

amt-2014-339: The Radio Occultation Processing Package ROPP

I. D. Culverwell , et. al.

Response to Interactive comment by Anonymous Referee #1

General comments:

The paper describes the ROPP. The paper is very well written and provides an excellent overview including some RO data example. As a whole it is a solid piece of work. I recommend publication. I have some minor comments and questions.

We thank the referee for his or her careful reading of the paper, helpful and incisive comments, and the recommendation to publish.

Minor comments:

*conclusion (P172,L18): '...the intention of this paper is to encourage other RO scientists to use ROPP to process their data'. Suppose, that i have my own software package called XYZ. After reading the paper i am not convinced to switch from XYZ to ROPP because nowhere in the manuscript you point out that ROPP produces high quality RO bending angle/refractivity.

Fair point. We will replace the prescriptive "The intention of this paper is to encourage other Radio Occultation scientists to use ROPP to process their data." by the more measured "The hope is that this paper may encourage other Radio Occultation scientists to try using ROPP to process their data."

For example, on P126,L19 you cite Gorbunov et al. 2011. At this point you could include some comment on OCC/UCAR comparisons.

Good point. We will replace the beginning of Section 5 by "The ROPP PP module has been largely adopted from the OCC code developed by Michael Gorbunov at the Institute for Atmospheric Physics, Moscow. OCC has been shown to generate refractivities that are in excellent agreement (less than 0.2% systematic difference) with those calculated at UCAR (CDAAC, 2014) and by forward modelling ECMWF analyses (ECMWF, 2014) (Gorbunov et al., 2011)."

This brings me to my second comment.

*A single COSMIC profile is processed and you make some comparison with ECMWF. No doubt, ECMWF is a good reference (and you use it in 1dvar), but UCAR is processing COSMIC as well. For this single COSMIC profile it is obvious to show ROPP minus UCAR bending angle/refractivity.

Good point. We will replace Fig 5 and its caption by the following:

