Air quality in Aveiro (Portugal): Influence of sea breezes and surrounding industry

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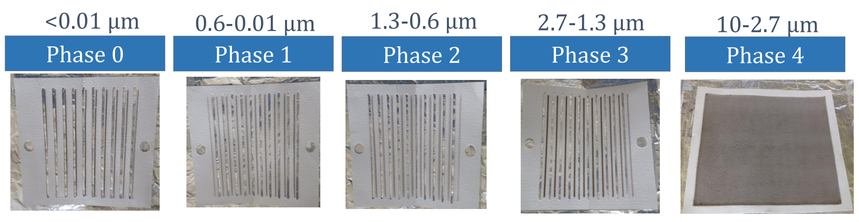
Introduction

The Sea-Breeze (SB) phenomenon, a recognized mesoscale circulation pattern, impacts air quality in coastal cities (Di Bernardino et al., 2021). The SB acts as a lid that limits the vertical mixing of air and the dispersion of pollutants. Furthermore, it causes the dragging of pollutants landward during the night. Therefore, the study of the air quality-SB relationship is crucial for the air quality legislation applicable to such cities, since they are affected by particle and gas emissions from distant sources.

The main objective of this study is to analyse of pollutant concentration during day and night in a coastal city, as well as the chemical analysis of the particles according to their size.

Sampling

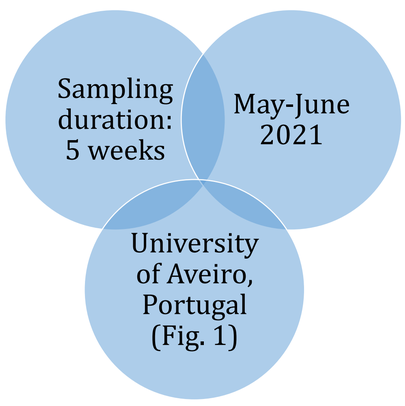
A High Volume PM10 sampler type cascade (MCV model IC-CAV) for collecting filters in 6 stages (≥ 10 µm, 10 – 4.9 µm, 4.9 – 2.7 µm, 2.7 – 1.3 µm, 1.3 – 0.61 µm, ≤ 0.61 µm) during 168 h.



A Scanning Mobility Particle Sizer spectrometer (TSI-SMPS Model 3938) to measure the particle number concentration between 8 and 310 nm in 110 channels.

A gas analyser Horiba APOA-370 to measure O_3, NO, NO_2 and CO

A weather station to monitor some meteorological variables.



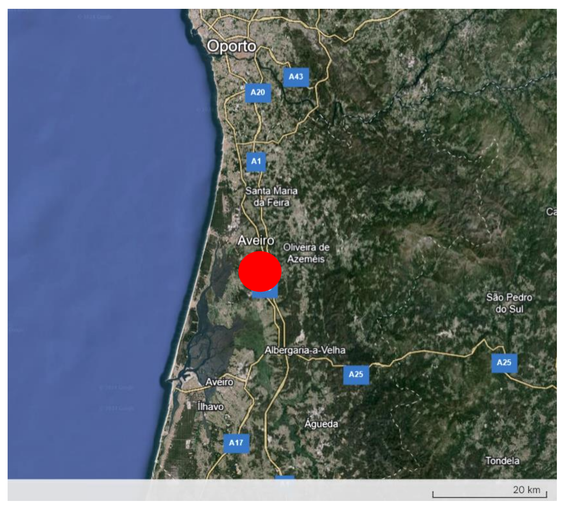


Figure 1. Sampling point at 10 km from the coast.

