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AIR POLLUTION METEOROLOGY. CASE STUDY: SO_2 AND NO_2 MONITORING IN ARGEȘ COUNTY

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Abstract
Air pollution is one of the most dangerous forms of pollution, which can have disastrous effects on the environment. For example, pollution with sulfur oxides contributes to the formation of acid rain and nitrogen oxides promote the accumulation of nitrates in the soil.
Meteorological factors, such as temperature, significantly influence the levels of pollution and the spread of pollutants in the lower atmosphere. Air pollution meteorology helps to understand how pollutants are emitted and dispersed in the ambient air. Therefore, the purpose of the paper was to monitor for one year the concentrations of NO_2 and SO_2 in Argeș County and to correlate these data with climatic and urban parameters.
The study concludes with a simulation of the dispersion of pollutants emitted by a source, having dimensions and location similar to those of the evacuation tower from CET Bradu, in conditions of a stable atmosphere at various temperatures.

Keywords: air pollution, nitrogen dioxide, sulphur dioxide, vertical temperature gradient

1. INTRODUCTION

Environmental issues have risen significantly to the top of scientific concerns, accumulating an impressive capacity of ideas, questions, controversies, arguments, which have created the need for a global approach. The causes of increasing atmospheric pollution are: the chemical, metallurgical and cement industries, road and air traffic, the burning of waste, the growth in energy production, etc. This pollution is due either to an increase in the concentration of certain constituents in the air (carbon dioxide, nitrogen oxides, sulphur oxides, etc.) or to the penetration into the atmosphere of compounds foreign to this environment (radioactive elements, synthetic organic substances, etc.).
Meteorological conditions determine how pollutants disperse through the air (Chris, 2002, Strâmbeanu et al., 2016). The time that pollutant emissions spend in the air and the place where the maximum pollutant concentration reaches the ground is influenced by several meteorological conditions, such as: thermal inversion, high air humidity, wind and calm atmospheric, etc. (Di Bernardino and al., 2021) Recent research show a reduction in the average wind speed of up to 62% experienced at the pedestrian level with increasing density of urban buildings (Palusci et al., 2021).
Both sulphur and nitrogen dioxide are among the regular urban air pollutants, whose values may increase due to the anthropogenic sources of pollution (Constantin et al., 2017). Sulphur dioxide

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(SO_2) is a colourless gas with a pungent and irritating odour. It also has different consequences for human health, depending on the concentration and the period of exposure. In the atmosphere, it contributes to the acidification of precipitation, with toxic effects on vegetation and soil. Nitrogen dioxide (NO_2) is a reddish-brown gas with a strong, stifling odor. It is the result of road traffic, industrial activities, electricity production. The population exposed to this type of pollutants may have difficulty breathing, respiratory tract irritation, lung dysfunction (especially children). Due to the fact that individuals are simultaneously exposed to several air pollutants, recent epidemiological studies have focused on assessing the individual and common effect of mixtures of air pollutants (PM2.5, O_3 and NO_2) on population mortality. The results suggest a strong association between the mixture of pollutants and mortality of any cause, determined mainly by PM2.5 (Li et al., 2021). Moreover, nitrogen oxides contribute to the formation of acid rain and promote the accumulation of nitrates in the soil which can cause alteration of the environmental ecological balance.
The main aim of the study is to follow the dispersion mode for the air pollution indicators sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) in Arges county, in relation to climatic and topographical factors, but also to the nature of the pollution sources.

2. MATERIALS AND METHODS

For this study on the meteorology of air pollution with sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) in Argeș County, the average daily concentrations of these two pollution indicators were monitored during one year, concentrations recorded at automatic monitoring stations located throughout the county.
The monitoring of the two pollution indicators - sulphur dioxide and nitrogen dioxide - in Arges county is carried out with the help of six automatic air quality monitoring stations located in different areas (see table 1), which are part of the national air quality monitoring network (www.calitateaer.ro).

