

Introduction

The impact of airports on pollution within the surrounding area is of major concern due to its implications for public health. In terms of particulate air pollutants, sub-micron particles are increasingly becoming a primary concern as they can penetrate far into the body due to their small size (HEI 2013). The most prominent parameter affecting particle number concentrations (PNC) in cities is road traffic (Kukkonen 2016, Kumar 2014), resulting in an increased morbidity and mortality (Khreis 2016). However, airport operations and air traffic are additional sources especially in the vicinity of large airports (Stafoggia 2016, Lorentz 2019, Hudda 2018).

Our study aims to analyse spatial differences in PNC in the east of TXL. The focus is on the two major sources of ultra-fine particles, road traffic and airport operations. The study analyses the effect of these two sources and compares their impact.

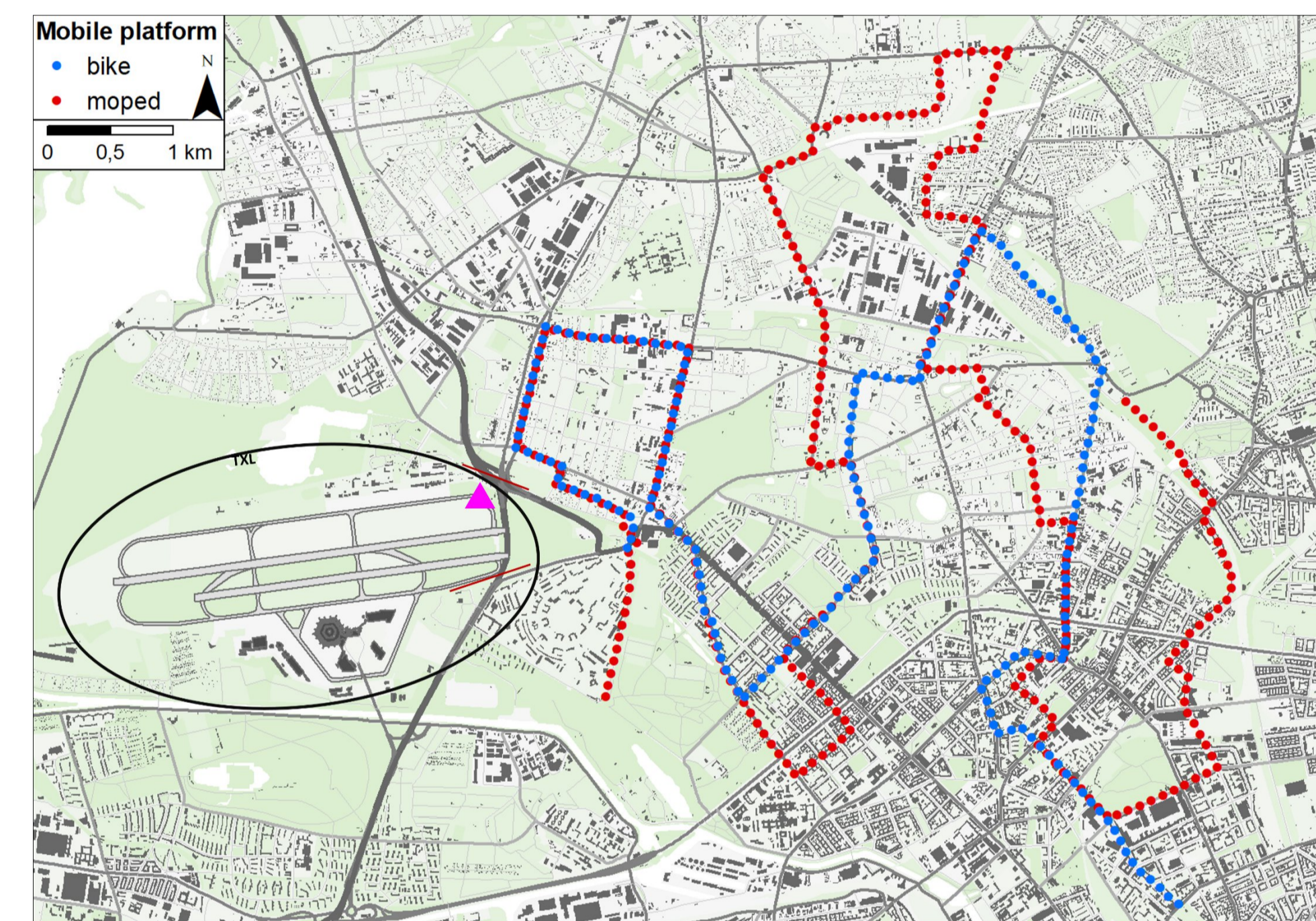


Fig. 1: Study area; Blue dots: Route of bicycle measurements; Red dots: Route of moped measurements. The highway (dark grey line) leads through an underground tunnel in the East of TXL (between red lines). Pink triangle: Weather station of Germany's National Meteorological Service (DWD); Data basis: Environmental Atlas Berlin.

Study site

- Observations in the East of TXL (Fig. 1) in summer 2019
- Two mobile measurement campaigns with a bicycle and a moped as monitoring platform
- Route crosses the prevailing wind direction multiple times at different distances from the airport
- 20 measurement runs on 14 days along a route of 20.2 km per bike
- 25 runs on 14 days along a route of 31 km per moped
- Observations on days without precipitation and with mostly southwesterly and westerly winds

Impact of airport operations and road traffic on particle number concentrations

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Results and conclusions

- Higher than average PNC in the lee of the airport with wind from west and southwest (Fig. 4)
- Clear but spatially limited impact of Berlin-Tegel Airport across the flight path in north-south direction (Fig. 5)
- No statistically significant decrease of PNC with increasing distance to the airport along the direction of the extension of the runway eastwards
- Main particle contribution from ground-based activities on the airfield

