

# Ultrafine particle concentrations in Kloten near the Zurich Airport (Switzerland)

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**OST**  
**LUFT**

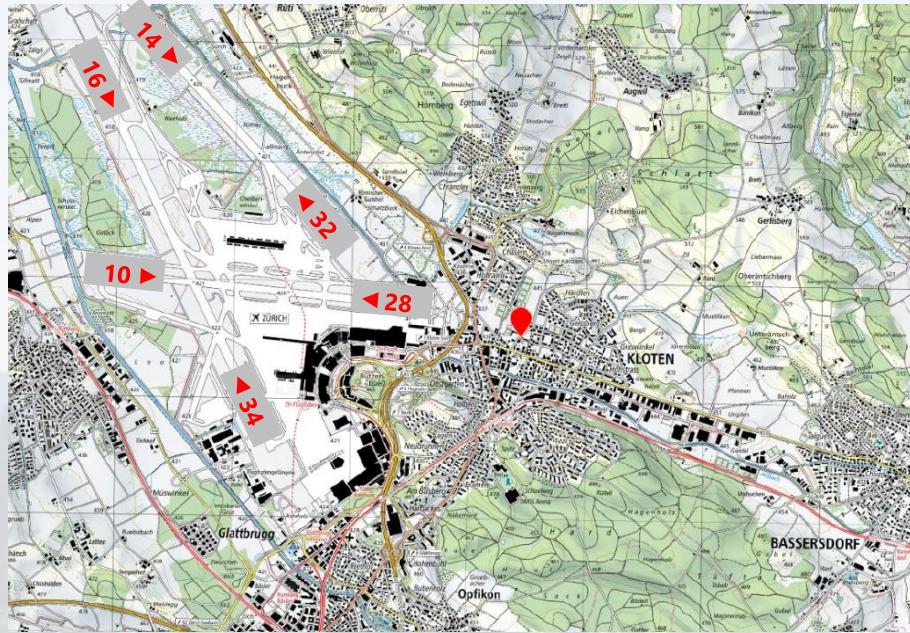
 **Empa**  
Materials Science and Technology

# Ultrafine particle (UFP) concentrations around airports

- UFP number concentrations around airports are clearly higher than at locations distant from airports
- Aircraft emissions are dominated by very small particles (10-20nm)
- See review paper by Stacey et al. *Atmos. Environ.* (2019)
- Situation around Zurich Airport?



# UFP measurements in Kloten next to Zurich Airport

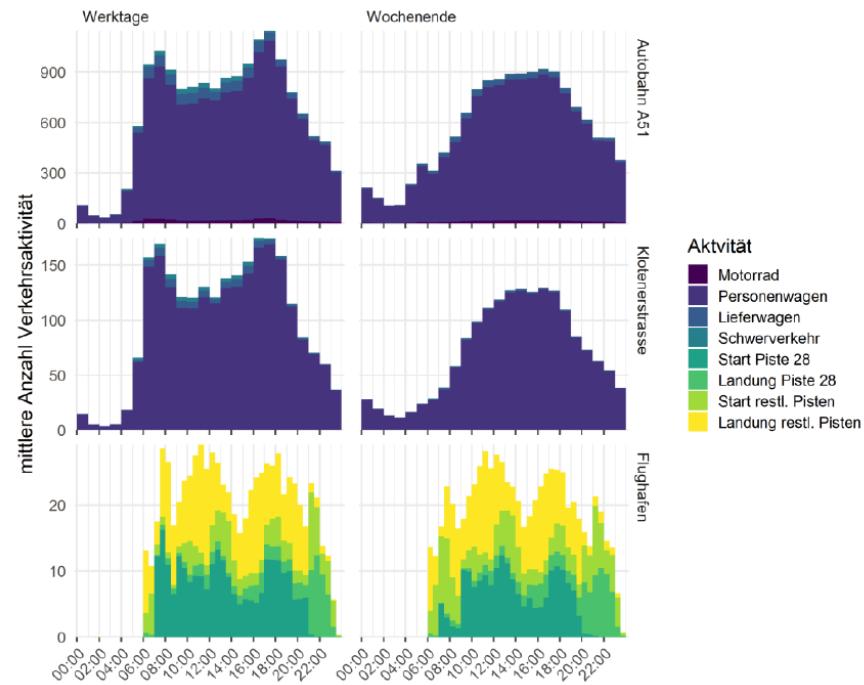


- UFPs defined here as particles in the 10-100nm size range
- UFP (particle size distribution PSD) measurements in Kloten started in February 2019 and are ongoing

