THE IMPORTANCE OF THE ACCURACY OF PUBLIC WEATHER FORECASTS FOR FARMERS IN THE CONTEXT OF CLIMATE CHANGE IN THE MANAGEMENT OF AGRO-TECHNICAL DECISIONS

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ABSTRACT

In the context of environmental policy, the term climate change has become synonymous with global warming.The management of agrotechnical decisions includes specific activities of elaboration, organization, command, coordination and control. The information received, including weather forecasts, influence the entire decision-making mechanism, and erroneous information can cause an unsatisfactory result.

The aim of the study is to verify the extent to which public meteorological forecasts developed for an agricultural area have been achieved to see if these forecasts can help farmers plan their activities according to these forecasts.

In this paper a statistical study was performed, comparing a forecast model for 3 meteorological stations located in the agricultural area of Oltenia.

INTRODUCTION

In the context of environmental policy, the term climate change has become synonymous with global warming. In scientific work, global warming refers to an increase in surface temperature, while climate change includes global warming and any factor that affects greenhouse gas levels.

Some human activities are the main causes of ongoing climate change, called global warming [2]. Climate change has already had a significant impact on ecosystems, the economy and human health, as well as on well-being in Europe [3].

As an effect of these changes, extreme weather events (heat waves, heavy rainfall and periods of drought) have increased in frequency and intensity in many regions. Climate forecasting patterns modified by these factors predict that extreme weather events will intensify in many European regions.

Climate factors are called climate forcing or "coercion mechanisms" [4]. This includes processes such as variations in solar radiation, variations in the Earth's orbit, variations in albedo or reflection of continents, atmosphere and oceans, mountain formation and continental drift, and changes in greenhouse gas concentrations.

The response of the climate system to these mechanisms could be rapid in the presence of volcanic ash in the air reflecting sunlight will cause a sudden or slow cooling in the case of thermal expansion of warm ocean waters or a combination in the event of sudden loss of albedo in the Arctic Ocean, as the ice melts, followed by more gradual thermal expansion of the water. The climate system may have a sudden response, but the definitive response to coercive mechanisms could take a long time.

The research of these phenomena comes in the context in which climate change has brought important changes in the current aspect of the weather and the degree of uncertainty of the forecasts has increased.

The aim of the study is to verify the extent to which public meteorological forecasts developed for an agricultural area have been achieved to see if these forecasts can help farmers plan their activities according to these forecasts.

The hypotheses from which the study was started were the following:

1. Farmers need as accurate information as possible regarding the evolution of certain climatic factors (temperature, precipitation, wind) to start or postpone the works, these being part of the activities through which the management of agricultural activities is put into practice.
2. The situation we are referring to is that of an ordinary farmer who cannot afford to pay a subscription to a weather service to benefit from this information.
3. The data provided by the forecasts must be relevant to farmers so that they can make the best decisions taking these forecasts into account.
4. Forecasts must be public, come from credible sources (weather forecasting institutes), and access must be easy and not involve additional costs for farmers.
5. In order to consider a forecast, the following factors were taken as reference:

• for the temperature data the forecasts for a temperature variation of ± 2 ° C were accepted as being made;

• for precipitation data the forecast is considered made even if the precipitation was observed near the weather station and of course at the weather station;

• for wind data a variation of ± 2 m / s is accepted.

MATERIAL AND METHOD

In this paper a statistical study was performed, comparing a forecast model for 3 meteorological stations located in the agricultural area of Oltenia from two forecasting institutes [5] [6], with the actual data measured at these stations [7] to see how close to the actual values are the values predicted in the models. They can be accessed from the internet without access or subscription costs.

We chose this situation by referring to an ordinary farmer who has to make decisions to do certain agricultural work in the spring and, to start this work, consult the public forecasts.

In order to carry out this study, we chose the period March 5-14, 2021, due to the fact that this period is the beginning of agricultural activities, and as meteorological stations we chose as representative for Oltenia the meteorological stations from Drobeta Turnu Severin, Râmnicu Vâlcea and Caracal, located in the west, northeast, and southeast of Oltenia, respectively, due to the fact that the data from these stations are archived for a long time on the site www.ogimet.com [7].

We used as forecast models the GFS models developed by the German Meteorological Service (DWD) [5] and the National Oceanic and Atmospheric Administration of the United States of America (NOAA) [6], due to easy access to forecast models over a period of 10 days in a chosen location. To obtain a forecast model for a point on the map, it is only necessary to insert the longitude and latitude data of the respective stations to generate a forecast model.

