Einflüsse meteorologischer Parameter und der Mischungsschichthöhe auf die Luftbelastung in urbanen Regionen

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- Objectives
- Tasks, methodology
- Results
- Conclusions

Objectives

- Influence of meteorological parameters and atmospheric layering (especially MLH) on exchange processes of ground level emissions

- Application of ceilometer monitoring information for MLH to interpret air pollution near ground in Essen

- Measurements of Benzene, Toluene and Isoprene (VOCs with quite different reactivity) and use of further air pollutant concentration data in Essen

- Strongest MLH influence: half-hourly-mean or maximum values

Schäfer, K., Emeis, S., Hoffmann, H., Jahn, C.: Influence of mixing layer height upon air pollution in urban and sub-urban area. Meteorol. Z. 15 (2006), 647.

Tasks

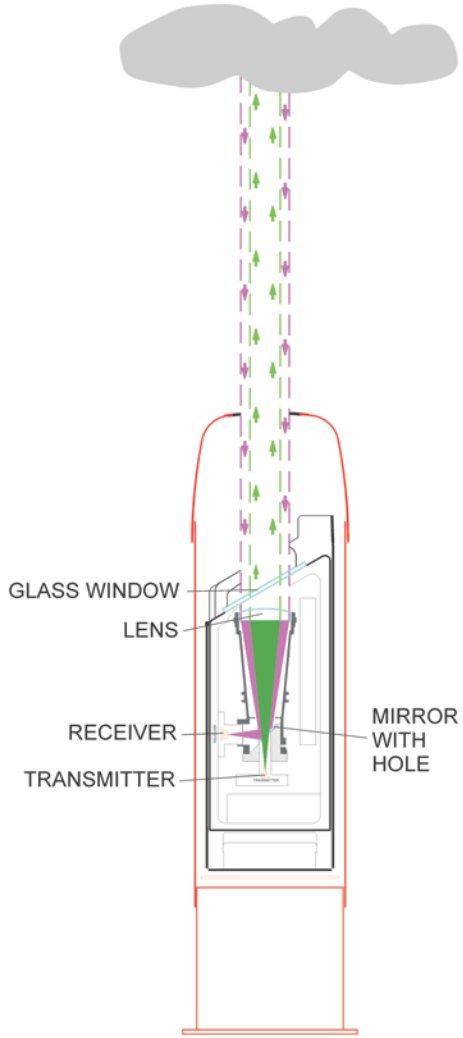
Measurements of meteorological parameters and air pollutant concentrations: 28/12/2011-17/04/2012, VOC 28/02-28/03/2012

- MLH: Software developed with MATLAB (*Vaisala, IMK-IFU)* for CL51 at *UDE* Campus Essen, radiosondes *DWD* station Essen
- VOC concentrations: kerb site Gladbecker Str. *(UDE)*
- NO, NO_x and PM_{10} concentrations of LANUV Nordrhein-Westfalen (LANUV): kerb site Gladbecker Str.

Correlations of continuous MLH data with air pollutant concentrations (*UDE, IMK-IFU*)

Emeis, S., Schäfer, K.: Remote sensing method to investigate boundary-layer structures relevant to air pollution. Boundary Layer Meteorology 121(2006), 377.

CL 51 ceilometer



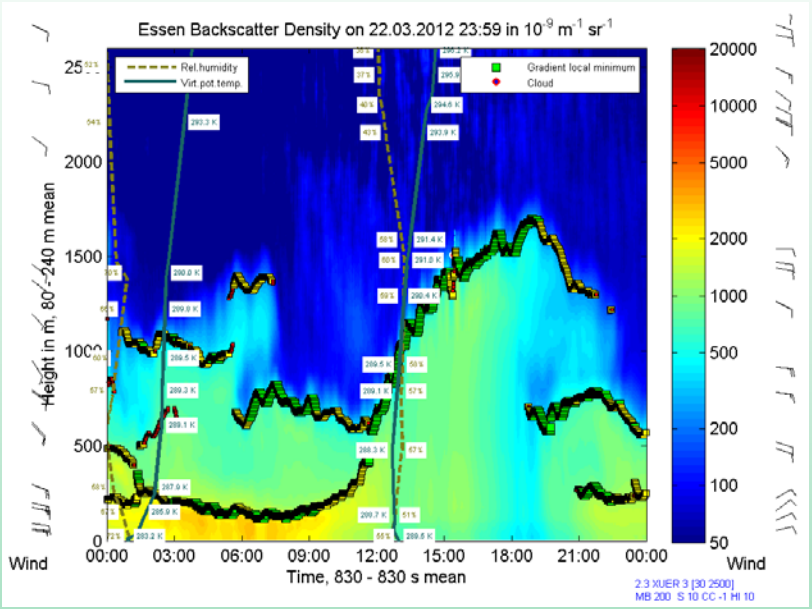
Typical range resolution for boundary layer	10 m
Backscatter profile range	Up to 15000 m
Range for boundary layer profiling	Up to 4000 m
Laser wavelength	910 nm

