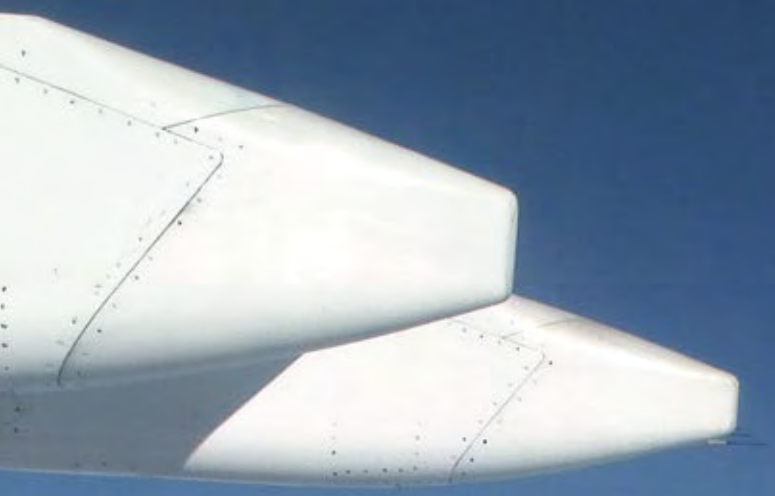
Lufft Ceilometer CHM 15k

A Passion for Precision



a passion for precision · passion pour la précision · pasión por la precisión · passione per la precisione ·

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Lufft

Practical Applications and

Measurement Results

The Lufft CHM 15k ceilometer is a simple, one-wavelength backscatter lidar. Within its operating range of up to 15 kilometers it reliably detects multiple cloud layers, cirrus clouds, and aerosol layers.

Excellent signal performance is achieved by a stable wavelength, narrow line width microship Nd:YAG laser operating at 1064 nm. It allows an efficient daylight suppression and minimized temperature fluctuations. The used pulse energy and frequency of the laser results in a eye-safe operating mode and an instrument classification as laser class 1M product.

Furthermore, the CHM 15k is distinguished by a user-friendly design and easy handling, both extremely important for unattended and continuous operation.

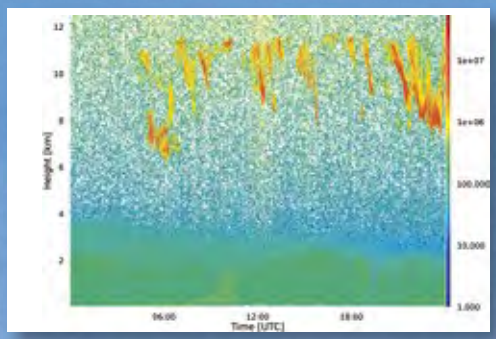
Either being used as sophisticated aerosol research instrument or being integrated in a larger networking operation, the CHM 15k is a state-of-the-art solution for today´s manifold requirements for atmospheric research.

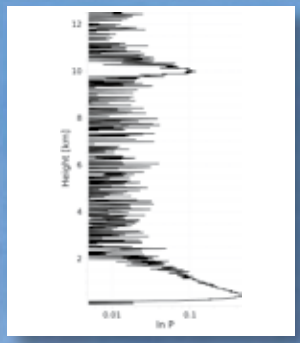
The following illustrations exemplify different meteorological situations that were measured by the Lufft CHM 15k ceilometer. Measurements were performed in Teltow & Berlin at our Lufft test sites.

Each photo represents a snapshot of a typical weather situation. The corresponding plots document the measured backscatter intensity, color-encoded as a function of altitude (vertical axis) and time (horizontal axis). The vertical line in the color plot shows a section for a marked time point, which is shown in the right figure as backscatter profile.