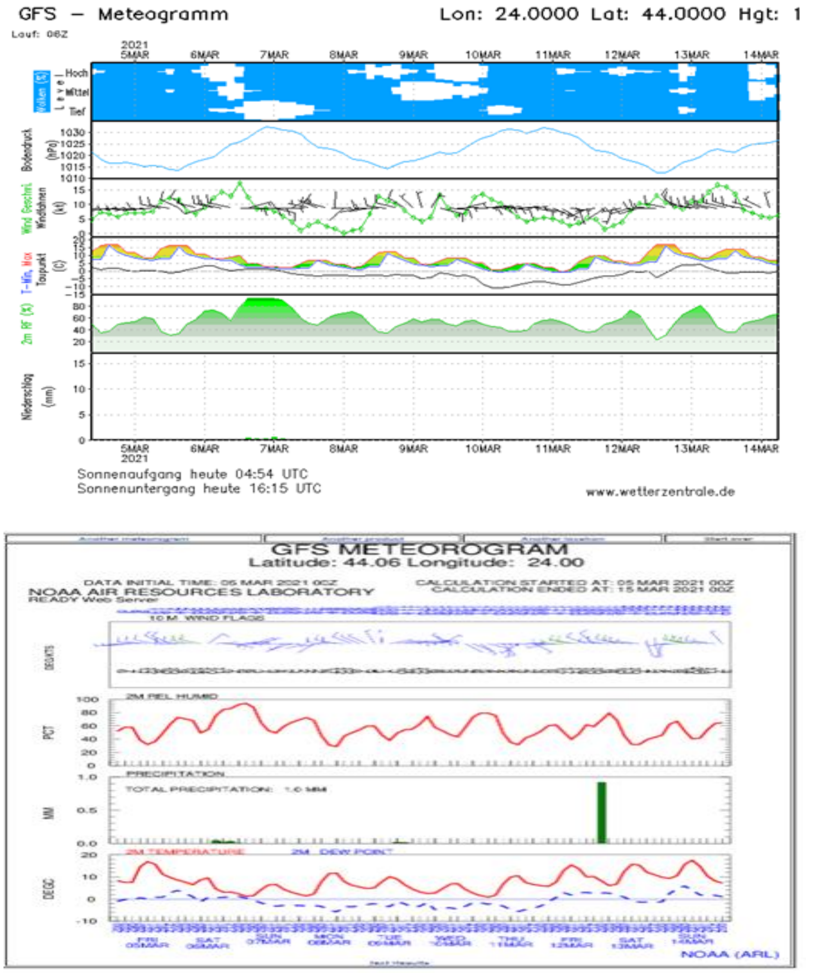
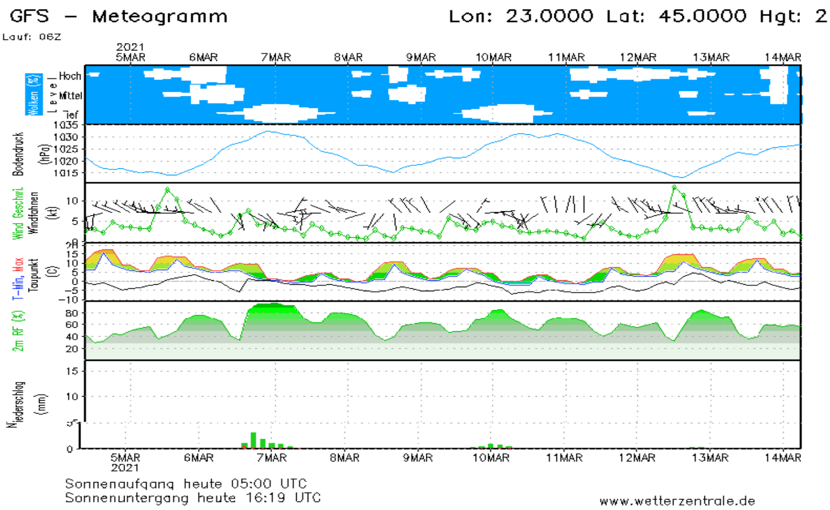