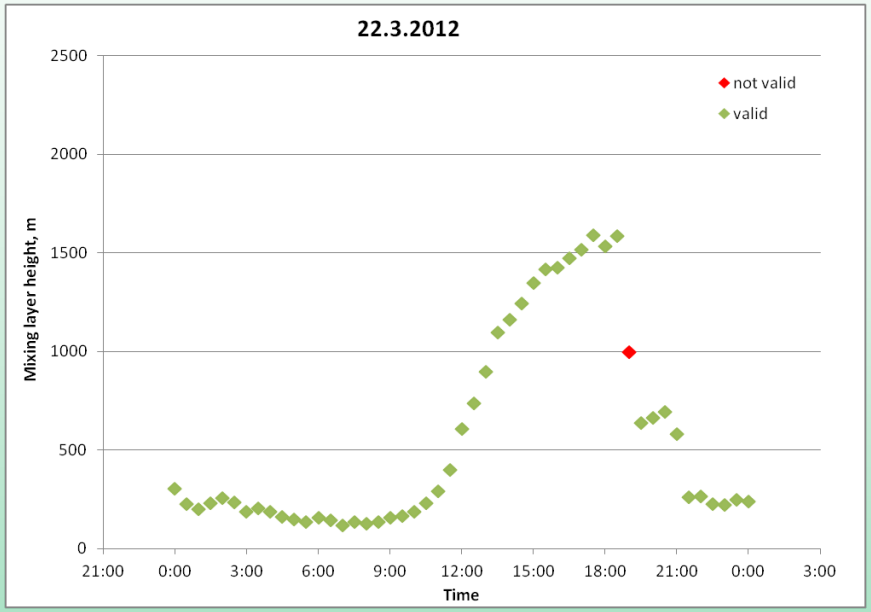
One-lens design – complete overlapping (Vaisala)

Continuous monitoring by uninterrupted remote sensing

Gradient method for MLH determination

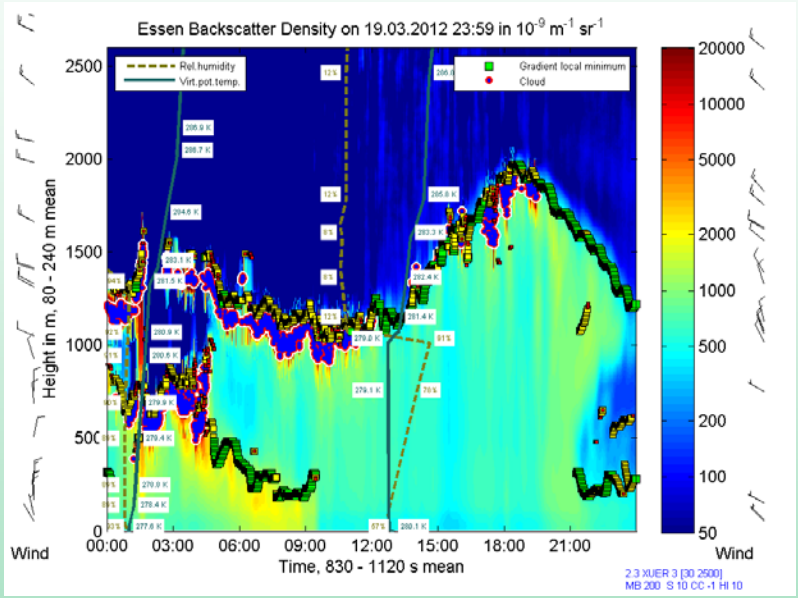
Ceilometer and radiosonde measurements in Essen

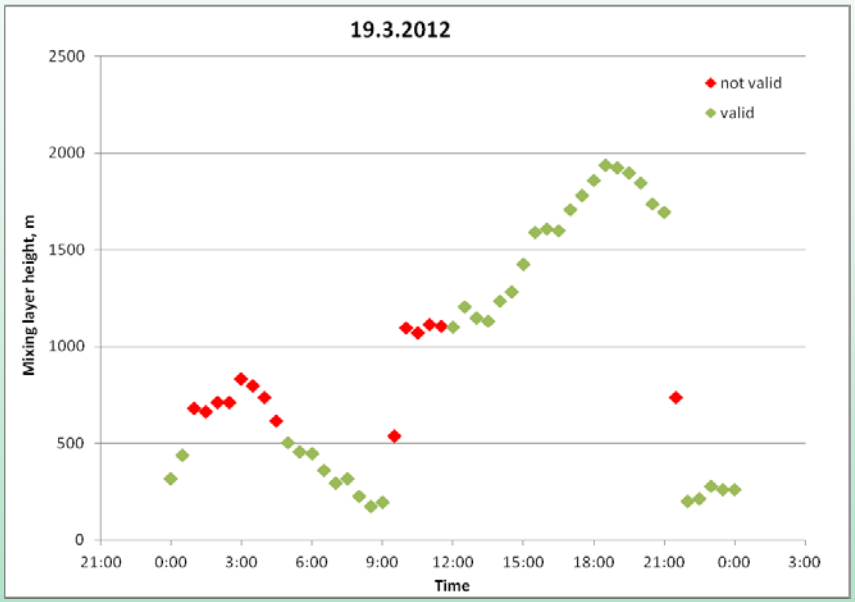




Residual layer during late night, increasing MLH during day-time, formation of a near surface layer during evening

