

INTRODUCTION

When we talk about touristic cities, we have to attend to natural surrounding. The air is an element specific to natural surrounding and to find out its grade of pollution, we have to make specific measurements, depending on hours, days, years. In our study, the Piatra Neamt city has small pollution sources. The industrial platform of the city it is situated at 16 kilometers outside of the city. However, the city has a lot of vehicles, some of them with deprecated pollution standard (Euro 4, Euro 3, Euro 2). The aims of the study conducted has as goal the evaluation of the air quality in the Municipality of Piatra Neamt, on the basis of the hourly data from the station NT1 (urban background) from the interval January 2009 - October 2019, relying on five chemical indicators: Nitrogen dioxide (NO₂), Sulfur dioxide (SO₂), Carbon monoxide (CO), Ozone (O₃) and PM₁₀ sedimentable particles.

The main objectives aimed at the identification of the variations in time of the average hourly or daily concentrations of these pollutants, with the outlining of their daily or annual evolution, with the explanation of their causality and with the identification of some episodes of pollution, but also at thereleasing of someaccurate assessments based on data, observations and findings of duration which to include the air inhaled by the inhabitants of the city and by the tourists in different intervals of quality.

STUDY AREA

The municipality of Piatra Neamt (46°55'39"N 26°22'15"E) is located in the NE of Romania in a lowland area of the Bistrita valley, at the contact between the Carpathian peaks and the sub-Carpathian hills, at an average altitude of 345 m. (Figure 1). With an area of 77.4 km², the city had 85.055 inhabitants according to the 2011 census, being an important economic and tourist center of the NE region of Romania.

