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Forecast of Meridien Wind in Southern Part of Madagascar by Neuron Networks

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SUMMARY: *This work consists in studying the meridian wind at the levels of 1000hPa in the southern part of Madagascar in order to predict this wind in Toliara by the neural network. And to achieve this, we used wind data on these levels from the European Center Medium Weither Forecast (ECMWF) from 1979 to 2017 in our study area. This data was processed using MATLAB software.*

Key word*: meridian wind, meridian wind speed, neural networks.*

I. INTRODUCTION

Several meteorological phenomenon take place in the troposphere, the layer closest to the earth's surface such as temperature, precipitation, wind, etc. Among these phenomenon, the wind in particular are produced by the differences in atmospheric pressure caused mainly by the differences in air temperature. Wind is moving air that is characterized by its direction, direction and speed [1]. Thanks to advances in technology, many methods of forecasting have developed, but in this work we use the neural network to predict the speed of the meridian wind.

II. Méthodologies

II.1 Data sources:

The meteorological data of the 1000hPa meridian wind speed used, come from the European center ECMWF (European Center for Medium range Weather Forecasts) or post-processing of digital models. These are the values of the wind speed from January 01, 1979 until December 31, 2017 in the southern part of Madagascar. The resolution for the meridian wind component is 0.5 ° x0.5 °. These data have a three-dimensional matrix form (latitudes, longitudes, days).

II.2. DATA ANALYSIS

II.2.1 Arithmetic mean

The arithmetic mean of a statistical series is equal to the sum of the character's values divided by their number.

$$\bar{X} = \frac{1}{T}\sum_{t=1}^{T} X_t \tag{1}$$

This operation is often used in climatology. This involves calculating the average of all data values during a specific time interval, that is to say 365 days for the annual average, 30 days for the monthly average [2].

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II.2.2 Moving average

The moving average, or sliding average, is a type of statistical average used to analyze ordered series of data, most often time series, [3].

A formula for calculating a simple moving average is:

$$\bar{x}_n = \frac{1}{N}\sum_{k=0}^{N-1} x_{n-k} \qquad (2)$$

II.2.3 The matrix of individuals

The data is in the form of a table with n rows and p columns, which is stored as an X matrix of size n × p, the columns of which contain quantitative variables and the rows represent individuals.

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{ip} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nj} & \cdots & x_{np} \end{pmatrix}$$

X: The matrix of individuals

x_{ij}: Value of the ith observation for the jth variable

x_i: ième observation of the matrix

x_j: jth variable of the matrix

n: number of individuals

II.3 The artificial neural network

It is a set of neurons interconnected between them, so that each connection has a weight (W). The architecture of the network is made up of the number of cells (a cell represents a neuron) [4].

II.3.1 Use of MLP (Multilayer Perceptron) neural networks in the context of forecasting

The usual procedure in the context of forecasting is supervised learning which consists in looking for a parameterized function g (x_k, w), carried out using a neural network, for which the cost function J (w) is minimum [5]:

$$J(\mathrm{w}) = \frac{1}{2}\sum_{K=1}^{N}\left[y_p(x_k) - g(x_k, w)\right]^2 \qquad (3)$$

Where, {x_k, k = 1 to N} is a set of measurements of the input variables, and $y_p(x_k)$ is the measured value of the quantity to be modeled.

To estimate the performance of a neural model, the most frequently used performance index is the Mean Quadratic Validation Error (MQVE) of expression:

$$MQVE = \sqrt{\frac{1}{N_A}\sum_{K=1}^{N_V}\left[y_p(x_k) - g(x_k, w)\right]^2} \qquad (4)$$

Where N_V is the number of elements in the validation set. The resulting error from (4) should be compared to the Mean Quadratic Learning Error (MQLE):

$$MQLE = \sqrt{\frac{1}{N_A}\sum_{K=1}^{N_A}\left[y_p(x_k) - g(x_k, w)\right]^2} \qquad (5)$$