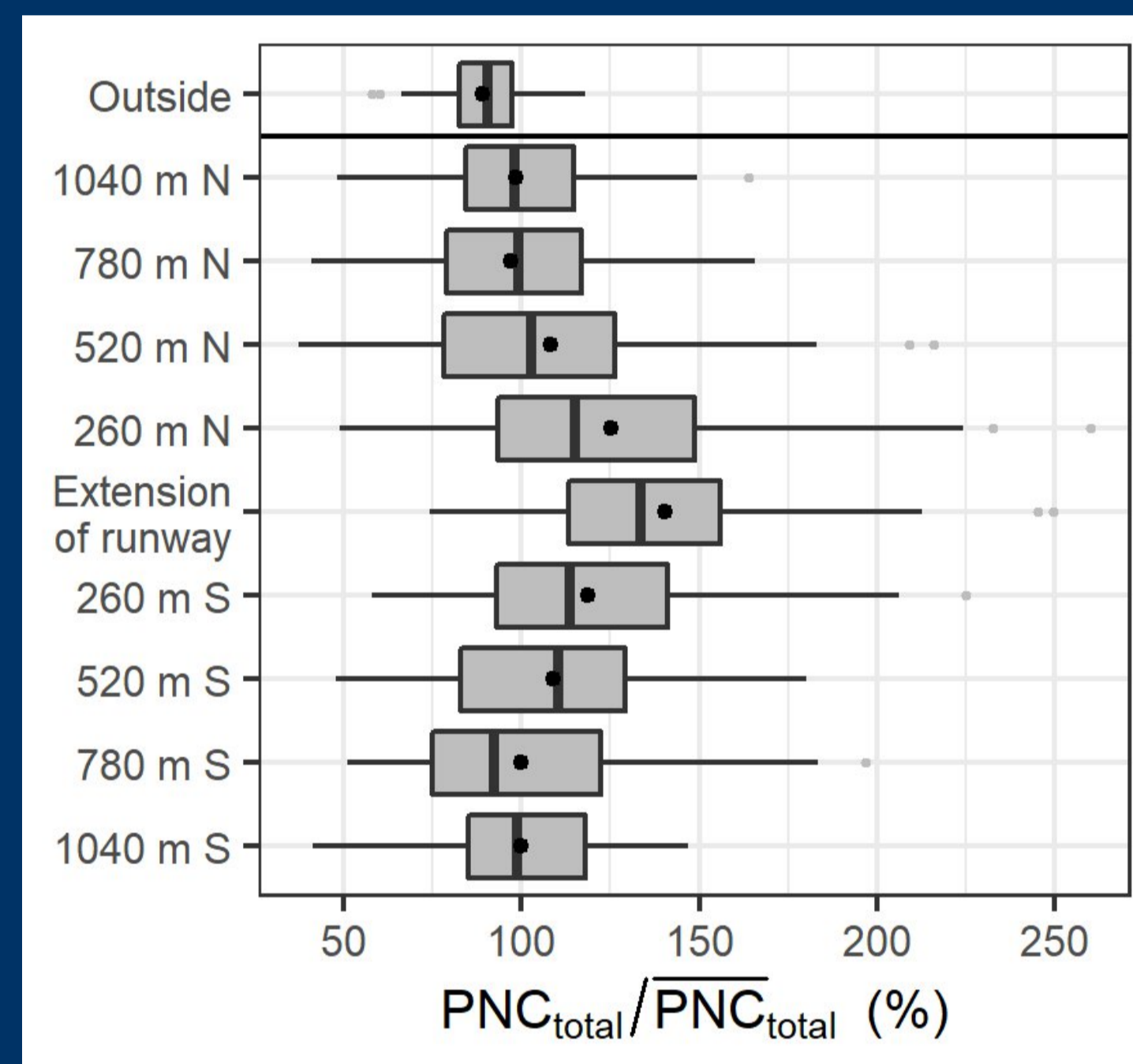


Fig. 4: PNC_{total}/PNC_{total} (%) for track points downwind of the airport to those not downwind. The category downwind was classified in three ways: track points within $\pm 10^\circ$, $\pm 20^\circ$ or $\pm 45^\circ$ downwind of the prevailing wind direction.

