

Atmos. Meas. Tech. Discuss., referee comment RC2
<https://doi.org/10.5194/amt-2022-208-RC2>, 2022
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Comment on amt-2022-208

Anonymous Referee #2

Referee comment on "A modular field system for near-surface, vertical profiling of the atmospheric composition in harsh environments using cavity ring-down spectroscopy" by Andrew W. Seidl et al., Atmos. Meas. Tech. Discuss.,
<https://doi.org/10.5194/amt-2022-208-RC2>, 2022

Review of A modular field system enabling cavity ring-down spectroscopy of in-situ vapor observations in harsh environments: The ISE-CUBE system

This manuscript describes a new modular box enclosure called ISE-CUBE that can be used to deploy water vapor isotopic analyzers and water vapor isotopic cold-trap systems in the field under extreme cold-weather conditions. The manuscript provides a short description of the enclosure and subsequently evaluates the isotopic analyzer's housekeeping variables from a two-week winter deployment in Svalbard. The housekeeping data suggest the analyzer is able to maintain satisfactory ranges for its Data Acquisition System temperature, its cavity temperature and pressure, and its warm box temperature. The analyzer's water isotopic measurement precision in the field is also comparable to its measurement precision while sampling calibration gas in a laboratory setting.

The manuscript also describes an optional "profiling module" for ISE-CUBE, consisting of a tripod with an articulating measurement arm, that can be used to position a heated inlet line for the isotopic analyzer anywhere from 4 to 205 cm above the ground surface. A 90-minute window of data is presented that shows water vapor concentrations and isotope ratios from six height levels within the articulating arm's 2-m range. The paper argues that the articulating arm provides a means to resolve and study the water and isotopic gradients closest to the surface, although doing so requires repositioning the inlet height via a manual pulley every few minutes.

Comments

Where this paper really advances our measurement abilities is in the design and presentation of the box enclosure for the isotopic analyzer and cold trap; yet most of these details are in the Supplemental material instead of in the main paper. I would recommend revisiting Figures 1-2 and using these to convey specific details about the box connections and tubing materials, something more akin to the Connectors Template in the SI. As currently presented, Figure 1a is simply too dark to make out details, and Figure 1b requires more detail and explanation. For example, what are the "power out" and "data" ports used for? Where are the fan inlets and exhaust ports? Where do the boxes connect to one another? Is the CRDS inlet unheated after the check valve? Which lines are PTFE and which SS? In addition, the main text mentions components such as an "adapter," an "exterior inlet bulkhead," "incoming ventilation tubing," and "manifold tubing." Can these be labeled on Figs 1-2? The list of components in Appendix A is fantastic. Consider also a corresponding diagram (again, like the Connectors Template) that shows where all these components go and telling readers how many of each part are required to replicate the system. Another way to think about this: what would a purchase list look like?

It would be helpful if the manuscript discussed the relevance of the ISE-CUBE enclosure to the wider measurement community. Much of the manuscript is specific to the deployment of a Picarro CRDS water vapor isotopic analyzer. Would ISE-CUBE work for other types of isotopic analyzers? If the enclosure is specific to the size and shape of the Picarro systems, could ISE-CUBE work for other gas-phase Picarro analyzers? Moreover, based on the short two-week deployment in Svalbard, is there any sense whether ISE-CUBE could last for longer periods for unattended measurements?

On a related note, the Data Processing section (Sect. 3.2, including Table 1) presents ISE-CUBE as producing three data streams generally, but these three streams are specific to the way the modular system was set up for testing during ISLAS2020. It would be helpful if the paper distinguished more carefully which aspects of the design are generic and applicable broadly vs. specific to the test case configuration.

The enclosure is presented as novel, in part, for minimizing disturbance to the environmental flow, but I think this claim might be overreaching, since most ground-based installations are designed to minimize flow disturbance (e.g. flux towers). The real draw of the enclosure in my mind is the ability to deploy a water vapor isotopic analyzer in an environment with minimal infrastructure support (e.g. nothing more than a power drop) and/or to reduce the length of inlet lines and thus measurement hysteresis.

To evaluate ISE-CUBE, the water vapor isotopic analyzer's performance in the field is compared to its performance in the laboratory. The intention is to compare two distinct environmental settings. However, there is another relevant difference that needs to be communicated more transparently: in the laboratory, the analyzer samples reference gas continuously, whereas in the field, the analyzer is measuring real variability related to the environment. I would not be surprised if this difference in sampled air causes the differences in humidity-binned standard deviations presented in Fig. 10 or results in the differences in spectral-fit residuals (RS) presented in Fig. 8. The paper concludes that the field data are "marginally less precise," but, again, I wonder if this is not just a reflection of the environmental air. Would one reach the same conclusion if the analyzer were measuring reference gas while deployed as part of ISE-CUBE in the Arctic?

While I'm not sure it is necessary for the point the paper is trying to make, it would be awfully interesting to see how the isotopic analyzer and cold trap compare during the ISLAS2020 deployment. Such a comparison could provide some indication of the accuracy of the isotopic analyzer when deployed with ISE-CUBE.

Lastly, for Fig. 12, it appears there are environmental data missing during the period highlighted in the text (9:07, onwards). In addition, it would be helpful to know, are these data from the AWS? And can the figure be made larger?

Overall, the paper is very clearly written; however, a few minor comments on presentation are provided below:

L 15 - perhaps "components" instead of "compartments"

L 29-32 is a bit awkward and could be presented more clearly

L 39 and elsewhere - "pneumatically" might be the wrong word as this implies compressed air

L 165 - is there a reference for ISLAS2020?

L 177 - Does the ISLAS2020 data span 21 Feb to 14 Mar?

L 187 - "reliable" seems like the wrong word for what is intended

L 219 requires clarification

L 239 and elsewhere - "minutely" means "meticulously." I think the paper intends to say "1 minute"

L 375 - since "field" and "laboratory" have specific meanings, I would use "remote observatory" or some other phrase here

Fig. C1 - caption says observatory margins are for the same "time" but not the same dates, right? Perhaps clarify.

L 521 - says "could be" but should it say "is" or does it really mean "might be comparable" (as in it's unknown)?

Fig. D1 seems to be missing the gray shading mentioned in the caption