Justification of Changes

Per: Referee #1

General:

- The consistency of naming should be improved throughout the manuscript. Some names are changed multiple times as an example: Teensy = Teensy 4.1 = data collection microcontroller = receiver. Also introduced acronyms should be used or left out. More consistency here would be very helpful.

We have corrected the use of acronyms throughout. “Atmopsheric Boundary Layer” has been defined once and used throughout the manuscript. “Tunable diode laser spectrometer” has been defined once and used throughout as the name of the developed instrument. Labeling of Teensy microcontrollers have been cleaned up to limit references of microcontrollers to part name only.

- The quality of language/sentence syntax should be improved. Many typos, slips of the pen, and complicated/convoluted sentences.

We have corrected a number of typos and some sentences to improve the quality of the paper. They appear in the marked up version of the revised manuscript and will not be listed in detail here unless the changes were significant. We will summarize those significant changes at the end of this document.

- The plotting ticks should be changed using to a more standard style as they are confusing that way. E.g.: Fig 5, yaxis highest tick should be 30, above the axis a common coefficient with $1x10^{-3}$.

Figure 5 y-axis changed.

Figure 6 y-axis changed.

Figure 8 y-axis a and b and x-axis b changed.

- Also cross check references if missing and use correct citation style: Textual citation XXX et al. (YYYY) vs. parenthetical citations (XXX etl al. YYYY)

Old L41: “(Wulfmyer et. al 2015)” moved to the end of the sentence. (New L40)

Old L58: “(Helbig et al., 2021; Petersen, 2016)” moved to end of sentence. (New L58)

Old L65: References changed to conform with AMT guidelines. (New L65)

Old L75: References changed here to conform with AMT guidelines for intext citations. (New L75)

Old L114: “(Rainwater 2022)” moved to end of sentence. (New L119).

Old L241: “(e.g. see Aslan et. al)” changed to “(Aslan et. al)”. (New L262)

2.1 Hardware Description

- The captions of Fig.1 to Fig. 3 should be extended to be self-explanatory and not reference to the text.

  For example: Fig 1, please explain the different components shown: are drive input and TEC input circuits by themselves, how does the TIA look, are the laser driver and data collection unit the two Teensy microcontrollers…

Figure 1 caption (L100-104 in new document, or “new L100-104) has been expanded to include the following:

> “individual components (microcontrollers, laser, temperature controller) or individual circuits (TIA, laser driver). The dotted line indicates all components contained on the printed circuit board and those housed outside. A fiber optic coupler and twisted wire pair are passed outside electronics box through hermetically sealed holes.”

Figure 2 caption (new L135-139) has been expanded to include the following:

> “Important components of the TDLAS laser scans as a function of time. Detector output (top panel) is the continuous voltage from the TIA. About one-third of the time the laser is off, and the signal is close to zero, the background for the detector and TIA circuit. Laser drive (middle panel) represents the voltage output by the Teensy 3.6 used to set the current of the laser. The trigger pulse signal (bottom panel) is sent by the Teensy 3.6 to the Teensy 4.1 to initiate the sampling and recording of the scan.”

- L 103: The laser *wavelength* is tuned via temperature?

Old L103 has been changed to “…the laser is tuned to the wavelength of a strong water absorption feature at 1368.59 nm by changing the temperature of the laser diode…” (new L105)

- L 105: add ± before 0.002 K

Old L 105: “±” has been added (new L108)

- L 127: adapt trigger pulse direction in Fig 1. From driver to data collection if the text is correct

Figure 1 (new L100) has been correction to be consistent with the description in the text (new L128).

- L129: After 5V reference to figure

The old Figure 2 has been replaced with a new figure, now numbered Figure 3, which is a circuit diagram of the complete electronics used in the instrument. The following sentence has been added at new L127:

"A complete electronic circuit diagram of the instrument is shown in Fig. 3."

5V is now referenced on New Line 156 and New Line 165

- L 141 – 146: Please clarify: Was the laser collimated or divergent? How much bigger is the laser beamwidth compared to the InGaAs sensor active area? Have there been any tests regarding vibrations? (Even collimated laser beams show a distinct Gaussian profile which could induce signal variations upon vibration)

Old Lines 141-146 have been changed to (New L143-147):

"The lens was configured so that the laser beam was divergent to fully illuminate the active area of a low-noise broadband indium gallium arsenide (InGaAs) semiconductor photodiode and reduce variations in intensity due to vibration and turbulent fluctuations of air density in the optical path. Multiple photodiodes of differing manufactures (Thorlabs FDGA05, ThorLabs FGA04, Fermionics FD1500) were used over the course of this work, with no significant difference in results or performance." Now appearing in New L143-147.

