ISSN: 3067-0144

Iris Journal of Astronomy and Satellite Communications

DOI: 10.33552/IJASC.2024.01.000517

Iris Publishers

Research Article

Impact of the Sun on the Maximum Sustained Wind Speed at the Rancho Boyeros Meteorological Station, Cuba, Using ROR Modeling

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Received Date: September 29, 2024

Published Date: October 23, 2024

Abstract

Among the causes that cause the maximum wind speed in Cuba are tropical cyclones (hurricanes), extra-tropical systems of the winter season (extra-tropical lows and cold fronts), severe local storms typical of summer and strong breezes due to the influence of high continental and oceanic pressures. In this work, the maximum sustained wind speed is modeled and forecast in the short and long term for the Rancho Boyeros meteorological station, Havana. With this forecast we can be alert about the risk of impact using Global mathematical and statistical models such as variables that depend on the Sun and impact the phenomena of Nature, health and society. To carry out this work, a database of climate data from 1973 to 2010 was available. First, these maximum sustained wind variables were modeled with the help of the ROR methodology, achieving the best model that explains 99.3% of the variance with an error of 3.04 km/h, and then a long-term forecast of how the sustained wind will behave depending on the Sun's magnetic activity index. The long-term model explains 99.8% of the variance with an error of 2.8 km/h and depends on this solar variable, solar variable, as it increases, sustained wind speed decreases. The short- and long-term models of the maximum sustained wind speed were obtained, determining the modulating impact of the Sun through the magnetic activity index of the Sun. The short-term trend is towards a decrease in the maximum speed of sustained wind, while in the long term the trend is increasing, the main statisticians of the models were shown. Everything points to the existence of a small 4-month cycle caused by THE Sun and that impacts climate phenomena, health and probably the economy and society.

Keywords: Forecast; Cuba; Rancho Boyeros; Maximum sustained wind speed; magnetic activity index of the Sun; ROR regression

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, adapt to the effects of climate change and variability. Increased preparedness for extreme climate events contributes significantly to reducing vulnerability (IPCC, 2007b) [1]. Climate prediction is one that predicts the average climate 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 forecast 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 on Climate Change (IPCC, 2007 a) [2] it is concluded that warming is unequivocal, this will bring disruptions in other climatic variables such as precipitation or rainfall and also in the behavior of winds and hurricanes. Weather and climate forecasts 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 planning activities of a social economic nature.

In Cuba, important work has been carried out to determine among groups of primary and calculated predictors of dynamic type and of the Temperature-Humidity complex the potential future predictors that intervene in the selection of real predictors for the rain forecast in Cuba [3], regarding hurricanes, important models have been obtained using regression [4], in the area Gray et al [5] have obtained good results regarding error levels. In the present work, a pure statistical forecast is used, searching in previous steps (Lags) for the informativeness of the process to be modeled, in our case the tri-hourly atmospheric pressure for CUBA and the possible impact on the weather of the hurricanes that will appear in the area. from the Caribbean. The objective of this work is to model and forecast the speed of the sustained wind by measuring the impact of the Sun's magnetic activity index on it, establish if there is any trend in this variable and see which are the main statisticians of the models, with the help of the Objective Regressive modeling ROR [6-11].

Materials and Methods

To carry out this work, we had a climatic database from the Rancho Boyeros station, Cuba corresponding to the period from January 1973 to December 2010 of monthly data, the ROR methodology was used for the modeling and forecasting of the variable sustained wind (VM), in addition to the data of three variables that represent the impact of the Sun, VS1, VS2 and VS3, which correspond to sunspots, the aa index of magnetic activity of the Sun and the neutron flux called as KN Kiel neutron respectively.

Results and Discussion

In Table 1, you can see the most significant statistics of the variables studied, particularly VM is highlighted in red with an average value of 25.96 km/h (Figure 1) with a standard deviation of 4.83, the maximum value reached corresponds to 51.2. Km/h and the minimum of 15.2 km/h.