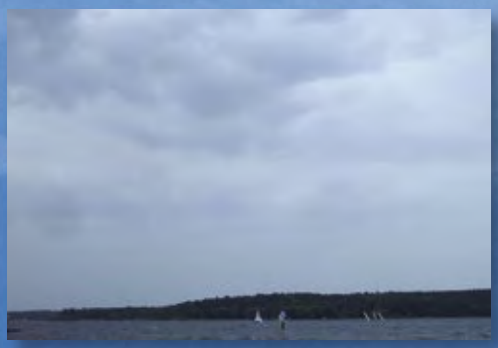
The Lufft Ceilometer CHM 15k in Action:

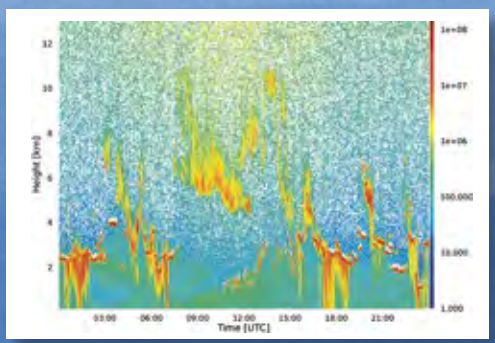
Examples of measurement results for meteorological events and practical applications

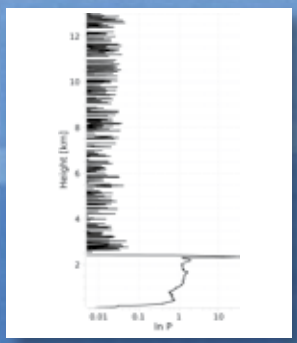




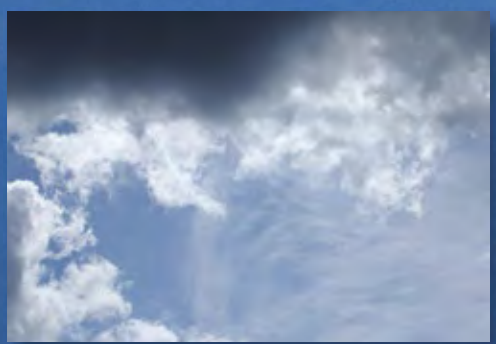
Cirrus Clouds Cirrus clouds were photographed on October 10th, 2005. The graphical view for backscatter intensity shows a similar cirrus cloud structure over the day between 6 and 12km and an aerosol layer structure until 2km altitude. The related height profile at 9pm is shown in the right diagram.

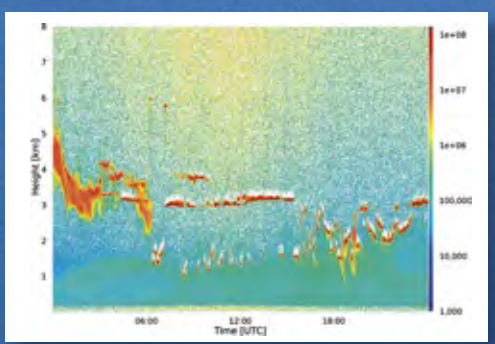






Rain The graphic shows a rain situation. A certain drop in cloud height and an increase in cloud mass and volume can easily be perceived in the graphical view by evaluation of the height profile (at 18:30 UTC) shown in the right subarea of the graphical view, one can identify precipitation and appraise the intensity of a likely precipitation event.