Where N_A est the number of elements of the learning set

III. Results

III.1 identification of the study area and individuals

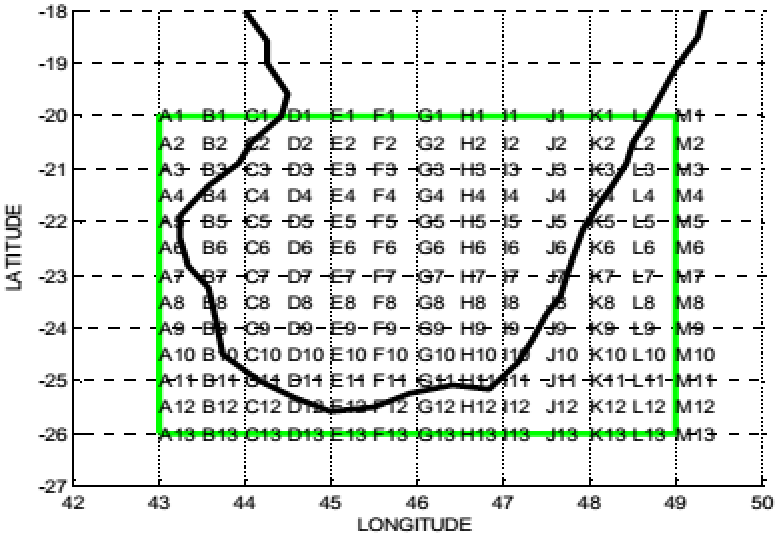

Figure 1: *Presentation of individuals in our study region*

Figure 2 shows the monthly average of the meridian wind at 1000hPa in our study area.

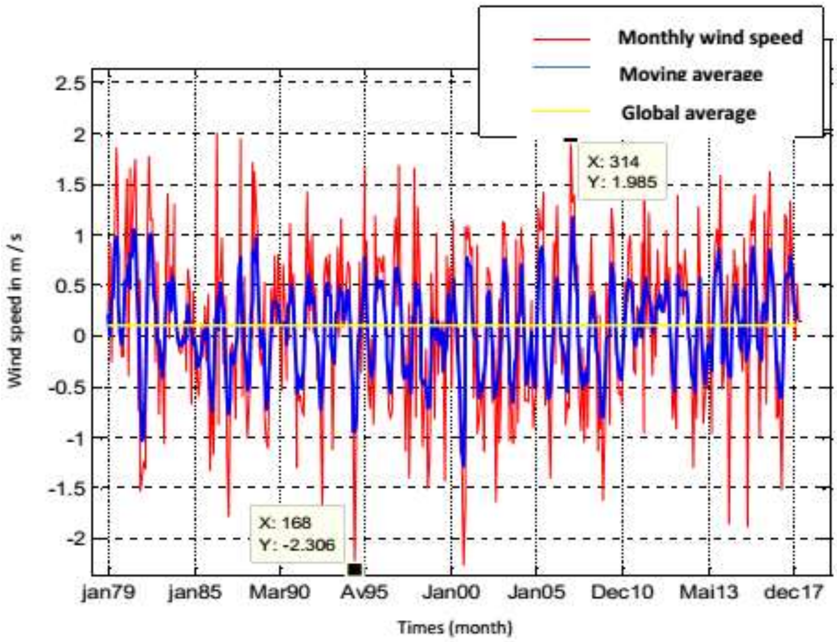

Figure 2: *Variation of the monthly mean meridian wind at 1000hPa*

III.5. Modeling of the meridian wind speed 1000hPa at Toliara

After a number of tests on the RNA with four inputs (WZT950hPa, WZT1000hPa, WMT950hPa, WMT1000hPa) for the meridian wind at 1000hPa, the best neural architecture retained is composed of a single hidden layer comprising 15 neurons and an output which is represented by figure 3

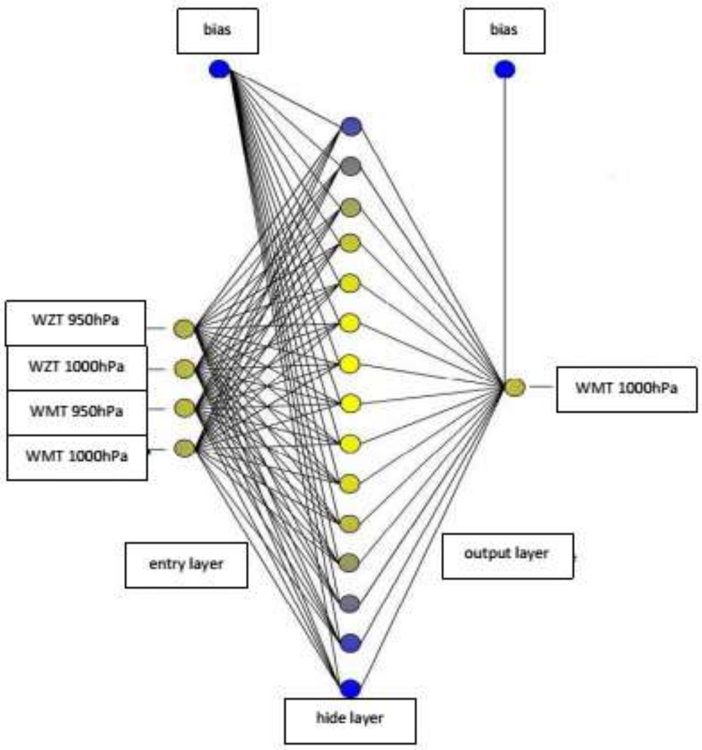

***Figure 3**: Architecture of the retained neural model.*

Figure 4 shows the progression of EQLE during network training. Learning stops when the EQVE achieves the best result.

