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Atmospheric Measurement Techniques Discussions

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Interactive Comment

Interactive comment on "A simplified approach for generating GNSS radio occultation refractivity climatologies" *by* H. Gleisner and S. B. Healy

H. Gleisner and S. B. Healy

hgl@dmi.dk

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Response to Referee 1

The referee has posted comments on several minor issues – some of them editorial – and one major issue that concerns the impact of small data numbers on the proposed processing concept. This is an important question since actual climate monitoring going back before 2006 rely on CHAMP data, which are fewer in number than the data from the COSMIC mission.

We mentioned this in the manuscript as a topic for future work, but the referee suggested we consider the question here.

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To better understand the issue, we compared the new processing concept ("average-profile processing") with the standard processing ("single-profile processing") when the data numbers are significantly lower. By randomly removing 85% of the data, we created a new data set with data numbers roughly corresponding to the pre-COSMIC period, while still having the same per-profile observational errors. In the discussion paper we showed, for each month, (a) the relative differences between the new and the standard processing of the observed data, (b) the relative differences between observation and collocated background using the new processing, and (c) the same using the standard processing. These three types of plot are here shown for the original data set (Figs. 1, 3, and 5) and for the reduced data set (Figs. 2, 4, and 6) including only 15% of the data. We show data for February 2011, but the general conclusions would be the same for the other months included in the study.

A general observation in Figs. 1 and 2 is that the region of differences smaller than 0.1% (light blue) is not much different for the reduced data set compared to the full data set. As expected, the noise levels are somewhat increased when reducing the data number, but it is not obvious to us that there are any systematic differences that would indicate biases. The new approach seems to be quite robust to an 85% reduction in profiles. Similar conclusions can be drawn from the observation minus background plots in Figs. 3-6, although the increased noise is more pronounced in these plots.

A preliminary answer to the referee's question would therefore be that, yes, we can use this new method also for the CHAMP data. However, to substantiate this answer further, we would need long time series including at least a few years of data. We would also need to describe how the observed data vary with data numbers in relation to the errors of the monthly mean data – and we need to do this both for the new and the standard processing.

We conclude that this would require more data, a substantial amount of work, and that it would require a considerable extension of the manuscript. Hence, we still believe that it is more suitable for a follow-up study. We will extend the short comment on this issue in the text, noting the preliminary results using only 15% of the available data, but we would prefer to save an extensive discussion on this issue until a later time.

Concerning the minor issues:

(1, 2, 3, 4, 7, and 9): these are purely editorial and will be addressed in an updated version of the manuscript.

(5): the COSMIC excess phase data were obtained from UCAR's CDAAC data base. The large variations in data number exist already in CDAAC. The reason for this is unknown to us.

(6): the referee is correct here. However, we showed in the paper that the impact of assumptions about the atmosphere above 80 km on altitudes below 40 km is negligible. The new method does not exclude the use of a realistic mesopause and mesosphere, but for altitudes below 40 km this is not necessary.

(8) High solar activity is likely to produce noisier individual bending angle profiles, and consequently less smooth average profiles. This can be noted in the text, but the noise is random and it should not introduce an systematic error in the estimate of the mean state.

Response to referee 2

(1) We will update the reference to the Ao et al. paper, and add a remark in Section 1 on the key differences between the two papers.

(2) We will add (perhaps in the beginning of Appendix A, to which we can refer in the text) a quantitative estimate of the degree of nonlinearity of the Abel transform.

(3) The 0.1% discretization error was obtained from a GRAS SAF report in which a few of the most commonly used implementations of the Abel/inverse Abel transforms were investigated. We will add a clarification that this is not an inherent limitation of the technique itself, and that it can be reduced.

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(4) We use the same QC screening as in the DMI / ROM SAF operational processing, and that was also used in the latest data set contributed to the ROtrends project (see Ben Ho et al., JGR, 2012). This includes the use of the L2 and the SO quality scores (developed by Michael Gorbunov, and computed by the ROPP code), and a final sanity check to ensure that the resulting refractivity profile does not deviate too much from ECMWF. The last step is just to make sure that the most extreme outliers are removed. It should not have any influence on the underlying distribution.