- L 149: Syntax wrong or double sentence

Duplicate wording in L149 has been removed. The sentence now reads (New Line: 151-152).

"The gain was tuned using a 1-10 kΩ variable resistor."

2.2 Spectral Processing

- L 163: please cross check values on where the offset/drift is determined 30 & 20 points vs. 10 point in fig 4 caption.

Old L163 has been changed to (New L170):

"Briefly, a small detector/amplifier offset is determined from 10 points each at the start and end of each scan while the laser is powered off.".

The following sentence, which was in the original Figure 4 caption has been deleted (New L210).

"The initial ~10 points and final 10~ points represent the signal with the laser powered off."

The following sentence has been added to Figure 4 caption (New L211):

"The fit is made between the points highlighted in red (30 points at the start of the scan and 20 at the end)."

L 165 – 169: This part requires more clarification on how to convert scan steps into wavelength.

The following paragraph was added to address this (New L174-189).

"To account for possible drift of laser wavelength (e.g., the position of the absorption feature in a scan), a relationship between scan position and laser wavelength was estimated using a closely spaced pair of weak water absorption lines at 7281.72 and 7281.80 cm^{-1} produced by a DFB laser-centered on a different wavelength than the one used for the measurements in this paper. The position of this pair was systematically scanned across the full temperature range of a single current ramp by slowly varying the setpoint of the WTC and the spacing between the two lines (0.08 cm^{-1}, or 0.015 nm) was measured in scan index (e.g., see Fig. 4). A linear fit to the ratio of this spacing to the difference in scan index as a function of scan position was determined as:

$$s(x)\ (nm/step) = 0.00052 + x * 5.00 * 10^{-7}$$

where s is the change in wavelength per scan index (of the 445 points) and x is the scan index. The use of this function results in a near-constant line width as a function of wavelength if the position of the absorption feature shifts slightly due to variations in laser baseplate temperature. Although such a shift was never observed in these experiments, it is a consideration for use in an environment where the ambient temperature may vary significantly – e.g., by many tens of degrees. This method also allowed for the determination of the full width of the scan to be 0.279 nm for the specific scan start and end points and scan rate used in these experiments."

- L 170: What do you want to say with the "[..] are then placed in an array?

We decided that this level of detail is unnecessary and so the following was deleted:

"The observed signal (i.e., Iobs(t)) and calculated background I0(t) are then placed in an array [i, Io(i), I(i)]."

- Fig4 (b) Unit should be wavenumber

Units in Fig. 4b have been changed to cm^{-1} (i.e., wavelength).

3. Results:

- Fig 5: Does the x-axis represent values measured by the Picarro or converted values from the TDLS?

  Please also state the lin-regress function parameters (slope, intercept, $^{r2)}$ or a plot of the

converted H2O-ppm from TDLS over H2O-ppm measured by the Picarro together with a 1:1 line and respective regression slope. Similar as for Figure 8 (b)

Fig. 5 x-axis label changed from "H_2O mixing ratio (ppm)" to "Picarro H_2O mixing ratio (ppm)" and the following has been added to the caption of Figure 5 caption (New L230):

"Fit Parameters: slope = 0.0006, intercept = 0.0039, R^2 = 0.9999." (New L234)

- L 216 – 220: This part needs more clarification. Was a different InGaAs sensor used for the calibration of the instrument than the actual measurement? That could yield a different conversion coefficient.

The following has been added earlier in the manuscript (New L146):

"Multiple photodiodes of differing manufactures (Thorlabs FDGA05, ThorLabs FGA04, Fermionics FD1500) were used over the course of this work, with no significant difference in results or performance."

L 239: Wu et al 2015 citation does not present in references

Wu et al. 2015 has been added to the references.

- Fig8 (a). Please convert the x-axis to actual time in UTC

Figure 8 x-axis has been converted to UTC.

- L 278: Doesn't the averaging over 30s smooth all variation on a spatial scale of 1.5m? Hence I am not surprised that that values align even the locations had a 1.5m separation.

Old L281: The following has been added (New L301):

"…including variability due to the Picarro inlet and optical cell being separated by 1.5 m." (New L300).

Some Typos:

- L 104: remove dot after "([…], MT)"

Old L104: Period removed. (New L107)

- L 111: add quotes " after receiver

Old L111: " added after receiver. (New L114)

- L 122: resister -> resistor

Old L122: Spelling corrected. (New L110)

- L 209: remove dot after “(black points)”

Old L209: period removed. (New 231)

- L 256: lowercase a before 25-m long

Old L256: “A” changed to “a” (New L277)

- L 298: Remove dot after power

Old L298: period deleted. (New L320).