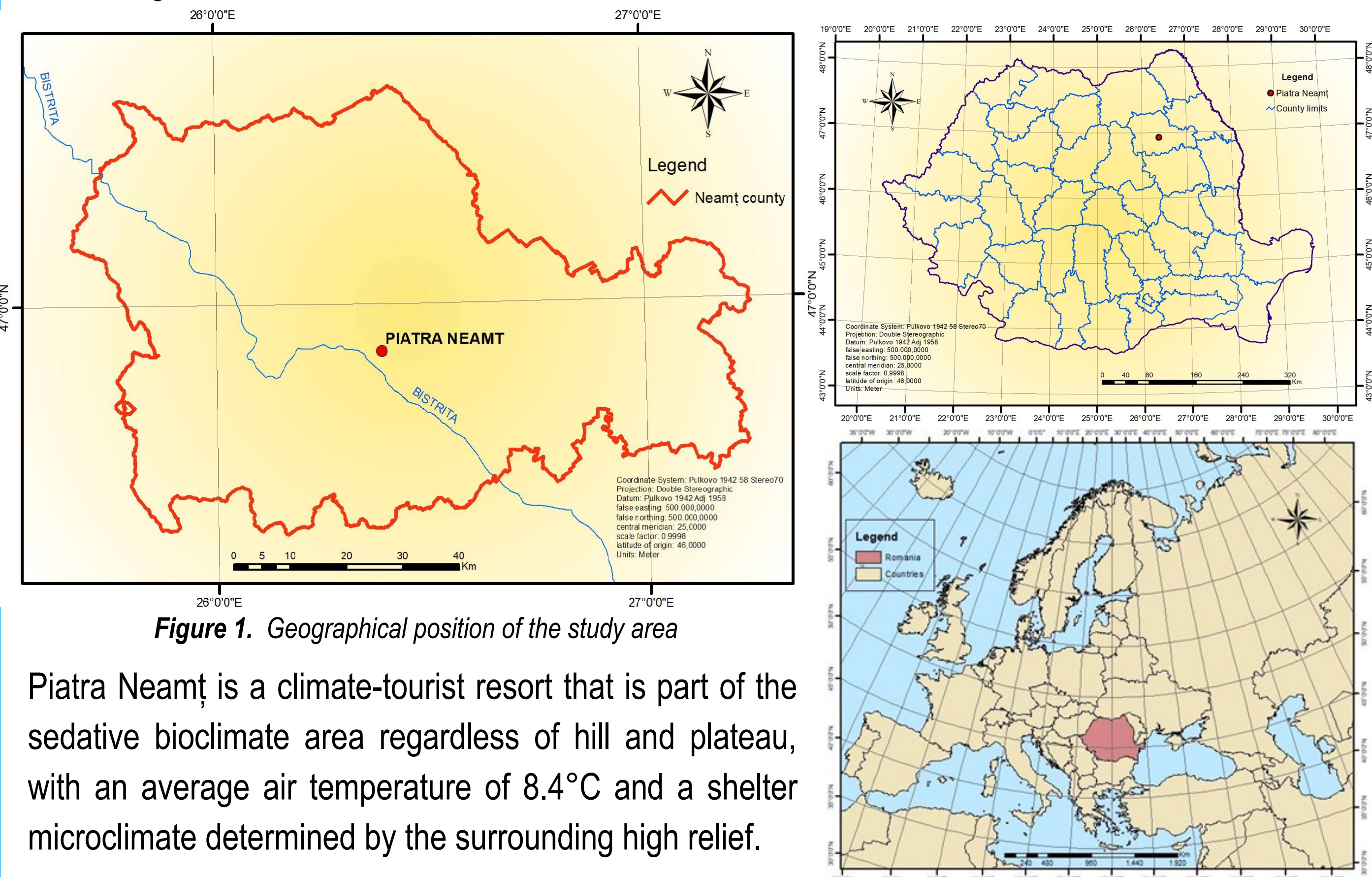


Figure 1. Geographical position of the study area

Piatra Neamt is a climate-tourist resort that is part of the sedative bioclimate area regardless of hill and plateau, with an average air temperature of 8.4°C and a shelter microclimate determined by the surrounding high relief.

MATERIALS AND METHODS

The data used in this study come from the NT1 Station in Piatra Neamt and cover the period from January 2009 to October 2019. The methodological flowchart is based on several steps that are presented in Figure 2. The first step includes the collection of data from the NT1 Station and the formation of a database with the hourly, diurnal and monthly values of the 5 pollutants: Nitrogen dioxide (NO₂), Sulfur dioxide (SO₂), Carbon monoxide (CO), Ozone (O₃) and PM₁₀ sedimentable particles.

All this data is entered into the Excel program. The second phase is processing and consists in the realization of the graphs with the diurnal and monthly variations of each pollutant (Figure 3). The third phase comprises the presentation of the results, their analysis and interpretation. Depending on the variations of each pollutant, it is ascertained whether or not the registered values are above the limit allowed at European level, and what are the causes that lead to the appearance of 'peaks', etc. These interpretations give us an overview of the degree of pollution in the city of Piatra Neamt.

