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Laser Ceilometer CL51 Demonstration Field Campaign Report

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ARM
CLIMATE RESEARCH FACILITY

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Laser Ceilometer CL51 Demonstration Final Campaign Summary

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Executive Summary

Improvements in the measurements of clouds and the ability to support observation systems are critically important to advancing our understanding and improving global climate model performance. The purpose of a demonstration of the Vaisala CL51 ceilometer was to evaluate its high-range capabilities as a possible augmentation to data provided by the CL31 ceilometer that currently is deployed at U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Climate Research Facility sites.

Vaisala performed a no-cost demonstration of the equipment; Pacific Northwest National Laboratory (PNNL) supported the data analysis; and ARM provided logistical support, power, maintenance, etc. The laser ceilometer provided measurements of cloud-base height, vertical visibility, and backscatter profile at a vertical range of 15 km. The ceilometer demonstration was conducted during the Characterization of Cirrus and Aerosol Properties campaign (CCAP) to provide coincident observations of cirrus cloud heights and potential backscatter signals by aerosols. This campaign included deployment of a CL51 ceilometer at the ARM Facility's Southern Great Plains (SGP) site, co-located with the current CL31, micropulse lidar, and balloon-borne sounding system. Data collected from these sensors were analyzed to compare and contrast the data from the CL51 ceilometer.

Acronyms and Abbreviations

ARM	Atmospheric Radiation Measurement Climate Research Facility
CCAP	Characterization of Cirrus and Aerosol Properties
CEIL	ceilometer
DOE	U.S. Department of Energy
MPL	micropulse lidar
PNNL	Pacific Northwest National Laboratory
SGP	Southern Great Plains, an ARM megasite

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1.0 Background

A demonstration of Vaisala's CL51 Ceilometer (CEIL) was conducted from November 14 to November 26, 2013, at the Atmospheric Radiation Measurement (ARM) Climate Research Facility Southern Great Plains (SGP) site to compare measurements of cloud height, boundary-layer height, and backscatter profile against the current CEIL, which is a micropulse lidar (MPL), and balloon-borne sounding system.

ARM uses Vaisala CL31 ceilometers at all its sites to obtain these measurements up to a maximum vertical range of 7.5 km. The model CL51 is designed to detect cirrus clouds up to 15 km (Table 1). In support of the Characterization of Cirrus and Aerosol Properties (CCAP) field campaign at SGP, Vaisala offered to conduct a concurrent demonstration of the CL51.

The Vaisala Laser Ceilometer CL51 Demonstration evaluated the high-range capabilities of the CL51, compared measurements of the CL51 with the current CEIL and MPL, and examined the microphysical properties of cirrus clouds and aerosols.

Victor Morris of PNNL arranged for SGP site operations support and conducted data analysis of the ceilometer measurements; Herb Winston of Vaisala Inc. provided the CL51, Shadrian Strong of Johns Hopkins University provided logistical support for the CCAP field campaign, and Connor Flynn of PNNL conducted data analysis of the MPL measurements.

Table 1. Instrument specifications

Specifications	Vaisala CL31	Vaisala CL51
Range	7.5 km	15 km
Resolution	5 m	10 m
Accuracy (solid target)	±5 m	±5 m
Measurement cycle	2–120 s	6–120 s
Laser	InGaAs pulsed diode	InGaAs pulsed diode
Wavelength	910 nm	910 nm
Size	34 × 33 × 119 cm	36 × 35 × 153 cm
Weight	31 kg	46 kg

2.0 Notable Events or Highlights

During the limited period of the field campaign, there were very few periods when upper-level cirrus clouds were present.

3.0 Lessons Learned

There was little coordination or communication between the principal investigators of the primary field campaign and the sub-campaign.

4.0 Results

The Vaisala CL51 ceilometer provides six times greater signal-to-noise ratio than the model CL31 (Figure 1) and provides better detection of aerosol layers and boundary-layer heights (Figure 2) with improved data quality at both near range and high range, including detection of cirrus clouds. Data collected using the CL51 was in good agreement with the MPL to about 10 km. The reduced ability to detect higher, thin cirrus clouds may be due to intervening lower clouds.

5.0 Public Outreach

None.

6.0 Laser Ceilometer CL51 Demonstration Publications

6.1 Journal Articles/Manuscripts

None.

6.2 Meeting Abstracts/Presentations/Posters

Morris VR, CJ Flynn, and H Winston. 2014. "A demonstration of Vaisala's high-range ceilometer." PNNL-SA-101403, presented at the Atmospheric System Research (ASR) Program Science Team/Principal Investigator Meeting, March 12, 2014, Potomac, Maryland. Available at http://asr.science.energy.gov/meetings/stm/posters/view?id=1171.

