

Supplementary Materials: The Association between Vessel Departures and Air Pollution in Helsinki Port Area 2016–2021

Mikko Heikkilä * and Jukka-Pekka Jalkanen

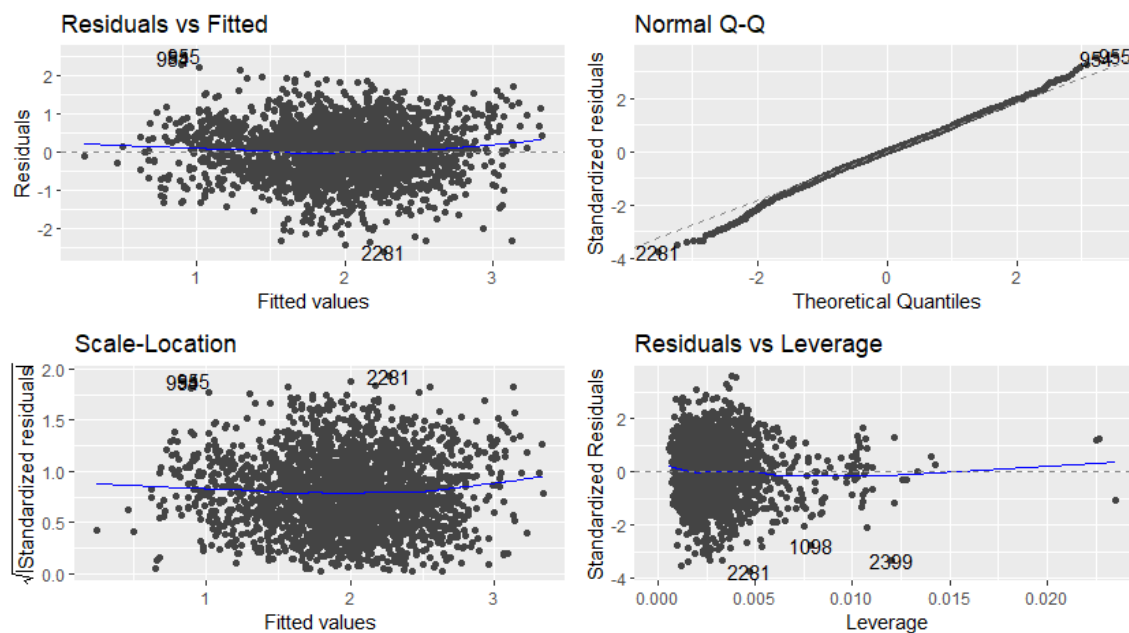


Figure S1. Diagnostic plots of the residuals and fitted values of the multivariable linear regression for log NO₂ and vessel departures at Vuosaari weekends in 2016.

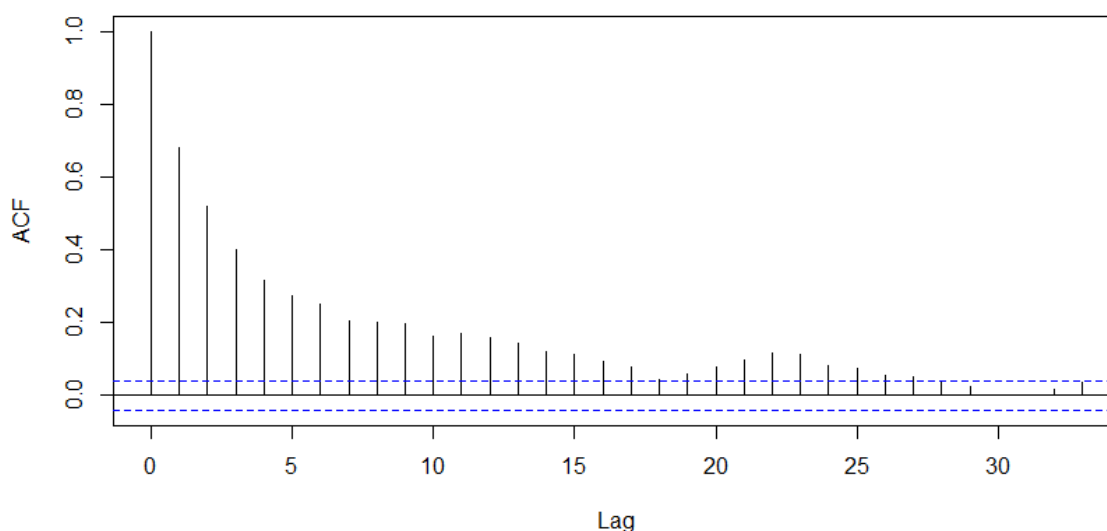


Figure S2. Autocorrelation function of the multivariable linear regression for log NO₂ and vessel departures at Vuosaari weekends in 2016.

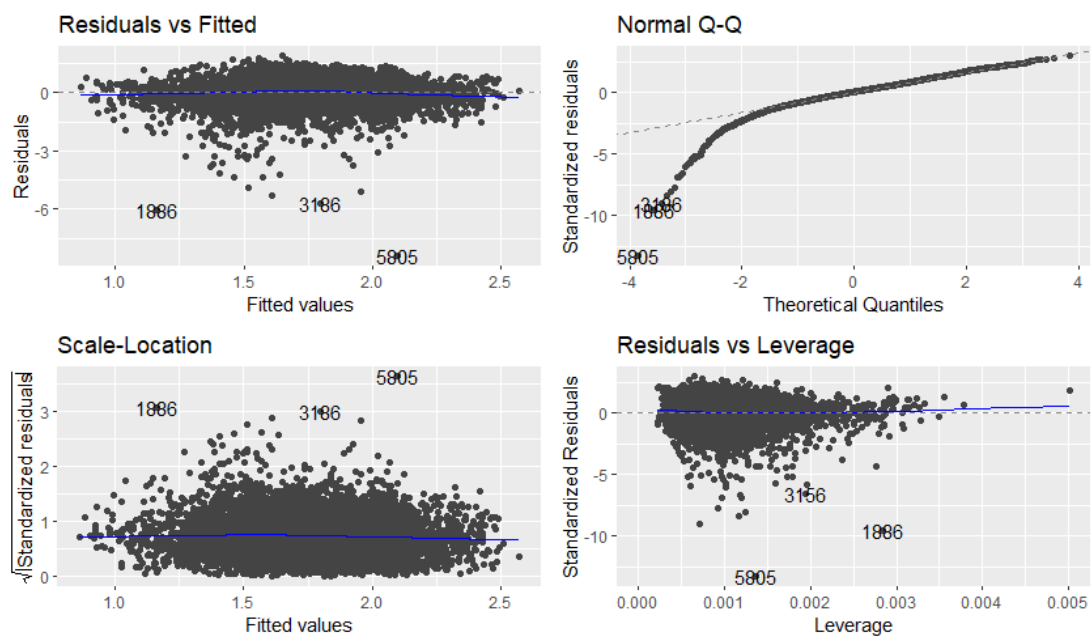


Figure S3. Diagnostic plots of the residuals and fitted values of the multivariable linear regression for log $PM_{2.5}$ and vessels at berth.

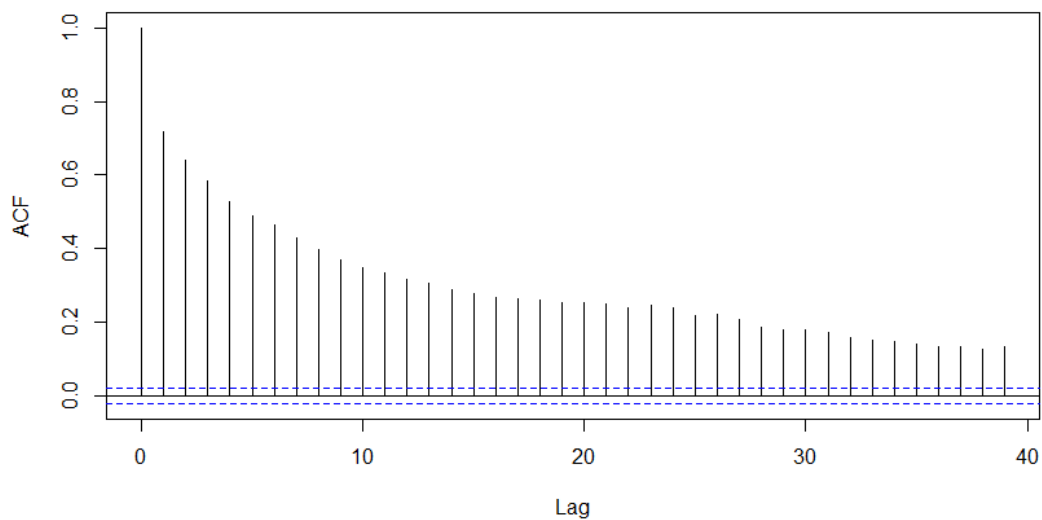


Figure S4. Autocorrelation function plot of the model collinearity of the multivariable linear regression for log $PM_{2.5}$ and vessels at berth.