- L 320: mission word(s) after water

Old L320: “over the water” deleted. (New L341)

- L 325: Either tested or powered

Old L325: “successfully tested powered” changed to “successfully powered” (New L349)

- L 333: remove with before TEC

Old L333: “with” deleted. (New L353)

- L 337 delete “configuring for use”

Old L337: “Configuring for use” deleted. (New L357)

- L 342: ABL was already introduced in the introduction

Old L342 “atmospheric boundary layer (ABL)” changed to “ABL”. (New L360)

Per Referee #2:

Specific comments:

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

Old L8: “The high spatial temporal variability of” deleted. Sentence now reads:

"Water vapor in the atmospheric boundary layer poses a significant measurement challenge with abundances varying by an order of magnitude over short spatial and temporal scales." (New L8-9)

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

Old L11: "atmospheric boundary layer" deleted. "Atmospheric boundary layer" and abbreviation "ABL" are now introduced on New L25. Subsequent uses of "atmospheric boundary layer have been changed to ABL.

L8: "possesses" should be "poses" (or "presents")

Old L8: "possesses" changed to "poses". (New L8)

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.

Old L11: hyphen deleted in "in-situ". (New L10)

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

Old L11: "Hyphen deleted" (New L10)

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.

The single instance where "TDLS" was used to refer to the method has been changed to "TDLAS" (New L10), and we retain the references to the instrument as the "TDLS."

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.

Old L12: "(SWIR)" is deleted as it is not used in other locations in text. (New L12)

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

Old L16: "proportional-integrating" changed to "proportional-integral" (New L16)

L17: "comprised of" should technically be "composed of" or "comprises"

Old L17: "comprised of" changed to "constructed of" (New L17)

L18: perhaps “agreed”

Old L18: “agrees” changed to “agreed” (New L18)

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

Old L19: “allows” changed to “is robust and simple to use and will” (New L19)

L29: “tropics”

Old L29: “Tropics” changed to “tropics” (New L29)

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

Old L32: “mesoscale” changed to “microscale” (New L32)

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

Old L39: “DIAL and Raman lidars” changed to “differential absorption Lidars and Raman lidars.” (New L39)

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

Old L45: “such as the infrared gas analyzers” changed to “such as infrared gas analyzers” (New L45)

L46: “have come to” -> “are typically used to”

Old L46: changed to “are typically used to” (New L45)

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?

Text has been added or edited to address this points:

Old L47: Ending sentences changed to: “These research-grade instruments, which are used predominantly at multi-instrumented flux towers and weather stations, tend to be expensive, often costing $20,000 or more. In addition, they can incur additional costs for factory service to maintain high accuracy. Consequently, their use in remote locations has been relatively limited.” (New L46-48)

Old L50-56: Paragrapgh edited to read: As fast in situ observations of H_2O are essential for numerical weather prediction and for investigations of the evolution of the ABL and its turbulence characteristics (e.g. large eddy simulations), and there is a need for more frequent measurements from remote locations, we have developed an economical new fast-response laser spectrometer (Helbig et al., 2021; Petersen, 2016). The instrument is capable of fast measurements of water vapor in the ABL, while demonstrating high accuracy and precision comparable to that of commercially available research-grade commercial instruments. Built from low-cost components that are readily available commercially, the instrument exhibits relatively low up-front costs with the ability to replace critical components, thus bridging the gap between the more expensive and highly accurate fast-response instruments and the relatively inexpensive, but slower response capacitive sensors. (New L56-L63)

L57: "prediction"

Old L57: "predictions" changed to "prediction" (New L56)

L57: "capable of"

Old L59: "for" changed to "capable of" (New L59)

L60: "development and performance"?

Old L60: Text edited as above (New L60)

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

Old L61: "High accuracy/precision like" has been changed to "high accuracy and precision matching that of commercially available research-grade commercial instruments" (New L58).

Old L62: "low cost and flexibility desired for more" has been changed to "lower cost and greater flexibility" (New L60)

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

Old L67: "generic" replaced with "common butterfly" (New L7)

L69: "components"? and "components and exhibits"

Old L69: "technology" has been changed to "components" (New L69)

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

Old L71: “research grade instruments” changed to “laser spectroscopy” (New L71)

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

Old L76: “the available instrumentation have slow response and limited vertical resolution” has been changed to “the instruments used have slow response times, resulting in limited vertical resolution” (New L76)

L78: an example of a location?

