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Atmospheric Measurement Techniques Discussions

Interactive comment on "The pilatus unmanned aircraft system for lower atmospheric research" *by* G. de Boer et al.

Anonymous Referee #1

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General Comments:

The manuscript describes the new unmanned research aircraft Pilatus, which is able to provide measurements of mean thermodynamic quantities, aerosol properties and radiation. The main goal in that study is to demonstrate the aircraft and the different on-board instrumentation, as well as show results from ground and flight tests. This aircraft can be a helpful contribution to improve the understanding of the aerosol properties and their radiative impact. The paper presents a novel system, combining measurements of radiation and aerosol observations on one airborne platform. Relevant scientific questions are listed, regarding these airborne measurements in the lower atmosphere. However they do not investigate these questions extensively here. The introduction of the aircraft is well presented and outlined, however at some points too many details

are given. The scientific payload section can be shortened, while more information on the data processing and correction should be added. The technical description is overloaded with too many details and information in some parts (e.g. on the data-acquisition), which makes the section hard to follow and is not suitable for this journal. On the other hand a better description of the aerosol payload is necessary. Parts of details are missing, like the description of the Particle counter, comparison with another ground station or the aerosol inlet system. The inlet system has an important influence on the sampling efficiency and should be discussed in more detail. Further, the particle counter is only referredÂăby one reference (Gao et. al 2015), however this paper is only submitted at this point, hence further information about the particle counter is not accessible to the reader at the moment. In general, data from more test flights would be helpful in order to derive substantial conclusions about the systems' capability. However, due to the airspace restriction and limited test flights this was not possible. Nevertheless, the first results are promising, that the platform is suitable for atmospheric research. Based on my remarks I would recommend the paper to publication subject to major revisions.

Specific Comments:

Title: Why is pilatus not written in capital letter ?

Abstract: l.20: In the manuscript no comparison between airborne system and ground-based instrumentation is presented.

Introduction:

p. 11989 l. 6: Please also refer to Platis et. al , 2015

p. 11990 l. 18: Other UAS campaign for aerosol investigation: Altstädter et. al. 2015, Platis et. al 2015.

Section 2.

General: Some parts of this section can be shorten. I think sometimes there are too

many details given, which are not necessary for a reader in that study. E.g.: -p. 11992 l. 13 ff : Turning RotMax 50cc , Microsoft-Windows based, Multistar high capacity Lipo... -Description of the data-acquisition system: p. 11997 l. 20-29: Description is overloaded with too many detailed information about data processing.

Section 2.1

p. 11991 l. 17 -19: This part is a repetition of the last section of the Introduction.

p. 11992 l. 6: How much payload is the Pilatus able to carry? Why is it substantially heavier than the ALADINA payload. What measurements targets are different? ALADINA measures also aerosol concentrations and thermodynamics.

p. 11993 l. 9f: Skip the sentence : Because no fuel is carried... There is no need to explain that, as well as that the landing weight equals take-off weight.

Section 2.2

General: This section is hard to follow due to its length (6 pages). Please divide this section into smaller subsection for each payload.

p. 11993 l. 12 – 16. You should skip this paragraph or put it into the introduction

p. 11993 l. 4: The down looking sensor is close to the ground surface. Have you experienced any problems when taking off on a dirty/mud runway due to dirt on the dome of the pyranometer?

p. 11995 l. 6: What is meant by 50-channel GPS? Is that important to know? Does the INS include a Kalman-Filter or is this done in post-processing?

p. 11995 l. 10-13: That sentence is not clear to me. What do you mean for correcting for aircraft attitude. Why do you have to correct the aircraft attitude with radiation data? Why does the shading pattern block half of the sky view? I am not an radiation expert, but may be you can make that point more clear to me. p. 11996 l. 6: What is the flow rate of air measured by the OPC? Please describe how many particle size channels

the OPC has.

p. 11996 l. 7: How is the tubing constructed? What about the aerosol inlet system (isokenetic, isoaxial?) and sampling efficiency during cruising flight? (You can refer to (Baron and Willeke, 2001))

In general a more detailed presentation of the aerosol particle counter is missing. The particle counter is only referred by one reference (Gao et. al 2015), however this paper is only submitted, hence further information about the particle counter is not accessible to the reader at the moment.

