

Review of the article “Performance of a 2.05 μm coherent DIAL-Doppler Lidar for CO₂ eddy-covariance turbulent flux measurements,” submitted by Mathys Thiers, Fabien Gibert, Julien Lahyani, and Nicolas Cézard

The manuscript “Performance of a 2.05 μm coherent DIAL-Doppler Lidar for CO₂ eddy-covariance turbulent flux measurements,” submitted by Mathys Thiers et al. describes an investigation that is relevant to Atmospheric Measurement Techniques in the field of remote sensing technique regarding a 2- μm coherent differential absorption lidar (CDIAL) for CO₂ and wind measurements. The paper provides a detailed description of the instrument, the new expression for random error after spatial averaging, and measurement performance of CO₂ turbulent flux with focusing on the detection limits and measurement biases using the CDIAL. The derivation of new expression for random error is interesting approach. Overall, the paper is well structured, readable and will be valuable to the scientific community. I believe that the manuscript will be of interest to the readers of Atmospheric Measurement Techniques. I therefore recommend the publication after revision according to the minor comments given below.

Specific Comments

1. Line 23: Please remove “,” after “”).
2. Lines 40-41: “requirement on mixing ratio random errors with spatiotemporal resolutions suitable for flux measurements”. Could you please add concrete details in the reference?
3. Line 45: signal-to-noise ratio is not defined. Please add explanatory sentences and relevant references.
4. Lines 56: The acronym SIRTA is not defined in the text.
5. Lines 75: What is the operating frequency of the acousto-optic modulator in the CDIAL?
6. Lines 82: Table1. Is controlling the wavelengths for lon and loff to two decimal places in nanometers sufficient for the measurement accuracy?
7. Lines 82: Table1. Could you please provide explanatory sentences and relevant references in the text regarding 20 kHz and 0.6 kHz, based on the freezing time of atmosphere?
8. Lines 82: Table1. How many points were sampled in the Real time 256-ns time gate?
9. Line 95: Please add the accuracy and precision of the wavemeter? Did you calibrate the absolute precision?
10. Line 95: What is the version of the HITRAN database?
11. Line 114: What is A^2 ?
12. Line 161: Eq (7). Please add a space or a centered dot between 2 and min.
13. Line 170: “13 s”. The value is introduced without prior discussion and is derived following the discussion in Sect. 4.1. It appears to be inappropriate in this context. Please consider removing it.
14. Line 223: Please add relevant references for the Carrier to Noise Ratio (CNR).
15. Line 223: Figs 2a and 2b. Each profile appears to be very smooth. Were these profiles plotted using $\Delta R = 38.4 \text{ m}$?

16. Line 240: $U=7.75$ m/s. A linear variation of temperature with altitude and vertically uniform humidity are assumed in the manuscript. How did wind shear affect the experimental data on the specific experimental date?
17. Line 243: “13 s”. The reviewer did not understand why the author choose “13 s”. Please clarify and add explanatory sentences.
18. Lines 253: Fig 3. Including the CNR profile would be helpful for understanding Figs 3a through 3c.
19. Lines 255: The acronym Δz is not defined in the text. Does Δz correspond to 3 times ΔR (=115.2 m)?
20. Line 262: The acronym ICOS is not defined in the text.
21. Line 268: Humidity in the CBL. How did you determine the humidity?
22. Line 289: No line breaks.
23. Lines 305: 115-m spatial resolution. Is the spatial resolution same as Δz ?
24. Line 321: Please add explanatory sentences clarifying how the resolution of 350 m is derived from Δz and ΔR .
25. Line 370: Please add explanatory sentences clarifying the quantitative improvement compared with the previous study (Gibert et al., 2011).
26. Line 370: signal-to-noise ratio is not defined in the text. Please add explanatory sentences.
27. Lines 375-376, Figure 6(a): It is not clear. Please explain the reason why F_{CO_2} became positive around 12:15 and 14:15?
28. Line 382: Please add “in” before Fig. 7.
29. Line 382: Is 426 ppm the average of 424-428 ppm shown in Fig. 7.
30. Lines 384 and 385: What was the nocturnal boundary layer height on 14-15 May 2025? To what extent are advection and mixing suppressed in the residual layer? Please add explanatory sentences.
31. Lines 399: “These characteristics allow for a random error of about 30 ppm in CO₂ mixing ratio measurements resolution of 13 s and 115 m”. The 30 ppm is not mentioned in the section 4.2 or other text. Please add explanatory sentences.