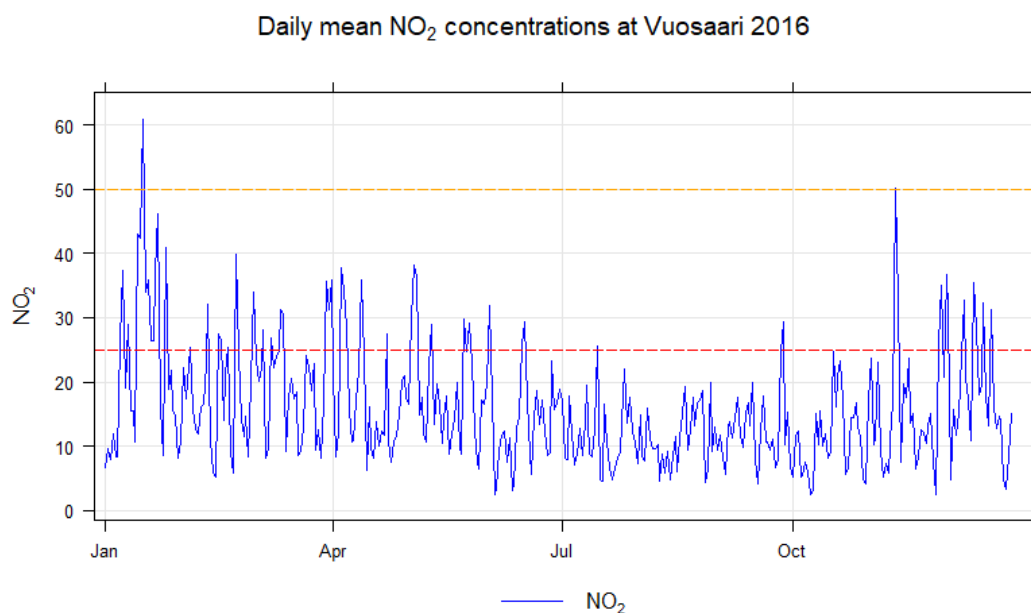


Figure S5. Time series plot of daily mean concentration of NO₂ in Vuosaari in 2016. Red dashed line is the WHO 2021 guideline value (25 µg/m³) and the orange line the EU Commission proposal (50 µg/m³).

Polarplot of NO₂ concentration (µg m⁻³) Vuosaari 2016

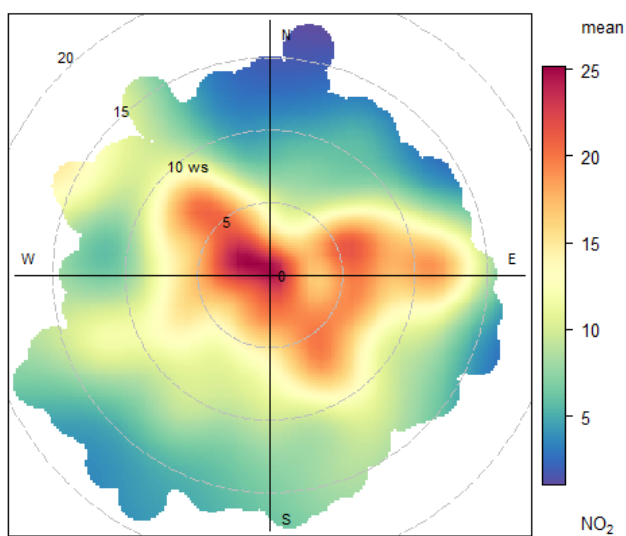


Figure S6. Polarplot of NO₂ hourly mean concentration by wind speed and direction at the Vuosaari port terminal in 2016.

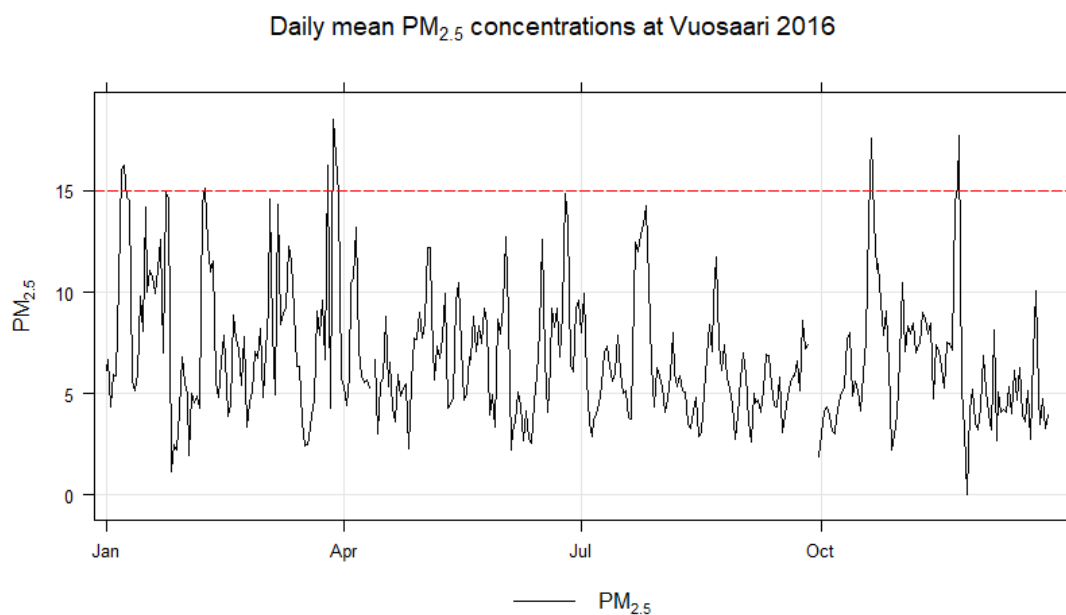


Figure S7. Time series plot of daily mean concentration of $PM_{2.5}$ in Vuosaari in 2016. Red dashed line is the WHO 2021 guideline value ($15 \mu\text{g}/\text{m}^3$).

Polarplot of $PM_{2.5}$ concentration ($\mu\text{g m}^{-3}$) Vuosaari 2016

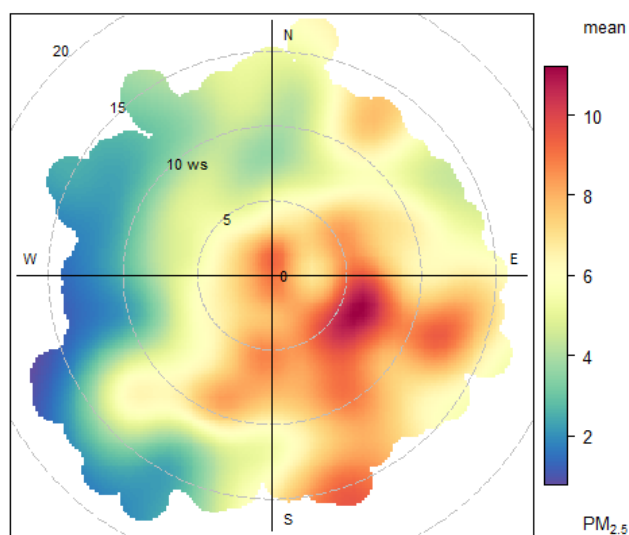


Figure S8. Polarplot of $PM_{2.5}$ concentration by wind speed and direction at Vuosaari in 2016.