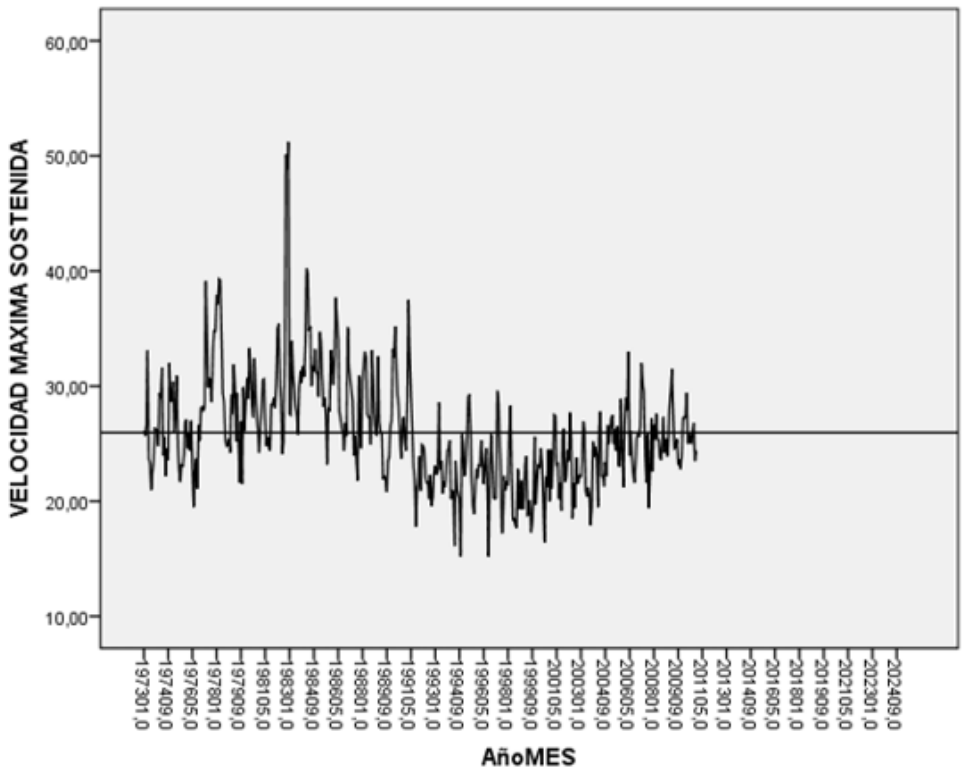

Figure 1: VM behavior over time at the Rancho Boyeros meteorological station.

Table 1: Descriptive statistics.

	N	Mínimo	Máximo	Media	Desviación estándar
YEAR	636	1973	2025	1999,00	15,309
MONTH	636	1	12	6,50	3,455
MEDIUM TEMPERATURE	456	17,60	27,90	24,4605	2,30201
MAXIMUM TEMPERATURE	456	22,40	34,00	29,7132	2,36505
MINIMUM TEMPERATURE	456	10,70	24,20	19,9711	2,74786
RH	456	60,80	92,80	78,4708	5,06011
TOTAL PRECIPITATION	456	,00	1897,39	70,8350	134,89183
MEDIUM VISIBILITY	456	6,10	13,20	7,8746	1,57142
AVERAGE WIND SPEED	456	5,20	26,00	11,8840	2,85529
MAXIMUM SUSTAINED SPEED (VM)	456	15,20	51,20	25,9625	4,83866
RAIN OR DRIZZLE	456	0	23	8,45	4,790
SNOW OR NOT	456	0	1	,02	,139
STORM OR NOT	456	0	25	5,58	6,129
FOG OR NOT	456	0	22	,77	1,538
VS1	432	,50	200,30	66,2303	53,31021
VS2	432	9,50	60,10	23,9954	7,86416
VS3	432	4841,00	6489,00	5963,2037	338,11,646
Valid N (per list)	432				

First, the VM was modeled using the ROR methodology, this short-term model explains 98.7 of the variance with an error of 4.26 km/h, the Durbin Watson statistic is small so the model is open to the inclusion of more variables, however, with what is obtained, short-term behavior can be predicted (Table 2).

Table 2: Summary of the model[c,d].

Modelo	R	R cuadrado[b]	R cuadrado ajustado	Error estándar de la estimación	Durbin-Watson
1	,987[a]	,974	,974	4,26428	,732

[a.] Predictors: Step118, Step119, NoC, DS, DI, Lag4VS2

[b.] For regression through the origin (the model without intercept), R square measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to the R squared for models that include intercept.

[c.] Dependent variable: MAXIMUM SUSTAINED SPEED

[d.] Linear regression through the origin

Fisher's F is 2695.327, significant at 100%.

