



SULPHURIC ACID AND AEROSOL PARTICLE PRODUCTION IN THE VICINITY OF OIL REFINERY

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BACKGROUND

Industrial activity is a major source of both gas and particulate phase pollution affecting the air quality in vicinity of industrial sites. We performed measurements in the Kilpilahti industrial area located in Porvoo, Southern Finland between June 7th and July 5th 2012.

In Kilpilahti industrial area there are about 6000 tons of sulfur dioxide emissions yearly. Sulfur dioxide oxidizes to sulphuric acid when adequate catalyst, for example hydroxyl radical (OH⁻), is present. OH⁻ concentration has a strong diurnal cycle which causes the sulfuric acid concentration to usually be lower during night and the highest around noon[1]. Sulfuric acid has an important role in the initial steps of nucleation[2].



Figure 1. Porvoo industrial area

METHODS

A chemical ionization atmospheric pressure interface time-of-flight mass spectrometer (CI-APi-TOF) [3] was used to observe sulfuric acid and other acidic compounds. A Particle Size Magnifier (PSM) [4] and a Differential Mobility Particle Sizer (DMPS)[5] were used to detect particles and their size distribution. Volatile organic compounds were observed by Proton Transfer Reaction - Mass Spectrometer (PTR-MS) [6]. In addition to the data of our own, Neste Oil provided us measured SO₂ concentrations from the closest ambient air measurement station.

RESULTS

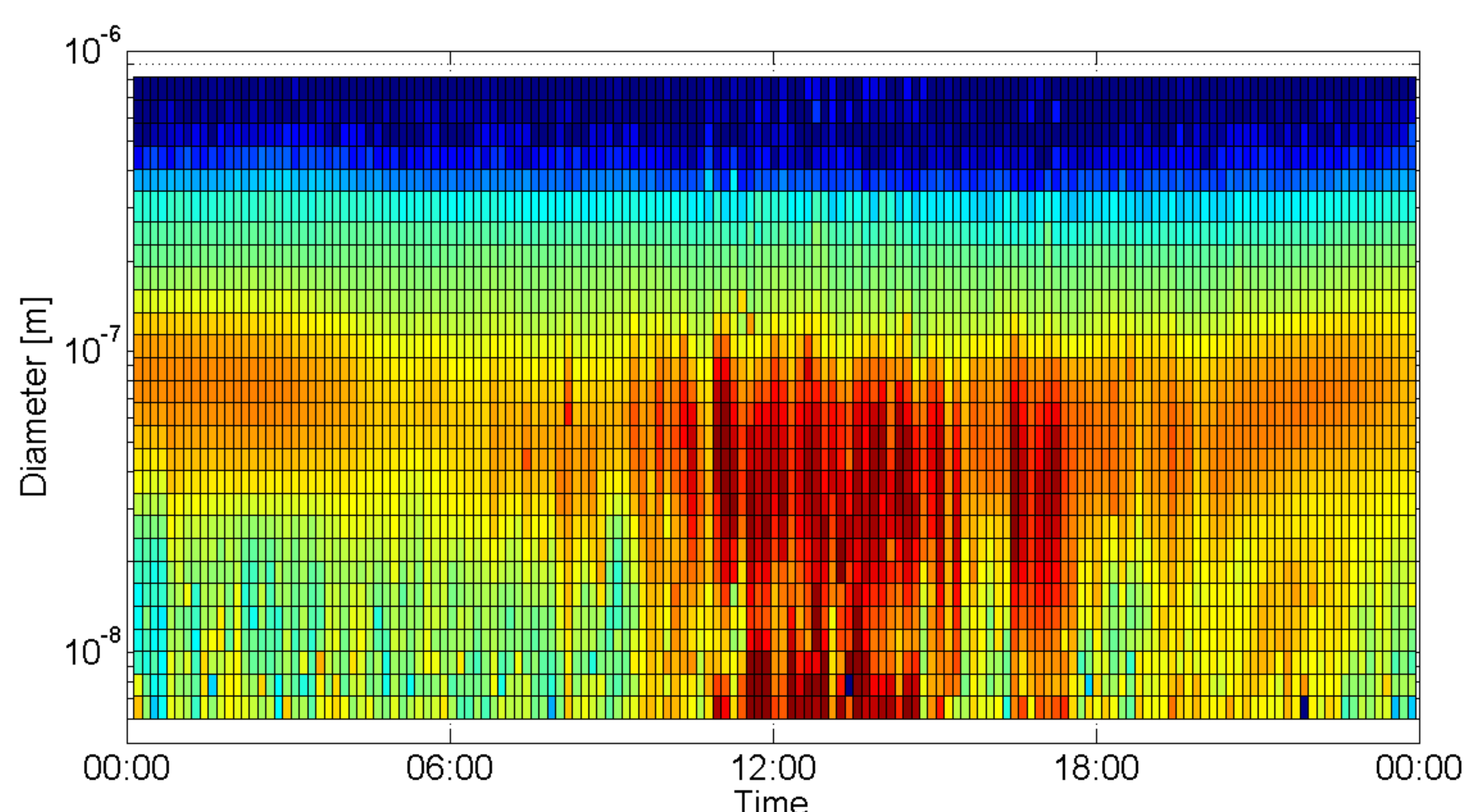


Figure 2. Particle size distribution on 26th of June. The air mass was coming from the oil refinery area between 7 and 19 o'clock and the particle concentrations rose to 1.5·10⁵ particles/cm³ at the highest.

