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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Technical note: A microcontroller-based automatic rain sampler for stable isotope studies" *by* N. Michelsen et al.

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Dear Dr. Groening,

Thank you very much for your valuable comments on our manuscript. Please find below your reproduced comments, followed by our responses.

COMMENT: Dear colleagues, I have read with interest this interesting manuscript on the design of an automated rain sampler minimising evaporation and therefore ensuring scientifically sound data for stable isotope process studies. The manuscript is well structured and provides a wealth of references to see the state of the art in recent efforts to ensure proper precipitation sampling for stable isotope analysis. I appreciate very much the details revealed by the authors to enable reproduction of such analyser

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in self-made mode, therefore probably minimising costs for most users having access to a workshop. The scientific findings are relevant, presented appropriately and comprehensively. The indicated very low energy consumption and use of cheap commercial batteries is a key advantage for successful application in many remote sampling scenarios. The setup may not be fully suitable for very cold conditions (anyway not below water freezing point). The experimental setting is solid and provides evidence of negligible isotopic fractionation due to minimal unavoidable evaporation. There are only few minor comments to potential users to improve the impact of the paper and minimise problems. I did not find details on how to connect tubes through the caps into the individual bottles (two connections necessary per cap). This could be seen as very minor issue, but the connection through the cap needs to be completely air tight to atmosphere. One photo would suffice to clarify it.

RESPONSE: Thank you for this positive and motivating evaluation. Concerning the tubing connections through the bottle caps, we have to admit that this crucial point was indeed not emphasized in our initial manuscript. We use cable grommets that also appeared in the bill of materials, but probably this aspect deserves more attention in the main text. We now added the following sentence: “All tubes are guided through the bottle caps by means of cable grommets (Fig. S2), ensuring a tight connection.” In the Supplement, we now provide additional details: “The water and air tubes are guided through the bottle caps by means of cable grommets. The used KAB SNAP 9 cable grommets (see bill of materials) are suitable for tubing diameters between 5.0 and 7.0 mm. They were installed by drilling two 16 mm bores into the bottle caps and pushing the conical part of the grommets through the bores.” Moreover, we now include a photograph (see Fig. 1).

COMMENT: One minor comment is related to the isolation of bottles after moving the upper disk to the next bottle position as discussed in section 2. This is the moment when each isolated bottle is keeping its actual air pressure at the time of closure, with its internal pressure not anymore being equilibrated via the tubing (page 3, line

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15). The experimental data in Table 1 show in general an increased evaporation for hermetically closed bottles versus one bottle open to the atmosphere via a long tube (section 3.2.1, page 4 line 34). This could be caused by the atmospheric pressure fluctuations, resulting in periods of higher or lower pressure in the bottle versus the open atmosphere, and may induce pressure induced air flow and leakages (it is nearly impossible to keep a large area flat sealing pressure tight). The increase of losses with increased water amount could point to a solubility issue (slow penetration of liquid water according to filling height through plastic material).

RESPONSE: We agree – it is very likely that pressure fluctuations (mostly triggered by the diurnal temperature regime) play a role, particularly if small leakages occur (very likely). Also the filling status of the blocked bottles seems to be relevant in terms of water losses. Hence, we have modified the corresponding paragraph in section 3.2.1 accordingly: "These data suggest that the diffusive loss through the tubing material of the connected bottles (two tubes per bottle, hence 0.28 g; see tubing loop data) is similar to the flux through the bottle material of Bottle 6 (0.24 g). As all connected bottles exhibited greater absolute mass losses, additional leakages, e.g. at the cable grommets in the bottle caps or at the distribution unit, seem likely. In this context, pressure fluctuations, induced by the diurnal temperature regime, probably play a role. It is also noteworthy that the blocked bottles 4 and 5, containing 300 and 400 mL of water, showed the greatest losses (> 2 g). This observation could point towards an influence of the bottle surface area in contact with liquid water on the diffusive water flux through the plastic. Nevertheless, the overall absolute losses are still rather small, particularly when compared to the worst case scenario, an unprotected bottle (Bottle 7)."

COMMENT: A second comment is related to the bottle types. I did not find an address for the provider of suitable bottles. However the quality of bottles is of major influence for such study. At the IAEA we have previously (2004) performed long term experiments with nearly 60 different bottle types used for regular water sampling, all filled

with same water in triplicate and kept for 6, 12 and 18 months before analysis, recording the weight loss and isotopic shift. After 12 months more than half of bottle types showed evaporation losses above one percent of water weight, associated to delta18O changes of above 0.5 permille. Therefore the proper selection of bottle type is crucial for storage. Glass bottles could be perfect (however even some glass bottle types (!) caused evaporation by imperfect fitting of glass surface to plastic caps), but in most cases high quality HDPE bottles showed best performance at moderate price and robustness. Overall the paper is of excellent quality and should definitively be accepted. Best regards, Manfred Gröning m.groening@iaea.org

RESPONSE: In our initially submitted manuscript, we mentioned our supplier, but admittedly quite late – in section 3.1 where we describe the methodology of our evaporation experiment. In section 2 outlining the design, we had tried to keep out suppliers to not impede reading flow and because the section was meant to only describe the principle of the collector. However, we agree that suitable bottles are crucial and hence added the following sentence upon first mention of the bottles, i.e., in the Design section: "With respect to the bottles, we recommend thick-walled HDPE bottles that effectively reduce diffusive water losses (Spangenberg, 2012; personal communication Manfred Gröning, IAEA, https://doi.org/10.5194/hess-2019-93-RC2). For our purposes, we selected 500 mL HDPE wide-mouth bottles by Labsolute (Renningen, Germany; wall thickness approx. 1.7 mm)." Initially we had only cited Spangenberg (2012) in this regard. Since the IAEA has apparently carried out such experiments much earlier, we now also refer to your comment as personal communication and provide the DOI of your review. We hope you agree with this.

Best regards, Nils Michelsen (on behalf of the author team)

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Fig. 1. Bottle caps with cable grommmets

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