The model in question can be seen in Table 3. It depends on DS and DI, which are variables of the ROR methodology representing Sawtooth and inverted Sawtooth, NoC, is the trend of the series which is negative, which is which indicates a decrease over time of VM, Lag4VS2, represents the impact of the Sun 4 months ago, as VS2 increases, VM decreases, the Step variables are the impact of case 119 and 118 in the series, both statistically significant. The impact 4 months ago coincides with other works where as the minimum temperature increases, four months ago the number of admissions for cerebrovascular diseases increases [11], this indicates the Sun as also a regulator of temperature and cerebrovascular diseases. Everything points to the existence of a small 4-month cycle caused by THE Sun and that impacts climate phenomena, health and probably the economy and society, coinciding with the 4 months of change of the seasons of the year.

In Figure 2 you can see the value of VM and its predicted value.

We wanted to improve the model so we added other variables obtaining a model with a lower error of 3.04 and a higher explained variance of 99.3%. This time we use lag 88 from VS2 and lag 1 month ago from VM, the Durbin Watson statistic this time is 2.08 which tells us that it is not necessary to include more variables (Table 4).

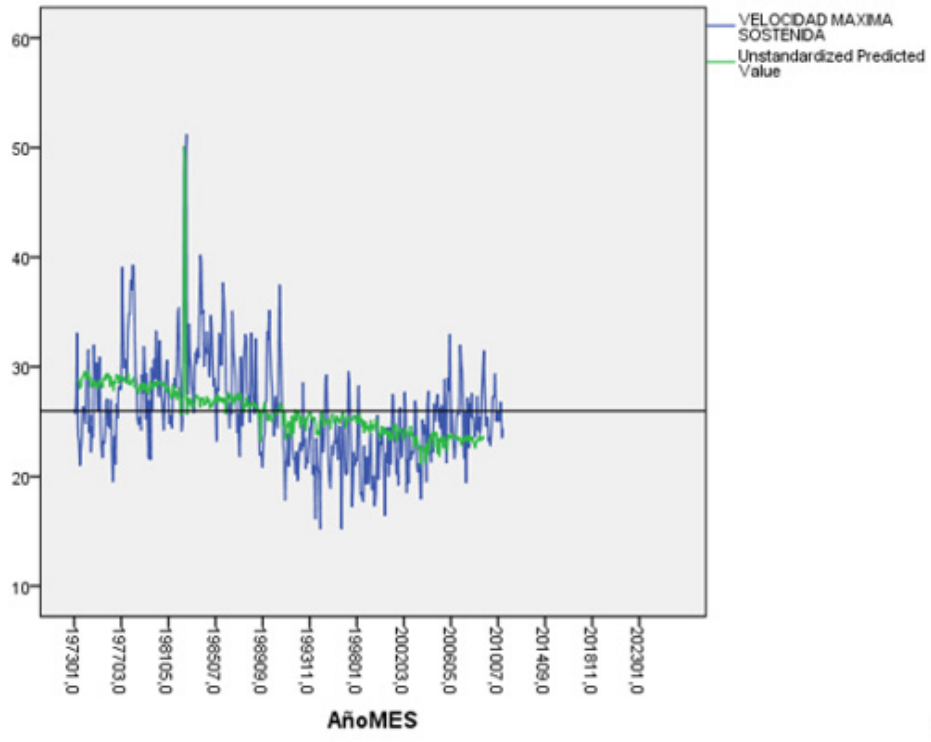

Figure 2: Result of the short-term forecast, model that accepts more variables.

Table 3: Coeficients[a,b].

Modelo		Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
B		Error estándar	Beta			
1	DS	31,136	,850	,833	36,645	,000
	DI	31,448	,851	,841	36,944	,000
	NoC	-,016	,002	-,153	-9,507	,000
	Lag4VS2	-,080	,027	-,076	-2,977	,003
	Step119	23,167	4,307	,042	5,379	,000
	Step118	23,097	4,282	,042	5,395	,000

[a.] Dependent variable: MAXIMUM SUSTAINED SPEED

[b.] Linear regression through the origin

Table 4: Coeficients[a,b].