We have tried to improve on the QC in order to avoid the use of medians, but it seems very difficult. An alternative way forward could be to include a check of the distribution in the QC, and remove those data that does not appear to belong to the distribution. There are standard ways of doing that, but in the end it would be almost the same as computing a robust mean.

(5) Done.

(6) Done.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 5245, 2012.

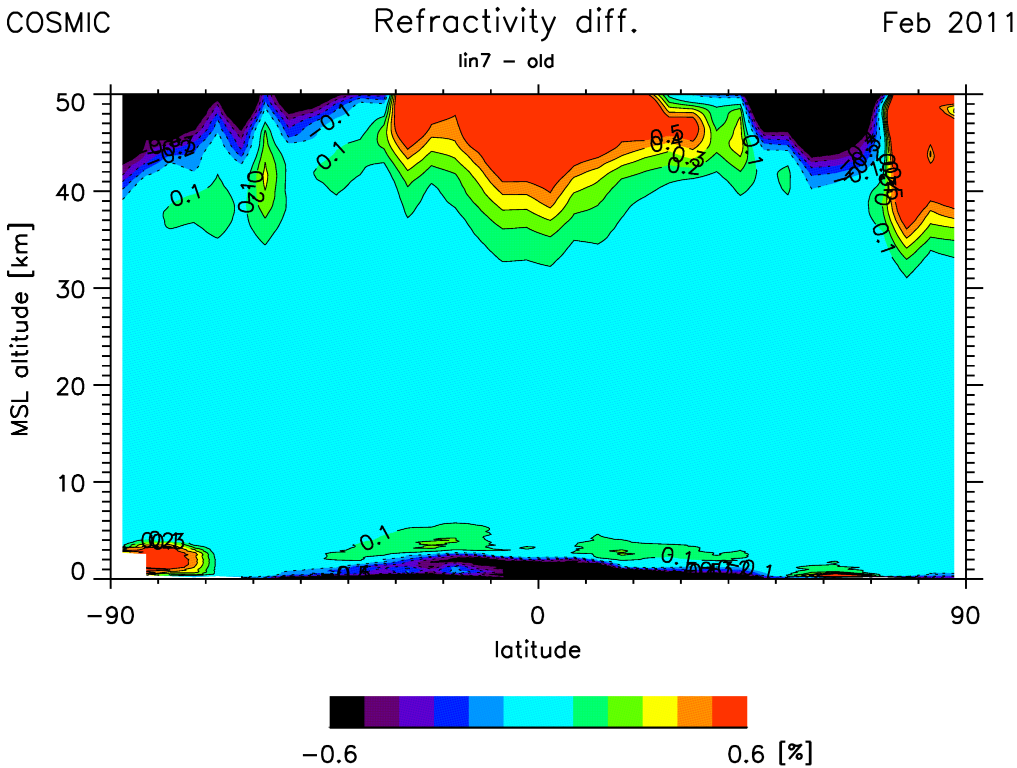

Fig. 1. Relative differences between the new and the standard processing for February 2011, using the full data set.

