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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Potential of airborne lidar measurements for cirrus cloud studies" *by* S. Groß et al.

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Interactive comment on "Potential of airborne lidar measurements for cirrus cloud studies" by S. Groß et al. – Anonymous Referee #1 Received and published: 14 May 2014

Review of manuscript "Potential of airborne lidar measurements for cirrus cloud studies" submitted to Atmospheric Measurement Techniques.

We thank this Reviewer for his careful reading of the manuscript and for his suggestions to help us improve the paper.

The answers are given in a direct response.

General Comments: This manuscript presents a new airborne lidar that uses DIAL technology to measure vertical profiles of water vapor mixing ratio. The capabilities of the so-called WALES system are demonstrated through observations inside and outside of cirrus clouds. The water vapor measurements are compared with in situ measurements obtained by a second airborne platform that flew 1.5-2 km below the WALES instrument, which flew onboard the HALO aircraft. The relative humidity with respect to ice (RHi) is computed using both the in situ aircraft data and also using the WALES measurement combined with ECMWF model output. The authors present a thorough analysis of a cirrus case study to demonstrate the capabilities of the WALES. The manuscript is well written organized and the figures are appropriate and support the findings. This manuscript primarily demonstrates new measurement capabilities, which is suitable for publication in AMT. Suggest publishing with minor changes as listed below.

Specific Comments: 1) Sec. 2.3 last sentence – do you have an estimate of uncertainty in the efficiency of the Rosemount inlet particle separation? Do you know the size range that is included/excluded using this inlet?

A quantification of the rosemount's particle separation efficiency is difficult since it strongly depends on the dynamic conditions and cloud properties (particle size and concentration) at the inlet. From our experience, the humidity measurements are not influenced by evaporating ice particles and typical cirrus conditions. However, in very dense cirrus we occasionally observe small spikes in the water vapor measurements which we link to evaporating ice particles. Usually, these artifacts can easily be identified. Small droplets and aerosol particle below 1μm are expected to partially enter the inlet, however these particles usually do not carry enough water to significantly alter the humidity measurements. We extended the last sentence of paragraph 2.3 to address the topic in are more specific way.

2) P. 4042 line 4: While the mean difference in the water vapor between WARAN and ECMWF is small (_1 ppmv), the standard deviation is very different between the two.

Suggest mentioning that here and referencing Table 3 here rather than in the next paragraph.

We added a comment here to make aware of this difference.

3) P. 4042 line 12-13. ": : :smaller temperature fluctuations have a minor: : :" Suggest quantifying and stating specifically the change in RHi due to temperature variability. i.e. RHi varies by X with a 1 K temperature variability (since you show later in Fig. 6 a 1 K offset between aircraft and model/radiosonde temperature).

The relative variability of ECMWF and in-situ temperature data along the flight track (0.0003 and 0.0006) does not show significant differences between both datasets. Furthermore the values are very small. The standard deviation of both temperature datasets along the flight track is about 0.06 to 0.1 and therewith the temperature variability can be neglected regarding the local variability of RHi which is discussed in this section. The local variability of RHi is mainly influenced by the relative variability of the water vapor data. Both properties show the same value. However, the offset of the mean temperature of both datasets of about 1 K has a strong impact on the retrieved variability which is also discussed in this section and also later in the comparison of the influence of temperature uncertainties on the retrieved RHi values. Uncertainties of about 1 K (as found between ECMWF and aircraft data) in this temperature range result in about 10 % uncertainties in the retrieved RHi . To make it more clear that we only consider the influence of the variability of temperature and water vapor we corrected the p4042,l12 as follows: '. . . have a minor influence on the local variability of RHi . . .'

4) P. 4042, line 27: ": : :differ only by about 10%..." A 10% uncertainty in RHi is pretty large for ice nucleation studies. Heterogeneous nucleation occurs in about a 10-15% RHi range, so 10% error would significantly impact any conclusions. Suggest modifying your sentence to reflect this and removing "only by" from this sentence.

Here the 10% difference is again referring to the relative variability of the retrieved

RHi values, showing that the relative variability of the temperature is negligible when regarding the relative variability of RHi.

5) Fig. 3 caption: What is meant by "signal overload"? Do you mean the detector is saturated? Please clarify.

That is right, 'signal overload' means that the detector is saturated. We changed this in the figure caption.

6) Fig. 8: Is there any way to quantify or discuss the uncertainty of the water vapor measurement (and hence RHi) in cirrus clouds vs. outside cirrus clouds. I am wondering what if any contamination of the lidar signal by ice crystals might have on the retrieval of water vapor inside clouds.

We added a discussion about these uncertainties in the text.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 4033, 2014.