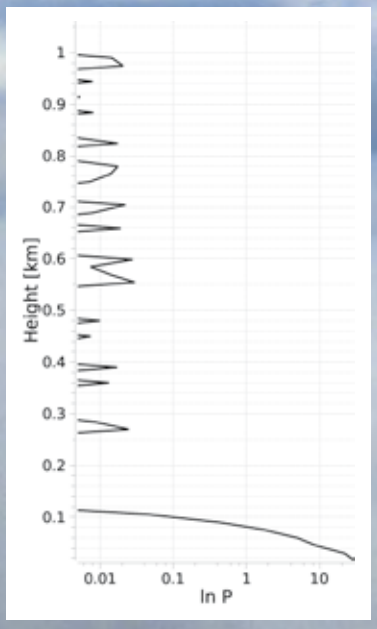


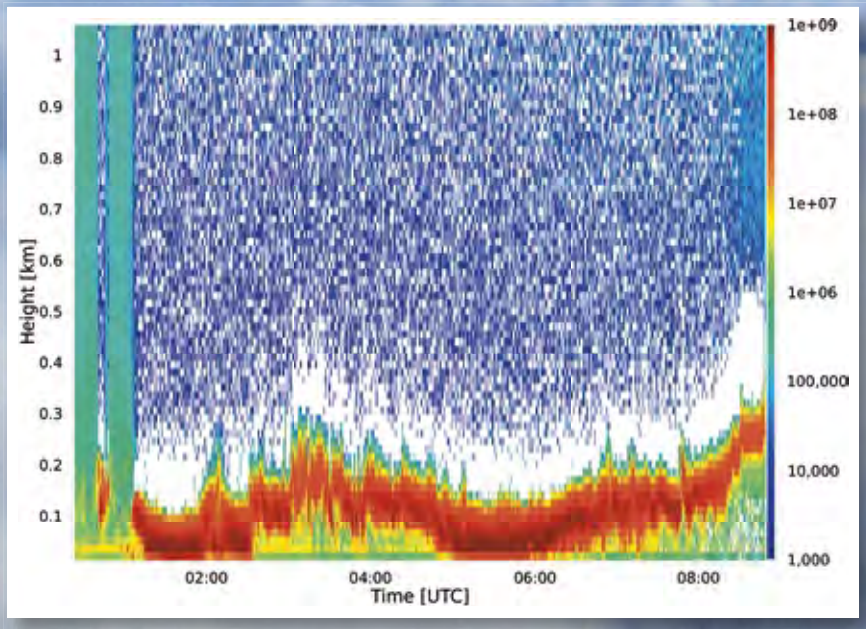
Multiple Cloud Layers The photo above shows a snapshot of several cloud layers at different altitudes. The measurement example on the right hand side illustrates the CHM 15k detecting four to five different cloud layers.

Fog, an Atmospheric Phenomenon with High Complexity

A visual range below 1000m close to ground is known as fog, when opacity is caused by super-saturated air with water vapor. Fog occurs when the air cools rapidly on clear nights, due to evaporation, or when warm air flows over a cold surface.
Since air can hold less water vapor at low temperatures than at high ones, it reaches the temperature at which vapor condenses as liquid water in the form of dew or droplets floating in the air, when the ambient temperature cools down.
In case the air cools down even further, more and more water droplets are formed, so that the fog is denser.
Fog droplets have typical diameters from 5 to 50µm. These are ideal to be detected by ceilometers.

Fog event of April, 2, 2014. Shown is a time progress chart from 2am to roughly 9am local time (CEST). During this time interval, the vertical visibility (VOR) varied between 80m and 200m (265ft and 655ft). The detection signal in this event is most of all generated by multiple scattering of the laser beam. By evaluation of the height profile, the fog event is detected.

