University
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Faculty
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Optical signal propagation in the atmosphere

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INTRODUCTION

- Free space optical (FSO) links are used as an alternative to radio links offering very high data rates comparable to optical fibers
- However, they are sensitive to local atmospheric conditions
- Proper verified models of optical signal propagation in particular phenomena (fog, clouds, rain, snow, atmospheric turbulence etc.) are needed for effective link planning
- Nowadays an implementation of ground-to-satellite optical link is being considered. The most critical factor is an attenuation in clouds.
- Our experimental site on Milesovka mountain is very often in the centre of clouds – we are able to contribute significantly to this research
- Experimental site is a joint workplace of Institute of Atmospheric Physics ASCR and University of Pardubice

Milesovka Mt.

OBJECTIVES

- Verification and updating of current models of attenuation in particular phenomena (fog, rain, turbulence)
- Development of a semi-empirical model of attenuation in clouds
- Research of other sources of attenuation such as mechanical vibration of transceivers, effect of sunshine etc.

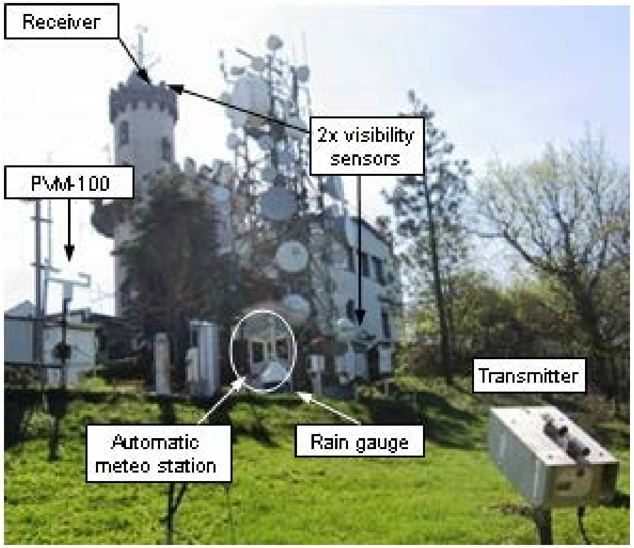
MATERIAL & METHOD

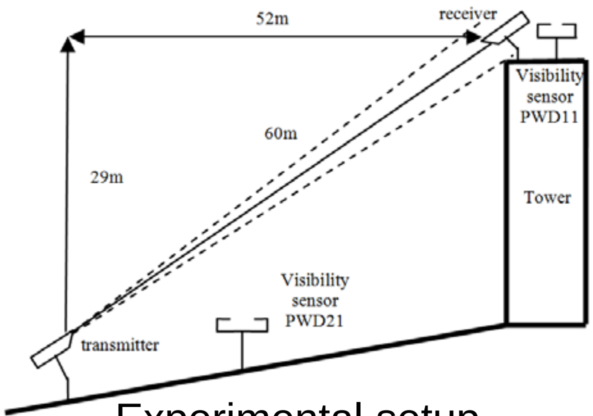
Parameters of the optical link

Channel	CH2	CH1
Laser diode	DL5032	RLT1550-15G
Wavelength λ	830 nm	1550 nm
Transmitted power P_{TX}	5 mW	7 mW
Divergence φ	10 mrad	
Dynamic range of receiver	45 dB	
Link length	60 m	
Elevation angle	≈ 29°	

Meteorological measurements:

- Visibility, rain rate, snow rate, liquid water content, particle surface area, 3D wind velocity, temperature, relative humidity, air pressure, height of clouds etc.
- Planned measurements: drop size distribution of rain and clouds