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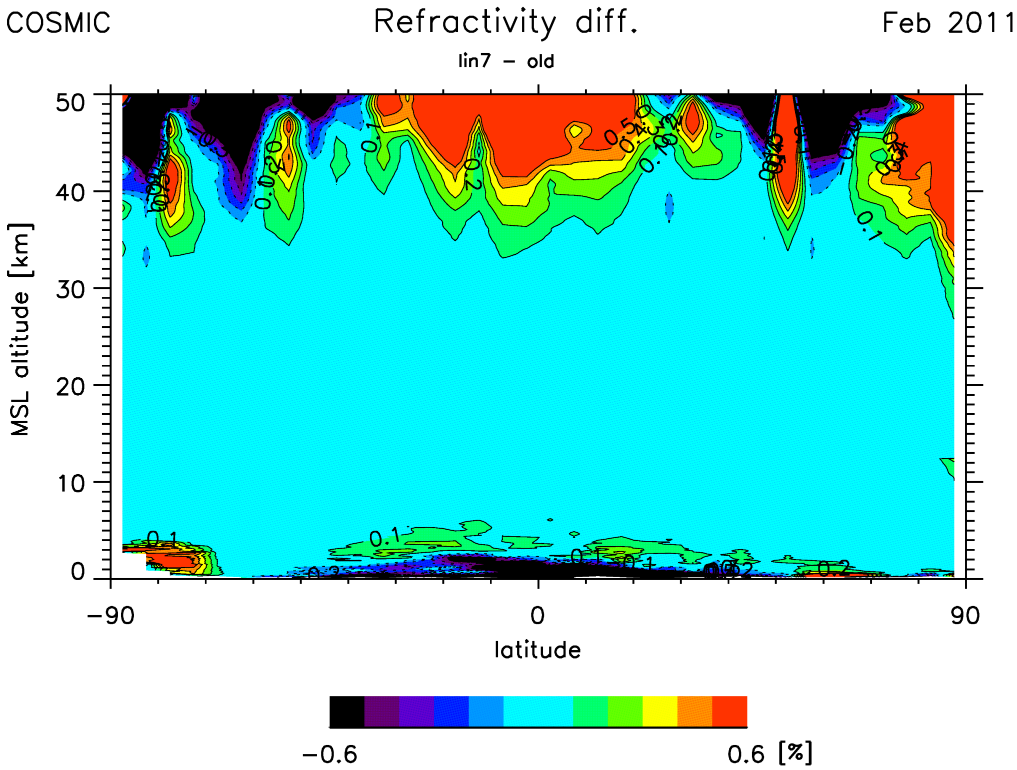

Fig. 2. Relative differences between the new and the standard processing for February 2011, using the reduced data set.

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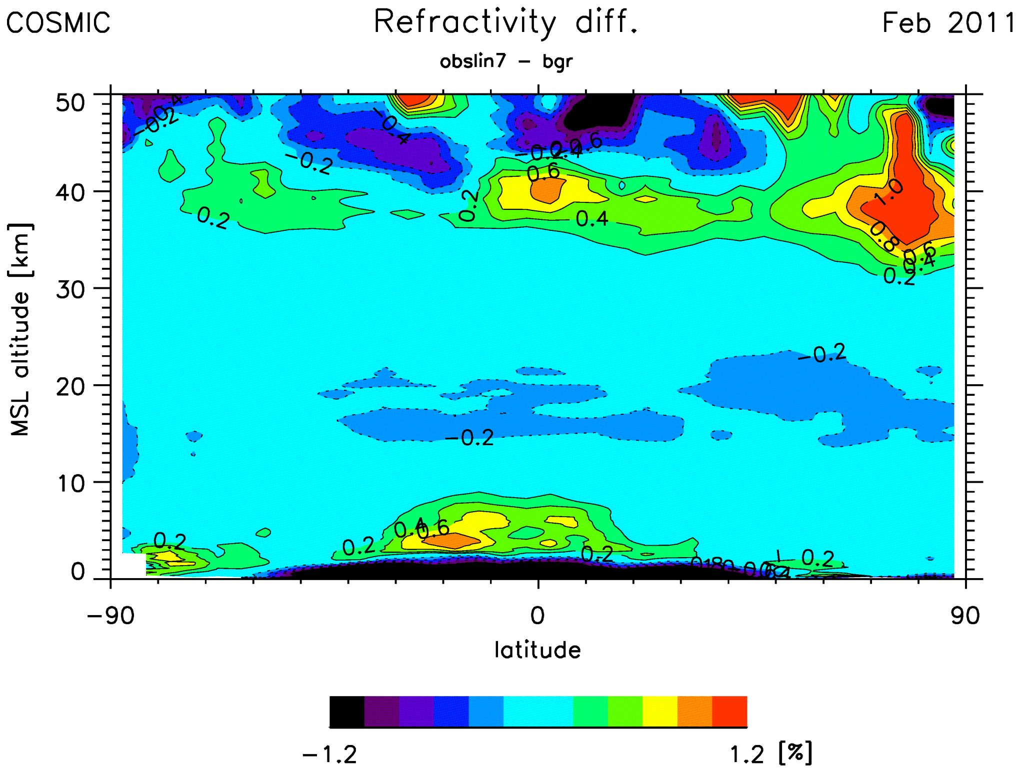

Fig. 3. Relative difference between observed and collocated background monthly means for the new processing method, using the full data set .