The area around the measurement site was divided into three categories: non-industrial area, oil refinery area and other industrial area (e.g. petrochemical) and the source areas were classified using HYSPLIT back trajectories[7]. The classification was based on the location of the air parcel one hour prior sampling.

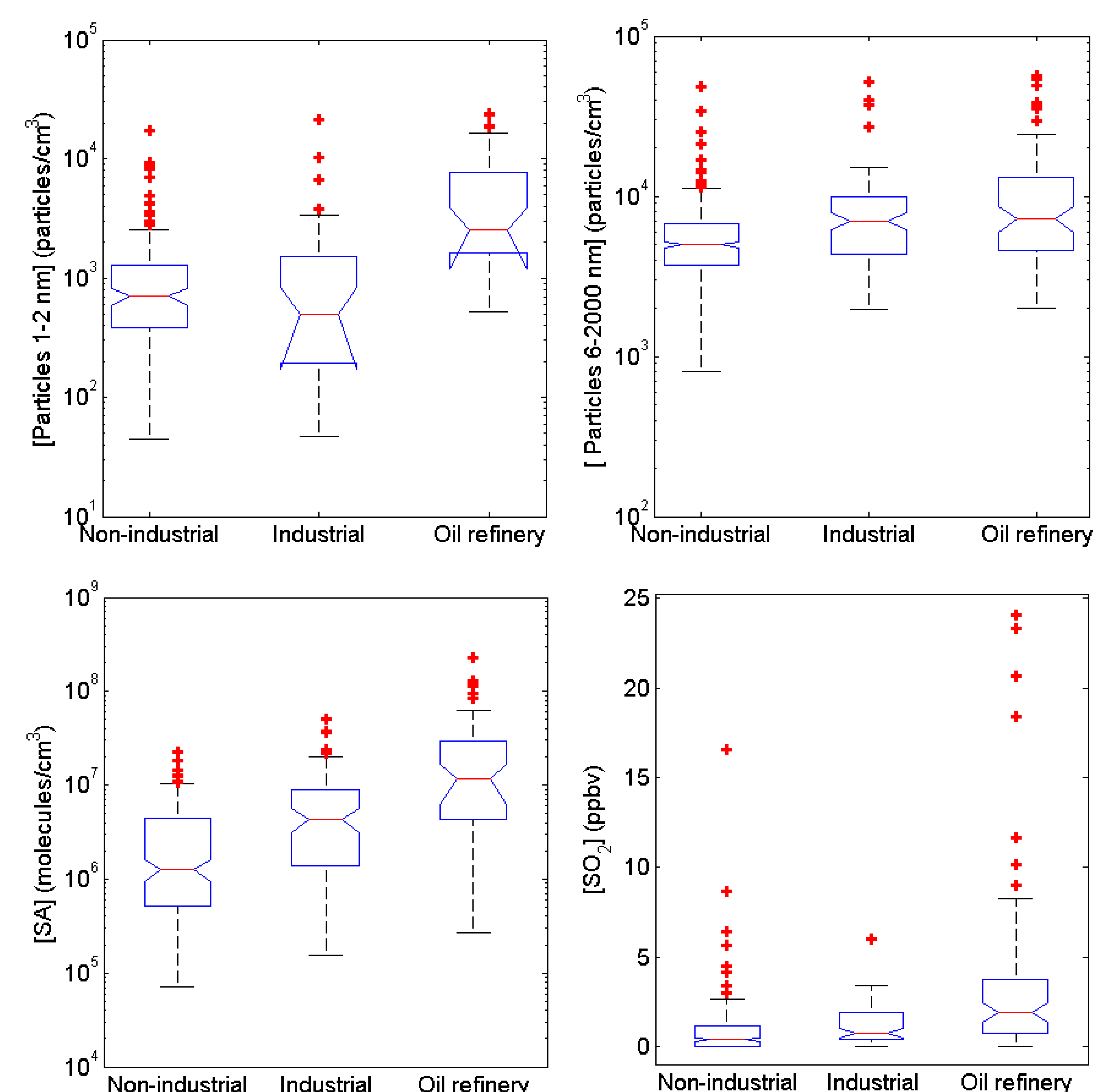


Figure 3. Box-plots of particle, sulphuric acid and sulphur dioxide concentrations. In each plot, the red line is the median, the bottom and the top are the 25 and 75 percentiles, the whiskers are the 5 and 95 percentiles and the red points are the outliers. Two medians are significantly different with 5% significance level if their intervals don't overlap. The interval endpoints are shown as the extremes of the notches.

CONCLUSIONS

- When the air mass was coming from the industrial or oil refinery area the particles arrived to the measurement site mostly as a big burst of particles of all sizes and the particle concentration decreased only when the wind direction changed (Fig. 2.)
- The sulphuric acid yield was higher when the air mass was coming from the oil refinery area compared to other source areas.
- For sulphur dioxide, sulphuric acid and 1-2 nm particles the median concentrations were significantly higher with 5% significance level when the air mass was coming from oil refinery.
- Two new particle formation events, from which we were able to calculate growth rates, were detected during the campaign. In those events high amount of the total growth was explained by sulphuric acid (36-65%).
- Influence on atmospheric chemistry would need long-term measurements

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- Figure 1. Jukka Palmgren / Porvoo kaupunki
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