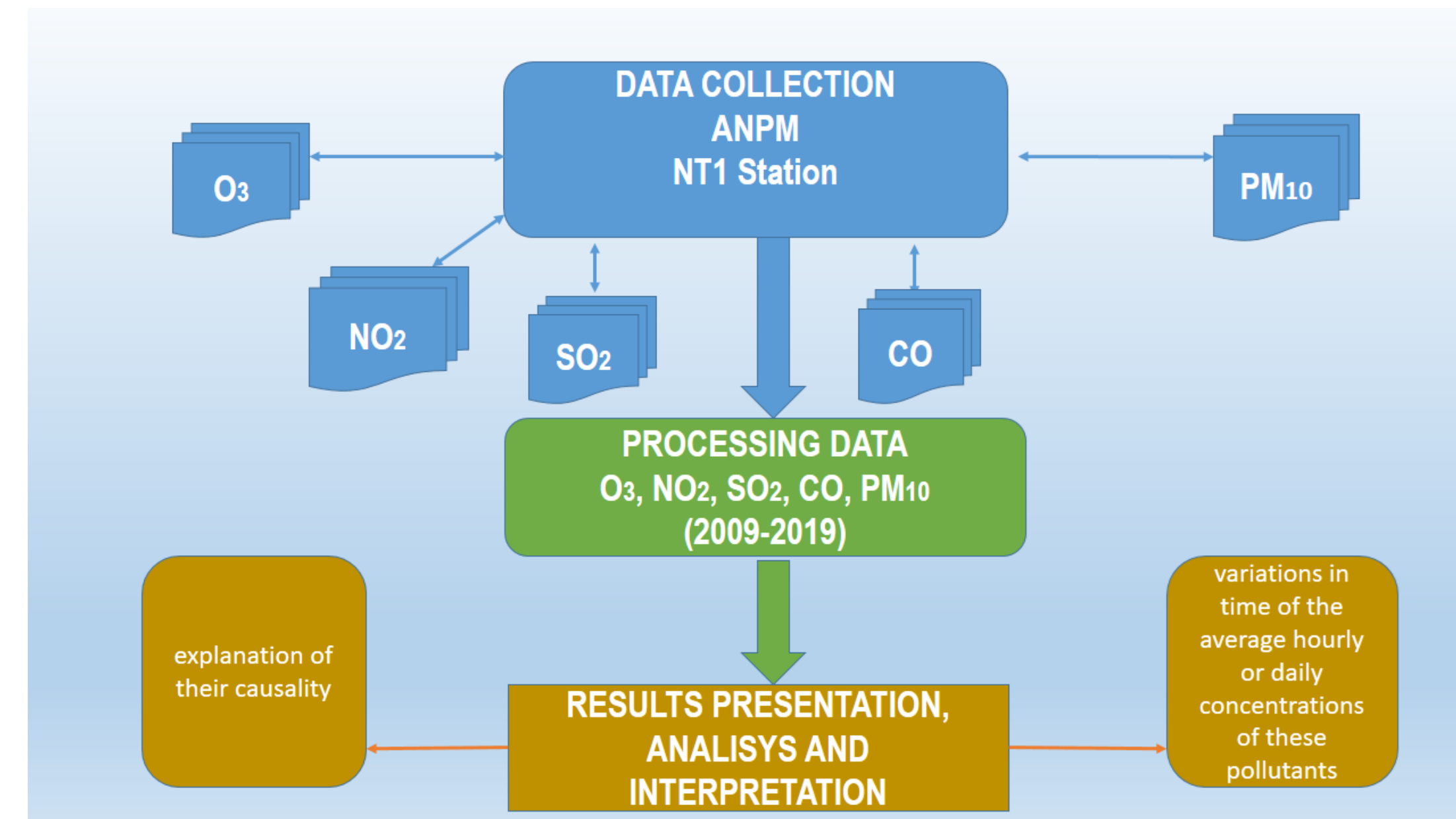


Figure 2. Flow chart of methodological steps

RESULTS AND DISCUSSIONS

The results obtained show that in Piatra Neamt the concentrations of NO₂ (with 94.36 % of the hours of observations with indices of air quality evaluated as excellent), SO₂ (with 99.59 % of the hours of observations with excellent indices of air quality) and CO (with 99.78 % of the hours of observations with indices of air quality also excellent) do not cause real problems to human health (Figures 3-9).

