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Atmospheric Measurement Techniques
Discussions

Interactive comment on "A horizontal mobile measuring system for atmospheric quantities" *by* J. Hübner et al.

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Unfortunately, a second public referee report on the paper 'A horizontal mobile measuring system for atmospheric quantities' by H́ubner et al. has not been submitted by the end of the public discussion phase. In order to not further delay the decision process, which has already been extraordinarily long, in my function as Associate Editor I will herewith sum up my opinion on this manuscript in order to substitute the missing referee report. A detailed review has already been provided by Referee #1 in the non-public initial review phase. The authors provided detailed answers these comments and modified the manuscript accordingly prior to publication in AMTD. In order to ensure the transparency of the review process, I will list these comments of Referee #1

and the answers by the authors at the end of this document.

General comments

The manuscript entitled 'A horizontal mobile measuring system for atmospheric quantities' by H́ubner et al. describes a new mobile observational platform which can be used to measure horizontal gradients of important atmospheric parameters (temperature, humidity, radiation and trace gases) autonomously. Measurements of this kind are of great importance for the understanding of the micrometeorological processes at locations where strong horizontal gradients occur, such as forest edges. Therefore, the topic of the manuscript fits well within the scope of AMT. The technical specifications of the platform and the instrumentation including measurement uncertainties are well described. Particular emphasis is on the characterisation of the sensor response times and their correction. Finally, sample results from a measurement campaign are presented. For these reasons, I recommend the publication of the manuscript in AMT after considering some minor technical corrections as listed below, and after appropriate response to the few issues raised by Referee #2.

Technical Corrections

4552.4: "with" -> "along"

4554.29: "climbing ability" -> "limited climbing ability". Can you provide an estimate of the maximum climbing angle of the HMMS?

4556.15: "It's" -> "Its"

4556.21: You mention a second electrical circuit, but it is not clear what the first circuit is supposed to be. Please clarify.

4557.11: If possible, please specify the power consumption of the BOX PC.

4557.23: "range from" -> "range of"

4558.21: "linear speed" -> "linear air velocity"

4558.23: Here you mention a reduction in time constant after modification of your sensor, but at this point it is not yet clear how you determined it. Here you should refer to section 3.1.

4561.10: "This effects" -> "These effects"

Communication between Referee #1 and the authors during the initial discussion phase

Replies by the authors are cited in italic

1. I am missing a more detailed description of the power requirements of the individual components of the HMMS even if there is a reference to Hübner et al. (2011) which contains more technical details

A: We mentioned on page 5, line 24 the infeed of 24V and 5 A, which covers the use of all components on the HMMS. The consume of all devices is approx. 3 A. The rest is used for the drive, which differ depending on the speed and/or the inclination. We modified this on page 5, line 24 to page 6, line 1. A list of the individual components' power requirement in a further Table would blast in our view too much the length of this article, because all used components are commercially available and the individual power consumption can be obtained from the manufacturer information.

2. The sampling process of the data acquisition system (section 2.1.2, page 7, lines 9 to 13) should be explained in a more detailed way because the described acquisition process is rather unusual. Why is there random noise in the incoming analogue sensors (better: in the incoming signals of the sensors)? Which is the magnitude of the random noise? Why are the first 10

A: A modified explanation can now be found on page 7, lines 9 to 15.

3. In section 2.1.3, page 8, lines 24 to 26 it is said that the lateral installation of the radiation sensors guarantees a rather free hemispheric view with an enormous reduction of 'shadowing'. The question here is: it is an enormous reduction compared to what?

A: We reformulated the sentence.

4. It is known that the accuracy of the Gascard R is not really high and that it is sensitive to temperature changes and thus also to changes in radiation. Why has this sensor been used? There are more accurate sensors available or a temperature compensation could have been developed.

A: We were looking for a fast responding and lightweight sensor, which we thought to find in the Gascard R. Sadly, we didn't know about the sensitivity problems. Usual CO2 sensors have a too high cargo load and the dimensions are too big for the HMMS. A development of a temperature compensation was considered, but our investigations have shown a complicated dependence of the errors on temperature and radiation, which made a correction impossible for daytime measurements.

5. In section 3.4, page 17, lines 19 to 21 it is said that it is not possible to show complete corrected time series of all measured variables for one day because of the large effort required. Isn't that a specific algorithm accounting for the time constant which could be used to correct an entire time series and which could be used for all sensors considering their individual time constants?