7.0 References

Schäfer, K, P Wagner, S Emeis, C Jahn, C Münkel, and P Suppan. 2012. "Mixing layer height and air pollution levels in urban area." In Remote Sensing of Clouds and the Atmosphere XVII; and Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing VIII, EI Kassianov, A Comeron, RH Picard, K Schäfer, UN Singh, and G Pappalardo (eds), Proceedings of SPIE vol. 8534, id. 853409, doi:10.1117/12.9743.

Morris, VR, C Flynn, and H Winston. 2009. "A demonstration of Vaisala's new ceilometer." Presented at the 19th ARM Science Team Meeting.

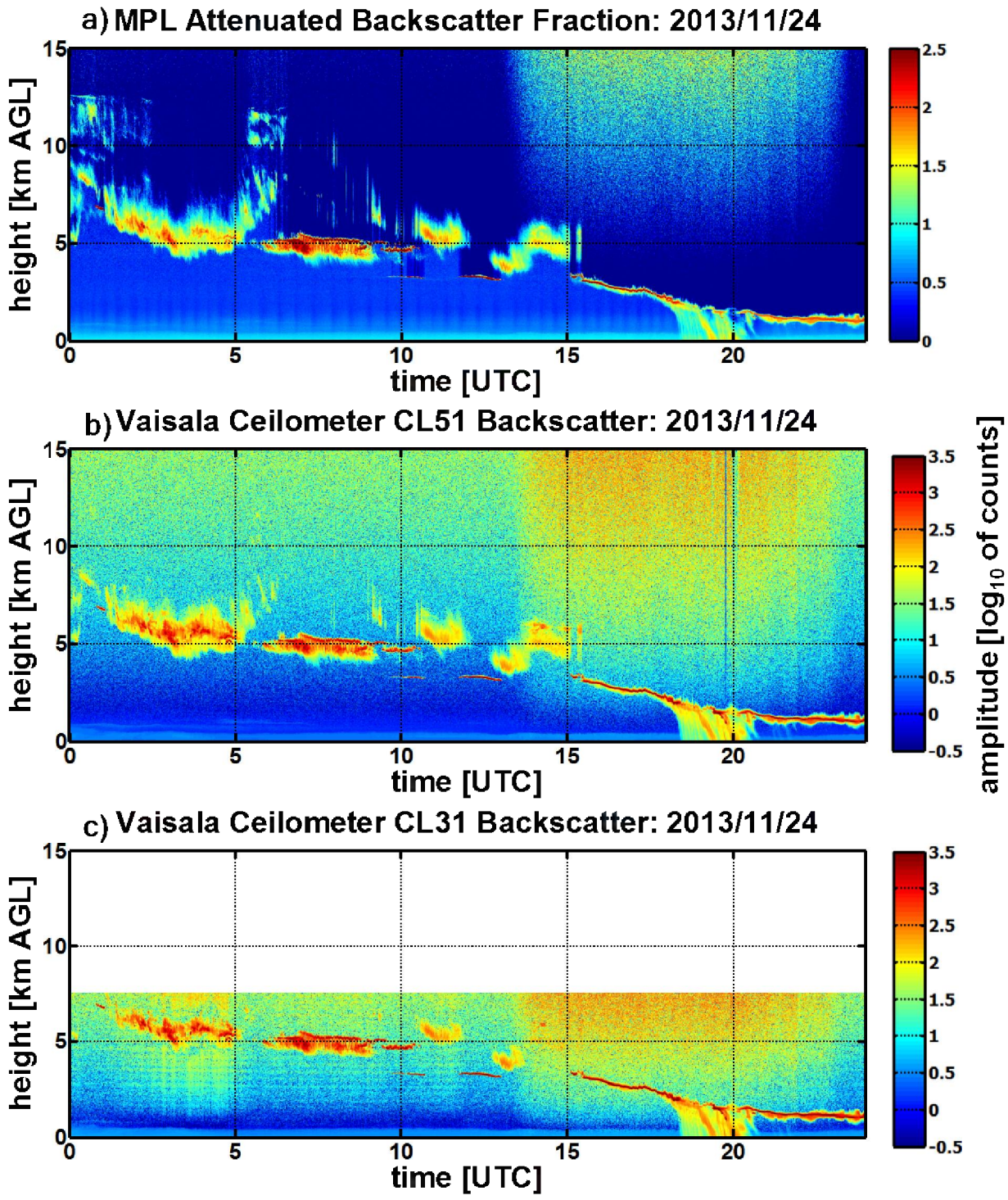

Figure 1. Backscatter density comparisons. Backscatter profile measured by a) MPL, b) CL51 ceilometer, and c) CL31 ceilometer at SGP on November 24, 2013.

