

Author's response to editor comments

July 18, 2014

Many thanks for the detailed review. In the following I will comment on each point. The referee comments will be repeated in blue italic before the answer.

General remarks

- *a) the sections that describe the model and dynamics better connected*
As described in the answers to referee # 2, the physical and dynamical model build on each other. An introduction to the connection will be given in Section 2.2 in the revised manuscript. Also, better references between the sections will be inserted. Sections 2.1, 2.4 and 3.1 are rewritten according to the comments of referee and editor comments.
- *c) these sections shortened where possible, and where the parts that are omitted are covered by reference to a textbook*
There is a contradiction between shortening the sections and referee #2's demand for better explanation about how the model was implemented. We tried to find the best compromise between text book references and explanation where necessary.

Specific comments

1. *page 3, lines 8,9; The word "distinct" is inappropriate. words that would be better include "better" or "more detailed".*
The sentence will be rephrased in the revised manuscript:
'A more detailed description of entrainment processes is needed [...]'
2. *Page 6, line 27; This reference to the product specification is inadequate, and ambiguous - it could be referring to a figure and table in this manuscript. Such a reference needs to be treated similarly to a journal paper.*

The reference [IST AG(2009)] will be added to a revised manuscript and cited in this sentence. The reference to the figure and table will be done earlier in the sentence.
3. *Page 7, line 3; The sentence starting " Since the P14 ..." is confusing. I suggest breaking this into two and removing superfluous words such as "at the same time" and "assumptions".*
The sentence will be rephrased in a revised manuscript.
4. *Page 7, line 6; The sentence "The polymer thickness ..." does not actually say what I think it is intended to say, because it does not actually confirm that the company (?) said that it was 1 micron. In any case it is better to state the thickness and make a reference (in the reference list) to a private communication from the company.*

A reference to a phone call [Krogmann(2012)] will be given in the revised manuscript.

5. *Page 7, line 12; The reference in the text to AMOC is unclear. Who made this in-house?*

The sentence will be rephrased in a revised manuscript: ‘The digital signal is then processed by the AMOC (Airborne Meteorological Onboard Computer), developed at the University of Applied Sciences Ostwestfalen-Lippe and the University of Tübingen. The computer stores the data at 100 Hz onto an SD card. At the same time, the sensor signal can be monitored in real-time on a remote computer.’

6. *Page 8, equation 2; the first line is superfluous as it has already been given as a standalone equation, and in the third line the left hand side does not need to be repeated.*

The suggested correction will be done in a revised manuscript.

7. *Page 9, line 22; The sentence "This also applies ..." is problematic. Do you have a reference to support this statement that the sensor you use has been optimised in the choice of polymer. If you mean simply that it shows a linear relationship then that needs to be clarified.*

We can only state that a polymer-based capacitive humidity sensor is not necessarily linear with relative humidity [Shibata et al.(1996)]. We found the P14 Rapid to be linear to relative humidity and only have small temperature sensitivity, which is why we assumed that the choice of the polymer was chosen with these important characteristics of a commercial humidity sensor in mind. The given paragraph will be rephrased to make this more clear.

8. *Page, 10, line 1; In figure 3, what temperature is kept constant? It really has to be the sensor temperature for the figure to make any sense, but it is worthwhile to say this, as initially this is confusing for the reader.*

The ambient temperature in the calibration chamber, and therefore of course the sensor temperature is kept constant. This will be made clear in a revised manuscript.

9. *Page 10, equation 8; It is worthwhile to repeat the definition of the variable c here, in order to better connect this section with the foregoing sections.*

Done.

10. *Section 3.1; This section is problematic because you develop a one dimensional model, but then apply Gauss' theorem which is meaningful only in three or more dimensions. In a one dimensional model what does the surface S mean? I suspect that you can get to the result of equation 13 without referring to Gauss' theorem, which is only confusing here. Also in the context of equation 12 (i.e. Gauss' theorem) the averaging bar placed over " c " is unexplained. In equation 14, you introduce c_m without explanation. The reference to figure 4 is out of place - it needs to be much earlier.*

Instead of restricting the model in Eq. 8 to only one dimension, we can work with the three-dimensional formulations until Eq. 12 of the manuscript:

$$\mathbf{J} = -D \cdot \nabla c \quad (8)$$

$$\frac{\partial c}{\partial t} = -\nabla \cdot \mathbf{J} \quad (9)$$

$$\frac{\partial c}{\partial t} = D \nabla^2 c \quad (10)$$

$$\iiint_{V_n} \frac{\partial c}{\partial t} dV = - \iiint_{V_n} \nabla \cdot \mathbf{J} dV \quad (11)$$

$$\frac{\partial \overline{c_n}}{\partial t} V_n = - \oint_S \mathbf{J} dS \quad (12)$$

in Eq. 13 of the manuscript, we restrict diffusion to only the vertical dimension with the following explanation:

‘Concentration gradients in horizontal directions are considered to be zero, as the sensor is small enough that a constant humidity above the whole sensor surface can be assumed. Therefore, there

will be no horizontal fluxes of water and the volume elements V_n can be simplified to layers as shown in Fig. 4.'

Page 11, lines 13 f will be changed in the revised manuscript to explain the bar notation better: 'In the following, concentrations with an index always represent spatial averages over a finite volume and the overbar notation to indicate the averaging as in $\overline{c_n}$ will be omitted.'

c_m is explained on page 13, line 11.

The reference to Figure 4 will be placed at the beginning of Section 3.1.

11. *Page 13, line 25; the sentence beginning "The sensor is presumed ..." needs rewording. The use of "flood" is odd, though I know what you mean! Better I think to say something like "We assume that the humidity around the sensor changes completely in less than 100 ms, based on ..."*

The sentence will be rephrased according to the suggestion:

'It is assumed that the humidity around the sensor changes completely in less than 100 ms, based on the outlet flow of the generator and the size of the chamber.'

12. *Page 14, line 25; You do not need to be selling the Laplace transform approach! Please consider deleting this sentence*

The sentence will be deleted in the revised manuscript.

13. *Page 16, line 5; The sentence beginning "The method described ..." is weak. You should assert that here you use the method of section 3. Also you should start a new paragraph for the sentence that begins "In Fig. 8 ...".*

The sentence is deleted. Instead, we rephrased the following sentence:

'In Figure 8 a vertical profile is shown with raw measurements and with restored signal for relative humidity, applying the method described in Section 3.'

References

- [IST AG(2009)] IST AG: P14 - Rapid Capacitive Humidity Sensor, datasheet V4.3-11/2009, 2009.
- [Krogmann(2012)] Krogmann, F.: discussion on the phone, IST AG, 2012.
- [Shibata et al.(1996)] Shibata, H., Ito, M., Asakura, M., and Watanabe, K.: A digital hygrometer using a polyimide film relative humidity sensor, Instrumentation and Measurement, IEEE Transactions on, 45, 564–569, 1996.