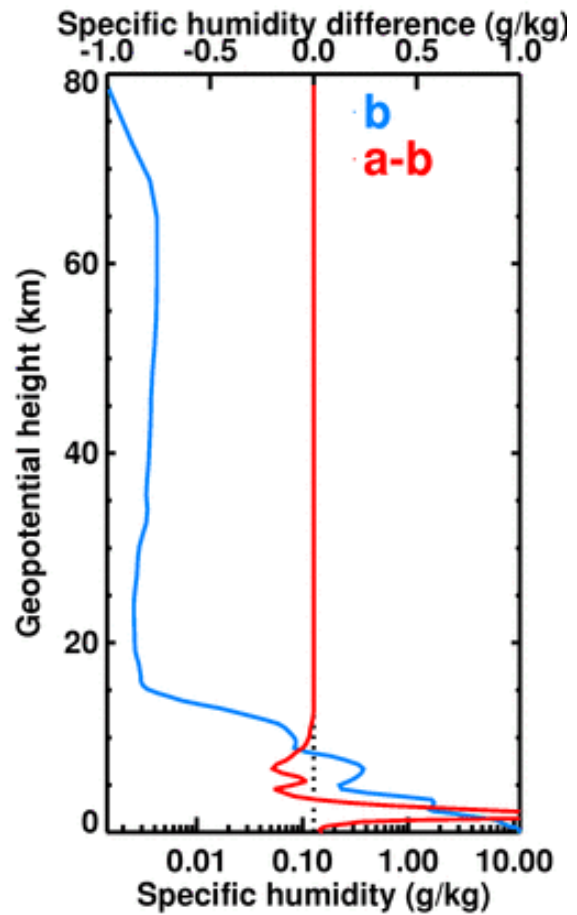
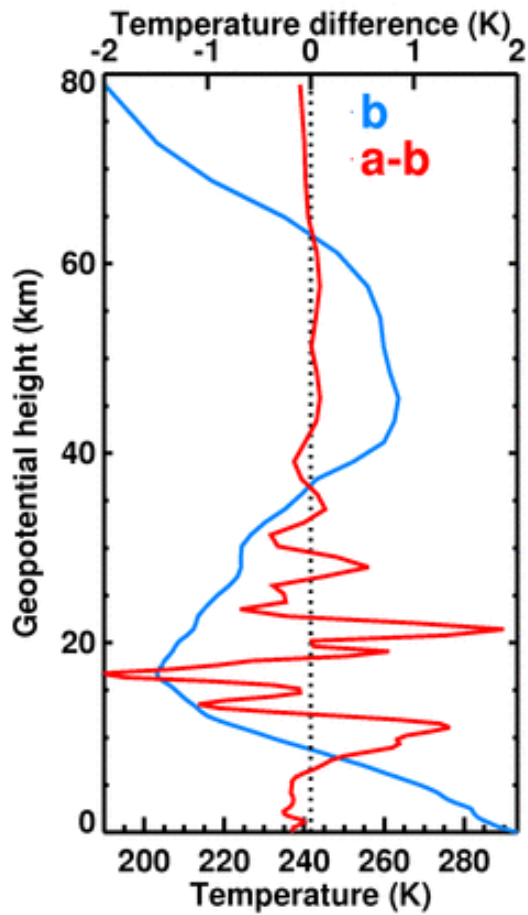
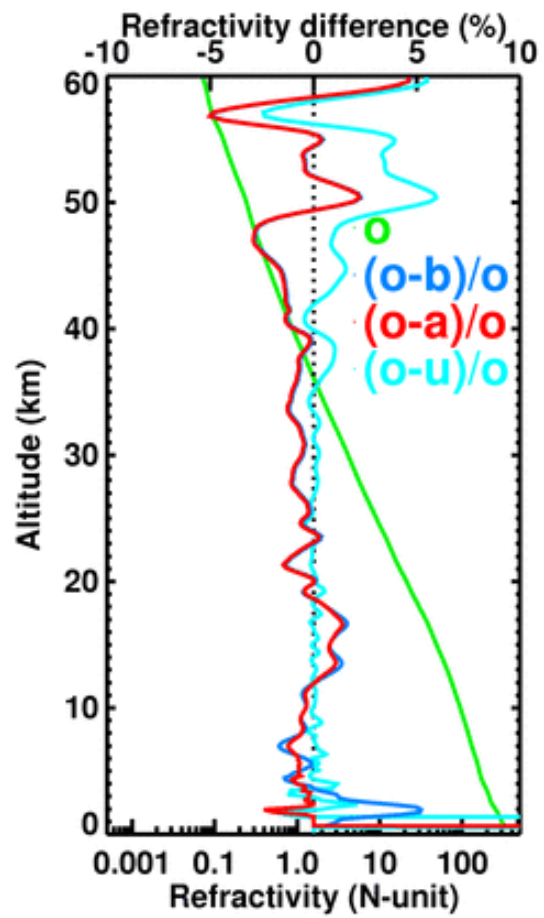
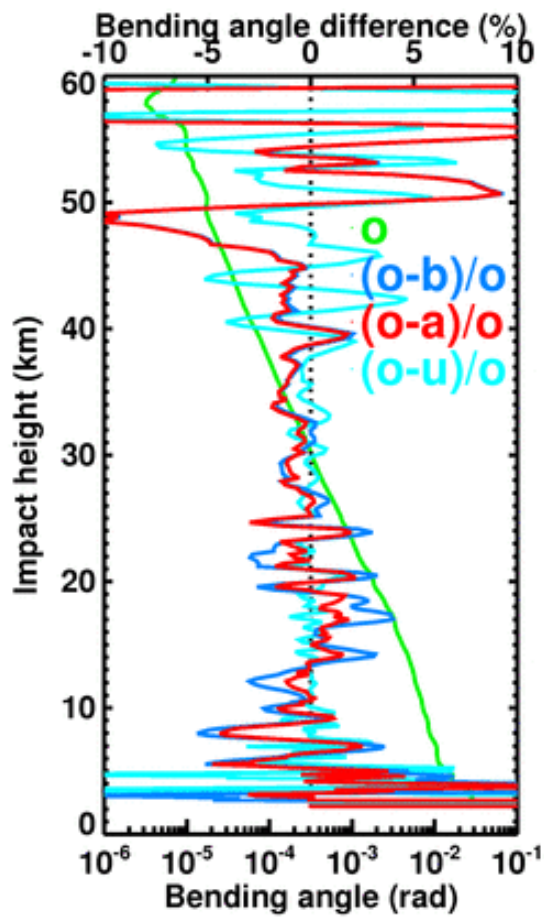


