

Airborne measurements of fine and ultrafine particle concentrations by using a multicopter system

Fischer C.; Kramer T.; Lange M.; Pohl T.; Amend D.; Weber K.

Motivation

It is well known from medical studies that fine particulate matter and ultrafine particles can be harmful to human health. The Laboratory of Environmental Measurement Techniques (UMT) of Düsseldorf University of Applied Sciences (HSD) has many years experience in ground based and manned aviation air pollution research and the development of measurement systems. Recently various multicopter systems were equipped with measurement systems to investigate air pollution in the atmosphere at different altitudes.

UFP Measurement near bridge

- Particle Counter (DiSCmini, Testo) for investigation of UFP (0.01 - 0.7 μm).
- Aethalometer (AE51, Magee Scientific) for investigation of BC.
- Aerosolspectrometer (OPC 1.109, Grimm Aerosol Technik) for investigation of PM_{10} , $\text{PM}_{2.5}$ and PM_1

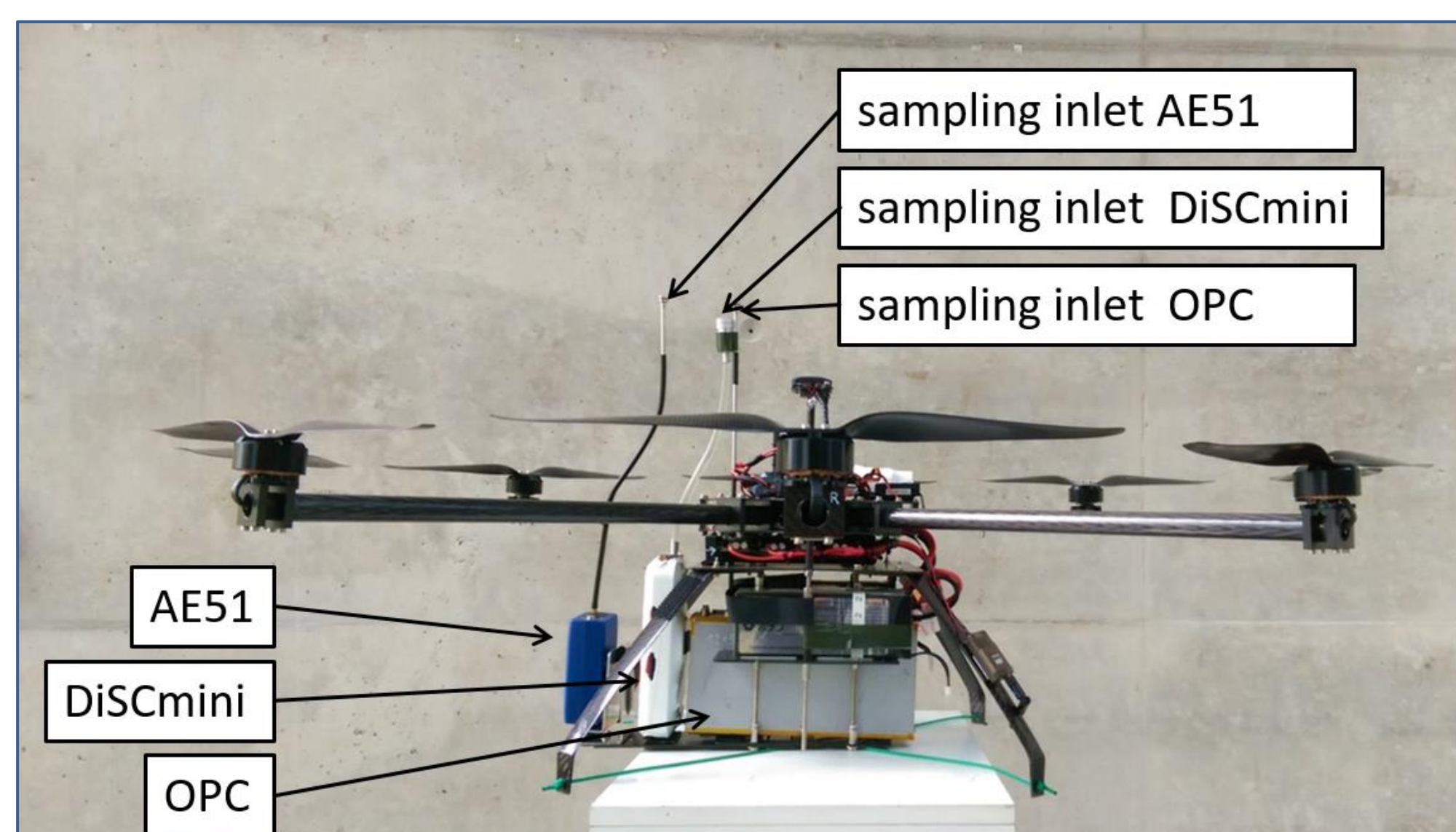


Fig. 1: Multicopter with measurement setup

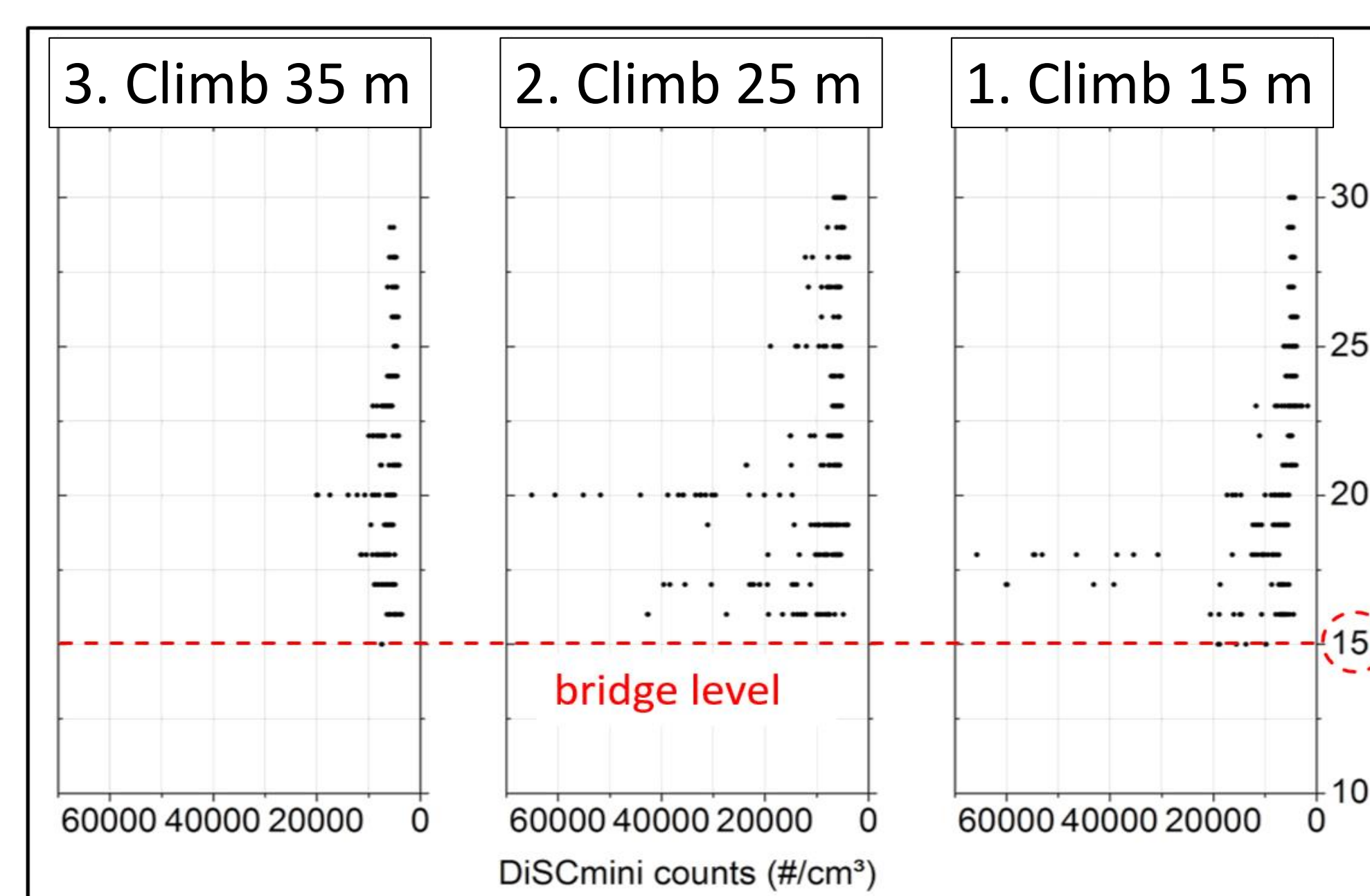


Fig. 2: UFP concentrations during three climbs at different distances. A significant UFP plume caused by the traffic could be detected.