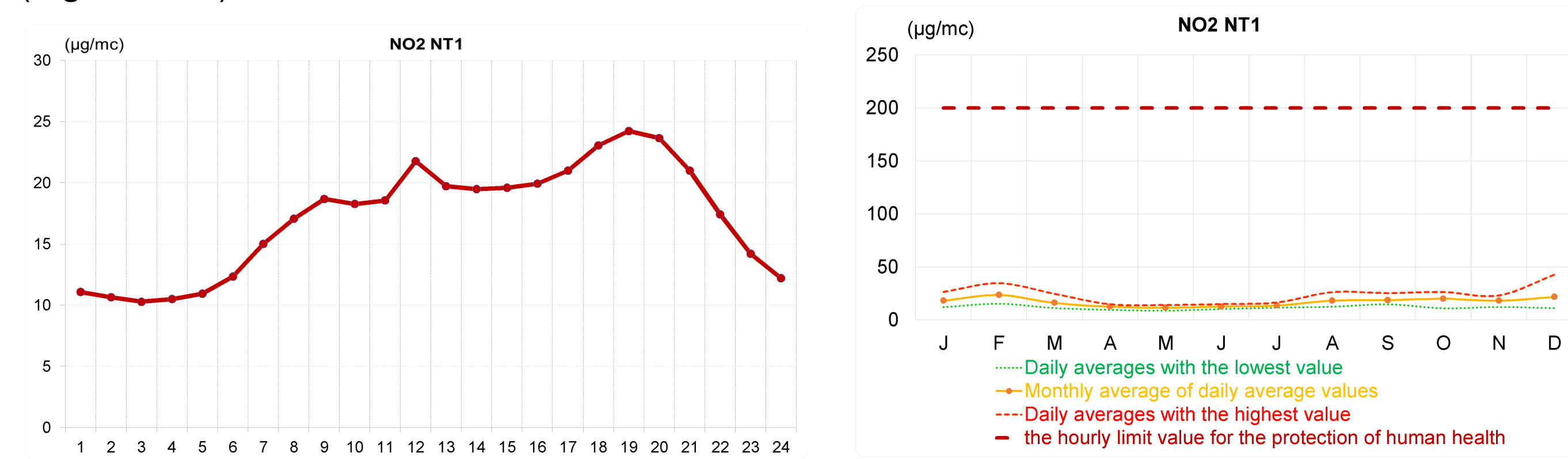


Figure 3. The diurnal regime of the NO₂ concentration and the annual regime of the minimum, average and maximum daily values of the NO₂ concentration of each month at the NT1 station (January 2009 - October 2019)