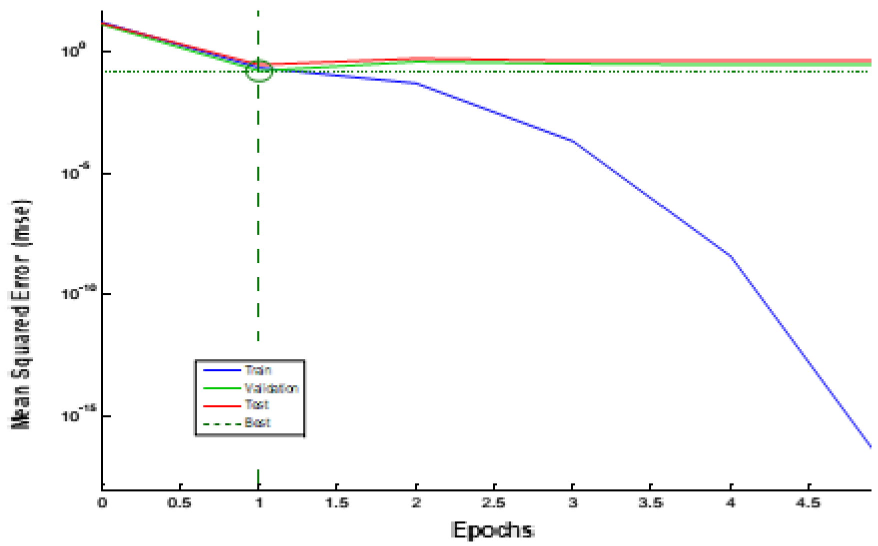

***Figure 4**: Evolution of EQMA during learning for the 1000hPa meridian wind at Toliara.*

Figure 5 illustrates the prediction of the 1000hPa meridian wind in Toliara from 2018 to 2036 which is obtained by the RNA. As we notice in the figure, the predicted wind is almost similar to the observed wind.

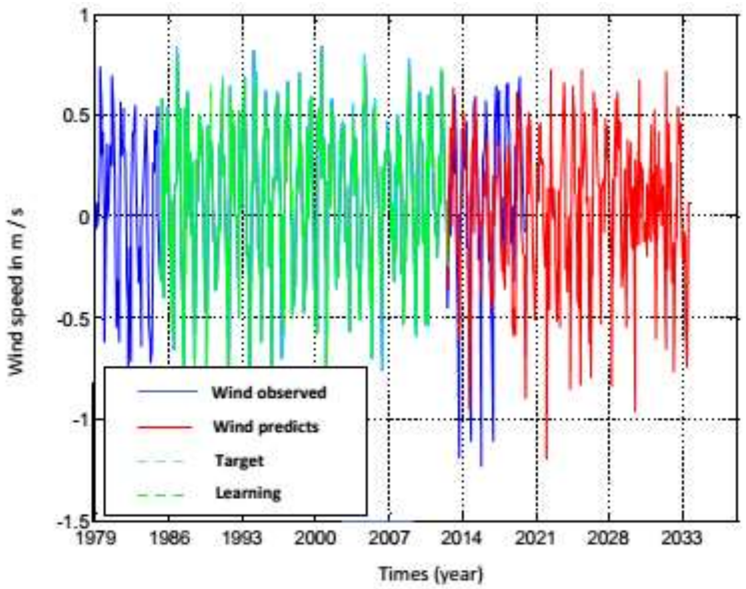

***Figure 5**: Meridian wind predicted at 1000hPa when learning the model in Toliara by RNA.*

IV. Conclusion

The work carried out in this thesis is to make known, the meridian wind at the level of 1000hPa in Toliara in the future by the artificial neuron network (RNA). All the results obtained by the model of the wind prediction using the ANNs allowed us to have a good performance of the forecast of the meridian wind at 1000hPa in our place of study.

V. BIBLIOGRAPHICAL REFERENCES

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