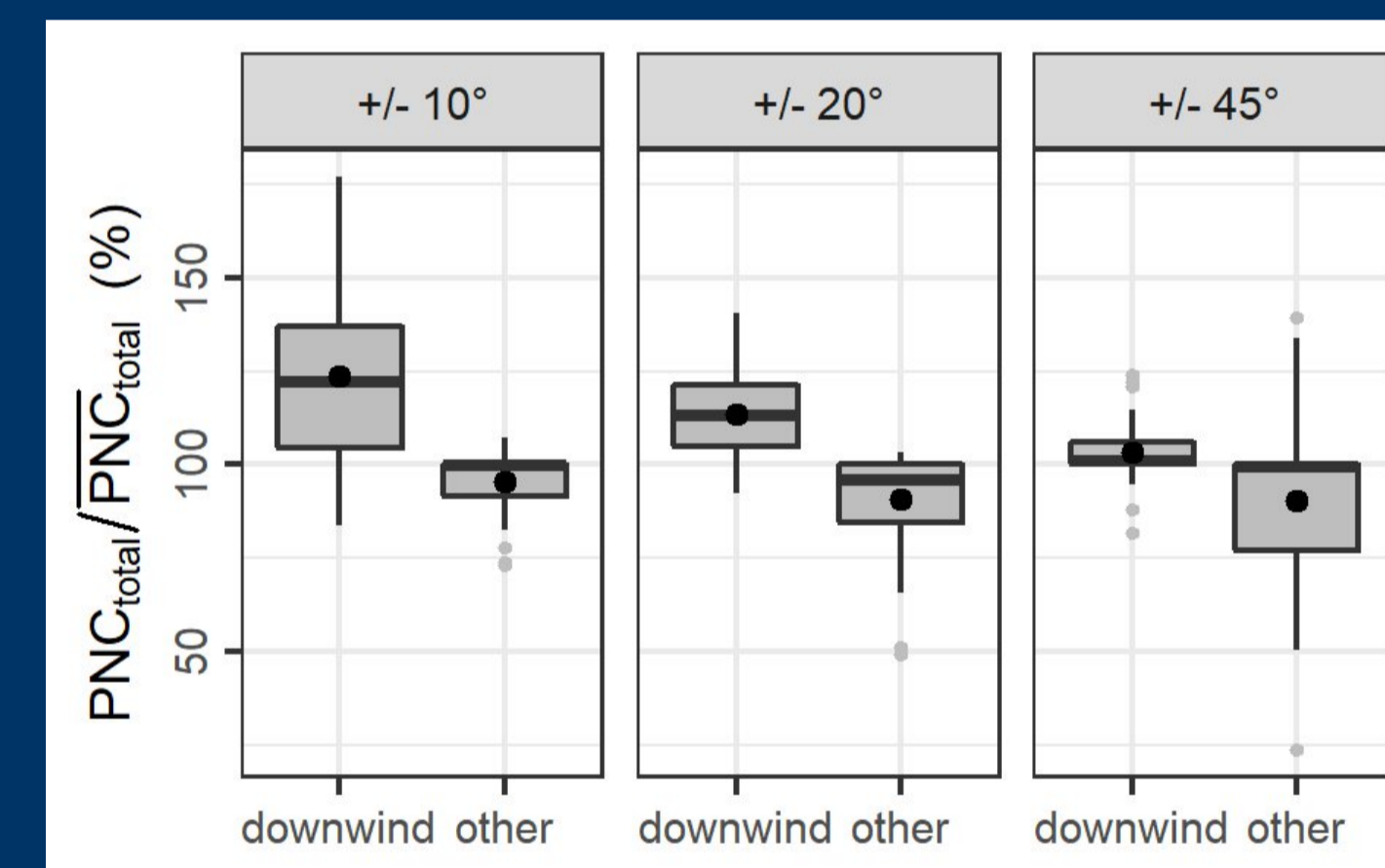


Fig. 5: PNC_{total}/PNC_{total} (%) for track points downwind of the airport to those not downwind. The category downwind was classified in three ways: track points within $\pm 10^\circ$, $\pm 20^\circ$ or $\pm 45^\circ$ downwind of the prevailing wind direction.

Comparison of road traffic and airport operations (Fig. 6, Fig. 7)

- high traffic volume and approach corridor in the lee of the airport lead to the highest PNC
- lowest concentrations occur in areas with low traffic volume which are also located outside the airport's approach corridor
- an increased volume of traffic outside the airport impact area is comparable to the effect of the airport in the area of the approach corridor, both in the mean of the concentrations and in the dispersion of PNC

While airport operations thus lead to significantly increased PNC, these are roughly comparable to the effect of busy roads in the neighbourhood. Clearly, the closing-down of TXL in late 2020 will have considerably improved air quality in the residential urban areas in the immediate vicinity of the airfield.

Road traffic leads to considerably elevated PNC as well (Fig. 3)