Table 1. The monitoring stations

Station	Type	Location	Parameters monitored
AG 1	Traffic	Bld. Bălcescu	NO, NO_2, NOx, SO_2, CO, PM_{10}, BTEX, Pb, Cd, Ni, As
AG 2	Urban background	Victoriei Street, no. 20	NO, NO_2, NOx, SO_2, CO, O_3, PM_{10}, BTEX, weather station
AG 3	Suburban background	Călinești, General School Radu Negru	NO, NO_2, NOx, SO_2, CO, O_3, PM_{10}, BTEX, Pb, Cd, Ni, As, weather station
AG 4	Suburban background	Budeasa, Calotești	NO, NO_2, NOx, SO_2, CO, O_3, PM_{10}, BTEX, Pb, Cd, Ni, As, weather station
AG 5	Industrial 2	Oarja	NO, NO_2, NOx, SO_2, CO, O_3, PM_{10}, BTEX, weather station
AG 6	Industrial 1	Câmpulung	NO, NO_2, NOx, SO_2, CO, PM_{10}, Pb, Cd, Ni, As, weather station

The UV fluorescence method was used to measure the pollution indicator sulphur dioxide (SO_2) and the chemiluminescence method was used to measure the indicator nitrogen dioxide (NO_2). For the study, data from the National Air Quality Monitoring Network (NAMN) were analized, processed

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and correlated with climatological data taken from the National Meteorological Administration (http://www.meteoromania.ro).

The study concludes with mathematical modelling of air pollutant dispersion. A numerical modelling program (called SCREEN) was used to study the influence of meteorological factors, especially air temperature, on the dispersion of air pollutants. This program is used to estimate the maximum pollutant concentration as a function of air temperature.

3. RESULTS AND DISCUSSIONS

Following the analysis of sulphur dioxide (SO_2) concentrations recorded in Argeș county during one year, it is observed that the maximum value of sulphur dioxide concentration was recorded in May, 17.74 µg/m³, at the suburban background monitoring station (AG 4), and the minimum concentration of the pollutant was recorded in April, 3.92 µg/m³, also at the suburban background monitoring station (AG 3). The maximum value recorded did not exceed the legislated value of 125 µg/m³ per day for the protection of human health.

