Tracking of Urban Aerosols Using a Scanning Mie Lidar

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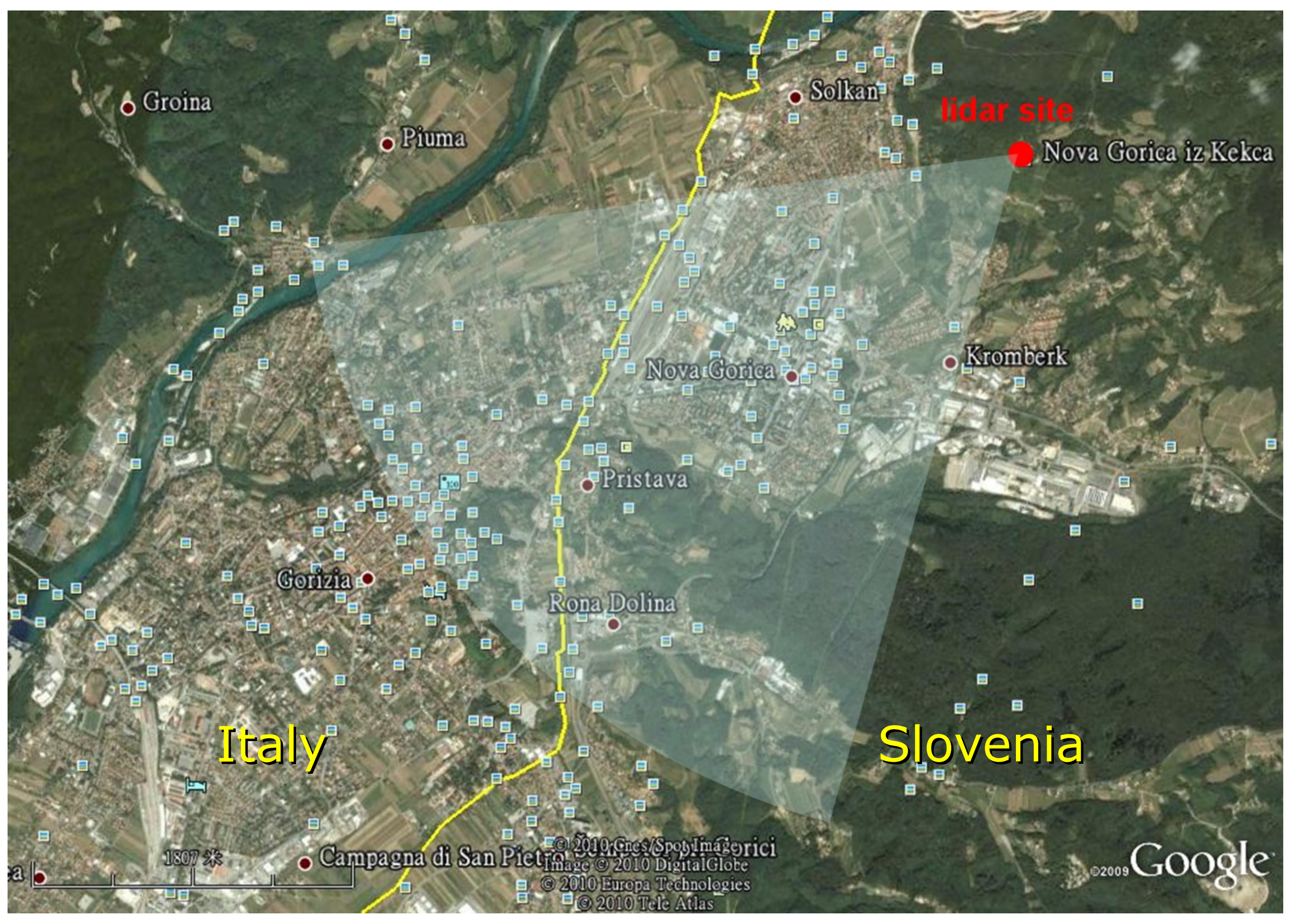
I. Introduction

Increase of aerosol concentration in urban areas caused by human activities has a significant impact on the status of the environment. Scanning aerosol lidars offer the ability to monitor visibility, air pollution, plume dispersion and to track plumes of potentially hazardous aerosols. We present the results of aerosol-loading variation above the neighboring towns of Nova Gorica in Slovenia and Gorizia in Italy on 24 April and 25 April 2010.