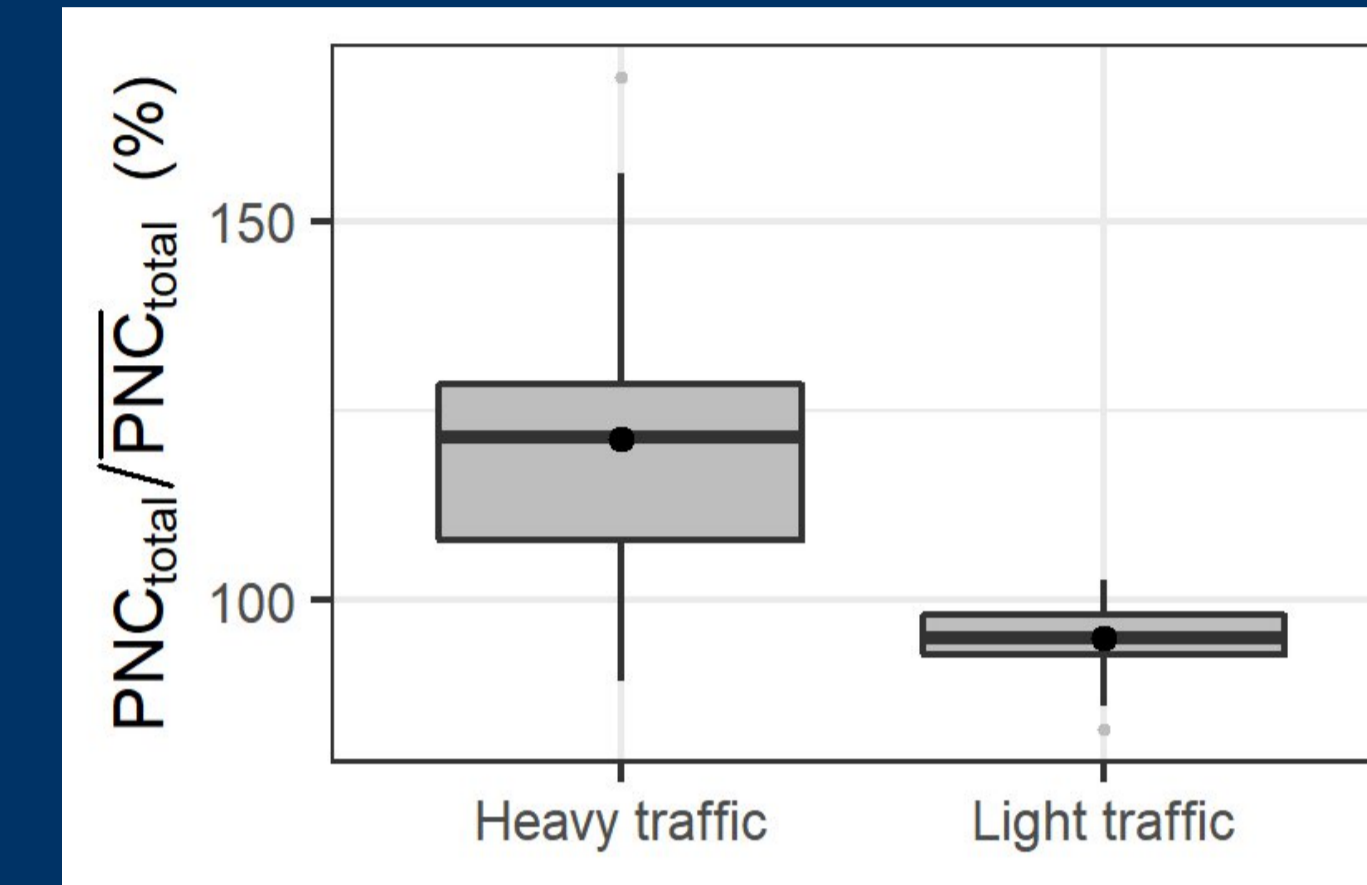


Fig. 3 Comparison of PNC_{total}/PNC_{total} (%) between heavy and light traffic areas. Data are averaged per run and category.