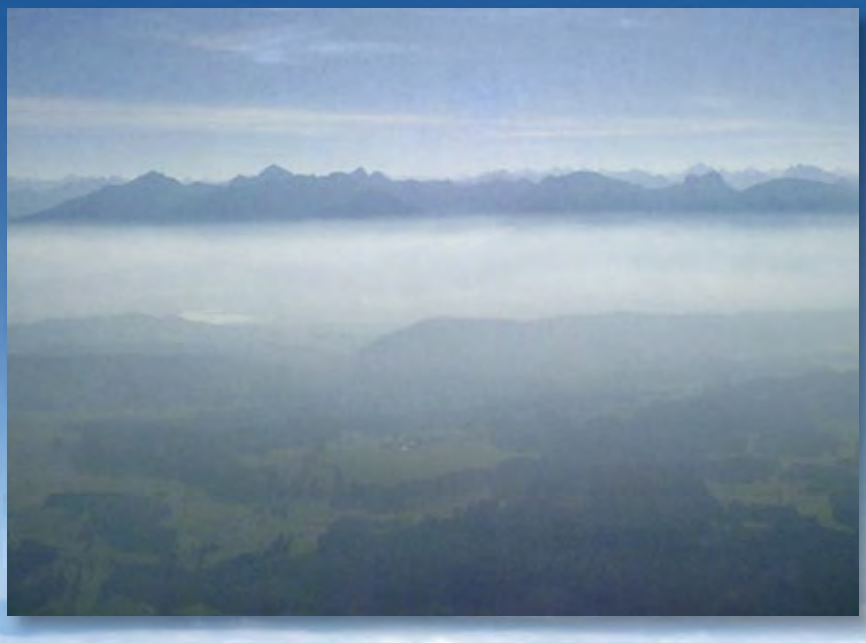




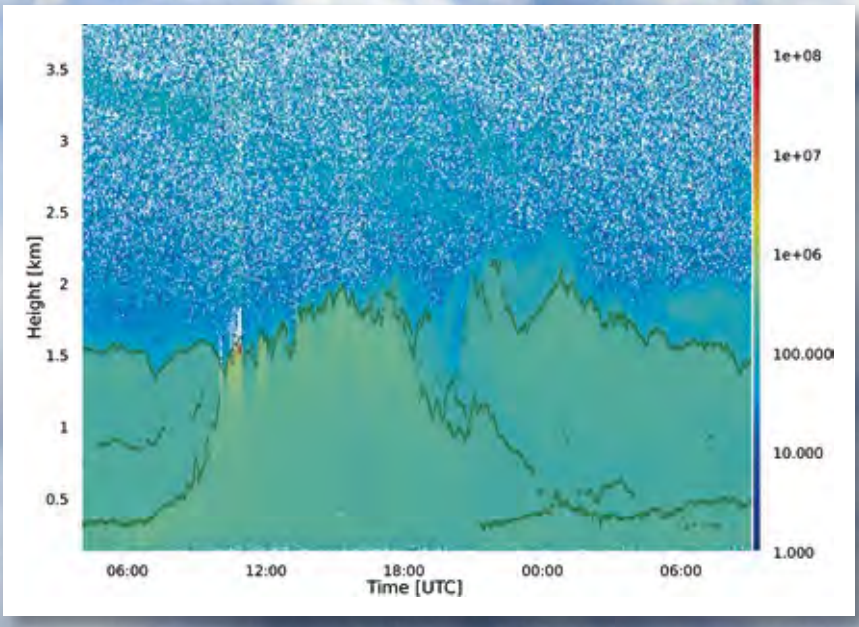
Planetary Boundary Layer and Mixed Layer Height

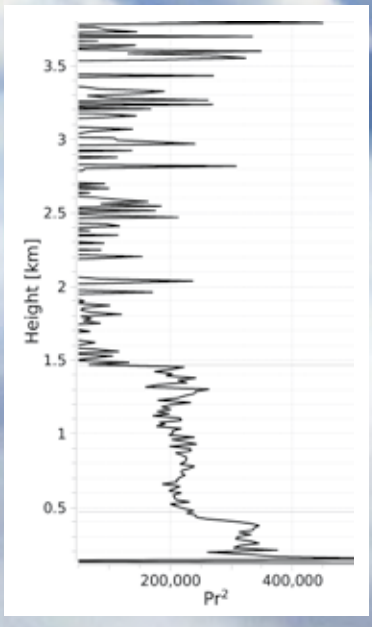
The atmospheric or planetary boundary layer (ABL or PBL) is the layer closest to Earth's surface affected by heat, wind, moisture or momentum transfer to or from the surface. On top of the PBL the free troposphere starts. The PBL itself can be divided in layers depending on used parameters (wind, temperature, aerosol/ particles) and the time scale. Close to ground the mixed layer height (MXL) is of special interest, because all aerosols/ particles and different gases arising from the earth surface are first of all concentrated and perfectly mixed within it in one hour time scale. Therefore, the measurement of the aerosol layer height gives valuable information on the particle concentration, for example on PM2.5 fine dust. The higher the mixing layer is, the lower is the concentration of particles in the air.
One example is vehicle emissions, which are inhaled by all of us each and every day. It's obvious, that there is a huge difference whether these gases have 100m or 1km to disseminate.