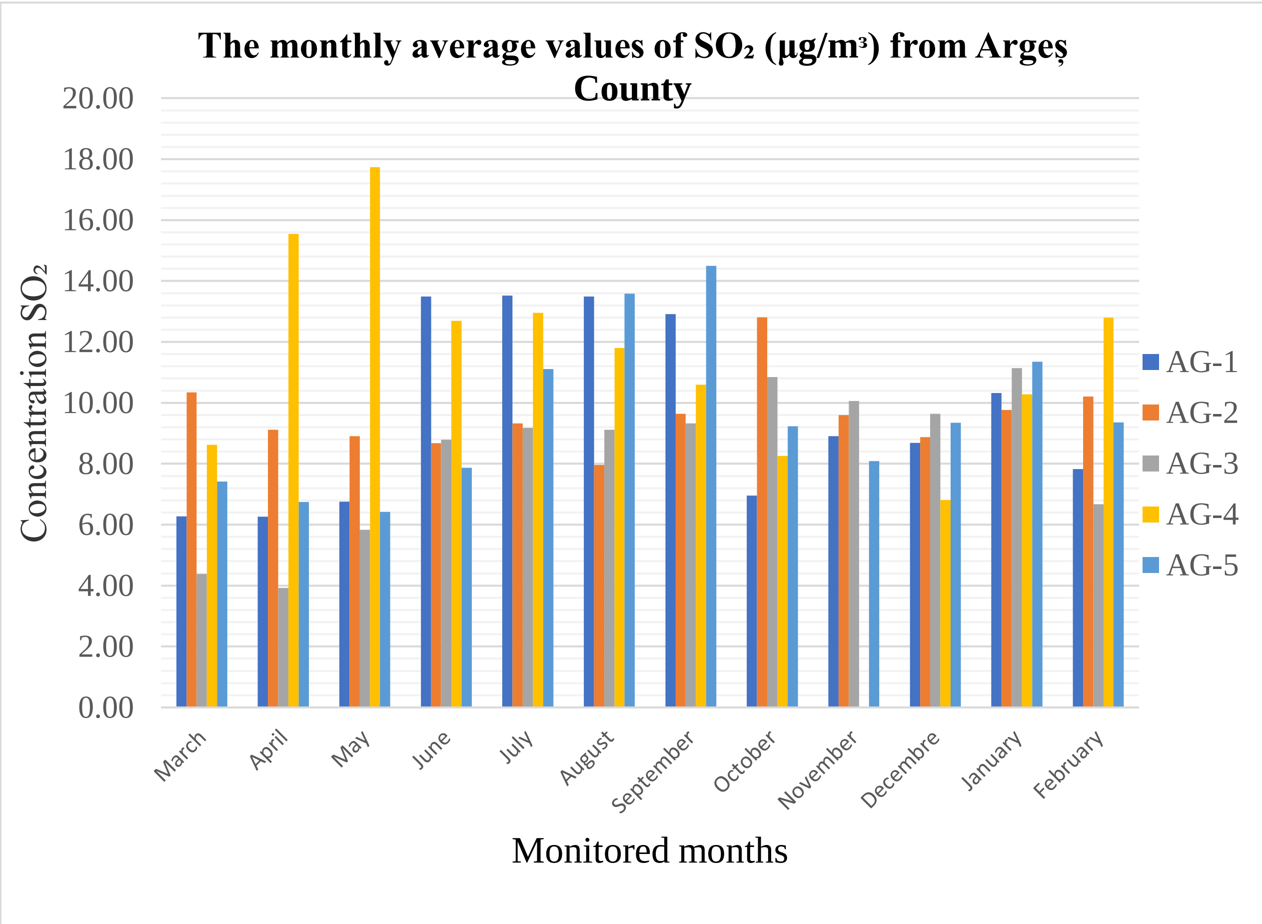

Figure 1. Evolution of the monthly average values (µg/m³) of SO_2, March 2020 - February 2021

The maximum concentration was recorded on 17 May 2020 and was influenced by the existence of a high pressure field over our country, caused by the appearance of Azoric with the barycentre

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Quirinius. During this period, temperatures of 11-14 ºC were recorded in Arges county during the night, while during the day the highs were around 19-20 ºC (see figure 2).

