Review of Wein et al., An Economical Tunable-Diode Laser Spectrometer for Fast-Response Measurement of Water Vapor in the Atmospheric Boundary Layer, AMT-2024-34, June 2024

The manuscript by Wein, et al. describes the recent development of a lightweight, low-cost, open-path TDLAS instrument suitable for research quality, fast-response measurements of water vapor in the atmospheric boundary layer and is highly appropriate for publication in AMT. The manuscript is well structured and describes details of the development and performance of the instrument that could reasonably allow reproduction of the instrument for use by others and includes discussion of a number of possible applications. The manuscript could use a number of minor corrections and modifications and I recommend publication following minor revision and considering of the following specific comments and questions.

Specific comments:

L8: First sentence could be restructured to remove redundancy of “high spatiotemporal variability” and “abundances varying…”

L8: ABL should be defined here rather than L11, and then L11 could just use “ABL”

L8: “possesses” should be “poses” (or “presents”)

L11: “in situ” is a Latin term and not hyphenated. I would think that you would want to include “open-path” in the description here since that is a critical aspect enabling the fast response time.

L11: “tunable diode” is generally not hyphenated (although I see it also was in Dorsi et al 2014).

L11: You define ‘TDLS’ first in the abstract as “tunable diode laser spectroscopy”, but then use it and subsequently define it as “tunable diode laser spectrometer”. Perhaps use “tunable diode laser absorption spectroscopy” in the abstract since that is the technique utilized and then TDLS as the spectrometer.

L12: you only need to include the acronym definition here if you will use the acronym alone later in the abstract. Comment also applies to L16 and L21.

L16: “proportional – integral”, as appears in L104 of the text

L17: “comprised of” should technically be “composed of” or “comprises”

L18: perhaps “agreed”

L19: perhaps “will allow” and preface with something like “The instrument is robust and simple to operate”

L29: “tropics”

L32: “underlying mesoscale processes”—meteorologically, mesoscale is typically 10 to 100s of km, which doesn’t seem appropriate here

L39: “DIALs and Raman lidars” or “differential absorption and Raman lidars”

L45: “such as infrared gas analyzers (IRGAs)”

L46: “have come to” → “are typically used to”

L47: it is really the cost (~x10, and for some applications the size/weight), not the limited number of vendors or some “highly specialized” nature that is the limitation, right? And potentially differences in required maintenance/recalibration? You expect the new TDLS to not require recalibration (does require initial calibration per L177) or regular maintenance, correct?

L57: “prediction”

L57: “capable of”

L60: “development and performance”?

L61: “high accuracy and precision matching that of” and “lower cost and greater flexibility that would allow widespread deployment for routine observations”

L67: “laser diode”? and what is meant by a “generic” package since it does require built-in TEC and tight coupling of the fiber?

L69: “components”? and “components and exhibits”

L71: I’m a little skeptical of the emphasis on the use of the instrument by fully inexperienced operators

L76: “2023), the reported instruments have had a slow response, resulting in limited vertical resolution”

L78: an example of a location?

L81: what is meant by “terrain and variable inhomogeneity”?

L89: “based on” would be more appropriate

L90: the clause “a schematic of which is shown in Fig. 1.” currently references the previously reported (Dorsi et al 2014) instrument. The clause could be inserted immediately after “described here” in L89 to be clear

L92: “is rapidly scanned”; “variations, a short”

L100: Figure 1 shows the trigger pulse passing from the receiver microcontroller to the laser drive, but the text states that the trigger pulse for data collection originates from the laser driver board.

L104: “TEC controller”

L105: “temperature of 0.002K” should be “temperature of XX.XXX ± 0.002 K” or say “A temperature stability of ±0.002 K, consistent…”

L107: “DFB” should be “laser” (or “DFB laser diode”)

L108: “a digital-to-analog (DAC) output” since the 3.6 has two, although the 4.1 does not have a DAC, so only from the 3.6 (although, as noted, now discontinued)

L110: “Arduino-compatible” hyphenated? But not “laser driving” or “data acquisition”

L111: “based on”

L112: “previous instruments” developed in your lab? Or universally?

L117: “scans to ~10 kHz and faster, resulting in high precision of the measurements”—precision from averaging over multiple scans? Current operation is only 10 Hz (100 msec) scans? L320 says “tests showing that full scans over the water [line] at ~1000 Hz are possible” and that higher scan (measurement) rates result in reduced precision (for individual scans)

L120: Reference to Figure 2 is missing from the text (~L129?). Fig 3 is already mentioned on L126. Reorder sentences to put “Prior to…” after the circuit discussion? Would it make sense to include Figure 2 in supplemental material? That would allow additional inclusion of the custom TIA circuit and supporting circuit board.

L129: “A Teensy model 4.1 with a built-in Micro-SD card feature was used…”; “a trigger pulse”

L131: ADC not defined at first use; “data acquisition analog-to-digital conversion (ADC) is started.”?

L132: There is some discrepancy regarding the discussion of Fig 3. It says here that the plot contains 445 points, but the figure shows 4 complete scans. Figure 4 shows 445 points

without showing a complete scan (~10+425+~10?). It would be best to clearly describe the sequence of one scan (475 points? 30 + 425 + 20?) and show the complete scan in Figure 4.

L132: How does the math for 7.2 kHz "raw" ADC work with 475 pts / 100 msec at 32x oversampling? Does 7.2 kHz already include the 32x and so is faster than the 4750 samples / sec?

L144: omit "on the opposite side of optical path both operated in photovoltaic mode"? A following sentence begins "The photodiode is operated in photovoltaic mode"

L148: It seems like the "AD1101, Analog Devices" is actually "HMCAD1101"? I could not find a part at Analog Devices that was just "AD1101".

L165: description here is "1st-order polynomial" while the caption in Fig 4 uses "linear fit"—these are indeed the same thing, but it might be clearer to be consistent

L166: It would be useful to have a little more clarity on the process of converting the temperature – wavelength determination to the current ramp scan to account "for the possible drift of the tune temperature by removing the nonlinear output laser wavelength response to a linear current ramp" and determination of the scan wavelength range.

L182: Accuracy metrics of the BMP280?

L187: Does "These calculations" refer to the real time processing that is planned for future implementation and not the present version that is the focus of the manuscript?

L190: The units of the x axis in Figure 4(b) are wavenumber, not wavelength as stated. Since wavelength is otherwise used consistently in the manuscript, I would suggest using wavelength here as well.

L190: In Figure 4(A), it might be helpful to use color on the trace to highlight the region of the scan used for the baseline fit. As noted in L132 comment, it would be clearer to plot a full scan including the 30 and 20 detector zero (laser off) points at the beginning and end of the scan.

L198: no hyphen needed between number and unit "25 L" even when used as an adjective

L200: "saturated to a mixing ratio of ~27,000 ppm"—was the air in the chamber saturated (potential condensation)? Or was the saturation temperature of the generator lower than the ambient temperature? What is/are the values (uncertainty) of the mixing ratio reported by the reference CRDS measurement rather than "~"?

L201: “admitted to the chamber”—also flow out of the chamber as well to maintain P?

L207: It would be good to include information about the linear regression as text in Figure 5

L209: remove period following “points)”; omit reference

L213: “Allan variance”

L222: sensitivity is not affected by averaging—“detection limit”?

L256: Omit “A long electrical line”? This was replaced with the “10 m twisted pair cable”? No comma needed after “cell” or hyphens between numbers and units; the word “long” could be omitted

L307: “Teensys”

L320: “tested powered”

L336: “include”

L342: ABL already defined in introduction