Figure 1 Forecast models for Caracal station 05.03.2021



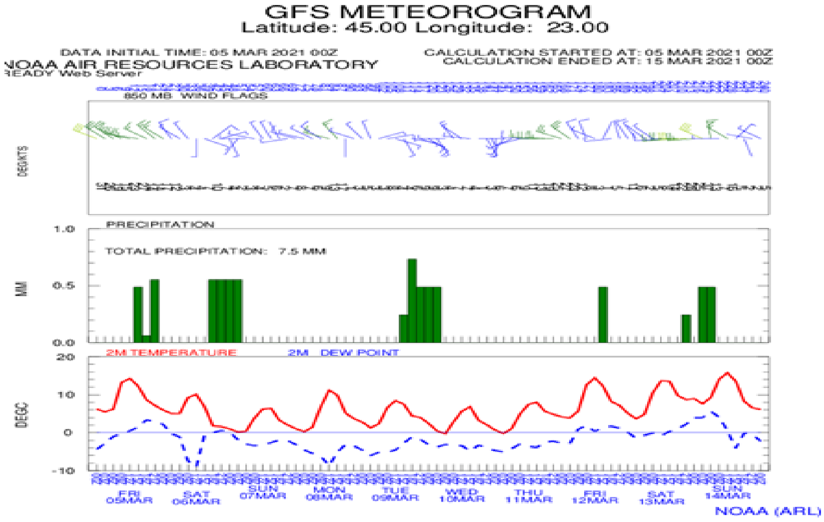


Figure 2 Forecast models for Turnu Severin station 05.03.2021

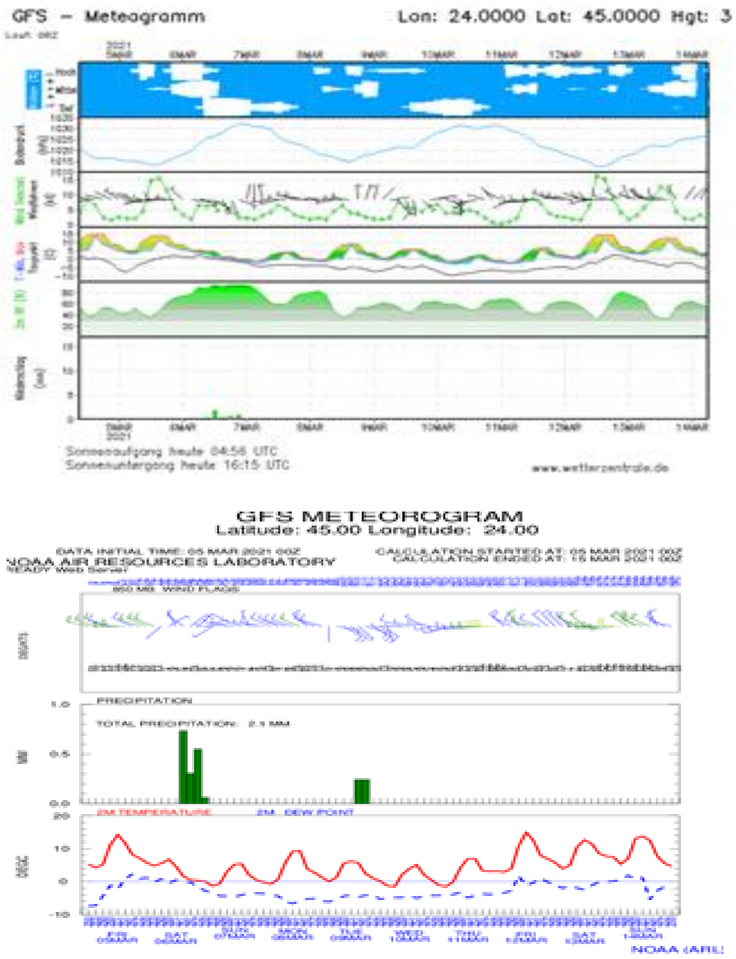
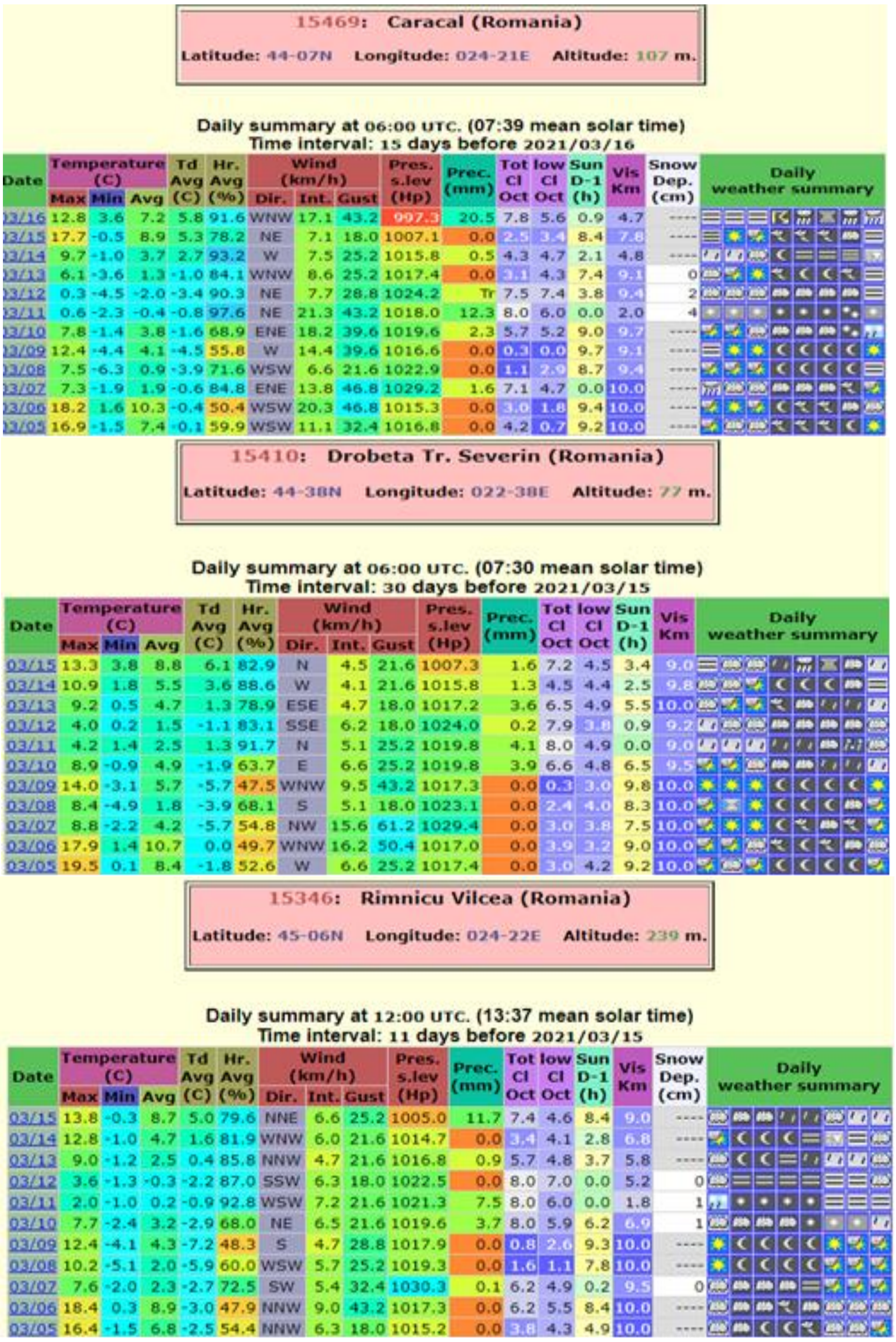


Figure 3 Forecast models for Rm. Vâlcea station 05.03.2021

To compare the forecasted data we used the archive of meteorological data from the site www.ogimet.com [7]. It is necessary for data collection to enter the name of the weather station and the period for which the data is requested. On this site you will find the data necessary for our study, with the parameters studied and the representative phenomena. .