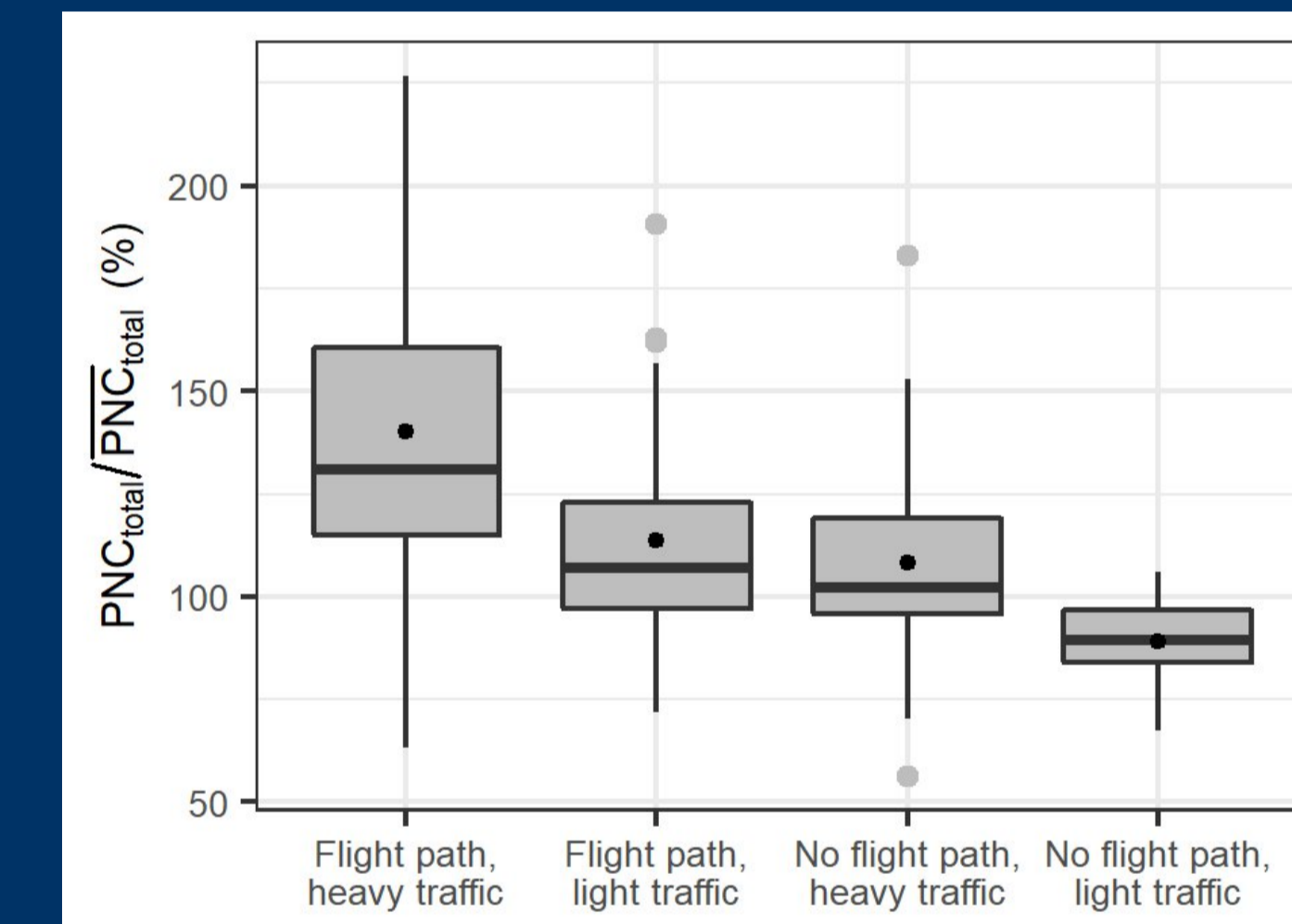


Fig. 6: PNC_{total}/PNC_{total} (%) averaged per run for four categories. Black dots indicate the arithmetic mean over all runs within the category.