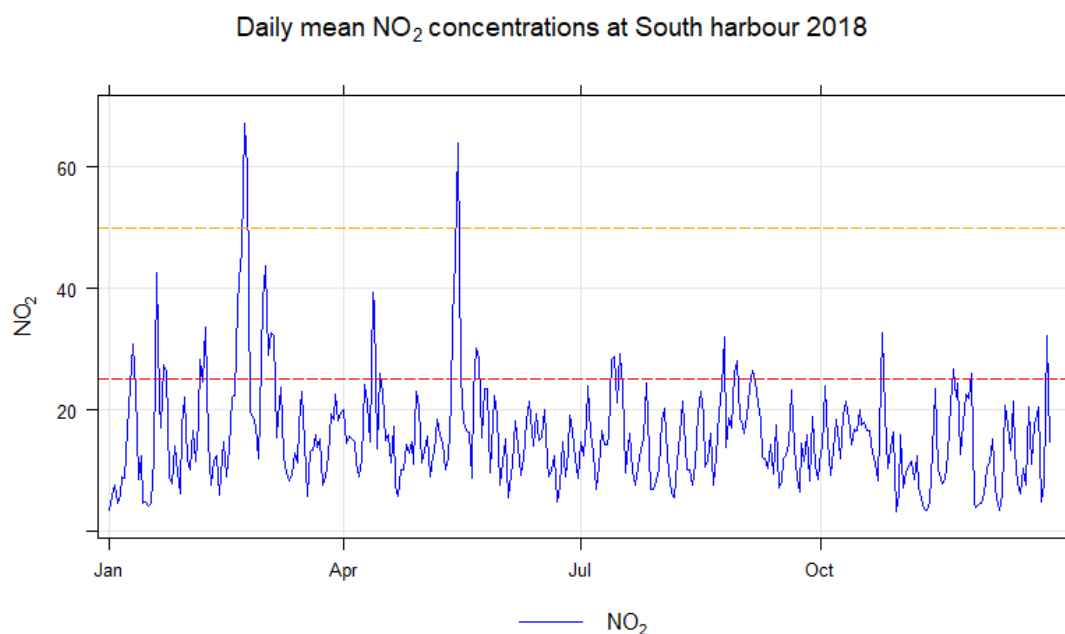


Figure S9. Time series plot of daily mean NO₂ at South Harbour in 2018. Red dashed line is the WHO 2021 guideline value (25 $\mu\text{g}/\text{m}^3$) and the orange dashed line the EU Commission proposal (50 $\mu\text{g}/\text{m}^3$).

Polarplot of NO₂ concentration ($\mu\text{g m}^{-3}$) South harbor 2018

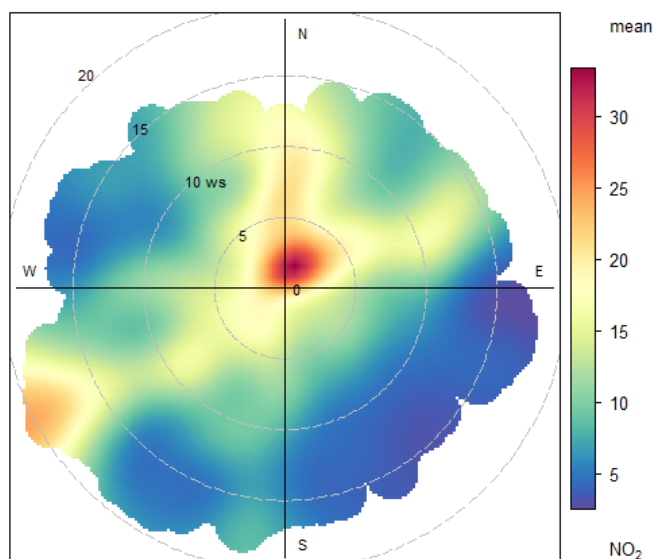


Figure S10. Polarplot of NO₂ concentration by wind speed and direction at South Harbour in 2018.

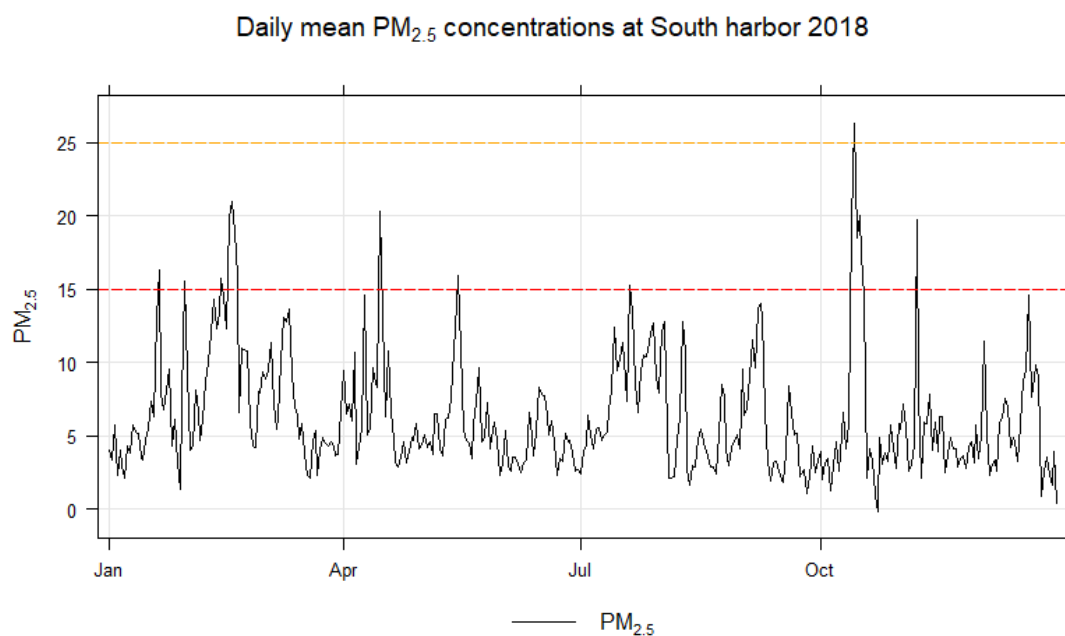


Figure S11. Time series of daily mean $PM_{2.5}$ at South Harbour in 2018. Red dashed line is the WHO 2021 guideline value ($15 \mu\text{g}/\text{m}^3$) and the orange dashed line the European Commission proposal ($25 \mu\text{g}/\text{m}^3$).

Polarplot of $PM_{2.5}$ concentration ($\mu\text{g m}^{-3}$) South harbor 2018

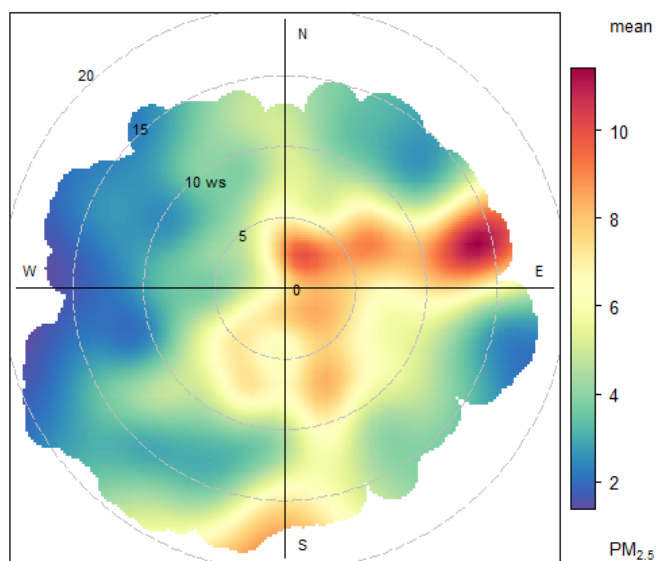


Figure S12. Polarplot of $PM_{2.5}$ concentration by wind speed and direction at South Harbour in 2018.