UFP Measurement at Düsseldorf Airport

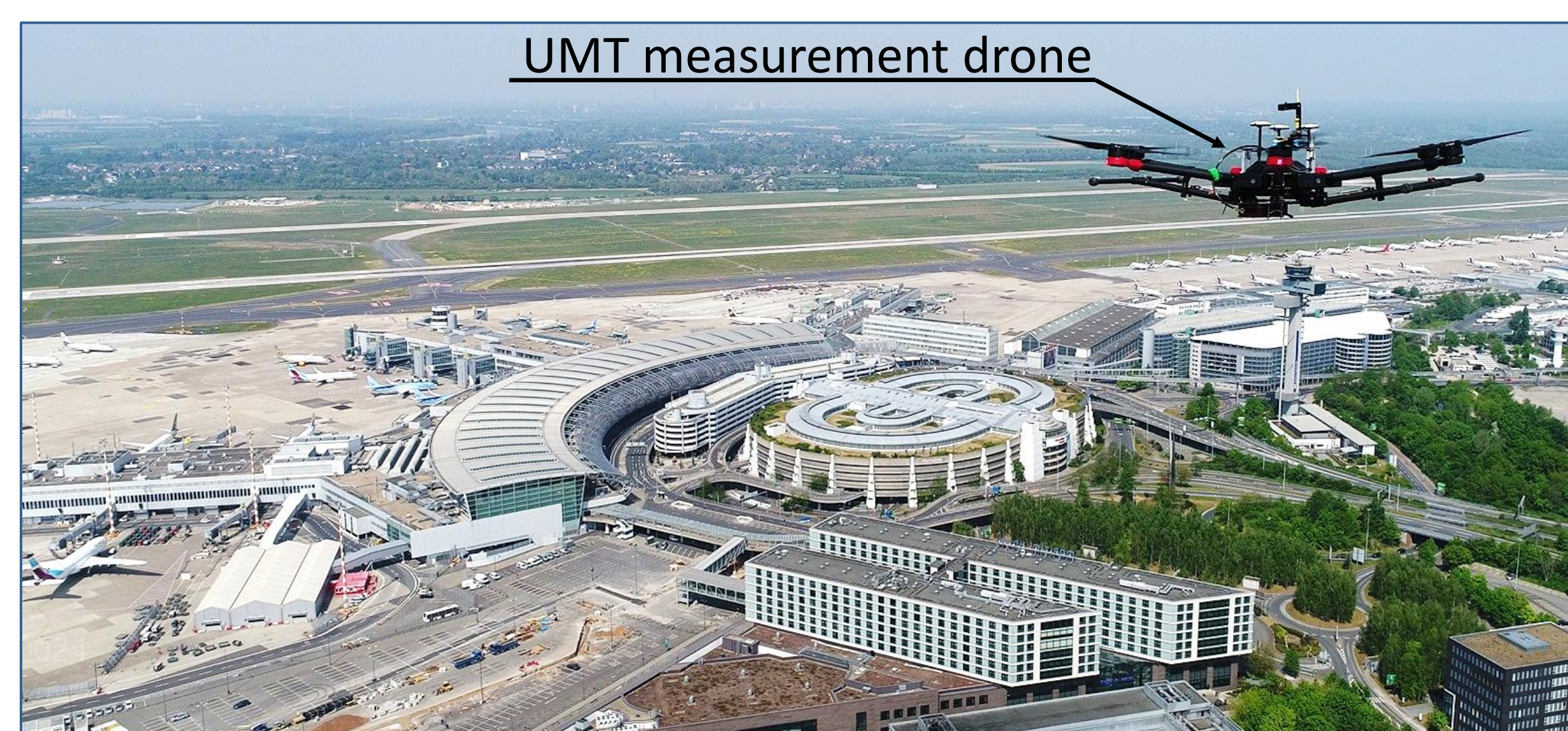


Fig. 3: Vertical UFP profil up to 300 m a.g.l. at Düsseldorf Airport