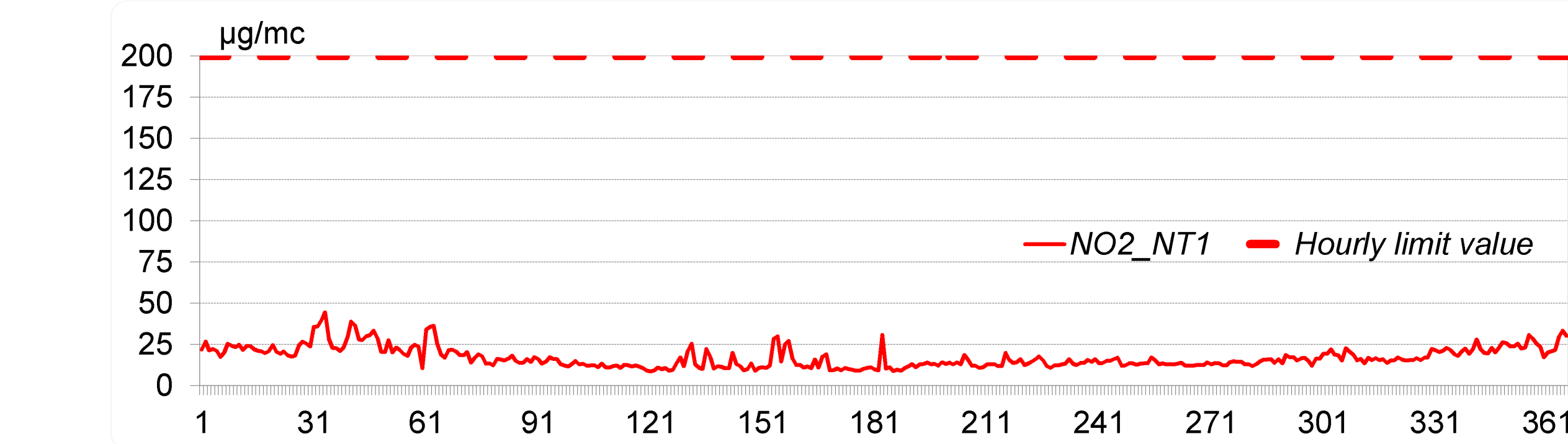


Figure 4. Annual regime of the daily average concentration values of NO₂ to NT1

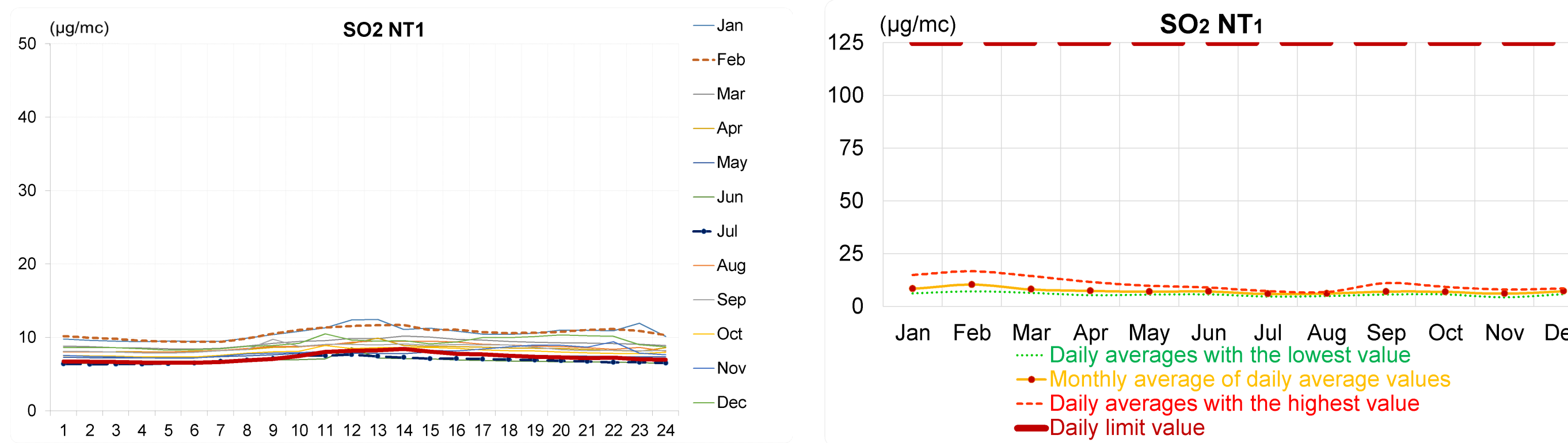


Figure 5. Daily regime of SO₂ concentration values in the atmosphere of the city of Piatra Neamt all months of the year and for an average year (January 2009 - October 2019)

