

INTERcomparison of Aerosol and Cloud Tracking, INTERACT

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Introduction and motivation

Observations of cloud base height are important for meteorology [1], observations of aerosols are important for air quality applications [2], observations of cloud cover and aerosols address key uncertainties in climate study [3]. One approach that can be taken to improve models and reduce uncertainty for all of these applications is to deploy high resolution networks of ground-based instruments. In order to achieve broad, high resolution coverage, inexpensive instruments are needed. However, if the data produced is going to be of value to the scientific community it is essential that the sensitivity, stability, biases and uncertainties of the instruments be well-understood.

Ceilometers are inexpensive instruments (typically in the 12k-20k euro range, though it is possible to spend closer to 50k on higher-end models) that are already deployed widely at meteorological observation stations and airports. These instruments are based on the lidar principle and measure elastically-backscatter returns, usually at 905nm or 1064nm, and have traditionally been used only to report cloud base and vertical visibility, rather than the vertical profiles of the aerosol backscattering coefficient on which they are basing these outputs. While further infrastructure for backscatter profiles to be captured and shared is badly needed [4], these instruments show great potential for aerosol applications such as volcanic ash tracking [5], boundary layer monitoring [6], as well as cloud parameterisation. In order to make the best use of existing and future ceilometer deployments, they must be better characterised. This is the purpose of the INTERACT study.

Scientific objectives

The scientific objectives of INTERACT are to evaluate the stability, sensitivity, and uncertainties of ceilometer aerosol backscatter profiles, to evaluate the sensitivity, uncertainties, and idiosyncrasies of ceilometer automated cloud base detection, and to put these into context by simultaneously evaluating the performance of a high specification research lidar. Here for the first time, three commercial ceilometers from different manufactures are to be compared with an advanced lidar [7], whose sensitivity and stability will also be assessed.

Reason for choosing station

CNR-IMAA Atmospheric Observatory (CIAO) [8] is in an ideal location for observations of maritime, continental and dust aerosols being subject to a combination of weather regimes. Equally important, the observatory has two advanced lidar systems, two ceilometers (CT25K by VAISALA and CHM15k by Jenoptik), and a host of other instrumentation for observation, including a microwave radiometer, Ka-band radar, and an automated radiosonde launching system, and the expertise to operate these sensors and interpret the data. With the addition of the third ceilometer loaned to the observatory by Campbell Scientific for the campaign, CIAO is unique in its capability to carry out this study.

Method and experimental set-up

In June of 2013, the Campbell CS135 ceilometer was installed on the observatory rooftop, the Vaisala CT25k was checked to ensure it was working properly, and the Jenoptik CHM-15k had its optical module and internal PC upgraded. All instruments were pointed vertically (90 degrees) and positioned as shown in Figure 1.

