FIRST AEROSOL OBSERVATIONS WITH A NEW AIRBORNE LIDAR SYSTEM DURING ASTAR 2004

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INTRODUCTION

The Arctic Study of Tropospheric Aerosols, Clouds and Radiation (ASTAR 2004) was focused on measurements of tropospheric aerosol characteristics in the Arctic (Herber et al., 2004). The campaign was performed in May/June 2004 in the vicinity of Spitsbergen in order to investigate the transition period from Arctic spring to Arctic summer aerosol conditions, in particular focussing on the occurrence of increased aerosol loads, called Arctic Haze. Airborne remote sensing with the aerosol backscatter lidar technique allows determining the horizontal as well as vertical extend and layering of such increased aerosol loads. The airborne lidar retrieves information of increased tropospheric aerosol layers between the ground and 2500 m altitude with a vertical resolution of 7.5 m and a horizontal resolution of 4 to 12 km, depending on the speed of the aircraft. Results are presented in terms of profiles of backscatter coefficients and depolarisation ratios.

METHODS

AMALi, the **A**irborne **M**obile **A**erosol **Li**dar was developed at the Potsdam Research Unit of the Alfred-Wegener-Institute for Polar and Marine Research in Germany. We developed an eye safe, airborne lidar system for the remote detection of the vertical and horizontal extent of increased tropospheric aerosol content (as occurring during so called Arctic Haze events) with high vertical and temporal resolution, operating at 1064 nm and 532 nm wavelengths with additional depolarisation detection at the latter wavelength. The instrument is designed for installation onboard of the AWI research aircraft Dornier Do228, but can also be operated on a stand-alone basis on the ground or on moving platforms like cars or ships. The system consists of a small Optical Assembly with a size of 50x70x25 cm, which comprises a Nd:YAG pulsed laser, directing and receiving optics, and electro-optical detectors. The laser control and cooling unit, and the data acquisition system (laptop PC, transient recorders) are installed in a standard size rack of a 55x50x60 cm. The instrument is installed in the Do228 air plane looking vertically downward (nadir configuration). Complete overlap of the laser beam with the telescope field of view is achieved after 235 m and the maximum range is determined by the maximum aircraft flight altitude of 3000 m during this campaign. The measurements in nadir configuration generally provide a better signal to noise ratio, as compared to ground based systems, because the measured aerosol concentration and the air density increase towards the ground. On the other hand, airborne applications allow only short integration times in order to achieve an acceptable horizontal resolution. A good signal to noise ratio is reached after an integration time of 2 min, corresponding to a horizontal resolution between 4.3 km and 12.3 km depending on the cruising speed of the aircraft over ground, which lies between a minimum speed of 130 km/h and maximum speed of 370 km/h.

The limited range of the recorded signals results in a difficulty to obtain the background light intensity, which has to be subtracted for the evaluation of the lidar data. To overcome this problem, the data acquisition is started by an adjustable pretrigger to the laser, especially designed by LICEL for an airborne application. The timing of the pretrigger can be chosen up to a maximum value of 500 bins (3750 m) of the signal.

The lidar profiles stored on the laptop provide information about the state of the atmosphere between the full overlap and the ground or sea level during the flight. They are displayed online using the acquisition and quick-look evaluation programme. Each second the display provides all three raw signals measured and each minute an averaged, background and range corrected aerosol profile at 1064 nm and at 532 nm, as well as a depolarisation information (532perp/532par). This online quick-look data evaluation allows the immediate, qualitative interpretation of the aerosol data during the flight. This feature had a special application during the ASTAR 2004 campaign providing sufficient information for the onboard operator to guide the second AWI research aircraft for its in-situ measurements.

APPLICATIONS

The first application of the AMALi system was during the ASTAR 2004 campaign. The retrieved backscatter and depolarisation profiles allowed distinguishing Arctic Haze layers from ice clouds and other aerosol enhancements. The occurrence, altitude distribution, reflectance and depolarisation of the vertical and horizontal extent of the Arctic Haze layers are presented.

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REFERENCES

Stachlewska, I., G. Wehrle, B. Stein, R. Neuber (2004). Airborne Mobile Aerosol Lidar for measurements of Arctic Aerosols, Proceedings of the XXII International Laser Radar Conference, Matera, Italy, 2004

Herber, A., J.F. Gayet , K. Hara, R. Krecji, A. Minikin, R. Neuber, C. Ritter, O. Schrems, J. Stroem, A. Schwarzenboeck, R. Treffeisen, S. Yamagata, and T. Yamanouchi (2004). Arctic Study of Tropospheric Aerosols, Clouds and Radiation (ASTAR 2004): First results, this issue.