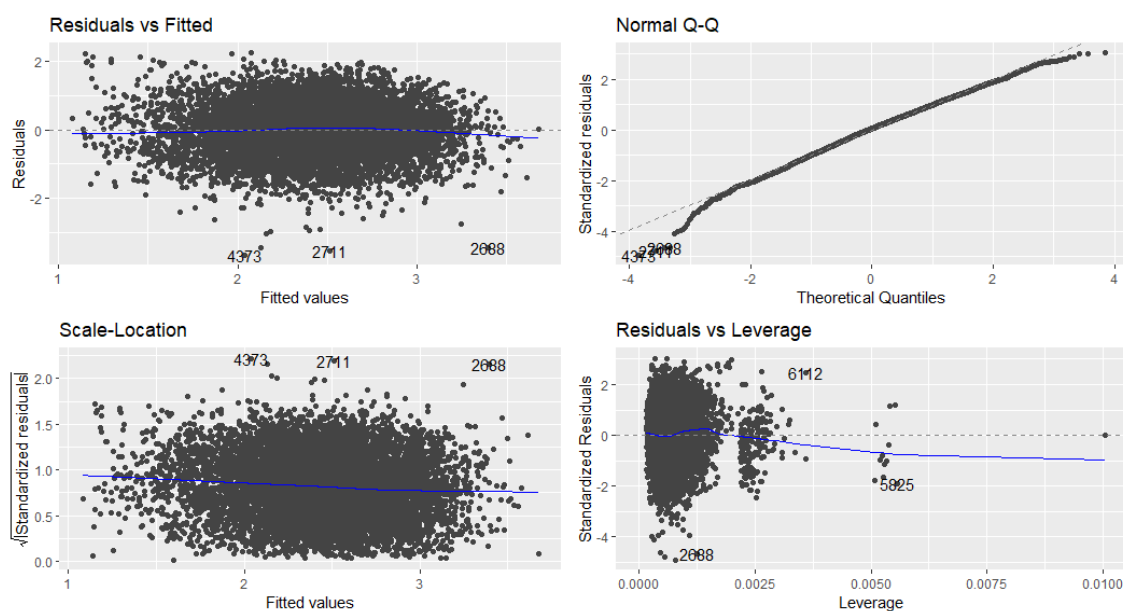


Figure S13. Diagnostic plots of the model residuals for departures and log NO₂ at South Harbour in 2018.

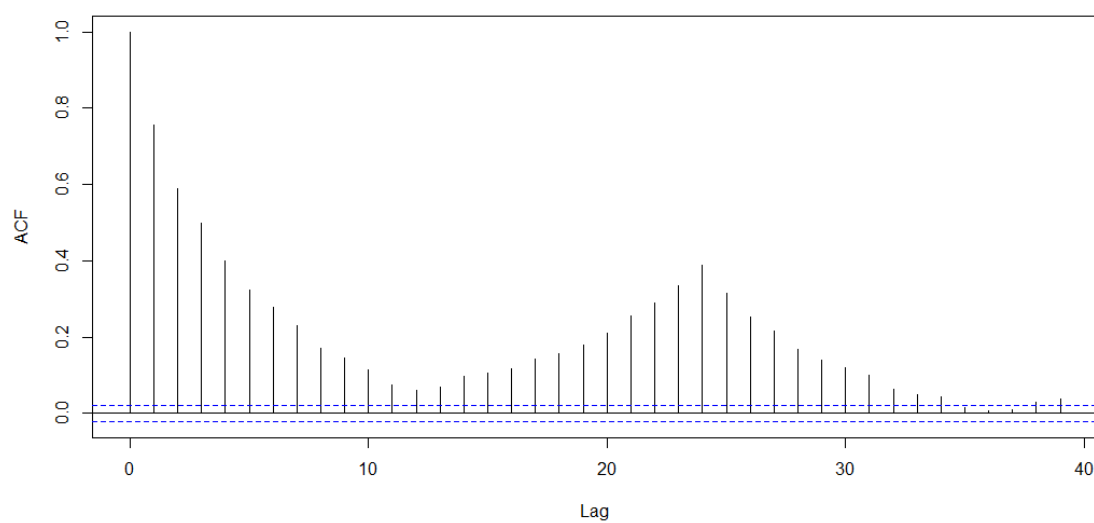


Figure S14. Autocorrelation function plot of the model residuals for departures and log NO₂ at South Harbour in 2018.

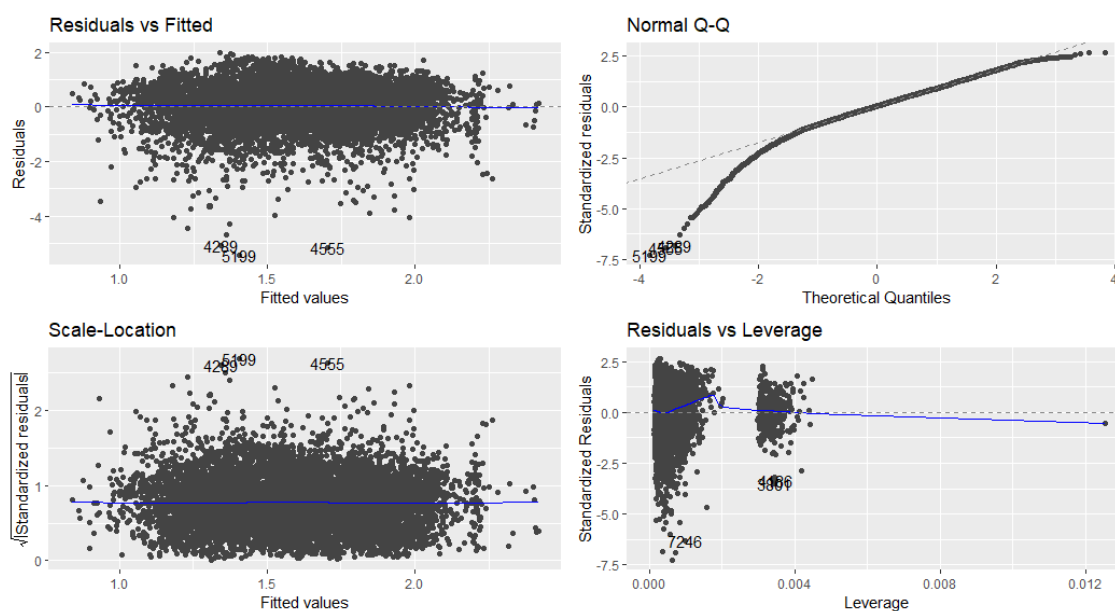


Figure S15. Diagnostic plots of the model residuals for arrivals to the Olympia quay at South Harbour in 2018 and log PM_{2.5}.

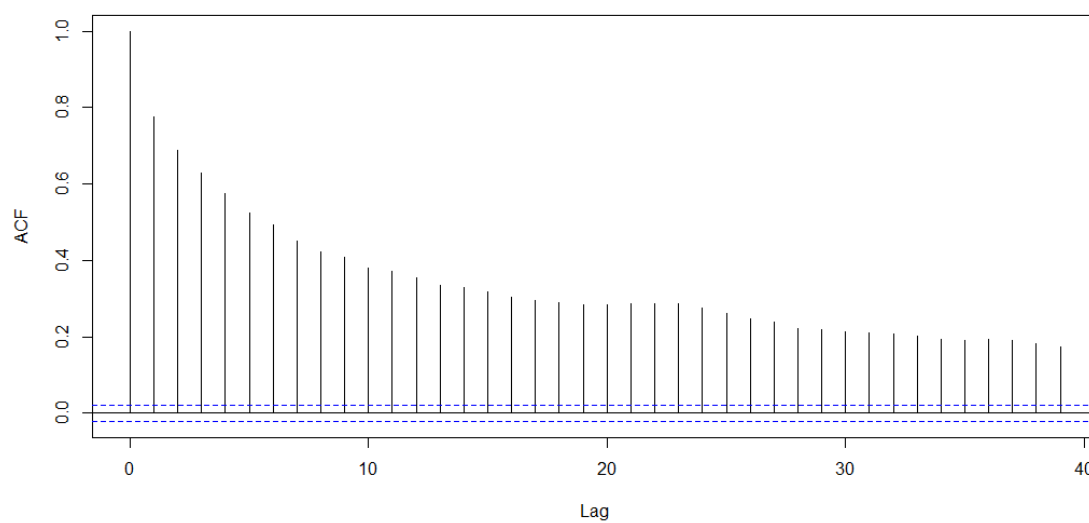


Figure S16. Autocorrelation function plot of the model residuals for arrivals to the Olympia quay at South Harbour in 2018 and log PM_{2.5}.