15469: Caracal (Romania)

Latitude: 44-07N Longitude: 024-21E Altitude: 107 m.

Daily summary at 06:00 UTC. (07:39 mean solar time)
Time interval: 15 days before 2021/03/16

Date	Temperature (C) Max	Temperature (C) Min	Temperature (C) Avg	Td Avg (C)	Hr. Avg (%)	Wind (km/h) Dir.	Wind (km/h) Int.	Wind (km/h) Gust	Pres. s.lev (Hp)	Prec. (mm)	Tot Cl Oct	low Cl Oct	Sun D-1 (h)	Vis Km	Snow Dep. (cm)	Daily weather summary
03/16	12.8	3.6	7.2	5.8	91.6	WNW	17.1	43.2	997.3	20.5	7.8	5.6	0.9	4.7	----	
03/15	17.7	-0.5	8.9	5.3	78.2	NE	7.1	18.0	1007.1	0.0	2.5	3.4	8.4	7.8	----	
03/14	9.7	-1.0	3.7	2.7	93.2	W	7.5	25.2	1015.8	0.5	4.3	4.7	2.1	4.8	----	
03/13	6.1	-3.6	1.3	-1.0	84.1	WNW	8.6	25.2	1017.4	0.0	3.1	4.3	7.4	9.1	0	
03/12	0.3	-4.5	-2.0	-3.4	90.3	NE	7.7	28.8	1024.2	Tr	7.5	7.4	3.8	9.4	2	
03/11	0.6	-2.3	-0.4	-0.8	97.6	NE	21.3	43.2	1018.0	12.3	8.0	6.0	0.0	2.0	4	
03/10	7.8	-1.4	3.8	-1.6	68.9	ENE	18.2	39.6	1019.6	2.3	5.7	5.2	9.0	9.7	----	
03/09	12.4	-4.4	4.1	-4.5	55.8	W	14.4	39.6	1016.6	0.0	0.3	0.0	9.7	9.1	----	
03/08	7.5	-6.3	0.9	-3.9	71.6	WSW	6.6	21.6	1022.9	0.0	1.1	2.9	8.7	9.4	----	
03/07	7.3	-1.9	1.9	-0.6	84.8	ENE	13.8	46.8	1029.2	1.6	7.1	4.7	0.0	10.0	----	
03/06	18.2	1.6	10.3	-0.4	50.4	WSW	20.3	46.8	1015.3	0.0	3.0	1.8	9.4	10.0	----	
03/05	16.9	-1.5	7.4	-0.1	59.9	WSW	11.1	32.4	1016.8	0.0	4.2	0.7	9.2	10.0	----	

15410: Drobeta Tr. Severin (Romania)

Latitude: 44-38N Longitude: 022-38E Altitude: 77 m.

Daily summary at 06:00 UTC. (07:30 mean solar time)
Time interval: 30 days before 2021/03/15

Date	Temperature (C) Max	Temperature (C) Min	Temperature (C) Avg	Td Avg (C)	Hr. Avg (%)	Wind (km/h) Dir.	Wind (km/h) Int.	Wind (km/h) Gust	Pres. s.lev (Hp)	Prec. (mm)	Tot Cl Oct	low Cl Oct	Sun D-1 (h)	Vis Km	Daily weather summary
03/15	13.3	3.8	8.8	6.1	82.9	N	4.5	21.6	1007.3	1.6	7.2	4.5	3.4	9.0	
03/14	10.9	1.8	5.5	3.6	88.6	W	4.1	21.6	1015.8	1.3	4.5	4.4	2.5	9.8	
03/13	9.2	0.5	4.7	1.3	78.9	ESE	4.7	18.0	1017.2	3.6	6.5	4.9	5.5	10.0	
03/12	4.0	0.2	1.5	-1.1	83.1	SSE	6.2	18.0	1024.0	0.2	7.9	3.8	0.9	9.2	
03/11	4.2	1.4	2.5	1.3	91.7	N	5.1	25.2	1019.8	4.1	8.0	4.9	0.0	9.0	
03/10	8.9	-0.9	4.9	-1.9	63.7	E	6.6	25.2	1019.8	3.9	6.6	4.8	6.5	9.5	
03/09	14.0	-3.1	5.7	-5.7	47.5	WNW	9.5	43.2	1017.3	0.0	0.3	3.0	9.8	10.0	
03/08	8.4	-4.9	1.8	-3.9	68.1	S	5.1	18.0	1023.1	0.0	2.4	4.0	8.3	10.0	
03/07	8.8	-2.2	4.2	-5.7	54.8	NW	15.6	61.2	1029.4	0.0	3.0	3.8	7.5	10.0	
03/06	17.9	1.4	10.7	0.0	49.7	WNW	16.2	50.4	1017.0	0.0	3.9	3.2	9.0	10.0	
03/05	19.5	0.1	8.4	-1.8	52.6	W	6.6	25.2	1017.4	0.0	3.0	4.2	9.2	10.0	

15346: Rimnicu Vilcea (Romania)

Latitude: 45-06N Longitude: 024-22E Altitude: 239 m.