II. Lidar Setup and Scan Region



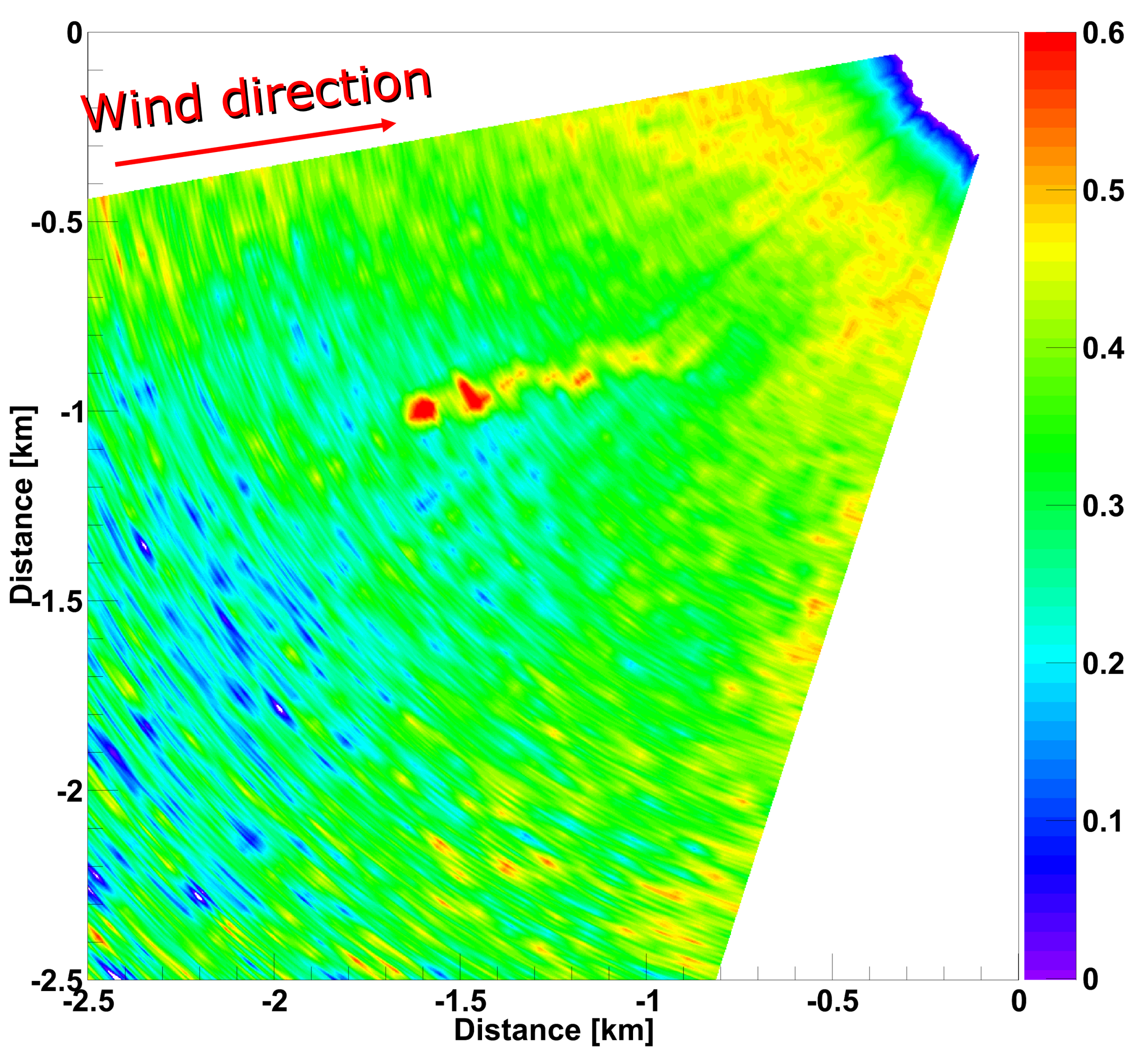
Satellite view of the scanning region (white shadow) and the lidar site (45.96°N, 13.64°E, 305m a.s.l., 220m above the town). The border between Slovenia and Italy is drawn with full yellow line.