Ceilometer and radiosonde measurements in Essen

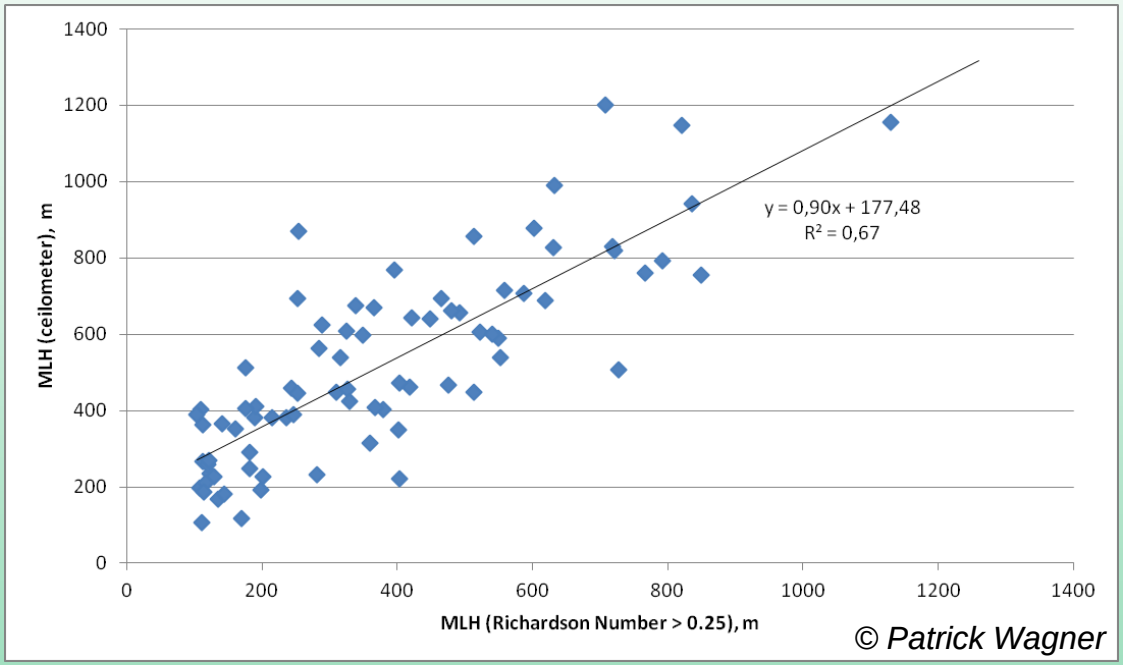




Time frames with low clouds excluded, cloud upper boundary taken as layer upper boundary from about 17:00 till 20:00,

no time periods with high variability of MLH (e.g. abrupt rise due to solar heating, formation of nocturnal inversion)

Comparison of mixing layer height measurements from ceilometer and radiosonde



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Deviations might be caused by:

1. Complex particle gradient structure affecting ceilometer MLH retrieval
2. Short-term stable layers affecting radiosonde measurements (threshold $Ri_c = 0.25$ used for MLH determination)
3. Urban heat island (city centre: ceilometer; suburban site: radiosonde)

Methodology

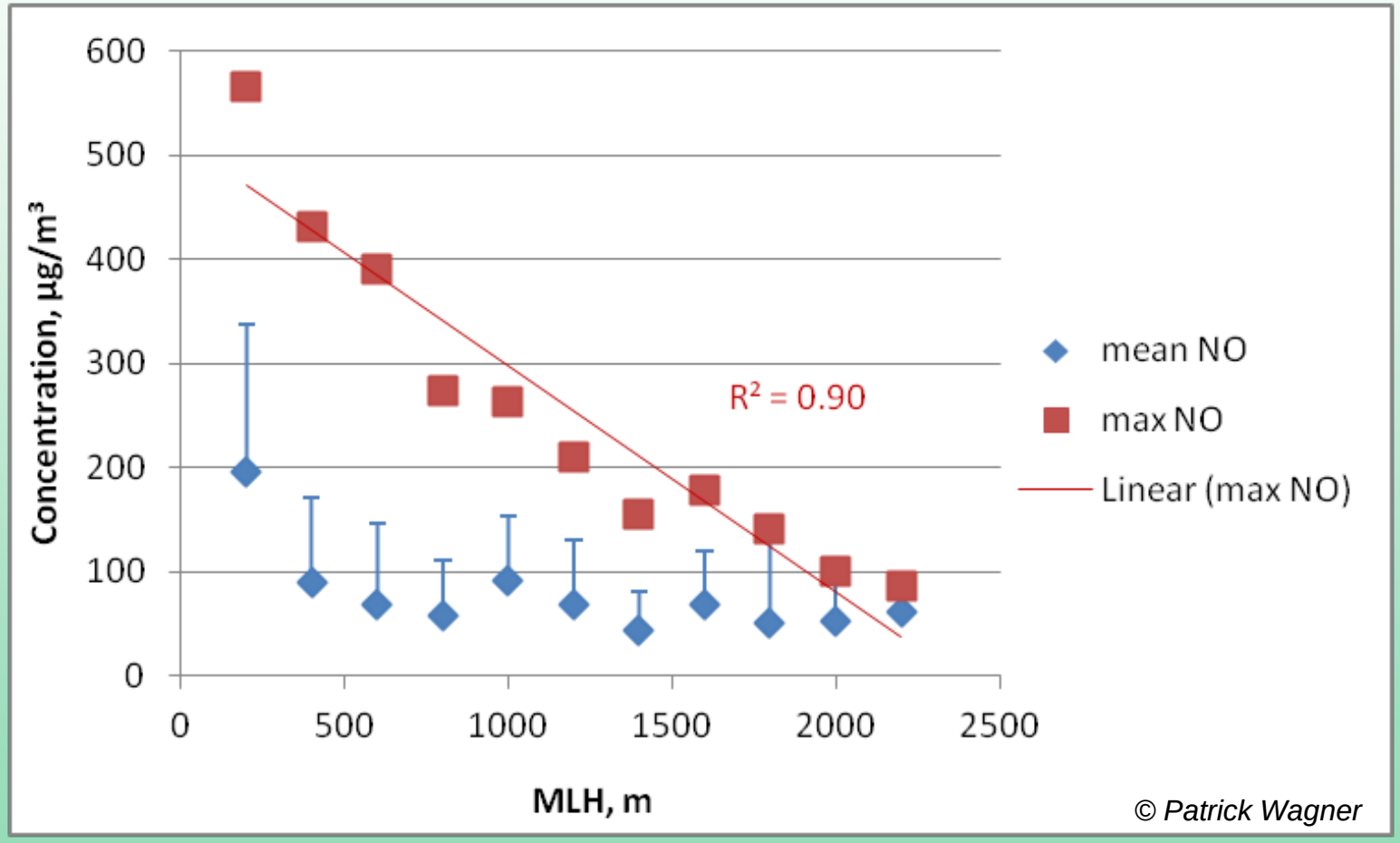
- MLH: classification scheme of Sturges: K = 1 + 3.32 log N, where K number of classes and N total number of observations