Old L78: We have added “remote land and ocean regions” and include a new citation to Brotzge, J. A., Berchoff, D., Carlis, D. L., Carr, F. H., Carr, R. H., Gerth, J. J., Gross, B. D., Hamill, T. M., Haupt, S. E., Jacobs, N., McGovern, A., Stensrud, D. J., Szatkowski, G., Szunyogh, I., and Wang, X.: Challenges and Opportunities in Numerical Weather Prediction, Bulletin of the American Meteorological Society, 104, E698–E705, https://doi.org/10.1175/BAMS-D-22-0172.1, 2023. (New L79)

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

Old L81: terrain and variable inhomogeneity” changed to “heterogenous scalar and vector fields resulting from complex terrain” (New L81)

L89: “based on” would be more appropriate

Old L89: “off” changed to “on” (New L89)

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.

Old L90: We have deleted “a schematic of which is shown in figure 1” and on Old L97 we have added “An overview of the instrument is depicted in Fig. 1.” (New L96)

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

Old L91: (NLK1E56AA, NTT Innovative Devices, Yokohama, Japan) has been moved to New L90 to improve clarity.

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.

Old L100: Figure 1 has been corrected to be consistent with the trigger signal described in the text. (New L100)

L104: “TEC controller”

Old L104: “proportional-integral (PI)” changed to “PI TEC”. (New L106)

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

Old L105: “±” has been added (new L108)

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

Old L107: “DFB” has been changed to “Laser” (New L111)

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).

Old L108: “output from one of the microcontrollers” has been changed to “digital-to-analog (DAC) output” (New L111)

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

Old L110: Hyphens deleted from “laser-driving” and “data-acquisition” (New L113)

L111: “based on”

Old L111: “off” changed to “on” (New L114)

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

Old L112: We have added “developed in our lab and elsewhere, employing the same measurement technique as reported here” (New L115)

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)

Old LM117: “10 kHz” has been changed to “1 kHz” (to reflect what has been implemented in lab) (New L120)

Old LM117: “and faster” has been changed to “being possible,” and “precision” has been changed to “resolution” (New L120)

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.

Based on this and the Editor's comments reiterating the request, we now include a circuit diagram of the entire instrument.

The old Figure 2 has been replaced with a new figure, now numbered Fig. 3, which is a circuit diagram of the complete electronics used in the instrument. The following sentence has been added at new L127:

> "A complete electronic circuit diagram of the instrument is shown in Fig. 3."

Old L126: We have added (new L125):

> "This voltage drives an operational amplifier (Analog Devices LT1101) that controls the current required to scan the laser from transistor (TIP 32AG n-channel JFET) in a textbook voltage-to-current converter circuit (Figure 6.31 of Horowitz and Hill, 1983)."

Old L148: We have added "The top panel in Fig. 2 shows the continuous output of this circuit." (New L150).

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

Old L130: "Upon receiving the trigger pulse, the internal clock is recorded into a buffer" has been changed to "Before the start of each scan, the Teensy 3.6 produces a digital pulse ("trigger"), shown on the bottom panel of Fig. 2, that initiates the data acquisition and storage process on a Teensy 4.1". (New L129)

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

Old L131: Sentence now reads: Before the start of each scan, the Teensy 3.6 produces a digital pulse ("trigger"), shown on the bottom panel of Fig. 2, that initiates the data acquisition and storage process on a Teensy 4.1. (New L129)

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.

Old L131: We have changed this to read:

> "At this time, the internal clock is recorded into a buffer and the output from the detector TIA is recorded as a single scan consisting of 445 discreet sampled at 12-bit resolution.

Although the Teensy 4.1 samples at 300,000 samples per second, we oversampled 32 times using a software function that reduces noise inherent in the ADC." (New L130)

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?

Old L132: The change to Old L131 addresses this comment.

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"

Old L144: The phrase "(either Thorlabs FDGA05 or Fermionics FD1500) on the opposite side of optical path both operated in photovoltaic mode" has been deleted to address the comment from Referee 1. (New L148)

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

Old L148: "AD1101" changed to "LT1013 CN8" (New L149)

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.

Old L165: "1st-order polynomial" changed to "linear fit" (New L173)

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.

Old L165: The following was added:

The following paragraph was added to address this.