Modelo		Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
B		Error estándar	Beta			
1	DS	10,430	1,417	,283	7,362	,000
	DI	10,761	1,416	,292	7,598	,000
	NoC	-,006	,002	-,063	-3,346	,001
	Lag88VS2	-,013	,021	-,013	-,619	,536

	Step119	6,619	3,172	,013	2,087	,038
	Step118	19,123	3,072	,038	6,225	,000
	Lag1VM	,655	,038	,655	17,410	,000

[a] Dependent variable: MAXIMUM SUSTAINED SPEED

[b] Linear regression through the origin

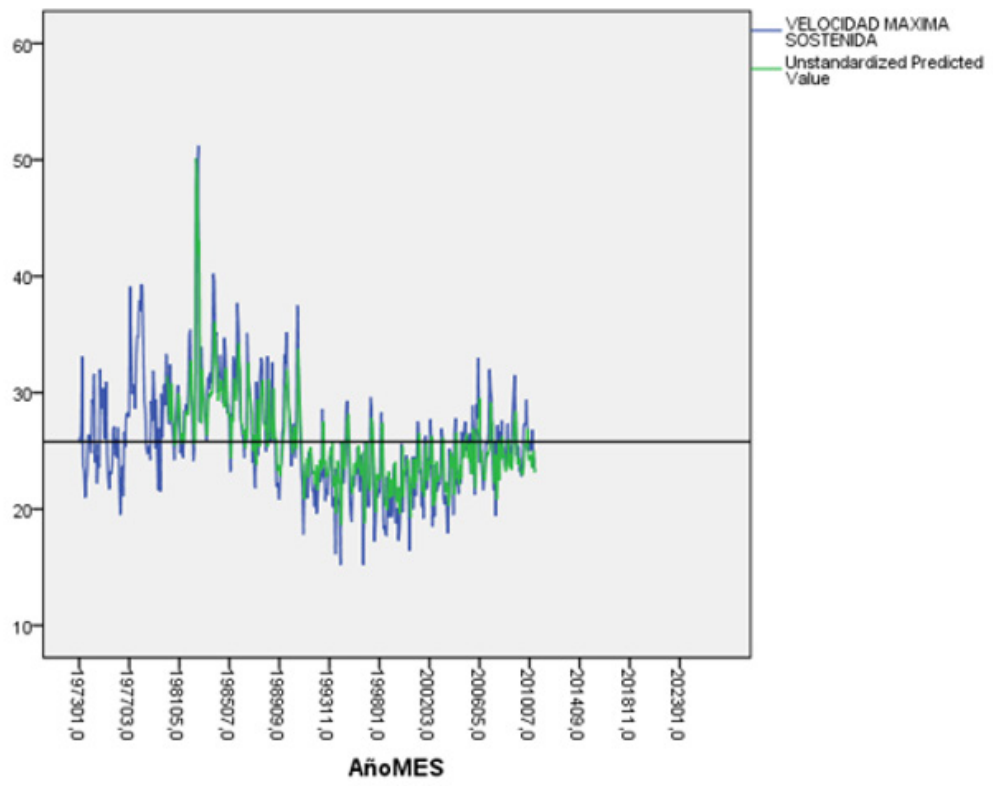

Figure 3: Short-term forecast result, improved model.

This time the predicted behavior is better (Figure 3).

Finally, we carried out a long-term model using the 22-year cycle of the Sun, the results can be seen in Table 5. The estimation error decreased even though the Durbin Watson also decreased.

Table 5: Summary of the model[c,d].

Modelo	R	R cuadrado[b]	R cuadrado ajustado	Error estándar de la estimación	Durbin-Watson
1	,993[a]	,986	,986	281,594	1,143

[a] Predictors: Lag220VS2, DS, DI, Lag264VM, NoC

[b] For regression through the origin (the model without intercept), R square measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to the R squared for models that include intercept.

[c] Dependent variable: MAXIMUM SUSTAINED SPEED

[d] Linear regression through the origin

In Table 6 the long-term model depends on the sustained speed, 22 years ago 22*12=264 steps back and VS2, 10 *22= 220 times back, significant at 90%. The NoC trend is now increasing. It is maintained that with the increase in VS2, VM decreases. The Sun is shown as a climate regulator [9]. Other authors have come to the conclusion that only solar energy has an impact on the number of mosquito outbreaks because as it increases, mosquito outbreaks decrease, at least in the city of Camaguey. In this work, models are obtained. exact data that explain 100% of the cases with the help of the Regressive Objective Regression, ROR, methodology. It should be noted that recent studies aim to modify the radiation that reaches the earth to try to reduce global temperature, so we warn against this initiative that can become a weapon of climate warfare [10].