- 11 classes and a class width of 200 m intervals of MLH (200 m – 2200 m) instead of original 10 m intervals used for correlation analyses

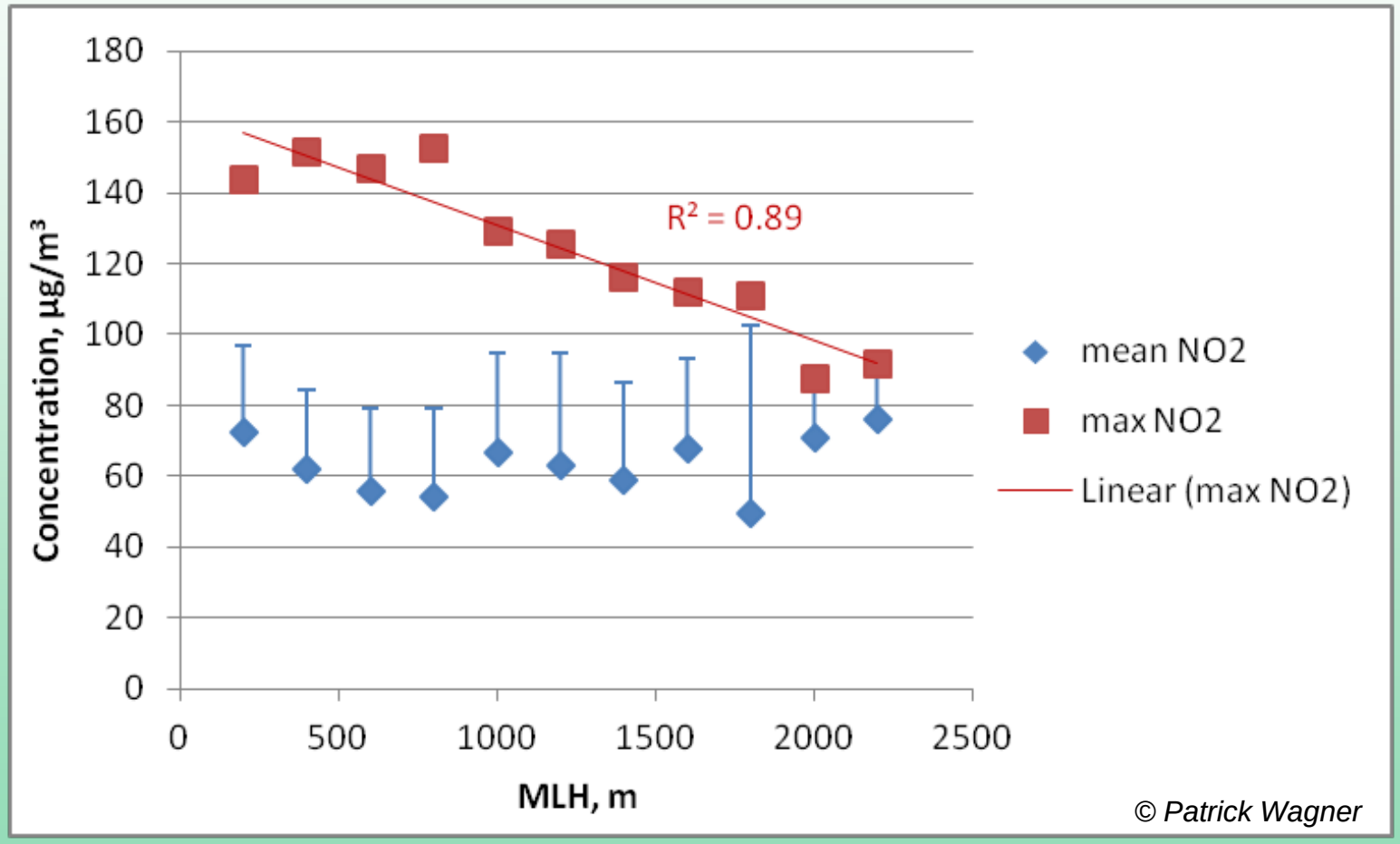
- Benzene, Toluene, Isoprene concentrations: every half hour by gas-chromatograph GC955 from Synspec b.v. during 20 min

