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RESEARCH ARTICLE

THE CLIMATE PREDICTION WITH A YEAR IN ADVANCE THROUGH THE BULTÓ'S INDEX FOR HAVANA CITY, CUBA

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ABSTRACT

The objective of this work is directed to model the Climatic Bultó Index for Havana city with a year of advance. This index is also modeled independent in the period 2001, month 1, until the year 2005, month 5. In total there are 52 cases, from which two models are obtained, one for the index with short term parameters, (Lag 1, Lag 4) like predictor and another model of the index with parameters of one year of advance (lag 12, lag 16). The first model explains 84.6 variance % with a standard error that can not be measure; the variables that influence in the modeling of the Index are the index in the previous month, and the index fourth months behind, all the variables were significant to 99%, the tendency was not significant. The second model uses the lag 12, the lag 14 and the Lag 10, then we can forecast the Bultó Index with a year of advance, even the Lag 10 is not statistically significant we maintain this parameter in the model because it helps to improve the variance in the model. It was used the Regressive Objective Regression, with the help of the statistical package of Social Sciences (SPSS) Version 13. The pattern of Regressive Objective Regression with a year in advance presents good results with a high correlation (R= 96.1 %) and errors not determined, charts and graphics of the real values are shown and predicted for 2006. The methodology used can prevent the episodes of sickness of persons with sufficient time of advance.

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INTRODUCTION

The OMM contributes basically to the lives protection through its programs and the net of more than 190 National Meteorological and Hydrological Services. The meteorological predictions and the early alerts facilitated to the governments, the different economic sectors and people help to prevent and mitigate the disasters effects. The Surveillance Meteorological World Cup has played an essential part in that sense. Settled down in 1963, in full cold war, it constitutes a landmark in the international cooperation. It contains observation systems, services of telecommunications and process centers and prediction of data, thanks to which all the countries have the information and the necessary meteorological and environmental services to carry out an exchange of information in real time and to lend effective services. When being needed more meteorological and climatic services, and before the spectacular scientific and technological advances, the Surveillance Meteorological World Cup has become today the central element of numerous programs, so much of the OMM as of other organisms. It contributes essentially to the priorities of the OMM thanks to the improvement of observations, the surveillance of atmosphere and oceans, and the diffusion of meteorological predictions in the entire world, especially of watchful early of climatic and meteorological phenomenon of devastating effects. Today, the improved climatic services are presented like one of the decisive tools to face and adapt to the climatic change. The presumption that past climatic and socioeconomic conditions are enough as indicator of current and future conditions, it is no longer enough. It is imperative to continue improving the understanding of climate and to use appropriately the climatic information to approach the

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necessities of the society in a world characterized by demographic growth, the changes in the use of earth, the urbanization and the difficulties to guarantee the alimentary security and the administration of the water's resources and the energy. In the doctoral thesis of Dr. Luis Romero-Sauchay (2014) states that "climate variability can be of various types," among those types including intraseasonal defined and speaks of the annual cycle, "this parameter to annual variability will be exploited to predict a year in advance climate Bultó index noting in our work that this approach can be used for an indefinite number of time series from the rain to earthquakes and diseases in animals and humans. Climate data of the Bultó index are taken from this thesis (Romero-Sauchay, 2014). The methodology ROR was used (Osés and Grau, 2011) for the modeling of different time series of parameters. Among the modeling methods, they were also used those of Box *et al.*, 1994, but these last won't be used in other works. According to Osés *et al.* (2012a), it has been observed that the methodology ROR presents better results. This methodology is also used for the prognosis of high intensity earthquake in Cuba (Osés *et al.*, 2012a), besides it was implemented in mosquitoes control (Fimia *et al.*, 2012a), and the results were used in the study of Climatic Change applied to animal health in Villa Clara, Cuba (Osés *et al.*, 2012b), the mathematical modeling was applied to malaria (Fimia *et al.*, 2012b). The methodology ROR is greatly spread in Meteorology, for example in the modeling of cold fronts and the impact of sun spots (Osés *et al.*, 2012c). The methodology ROR is also applied for predictions of anopheles mosquito larval density (Osés *et al.*, 2012d); moreover it was done a long term prognosis (one year) of meteorological variables in Sancti Spíritus, Cuba (Osés *et al.*, 2014).