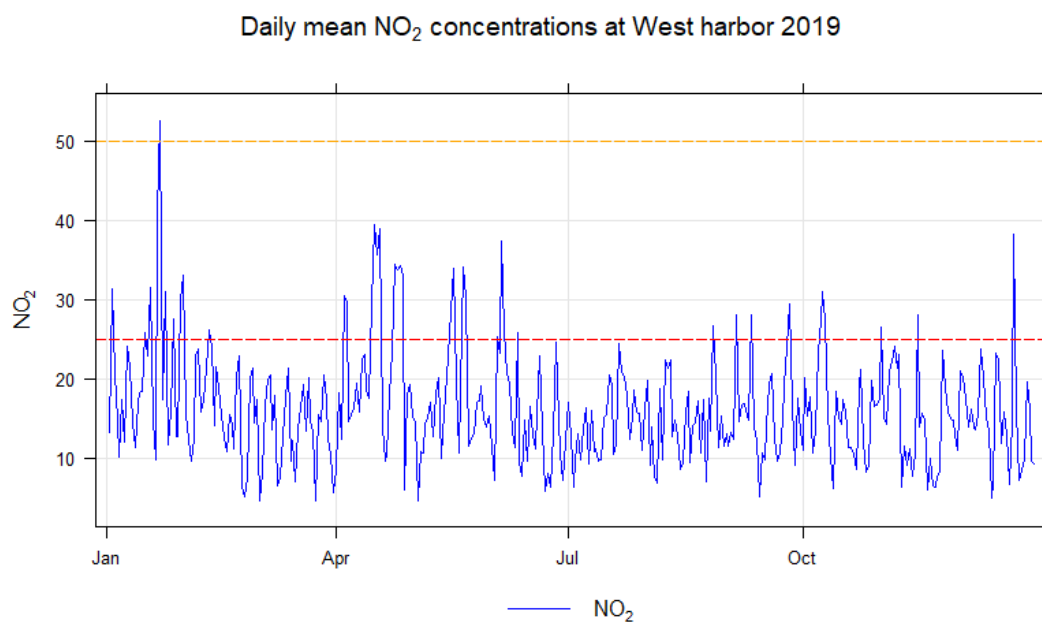


Figure S17. Time series of daily mean NO₂ concentration at West Harbour in 2019. Red dashed line is the WHO 2021 guideline value (25 $\mu\text{g}/\text{m}^3$) and the orange line the European Commission proposal (50 $\mu\text{g}/\text{m}^3$).

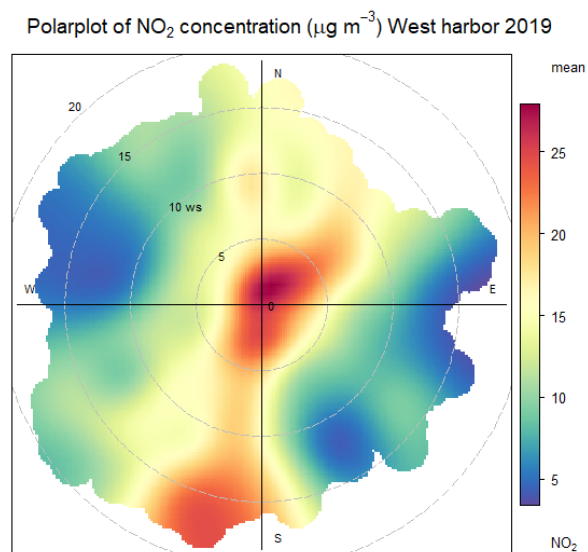


Figure S18. Polarplot of NO₂ concentration by wind speed and direction at West Harbour in 2019.

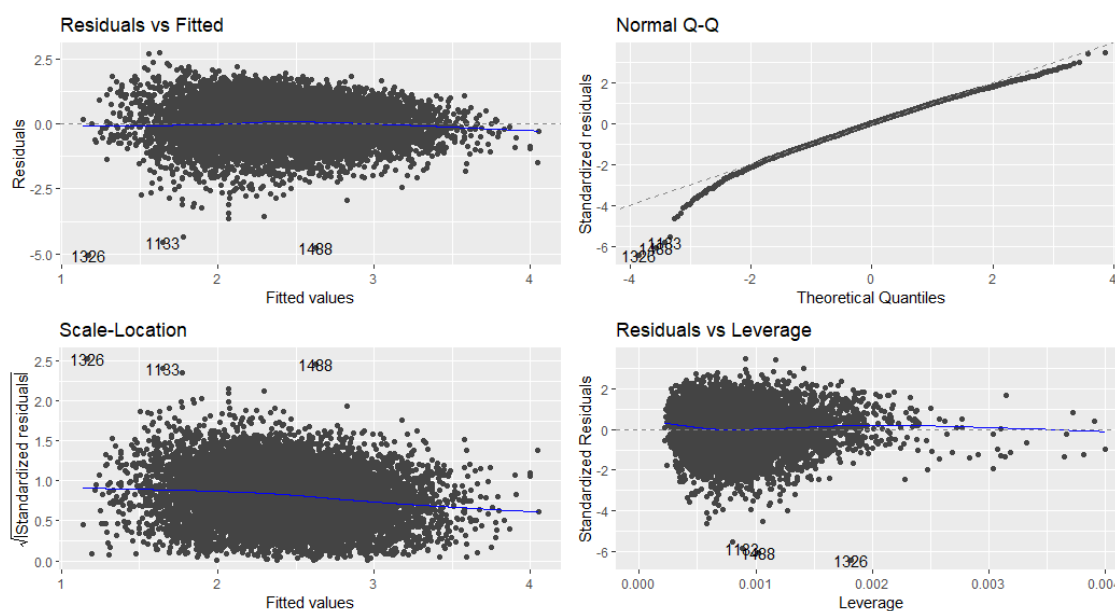


Figure S19. Diagnostic plots of the model residuals for departures and log NO₂ at West Harbour in 2019.

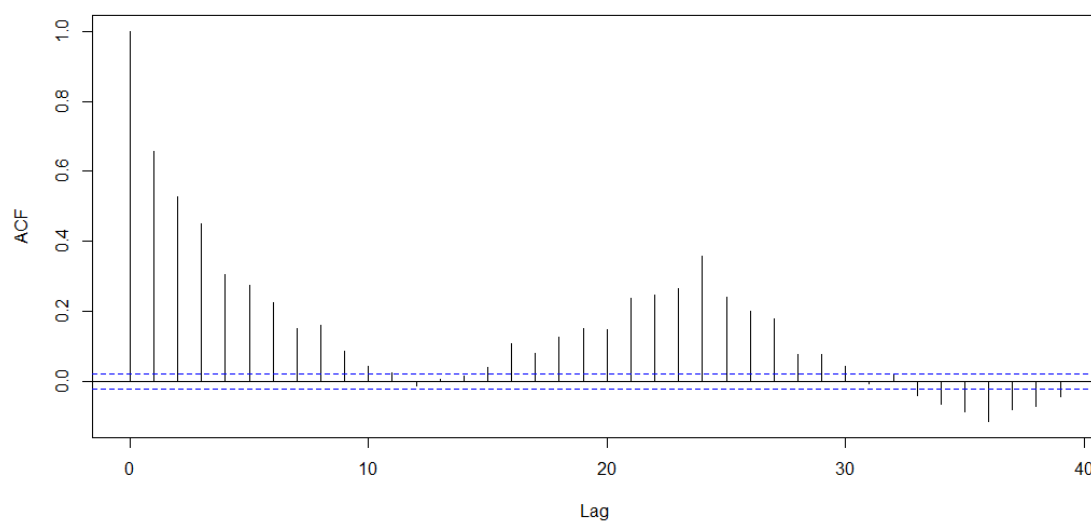


Figure S20. Autocorrelation function plot of the model residuals for departures and log NO₂ at West Harbour in 2019.

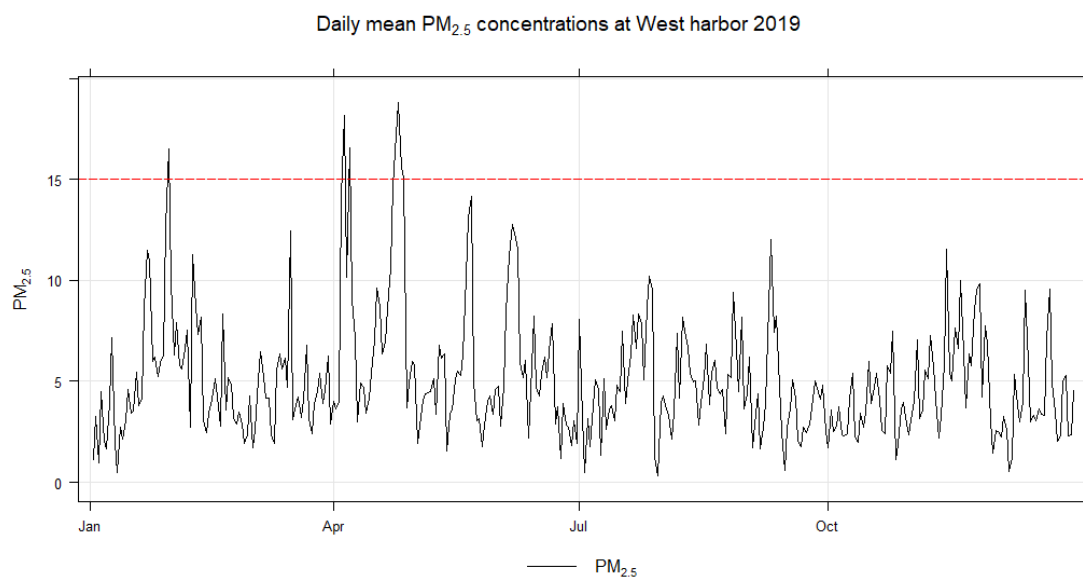


Figure S21. Time series plot of daily mean $PM_{2.5}$ concentration at West Harbour in 2019. Red dashed line is the WHO 2021 guideline value ($15 \mu\text{g}/\text{m}^3$).