Results

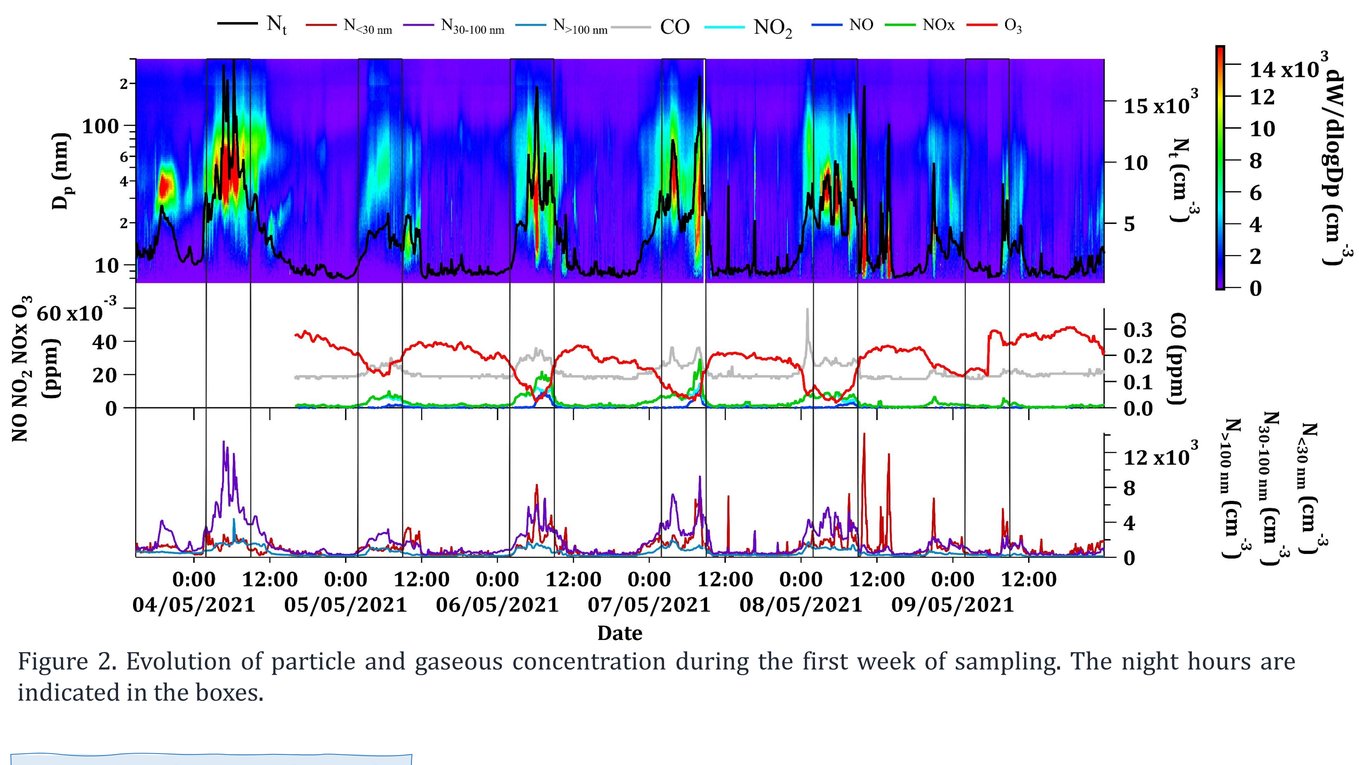
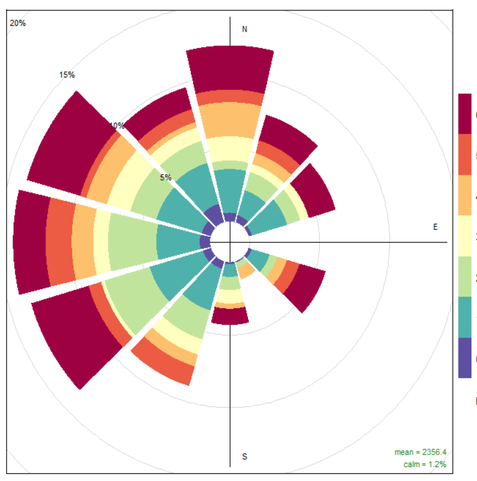


Figure 2. Evolution of particle and gaseous concentration during the first week of sampling. The night hours are indicated in the boxes.



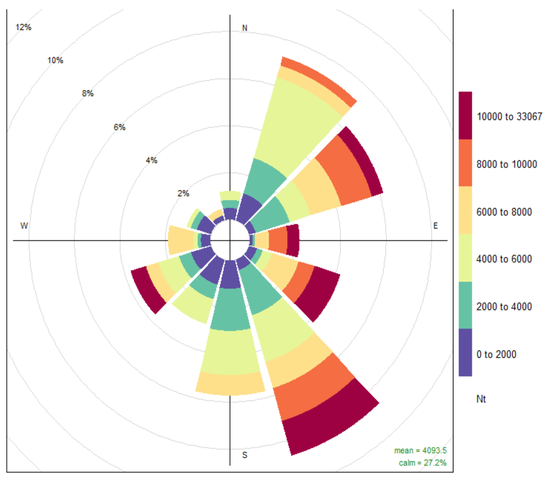


Figure 3. Polar plot concentration during; day (left); night (right). To the W lies the Atlantic Ocean, and to the E, the mainland of Portugal. Colour scale indicates the particle number concentration per cm^{-3}.

- During the sampling, the size range of P3 (2.7-1.3 µm) presented the highest PM10 concentration (ranged between 13.0 and 26.3 µg m^{-3}).
- The mean apportionment of each phase to the total PM10 was: P0 (4.5 %), P1 (6.6 %), P2 (17.1 %), P3 (55.0 %) and P4 (16.8 %).

