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Discussions

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Interactive comment

Interactive comment on "Correcting precipitation measurements of TRwS204 in the Qilian Mountains, China" *by* Qin Zheng et al.

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The paper presents the comparison of an automated weighing gauge (type TRwS 204) and the Chinese standard precipitation gauge (CSPG) inside a Double fence intercomparison reference (DFIR) with a two-year data set. Conclusions are drawn on the performance of the TRwS204.

There is known uncertainty in precipitation data. The World's Meteorological Organization (WMO)'s Solid Precipitation Intercomparison Experiment (SPICE) has tested the performance of many different gauge and wind shield configurations at several sites worldwide. The described site in the Quilian Mountains in China has a reference gauge following WMO's recommendations for a manual reference and recently added

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an automated reference (not analysed in this study). Gauge comparisons from the site are valuable as they extend the knowledge about gauge performances in different configurations and locations, thus this study fits into the scope of the special issue.

The presented analysis of the two-year data set has several weaknesses and thus the drawn conclusions on the performance of the tested gauge may not be representative.

General comments

The presented concept of separation into systematic and instrument-specific errors (*2.2 Data Analysis and 3.3 specific errors of TRwS*$_{SA}$) is a different approach and might be interesting.
The derivation of the concept, however, is not convincing and is based on assumptions which are not further proofed. Generally, the rather small data set and very limited meteorological conditions at the site would make it difficult to evaluate another aspect of possible gauge errors in a representative way.
Instead of just stating that the wind-induced errors for TRwS$_{SA}$ and CSPG$_{SA}$ are the same, I suggest that you first present and compare data for both instruments and then eventually discuss this idea further based on the presented data and analysis.

Wind speeds during the two year measurement period reached maxixmal 2 m/s, which makes the evaluation of a wind dependent error very difficult and the derivation of an own set of wind dependent transfer functions does not make sense (*3.3 systematic errors of TRwS*$_{SA}$) as they won't be valid for other meteorological conditions or sites.
Instead, I recommend to use your valuable data sef of not yet in detail tested gauges and wind shield configurations to test existing transfer functions.

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Please be aware that it is not meaningful to conclude on the effect of the single Alter wind shield (*4 conclusions*) for the light wind speeds you experienced during your measurement period.

The authors compare 30-min precipitation data of an automatic gauge with 12 or 24 hour data of a manual gauge. It remains unclear how the 12/24 hour data for the automated gauge are derived and which data product of the automated gauge is used. Beside calculated precipitation accumulations for the chosen measurement interval (here 30 min), the TRwS 204 also provides the raw bucket content. I assume that you summed up the precipitation totals of each individual 30 min period to determine the precipitation measured during the 12 h or 24 hour period? If my assumption is correct, then you divide already low daily precipitation totals as measured from the manual gauge to the 30 min periods measured by the TRwSS204 (*3.1 Total losses of* $TRwS_{SA}$). Most of those 30-min totals may be lower than the detection threshold from the gauge, thus resulting in a lower precipitation total. For those kind of comparisons, it would be more fair to either increase the measurement period of the TRwS 204 (if possible) or to use the change in the bucket content instead. The TRwS204 is a collecting gauge and over a longer period the accumulation would add up eventually, so that the accumulation is measurable.

The repeated statement of the absolute difference in precipitation measurements for different precipitation types is misguiding as it does not take into account the very different amounts measured for each precipitation type.

Specific comments

1 Introduction

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Page 2, lines 25-26: I think you don't want to imply that only automatic gauges tend to underestimate precipitation in the presence of wind. The placement of **in contrast to** needs to be changed to make that clear.

2.1 Site and Data Sources

Page 3, lines 9-10: How did you determine values for annual total precipitation and annual mean air temperature? From the two years of data or any other period? Which period? Why are you using the term approximately?

Page 3, line 17: Please give a source for the stated resolution of the TRwS, I assume you took that from the provider's manual or other documentation.

Page 3, lines 17-19: Please state that the sensor comes with an in-built software which filters the data for vibration and evaporation.

Page 3, line 25: Could you please describe the filtering process and the manual quality control in some details?

Page 3, lines 25-26: Are the half-hour values averages or just aggregated values?

Page 3, section 2.1: It would be great, if you could add the following information:
- Which parameters are you recording form the TRwS?
- Map of the location of the site
- Layout of the site with instrument set up, also for anxcillary measurements like

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temperature, wind, humidity, ...
- Instrument types of anxcillary measurements or citation of a more detailed description of the site
- height of the gauge inside the DFIR

Page 3, section 2.1.: I think the information on the new automated gauge (given in section 3.3.) in a double fence can also be stated here for a complete description of the site.