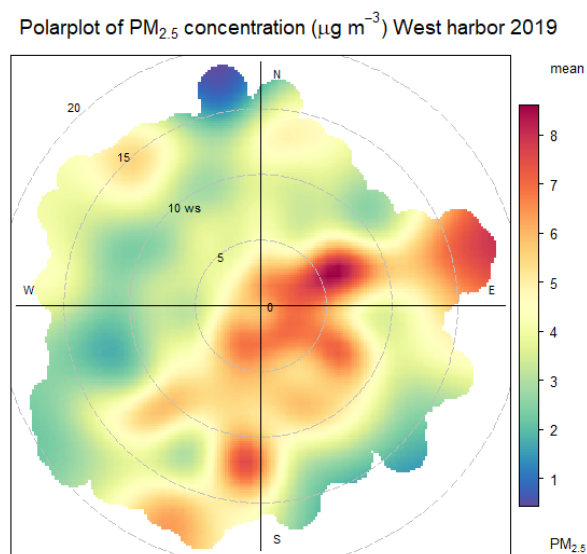


Figure S22. Polarplot of $PM_{2.5}$ concentration by wind speed and direction at West Harbour in 2019.

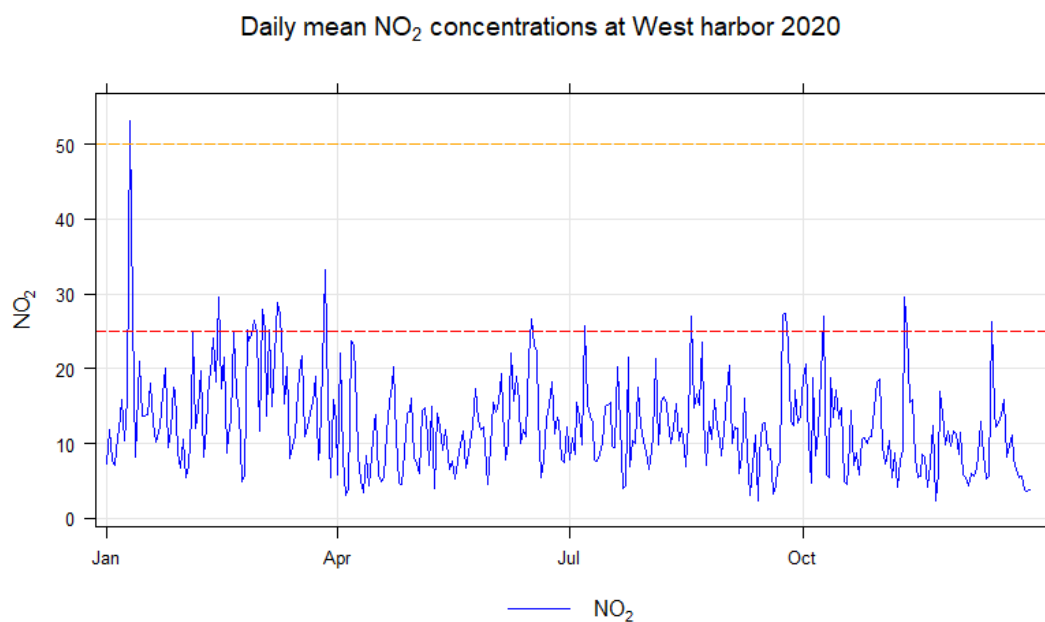


Figure S23. Time series plot of daily mean NO₂ at West Harbour in 2020. Red dashed line is the WHO 2021 guideline value (25 $\mu\text{g}/\text{m}^3$) and the orange dashed line the European Commission proposal (50 $\mu\text{g}/\text{m}^3$).

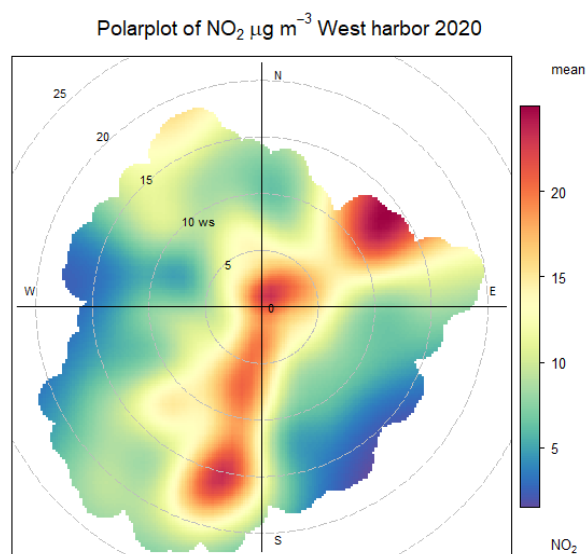


Figure S24. Polarplot of NO₂ concentration by wind speed and direction at West Harbour in 2020.

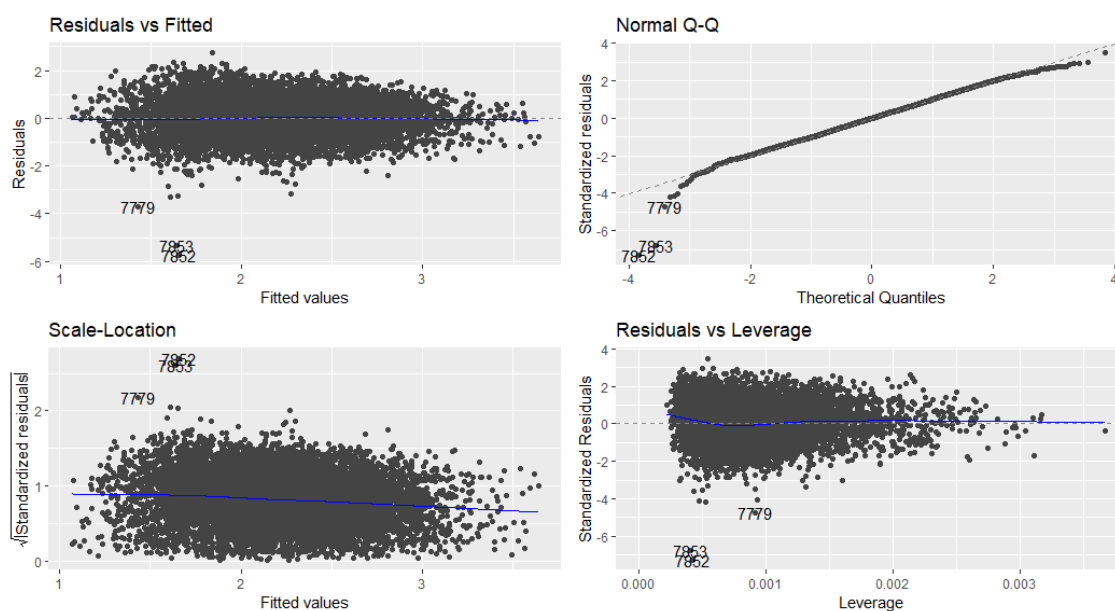


Figure S25. Diagnostic plots of the model residuals for departures and log NO₂ at West Harbour in 2020.