# UFP measurements in Kloten next to Zurich Airport

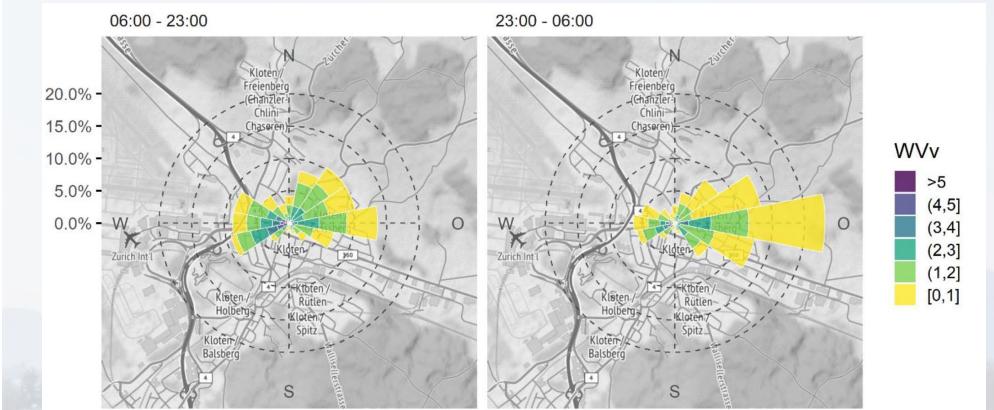
Kloten - Gerlisbergstrasse	SMPS TSI 3034 (10-470nm)	Kloten - Feld	SMPS TSI 3938N89 (5-150nm)
01.01.2019 – 23.02.2020			Seit 01.03.2020
			

# Traffic activity and wind conditions at the measurement site



Aktivität

- Motorrad
- Personenwagen
- Lieferwagen
- Schwerverkehr
- Start Piste 28
- Landung Piste 28
- Start restl. Pisten
- Landung restl. Pisten



Source: Bundesamt für Strassen, Tiefbauamt Kanton Zürich, Flughafen Zürich AG

# Mean UFP number concentrations (PN) in Kloten and other Swiss sites

Site	Site type	Year	PN (#/cm <sup>3</sup> )	Size range	Reference
<b>Kloten-Gerlisbergstrasse</b>	<b>Suburban</b>	<b>2019</b>	<b>20'192</b>	<b>10 - 100 nm</b>	<b>Ostluft (2020)</b>
Basel-Binningen	Suburban	2019	8'793	4 nm – 3 µm	Empa (2020)
Zürich-Kaserne	Urban	2014	12'862	4 nm – 3 µm	Empa (2020)
Zürich-Stampfenbachstrasse	Urban, Traffic	2019	14'272	4 nm – 3 µm	City of Zürich, UGZ
Zürich-Schimmelstrasse	Urban, Traffic	2019	14'953	4 nm – 3 µm	City of Zürich, UGZ
Bern-Bollwerk	Urban, Traffic	2019	16'897	4 nm – 3 µm	Empa (2020)
Haerkingen-A1	Rural, Traffic	2019	22'923	4 nm – 3 µm	Empa (2020)
Zurich Airport, Terminal A	Airport	2019	41'141	7 – 470 nm	Fleuti (2020)

