**Atmospheric
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Interactive comment on "UV Raman lidar measurements of relative humidity for the characterization of cirrus cloud microphysical properties" *by* P. Di Girolamo et al.

Anonymous Referee #1

Received and published: 27 August 2009

The manuscript presents a case study of a cirrus cloud observed on 6 September 2004 over Potenza, Italy. Raman lidar measurements of particle backscatter coefficient, water vapor mixing ratio, and relative humidity, among other parameters, are compared and interpreted with 1-dimensional microphysical simulations. Furthermore, spectral radiances measured by an airborne spectrometer are used to determine the radiative properties of the cirrus cloud. The measurement capabilities of Raman lidar to measure humidity below and even inside the cirrus cloud are discussed. The mid-latitude humification observed in this case is related to precipitating ice crystals.

The manuscript is generally well written and the topic of this case study is clearly in the

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scope of ACP. While the lidar technique reported in the manuscript is not new itself (see below), the combination with airborne spectral measurements and the interpretation of the case with microphysical simulations makes an interesting study which I consider well suited for ACP after major revision.

Major comments

Raman lidar measurements of both water vapor number density and temperature are not new. Worldwide a number of Raman lidars exist which use the water vapor Raman lidar technique and the rotational Raman lidar technique for temperature measurements in combination (see page 14739, line 13ff, of the manuscript). So, also relative humidity profiling with Raman lidar has been described in the literature before (e.g., Mattis et al. 2002), even in cirrus clouds (e.g., Behrendt et al. 2002). And in consequence, the measurements presented in this paper are not the first (the authors are wrong in assuming so; page 14373, line 23 ff).

A major benefit of Raman lidar compared to other techniques is that the statistical uncertainty of the measurement can be calculated with the signal intensities. Unfortunately, this error assessment is missing in this manuscript and it remains unclear, how precise especially the values of relative humidity over ice (RHI) inside the cloud are. I consider it essential to add a detailed discussion of the measurement errors of both the water vapor mixing ratio (Figs. 5, 6, 9) and RHI (Figs. 4, 5, 9) to proof the high performance of the lidar measurements as basis for the interpretation of this case.

Minor comments

1. Page 14739, line 15: Larger values have been proven, e.g., at least 45 (Behrendt and Reichardt 2000).

2. Page 14740, line 5ff: I suggest marking these locations in Fig. 1

3. Page 14741, line 10: Please delete "completely". The measurement of the particle backscatter coefficient uses both the N2 Raman signal and the elastic signal.

4. Page 14741, line 16ff; Fig. 3: Are there parts of the cloud which are not reached/penetrated by the lidar beam due to too large extinction and are therefore not taken into account in the measurements of the cirrus cloud optical thickness? Please comment on that.

I order to avoid any misunderstanding, I suggest to mention the definition of optical thickness (basis e not 10).

5. Page 14742, line 10 ff; Fig. 4: It seems that there are also values of RHI > 100 % outside the cloud due to statistical noise of the data.

6. Page 14744, line 9: Please introduce the abbreviation FOVS.

7. Page 14744, line 24 ff: This assumption can be validated by calculating the extinction-to-backscatter coefficient ratio (lidar ratio).

8. Page 14745, line 5: Please introduce the abbreviation DIFA.

9. Page 14747: Why are radiosonde data used in the simulation and not lidar data?

10. Page 14749,line 6: What is the lidar ratio measured by the lidar in this case (see also point 7 above)?

11. Page 14749: Please explain all parameters used in the formulas.

12. Page 14758, Table 1: Please introduce all abbreviations.

13. Page 14759, Table 2: Please introduce all abbreviations.

14. Page 14760, Fig. 1: What is the scale of the plots?

15. Page 14761, Fig. 2: The red marks of the cloud boundaries are not clearly visible.

16. Page 14762, Fig. 3: I guess the leading digits of the scale are missing.

References

Behrendt, A. and J. Reichardt, "Atmospheric temperature profiling in the presence of

clouds with a pure rotational Raman lidar by use of an interference-filter-based poly-chromator." Appl. Opt., 39, 1372-1378, 2000.

Mattis, I.;A. Ansmann, D. Althausen, V. Jaenisch, U. Wandinger, D. Müller, Y. F. Ar-shinov, S. M. Bobrovnikov, and I. B. Serikov, "Relative-Humidity Profiling in the Tropo-sphere with a Raman Lidar," Appl. Opt. 41, 6451-6462, 2002.

Behrendt, A.; T. Nakamura, Y. Sawai, M. Onishi, T. Tsuda, "Rotational vibrational-rotational Raman lidar: Design and performance of the RASC Raman lidar at Shigaraki (34.8 deg N, 136.1 deg E), Japan." Proceedings of SPIE - The International Society for Optical Engineering, Vol. 4484, 151-162, 2002.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 14735, 2009.