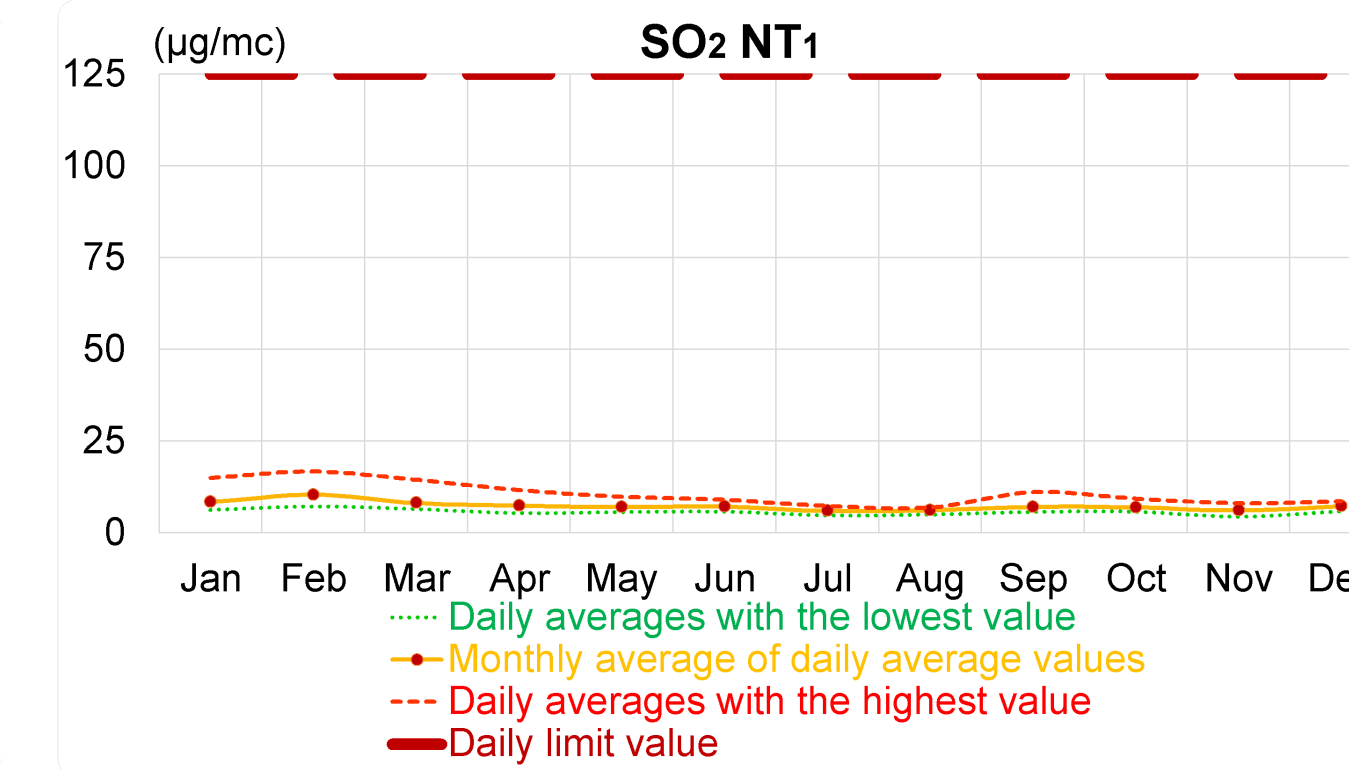


Figure 6. The annual regime of the minimum, average and maximum daily values of the SO₂ concentration of each month at the NT1 station (January 2009 - October 2019)

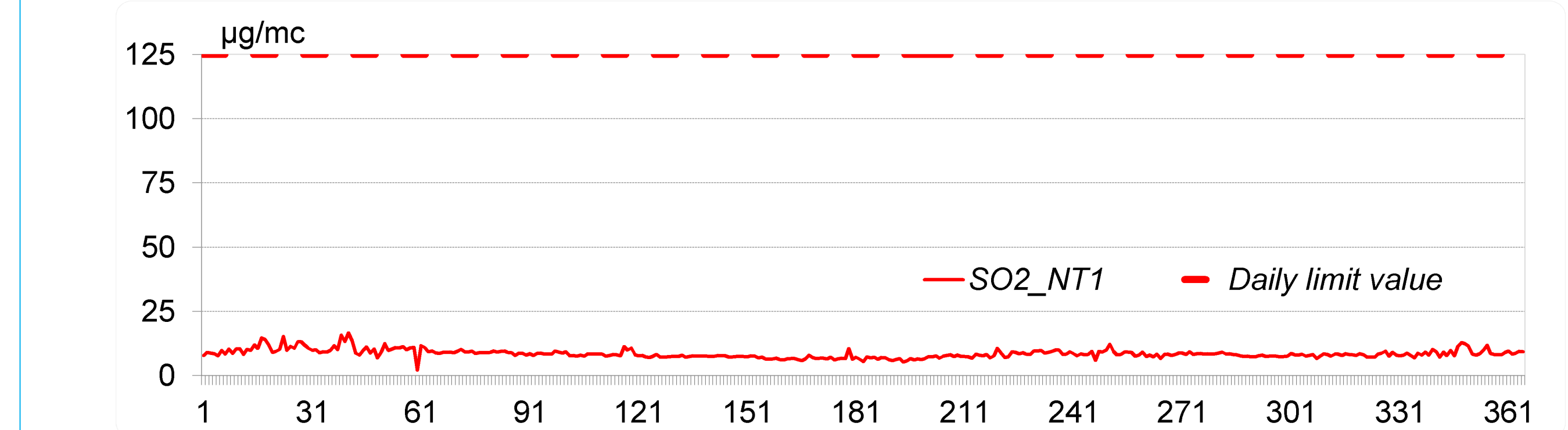


Figure 7. Annual regime of the values of the daily average concentration of SO₂ at NT1 (January 2009 - October 2019)