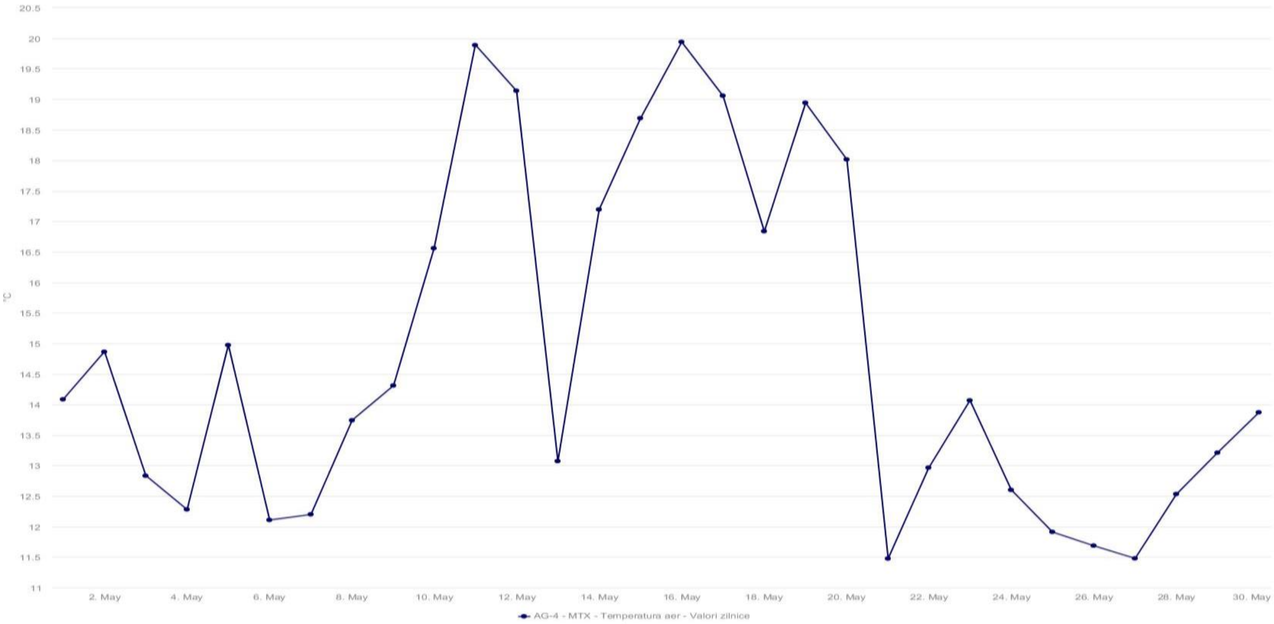

Figure 2. Distribution of air temperature in Argeș country in May

Analyzing the annual regime of nitrogen dioxide (NO_2) in Argeș County, it is observed (figure 3) that the highest value of the monthly average concentration of nitrogen dioxide was recorded in November 2020 and had a value of 45.62 µg/m^3, recorded at the road traffic monitoring station (AG 1). The lowest nitrogen dioxide concentration was recorded at the industrial area monitoring station in July 2020, with a value of 4.44 µg/m^3. As in the case of sulphur dioxide, the maximum recorded concentration of nitrogen dioxide did not exceed the maximum allowable concentration either.
The maximum concentration of nitrogen dioxide was recorded on 27 November 2020, as a result of the presence of a high-pressure field associated with an East European anticyclone over the Black Sea area. With the appearance of this anticyclone in the Black Sea area we also experienced negative temperature deviations of (-4) - (-6) ºC from the normal period. Daytime highs remained around the 0 ºC threshold across the county, while overnight temperatures dropped sharply, with lows of negative (-4) - (-6) ºC. All these conditions resulted in high nitrogen dioxide concentration in Arges County.
In order to study the influence of air temperature on the movement of the pollutants, a simulation of the dispersion of pollutants emitted from a source similar in size and location as that of CET Pitesti (with a height of 180 m and the inner dimension of the exhaust chimney of 5 m) (figure 4) was performed.

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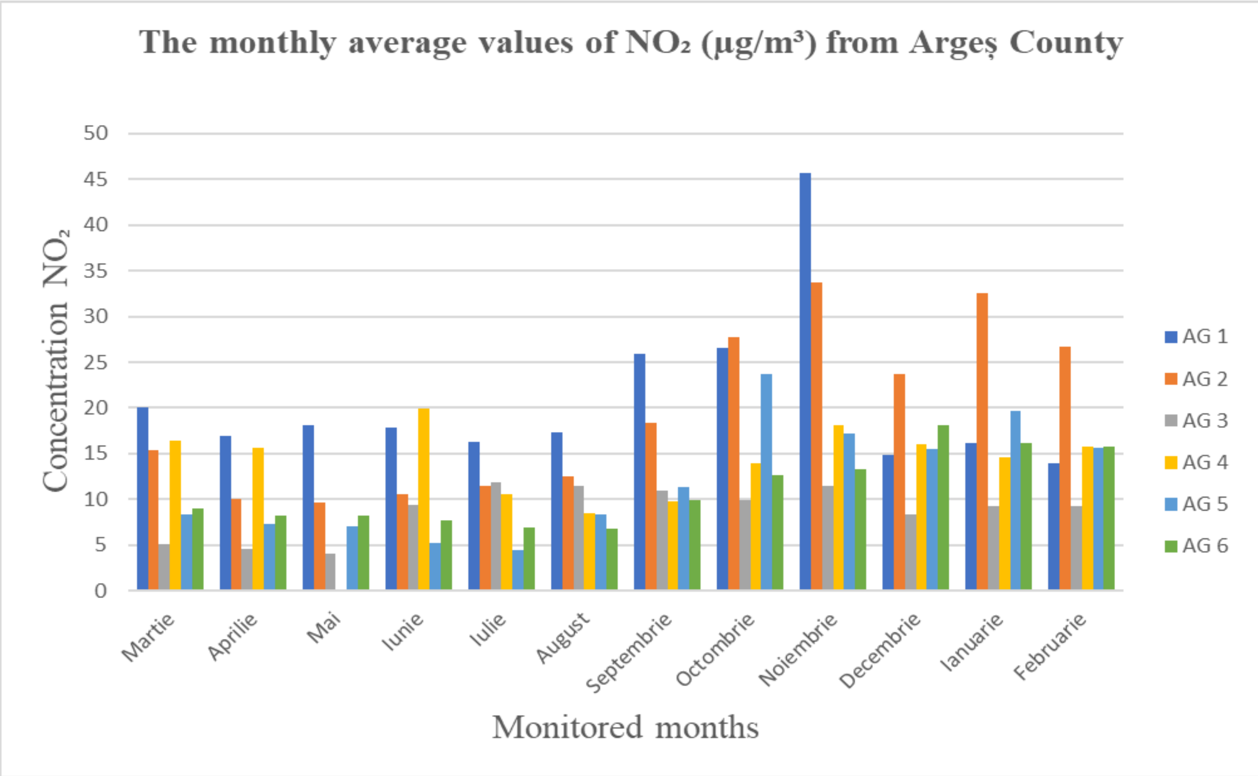