The objective of this work is directed to model the Climatic Bultó Index for Havana city, Cuba with the help of the ROR methodology, and to measure with a year in advance.

MATERIALS AND METHODS

The methodology ROR was used (Osés and Grau, 2011) for the modeling, of the Bultó Index using the statistical package SPSS Version 13. This index is modeled independent in the period 2001, month 1, until the year 2005, month 5. In total there are 52 cases. A year 2006 is predicted with a year in advance.

RESULTS AND DISCUSSION

The pattern using the Regressive Objective Regression with meteorological variables gave a result that explains to itself 84.6 variance% with a standard error that cannot be measure. The Durbin Watson parameter is near at two for what correlation doesn't exist among the errors (Table 1). The Analysis of Variance went significant to 100%, with an F of Fisher 21.656 (Table 2). The pattern for this stage can be observed in table 3, where DS and DI variables explain the ups and downs of the series, being both significant to 100%. The variables that influence in modeling the Climatic Bultó Index are the index in the month behind (Lag1Havana city) and the index fourth months behind (Lag4 Havana city), Results that can be extrapolated to investigations for entities of viral and parasitic etiology transmitted by vectors, as well as to influenza in its variants or types, all associated to meteorological variations, with high incidence of temperature and humidity (Chan *et al*., 2009, Jaakkola *et al*., 2014, Zhang *et al*., 2015). The tendency in time was not significant. This is the short term model.

Table 1. Summary statistics of the Bultó Index for Havana city

Model Summary[c,d]

Model	R	R Square[a]	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.846[b]	.716	.683	***********	2.145

a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.

b. Predictors: Lag4 Havana city, Lag1 Havana city, DS, DI, NoC

c. Dependent Variable: Havana city

d. Linear Regression through the Origin

Table 2. Analysis of Variance of the pattern of Bultó Index for Havana city

ANOVA[c,d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4E+017	5	8.068E+016	21.656	.000[a]
	Residual	2E+017	43	3.725E+015		
	Total	6E+017[b]	48			

a. Predictors: Lag4 Havana city, Lag1CiudadHabana, DS, DI, NoC

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: Havana city

d. Linear Regression through the Origin

Table 3. Model ROR of the Short term model

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	DS	7E+007	2E+007	.476	3.090	.003
	DI	4E+007	2E+007	.281	1.766	.085
	NoC	-376894	641923.8	-.110	-.587	.560
	Lag1 Havana city	.626	.100	.626	6.272	.000
	Lag4 Havana city	-.401	.098	-.402	-4.088	.000

a. Dependent Variable: Havana city

b. Linear Regression through the Origin

The residual standardized (Table 4) present half zero and standard deviation is one, the residual maximum is of 2.157, the standard deviation of the standard residual ones is 0.957 near to cero.

Table 4. Residual of the pattern for climatic Bultó Index. Short term model

Residuals Statistics[a,b]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	*********	*********	*********	************	48
Residual	*********	*********	********	************	48
Std. Predicted Value	-1.759	1.721	.000	1.000	48
Std. Residual	-2.079	2.157	.000	.957	48

a. Dependent Variable: Havana city

b. Linear Regression through the Origin

Subsequently, it is presented in Figure 1 the distribution of frequencies of the residual ones following a near distribution to the normal, something very good for the pattern. In Figure 2 an almost straight line is appreciated in some tracts between the prospective probability and the very beneficial standardized Observed Probability of the residual ones for the pattern.