The Lufft ceilometer is capable of detecting the height of the PBL as well as different aerosol layers within it.
It supports users by identifying the MXL height. All algorithms are built in the ceilometer and the results are emitted in real time.
Another application for the CHM 15k is the identification of volcanic particle layers in the atmosphere.



The right diagram part below shows an aerosol profile for a typical mixing layer as it develops in the course of a day. These measurements data were recorded on July 18, 2014. Each individual reading was measured over a time length of 15s. For better visual traceability of the layer structure, a linearized presentation format has been selected (in units of ln P).





Ceilometer CHM 15k Measuring Clouds, Aerosol Height Profiles and Visibility

High optical sensitivity for exact results
Accurate results in day- and nighttime are obtained by

- a solid state laser source with long lifetime
- small bandwidth filters
- a highly sensitive photo receiver

Reliable operation in any climate
The CHM 15k series is prepared to work throughout the year and in any climate. Due to their double case structure combined with a window blower and an automatic heating system, the ceilometers are not interfered with fogging, precipitation, freezing or overheating.

The data telegrams in detail

1 - Standard data telegram
Output interval, date, time, detected cloud layers, penetration depths, vertical visibility, max. detection range, local altitude, unit (m/ft), system status, precipation index, checksum

2 - Extended data telegram
Standard telegram combined with additional status messages and device specific parameters

3 - Raw data telegram
Extended telegram with measured raw data (in NetCDF format)

4 - CHM 15k data telegram
Output interval, date, time, unit, sky condition index, total cloud cover, cloud layers, cloud penetration depths, VOR, max. detection range, quality index aerosol layer, aerosol layer heights, status, checksum

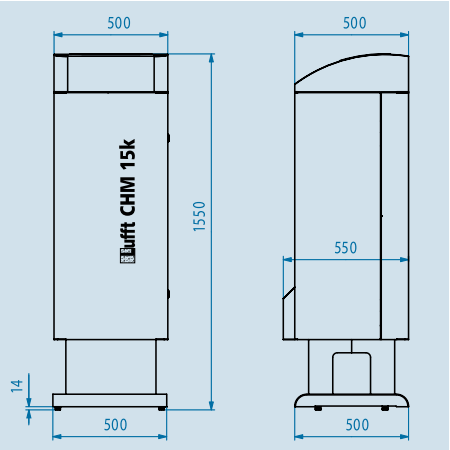
5 ... 9 CHM15k user data telegrams
Configurable user data telegrams are available