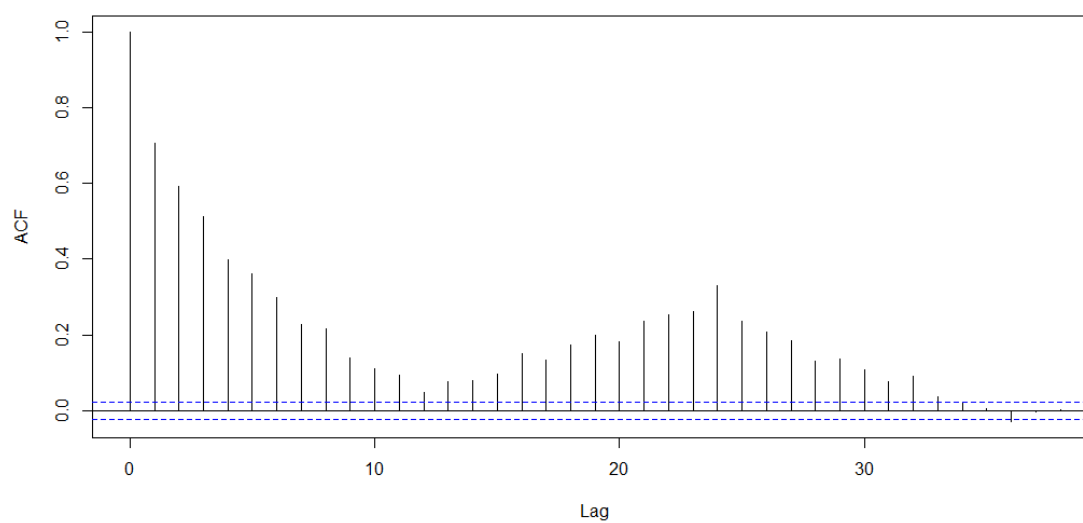


Figure S26. Autocorrelation function plot of the model residuals for departures and log NO₂ at West Harbour in 2020.

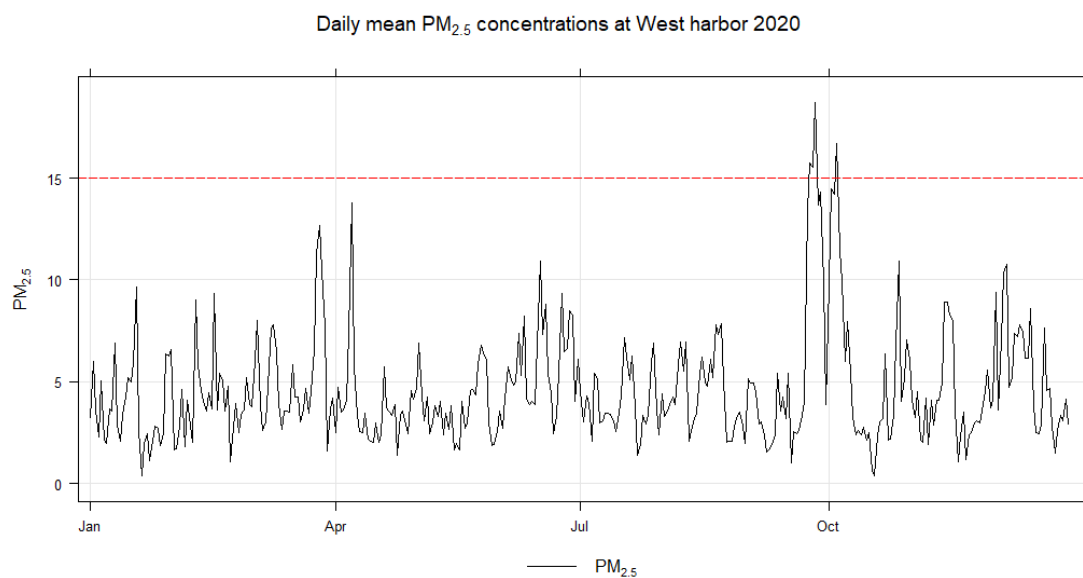


Figure S27. Time series plot of daily mean $PM_{2.5}$ at West Harbour in 2020. Red dashed line is the WHO 2021 guideline value ($15 \mu\text{g}/\text{m}^3$).

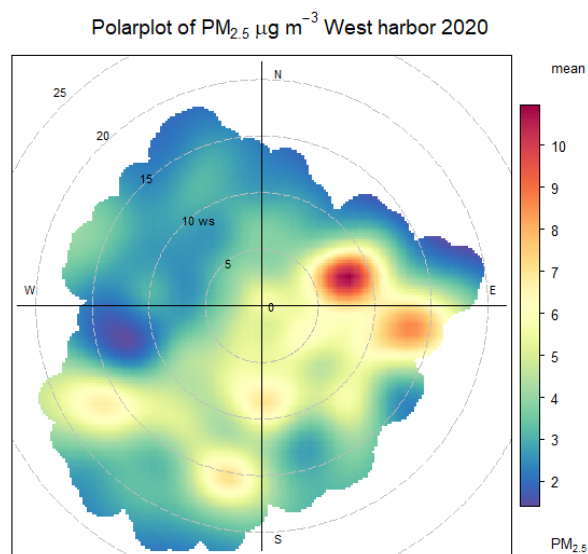


Figure S28. Polarplot of $PM_{2.5}$ concentration by wind direction and speed at West Harbour in 2020.

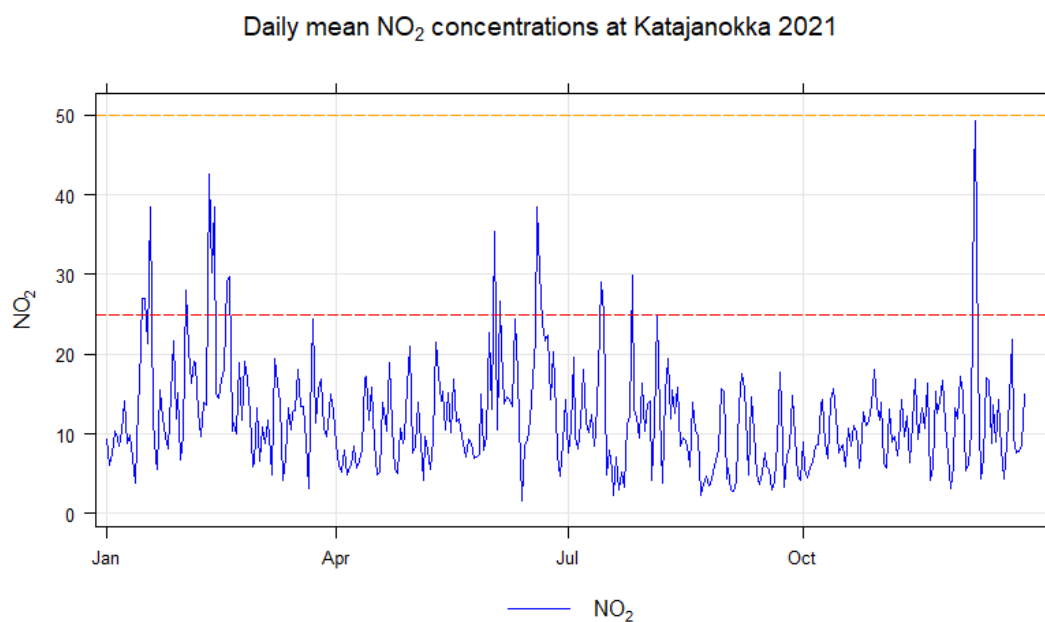


Figure S29. Time series plot of daily mean NO₂ at Katajanokka in 2021. Red dashed line is the WHO 2021 guideline value (25 µg/m³) and the orange dashed line the European Commission proposal (50 µg/m³).

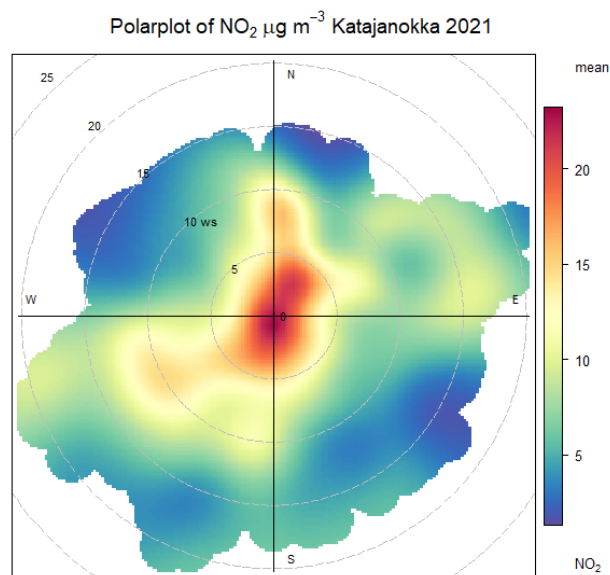


Figure S30. Polarplot of NO₂ concentration by wind speed and direction at Katajanokka in 2021.

