NEURAL NETWORK TECHNIQUES FOR NOWCASTING OF FOG AT GUARULHOS AIRPORT

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ABSTRACT

It is well known that a restrictive weather condition plays important role in the control of landing and takeoff procedures of all airports. In this work is presented three nowcasting approaching (for up to 3 hours) for fog events regarding to landing and takeoff limits of Guarulhos airport in the São Paulo state (Brazil). A Multiple Linear Regression (MLR), Probabilistic Neural Network (PNN) and Generalized Regression Neural Networks (GRNN) were trained and validated using hourly meteorological observations for a dataset of approximately 56 years, from Guarulhos airport meteorological station. The techniques results were compared for hourly nowcasting up to 3 hours ahead by using sensitivity and specificity statistics. In summary, the best results performance was obtained by PNN technique which its nowcasting sensitivity and specificity statistics are higher the 83% and 89% for first, second and third hour fog forecasting, respectively.

1. INTRODUCTION

The takeoff and landing are the most dangerous phase of a flight and the weather condition is definitely critical factor for the aircraft controller takes any action.

Despite the great current progress of numerical weather prediction models in the last decades or so, they can not be able, so far, to produce confident performance during the nowcasting interval, i.e., just after the data assimilation (approximately 5 to 6 hours), (Almeida, 2009).

The present work mainly aims to test, trained and validated three different approaching for nowcasting purposes (up to 3 hours) of fog using hourly meteorological observations for a dataset of approximately 56 years from Guarulhos airport. The techniques used are one multiple linear regression and two types of artificial neural networks (named PNN and GRNN). In general speaking, the neural network is currently well recognized tool for modeling the complexities embedded in any artificial or physical system (Bishop, 2006; Haykin, 2002).

2. DATA and METHODS

2.1 Study area and Data

The Guarulhos Meteorological Station (at 23° 26'S, 46°28'W), is located in the international airport of Guarulhos which is about 25 km far from São Paulo´s city center. As aforementioned, the dataset used was collected in hour frequency from January 1951 to March 2007. The nowcasting techniques utilized here have its inputs and outputs based on ten meteorological parameters as follows:

a) Julian day
b) Hour
c) Wind direction;
d) Wind speed;
e) Horizontal visibility;
f) Present weather;
g) Type, height and quantity of the clouds;
h) Air temperature;
i) Humidity;
j) Atmospheric pressure.

2.2 Methods

In here is briefly only discussed about the neural network techniques. For the training, testing and validation of the ANN, it has been used NeuroShell Predictor (which uses networks PNN) and NeuroShell

Classifier (which uses network GRNN) of Ward Systems Group, Inc. networks PNN and GRNN were initially proposed by Specht (1990, 1991). The two neural networks are trained using the algorithm TurboProp2 developed by Ward Systems Group, which is a variant of the Cascade Correlation Algorithm (CC) developed by Fahlman *et al*. (1990).
In order to evaluate the two networks tested here, eight training sets were created. Besides, these datasets were slightly modified by increasing proportionally the number of meteorological events such as low visibility and fog have appeared.

The method is composed six steps as follows:

1. Data preprocessing;
2. Selection of inputs and outputs;
3. Creation of training and validation datasets;
4. Training;
5. Validation;
6. Results Analysis.

The results are assessed by measures of sensitivity and specificity statistics. Sensitivity is the ability of the model to correctly classify the desired event or the percentage of true-positive, specificity is the ability of the model to correctly classify the non-event or the percentage of true-negative (Wilks, 2006).

3. RESULTS AND CONCLUSION

Table 1 is presented the sensitivity (column 3) and specificity (column 4) values of MLR, PNN and GRNN for nowcasting of FOG. In sumury, the PNN has shown the best performance among the techniques with sensitivity and specificity high than 83% and 89% for first, second and third hour fog forecasting, respectively.
The system is operationally working at Guarulhos airport since 2009.

Table 1 – Sensitive and specificity results for FOG forecasting using eight dataset and MLR, PNN and GRNN nowcasting techniques.

Hour	Method	Sensitivity(%)	Specificity(%)
1ª	MLR	70	99
	GRNN	75	96
	PNN	95	93
2ª	MLR	64	96
	GRNN	69	97
	PNN	91	94
3ª	MLR	49	97
	GRNN	53	98
	PNN	83	89

4. REFERENCES

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