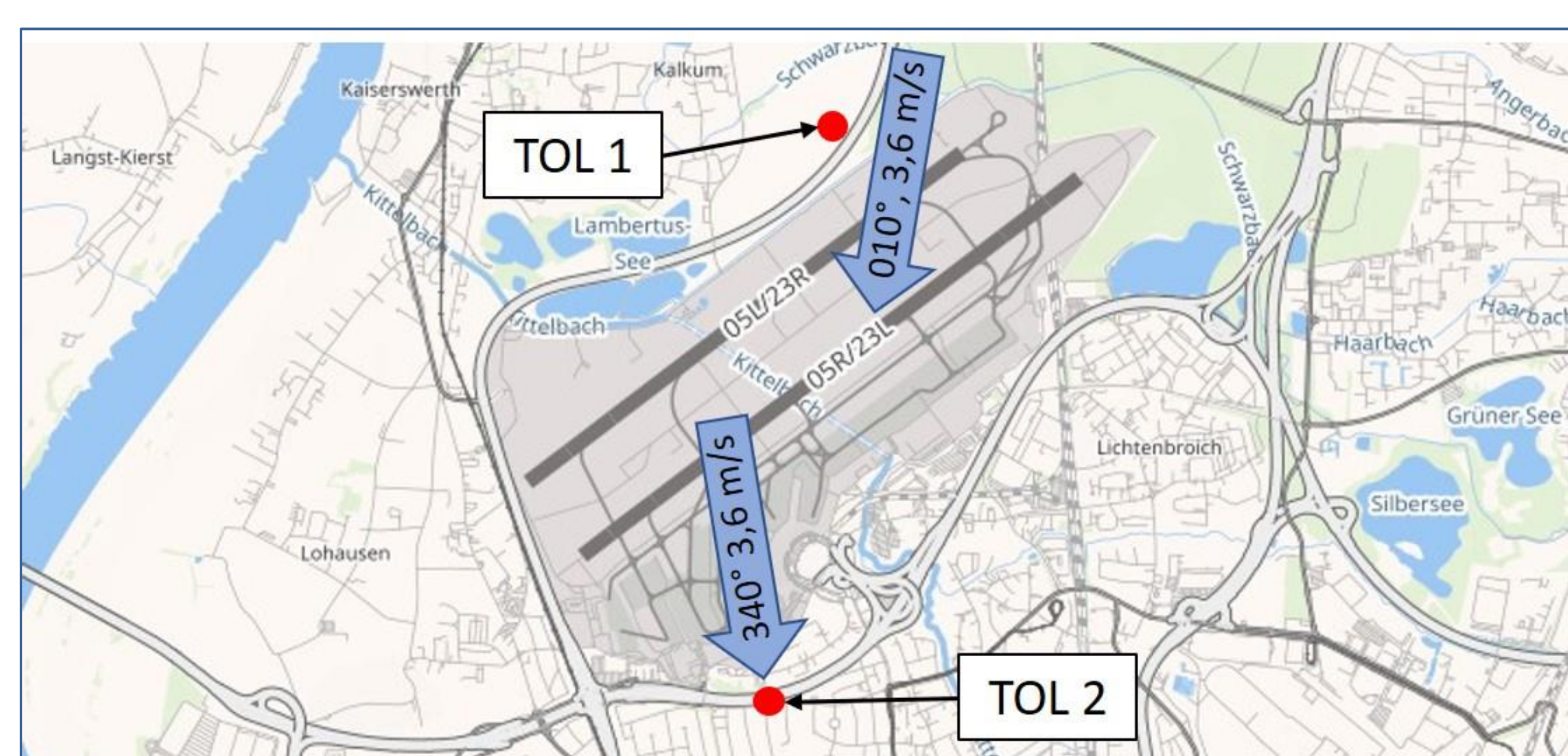


Fig. 4: Take off and landing positions of multicopter in upwind and downwind situations