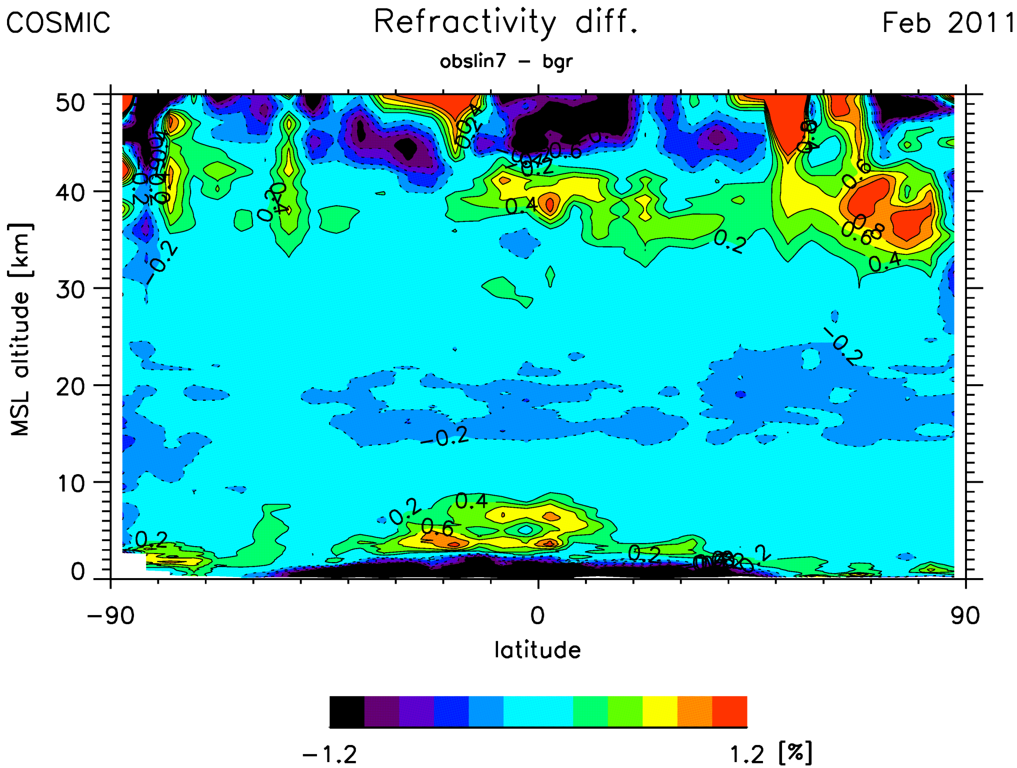

Fig. 4. Relative difference between observed and collocated background monthly means for the new processing method, using the reduced data set