Jenoptik Ceilometer CHM 15k"Nimbus"			Order No.
Ceilometer			**8350.00**
Technical Data	Dimensions (LxWxH)	500 mm x 500 mm x 1550 mm	
	Weight	70 kg (130 kg incl. packaging)	
Operating conditions	Temperature	-40°C ... 55°C	
	Relative humidity	0% ... 100%	
	Wind	55 ms^{-1}	
Measuring parameters	Measuring principle	Optical (LIDAR)	
	Measuring range (CBH)[1]	5 m ... 15,000 m (16 ft ... 50,000 ft)	
	Accuracy[2]	± 5m (± 16 ft)	
	Range resolution	5 m (16 ft)	
	Sampling rate	100 MHz	
	NetCDF raw data resolution	5 m, 10 m or 15m	
	Time to measure	2 s ... 600 s (programmable)	
	Targets	Aerosols, clouds	
	Quantities to be measured	- CBH1, preset: 3 layers; maximum 9 layers - Cloud penetration depth - Cloud amount and sky condition index - Vertical visibility (VOR) - Height of aerosol layer - Aerosol backscatter profiles	
	Light source	Nd:YAG solid-state laser, wavelength 1064 nm	
Interfaces and software for data output and device configuration	Standard interface	RS485, LAN	
	Optional interfaces	VDSL, Modem	
	Communication	LAN Port: Web-Interface Serial Port: DataClient Software or standard terminal programs	
	Optional software	Viewer-Software for convenient visualizing measured results	
Electrical parameters	Power supply	Standard: 230 VAC, ±10% Optional: 110 VAC, ± 10%	
	Power consumption	250 W (Standard) 800 W (in maximum heating mode)	
	UPS functionality (opt.)	Internal backup battery for electronics, > 1 hrs	
Operating safety	Environmental requirements	ISO 10109-11	
	Laser protection class	1M according to IEC 60825-1:2007	
	Internal protection class	IP65	
	EMC	Class B, DIN EN 61326-1	
	Electrical safety	DIN EN 61010-1	
	Certifications	CE	

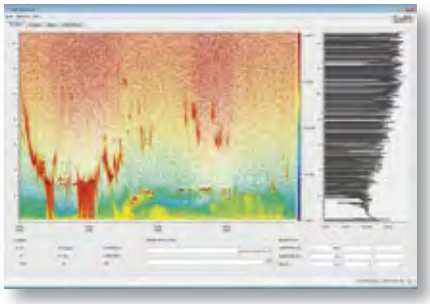
[1] CBH - Cloud Base Height [2] measured on hard target in 10 km distance

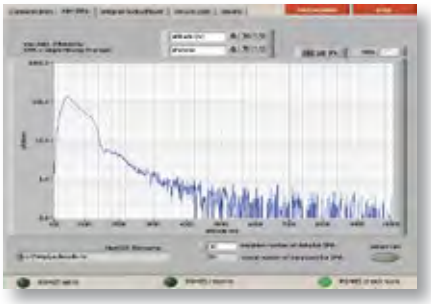
Benefits

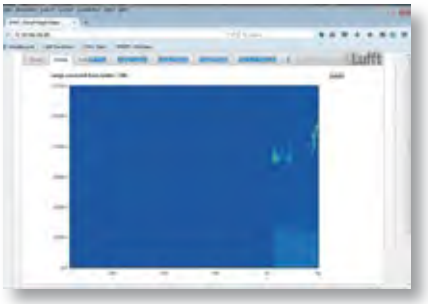
- Great measuring range up to 15 km (50 000 ft)
- Enhanced multiple cloud layer detection
- Simple and eye-safe routine operation
- Service-friendly modular device setup
- Various data telegrams, including raw data
- GUI software for device control and display of measured backscatter data in NetCDF format