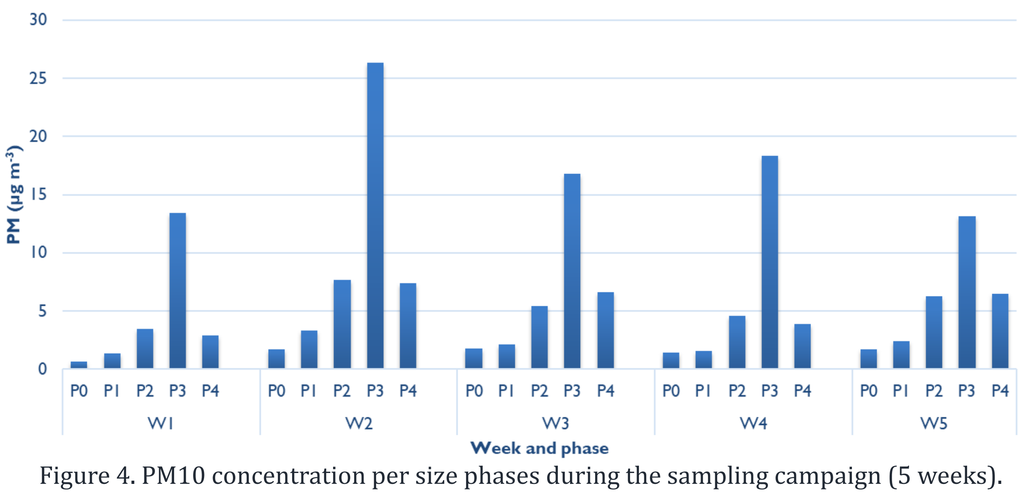


Figure 4. PM10 concentration per size phases during the sampling campaign (5 weeks).

- The results indicated a clear difference between day and nights periods. A clear increase in particle, CO and NOx concentration was registered between 0000 and 0800 UTC (Figure 2).
- During the day, westward winds were predominant, while eastward winds prevailed at night (Figure 3). It is noteworthy the high concentrations recorded during the nighttime period due to the transport of pollutants from inland Portugal, which are carried by the SB towards the ocean, implying poor air quality in the studied city.
- The maximum hourly concentration during night was 33,000 particles cm^{-3} while during day was 12,800 particles cm^{-3}.
- The backward retrotrajectories of air masses (Figure 5) showed that the air mass origin during the day and night is different. When ending is at 1700 UTC a pass of air masses through ocean cause a decrease of pollution.

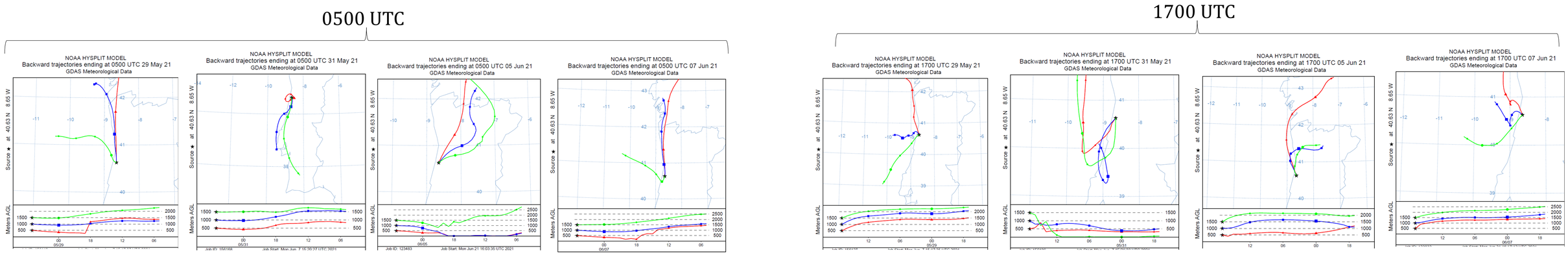


Figure 5. Backward retrotrajectories of air masses over Aveiro at 500, 1000 and 1500 m with a duration of 24 h evaluated at 0500 UTC and 1700 UTC for 5 days representatives of sampling.

Conclusions

- There is a clear difference in air quality between daytime and nighttime periods, influenced by both wind patterns and the transport of pollutants from inland to the coast. The high concentration of particles at night is mainly due to the transport of pollutants by eastward winds from inland Portugal to the coastal area.
- This factor must be taken into account for compliance with current air quality legislation in coastal cities.

References

- Di Bernardino, A., Iannarelli, A. M., Casadio, S., Mevi, G., Campanelli, M., Casasanta, G., Cede, A., Tiefengraber, M., Siani, A. M., Spinei, E. and Cacciani, M. (2021). Urban Climate, 37.

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