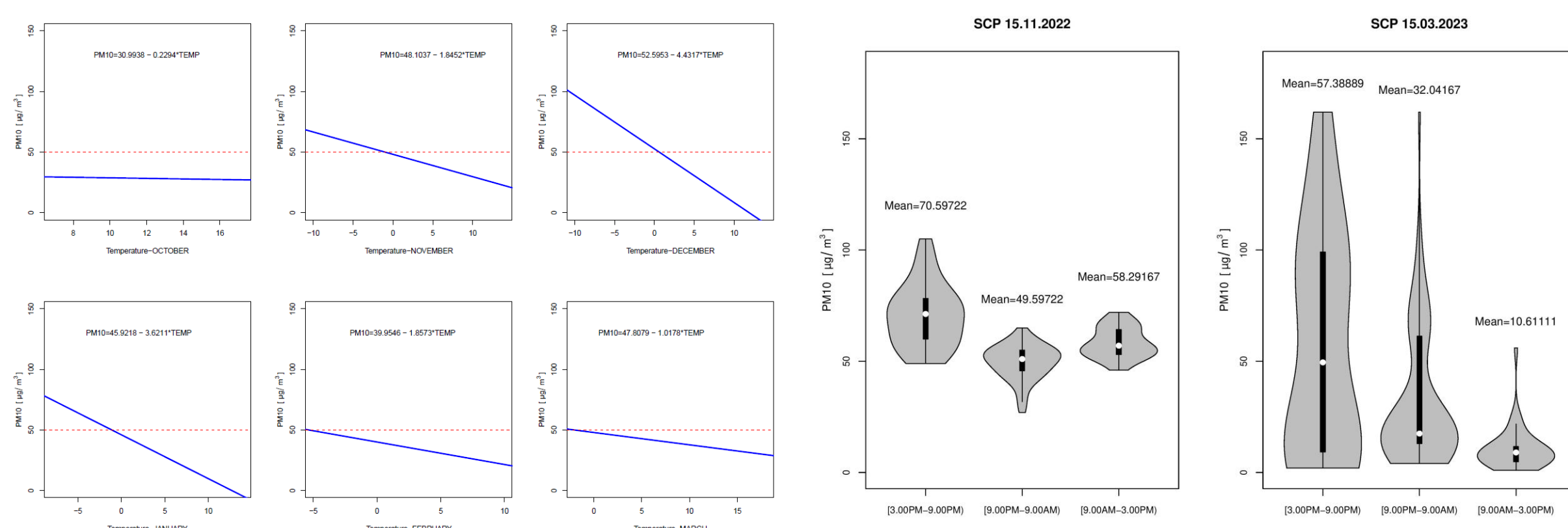