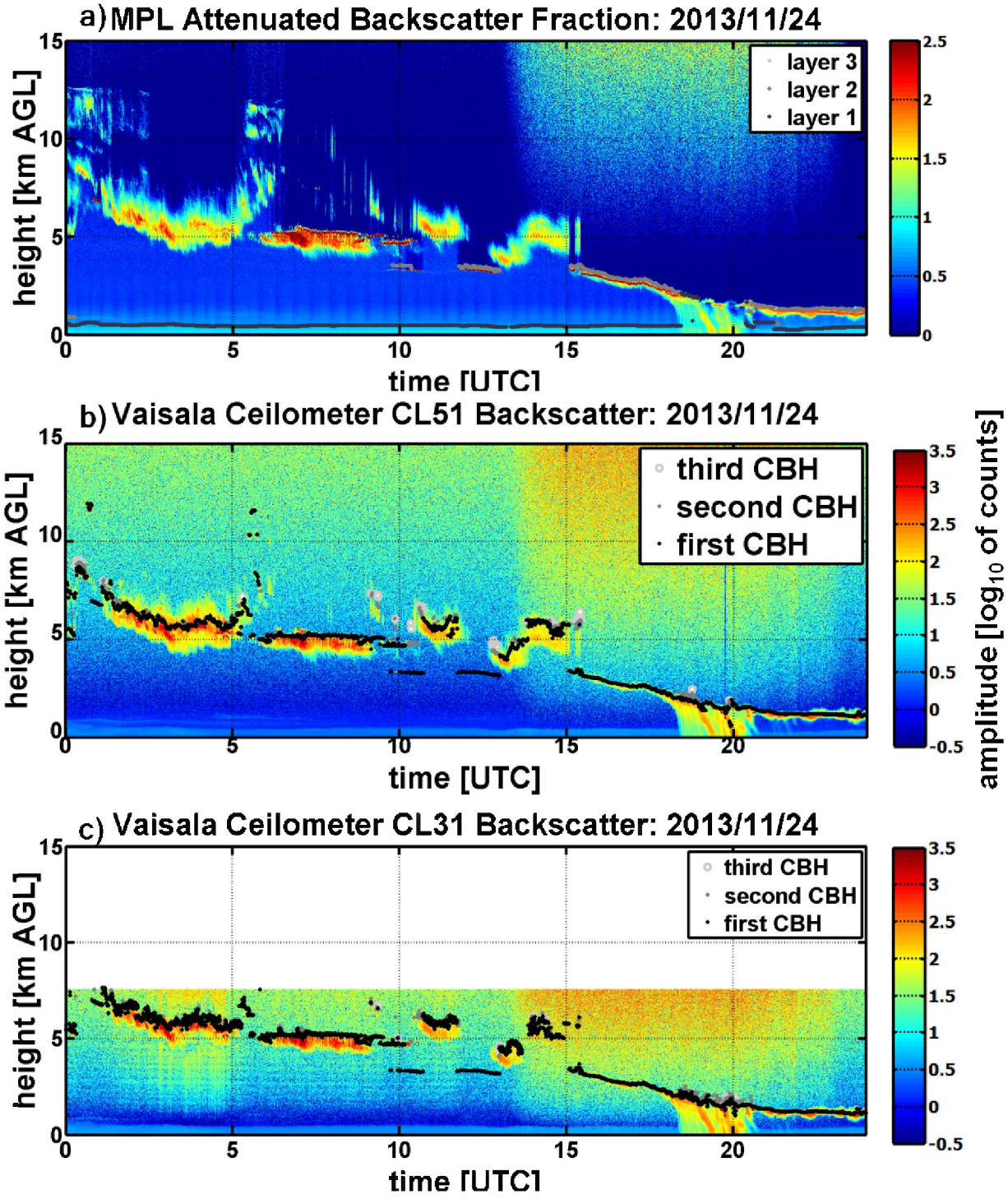

Figure 2. Cloud height comparisons. Aerosol backscatter profile measured by a) MPL with boundary-layer heights derived from CL51, b) CL51 ceilometer with cloud heights, and c) CL31 ceilometer with cloud heights at SGP on 24 November, 2013.

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