# Dependence of UFP concentration on wind direction and wind speed

## Kloten-Gerlisbergstrasse

weekdays

06:00 – 23:00

weekdays

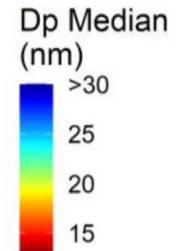
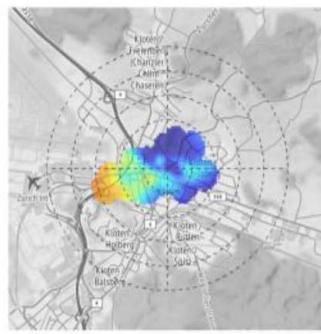
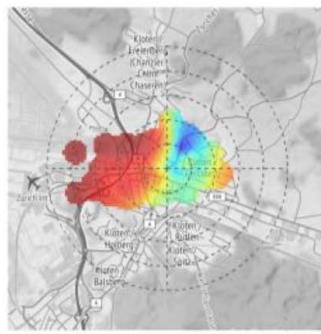
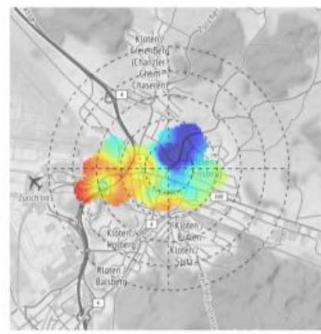
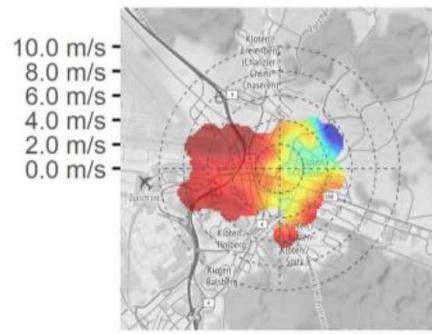
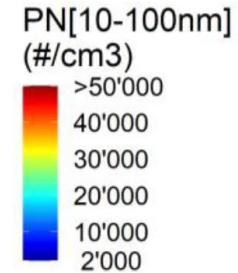
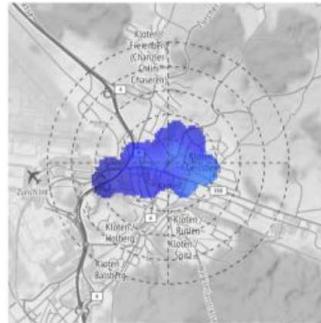
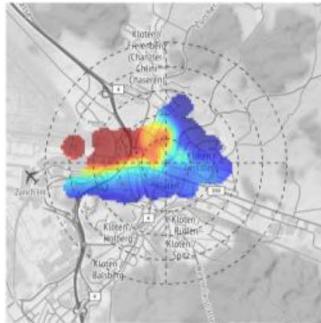
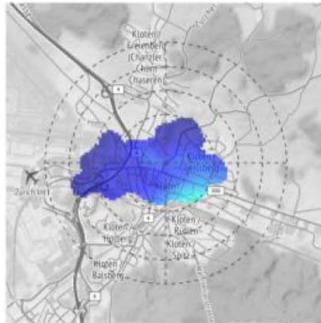
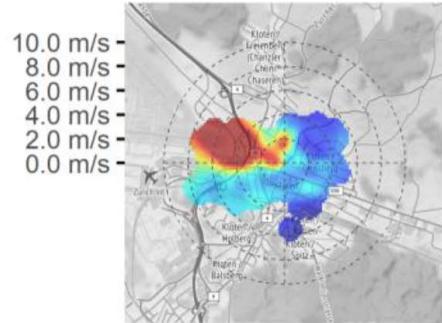
23:00 – 06:00

