Atmos. Meas. Tech. Discuss., 7, C2362–C2369, 2014
www.atmos-meas-tech-discuss.net/7/C2362/2014/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Determining the temporal variability in atmospheric temperature profiles measured using radiosondes and assessment of correction factors for different launch schedules" *by* D. Butterfield and T. Gardiner

Anonymous Referee #1

Received and published: 26 August 2014

The authors used radiosonde temperature profiles of several sites to derive the temperature changing rate of different sites, altitudes and seasons. There are mainly two goals of this manuscript: the first one is to compare the temperature changing rate (correction factors) for launch schedule of fewer times (2, 4 times) with 8 times per day; the second goal is to estimate the temperature differences for certain temporal mismatch and suggest a minimum number of repeated measurements needed for the assessment of temperature differences. The authors considered the different factors such as sites, seasons, altitudes, times of the day on the temperature changing rates,

but did not address these factors fully when providing the "correction" for time mismatch in Figure 6 and Table 2 and discussing the minimum number of measurements needed. In addition, there are a few places that the analyses / calculations need to be clarified, and suggestions are given in the following text. The biases/uncertainties in radiosonde measurements also need to be sufficiently addressed. Overall, the reviewer thinks that the datasets are valuable and the analyses are important for improving the understanding of uncertainties in radiosonde temperature measurements, and also for future comparisons with other datasets. Thus the reviewer thinks the manuscript is appropriate for publication in Atmospheric Measurement Techniques if the following comments are carefully addressed.

The first major comment is on the definition and discussions on "correction factor". First, there are two places where the authors used the term "correction factor", one is 8344 Line 1, and the other one in 8345 Line 15. The first time, the term is used as "The correction factor <between> the base set and the mean hourly rate of change in temperature for a single launch (i.e. no correction), 2 launches a day and 4 launches a day were calculated" (8344 Line1-3). The term of "correction factor" is misleading, because it seems to describe the "difference" in temperature changing rate (k/hr) between 3 hr launch schedule and 6 h, 12 h schedules (results shown in Fig 3). And the legend in Figure 3 says "4 launches/day, 2 launches/day, no correction". What is "no correction", and what is the ones being "corrected"? The second time, the authors defined the term "temperature correction factor" as "temperature changing rate", which is not the "difference" in temperature changing rate. Because of these confusions, the reviewer suggests the authors always use the term "temperature changing rate" instead of "correction factor", because the latter one is usually used to describe bias corrections on measurements, which is not the case here. This will also revise the term used in the title.

In addition, there are two analyses (Figure 3, and Figure 4, 5) that the authors did not explain exactly how the values are calculated in these figures. The reviewer suggests

AMTD
7, C2362–C2369, 2014

that the authors clarify the calculation for the values used in Figure 3, 4, 5 in both text and equation forms. For example, if using dT/dt_3h, dT/dt_6h, dT/dt_12h to define the temperature changing rates, how is "mean hourly rate of change in temperature" calculated? Is it the mean or absolute mean of the values in Figure 2? Does the "differences in correction factor (temperature changing rate)" in Figure 3 represent the difference of the mean of the absolute temperature changing rate, or the difference of the mean of the temperature changing rate, or mean of the difference of temperature changing rates? Also the difference is which dataset minus which one? The authors should explain which of the following is the way that "correction factor difference" was calculated (or other ways):

mean(abs(dT/dt_3h_i) – abs(dT/dt_6h_j)), i = 0 to 7; j = 0 to 3

or abs(mean(abs(dT/dt_3h_i)) – mean(abs(dT/dt_6h_j))), i = 0 to 7; j = 0 to 3

or abs(mean(dT/dt_3h_i) – mean(dT/dt_6h_j)), i = 0 to 7; j = 0 to 3

The term of "hourly rate change in temperature" in Figure 4 and 5 needs to be clarified in two steps. First as the question for Figure 3, how is "hourly rate change in temperature" calculated? Second, when averaged into different altitudes, how are the values averaged, and what are the bins of altitudes? Until the authors explain how exactly these terms are calculated, the discussions of Figure 3 and later on 6 h dataset for Figure 4 and 5 are not clear.