The forward forecast is shown in Figure 4, an increase in VM is seen.

Table 6: Coeficients[a,b].

Modelo		Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
B		Error estándar	Beta			
1	DS	12,603	1,684	,374	7,485	,000
	DI	12,722	1,703	,377	7,472	,000
	NoC	,023	,004	,354	5,920	,000
	Lag264VM	,135	,044	,166	3,104	,002
	Lag220VS2	-,051	,027	-,056	-1,897	,059

[a] Dependent variable: MAXIMUM SUSTAINED SPEED(VM)

[b] Linear regression through the origin

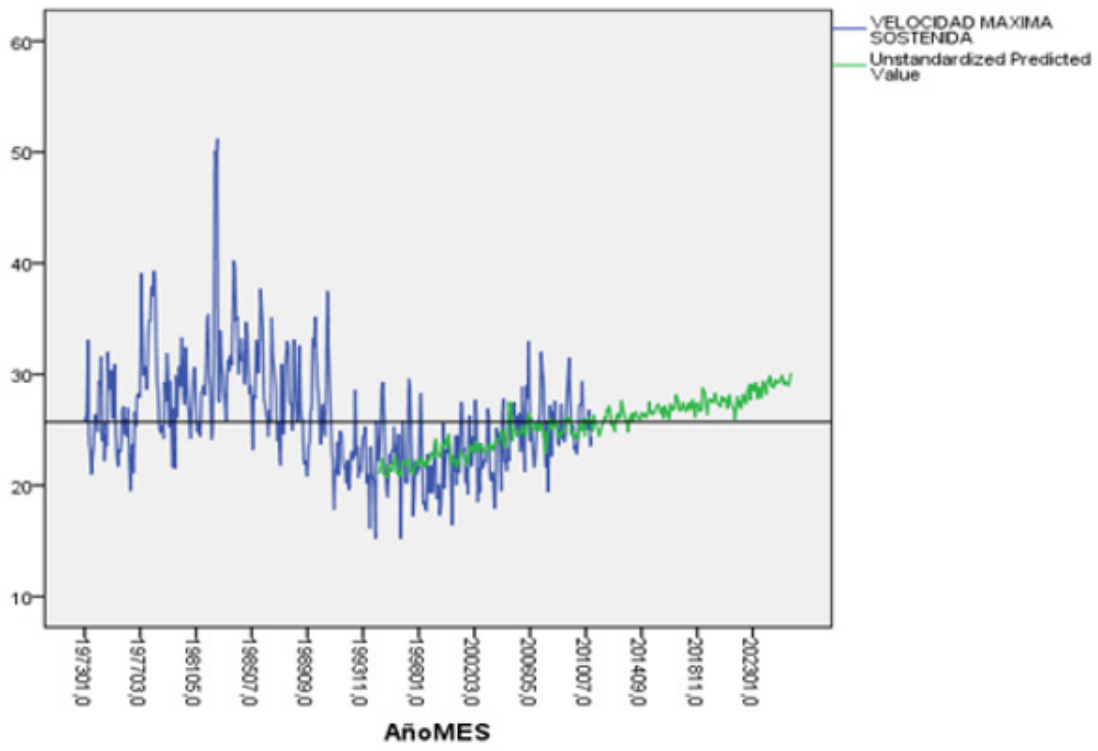

Figure 4: Long-term forecast of VM.

Conclusions

The short and long-term models of the Maximum Sustained Speed were obtained, determining the modulating impact of the Sun through the index of magnetic activity of the Sun, which is a geomagnetic index, the short-term trend is to decrease VM, while at in the long term the trend is increasing, the main statisticians of the models were shown. Everything points to the existence of a small 4-month cycle caused by THE Sun and that impacts climate phenomena, health and probably the economy and society.

Acknowledgments

We would like to thank Doctor of Science Uvedel Bernabe del Pino for kindly providing us with the data without which this work would not have been possible, as well as his teachings throughout our training as a researcher and Dr. Rigoberto Fimia Duarte for his unconditional help in our investigations.

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