weekend

06:00 – 23:00

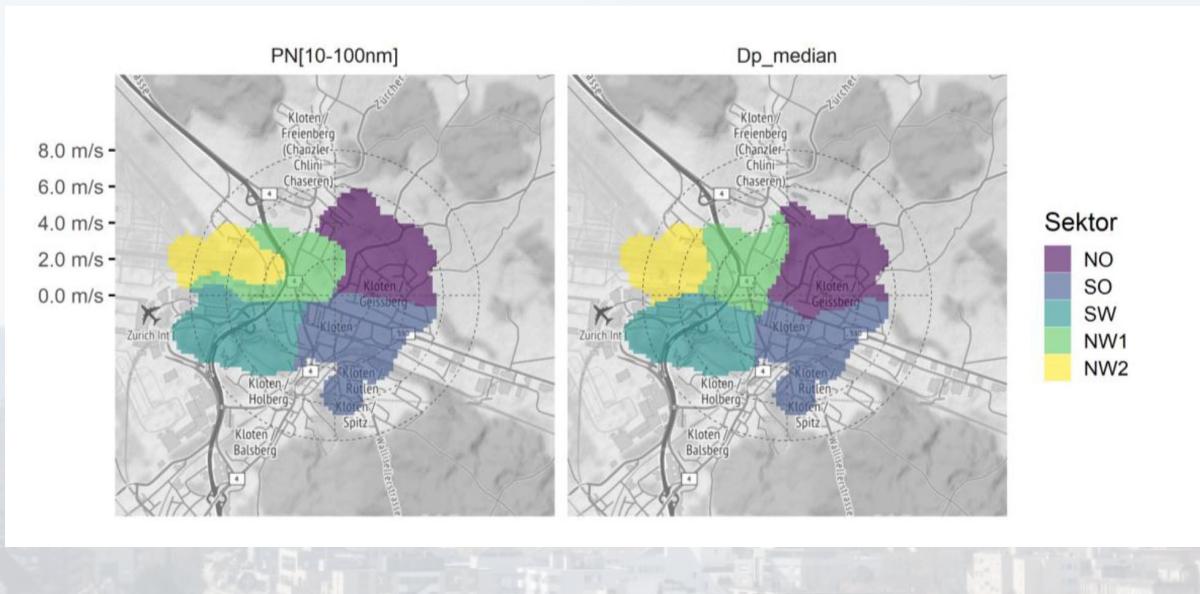
weekend

23:00 – 06:00



# Classification of wind sectors

## Kloten-Gerlisbergstrasse

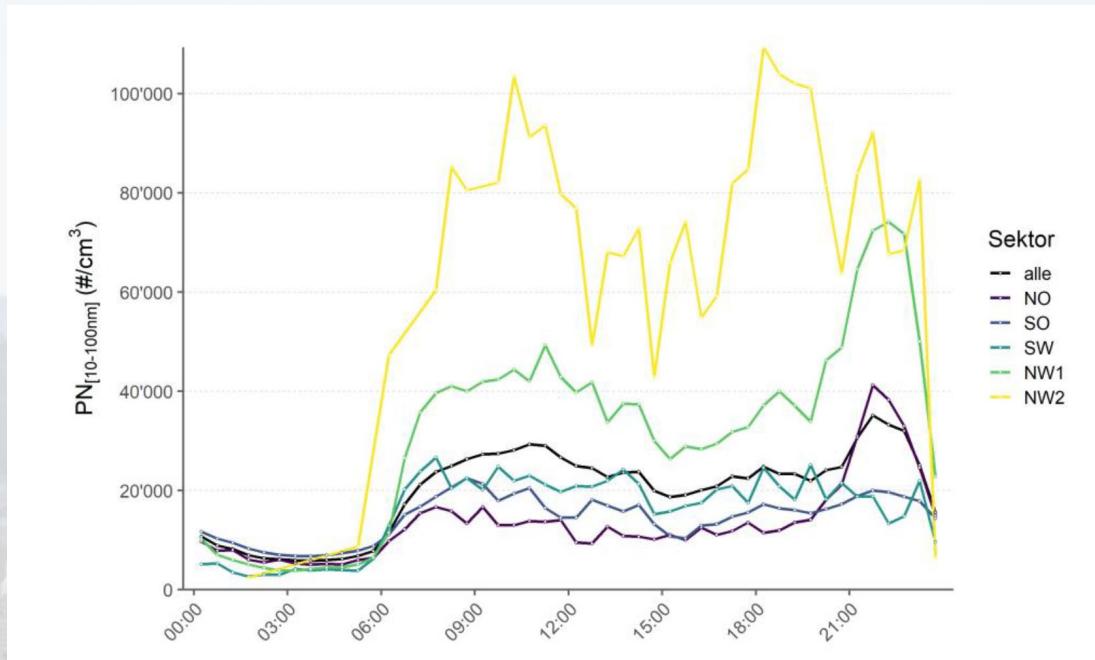


NO  
SO  
SW  
NW1  
NW2

suburban background  
suburban background + local city traffic  
suburban background + local city traffic + motorway A51 (+ airport)  
airport + motorway A51 (+ local city traffic + suburban background)  
airport + motorway A51 (+ local city traffic + suburban background)