Daily summary at 12:00 UTC. (13:37 mean solar time)
Time interval: 11 days before 2021/03/15

Date	Temperature (C) Max	Temperature (C) Min	Temperature (C) Avg	Td Avg (C)	Hr. Avg (%)	Wind (km/h) Dir.	Wind (km/h) Int.	Wind (km/h) Gust	Pres. s.lev (Hp)	Prec. (mm)	Tot Cl Oct	low Cl Oct	Sun D-1 (h)	Vis Km	Snow Dep. (cm)	Daily weather summary
03/15	13.8	-0.3	8.7	5.0	79.6	NNE	6.6	25.2	1005.0	11.7	7.4	4.6	8.4	9.0	----	
03/14	12.8	-1.0	4.7	1.6	81.9	WNW	6.0	21.6	1014.7	0.0	3.4	4.1	2.8	6.8	----	
03/13	9.0	-1.2	2.5	0.4	85.8	NNW	4.7	21.6	1016.8	0.9	5.7	4.8	3.7	5.8	----	
03/12	3.6	-1.3	-0.3	-2.2	87.0	SSW	6.3	18.0	1022.5	0.0	8.0	7.0	0.0	5.2	0	
03/11	2.0	-1.0	0.2	-0.9	92.8	WSW	7.2	21.6	1021.3	7.5	8.0	6.0	0.0	1.8	1	
03/10	7.7	-2.4	3.2	-2.9	68.0	NE	6.5	21.6	1019.6	3.7	8.0	5.9	6.2	6.9	1	
03/09	12.4	-4.1	4.3	-7.2	48.3	S	4.7	28.8	1017.9	0.0	0.8	2.6	9.3	10.0	----	
03/08	10.2	-5.1	2.0	-5.9	60.0	WSW	5.7	25.2	1019.3	0.0	1.6	1.1	7.8	10.0	----	
03/07	7.6	-2.0	2.3	-2.7	72.5	SW	5.4	32.4	1030.3	0.1	6.2	4.9	0.2	9.5	0	
03/06	18.4	0.3	8.9	-3.0	47.9	NNW	9.0	43.2	1017.3	0.0	6.2	5.5	8.4	10.0	----	
03/05	16.4	-1.5	6.8	-2.5	54.4	NNW	6.3	18.0	1015.2	0.0	3.8	4.3	4.9	10.0	----	

Figure 4 Atmospheric parameters measured at the 3 weather stations

The compared parameters were: temperature (minimum and maximum) - columns 1 and 2, precipitation-column 10 and average wind speed-column 7. The phenomena at the station and near the station are in the last 8 columns.

The 10-day GFS forecast models were collected from both sources from the three stations and the parameters necessary for the research were selected, then the data were transformed by entering them in tabular form, then the diagrams were compiled.