Figure 3. Evolution of the monthly average values (µg/m³) of NO_2, March 2020 - February 2021

Figure 4. Detail CET Bradu and planimetric coordinates Stereo 70

From the data obtained by running the SCREEN program it was observed that the variation in pollutant concentration is directly proportional to the variation in air temperature, i.e. the higher the air temperature, the higher the concentration of the pollutant. The maximum air temperature occurs close to the earth's surface in the troposphere, it decreases uniformly with altitude with a gradient of about 0.65 ºC/100 m. From table 2 it can be seen that the highest concentration of the pollutant was 8.759 µg/m³ at a temperature of 311 ºK

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Table 2 The variation of maximum pollutant concentration with air temperature (for stability class-2)

No. crt.	Stability class	Temperature (ºK)	Maximum concentration (µg/m²)
1	2	273	5.493
2	2	275	5.593
3	2	277	5.696
4	2	279	5.804
5	2	281	5.916
6	2	283	6.033
7	2	285	6.156
8	2	287	6.284
9	2	289	6.418
10	2	291	6.558
11	2	293	6.706
12	2	295	6.861
13	2	297	7.024
14	2	299	7.154
15	2	301	7.381
16	2	303	7.622
17	2	305	7.879
18	2	307	8.153
19	2	309	8.445
20	2	311	8.759

From the figure 5, it can be seen that as it moves away from the source, the maximum concentration of the pollutant decreases liniar.

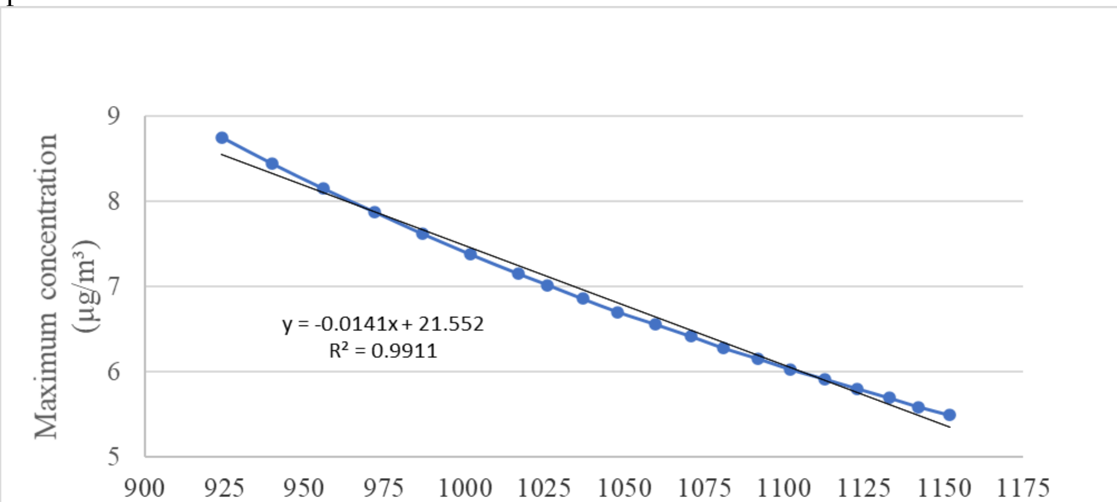

Figure 5. Evolution of the maximum pollutant concentration as a function of the distance from source (m) at which the pollutant reaches the ground

The knowledge of air pollution meteorology is very important in modelling pollutant dispersion. Air pollution meteorology helps us to understand how pollutants enter the atmosphere and are dispersed.