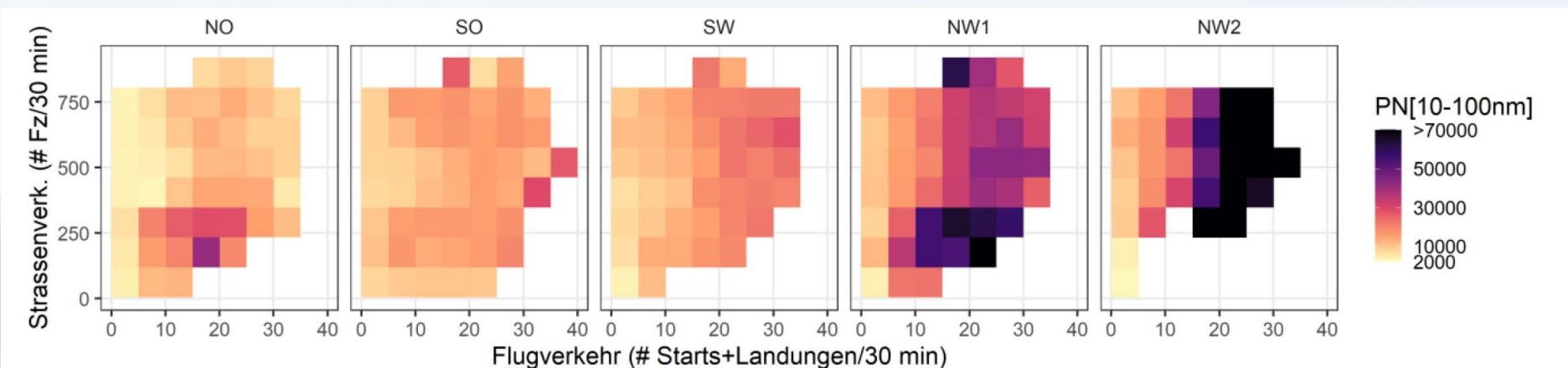
# UFP concentrations for different wind sectors

Kloten-Gerlisbergstrasse



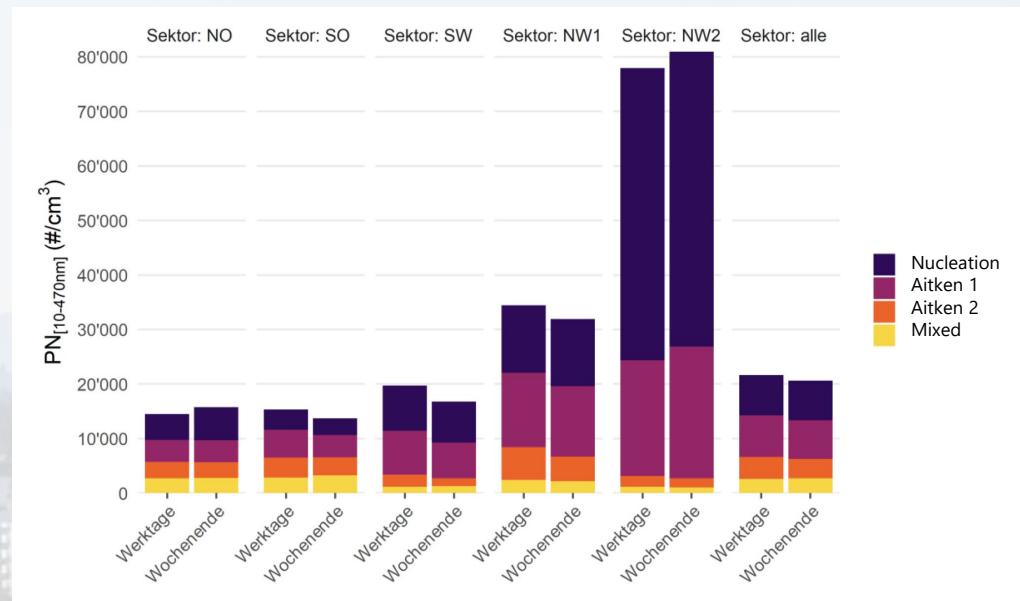
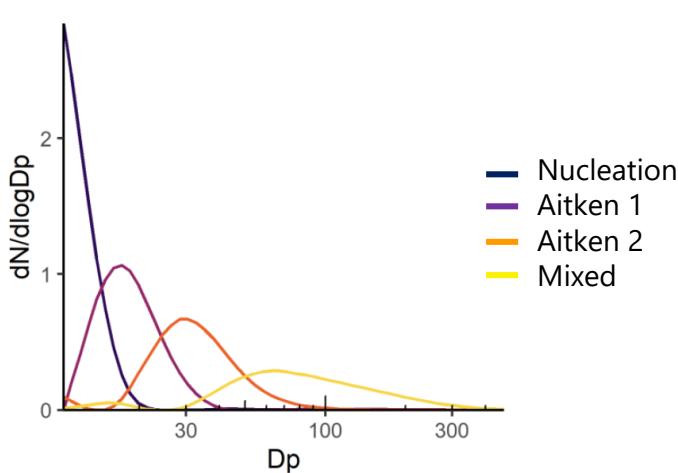
Sector	PN (#/cm <sup>3</sup> )	D <sub>p</sub> median (nm)	Frequency (%)
NO	14'021	23.8	23
SO	13'912	23.0	42
SW	17'717	15.9	9
NW1	32'810	19.4	25
NW2	72'122	13.2	2
All	20'192	21.4	100

