

## Review report

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Title : **Vertical wind profiling from troposphere to the lower mesosphere based on high resolution heterodyne near-infrared spectroradiometry**

Author(s) : Alexander V. Rodin et al.

The authors report on a new technique of wind-speed remote sensing through Doppler shift analysis of a CO<sub>2</sub> absorption line at 1.605 μm using high-resolution laser heterodyne spectroradiometry (LHS). A DFB laser-based LHS, combined with a reference cell involving integrated cavity output spectroscopy (ICOS), was used to measure atmospheric absorption spectrum of CO<sub>2</sub> with spectral resolution  $\lambda/\delta\lambda \sim 10^7$ -  $10^8$  which allowed to retrieve vertical profiles of wind speed with an accuracy of 3-5 m/s and vertical resolutions varying from 2 km near the ground to 6 km in the stratosphere.

### General comments

The manuscript is well structured and written, scientifically sound. It would be acceptable for publication in AMT after minor revision by addressing the comments and questions listed below.

### Specific comments

#### (1) Spectral resolution issue

The authors emphasize a high spectral resolution of  $\lambda/\delta\lambda \sim 10^7$ -  $10^8$ , while once the corresponding laser line width is less than the electronic filter bandwidth, the LHS spectral resolution is determined by the used electronic filter bandwidth. The authors never discuss on the real spectral resolution : what was the used electronic bandwidth and what was its impact on the spatial (vertical) resolution obtained in the retrieved vertical profiles of wind speed? Please make a detailed discussion.

#### (2) Experimental spectral comparison between LHS and ICOS spectra

The measurement technique presented in the paper relies on Doppler shift analysis of a measured LHS spectrum line related to the same absorption line recorded in a reference cell. It should be important to show an experimental LHS spectral line in comparison with the

reference spectrum and make some discussion because this is the key technical element to support this paper.

(3) Please provide more detailed information on the used devices in the LHS setup, such as laser power, model, etc.

### Technical corrections

(1) Page 1, line 13 : "provides" should be "provide"

(2) Page 2, line 57 : recent work of Wang et al. on LHR-CH<sub>4</sub>, in Opt. Ex. **27** (2019) 9610-9619, should be included.

(3) Page 4, line 108 : please check the English usage in the following sentence "single mode fiber geometric aperture factor  $\sim 2.6 \cdot 10^{-8} \text{ cm}^2$ , corresponding to field of view  $\sim 0.006^\circ$ , is close to the maximum available for heterodyne detection expressed by ....?"

(4) Page 5, line 127 : "is passed through consecutive low-pass filter, another amplifier and high-pass filter" should be "is passed through consecutive high-pass filter, another amplifier and low-pass filter" according to Figure 1?

(5) Page 5, line 129 : it would be better to replace "after the filter chain" by "after the IF receiver" according to Figure 1?

(6) Page 6, line 155 : "The ratio of heterodyne signal with subtracted dark signal and baseline approximated by square polynomial ....", the sentence is not clearly stated;

(7) Page 6, line 162 : "In addition to the target CO<sub>2</sub> line R2 14<sup>0</sup>1←00<sup>0</sup> at 6230.22 cm<sup>-1</sup>, other CO<sub>2</sub> lines at 6230.25 cm<sup>-1</sup>, 6230.02 cm<sup>-1</sup> and 6229.98 cm<sup>-1</sup> have also been included in calculations" : under atmospheric pressure, how is presented the CO<sub>2</sub> line at 6230.25 cm<sup>-1</sup> related to the line at 6230.22 cm<sup>-1</sup>? It would be better to show the simulation spectrum in combination with the measured LHR spectrum.

(8) Page 6, lines 165 : Please provide more detailed information on the constructed "model of the atmospheric transmission spectrum".

(9) Page 7, line 198 : remove "-" after  $\nu_0$ ;

(10) Page 8, line 233 : "where J is ....", where is J in equation (10)?

(11) Page 8, line 236 : please add the reference(s) in "(ref)";

(12) Page 13, Table 1 : please add the used electronic bandwidth