- Enriched on Tenax GR before analyzed by GC-PID system

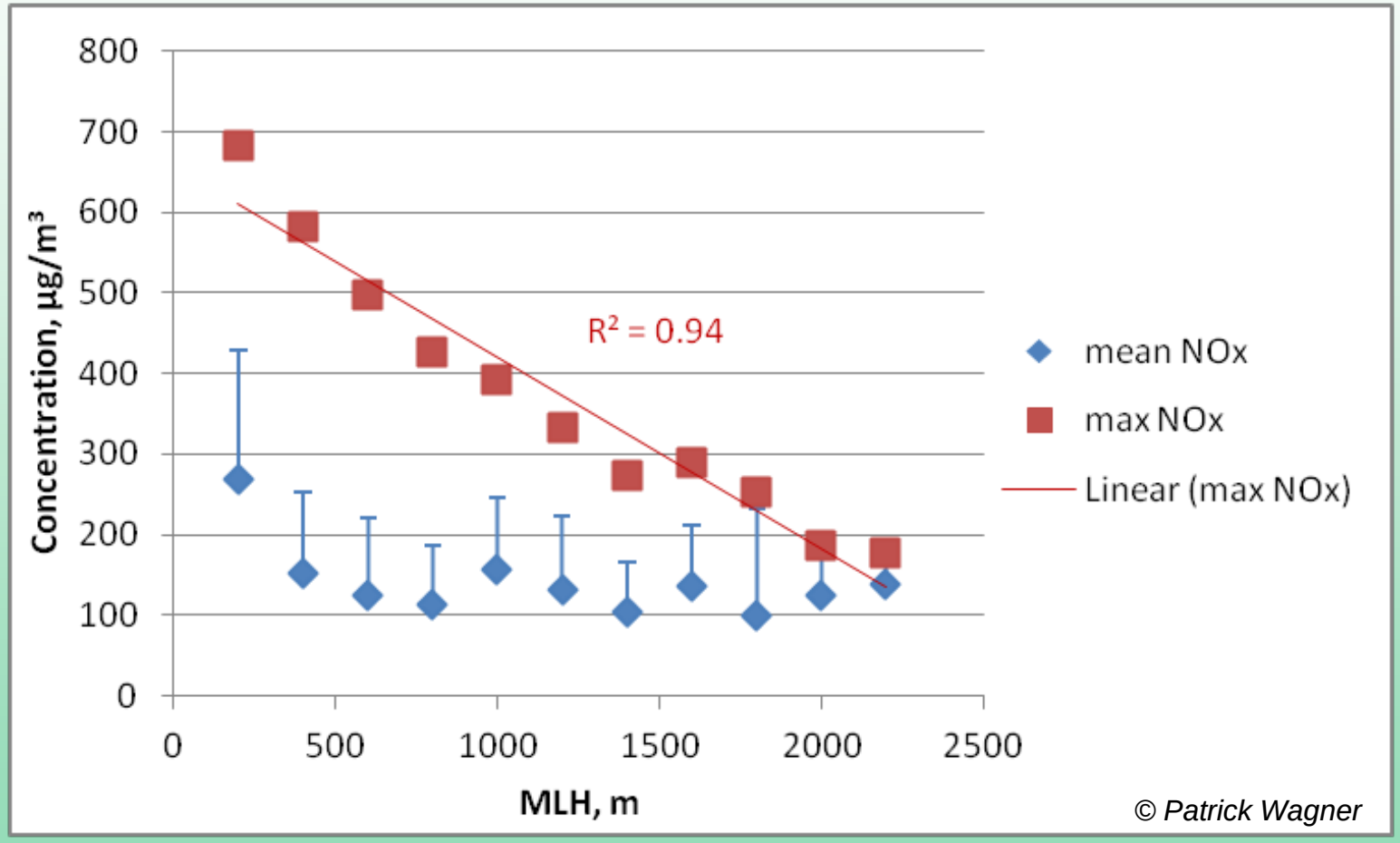
Correlation of NO concentrations with mixing layer height (Essen, Gladbecker Str.)