Transmitter	Big Sky CFR400
Wavelength	1064 nm
Pulse energy	40 mJ
Repetition rate	10 Hz
Receiver	Newtonian telescope
Diameter	300 mm
Focal length	1500 mm
Detector	EG&G APD
Type	C30954
Voltage	300 V

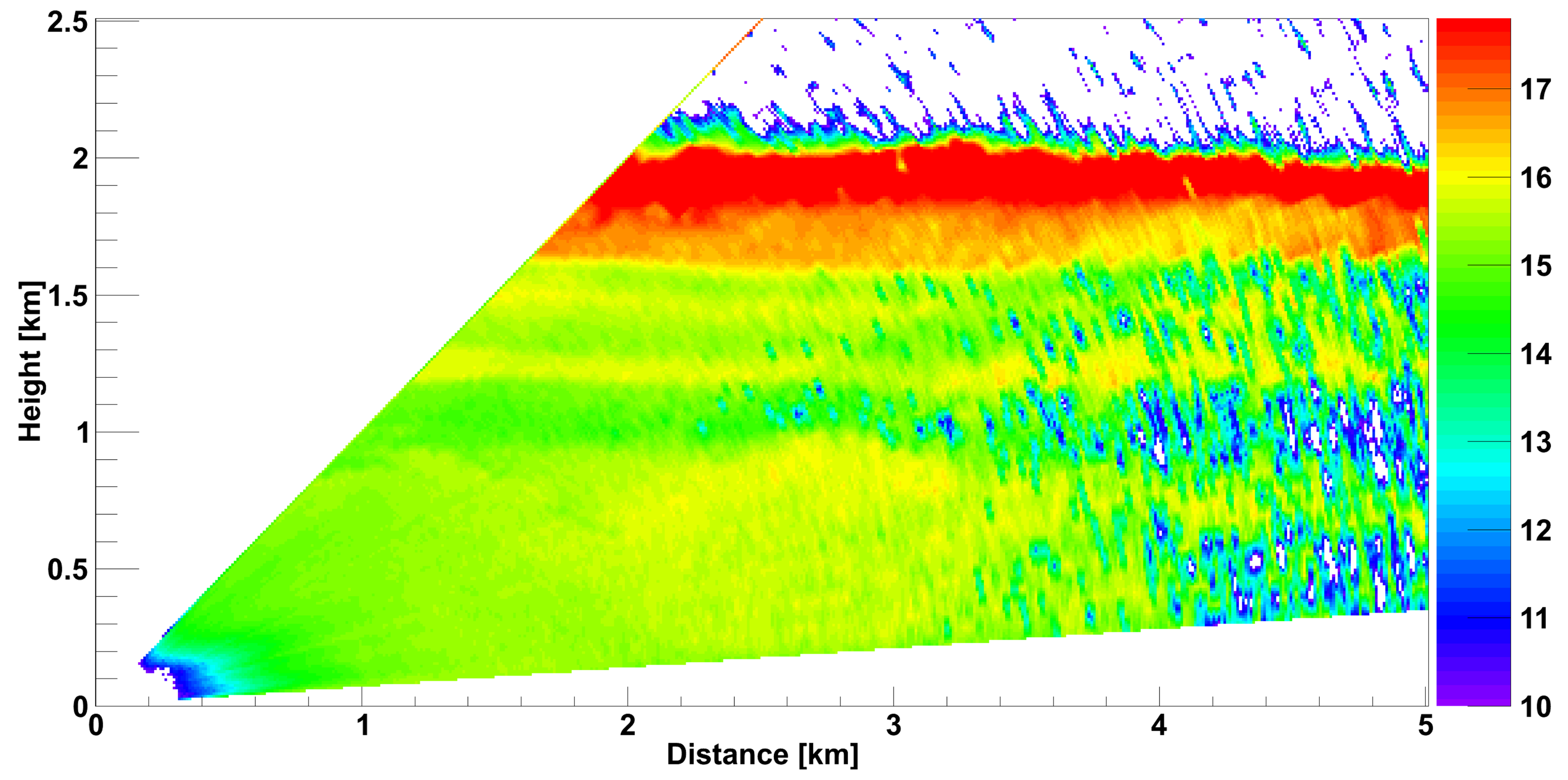
Setup of the lidar system (left) and its specifications (right).

III. Measurements

A time series of horizontal plane position indicator (PPI) scans are performed between 260° and 198° in azimuth with anti-clockwise direction from 9AM to 6PM on 25 April 2010.



Example of a horizontal PPI sector scan from 260° to 198° in azimuth with an angular step of 2°, performed at 11:28 CET on 25 April 2010. Elevated aerosol concentration in the town center was detected and the aerosol dispersion due to the wind conditions can be clearly seen.