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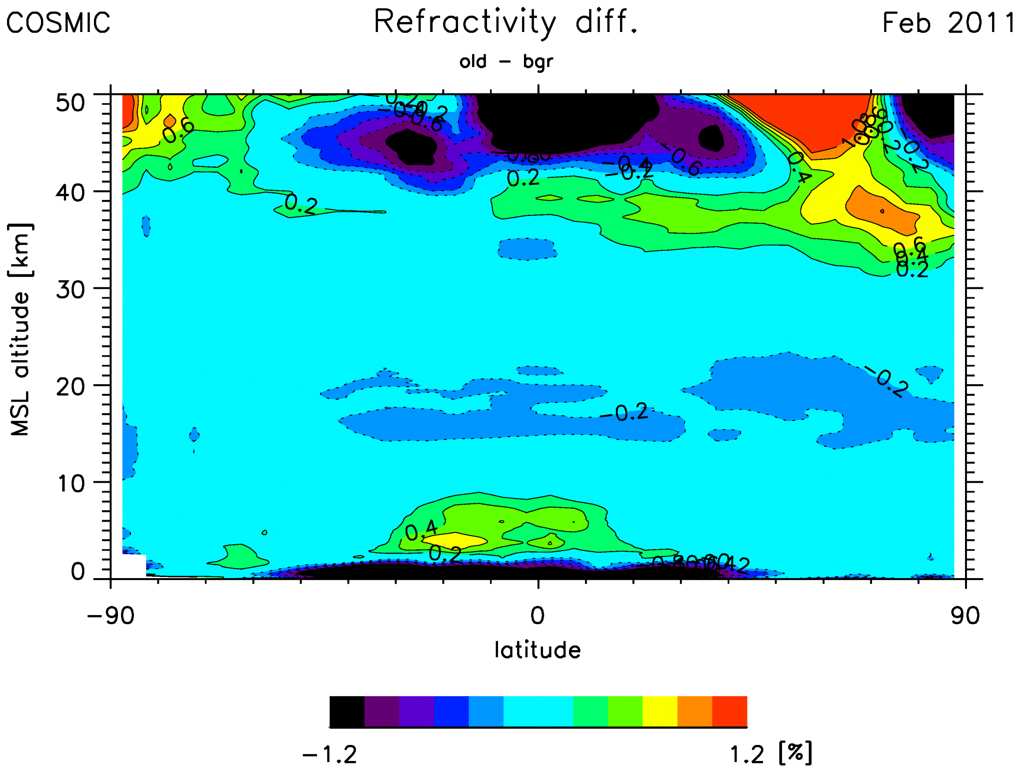

Fig. 5. Relative difference between observed and collocated background monthly means for the standard processing method, using the full data set.

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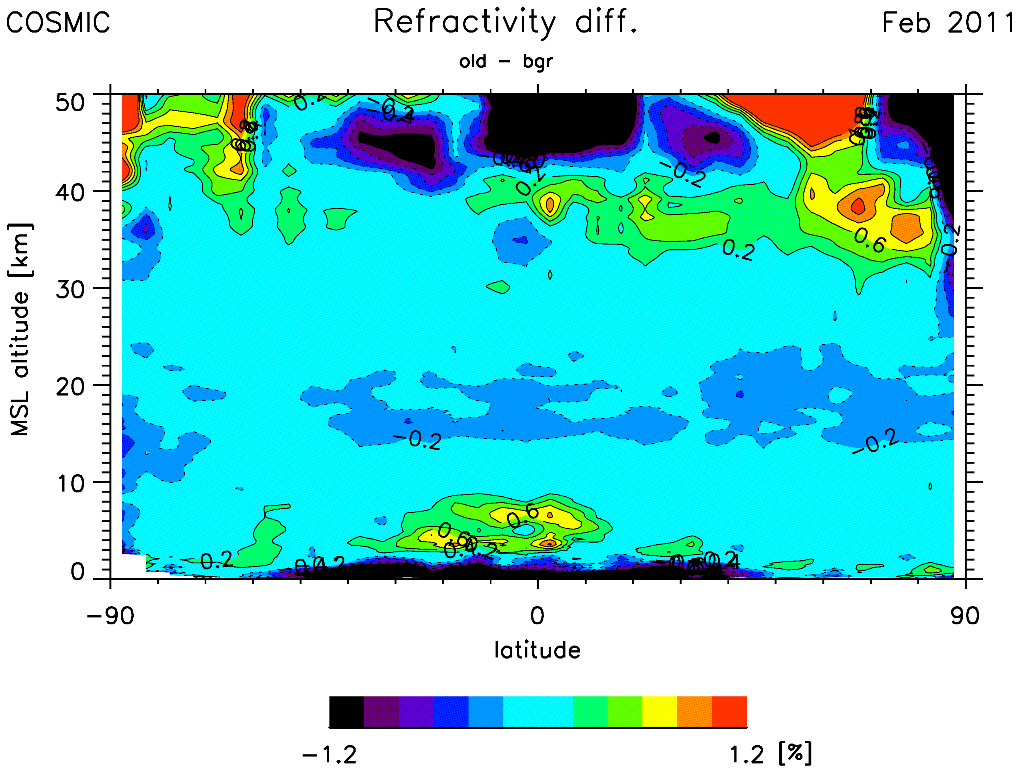

Fig. 6. Relative difference between observed and collocated background monthly means for the standard processing method, using the reduced data set.