2.2 Data Analysis

Page 4, Equation 2: Please check the first line of the equation. According to Allerup et al. (1997), the corrected precipitation is
P=R$_{measured} + \Sigma(\Delta R_{errors}$)=k(P$_{measured} + \Sigma(\Delta R_{errors}$)
where R, is refering to a **reference gauge** while P is refering to the gauge under test.

Page 4, Lines 15-16: For your analysis you make the assumption that the systematic errors of the CSPG$_{SA}$ and the TRwS$_{SA}$ are the same. While it is an interesting idea to separate the errors in instrument-specific and systematic error, I find that you have at this point of the manuscript to little substance to introduce this step and it seems rather artificial and complicated. I suggest that you first present and compare data for both instruments and then discuss this idea based on the analysed data.

Page 4, line 25: Earlier you introduce that manual measurements are performed twice a day (Page 3, line 23). Here you refer to daily precipitation. Are you using 12 or 24 h periods? In case of 24 h-periods (= daily) which of the two daily measurements are you using?

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3.1 Total Losses TRwS$_{SA}$

Table 1 and related text in the section: For completeness, please add the measurements of CSPG$_{SA}$ in the table and discuss those. As discussed under general comments, I think the comparison of precipitation totals based on separate 30-min-periods with totals for 12 or 24 h periods introduce an additional (non-real) bias for the automated gauge. It is possible for the TRwS to measure the total accumulation over the longer interval, thus also the TRwS may be able to register those small amounts of preciptiation.

Further, 10 out of 207 events are less than 5%. That means, in more than 95% of the cases, the TRwS$_{SA}$ detected precipitation measured by the reference. I find that is a very important and positive result which should be mentioned. I find it doubtful to conclude on remaining instrument issues caused by temperature effects and inaccurate measurement of small amounts of precipitation from 10 single cases.

Page 5, line 9: Isn't the definition of trace that the amount of precipitation can't be measured? Thus, the fact that the manual methods did not measure the trace is redundant and not a special fact which needs to be explained by the complex microtopography of the area.

Page 5, line 18: To my knowledge are winds up to 3 m/s called light. The term moderate is used for winds higher than 5.5 m/s. That is important, because for light winds the expected wind-induced undercatch is very small.

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Page 5, line 19: The different precipitation types occured in very different numbers (both number of events and amount of preciptation) and the comparison of absolute values is not giving the right impression on where you noticed large and small deviations. From the numbers in table 2, I calculate that the reference measured on average 2 mm snow, 3 mm sleet and 7 mm of rain per event. Your stated average undercath of 0.4 mm for snow, 0.2 mm for sleet and 0.8 mm for rain relates to 20% undercath for snow and approx. 10% undercatch for rain and sleet. I find those kind of numbers better comparable with results from other studies.

Page 5, line 20-22: The sentence "**This result was unexpected ...**" belongs into conclusions and should be discussed there.

Table 2 and related text in the section: For completeness, please add the measurements of CSPG$_{SA}$ in the table and discuss those.

3.2 Linear Correlation of TRwS$_{SA}$ Measurements and "True" Precipitation

Figure 2: I wonder if it is possible to combine those plots into one, using different colors for the different precipitation type, thus giving a more comparable impression of the scatter plots. For completenes, please add a similar plot(s) for the measurements of CSPG$_{SA}$. I find it questionable to calculate new regression lines, as especially for sleet and snow the low number of points make it difficult to reach statistically significance. Why not calculate the standard deviation and the standard error?

Page 6, lines 9-10: Instead of stating that half of the measured events were overestimated, I recommend to state that the deviations seems to be randomly distributed around the 1-1-line and both over- and underestimate, or generally that a larger scatter

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was observed. The calculation of standard deviation would help to set this in relation to rain and snow. The different scales of the panels in figure 2 makes it difficult to see which deviations are actually "larger" and "smaller".

3.4 Systematic Errors of TRwS$_{SA}$

Page 7, line29: The Alter shield has also in other studies shown good effect for reducing wind-induced undercatch for light wind speeds.

Pages 8-9: I don't understand why you try to generate new transfer functions with you data set instead of applying existing (with advantage from different authors) transfer functions and discuss if they work. As you don't have data with gentle, moderate or strong wind speeds, it will be difficult to develop new representing transfer functions depending on wind speed.

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