# Dependence of UFP concentration on road and air traffic activity

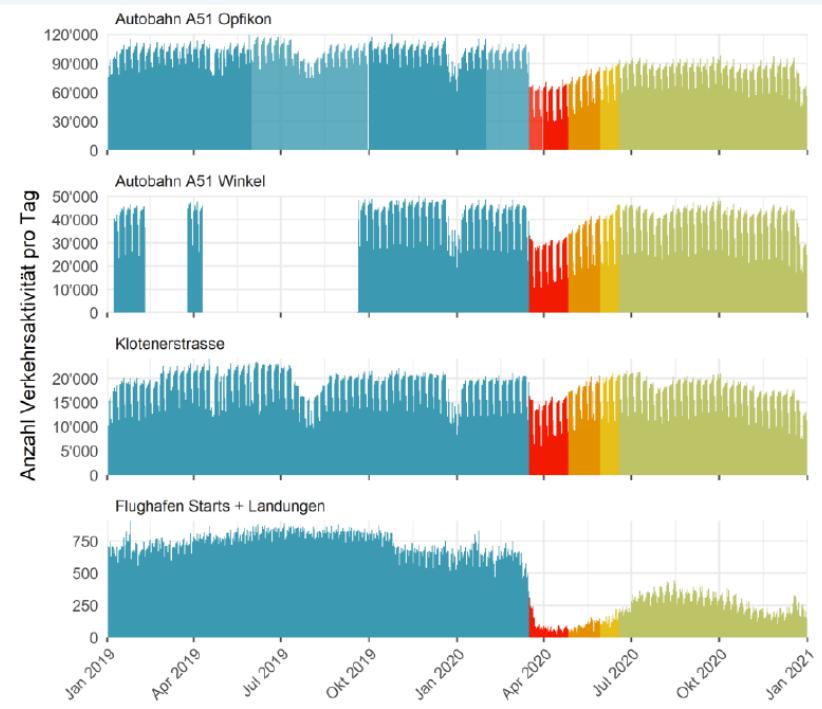


# Analysis of particle size distributions (PSDs)

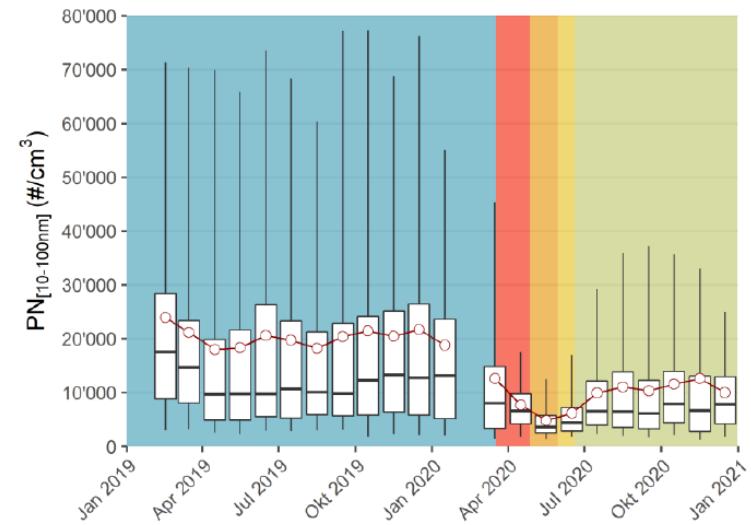
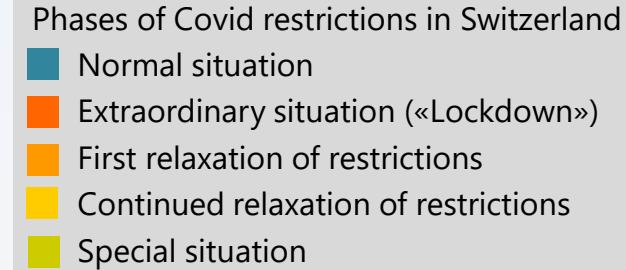
## Decomposition of PSDs by Positive Matrix Factorization