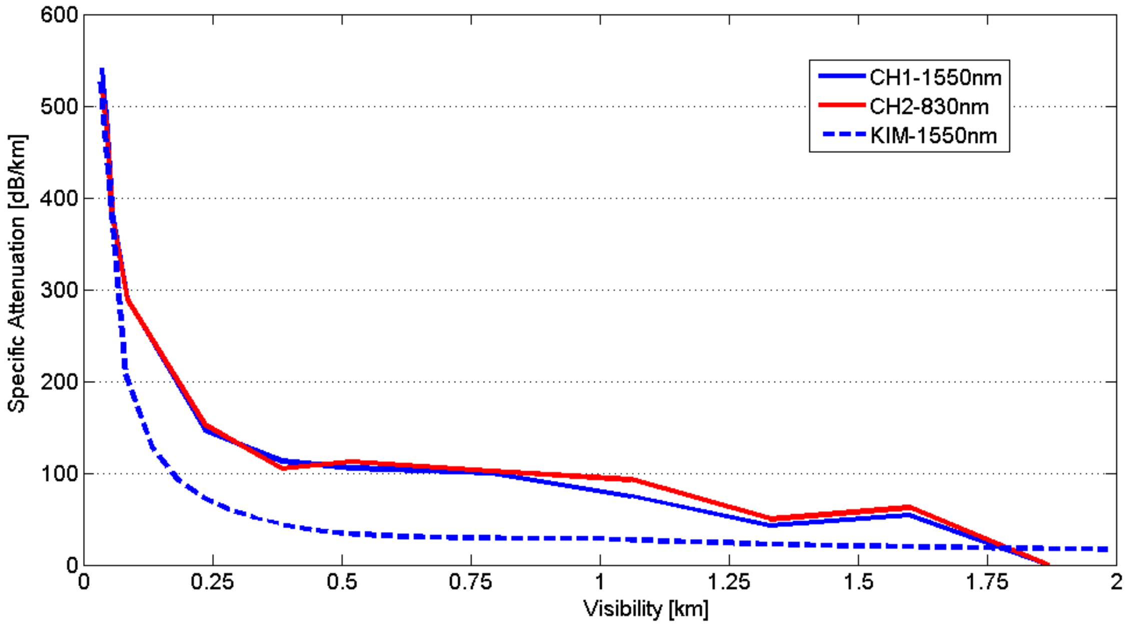


Experimental setup

RESULTS

Dependence on visibility

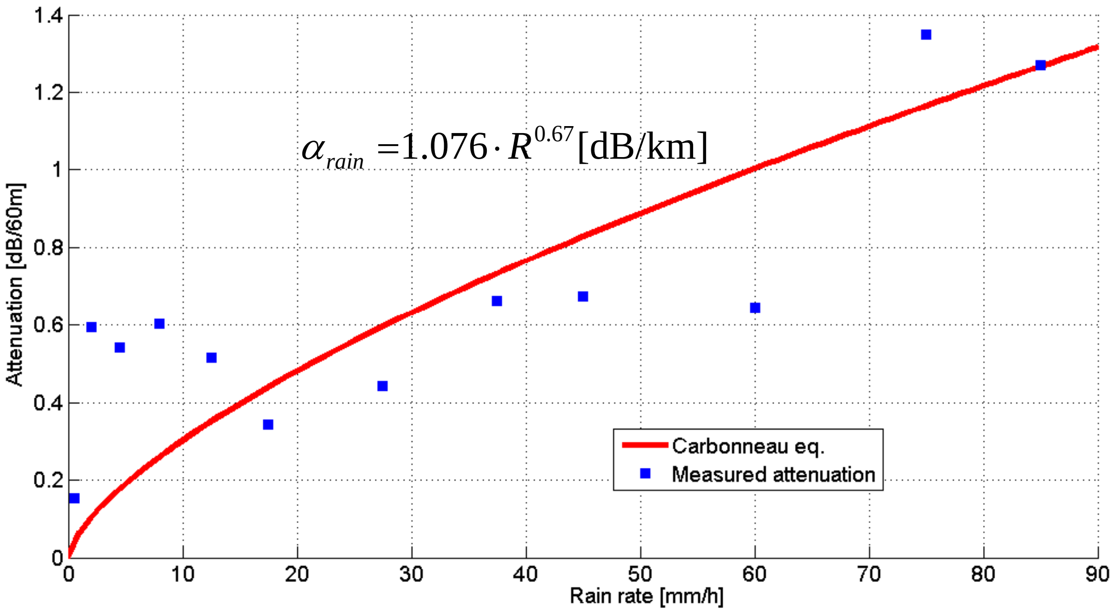
- There is no wavelength dependence in low visibility as expected
- Measurement in clouds doesn't confirm the Kim formula valid for fog. Therefore there is a need to develop a model for cloud



RESULTS

Rain impact

- The model for rain attenuation by Carbonneau (ITU-R recommendation) is confirmed by our measurement
- Rain has a minimal impact, specific attenuation causes up to several dB/km



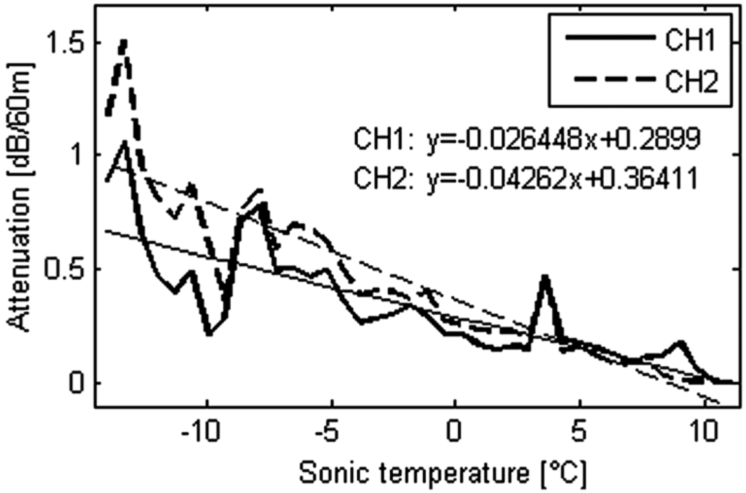
RESULTS

We have found a high correlation of attenuation with **sonic temperature**

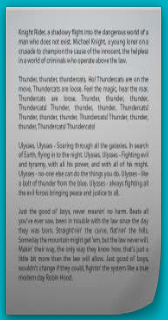
$$T_s = T\left(1 + 0{,}32\frac{e}{p}\right) \quad [K]$$

T is temperature in K, *e* is the pressure of water vapour [hPa],
p is the total air pressure [hPa]

Sonic temperature is measured by sonic anemometer and expresses the status of atmosphere from the "clear air" point of view. It reflects the impact of the atmospheric gases (especially water vapor) on the FSO link attenuation



ACKNOWLEDGEMENT & CONTACT



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