Figure 5. The results of passing COSMIC bending angles and refractivities, and the colocated/simultaneous ECMWF background fields, through ropp_1dvar_bangle and ropp_1dvar_refrac respectively. Top left: observed bending angle profile **o**, as generated by ropp_pp_occ_tool (see Fig. 3), and its fractional difference from the background **b** and 1D-Var solution **a**, after forward modelling (effectively) by ropp_fm_bg2ro_1d. Also included: fractional difference to UCAR-generated bending angle **u**. Top right: same but for refractivity. Bottom left: background temperatures, as generated by grib2bgrasc and bgrasc2ropp (see Fig. 3) and the difference from the solution temperatures, as returned by ropp_1dvar_bangle. Bottom right: as bottom left but for specific humidities.

We will also add these paragraphs after P168/L8:

“Figure 5 also compares the ROPP-derived bending angles and refractivities with those in the corresponding ‘atmPrf’ file, as processed by UCAR (CDAAC, 2014). Below 40 km the ROPP refractivities are closer to those of UCAR than the ECMWF background or analysis, which lends confidence to the integrity of the ROPP refractivities for this occultation. Above 40 km the ROPP refractivities are up to 5% bigger than those of UCAR. This may be due to different statistical optimisation (blending of noisy bending angles with smoother climatology) applied in the two codes. ROPP is closer to the ECMWF background or analysis in this regime.

The UCAR and ROPP bending angles are also closer to each other than either is to the forward modelled ECMWF bending angles between 10 and 40 km. Below 10 km the difference between UCAR and ROPP is possibly due to different treatments of the open loop data in this regime. Above 40 km the differences may again be due to different statistical optimisation in the two codes.”

We feel reluctant to say any more, since an involved comparison between ROPP and UCAR would be a (very worthwhile) paper in itself.

*P163,L5: ‘...ROPP PP provides routines to compute L1 and L2 bending angles from measured excess phase by geometrical optics...’. I think ‘measured’ is not the correct word. Correct me if i am wrong, but i think that the ‘measured’ excess phase you refer to is actually the output of some other preprocessing (see e.g. Sokolovskiy et al. 2009 Postprocessing of L1 GPS radio occultation signals recorded in ol mode, Radio Science). Does the ROPP include such preprocessing, i.e., the L1 preprocessing described on P739-P740 in Gorbunov et al. 2011? In this case, i download the ROPP immediatly (i urgently need some reference preprocessing).

1) We will omit the word ‘measured’ from this sentence.

2) The starting point for the ROPP preprocessing module is time-series of L1 and L2 excess phases and POD data. In practice these come from the ‘atmPhs’ stream of the CDAAC data centre. Presumably, then, most or all of the Sokolovskiy et al 2009 preprocessing has already been applied to the data. ROPP then undertakes further preprocessing, including: mission-specific processing (noisy CHAMP L2 amplitude set equal to L1 amp, application of navigation bits to generate correct excess phase

for COSMIC and GRAS in the open loop/raw sampling regions respectively), rejection of data with large signal tracking errors, and the correction of L2 data because of its poorer signal tracking and larger noise.

As far as we can see, this does include the processing described in pp 739-740 of Gorbunov et al 2011. Certainly, Eqns (1) and (3) of that paper appear in the code.

We feel that this level of detail is likely to lie beyond the interest of most potential readers of the paper, which is why we summarised it as:

“Filter, quality control and carry out mission-specific processing of amplitude and phase data (Gorbunov et al., 2006).”

Readers interested in more details of the ROPP excess phase-processing can find full details in the User Guide to the ROPP PP module, which is available from the ROM SAF website, which is signposted in the Introduction and Secs 2.2, 11 and 12.

*Figure 2 and 3: ‘...the results of passing “raw“ COSMIC data through some of the tools...’ What does “raw“ stand for? Is it the same as “atmPhs“ downloaded from CDAAC?

Correct. We will replace ‘raw’ by the more precise term ‘atmPhs’ in the Fig 2 and Fig 3 captions. Thank you.