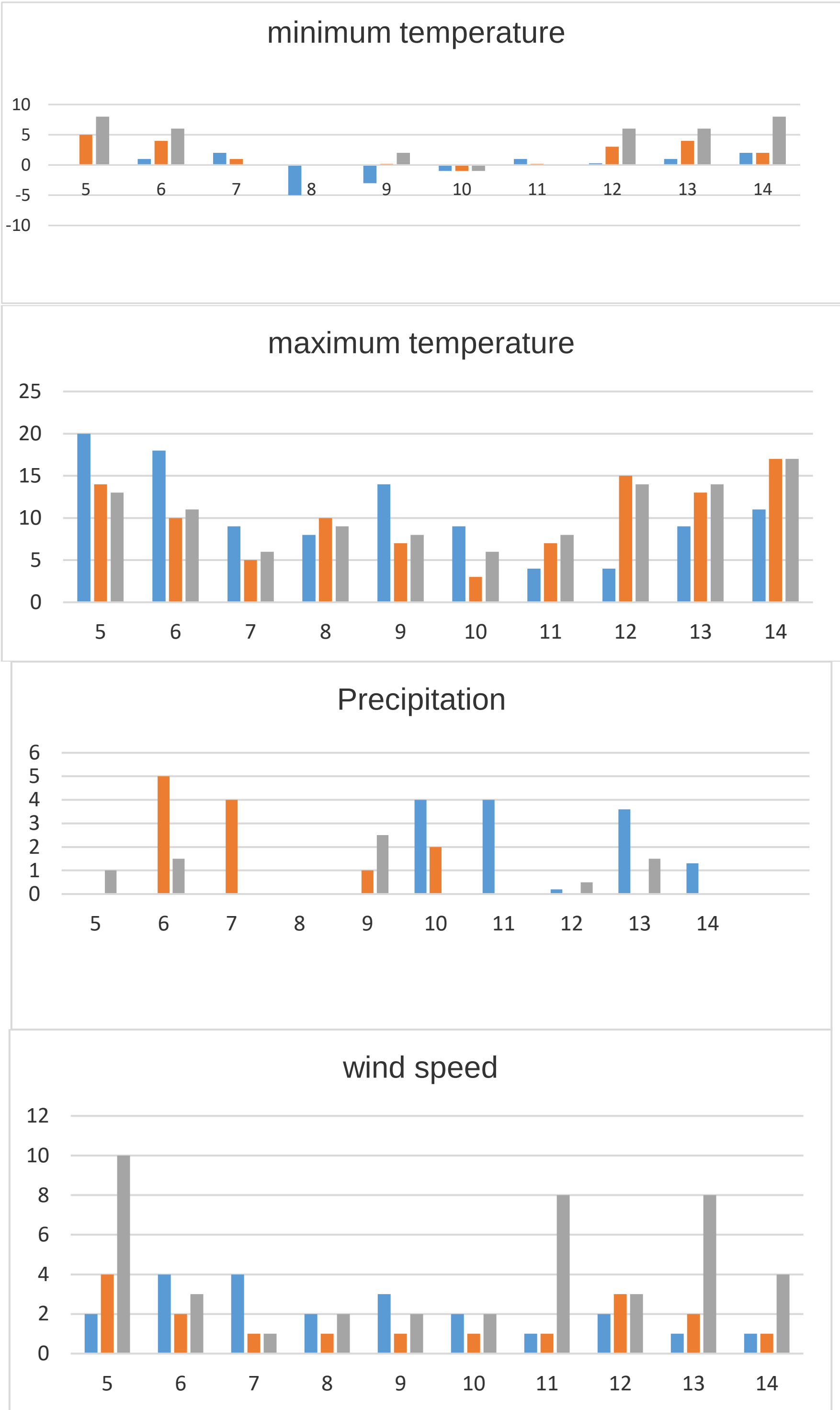


Figure 5 Comparison between measured and forecast data at Drobeta Turnu Severin station