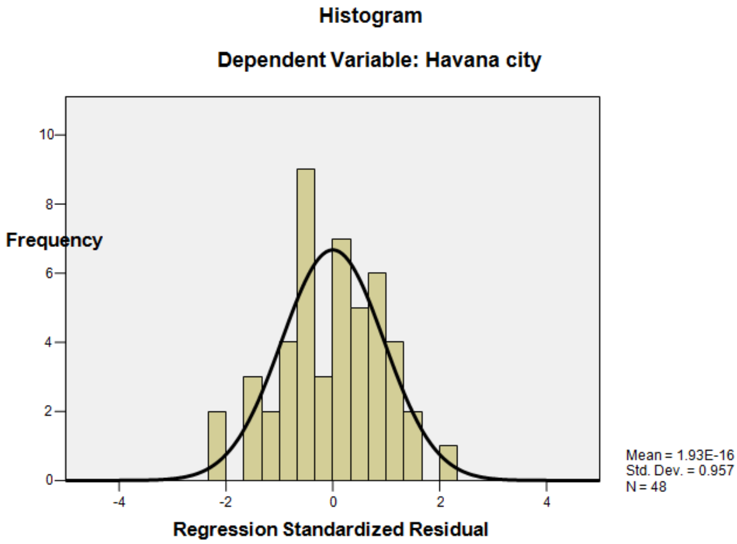

Figure 1. Distribution of Frequency of the Residual with Regressive Methodology

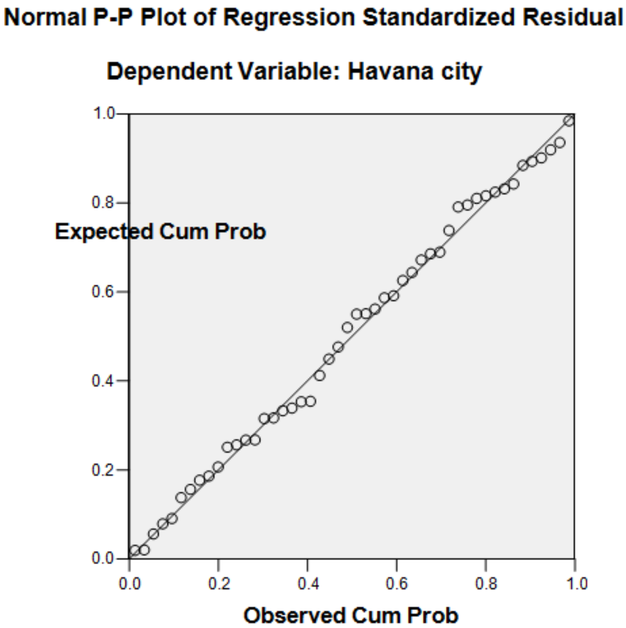

Figure 2. Plotting of probabilities of the residual ones with Regressive Methodology

Table 5. Results of the pattern with the Regressive Methodology of the Bultó Index with a year in advance

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	DS	4E+007	3E+007	.275	1.651	.110
	DI	2E+007	3E+007	.132	.823	.417
	NoC	-219024	569739.9	-.071	-.384	.703
	Lag12 Havana city	.893	.071	.880	12.584	.000
	Lag16 Havana city	-.165	.093	-.162	-1.760	.089
	Lag10 Havana city	-.041	.091	-.040	-.445	.659
	Step41	-2E+008	4E+007	-.261	-4.766	.000

a. Dependent Variable: Havana city

b. Linear Regression through the Origin

Table 6. Correlation of the residual ones with both models

Variable	ROR Modeling of short parameters	ROR Modeling of Long parameters with a year of advance
Pearson correlation	0.762	0.942
Signification to 99 %	0.00	0.00