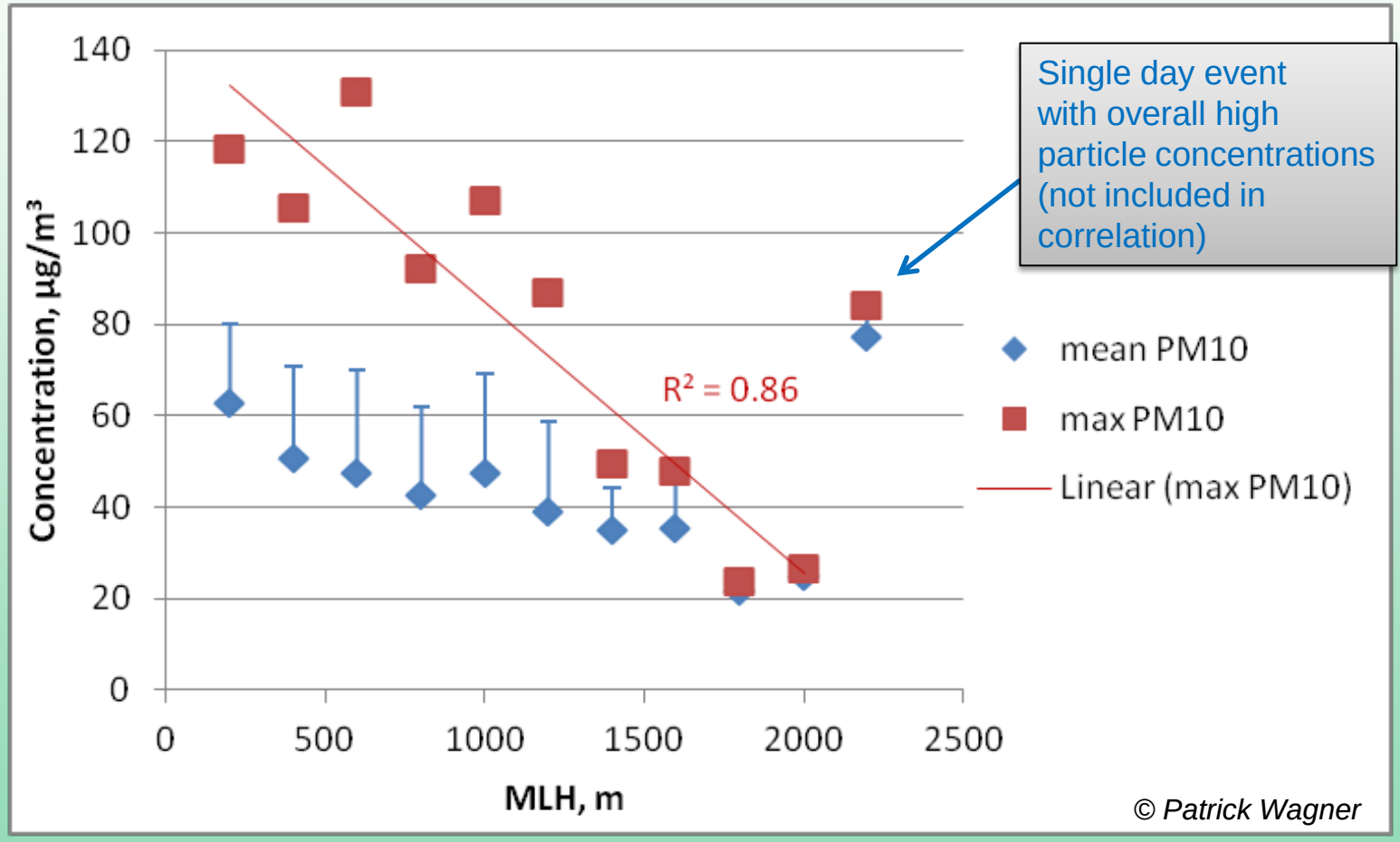
Correlation of NO_2 concentrations with mixing layer height (Essen, Gladbecker Str.)



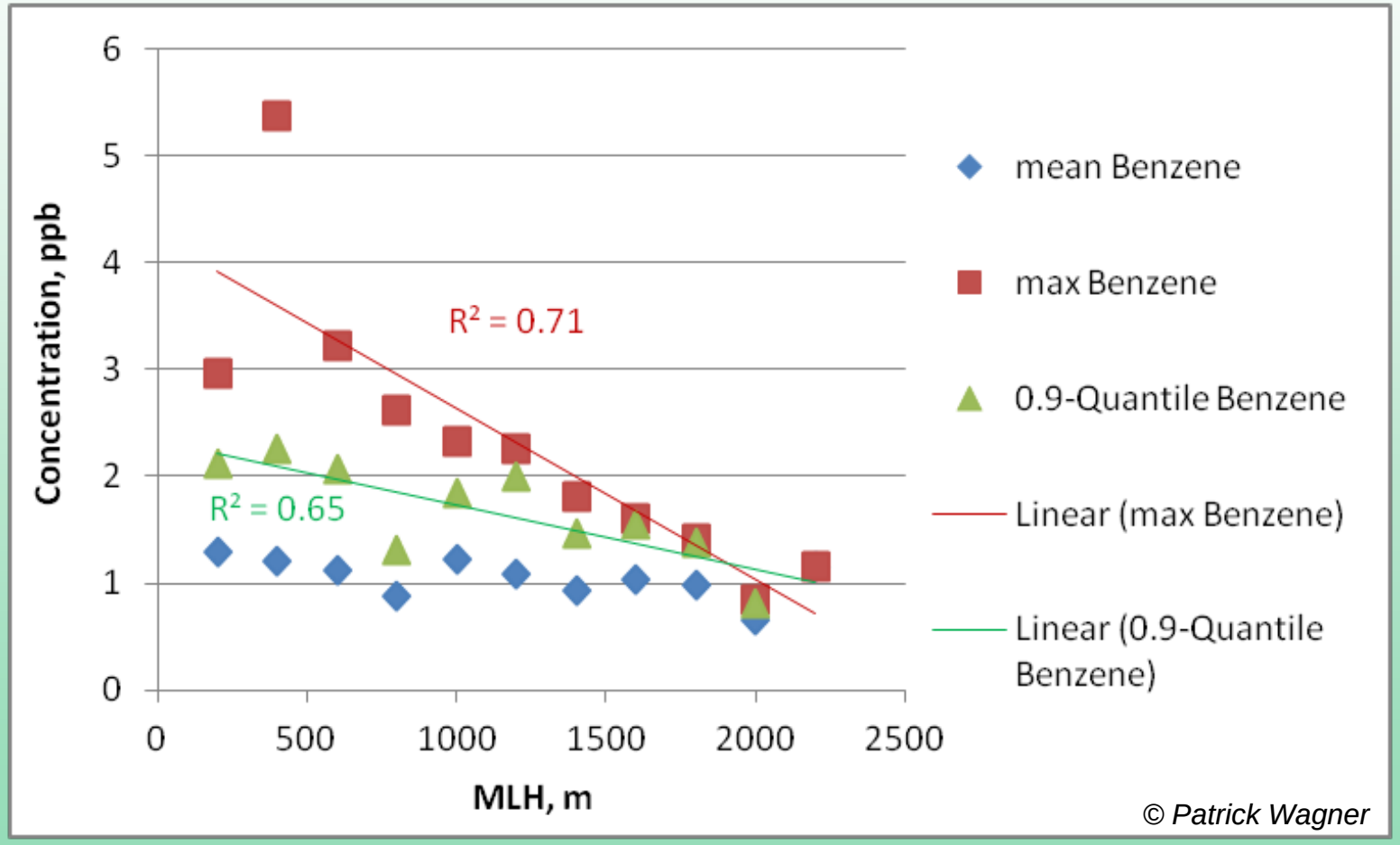
Correlation of NO_x concentrations with mixing layer height (Essen, Gladbecker Str.)



