

## ***Interactive comment on “Robust, spatially scanning, open-path TDLAS hygrometer using retro-reflective foils for fast tomographic 2-D water vapour concentration field measurements” by A. Seidel et al.***

### **Anonymous Referee #1**

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#### General Comments:

Overall I think the authors describe a novel and scientifically important instrument. They have performed useful sensitivity studies and characterized the precision and accuracy of the instrument. There are a few points which could be clarified, as described below. The main weaknesses I saw were in outlining motivation for tomographic water measurements in particular and in not explicitly describing how the absorption path-length is calculated.

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#### Specific Comments:

The motivation in paragraph 1 seems more applicable to methane or CO<sub>2</sub> emissions than water emissions. Is water emitted from soil really important as a greenhouse gas or to understand the emission of methane? Could use more specific motivation as to why we care about tomographic water vapor measurements. (Or if water is a stand-in and the goal is to measure methane by this method, to state that). 12828 Ln 8: “where greenhouse gas emission from certain soil structures shall be monitored” Are you considering water to be a greenhouse gas?

12829 Ln 15: What is the spatial scale of the soil structures that you are concerned with emitting greenhouse gases? You specify 0.5 m as the required length scale – how did you arrive at that number and what soil structures are that small?

How do you measure the pathlength? You alluded to it in 12837 Ln 11, but more detail is needed. Accuracy in the pathlength measurement is essential to the accuracy of the instrument, and given that the beam is moving it does not seem trivial. A detailed explanation of this calculation and the uncertainty in the calculation are needed.

Why is the exterior boundary square? Wouldn't setting the reflectors in a circle make the reflections stronger and the pathlength calculation more accurate?

Is there any pathlength that the laser travels within the instrument before entering the field (between the collimator, polygon-mirror, and exterior, or exterior and detector) which is unaccounted for in the calculation, and have you demonstrated that it will not impact your measurement?

How high above the ground is the measurement made? Would be useful to specify (particularly because at first I got the impression that you were actually measuring the soil water content, not the air).

12834 Ln 25: What are the accuracies of the temperature and pressure sensors and are their uncertainties included in the stated instrument accuracy?

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12835 Ln 24: Why are you fitting 19 lines? Are these other absorbers which interfere with the absorption line at 7299.43 cm<sup>-1</sup>? If so, how do you know the concentrations of the other absorbers?

Based on better accuracy from the stepwise measurement and the possibilities for improving the speed of the measurement with a VCSEL laser, would it be possible to achieve a step-wise measurement at 1 Hz or better to take advantage of the better accuracy of a stepwise over a scanning instrument?

Technical Corrections:

12829 Ln 5: "They not only have to be quantified"

12829 Ln 15: "In the special case of permafrost monitoring, measurement areas of at least 0.5 m edge length to several meters have to be covered."

12829 Ln 19: What velocity are you measuring, wind velocity? Vertical or horizontal?

12829 Ln 27: "they are based on robust, industrially available components."

12829 Ln 29: "into a tomographic setup"

12830 Ln 4: "field measurement rate equals the rate at which the concentrations"

12830 Ln 8: "Ma et al., 2013) or are somewhat ..."

12830 Ln 17: "minimal amount of equipment"

12830 Ln 26: "amounts to"

12832 Ln 6: "After passing through the absorption medium"

12833 Ln 1: "field edges are covered"

12834 Ln 6: "TTL signals" – acronym not explained.

12834 Ln 22: "with a high field measurement rate"

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12836 Ln 15: "In the left column, all four fan-beam units, represented by channels 0–3, are shown for a 2-D field measurement rate of 2.5Hz; the same is shown in the right column for 1.25Hz."

12836 Ln 23: "amounted to"

12837 Ln 4: "from the reference measurement"

12837 Ln 10: "inaccuracies in the assumed"

12837 Ln 23: "This might be a source of measurement error, as well as inaccuracies of absorption lengths of both reference and scanning channels..." Unclear. Also, why would there be pathlength uncertainty in the reference channel? Suggested revision: "This may be the reason for the better accuracy of the step-wise measurement compared to the scanning channel, in which there are more likely to be inaccuracies in the absorption pathlength."

12838 Ln 9: "amounted to"; Ln 10: "amounted to"

12838 Ln 17: "As static measurements with distances of more than 5 m between the emitting side and the retro-reflective foil have been ..."

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 12827, 2014.

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