A: This algorithm based on the convolution of two functions, the exponential function of the sensor individual time constant and the function of the given change in the input signal (gradient). In this work a linear adaptation (first-order) was deliberately chosen, because of a reasonable easy formation of the Laplace- Transformation to perform the convolution. The mentioned second-order system (Brock and Richardson, 2001) require the function of the non-steady-state conditions, but which is unknown. An approximation by the derivation of a parabola-like transfer function with the consideration of local heterogeneities (combination of first and second-order system) is possible, but very work-intensive. Another possible way is an approximation with many overlaid linear functions, which yields to a small enhancement. But, regardless which kind of algorithm we choose, an approximation is only possible for one run (one direction) and *not for the entire time series. Reason is that the transition from the forest to the clearing is (except of radiation) immensely influenced by turbulence (coherent structures), changing the conditions there immediately.*

6. Why was a transparent cover used for the HMMS which I assume to behave like a greenhouse and which unnecessarily leads to temperature problems of the sensors and other electronic components?

A: We mainly used a transparent cover to have a view into the HMMS and here especially on the monitor to access the HMMS software. Temperature accumulation we prevented with an active circulation. Several small PC fans at the plate and one big PC fan at the end of the HMMS (No. 17 in Fig.1) were sufficient. So we can exclude temperature problems of the sensors, but if we had known about the radiation problems of the Gascard R, of course we would have chosen a nontransparent cover. We added a short remark to the conclusions (page 20, lines 8 to 10).

7. Why was not made use of a datalogger for data acquisition and system control which would have been more flexible and maybe less heavy compared to microcomputer plus monitor plus DAQ device plus signal amplifiers?

A: For position control, we decided to use a bar code scanner, which can only be used with a computer. Consequently we had to write a software which can handle the information from the scanner and can also control and change the speed of the HMMS. Additionally, we have the possibility to start predefined operation programs, with different speed and distances to focus on different observation points. For change of the speed and driving direction a potentiometer from LGB (Garden railway manufacturer) was used, which is located on the HMMS (page 6, lines 3 to 7). The potentiometer can be adjusted by the software and an analogue output of the DAQ device, which can also be used for data acquisition. and change the observation program (speed, distance etc.). Typical data loggers have not this flexibility and the weight of e.g. CR3000 and our version is not much different. Because of problems with an access via WLAN and

remote desktop we decided to install a small monitor, in order to start and stop the HMMS software.

8. There should be a broader discussion of lacking of the system and of possible improvements of the HMMS including the rail system.

A: In the conclusions we tried to give a broader discussion of lacking and possible improvements. Therefore we also had to modify one sentence in Section 2.1.1, page 5, line 24 to page 6, line 1.

9. Which other applications or employments of the HMMS are possible or could be sought.

A: In the conclusions we mentioned a subsequent project in 2012 (EVENT project of the University of Bayreuth). Here, the HMMS measured along a transect of 120m (measuring track like the letter U) driving trough open areas and below shelters. Investigation focus were extreme events on ecosystems (grasslands). Link to: EVENT Webpage. Publication: Jentsch and Beierkuhnlein, 2010, Link

10. Section 3.4 seems to be a bit weak: it is a pure qualitative description of the measurement results. It would be worthwhile to see here also some numbers and to get an idea what has been achieved with this system what has not been expected before. Which are the real benefits of this kind of mobile measurement system? Which atmospheric processes or effects can be studied in this particular experiment or in other setups which can not be studied with a number of locally fixed sensors?

A: According to the character of the journal the paper is the description of the device with one example. Our research goes in two directions: investigation of the heterogeneity of scalars in combination with the results found in Foken et al. (2012) and influence of coherent structures on horizontal structures according the findings by Eder et al. (2013). We added some remarks (page 20, lines 11 to 12 and page 20, line 29 to page 21 line 3). Fixed sensors in a short distance of about 5 to 10 m over abou 100 m *length are to expensive for all measured components. Eder, F. et al. (2013). Coherent structures at a forest edge: Properties, coupling and impact of secondary circulations. Bound.-Lay. Meteorol., 148 (2), pp. 285–308. DOI: 10.1007/s10546-013-9815-0 Foken, T. et al. (2012). Coupling processes and exchange of energy and reactive and non-reactive trace gases at a forest site – results of the EGER experiment. Atmos. Chem. Phys., 12 (4), pp. 1923–1950. DOI: 10.5194/acp-12-1923-2012*

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 4551, 2014.