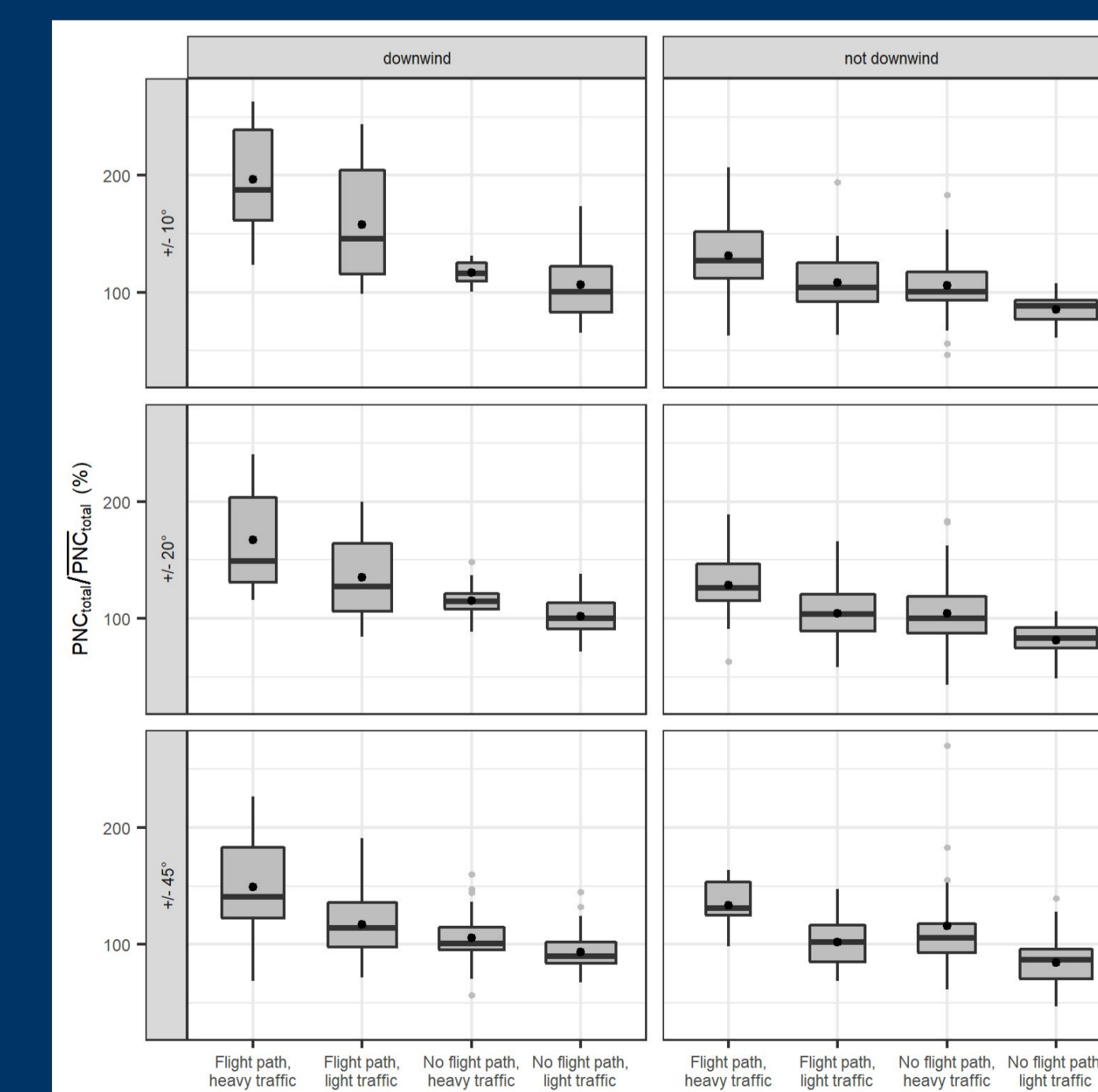


Fig. 7: Comparison of track points located downwind (dark grey boxes) and those non downwind (light grey boxes) of the runway. PNC_{Cat}/PNC_{Cat} (%) averaged per run for the four categories.