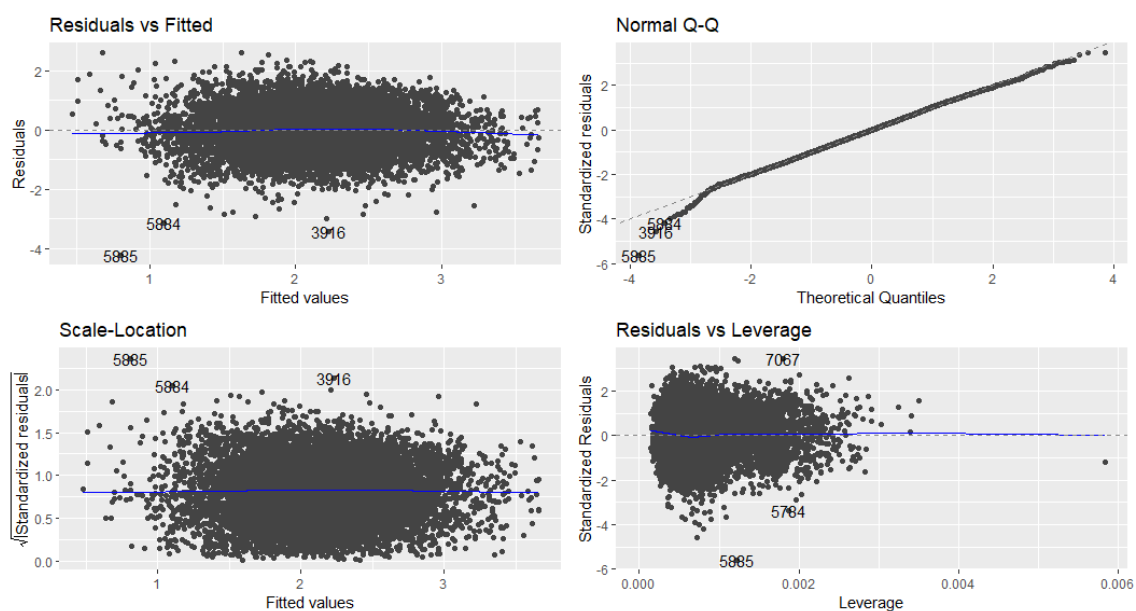


Figure S31. Diagnostic plots of the model residuals for closest ferry departures and log NO₂ at Katajanokka in 2021.

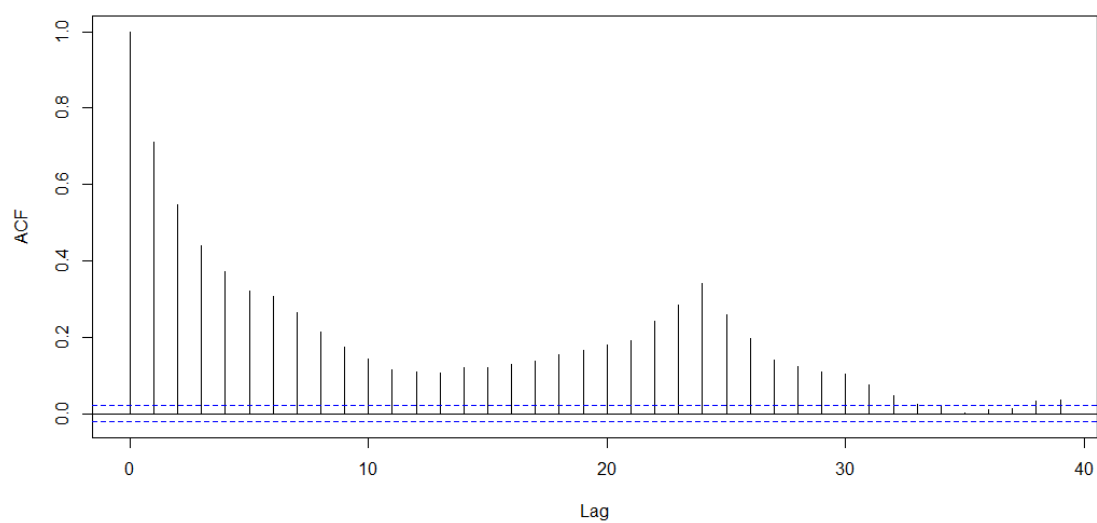


Figure S32. Autocorrelation function plot of the model residuals for closest ferry departures and log NO₂ at Katajanokka in 2021.

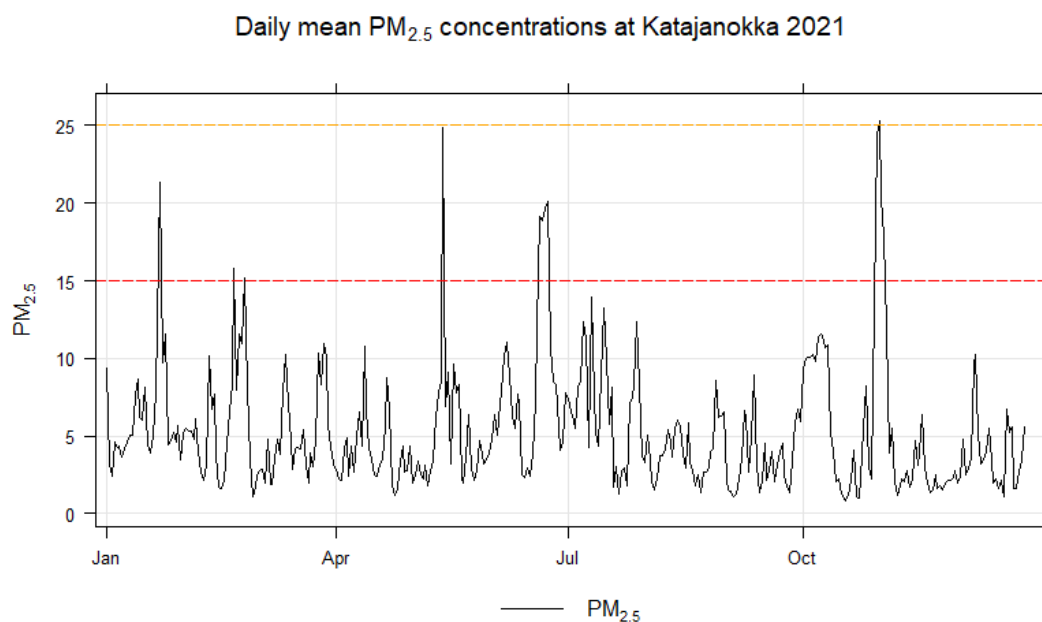


Figure S33. Time series plot of daily mean PM_{2.5} at Katajanokka in 2021. Red dashed line is the WHO 2021 guideline value (15 $\mu\text{g}/\text{m}^3$) and the orange dashed line the European Commission proposal (25 $\mu\text{g}/\text{m}^3$).

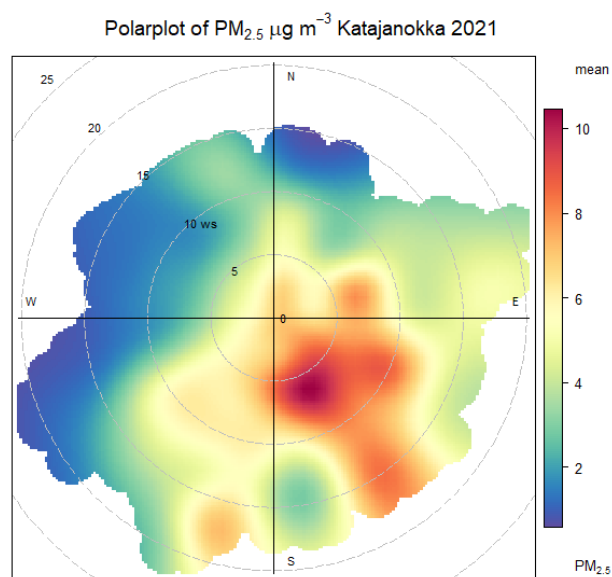


Figure S34. Polarplot of PM_{2.5} concentration by wind direction and speed at Katajanokka in 2021.