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RESEARCH ARTICLE

Modeling of Climatic Records for the Province of Villa Clara, Cuba

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ABSTRACT

The objective of this work is to model the extreme temperature climatic records of Villa Clara Cuba and see if there is a trend in them, in addition the variable date on which they occurred was modeled, with the help of the Regressive Objective Regression (ROR). A database from 1966 to 2020 of the 4 weather stations with the account of the province of Villa Clara is used. The explained variance of the models is 100% for the maximum temperature and 99.8 for the minimum with errors of 0.58 and 1.4°C. You can estimate the graphs for the maximum temperature as for the minimum with the predicted values and the errors that the model commits. The trend for the date of the maximum trend is negative while for the minimum it is positive. The records depend on the temperature returned in 1 month (LAG1T) and the temperature returned in 12 months (LAG12T), both for the maximum TX and for the minimum TN, as well as the station value. The correlations between the actual and predicted value for the maximum and minimum temperature records and for the date models are high, greater than 90% and 99% variable.

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INTRODUCTION

The ability to predict climate variables in advance offers the possibility of being able to act in time and reduce adverse impacts that is to adapt to the effects of climate change and variability. Increasing preparedness for extreme weather events contributes significantly to reducing vulnerability [1].

The climate prediction is one that foresees the average weather conditions for periods of duration from one month to one or two years. In practice, two large groups are distinguished: those who make forecasts of the value of the element in question, deterministic forecasts, and those who predict the probability of occurrence of a certain value of the element, probabilistic forecasts, this work uses deterministic statistical models using the regressive objective regression. In the most recent Scientific Assessment report of the Intergovernmental Panel of Experts on Climate Change [2] it is concluded that warming is unequivocal, this will bring disruptions in other climatic variables such as rainfall or rainfall and also in behavior from the winds and hurricanes.

Forecasts of both the weather and climate are an important element in the life of modern society. Having a forecasting system on several scales (monthly, daily and annual) allows us to have a powerful tool in the planning of economic and social activities. In Cuba, important work has been carried out to determine between groups of primary and calculated predictors of a dynamic type and of the Temperature-Humidity complex the potential future predictors that intervene in the selection of the real predictors for the rain forecast in Cuba [3], regarding hurricanes, important models have been obtained using regression [4], in the area have obtained good results regarding the levels of errors. In the present work, a pure statistical forecast is used, searching in previous steps (Lags) for the informativeness of the process

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to be modeled, in our case, the monthly records of the maximum and minimum extreme temperatures for Villa Clara, Cuba.

The objective of this work is to model the climatic records of extreme temperatures of Villa Clara Cuba and see if there is a trend in them, in addition to model the variable date in which they occurred, with the help of the Objective Regressive Modeling ROR.

MATERIALS AND METHODS

For modeling, a database was used from 1966 to 2020, which is in operation in the Forecast Department of the Provincial Meteorological Center of Villa Clara, in the records are observed by months and the date of occurrence for the 4 meteorological stations that our province of Villa Clara. The Regressive Objective, Regressive modeling was used with the help of the SPSS Version 19 statistical package. Figure 1 shows the location of the meteorological stations.

RESULTS AND DISCUSSION

Table 1 shows how the explained variance is almost 100% for all stations with small errors less than 0.5858°C for the maximum and 1.4025°C for the minimum. Long-term trends indicate that the values tend to be slightly negative, but very close to zero. The trend for the date of the maximum tends to be negative while for the minimum it is positive. Table 2 shows the mathematical model for the maximum temperature, as can be seen all the parameters are 99% significant, the model depends on the maximum temperature returned in 1 month (LAG1TX) and on the temperature

returned in 12 months (LAG12TX), as well as the value of the station that is the number by which the meteorological station is known, the tendency is to decrease. In the case of minimum temperatures (Table 3), the records depend on the minimum temperature returned in 1 month (LAG1TN) and the temperature returned in 12 months (LAG12TN), as well as the value of the station that is the number by which the meteorological station is known the tendency is to decrease as for the maximum temperature, this behavior is related to the disposition in which the records have been arranged starting with the station 343,338,348 and 326 respectively, it can be said that with respect to the previous year, the records increase, as well as they increase with respect to the previous month observing the positive values of the LAG1TN and LAG12TN coefficients, and in the case of the records of the maximum temperatures LAG1TX and LAG12TX.