Similarly, the term of "hourly rate of change of temperature" in Figure 6 and Table 2 should also be clarified. In fact, if this term stands for mean of the dT/dt_6h, then this mean value has averaged out the positive/negative dT/dt_6h values throughout 24 hours, and the final mean value (such as 0.081 K in the given example), does not represent the real dT/dt_6h at a given time of a day. Especially as shown in Figure 2, some parts of the day have dT/dt_6h as negative values, some parts are positive. The reviewer thinks that if the authors want to use the dT/dt_6h as a method to estimate temperature differences for dataset intercomparisons with time mismatch, this

AMTD
7, C2362–C2369, 2014

temperature difference factor should be given as different values for different times of the day.

The second main comment is that when comparing temperature changing rate (difference between dT/dt_3h and dT/dt_6h), the statistical significant test should be done, such as showing whether the dT/dt of different launch schedules are within their 95% confidence interval. This is necessary if the authors later on use 4 times launch as adequate dataset: "Once a 6 h launch frequency was accepted to adequately represent the rate of change in temperature. . ." (Line 13-14 8344). In addition, it should be discussed if the 4 times launch schedule dT/dt is sufficiently showing temperature changing rate for different sites, seasons, and altitudes. Currently, the discussion of Figure 2 and 3, the correction factor differences between 2, 4, 8 times, are based on the dataset from Manus Island. The authors did not clarify if Fig 2 and 3 are based on Manus Island dataset for all seasons. If they are for all seasons, then it is unclear and also how this dT/dt comparison would change with seasons, and geographical locations. Especially since Figure 4 and 5 show that the temperature changing rate changes with season and sites.

The third question is on the radiosonde instrument uncertainty and precision. The authors need to provide references and previous validations/lab calibration results on the radiosonde temperature measurements. In particular, the radiosonde temperature measurement is shown to have differences in "T error characteristics" for daytime and nighttime, as mentioned in Sun et al. 2010 (JGR). In addition, Sun et al. 2010 also suggested that the radiosonde day-minus-night T differences increase with height: "For most radiosonde types, daytime mean(delta_T) tends to be larger than nighttime for the upper troposphere and stratosphere... Average (over all types) day-minus-night mean(delta_T) increases from about zero at 350 hPa, to 0.10 K at 50 hPa, to 0.20–0.30 K at 10–20 hPa." Then this leads to the question, if there are different biases in T between day and night, the temperature changing rate would have unevenly distributed biases throughout the 24 hr of the day as well. Thus the authors need to take this part

AMTD

7, C2362–C2369, 2014

into consideration and discuss the influences on the results.

Fourth, for the discussion on how many measurements are needed to have temperature uncertainty within a certain range. Here the authors only used the dataset at altitude of 5km, in spring, and in one time range 13:00-19:00 hr local time. But it is unclear if the minimum number of measurements needed would vary with altitudes, seasons, and times of the day. The authors should provide more information on these factors and show if 10 measurements are sufficient for all these conditions. In addition, it is unclear how the authors chose 1, 10, 100 measurements, like randomly or other ways? Please explain how the standard deviation is calculated for 1 measurement?

General comments on all figures, the datasets used for each figure should be clarified (at least in the figure caption). That includes, whether the datasets are for all seasons, all times of the day, all altitudes, given that some of the information cannot be guessed from the figure itself. Also for Figure 2, 3, 4, 5 and Supplementary Figure 3 and 4, the number of measurements need to be provided. These numbers are not provided in the supplementary material either.

Below are the detailed comments:

8340 Abstract. Line 1-4. This first sentence in abstract needs rewording. Suggest: "Radiosondes provide one of the primary sources of upper atmosphere temperature data for numerical weather prediction, the assessment of long-term trends in atmospheric temperature, the study <add: of> atmospheric processes and [delete: provide a source of] <add: the> intercomparison [delete: data for] <add: with> other temperature sensors e.g. satellites."

8340 Line 13: "analysed" should be "analyzed".

8340 Line 14. The sentence needs rewording. Suggest: This provides the appropriate estimation of temperature differences for given temporal separation and the uncertainty associated with them.

AMTD

7, C2362–C2369, 2014

8340 Line 17. What is “standard uncertainty”? Do the authors mean standard deviation, or uncertainty?

8340 Line 20-23. Please put a citation for: “. . .used globally as input data for numerical weather prediction {ref}.” Also please put citations for “Radiosonde data can also be used to assess long-term trends in atmospheric temperature {add ref}, study atmospheric processes {ref} and provide a source of intercomparison data for other temperature sensors e.g. satellites {ref}.”

