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Atmospheric Measurement Techniques Discussions

Interactive comment on "Processing of GRAS/METOP radio occultation data recorded in closed-loop and raw-sampling modes" *by* M. E. Gorbunov et al.

Anonymous Referee #1

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Review of the paper "Processing of GRAS/METOP radio occultation data recorded in closed-loop and raw sampling modes" by M.E. Gorbunov, K.B. Lauritsen, H.-H. Benzon, G.B. Larsen, S. Syndergaard, and M.B. Soerensen.

The paper describes the data inversion process for the GRAS/METOP receiver and presents some statistical comparisons of the results with the ECMWF model. Because the GRAS/METOP receiver data is more complicated than that of other GPS RO receivers, discussions of the inversion process and comparisons of the results obtained by different authors and groups are especially important. I found the paper well written and reasonably concise, and I recommend publishing it. However, before publishing I

would like the authors to include some more specific details about their processing and to resolve some questions. My comments are below.

Main comment:

Please explain down to what height the RO signals were used for inversions. It is known that GRAS/METOP data contain a significant amount of data gaps both in CL and RS modes. How were the RO signals with data gaps handled? This needs to be explained.

Other comments:

Page 1062, lines 4-5, "600-700 measurements per day." Better to say "...occultations..."

Page 1062, line 25 - page 1063, lines 1-2, "From the processing view point, these modes are similar to phase-locked loop (PLL) and open-loop (OL) modes implemented in COSMIC". There is no full similarity. COSMIC OL uses frequency and delay models without feedback. GRAS/METOP RS uses the frequency model and the delay-locked loop (DLL). The DLL results in data gaps in RS mode (Bonnedal et al., GRAS on MetOp: Instrument Characteristics and Performance Evaluation, Presentation at OPAC-4 Int. Workshop, Graz, 2010). From the processing view point, a user needs to decide how to handle data gaps (see main comment above). This introduces an additional uncertainty.

Page 1064, lines 4-6, "This makes the internal demodulation of the navigation bits easier, because the phase variation between signal samples is much smaller than for the 50 Hz sampling rate". I am not sure this is so trivial. Yes, the signal phase lapse is 20 times smaller for 1 kHz than for 50 Hz sampling. But there is another competing reason: additive noise. Down-sampling from 1 kHz to 50 Hz (by aligning the integration intervals with the navigation data chips) reduces the noise sqrt(20) times. In other words, for a strongly fluctuating signal with low noise or for a smooth signal with high noise the 1 kHz or 50 Hz may be advantageous for distinguishing the navigation data

phase flips.

Page 1065, lines 14-17, "The bending angle profile below 2 km is not related to the atmosphere, because it is obtained from the phase model used to fill in the area where the receiver was unable to track the signal. This part of the profile is discarded in the inversion". Was the receiver completely unable to track the signal below the impact height $\sim$2 km or is there a data gap? In any case, if this part of the profile is discarded from the inversion, then the reason for applying the phase model should be explained. These questions should be considered part of the main comment above.

Page 1066, lines 17-19, "The choice of the background atmospheric model used for the statistical optimization (Gorbunov, 2002a) is referred to as the initialization" so the initialization is defined as the choice. In Gorbunov, 2002a: "The use of background ... instead of measurements at big heights ... is referred to as the initialization" I recommend to avoid unnecessary ambiguities in terminology.

Page 1066, lines 21-22, "... differences and standard deviations GRASECMWF are very close to those of COSMIC..." is sloppy, please revise.

Page 1066, line 29, "... data have does not penetrate ...", please revise.

Page 1067, lines 8-9, "[GRAS] raw sampling mode ... allows for accurate measurements of wave fields..." I recommend moderation of this statement; with the data gaps, the measurements of wave fields cannot be accurate.

Page 1067, line 27, "... the COSMIC lifetime is expected to be a matter of one or two more years". I recommend providing either a reference or justification of the expectation or, in the absence of both, removing the statement.

Page 1068, lines 4-5, "The GRAS instrument with its raw sampling mode meets the high standards defined by COSMIC". I don't believe that the "high standards" is a relevant expression and recommend being more specific. If retrievals of data from two instruments are compared in terms of differences with a reference model, it should be

written explicitly what has been found.

Page 1069, lines 25-29, I did not find the referenced paper on the AMT website.

Page 1075, "Fig.5. [S]tatistical comparison..."

Pages 1075 and 1076, Figs. 5 and 6. What are the dates and for those figures? What is the sample number for Fig. 5: the same as for Fig. 4 or Fig. 6? Apparently, Fig. 6 is aimed at demonstrating the difference between CL+RS and CL processing in the LT. Concurrently, it shows substantial differences in the UTLS and above compared to Fig. 5. Those differences cannot be related to RS. If they are related to different samples used for Figs. 5 and 6, this reduces confidence in the found differences in LT. This needs to be explained.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 1061, 2011.