I would like to thank the anonymous reviewer for taking the time to thoroughly review this manuscript and offer suggestions for revisions. The comments are appreciated and will serve to improve the manuscript.

Interactive comment on “Measuring precipitation with a geolysimeter” by Craig D. Smith et al.

Anonymous Referee #2

Received and published: 23 May 2017

This paper could make a useful contribution by quantifying the relationships between a precipitation gauge and a geolysimeter. The authors have a done a good job of identifying many of the hydrological processes which can account for some of the differences between the sets of measurements, particularly those of the snowfalls.

Unfortunately, the authors have not adequately accounted for the difference between the areas of the rain gauge and the geolysimeter. The areal reduction factor, which quantifies the reduction of rainfall extremes over a region, compared to a point, is well known in hydrology. ARF values have been derived for many regions and are a standard part of engineering hydrology. Because the area of the geolysimeter is so large (almost 5 km^2) it approaches the sizes of the regions referenced in some published areal-reduction factor curves.

More theoretical analyses (De Michele et al, 2001, among others) also demonstrate that the reduction factor is related to the size of an event, which is also shown by the plot of the geolysimeter and gauged rainfalls in Figure 3. However, the reduction factor also depends on the length of the event, while the authors have combined events of varying lengths. It would be possible to compare areal reduction factors for intensities, durations and frequencies derived from the data with published values.

At the very least, the effect of the area of the geolysimeter on the difference between its rainfall estimates and those of the gauge needs to be addressed.

De Michele, Carlo, Nathabandu T. Kottegoda, and Renzo Rosso. "The derivation of areal reduction factor of storm rainfall from its scaling properties." Water Resources Research 37, no. 12 (2001): 3247-3252

The reviewer brings up a good point that we had originally only considered lightly. Quantifying event lengths is somewhat of an arbitrary methodology with a very wide variety of thresholds used in the literature, so we would rather avoid analysis based on quantified event length for this manuscript but would reconsider further analysis in the future. In this analysis, events have been identified that have a clear beginning and clear end to precipitation, (as shown in the example in Figure 2) and if you define the event length to start at the first trace of precipitation and end immediately after the last trace of precipitation with no breaks larger than a few hours in between, then our lengths vary from 7 to 74 hours, averaging about 24 hours. Extrapolating from De Michele et al. (2001), the approximate ARF for the average event length is about 95%. Applying this adjustment, the bias between

the geolysimeter and the gauge is reduced to -1.5% from -7.0% and the rmse is reduced to 1.6 mm from 2.3. The slope of the regression line also becomes closer to 1 (increasing from 0.90 to 0.95). Therefore, precipitation scaling could certainly explain much of the negative bias in the geolysimeter, combined with evapotranspiration, runoff, and potential timing of geolysimeter peaks relative to the timing of the measurement. However, we feel that areal reduction factors for this field site are neither well known nor understood. This is complicated by the fact that the geolysimeter is at the centre of the response area and the sensitivity to load changes per unit area falls off with distance, making us less confident in using any ARF.

This is addressed in the Discussion section on page 11.

General The writing needs revision. The language is excessively colloquial and the terminology is frequently sloppy. A few examples are shown below

Besides the corrections noted below, we will do another thorough proofread and correct language issues.

Page 1, Line 15 “Correlations varied from 0.99 for rainfall to 0.94 for snowfall.” I believe that you are referring to the correlation coefficients of the linear regressions (r^2) rather than values of correlations between the data sets.

Corrected

P 3, L 3 “wider area” Area is not the same thing as width! This sloppy usage is repeated throughout the document.“(hectares vs m^2)” The exact areas of the gauge orifice and of the geolysimeter and their ratio should be given. This sentence grossly understates the ratio, i.e. the ratioof 1 hectare to 1 $m^2$is 10,000:1. According to the manufacturer’s website, the gauge orifice area is 200 cm^2, i.e. 0.02 m^2. If the radius of the geolysimeter measurement area is 1.25 km (as stated), then the ratio is more than 245 million to 1!

The intent of this analysis was not to do an extensive scaling experiment. We don’t want to debate the spatial representativeness of the 200 cm^2 gauge orifice. The point of this sentence was simply to state that there could be advantages to measuring precipitation at the scale of hectares rather than square metres (or smaller). The reference to “m^2” has been removed to avoid the implication that this is a scaling experiment. The language has been corrected in the rest of the manuscript.

P 4, L 7 “This stress transmission” The previous sentence refers to the load (i.e. a force) and the pore-water pressure, not to a stress. Please make this clearer.
L 27 “at 13U 417810E, 5863437N.” Why not specify the location by its longitude and latitude? They are global values, rather than being specific to a region, and are more easily understood.

Corrected

P 7, L 2 “and earth tides”
Earth tides were not mentioned previously, when discussing the adjustment of the raw

data, but probably should have been.

This was included in the context of the methodology. A mention of the earth tide effect is now included in the Groundwater theory section (Page 5, lines 6-10), including a reference.

P 8, L 13 “Evapotranspiration was likely minimal since relative humidity during the night ...”

Does plant transpiration of water ever occur at night? The word “minimal” is being used in a colloquial sense. It would be better to say “very small”.

Plant transpiration can occur at night and so can evaporation. We qualitatively state that these are likely minimal because humidity is high and therefore vapour pressure deficit is likely small, but we don’t quantify the evapotranspiration so this is speculative. We will change the wording as suggested.

L 21 “significant” This word should not be used in a scientific paper, unless you are giving the level of significance.

Agreed

P 9, L 1 “Summary statistics ...” How were these computed? What program did you use?

MATLAB

L 5 “RMSE varies ...” The abbreviation should be defined. Also, since the gauge data are also believed to be in error, what you are actually computing is the root mean squared deviation (RMSD) between the two datasets.

OK, changed RMSE to RMSD and defined the abbreviation.

P 10, L 29 What is an “adequate snow catchment”?

Poor choice of words. The sentence reads correctly when the word “adequate” is removed.

Figures P 18 Figure 1 caption “response area of ~1.25 km” Area is not measured in km. This would appear to be the radius of the geolysimeter response area, correct?

This has been corrected to read “…with a radius of ~1.25 km”.

P 24 Figure 7 It appears that a point is missing from the plot. There is a point plotted for largest gauge unadjusted precipitation, and for the sigmoidal adjusted value, but there does not appear to be a corresponding point for the exponential arctan adjusted value.

Those plot axes were scaled incorrectly. This was corrected.