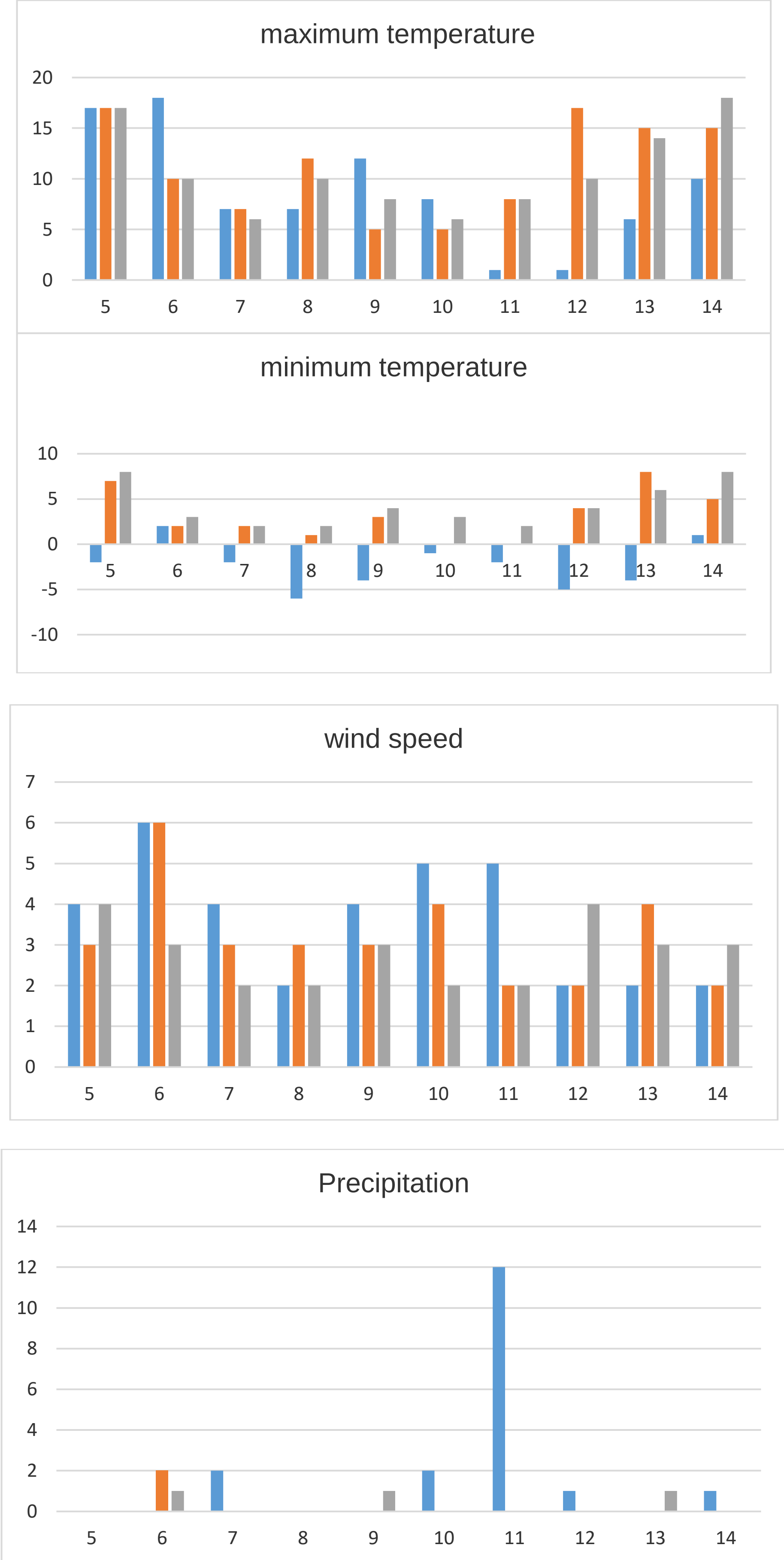


Figure 6 Comparison between measured and forecast data at Caracal station

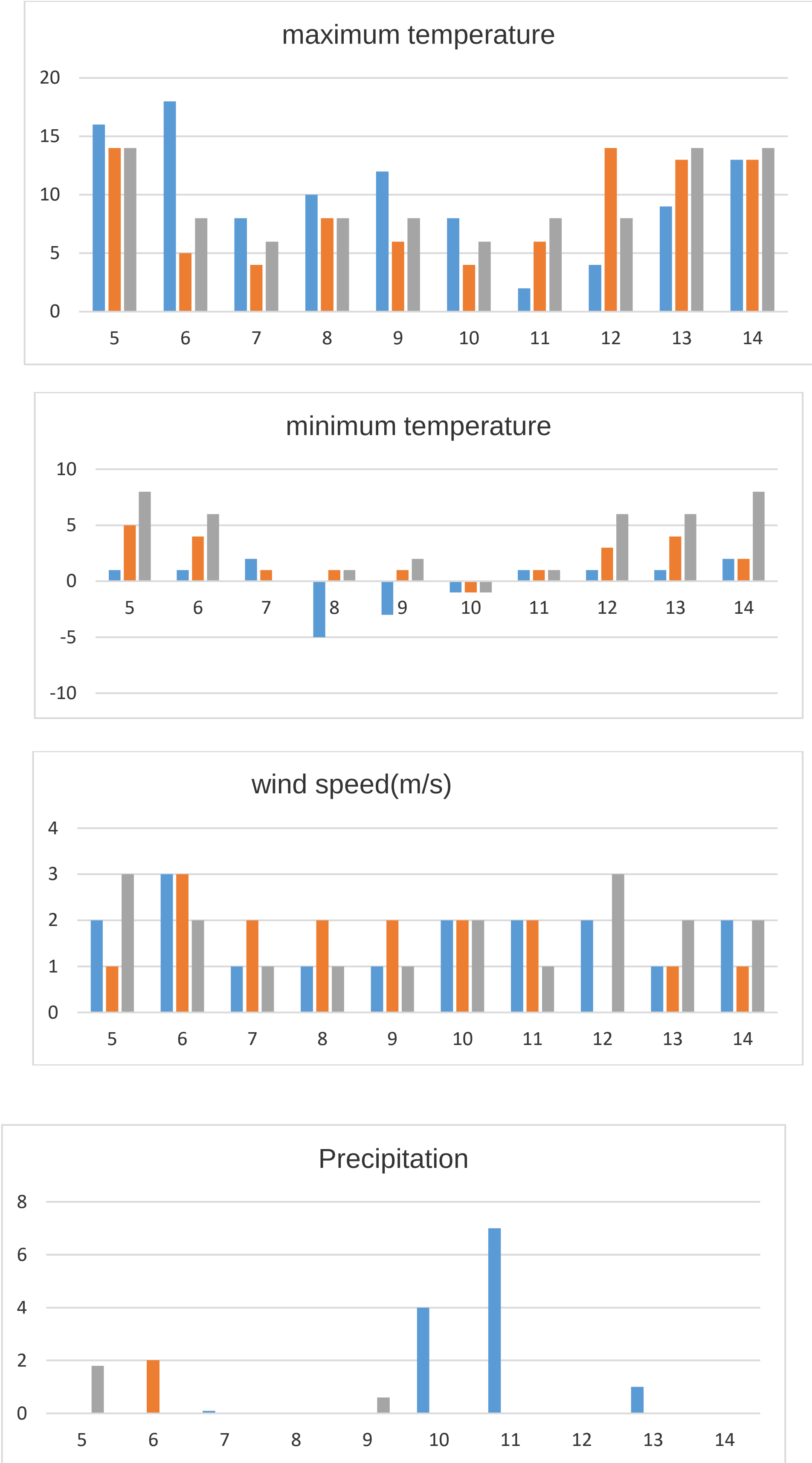


Figure 7 Comparison between measured and forecast data at Rm.Vâlcea station

The parameters of temperature (minimum and maximum), precipitation and wind from the 3 stations were measured in the diagrams, which were measured and forecasted at the 3 stations.

RESULTS AND DISCUSSIONS

The analysis of the forecast models from 05-14.03.2021 and the measured data showed the following:

1. At Drobeta Tr, Severin station, the value of the maximum measured temperature exceeded the value predicted by both models in the first 2 days of the interval, then in the next 4 days the measured value was in the range of 2 ° C compared to the predicted value. In the last 4 days the measured value was lower than the predicted value.

The minimum forecast temperature was only 3 days (7,10,11) in the margin of error, and on days 12 and 14 the Wetterzentrale model was in the margin of error.

In terms of wind, the Wetterzentrale model predicted on most days the wind speed close to the measured one (9 out of 10), and the NOAA model one day less.

Regarding precipitation, only on days 10,12,13 one of the models predicted precipitation in the margin of error of 2 l / sqm. On days 12 and 14 precipitation was reported, but was not forecast.