Correlation of PM_{10} concentrations with mixing layer height (Essen, Gladbecker Str.)



Correlation of Benzene concentrations with mixing layer height (Essen, Gladbecker Str.)



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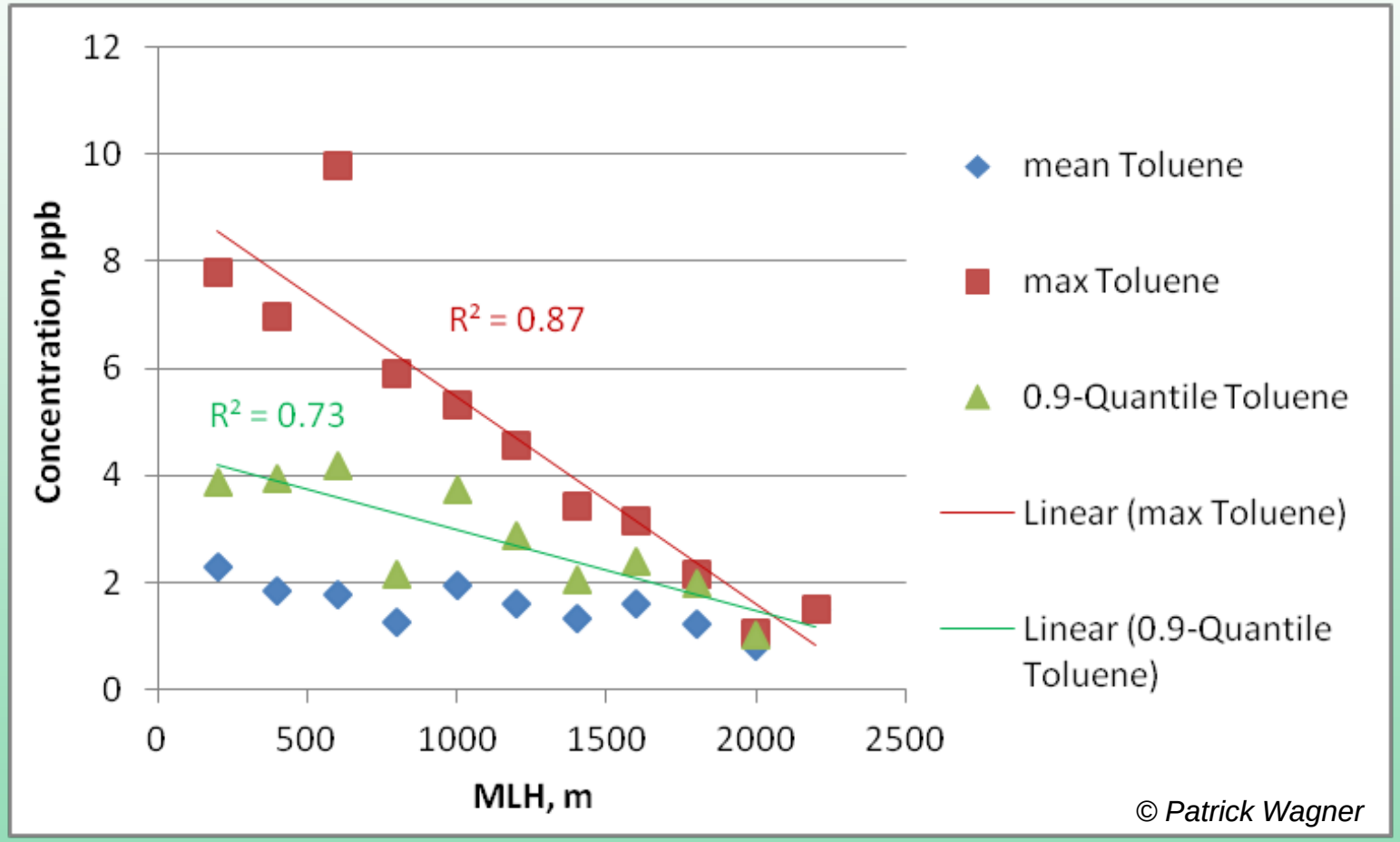
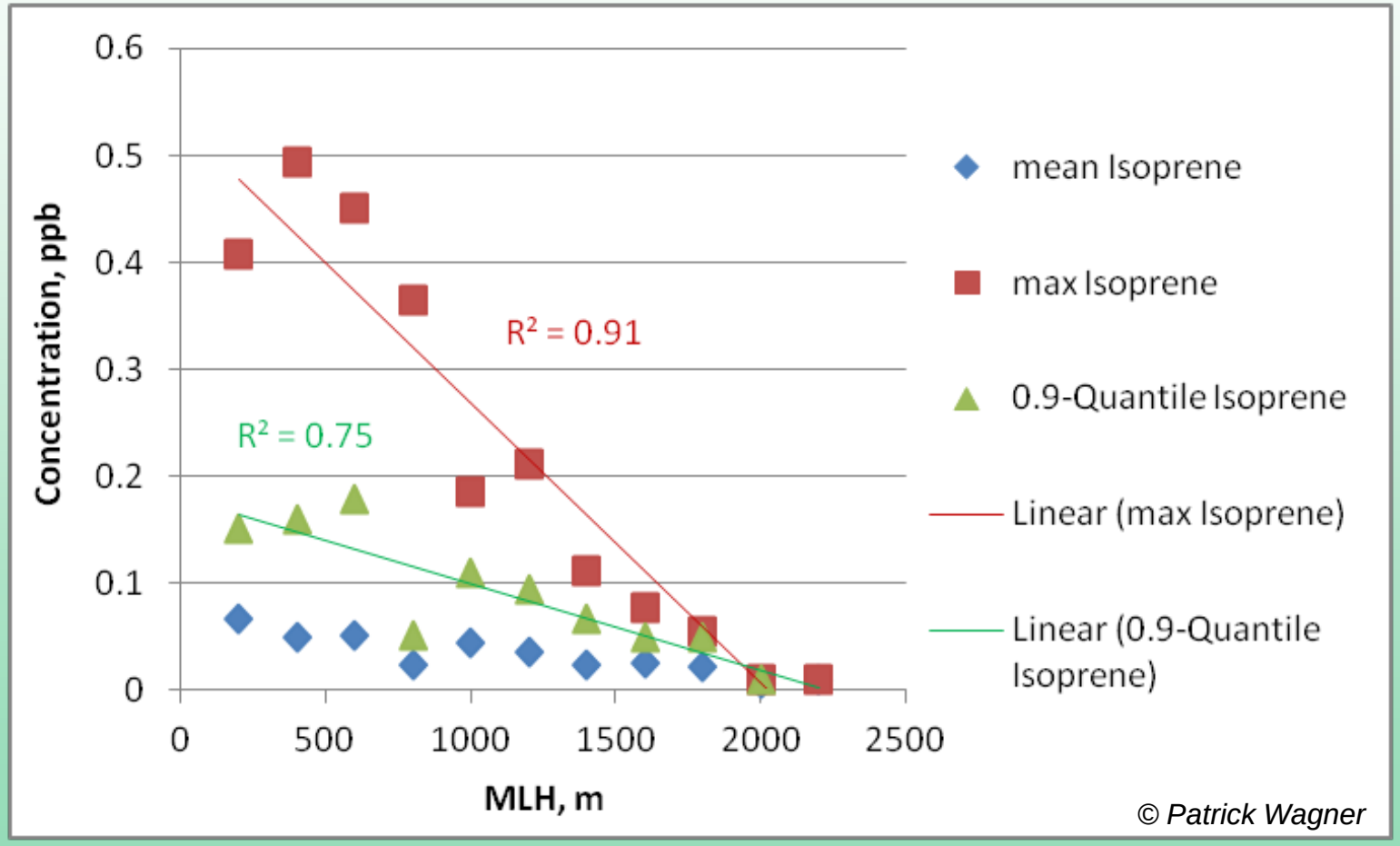
Correlation of Toluene concentrations with mixing layer height (Essen, Gladbecker Str.)



Correlation of Isoprene concentrations with mixing layer height (Essen, Gladbecker Str.)



Conclusions

- Mainly maximum concentration of pollutant at kerb site affected by MLH
- Best results for 200 m intervals of MLH
- Important part of variance of observed maximum NO, NO_2, PM_{10}, Benzene, Toluene, Isoprene concentrations in street canyon in Essen caused by MLH - as for mean concentrations in urban and rural background (Munich, Hannover, Augsburg, Budapest)

Alföldy, B., Osán, J., Tóth, Z., Török, S., Harbusch, A., Jahn, C., Emeis, S., Schäfer, K.: Aerosol optical depth, aerosol composition and air pollution during summer and winter conditions in Budapest. Science of the Total Environment 383, 1-3 (2007), 141-163, doi: 10.1016/j.scitotenv.2007.04.037.

Schäfer, K.; Emeis, S.; Schrader, S.; Török, S.; Alföldy, B.; Osan, J.; Pitz, M.; Münkel, C.; Cyrys, J.; Peters, A.; Saragiannis, D.; Suppan, P.: A measurement based analysis of the spatial distribution, temporal variation and chemical composition of particulate matter in Munich and Augsburg. Meteorologische Zeitschrift, 21, 1, 47-57 (2011); DOI 10.1127/0941-2948/2011/0498.

Karlsruhe Institute of Technology

Thank you very much for your attention