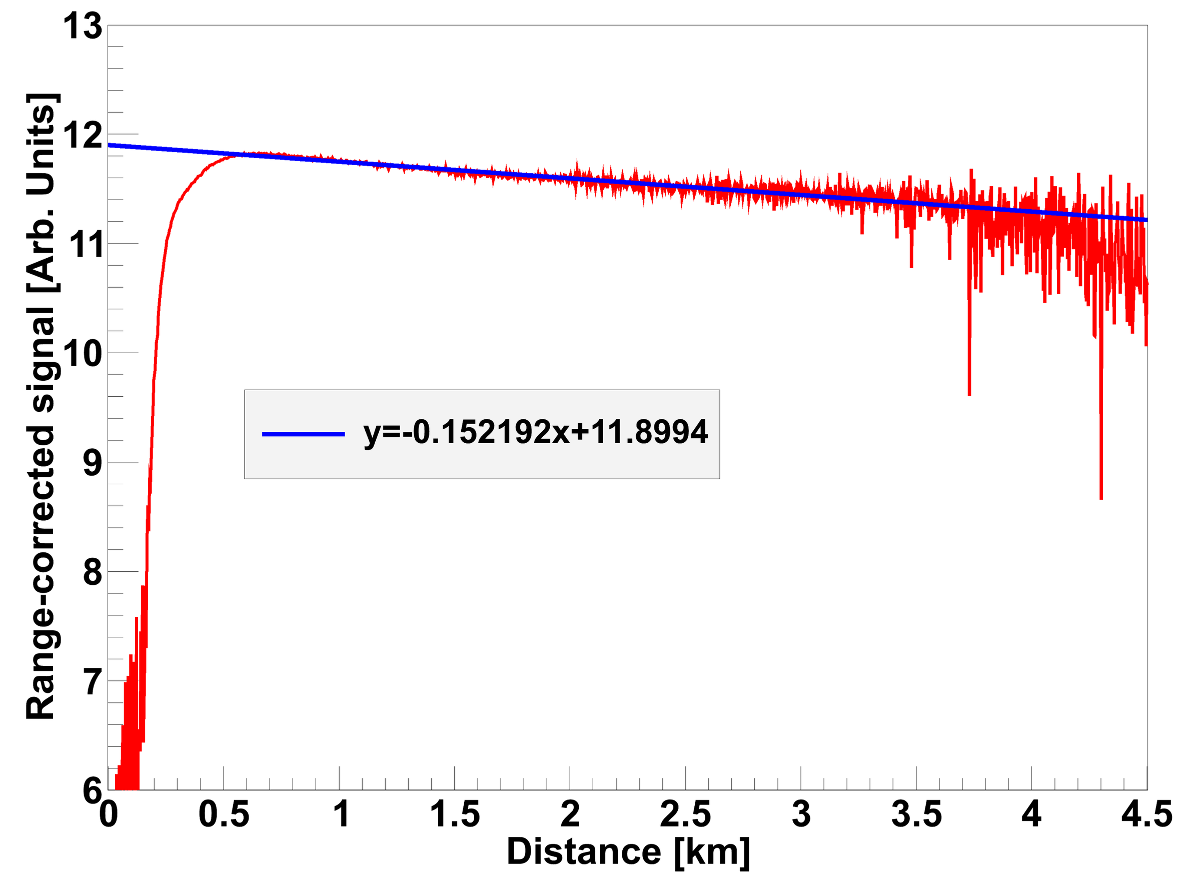
Example of a vertical RHI scan from 4° to 45° with angular step of 1°, performed at 11:03 CET on 24 April 2010. The atmosphere is horizontally stratified from 1km and 2km. At 2km a.s.l. lidar signal is effectively blocked by a layer of clouds.