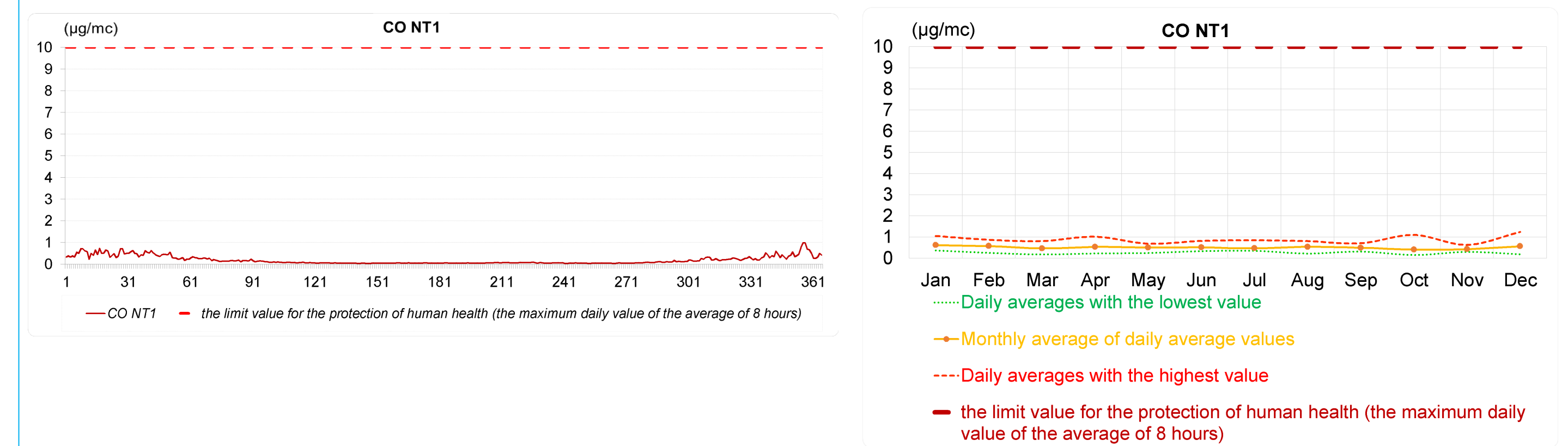


Figure 8. Annual regime of the values of the daily average concentration of CO at NT1 (January 2009 - October 2019)

Figure 9. The annual regime of the minimum, average and maximum daily values of the monthly CO concentration at the NT1 station (January 2009 - October 2019)

For the O₃ in 0.8 % of the hours of observation from NT1, the concentration of this gas has exceeded the threshold of 120 µg / mc which, according to the European directives, is the target value for the protection of human health. Neither the concentration of PM₁₀ sedimentable particles causes problems (the amount of time with exceedings of the daily limit value for the protection of human health being on average 2.8 days / year⁻¹-Figures 10-11). The October-March interval, with thermal inversions, with radiation fog and persistent stratiform clouds is more favorable for keeping this pollutant in suspension.

Value limits µg/mc	Quality indices	The significance	Percentage held NT1 (%)
0-40	1	Excellent	49,70
40-80	2	Very good	41,83
80-120	3	Good	7,65
120-180	4	Medium	0,80
180-240	5	Bad	0,01
>240	6	Very bad	0,01
Total			100

Figure 10. Percentages held by the values of the hourly concentration of O₃ at different intervals and quality indices related to them at the air quality monitoring station NT1 (January 2009– October 2019)

Value limits µg/mc	Quality indices	The significance	Percentage held NT1 (%)
0 - 10	1	Excellent	17,4
10 - 20	2	Very good	38,5
20 - 30	3	Good	23,3
30 - 50	4	Medium	18,0
50 - 100	5	Bad	2,4
> 100	6	Very bad	0,4
Total			100

Figure 11. Percentages held by PM₁₀ daily concentration values at different intervals and quality indices related to them at the NT1 air quality monitoring station (January 2009 - October 2019)

CONCLUSIONS

The quality of the air from the city of Piatra Neamt atmosphere is excellent. The sedative-indifferent bioclimate and the sanogenous atmosphere of this city at the contact between the Eastern Carpathians - Subcarpathians of Moldova increase the tourist attraction of the municipality of Piatra Neamt. The only pollutant that rarely raises pollution problems through its concentrations in the atmosphere is PM₁₀.

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