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Atmospheric Measurement Techniques Discussions

Interactive comment on "An investigation of seasonal temperature trends in the Antarctic using CHAMP GPS radio occultation data" *by* K. Zhang et al.

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First of all, the authors are highly appreciated the reviewers' effort, and the detailed and important comments and suggestions on the manuscript. All comments have been carefully examined and addressed in the revised paper.

It has been a major revision of the manuscript. The evaluation study has been re-conducted with help of a senior statistician lecturer from the school. The time was limited and few works had to be left out for future study.

A revised manuscript has been completed and will be uploaded for further review with instruction of the handling editor.

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Interactive Discussion

Discussion Paper

Thanks again and please see the detailed response below.

"**" marks the responses following the comments.

Review conclusions and general comments

From the first reviewer:

My conclusion is that the collocation study is worth to be published after a major revision that includes addressing the issues raised above. However, the trends study should not be published.

A suggestion would be: change the title of the paper, concentrate on the evaluation study, and come back to the trends study as a separate work in the future. That trends study should then consider previous publications in the field and address the fundamental statistical issues that arise when trying to detect small trends from variable data using uncertain and sparse observations.

From the second reviewer:

Concerning the trend study, the paper contains significant problems in method and presentation and it should not be published in its present form. However, I think that there is interest in the community for the comparison between radio occultation and radiosonde data. Unfortunately there are many aspects unclear in this study, and therefore, I would like to suggest for major revision of this manuscript.

**The authors' response:

**Both reviewers suggested focusing on the evaluation study for this paper. Therefore, the time series section in the original paper has been removed. The evaluation study uses radiosonde measurements from 38 Australian stations and the collocated CHAMP and COSMIC data. As consequence, the study area now is not the Antarctic but the area covered by the 38 Australian stations even with three stations in the Antarctic.

**The changes above led to a major revision of the paper, particularly the title, abstract,

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introduction and references. One more table is added to address the statistical significance questions. Specific comments on the evaluation studies from the reviewers have been examined carefully and are responded by the authors in the following section.

**Dr Yan Wang, a statistician senior lecturer from the school, contributed to the revision of the paper and is added as co-author.

Specific comments related to the evaluation study

From the first reviewer:

Figure 1 shows the locations of 17 stations in the Antarctic: 14 WMO stations and 3 Australian stations. Have the WMO stations been used in the study? If not, why? Where are the other 35 Australian stations that were used in the study located?

**Figure 1 has been replaced by a distribution map of the 38 Australian stations.

One wonders how the individual profiles compares? A few examples, say one or two for the South Pole and one or two for the coastal region would give the reader a better insight.

**It decided not to include this in the current paper.

How where the confidence intervals computed?

**The confidence intervals for the population mean temperature difference are computed using the discrepancies between radiosonde and RO data at each pressure level.

From the second reviewer:

I recommend more extensive literary research on the comparison between RO and radiosonde data.

**More references of evaluation studies and also studies on the collocation criteria have been included.

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He et al. (2009) compared dry temperature profiles from different types of radiosonde systems and COSMIC RO. They found different biases for different radiosonde systems. What kind of radiosonde systems are used at the Australian stations? Is it possible to attribute the vertical bias structure shown in Figures 2 and 3 to a certain brand of radiosonde system?

**Australia has been continuously using Vaisala radiosonde system for all the stations (information is added in the revised paper).

It is known that radio occultation observational errors increase above ∼20 km at high latitudes in the winter hemisphere. These errors are related to observational noise and the use of ancillary data used for the initialization of the Abel integral. It would be interesting to analyze differences between RO and radiosondes at high latitudes in different months and seasons.

**A future study will be carried out to study the seasonal variations later soon.

How independent are CHAMP and COSMIC "wet" temperature profiles from the first guess used in the 1DVar (especially in regions where humidity is not negligible)?

**Both CHAMP and COSMIC temperature are the wet atmospheric profile product processed by the UCAR COSMIC office.

I recommend to use the term "RO profiles" instead of "RO retrievals".

**Changed as suggested

Page 513, line 8: How many radiosonde measurements are available per day?

**In general, the each radiosonde station performs 2 to 4 observations each day (information is added in the revised paper)

Page 514, lines 10 and 11: provided by the COSMIC Data Analysis and Archive Center (CDAAC)

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**Changed as suggested

Page 514, lines 10 and 11: which data version did you use?

**The data was downloaded from CDAAC website in early of 2010.

Page 514, lines 13 to 17: From the text it is not clear which vertical coordinate you used for the comparison between RO and radiosonde profiles.

**The RO temperature profiles were interpolated at 16 pressure levels (i.e. 30, 50, 80, 100, 150, 200, 250, 300, 400, 500, 600, 700, 800, 850, 900 and 950 hPa) to match the radiosonde profiles.

Page 514, line 20: How do you define significant?

**We have performed statistical analyses to verify the statistical significance. Both ANOVA tests have suggested that there are no statistical differences found using the selected collocation criteria.

Page 514, lines 25, 26: Why does COSMIC have a better quality than CHAMP? Are COSMIC profiles more accurate than CHAMP profiles? Is there any reference?

**The result of this study suggests that FORMOSAT-3/COSMIC RO mission has better agreement with radiosonde data than the earlier CHAMP mission. No related references are found.

Page 514, discussion of Table 1: I missed the number of collocated profiles, which is used to calculate the statistics. It might influence the statistics.

**The numbers of collocated profiles have been added in Table 1.

Page 514, discussion of Table 1: smallest difference between COSMIC and radiosondes can be found with collocation criteria of 100 km and 2 h. Why?

**The recorded values comprise a random sample of the underlying population. Further statistical tests, however, show that the differences among these combinations of

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collocation criteria are not significant.

Page 515, lines 3 to 5: How significant are the last digits of these values? Page 520, Table 1: How significant are the last digits in Table 1? Omit at least the third decimal place.

**Changed to 2 digits

Page 515, line 6: I recommend to use “systematic difference” instead of “bias”.

**Changed as suggested

Page 515, line 10: How is the confidence level computed?

**The confidence intervals for the population mean temperature difference are computed using the discrepancies between radiosonde and RO data at each pressure level. In Figures 2 and 3, the associated sample sizes to compute the confidence intervals are also displayed.

Page 522 and 523: I recommend to use logarithmic pressure scales in Figures 2 and 3.

**The differences between RO and radiosonde data at different layers (pressure levels) of atmosphere is of interest to many readers. We think the current representation will give readers a good picture.

Page 522 and 523, Figures 2 and 3: If you use a second x-axis, which specifies the number of profiles, you could focus on $\pm$0:5 K on the first x-axis.

**For Figure 2, there would be no much difference as the count line is apart from the mean and confidence intervals. In this way, readers can easily see the sample size related to the means and confidence intervals at different pressure levels.

Page 517, line 22: CHAMP instead of CHAPM

**Corrected

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Page 517, line 22: COSMIC Data Analysis and Archive Center (CDAAC)

**Corrected

References

**All errors or missing information in the original reference list have been either corrected or updated. There are some references removed and also new references added in because of the major revision of the paper. All references are checked against the Copernicus publication style.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 511, 2011.