On days 5,6,7, precipitation was forecast by one or both forecast models, but no precipitation was reported at the station. Instead, precipitation was reported in the field of view (about 20 km around the station.

2. At Caracal station the value of the maximum measured temperature exceeded the value predicted by both models in the first 2 days of the interval, then in the next 4 days the measured value was in the range of 2 ° C compared to the predicted value. In the last 4 days the measured value was lower than the value predicted by the models.

In terms of wind, the Wetterzentrale model predicted on most days the wind speed close to the measured one (9 out of 10), and the NOAA model two days less.

Regarding precipitation, the NOAA model correctly predicted the precipitation reported on days 6, 9 and 13.03 with deviations of 6-12 hours, the WTZ model only on 6.03.

In this case, two aspects must be pointed out:

• There were 5 days with reported rainfall and were forecast by models maximum 3, and between 11-13.03 it snowed, On 11.03. precipitation of 12 l / sqm was reported.

• Also on 05.03, visual precautions were reported, unpredictable

3. At the Rm .Vâlcea station, the value of the maximum temperature was correctly predicted by the WTZ model only in 3 days, and by the NOAA one in 6 days. The minimum temperature value was correctly predicted by the WTZ model in only 5 days, and by the NOAA model in 4 days.

In terms of wind, the Wetterzentrale model predicted on most days the wind speed close to the measured one (9 out of 10), and the NOAA model on all days.

Regarding precipitation, the NOAA model correctly predicted the precipitation reported on days 5 and 9.03, the WTZ model only on 6.03.

In this case, two aspects must be pointed out:

• There were 5 days with reported rainfall and were forecast by models maximum 3, and between 11-13.03 it snowed, On 11.03. precipitation of 7 l / sqm was reported.

• On 05.03, visual field precipitations were reported, predicted by the NOAA model.

To be objective, it should be emphasized that the meteorological stations where the measurements and observations were made are located near cities.

Influences related to pollution in cities are amplified by the difference in level between the altitude of the station and the average altitude of cities which, against the background of uneven warming of the earth's surface and a difference of 2-3 degrees between the city center and the weather station, generates deviations. of the predicted temperature.

Under these conditions there is a fairly strong local current in the area with a direct influence on wind speed and direction and in the formation, development and evolution of clouds.

The way in which the forecast affects agricultural activities must be seen in relation to the forecasted phenomena to the existing crops.

Thus, for sown crops (wheat, barley, soybeans, etc.) the fall of precipitation in the form of snow and the sudden drop in temperature affected the development of plants, but also the application of fertilizers for the affected crops.

For the cultivation of peas and those to be sown determined the postponement of these works.

The danger of soil erosion was present due to heavy rainfall on 11.06. These values were not predicted and farmers could not make decisions to reduce the side effects.

The most dangerous were 2 elements that were not properly forecasted, respectively the amount of precipitation from 11-13.03 when the amount of precipitation was 7-11 l / m.p., unpredictable in the form of snow.

CONCLUSIONS

Climate change is an indisputable reality. Farmers are aware of the effects of these changes and are working to adapt their work to cope with these changes.

Currently there is an increase in the frequency and intensity of extreme weather events, as a result of the intensification of global warming, respectively the increase of days with extreme temperatures, frost and floods.

The weather forecast is one of the important sources of information we need every day, but only the short-term weather forecast provides the safest information, not more than 12 hours.

The composition of our atmosphere seriously limits our ability to shape it and, therefore, to predict for a long time.

The optimal periods for each stage of a crop depend on certain meteorological parameters, and a favorable forecast determines the start of activities, and failure to make this forecast causes not only postponement of decisions or change of decisions, but also damage.

There are forecast models available that can provide farmers with data on atmospheric parameters for a period of 10 days and that provide farmers with an overview for the next period, but it should be noted that the forecast for periods longer than 3 days changes daily, with entering data from observations.

To see how the accuracy of forecasts in the context of climate change influences agricultural activities, studying the GFS forecast model for a period of 10 days for meteorological stations Drobeta Tr. Severin, Caracal and Rm .Vâlcea and comparing the forecast data with those from observations and measurements at those stations at that time it turned out that the forecasts for a period of 10 days are not helpful to farmers to plan their activities.

Regarding the temperature, the models provided a good to very good forecast during this period for a maximum period of 3 days. Over this period, the forecast is satisfactory and sometimes has deviations from the measured temperature of 3-4 ^{0} C.

Regarding the amount of forecasted precipitation, the models provided an unsatisfactory forecast during this period, compared to the number of days when precipitation was forecast compared to the actual number of days when precipitation was reported.

A special problem is in the case of days 11-13.03, when the amount of precipitation was 7-11 l / m.p., unpredictable in the form of snow.

In terms of wind speed the forecast is very good.

It should be emphasized that the meteorological stations where the measurements and observations were made are located near the cities and there are influences related to pollution in the city and each of them has specific influences.

The management of agro-technical decisions includes specific activities through which actions are foreseen for the elaboration of action plans and programs, the whole set of activities is organized, the order is made, through which the system works, all actions and all efforts are coordinated in order to achieve the objectives at the end, the results obtained are checked[1].

Information received, including weather forecasts. influences the whole decision-making mechanism, and erroneous or highly uncertain information can cause an unsatisfactory result.

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