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4. CONCLUSIONS

The continuous monitoring of the main air pollutants and the establishing the role of environmental factors in their diffusion are necessary steps in maintaining a quality of life. It is necessary to determine the causes of pollution and apply sustainable solutions to keep the pollutants concentration in the atmosphere within the limits imposed by European legislation. In our study, during the monitored period, the maximum allowed values for SO_2 and NO_2 were not exceeded in any month.

The level of pollution and spread of harmful noxious substances in the lower atmospheric layer is significantly influenced by meteorological factors. The transfer and dispersion of harmful substances, which enter the atmosphere, occurs according to the laws of turbulent diffusion. It depends on the vertical temperature distribution (thermal stratification) and wind speed. If the temperature with height decreases and unstable stratification occurs, then conditions of intense turbulent exchange are created, the concentration of pollutants decreases. If in the lower atmospheric layer, the temperature increases with height (thermal inversion), then the dispersion of pollutants decreases, because containment layers appear, which limit the rise of emissions and contribute to their accumulation in the air layer near the ground.

In this case, in order to reduce the concentration of SO and NO pollutants, it is necessary to: modernize all municipal roads in Argeș county, make ecological and economical cars and obtain a plan to reduce energy consumption (ECO Energy) which could result in a reduction of emissions by reducing consumption.

It is necessary to replace traditional technologies for the elimination of environmental pollutants with new technologies, cost-effective and efficient, based on nanomaterials, which ensure the remediation of pollution in a sustainable manner.

5. REFERENCES

Chris, J.W. (2002). Effects of wind shear on pollution dispersion. *Atmospheric Environment*, *36*, 511 – 517

Constantin, D.M., Grigore, E., Bogdan, E., Manta, D.R., Ilea, R. (2017). The influence of the synoptic conditions in the dispersion of the air pollution indicator – the sulphur dioxide (SO_2) in the Slatina area. 289-296, https://www.researchgate.net/publication/324993704.

Di Bernardino, A., Iannarelli, A.M., Casadio, S., Perrino, C., Barnaba, F., Tofful, L., Campanelli, M., Di Liberto, L., Mevi, G., Siani, A.M., Cacciani, M. (2021). Impact of synoptic meteorological conditions on air quality in three different case studies in Rome, Italy. *Atmospheric Pollution Research, 12(4),* 76-88. (https://www.sciencedirect.com/science/article/pii/S130910422100091X).

Li, H., Deng, W., Small, R., Schwartz, J., Liu, J., Shi, L. (2021).Health effects of air pollutant mixtures on overall mortality among the elderly population using Bayesian kernel machine regression (BKMR). *Chemosphere*, *286(1),* (https://www.sciencedirect.com/science/article/pii/S0045653521020385).

Palusci, O., Monti, P., Cecere, C., Montazeri, H., Blocken, B. (2021). Impact of morphological parameters on urban ventilation in compact cities: The case of the Tuscolano-Don Bosco district in Rome. *Science of The Total Environment, 807 (2)*, (https://www.sciencedirect.com/science/article/pii/S0048969721055674).

Strâmbeanu, N., Gherebeanu, D., Bumbu, B., Mihailescu, M., Popa, A.D. (2016). Statistical study of the atmospheric dispersion of sulphur and nitrogen oxides at the stack of a special waste incineration plant located in the southern part of Timisoara. https://ibn.idsi.md/sites/default/files/imag_file/2016_Book_of_Abstracts_SIMI.pdf

*** (2013), Premature Mortality Due to Air Pollution, Earth Observatory, NASA http://earthobservatory.nasa.gov/IOTD/view.php?id=82087&eocn=home&eoci=io td_title, accessed on January 31, 2021

www.calitateaer.ro accesed on July 2020

http://www.meteoromania.ro, accesed on May 2020

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