8341 Line 4. Please explain “major void”: “. . .designed to meet climate requirements and to fill a major void in the current global observing system (Thorne, 2013).”

8341 Line 26-28. Need to add some details, what satellite was used, and the 0.15 K difference for what pressure level? In addition, the authors need to point out what is the new contribution of this work compared with the Sun 2010 work, and other previous work on temperature variabilities in time/space.

8342 Line 18. Please spell the full name of “DYNAMO”.

8343 Line 19. To statistically demonstrate the 3h and 6 h launches have “similar” profiles, besides “within the error bars (standard error of the mean)”, the authors should show a statistical significant test for their differences.

8343 Line 12-14: For Fig 2, the time stamp, Local time (hr) should be mentioned in the figure x-axis legend, and also should be mentioned when describing the Fig 2 in Line 12-14. Otherwise there is no unit for “Time” and readers could assume either UTC or local time by just reading the figure.

8344 Line 25. Figure 4 should be Figure 5 in the text.

8345 Line 1-5. The discussion on the differences between sites at different seasons. The authors should explain if the significant differences for different seasons/sites are due to different reasons. For example, the summer time differences between Southern Great Plain and Lindenberg, are they due to the differences in their climate, typical

AMTD

7, C2362–C2369, 2014

weather condition? And for the comments on the differences in Lindenberg data as a result of changes in radiosonde type and analyses procedures, the authors should add references to these documented changes in instrumentations, and maybe previous work on the calibration / intercomparisons of different instrument of radiosonde.

8345 Line 14. "10 and 100 repeat measurement", suggest use "repeated measurement". Please revise.

8345 Line 20. "Figure 6. . .... in Spring and for 13:00 and 19:00 local time. . .".

8345 Line 23. Please explain why use temperature <= 0.1 K/hr. This might be derived from Sun et al. 2010, where temperature is found to have 0.35 K/3 hr changing rate. Yet, besides the work of Sun et al. 2010, which acknowledged that the radiosonde biases in T change magnitude/sign with day/night, altitudes, sites/instrumentations, the authors should also add citations of other datasets, for example, higher resolution dataset of temperature variability in time, for the definition of "acceptable bounds" of temperature changing rate.

8345 Line 24. Missing Table 3.

8345 Line 25. ". . . similar to those. . . in Fig. 1 (0.038)." It is unclear what 0.038 value the author meant in Figure 1, please explain where this value comes from.

8346 Line 1. "Correction of 0.081 K should be applied. . ." Please explain in text or equation how this 0.081 K is applied, like plus or minus? In fact, as mentioned in the general comments, some parts of the day have positive dT/dt, and the other parts have negative dT/dt. The "correction" should be given for different times of the day.

8346 Line 4-5. "The overall results presented here enable such an evaluation to be made for any altitude, time of day and season." The reviewer does not agree with this sentence, because the results presented here only represent 13:00-19:00 hr local time, and only in spring, and the authors haven't shown any analyses whether the factors such as season and time of the day would matter to the "correction" (such as

AMTD
7, C2362–C2369, 2014

0.081K) and uncertainty (0.316K). If the authors address the question for 8346 line 1, that is, how the correction is applied with 0.081K, then maybe this method can be applied to specific location/time/season, but the results presented here are not covering all conditions.

8346 Line 16-18. Rewording. "... provide appropriate estimation in temperature differences for a given temperature separation and the uncertainties associated with them."

Table 2. Altitude range needs to be clarified. ~5km, is it 0-5km, 5+/- 5km? First row, "Mean rate of change K/hour", is this the mean of (dT/dt), or absolute mean? As mentioned in the general comments, if it is the mean, then positive and negative values cancel out; if it is the absolute mean, then which direction should the dataset be adjusted? Similarly for Figure 6 caption, please define "mean rate of change of temperature".

Comments on supplementary material

1. Complete Figure 3 and 4. Number of measurements should be provided.

2. Table 2a and c, the altitude "= 5 km" is not consistent with "~ 5km" in the Table 2 of the manuscript, please clarify if 0-5 km, 5+/-5km or otherwise.

3. In the excel sheet for "Data for Figure 2", the date "1/1/1900" at the bottom of each data column is wrong should be corrected or removed.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 8339, 2014.