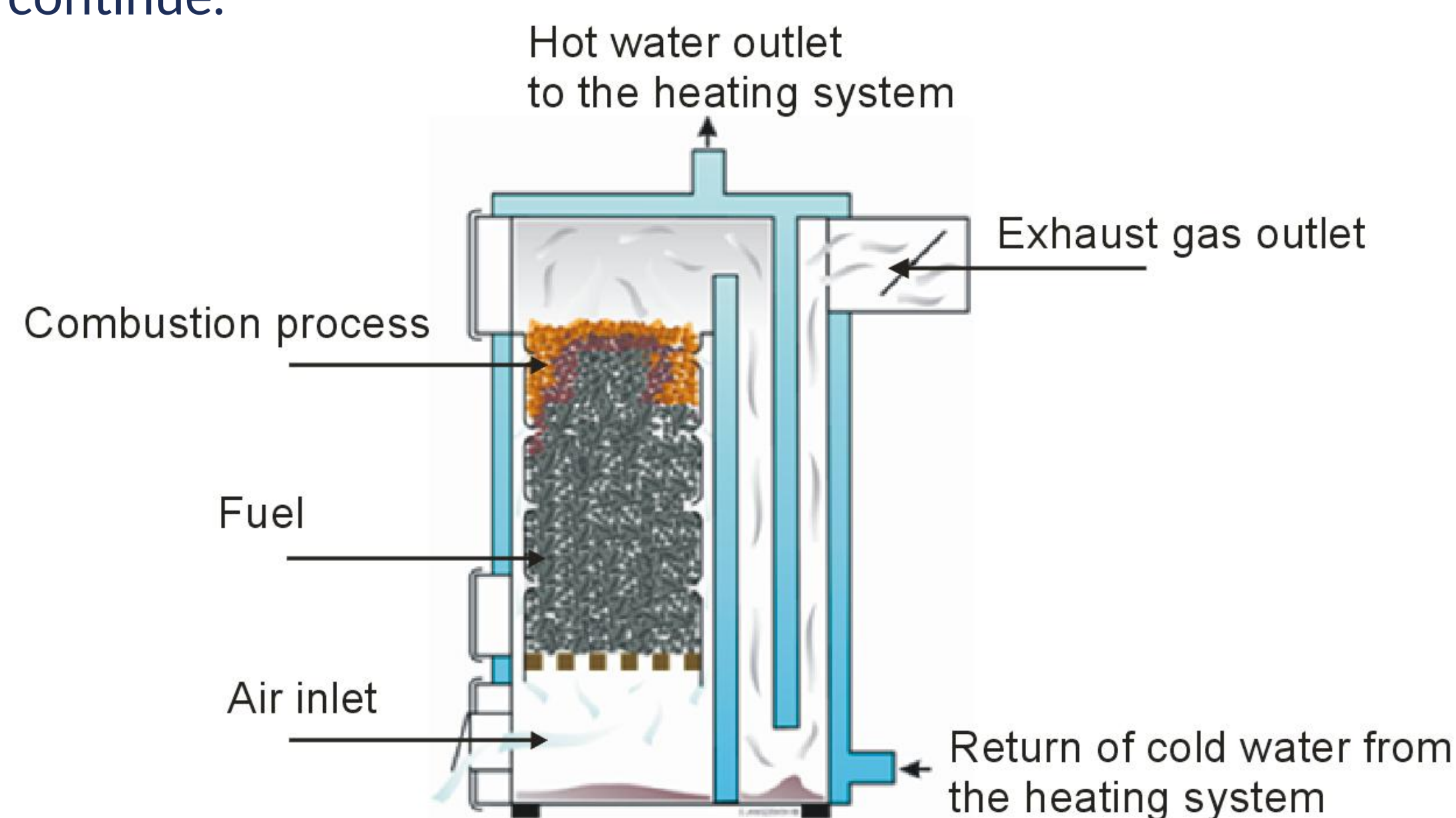