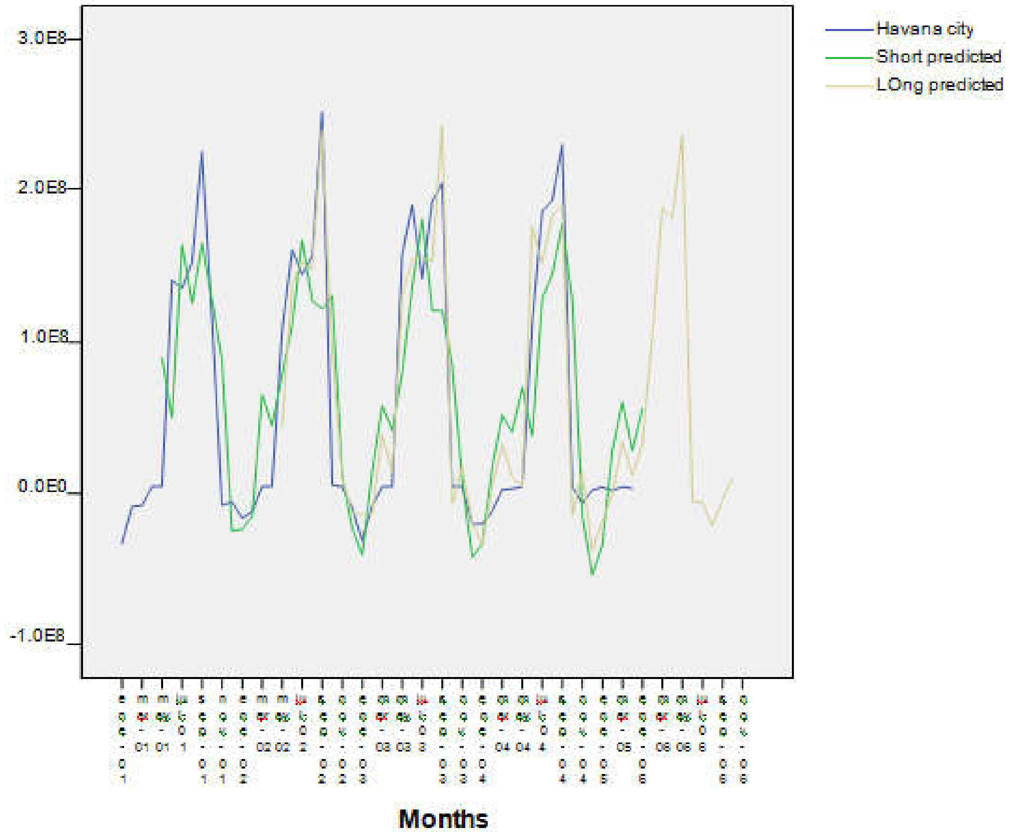

Figure 3. Results of the real and predicted values of the climatic Bultó Index for Havana city

In Table 5 it can be appreciated that all the parameters were significant for the pattern of the Index, the parameter lag12Habana city was significant at 100% and lag16 Habana city was significant to 90%. Step41 corresponds to the impact of the case41 in the database. In this model, 96.1% is explained with an error that cannot be measured. The tendency NoC is not significant, the parameter Lag10CiudadHabana it is not significant but helps to improve the variance in the model. This is the Long term parameters with a year of advance, the lag 1 corresponds to Lag 12, Lag 4 with Lag16, attending to the cycle of the earth rotate around the sun (12 months). The shape of the Index should be repeated every 12 months that can be use to predict the Climatic Bultó Index and every cyclic parameter that can be used. Once calculated both models, the correlations are presented with the real value (Table 6) being good the correlation obtained since it is high and significant to 99%. Finally, they were printed the real values and those predicted for the modeling ROR of the index in 2006, being good the coincidence observed among real values and predicted during the modeling stage (Figure 3). It is advisable that to many other time series can be predicted with a year of advance, and for the precipitation is possible too (Osés *et al*., 2015). In you can see how much information can be extracted from a white noise, which is important to modeling different series of data (Osés *et al*., 2015).

Conclusion

1. The variables that influence in the modeling of the Climatic Bultó Index are the Index of the previous month, and the Index 4 month behind, all the variables went significant to 99%.
2. The tendency was not significant to both models.
3. The variables that influence in the modeling of Climatic Bultó Index with the year in advance are the Index in the 12, 16 and 10 months behind.
4. The pattern of Regressive Objective Regression with a year in advance presents good results with a high correlation and the errors could not be measured.

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