"To account for possible drift of laser wavelength (e.g., the position of the absorption feature in a scan), a relationship between scan position and laser wavelength was estimated using a closely spaced pair of weak water absorption lines at 7281.72 and 7281.80 cm^{-1} produced by a DFB laser-centered on a different wavelength than the one used for the measurements in this paper. The position of this pair was systematically scanned across the full temperature range of a single current ramp by slowly varying the setpoint of the WTC and the spacing between the two lines (0.08 cm^{-1}, or 0.015 nm) was measured in scan index (e.g., see Fig. 4). A linear fit to the ratio of this spacing to the difference in scan index as a function of scan position was determined as:

$$s(\mathrm{x})\ (nm/step) = 0.00052+\mathrm{x}*5.00*10^{-7}$$

where s is the change in wavelength per scan index (of the 445 points) and x is the scan index. The use of this function results in a near-constant line width as a function of wavelength if the position of the absorption feature shifts slightly due to variations in laser baseplate temperature. Although such a shift was never observed in these experiments, it is a consideration for use in an environment where the ambient temperature may vary significantly – e.g., by many tens of degrees. This method also allowed for the determination of the full width of the scan to be 0.279 nm for the specific scan start and end points and scan rate used in these experiments." (New L174-189)

L182: Accuracy metrics of the BMP280?

Old L182: We have added "with an accuracy of ± 1 % when compared to laboratory standards." (New L201)

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?

Old L187: "These calculations take" has been changed to "Processing of spectra in real time takes". (New L207)

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.

Old L190: Units in Fig. 4b have been changed to cm^{-1} (i.e., wavelength). (New L210)

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.

Old L190: Points have been colored red in Figure 4a to show which points were used in the fit. (New L210)

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

Old L198: "25-L" changed to "25 L" (New L218)

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 "~"?

Old L200: The following description "The chamber was first saturated to a mixing ratio 200 of ~27,000 ppm with the dew point generator, after which lab air with ~13,000 ppm of H2O was

admitted to the chamber stepwise approximately every five minutes over the course of several hours" changed to:

> "A beaker of warm water was placed inside the chamber to humidify the air to a value just below the saturation point at lab temperature. Over the course of two hours, water vapor mixing ratios were reduced to ~13,000 ppm by stepwise-addition of relative dry ambient air from the laboratory into the chamber." (New L220)

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

Old L198: "a" has been changed to "an unsealed" (new L218)

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

Old L211: the following has been added to the caption of Figure 5 caption (New L233):

> "Fit Parameters: slope = 0.0006, intercept = 0.0039, R^2 = 0.9999."

Old L209: remove period following "points)"; omit reference

Old L209: Period and reference have been deleted. (New L232)

L213: "Allan variance"

Old L213: The hyphen has been removed. (new 235)

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

Old L222: "sensitivity" has been changed to "precision" (New L243)

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.

Old L256: This has been changed to "A 25 m fiber optic patch cable connected the output of the laser to the collimating lens on the input of the optical cell and a 10 m twisted pair of wires brought the detector signal back to the TDLS electronics box which was housed in the shipping container" (New L277)

L307: "Teensys"

Old L307: "Teensy's" has been changed to "Teensys" (New L328)

L320: "tested powered"

Old L325: “successfully tested powered” has been changed to “successfully powered” (New L346)

L336: “include”

Old L336: “including” has been changed to “include” (New L356)

L342: ABL already defined in introduction

Old L342: “atmospheric boundary layer (ABL)” changed to “ABL” (New L360)

In addition to the changes to address the referees’ comments, we have made the following revisions:

A number of minor changes were made throughout text to correct typographical errors discovered in final proofreading.

Figure 2: The contrast was increased, and the acronym “GRIN” was deleted in the figure as it was incorrect.

Figure 4: The X-axis label has been changed to “Scan Index”

Figure 5: The units of the X axis have been changed to “10^3 ppm”. The units of the Y-axis (top) have been changed to “10^{-3} nm”.

Figure 6: The Y-axis (top) changed to 10^3 ppm

Figure 8: The units of Figure 8a have been simplified from “date/time” to “time” and the caption has been edited to clarify the starting date. The units have been changed to “10^3 ppm” on 8a and 8b.

Old L33-36: We have improved clarity by careful editing. New text reads:

“Observations of this variability are essential for elucidating the underlying micrometeorological processes and quantifying local-scale (100 m) radiation budgets important to the prediction of turbulent and convective processes and their impacts (Couvreux et al., 2009; Fabry, 2006; Ogunjemiyo et al., 2002). However, observations have been limited by the relatively high cost of existing instruments and the lack of high-quality data from more economical ones (Geerts et al., 2018).” (New L32-35)

Old L197: We have corrected the range over which calibration took place to 5000 to 25000 ppm to be consistent with Figure 5. (New L217-228)

Old L206: We added “This is larger than the precision of the Picarro, which is ~10 ppm, and so the deviation is mostly due to small differences in water vapor in the paths sampled by the two instruments.” (New L228)

Old L311: We added part numbers for the optical cell and the manufacturer and part number for electronics box in the Table 1. (new L330)