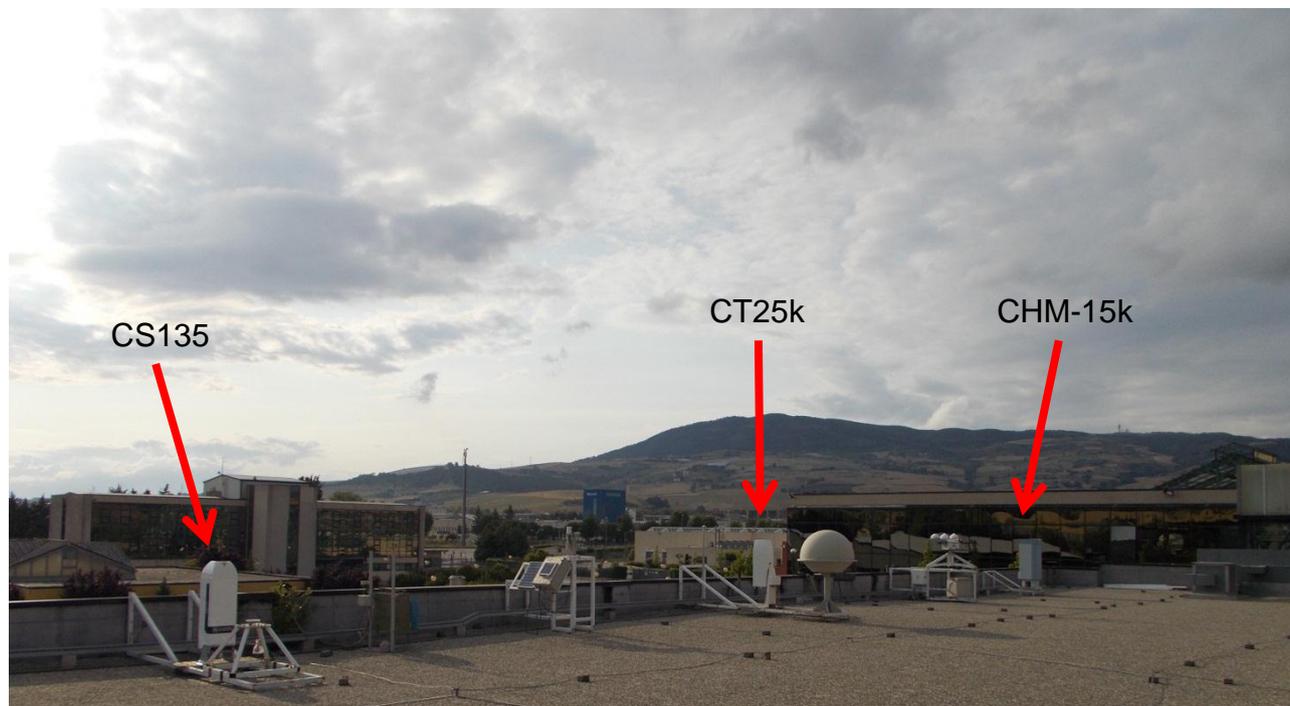


Figure 1. Ceilometer locations on CNR-IMAA Potenza observatory roof.

Data collection for the campaign began officially on 1 July, 2013. The ceilometers run 24-7, reporting at least once per minute. MUSA, the observatory's mobile lidar, is parked outside the observatory and monitoring throughout the campaign which concludes on 1 November, 2013. As MUSA, PEARL, the other observatory's laboratory-based lidar, is typically operated about four times a week, once during daytime, according to the EARLINET (European Aerosol Research Lidar NETWORK) measurements schedule.

The key aims of the study are to assess 1) the aerosol backscatter sensitivity of each ceilometer 2) the stability of the ceilometers and lidar systems with regard to aerosol backscatter retrieval and 3) the sensitivity of ceilometers to different cloud types and heights. In addition, several other areas will be studied, including ceilometer boundary layer height retrieval intercomparison and implications of ceilometer transmitter / receiver overlap functions, hardware instabilities, and performance at different background light levels and in different weather conditions.

Preliminary results and conclusions

Data collection is still underway, so analysis has not yet begun. However, this is the first aerosol campaign for the Campbell CS135, so a test date for intercomparison was selected. The 905nm CS135 attenuated backscatter was compared with MUSA's 1064nm range-corrected signal during an aerosol event on 21-22 June, 2013. The major features of the aerosol event captured by MUSA shown in Figure 2 are visible on the CS135 data from the same time as shown in Figure 3.

Tito(PZ) (40.60N, 15.72E, 760.0m asl) MUSA
RCS @ 1064nm 21/06/2013, 22:46:00–02:44:05 UT

