**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.

Anonymous Referee #2

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This paper presents the potentially interesting comparison between CHAMP/COSMIC radio occultation (RO) data and radiosonde measurements performed at Australian meteorological stations, including the evaluation of different collocation criteria. In the second part of the paper, the authors show results of a temperature trend study in the Antarctic region using seven years of CHAMP data from 2001 to 2008.

Concerning the trend study, the paper contains significant problems in method and presentation and it should not be published in its present form.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 there-

fore, I would like to suggest for major revision of this manuscript.

1 General questions and comments/major revisions:

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

2. 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?

3. 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.

4. 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)?

5. The abstract promises an evaluation of the accuracy of CHAMP profiles in the Antarctic region. However, to quantify the accuracy of RO profiles (CHAMP and COSMIC), the authors utilize only three Antarctic radiosonde stations and 35 radiosonde stations, which are located somewhere else. Where are these stations?

   Figure 1 shows the locations of 17 (not 18) radiosonde stations in the Antarctic region but the authors did not use data from these stations (except from three Australian stations). Why not use data from all Antarctic radiosonde stations?

6. I do not understand how temperature trends were actually calculated. How did you account for monthly variations and the number of occultations? How many CHAMP occultations do you find per 5° latitude and 10° longitude bin? How large is atmospheric variability? How large are observational errors and sampling errors of RO data?

7. I am pretty sure that atmospheric variability is too large, RO sampling density to small, and the RO record still too short to perform a reasonable trend study at high latitudes using RO data (cp. Steiner et al., 2009). I cannot recommend publication of trend study results.

2 Minor comments:

2.1 General:

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

2.2 Introduction:

- Page 512, line 18: include a reference

- Page 512, line 21: include a reference

- Page 513, line 8: include a reference

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

- Page 513, line 16: include also Anthes et al. (2008)

2.3 Evaluation study:

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

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

- 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.

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

- 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?

- 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.

- 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?

- Page 515, lines 3 to 5: How significant are the last digits of these values?

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

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

- Page 520, Table 1: How significant are the last digits in Table 1? Omit at least the third decimal place.

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

- 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 ± 0.5 K on the first x-axis.

2.4 Acknowledgements:

- Page 517, line 22: CHAMP instead of CHAPM

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

2.5 References:

- Page 518, Foelsche et al. (2008): there are 3 authors missing: G. Kirchengast, J. Wickert, and T. Schmidt

- Page 518, Foelsche et al. (2008): doi:10.1007/s00382-007-0337-7

- Page 518, Fu et al. (2009): pages 1054–1059

- Page 518, King (1994): doi:10.1002/joc.3370140402

- Page 518, Liou et al. (2005): doi:10.1007/s10291-005-0141-y

- Page 518, Liou et al. (2007): Title: FORMOSAT-3/COSMIC GPS. . .

- Page 518, Liou et al. (2007): number 11, not number 10

- Page 518, Thompson and Solomon (2002): pages 895–899

- Page 518, Thompson and Solomon (2002): doi:10.1126/science.1069270

- Page 518, Turner et al. (2006): doi:10.1126/science.1121652

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- Page 519, Wickert et al. (2001): König instead of KÖnig

- Page 519, Wickert et al. (2001): doi:10.1029/2001GL013117

- Page 519, Zhang et al. (2009): I cannot find this reference

References

Anthes, R. A., Bernhardt, P. A., Chen, Y., Cucurull, L., Dymond, K. F., Ector, D., Healy, S. B., Ho, S.-P., Hunt, D. C., Kuo, Y.-H., Liu, H., Manning, K., McCormick, C., Meehan, T. K., Randel, W. J., Rocken, C., Schreiner, W. S., Sokolovskiy, S. V., Syndergaard, S., Thompson, D. C., Trenberth, K. E., Wee, T.-K., Yen, N. L., and Zeng, Z.: The COSMIC/FORMOSAT-3 mission: Early results, BAMS, 89, 313–333, doi:10.1175/BAMS-89-3-313, 2008.

He, W., Ho, S.-P., Chen, H., Zhou, X., Hunt, D., and Kuo, Y.-H.: Assessment of radiosonde temperature measurements in the upper troposphere and lower stratosphere using COSMIC radio occultation data, Geophys. Res. Lett., 36, L17807, doi:10.1029/2009GL038712, 2009.

Steiner, A. K., Kirchengast, G., Lackner, B. C., Pirscher, B., Borsche, M., and Foelsche, U.: Atmospheric temperature change detection with GPS radio occultation 1995 to 2008, Geophys. Res. Lett., 36, L18702, doi:10.1029/2009GL039777, 2009.