# Changes in 2020 due to COVID-19 restrictions



Source: Bundesamt für Strassen, Tiefbauamt Kanton Zürich, Flughafen Zürich AG

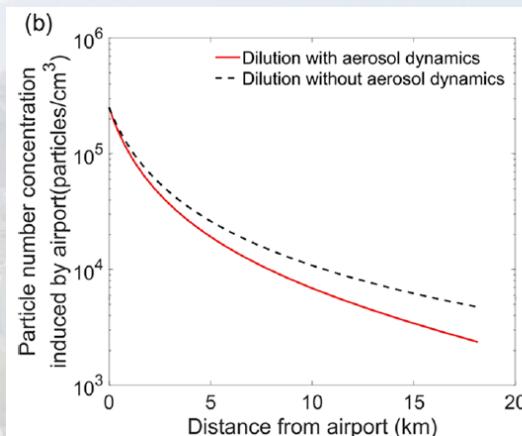
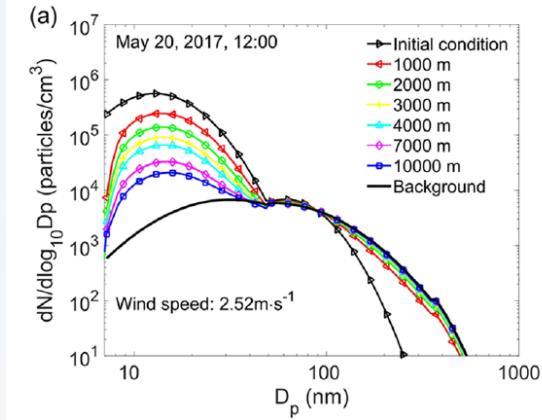
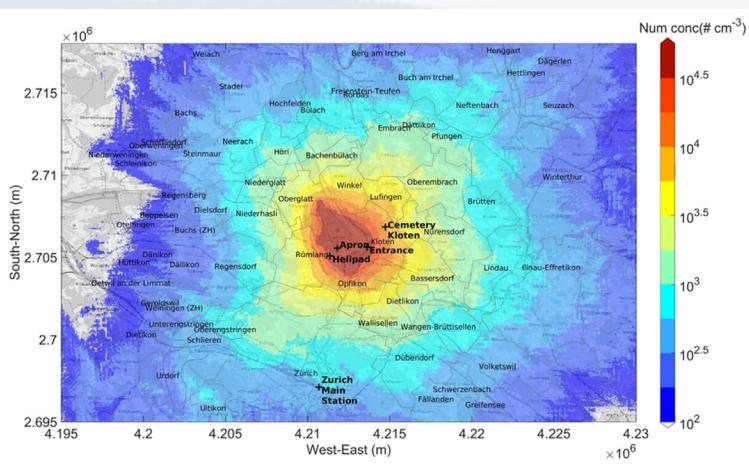


# UFP dispersion modelling study (Zhang et al. ES&T, 2020)



GRAMM/GRAL considering aerosol dynamics (MAFOR model)  
Simulation for 2017

Annual mean particle number concentration from aircraft emissions  
2m above ground:



# Summary

- UFP concentrations around Zurich airport are higher than at similar types of locations distant from the airport
- At the suburban site in Kloten, UFP concentrations were highly variable, higher peak concentrations (e.g. 95-percentile) than at traffic sites. Highest concentrations occur when wind is blowing from the airport
- A strict distinction between contributions from motorway traffic and the airport/aircrafts was not possible
- However, high peak concentrations and the small particle size are clear indicators for the influence of aircraft emissions at the Kloten site
- As a result of the Sars-CoV-2 pandemic, the number of take-offs and landings at Zurich Airport fell massively. UFP concentrations and variability at the Kloten site drastically declined from April to December 2020
- The Kloten data set is very interesting and continues to grow, further detailed evaluations are planned

# Thank you!

See report (in German) <https://jahresbericht.ostluft.ch/2020/>

## Acknowledgement:

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OST LUFT - Die Luftqualitätsüberwachung der Ostschweizer Kantone  
und des Fürstentums Liechtenstein



**Ultrafeine Partikel in Kloten 2019 & 2020**  
**Belastungssituation und Einfluss des Flugverkehrs**