

This is a review of manuscript amt-2017-353,
“Comparison of the fast Lyman-Alpha and LICOR hygrometers for
measuring airborne turbulent fluctuations”

Astrid Lampert¹, Jörg Hartmann², Falk Pätzold¹, Lennart Lobitz¹, Peter Hecker¹, Katrin Kohnert³,
Eric Larmanou^{3,4}, Andrei Serafimovich³, and Torsten Sachs³

What follows are comments to be shared with the authors.

GENERAL COMMENTS:

This is a review of manuscript amt-2017-353,
“Comparison of the fast Lyman-Alpha and LICOR hygrometers for
measuring airborne turbulent fluctuations”. The LICOR sensors in different forms are used at
automated field stations for research networks covering large temporal and spatial scales, and are
well characterized.

The purpose of this manuscript is to evaluate LICOR humidity sensors in a new environment, on
aircraft, compared with standard Lyman-alpha hygrometers. The results show that the LICOR
sensors are well suited for airborne measurements of humidity fluctuations, provided that a
vibrationless environment is given, and this turns out to be more important than close sensor
spacing.

This is a detailed technical assessment of LICOR sensors that should be posted online for discussion in AMTD
after some major revisions are made. LICOR sensors are widely used on aircraft, so validation of their
performance is needed. The manuscript is an important contribution because it analyzes the environments in
which the LICOR sensors perform well compared to the “gold standard” of Lyman-alpha hygrometers. I
appreciate the hard work of the authors to collect the field data and carefully analyze the results. What remains
for the authors to do is to rewrite the manuscript with better explanation of their reasoning and conclusions.
The manuscript could also benefit from better English editing.

SPECIFIC COMMENTS:

1) I have a concern that the authors and other research groups are using LICOR sensors in an environment that
the manufacturer does not recommend.

Manuscript page 4, lines 9-12: The authors stated that “the manufacturer warns in the manual that the sensor
should not be applied with vibrations around 150 Hz and around the harmonics”.

Is it possible for the authors to contact the LICOR manufacturer to get approval - or feedback from the
Technical Support department - for flying a LICOR on aircraft?

2) The reported experiment involved one vibration-isolated closed-path hygrometer and two non-isolated
open-path hygrometers, so how do you know whether the drift and noise are due to vibration or the open-path?
Are there other possible reasons for the drift (such as drift in the electronics response or internal processing?)?

3) Section 1.3, page 3, lines 14-25, describe laser hygrometers but has some gaps as listed below:

3.1) Page 3, lines 24-25 claim that “it is not possible to obtain real-time humidity data.” Although the
Buchholz et al. hygrometer (Buchholz et al. 2014) does not provide real-time humidity data, other
laser hygrometers do this routinely (see papers such as S. B. Smith et al., JGR, 2017, R. L. Herman
et al., ACP, 2017, or M. Zondlo et al.).

3.2) page 3, line 25 claims that “The spectroscopic sensors are experimental systems and not
commercially available” but the Picarro and Los Gatos systems mentioned earlier are commercially
available laser hygrometers that have sufficient accuracy for the science. They can also provide real-
time humidity data.

3.3) page 4, lines 10-11 claims that "...the LICOR sensor is currently the fastest and cheapest water vapor sensor commercially available" but laser hygrometers are faster than the LICOR.

4) I find the discussion of the time resolution of the LICOR to be disorganized and confusing (Sections 2.1 and 2.2 and 3.4). I recommend that the authors should reorganize the discussion of the time response, time delay and time synchronization to one section because these are related.

4.1) What is the time resolution of the LICOR instrument? Page 5, line 2, indicates that the data is "internally processing and finally provided at a maximum frequency of 20 Hz."

Are the detector and electronics signal chain sufficiently fast to resolve changes in water vapor at 20 Hz?

4.2) Page 5, line 9: what is the response time of the Rosemount EL102 sensor? It is only characterized here as a "fast response time." How fast?

4.3) Page 5, lines 25-30: How can you carry out successful fast measurements with the closed-path LICOR if there is a 250-millisecond calculated delay? Have you tested the delay? What is the residence time in the sample cell?

4.4) Page 10, line 23 and Page 11, line 25: the authors state the "Generally a temporal resolution of 20 Hz is sufficient for humidity flux calculations." It is not clearly explained how the authors came to this conclusion. Is there a reference that can be cited as evidence for this? Furthermore, it is unclear from this manuscript whether the LICOR has an actual temporal resolution of 20 Hz (when the sampling delays and internal processing are included).

5) Flight figures 3 and 6 are hard to read: please consider larger font text.