Reply to Anonymous Referee #1

We thank referee #1 for the constructive comments. The original comments are in black font, our replies to the comments below appear in blue font, and changes in the manuscript are in red font.

1) The analysis included accounting for sample blanks, where no sample was drawn. However no ambient background samples were acquired. I realize that the collection times are quite large. However, if the prevailing winds shifted for a long enough period, some background from a non-airport source would be useful to compare to the airport source. I presume that the long sample times preclude collecting sample in a traffic-free period with the prevailing wind direction, although that might even be a preferable ambient background target to another wind direction.

Sampling representative ambient background samples is a difficult task. As the referee mentioned, the night-flight ban period is not long enough to accumulate sufficient mass for filter analysis. Another problem is that between 23:00 – 5:00 CET, although no flight movements are allowed, some aircrafts still arrive in this period due to delays and important medical cargo aircrafts that have an exceptional permission. This would lead to ambient background samples with contributions of aircraft emissions.
We also think that ambient background samples collected from another wind direction are not representative for the ambient background of Frankfurt airport when sampling during southerly wind direction, as further urban (north-east) and industrial (north-west) sources will contribute, that certainly do not contribute during airport sampling (south). The only way to go, to get a realistic picture of the background aerosol is to sample simultaneously north and south of the airport during southerhly wind direction. This approach however is not easily realizable, and could not be implemented during this study.

2) Line 38-39, forecasts are quoted for airline traffic growth. I think during the current pandemic, a sentence or two should mention that 2020 has seen a steep decline in air traffic and the recovery to pre-pandemic growth rates in highly uncertain in both time and value.

We agree- the global decline in air traffic 2020 due to the corona pandemic needs to be mentioned. We will also implement the decline in flight movements at Frankfurt airport in 2020, and update the given data about operations at Frankfurt airport from 2018 to the sampling campaign year 2019.

Line 39-41 (old version line 38-39): Due to the corona pandemic however, the European flight traffic in 2020 declined by 55% compared to 2019 (Eurocontrol, 2021). Current forecasts predict a full recovery of flight movements between 2024 and 2029, depending on the pandemic course (Eurocontrol, 2020).

Line 84-87: Frankfurt airport is one of the largest airports in Europe with more than 500,000 flight operations in 2019, shared over four runways. It is located in the Rhine-Main metropolitan area within a distance of around 12 km to the city centre of Frankfurt. In 2019 more than 70.5M passengers and 2.1M tons of cargo have been transported with a consumption of around 5.5×10^6 m^3 of kerosine (Fraport AG, 2020).

Line 87-88: The corona pandemic caused a decline in flight movements by 58.7% in 2020 compared to 2019. The transported cargo decreased by 8.5% and passenger numbers by 73.4% (Fraport AG, 2021).

3) Lines 266-267 (and also abstract line 19), "... the sampled UFP are mainly composed of lubrication oils." Other studies quoted in this report have shown that lubrication oil is an important but not sole contributor to the organic component of aircraft PM. The paper goes on to say "However, other techniques might reveal the presence of additional compounds, which are not detected by the presented technique." Yet it is not clear what fraction of the organics can be attributed to aircraft engine oil. I think some further discussion should be included to either qualify this statement or to provide a quantitate estimate of the oil contribution, with whatever error bounds can be offered. Is UFP more than 50% composed of engine oil (I think not)? Can an estimate even be offered?

Determination of the jet engine oil fraction in UFP is challenging, as it is not clear how efficient the Nano-MOUDI is sampling the UFP-fraction. Two possible types of losses / sampling artefacts can occur: (1) Wall-losses during sampling due to diffusion of the smallest particles, and (2) evaporation of semi-volatile compounds from the Nano-MOUDI stages due to the reduced pressure during sampling (100 mbar operating pressure on the smallest stage). Both processes can potentially reduce the fraction of jet engine oil in UFP in the given results, which would result in an underestimation of these compounds. Therefore, in the current stage we cannot give a quantitative estimate, since it requires a detailed compound-specific characterization of the nano-MOUDI sampling artefacts.

We like to rephrase our statement that based on our results it is suggested that UFP are mainly composed of jet engine lubrication oils. We soften the statement in line 266-267 (new file: 273-275), while we keep the statement in abstract line 19 unchanged, since it only describes our results in a qualitative manner.

Line 273-275 (old version l. 266-267): Hence, the results of the non-target analysis suggest that the sampled UFP are mainly composed of lubrication oils. However, other techniques might reveal the presence of additional compounds (e.g. metals, black carbon, inorganic compounds, etc.), which are not detected by the presented technique.

4) Line 357: I believe "neurotoxin" is misspelled as "neurotoxine".

Technical correction line 366 (old version: l. 357): neurotoxin