UFP measurement DUS - 09.06.2020, upwind 10:58 UTC | downwind 11:34 UTC

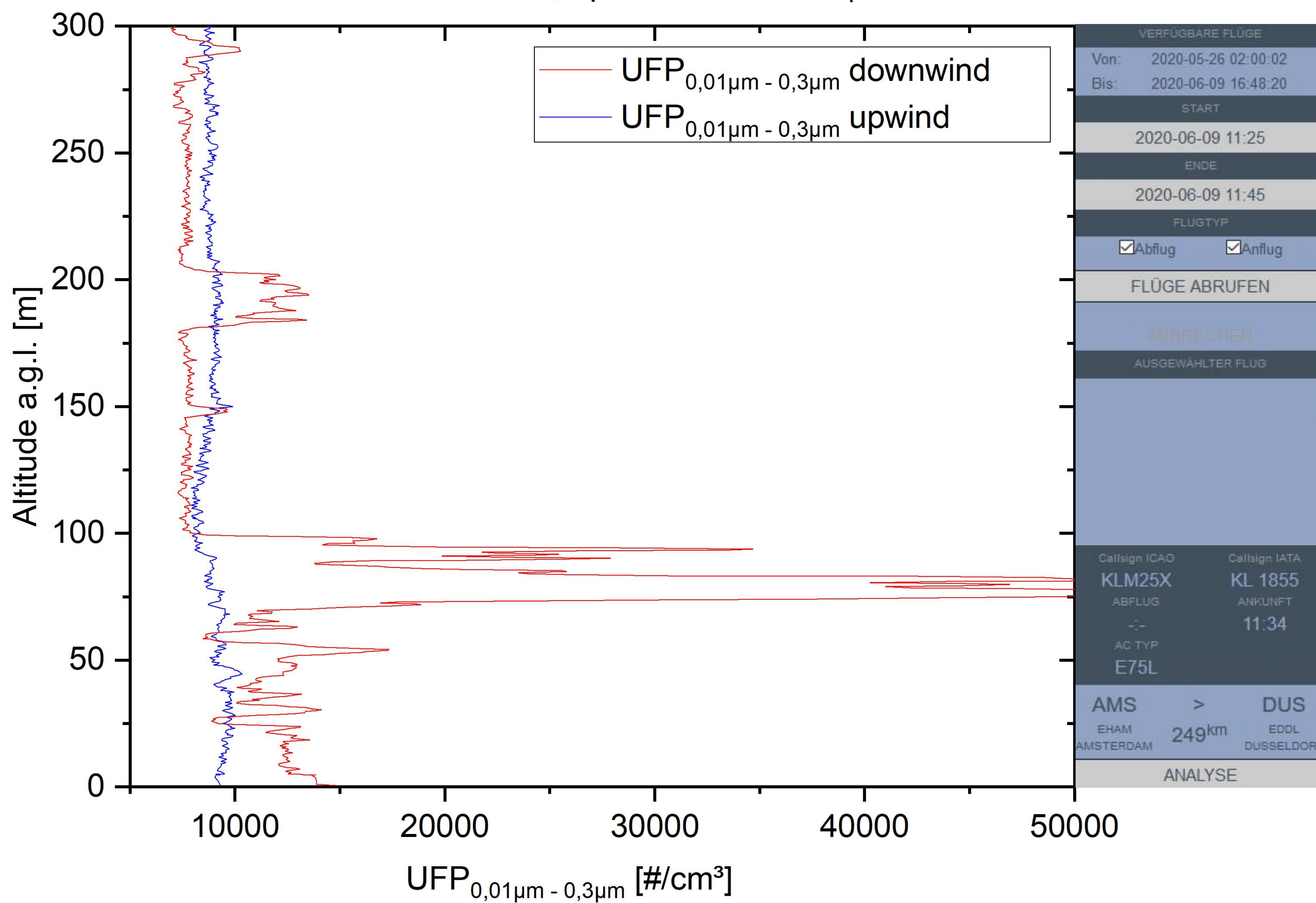


Fig. 5: Difference in UFP concentrations in upwind and downwind situations. Clearly an UFP plume could be detected at an altitude of about 80 m a.g.l. It could be proven that this is caused by an airplane. It was the only airplane shown on the stanley track by the German flight service.

Current Projects



Fig. 6: OPC on tiny drone for industrial indoor-measurements or swarm applications



Fig. 7: Measurement data transmission in real time up to 2 km distance



Fig. 8: Development of mobile system capable for industrial and volcanic SO_2 flux measurements



Fig. 9: First functional prototype of the drop-sonde with CO_2 measurement system and data transmission

Conclusion

Fine and ultrafine particles can be investigated in their vertical distribution by the use of a multicopter system. We were able to prove over the past few years, that the use of drones is a very powerful tool for the measurement of air pollution. Due to the successful measurements, the laboratory is currently working to install new measurement technology to drones. In addition to aerosol measurement, gas sensors are also used in order to investigate fugitive emissions.

References

1. Weber, K., Heweling, G., Fischer, C., Lange, M., The use of an octocopter UAV for the determination of air pollutants – a case study of the traffic induced pollution plume around a river bridge in Duesseldorf, Germany, International Journal of Environmental Science, 2017; <http://www.iasos.org/iasos/journals/ijes>
2. Landeshauptstadt Duesseldorf, Amt für Verkehrsmanagement

Contact

Konradin Weber
Phone: +49-211-4351-3469
konradin.weber@hs-duesseldorf.de