Appendix

1. Eq A5: Term $\sigma_{n,x_{CO_2}}(z_i)$ appears twice in the right. Is it correct? Please also confirm that there are no errors in the retrieval algorithm.
2. Eqs A17 and A18: Which is correct “+2” or “-2”?
3. Eq A21: The left-hand side should probably be $\langle \sigma_{n,F} \rangle_{z_{\min}}^{z_{\max}}$ without the exponent 2. Please also confirm that there are no errors in the retrieval algorithm.
4. Eqs B8 and B9: Please verify Eq. (B9), where the left-hand side should be $\sigma_{n,x_{CO_2}}^2(z_i)$ with a square to denote variance, and the right-hand side has extra double parentheses in $(\sigma(\tau(z_{i+1})))^2$. Please also confirm that there are no errors in the retrieval algorithm.

References

Please re-check the manuscript to ensure all references conform to the AMT style guide. Specifically, please ensure the serial comma before "and" is added, the DOI formats are standardized (e.g., using full URLs like <https://doi.org/10.xxxx/xxxx>), journal name abbreviations and page ranges are unified, and any redundant text is removed. Please use an en-dash (–) rather than a hyphen (-) for page ranges.

1. Behrendt et al. Please use a full URL. Please use an en-dash.
2. Berger et al. "K. J. and" => "K. J., and". "J. Atmos. Ocean. Tech." => "J. Atmos. Oceanic Technol.". Please use an en-dash.
3. Billesbach et al.
"Agricultural and Forest Meteorology, Volume 151, Issue 3, 394-405
<https://doi.org/10.1016/j.agrformet.2010.12.001>"
⇒ "Agric. For. Meteorol., 151, 394–405, <https://doi.org/10.1016/j.agrformet.2010.12.001>"
4. Delwiche et al. Please use a full URL. Please use an en-dash.
5. Engelmann et al. Please use a full URL. Please use an en-dash.
6. Gibert et al. (2006) Please use a full URL. Please use an en-dash.
7. Gibert et al. (2008) Please use an en-dash (–) rather than a hyphen (-) for page ranges.
8. Gibert et al. (2011) Please use an en-dash.
9. Giez et al. "K. J. and" => "K. J., and". "J. Atmos. Ocean. Tech." => "J. Atmos. Oceanic Technol.". Please use an en-dash.
"[https://doi.org/10.1175/1520-0426\(1999\)016%3C0237:WVFMFG%3E2.0.CO;2](https://doi.org/10.1175/1520-0426(1999)016%3C0237:WVFMFG%3E2.0.CO;2)" =>
"[https://doi.org/10.1175/1520-0426\(1999\)016<0237:WVFMFG>2.0.CO;2](https://doi.org/10.1175/1520-0426(1999)016<0237:WVFMFG>2.0.CO;2)"
10. Haeffelin et al. Please use an en-dash.
11. Hannun et al. Please use a full URL.
12. Lahyani et al. Please use a full URL.
13. Lenschow et al. (1994) Please use a full URL. Please use an en-dash.
14. Lenschow et al. (2000) Please use a full URL. Please use an en-dash.
15. Miyazaki et al. Please use a full URL.
16. Ramonet et al. "ICOS RI" => "ICOS RI [data set]".
17. Rannik et al. Please use an en-dash.
18. Rye, B. J. Please use a full URL.
19. Senff et al. "Bösenberg, J. and Peters G." => "Bösenberg, J., and Peters, G.". "11," => "11, 85–93".
"[https://doi.org/10.1175/1520-0426\(1994\)011%3C0085:MOWVFP%3E2.0.CO;2](https://doi.org/10.1175/1520-0426(1994)011%3C0085:MOWVFP%3E2.0.CO;2)" =>
"[https://doi.org/10.1175/1520-0426\(1994\)011<0085:MOWVFP>2.0.CO;2](https://doi.org/10.1175/1520-0426(1994)011<0085:MOWVFP>2.0.CO;2)". Please use an en-dash.
20. Stull, R. B. Please use an en-dash.
21. Webb et al. Please use an en-dash.
22. Wulfmeyer et al. Please use a full URL.