Software / References





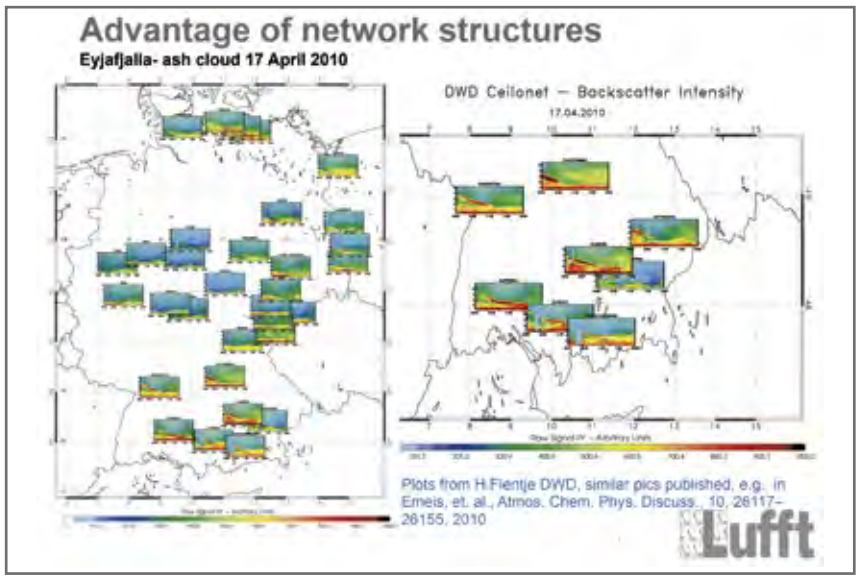


Software:

A special software developed by Lufft is available to visualize the data that were measured by the CHM.

Furthermore, each instrument comes with DataClient - the standard RS485 comunication software.

The CHM 15k can be configured and accessed via a convenient web interface.



References: German Weather Service DWD

DWD Ceilonet: Quick time view of CHM 15k ceilometers spread out over Germany. The following example shows the complete map of Germany during the volcano eruption on Iceland in 2010. If you look at the ceilometer backscatter profiles in the different regions (left side), you notice that only in the center of Germany the dark red plume moving from the upper troposphere to the lower level is missing. The zoom (right side) shows in detail how the high levels of volcanic ash are dropping closer and closer to the earth.

DWD Weather station Falkenberg: Perfect atmospheric monitoring by combining CHM 15k with microwave radiometer and cloud radar. The German meteorological service (DWD) operates a network of close to 100 Lufft CHM 15k today. Though initially designed for the detection of clouds the DWD is using the CHM 15k for the detection of aerosol layers and the retrieval of vertical profiles of particle backscatter coefficients. The large numbers of installed ceilometers are joined together in a network to effectively detect aerosol particles over Germany as well as monitor its movement as well as its vertical distribution in the troposphere.

References: Dutch Weather Service KNMI

The KNMI is undertaking a similar effort as the DWD in preparing its measuring network for the challenges of the 21st century: A network of more than 40 Lufft ceilometers shall support the Dutch Weather Service for precise and real-time monitoring of all aerosol and clouds activities over the Netherlands itself as well as on various offshore locations in the North Sea. Volcanic ash from Iceland, sand dust from the Sahara desert or smoke plumes carried over the Atlantic and caused by American forest fire emissions are only a few cases showing the importance of having a dense network of ceilometers for continuous and unattended atmospheric monitoring of the Dutch sky.

Special adapted version of the Lufft CHM 15k for the KNMI network

G. LUFFT Mess- und Regeltechnik GmbH

Lufft Germany:
Fellbach Office:
Postal Address:
Gutenbergstraße 20
70736 Fellbach
Address:
P.O. Box 4252
70719 Fellbach
Phone: +49 711 51822-0
Fax: +49 711 51822-41
www.lufft.com
info@lufft.de

Berlin Office:
Carl-Scheele-Straße 16
12489 Berlin
Phone: +49 711 51822-831
Fax: +49 711 51822-944

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Lufft North America:
Lufft USA, Inc.
1110 Eugenia Pl Unit B
Carpinteria, CA 93013
Phone: +1 888 519 8443
Fax: +1 805 845 4275
E-Mail: sales@lufftusainc.com
www.lufft.com

Lufft China:
Lufft Shanghai
Measurement & Control
Technology Co., Ltd.
Room 507 & 509, Building No.3,
Shanghai Yinshi Science and
Business Park,
No. 2568 Gudai Road,
Minhang District,
201199 Shanghai, CHINA
Phone: +86 21 5437 0890
Fax: +86 21 5437 0910
E-Mail: china@lufft.com
www.lufft.cn

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