising and setting data. This issue is complicated because the forward models used in the NWP systems compute bending angles, but use a maximum gradient ($\sim$half ducting) in their computations for numerical reasons. Furthermore, they do not compute bending angles below ducting levels. Are similar restrictions used here? The point being that a relatively simple change like this, can have a significant impact on the sampling and subsequent biases, even changing the sign of the bias.

It seems that the bias correction model presented here would currently make Met Office and ECMWF bending angle biases worse. Is that correct? Should the model be applicable to GRAS data?

The bias correction model given in section 2 seems overly complicated and requires many predictors. How many predictors are used typically in the radiance bias correction schemes? Are more predictors required here? Why?

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