Section 3

p. 11998 l. 20-27: Please shorten. I think it is enough if you mention the maximum flight altitude is limited to 122m due ti airspace restrictions.

p. 11999 l.6 : May be readers , who haven't worked with INS, get confused with the term "offset characterization".

p. 11999 l.8 : May be you should explain the term "level flight leg". Readers, who haven't worked with flight data, might not know what it means. (Same with non-level flight, non-level configuration).

p. 11999 l.11-25: Does the Kalman-Filter work differently ,when using the INS on a car platform compared the more dynamical airborne platform? Did you change the setup of the INS then?

Fig.2: Figures b) and c) are hard to read because they are too small.

Fig.3: Is it possible to include the theoretical value of the shortwave radiation for that location and time as a comparison to the measured value?

Section 4

Fig. 4: May be it would be more convenient to plot the potential temperature instead of

the absolute temperature for indication of the mixed layer.

Fig. 5. The closed circle can hardly be distinguished from the thick line.

Fig. 6 and p. 12002 21 – p.12003 l. 4: It would be interesting to see a plot of roll angle compared to the down-welling shortwave signal, in order to see if both signals correlate or not. I did not understand if the periodic variations in the signal is only due to surface and cloud features or also due to the aircraft motion itself. (You refer to that also in the summary. There it is more clear to me.)

Fig. 7: Figure is hard to read. I suggest splitting the figure into 3 sub-figures for Down, Net and Up.

p.12003 l. 7-10. The authors state that the radiation measurements "agree reasonably" with a nearby reference station. More details on this comparison should be provided. The errors resulting from the aircraft movement in combination with possible cloud coverage and terrain features are the key point in assessing the feasibility of the presented approach. More comparisons with reliable radiation measurements should be provided to substantiate the claim of reasonable agreement.

p.12003 l.15-24. This paragraph sounds more like methods and should be place in Section 3.

Summary:

p.12006 l. 20-p.12007 l.23: This paragraph sounds more like a very detailed outlook than like a summary. In general I think that this outlook is far too detailed and is very speculative. For example, the sentence "Similarily, continued advancement in battery technology will allow the current aircraft to extend its mission time over the coming years" is purely speculative. The LiPo batteries used in this work are the current state of the art and have been so for some years now. Additionally, the authors want to deploy the aircraft in the arctic, where the low air temperature will limit the performance of the batteries.

Technical Corrections:

p. 11989 l. 2:. has has... remove one has

p. 12001 l. 13: change to boundary-layer temperatures

p. 11992 l. 22: ...and sold by ICARE... I think this information is not really necessary for the readers.

References: Altstädter, B., Platis, A., Wehner, B., Scholtz, A., Wildmann, N., Hermann, M., Käthner, R., Baars, H., Bange, J., and Lampert, A.: ALADINA – an unmanned research aircraft for observ- ing vertical and horizontal distributions of ultrafine particles within the atmospheric boundary layer, Atmos. Meas. Tech., 8, 1627–1639, doi:10.5194/amt-8-1627-2015, 2015. 11992

Gao, R.-S., Telg, H., McLaughlin, R., Ciciora, S., Watts, L., Richardson, M., Schwarz, J., Per- ring, A., Thornberry, T., Rollins, A., Markovic, M., Bates, T., Johnson, J., and Fahey, D.: A light-weight, high-sensitivity particle spectrometer for PM 2.5 aerosol measurements, Atmos. Science. Technol., submitted, 2015. 11996, 12005

Platis, A.; Altstädter, B.; Wehner, B.; Wildmann, N.; Lampert, A.; Hermann, M.; Birmili, W. & Bange, J. An Observational Case Study on the Influence of Atmospheric Boundary-Layer Dynamics on New Particle Formation Boundary-Layer Meteorology, Springer Netherlands, 2015, 1-26

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 11987, 2015.