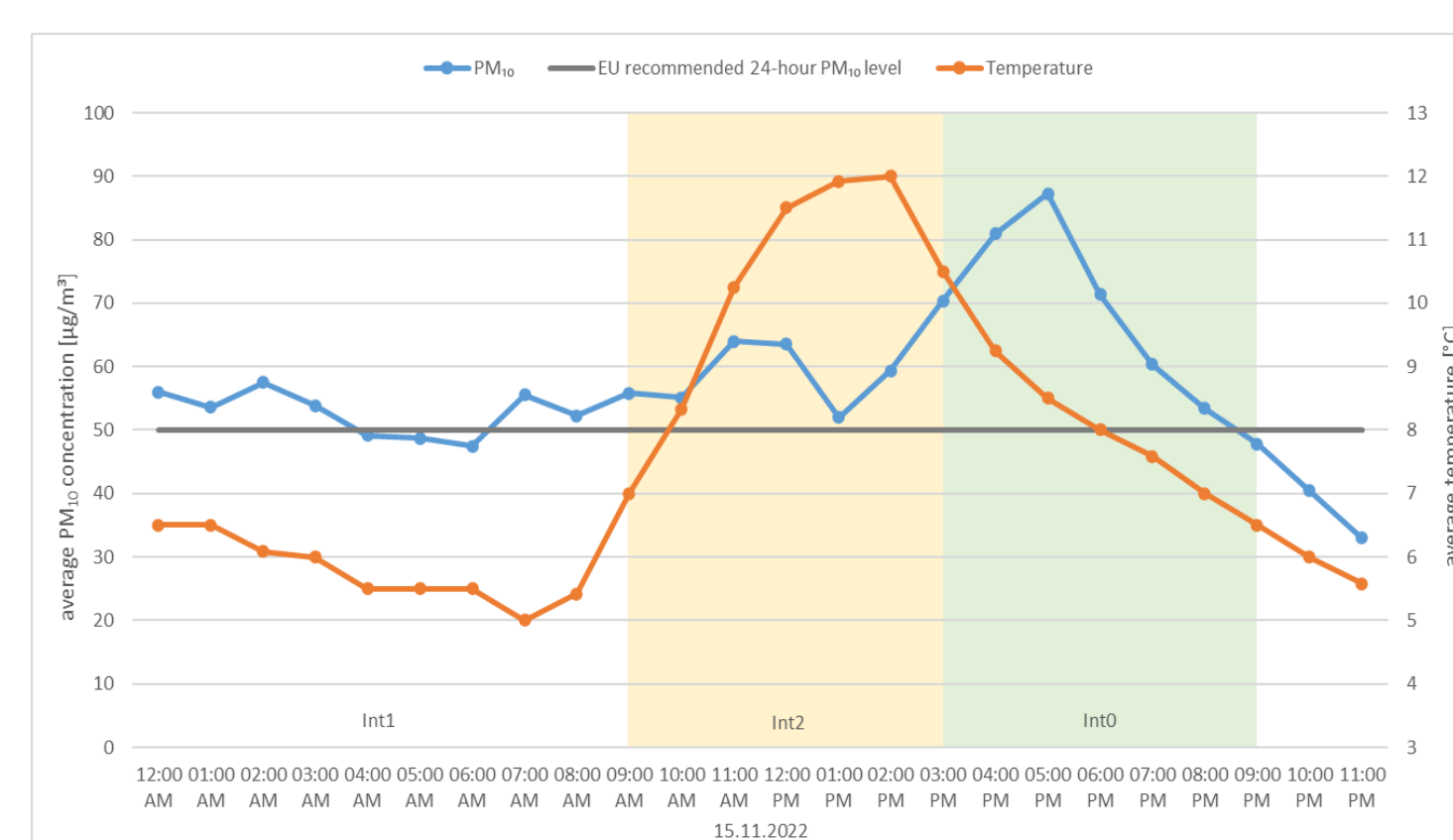
ABSTRACT

Air pollution with particulate matter (PM), recognized by the EU and WHO as a significant factor affecting human health, is subject to standards. Exceeding these standards on a daily or annual basis poses an increased health risk. This study presents an analysis of data from 2022 to 2024 from the administrative area of Pleszew (Poland), which, in 2023, ranked second in the country in terms of annual PM10 concentration [$\mu\text{g}/\text{m}^3$]. The main cause of the poor air quality is identified as so-called “low emissions” resulting from residential heating using high-emission coal-fired boilers. The methods used in this analysis not only identified the main causes of pollutant emissions but also demonstrated the seasonal impact of these sources on air quality, both on an annual and daily basis. The analysis utilized statistical tools such as a mixed linear regression model and Tukey’s post hoc tests performed after analysis of variance (ANOVA). The obtained regression model of PM10 concentration on the outside air temperature (defining the intensity of operation of heating devices) clearly indicates the predicted air pollution. Dividing the day into three-time intervals proved to be an effective analytical tool enabling the identification of periods with the highest risk of high PM10 concentrations. The highest average PM10 concentration values were recorded in the autumn and winter months between 3:00 PM and 9:00 PM. The developed methods can serve as fundamental tools for local government authorities, guiding further energy policy directions for the study area to improve the identified situation. At the same time, daily and hourly air pollution analysis clearly confirmed the characteristics of inefficient heat sources, which will allow residents to protect their health by avoiding spending time outdoors during peak particulate matter concentration hours. Until the energy situation in the region changes, this will continue.



CONCLUSIONS

- The statistical analysis carried out in this study showed a significant relationship between the temperature drop and the increase in the concentration of suspended PM10 particulate matter in the heating season, which confirms the hypothesis about the dominant influence of atmospheric conditions (especially low temperature) on pollutant emissions.
- The key role of manually hand-fired boilers in shaping the level of particulate matter emissions was pointed out, which suggests the need for further regulation and modernization of this type of combustion source.
- Division of the day into three-time intervals (Int0, Int1, Int2) proved to be an effective analytical tool enabling the identification of periods with the highest risk of high PM10 concentrations.
- The results confirm that pollutant emissions are not solely a function of technical factors but are also significantly related to residents’ lifestyles, highlighting the importance of social aspects in air quality research.
- The developed linear regression model enables effective forecasting of local PM10 concentrations depending on temperature, which is a useful tool in planning environmental policy and preventive measures.
- The conducted analysis of variance (ANOVA) and Tukey’s post hoc tests revealed significant differences among the average particulate matter concentrations during the three daily intervals, indicating the complex nature of emission dynamics and the need to account for temporal variability in research and modeling.



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