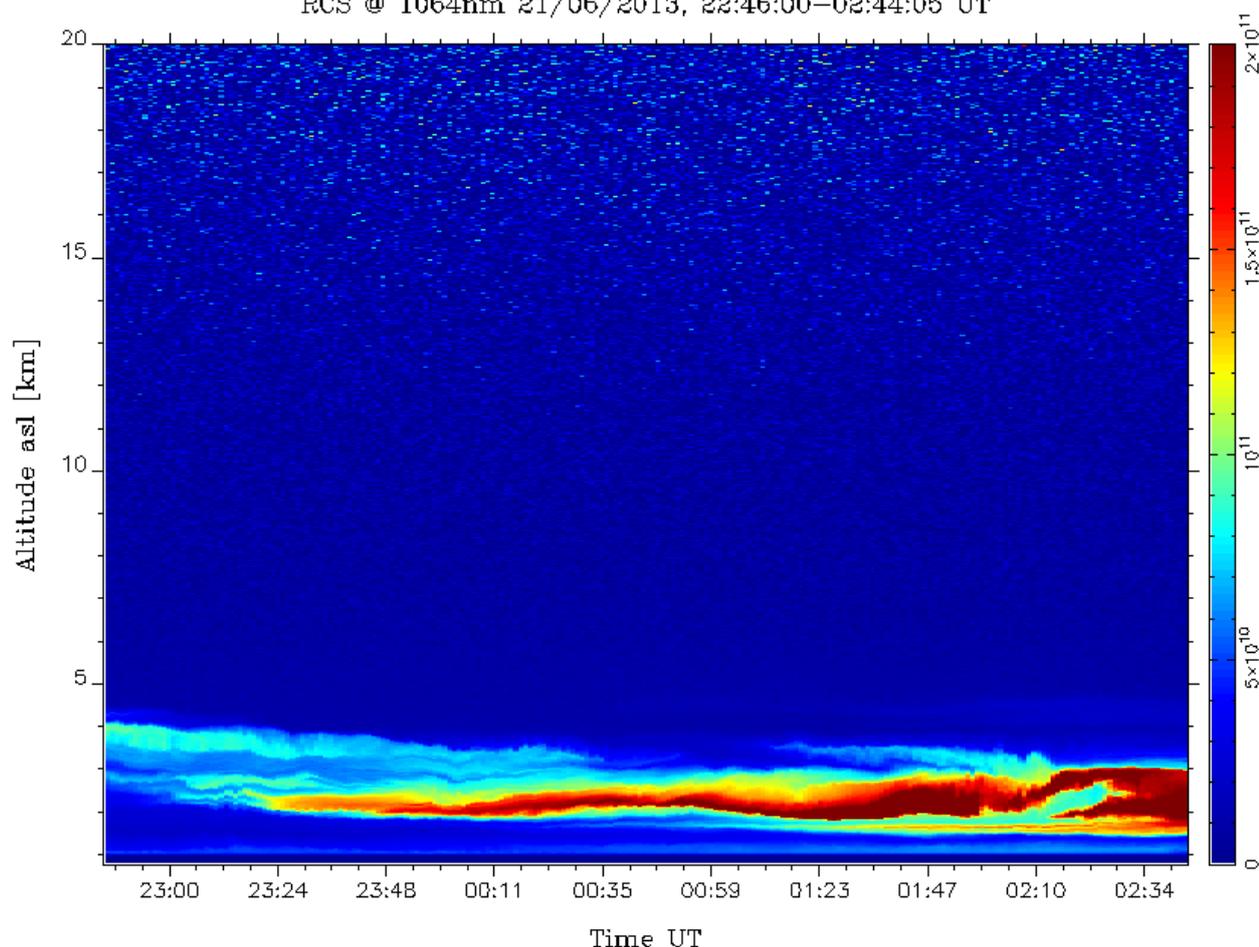


Figure 2. MUSA 1064nm range-corrected signal during aerosol event 21-22 June, 2013.

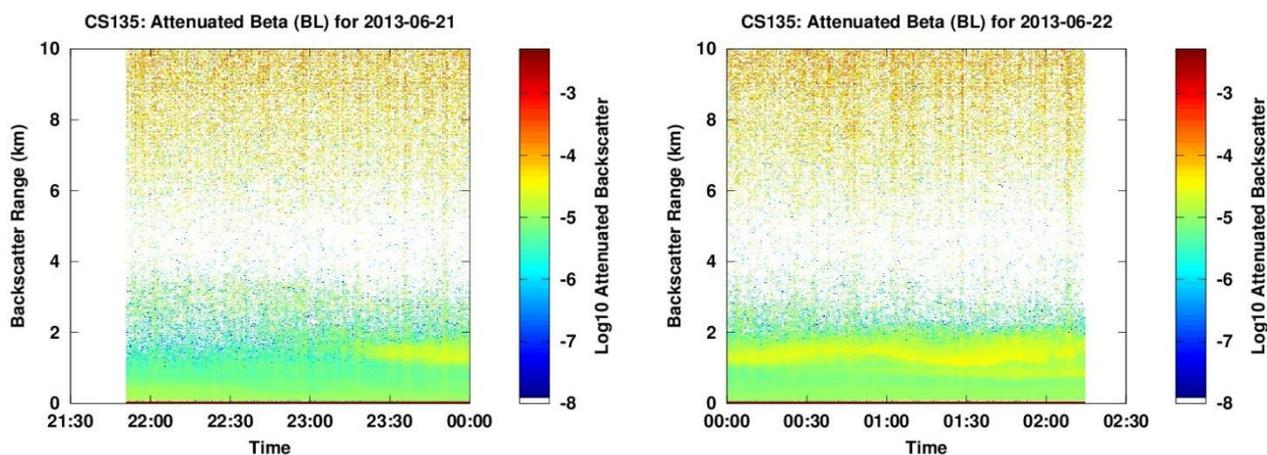


Figure 3. CS135 ceilometer 905nm attenuated backscatter during aerosol event 21-22 June, 2013.

Outcome and future studies

The outcome of the data analysis will be published both in peer reviewed papers and in a WMO report on recommendations for ceilometer aerosol retrieval capabilities and procedures, solicited by the WMO representatives. It is hoped that additional funding will be secured to purchase additional ceilometers for a long-term study to be conducted at CIAO in Potenza, from which longer-term PDF's of clouds and aerosol detections can be produced from several years of data.

References

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