In figures 2,3 you can see the excellent agreement between the real and predicted values as well as the error that is committed in each record. Mathematical models were also obtained for the dates of occurrence of the two obtained we show that of the maximum temperature (Table 4) that has the highest correlation between the real value and the forecast of .535 significant at 99%. As can be seen, the value of the trend is decreasing that is at early dates in the year as we can interpret this is a profitable attempt to model the dates of the records that needs a more exhaustive examination. Temperature parameters returned one month (LAG1TX) and returned one year (LAG12TX) are not significant variables although they contribute important variance to the model. The station number is 95% significant. Finally, we can see in table 5 the correlations between the real and predicted

Figura: Ubicación de las estaciones de Villa Clara.

Yabú: Lat: 22° 26' N, Long: 79° 59' W

Sagua: Lat: 22°13' N, Long: 80°02' W.

Caibarién: Lat: 22° 29' N, Long: 79°28' W.

INIVIT: Lat: 22°58, Long: 80°22.

La Piedra: Lat: 22° 11' N, Long: 79° 98' W

Figure 1 Geographical distribution of meteorological stations.

Table 1: Fundamental statistical parameters for the models according to the ROR Methodology.

Variable	R (%)	Standard Error hPa.	Trend	Significance of the trend
Maximum Temperature	100	0.5858	-0.038	0.002
Date of the maximum	99.9	587507:59:45.659	-17795470.381	0.080
Minimum Temperature	99.6	1.4025	-0.077	0.009
Date of the minimum	99.9	531517:05:47.284	11380131.833	0.219

Table 2: Model coefficients for maximum temperature records in Villa Clara.

Coefficients ^{a,b}						
Model		Non-standardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	DS	19.451	5.316	.387	3.659	.001
	DI	19.619	5.319	.390	3.689	.001
	Trend	-.038	.011	-.034	-3.395	.002
	LAG1TX	.292	.104	.291	2.817	.008
	LAG12TX	.648	.103	.644	6.298	.000
	Station	-.048	.013	-.452	-3.566	.001

Table 3: Model coefficients for minimum temperature records in Villa Clara.

Coefficients ^{a,b}						
Model		Non-standardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	DS	-57.651	12.398	-3.000	-4.650	.000
	DI	-57.581	12.412	-2.996	-4.639	.000
	Trend	-.077	.028	-.182	-2.785	.009
	LAG1TN	.236	.074	.236	3.187	.003
	LAG12TN	.819	.075	.834	10.935	.000
	Stación	.175	.036	4.340	4.893	.000

Figure 2 Actual and forecast value.

Maximum temperature (Blue colour).

Unstandardized Predicted Value (Green Colour).

X axis: Date of the record; Y axis: Maximum temperature (°C) on the left and minimum temperature (°C) on the right.

Figure 3 Actual and forecast value.
Minimum temperature (Blue colour).
Unstandardized Residual (Grey Colour).
X axis: Date of the record; Y axis: Maximum temperature (°C) on the left and minimum temperature (°C) on the right.

Table 4: Model coefficients for the date of the maximum temperature records in Villa Clara.

Model		Non-standardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	DS	24882751366.542	4684936302.202	1.346	5.311	.000
	DI	25031251816.114	4687411567.946	1.355	5.340	.000
	Trend	-17795470.381	9815760.033	-.044	-1.813	.080
	LAG1TX	74155827.754	91223648.933	.202	.813	.423
	LAG12TX	-139978003.328	90677674.370	-.378	-1.544	.133
	Estación	-26835889.400	11774152.278	-.693	-2.279	.030

Table 5: Correlations between the actual and predicted value of the modeled variables.

Variable	Predicted value N = 36 No. of cases
Maximum Temperature	0.912**
Date of the maximum	0.535**
Minimum Temperature	0.972**
Date of the minimum	0.399**

values for the temperatures and for the date models. They are all high and 99% significant (**).

CONCLUSION

1. The explained variance is 100% for all stations with small errors less than 1.4 and .58°C for the minimum and maximum respectively.

2. Long-term trends indicate that the record values for both temperatures tend to be slightly negative, but very close to zero.
3. The trend for the date of the maximum tends to be negative while for the minimum it is positive.
4. The records depend on the temperature returned in 1 month (LAG1T) and the temperature returned in 12 months (LAG12T), both for the maximum TX and for the minimum TN, as well as the value of the station.
5. The correlations between the actual and predicted values for the maximum and minimum temperature records and for the date models are high and 99% significant (**).

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