Methodology

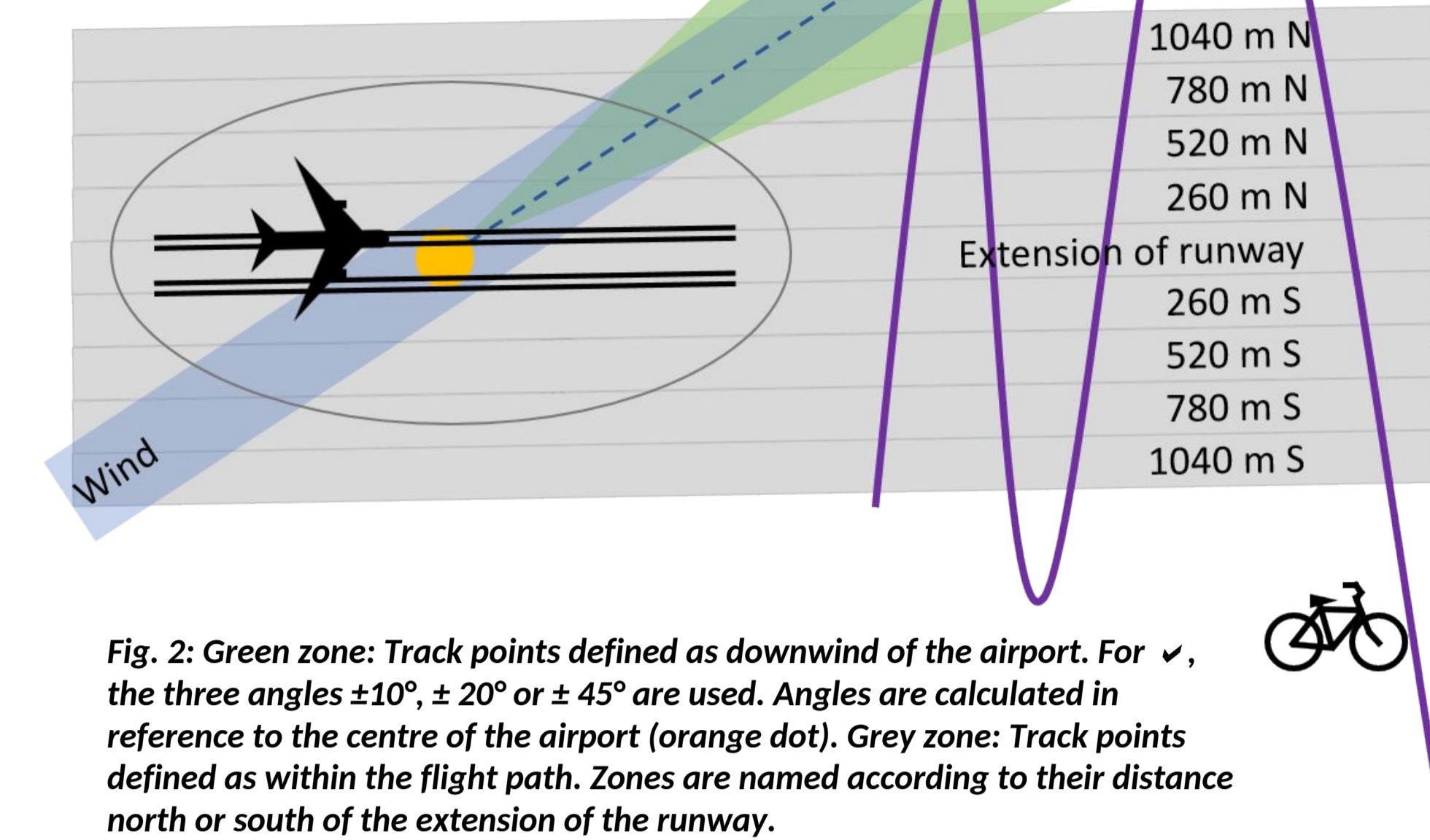


Fig. 2: Green zone: Track points defined as downwind of the airport. For α , the three angles $\pm 10^\circ$, $\pm 20^\circ$ or $\pm 45^\circ$ are used. Angles are calculated in reference to the centre of the airport (orange dot). Grey zone: Track points defined as within the flight path. Zones are named according to their distance north or south of the extension of the runway.

Total PNC was recorded with two condensation particle counters (CPC) of the type TSI CPC 3007. The particle size ranges from 10 nm to 1000 nm with an accuracy of 20%. To produce inter-route consistency, track points are generated along the measurement routes at intervals of 100 m. PNC was divided by the mean per run to adjust for diurnal variation of background concentrations.

The study investigates the impact of road traffic and airport operations and contrasts them in three subsequent steps:

- the impact of road traffic on air pollution is analysed using traffic data like
- the impact of the airport on PNC is investigated on the basis of the distance of the observations to the airfield along the direction of flight as well as across the direction of flight depending on the wind direction (Fig. 2)
- the magnitude of their relative effect on PNC is compared by classifying the study area into sections with above-average road traffic in contrast to those with lower traffic volumes. These two categories are cross-referenced with areas in and outside main flight path of approaching or incoming aircraft

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