IV. Retrieval of Extinction Coefficient

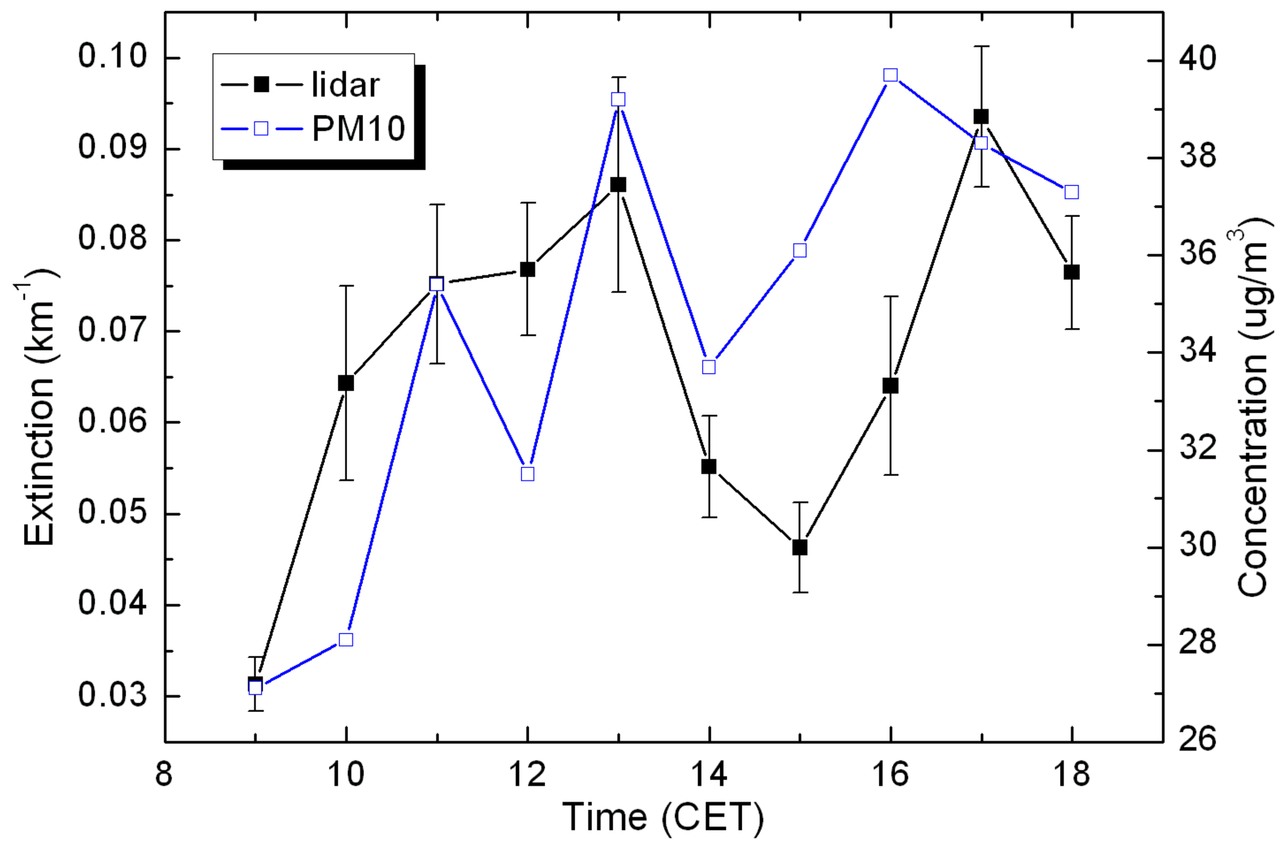
With the assumption of atmospheric homogeneity, the horizontal atmospheric extinction can be obtained with the slope method,

$$\sigma = -\frac{1}{2}\frac{dS(z)}{dz}$$

where $S(z) = \ln C\beta(z) - 2\int_0^z \sigma(z')dz'$.



Averaged range-corrected signal for horizontal measurements, with the apparent nonlinear data excluded. The line y=-0.152192+11.8994 is a result of least squares linear fit to the data between 0.8 and 3.5 km. With the slope method, horizontal atmospheric extinction coefficient is 0.076 km^{-1}. The full overlap is reached at approximately 0.7 km.



Comparison of the measured horizontal atmospheric extinction and the aerosol concentration of PM_{10} during the daytime on 25 April 2010. The trends in two independent data are in good agreement, with a small offset, which is possibly due to the displacement of 220m in altitude between lidar measurements and PM_{10} measurements.

V. Discussion and Conclusions

1. Aerosol concentration in Nova Gorica manifests local peak around noon, brief decrease in the early afternoon and then an increase towards its daily peak around 5PM.
2. Spatially localized temporal variations of the lidar return signal were observed, which are a result of the presence of point sources of particulate matter.
3. The detectable range (5 km) and overlap correction of the scanning mobile lidar (0.7 km) were estimated.

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