

ECONOMETRIC METHODS IN PRECIPITATION FORECAST

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1. INTRODUCTION

This research was elaborated according to Agreement on Scientific and Technological Cooperation in the Field of Statistical analysis of meteorological data between The Federal University of the Alagoas of Brazil and the New Economic School, an Independent Graduate School of Economics of Russia.

In the paper we address the very basic question: to what extent daily precipitations volume at the Maceio airport, Brazil, could be forecasted using only historical data on Maceio weather conditions.

We use multiple regression models for precipitations volume forecast and binary choice probit model for the heavy rains forecast. At first stage only conventional meteorological data were used. It turns out that predictive power of the models is rather low (e.g. only 22% of the variation in volumes were explained by the log-linear model). At second stage satellite and reanalysis NCEP data were added to the models it results in increase of the models predictive power to 27-28%.

From economic point of view forecast of average precipitations volume in the area is more important than the point forecast. Since point observations have large stochastic component due to small scale of precipitation source, it is expected that the forecast power of the models for average precipitation volumes will be larger than for the point forecast models. Indeed, tobit log-linear model for the average for 4 neighbour cities (Maceio included) precipitation volume explains up to 60% of the average volume variation.

The purpose of econometric modelling in meteorology is to pick out what part of meteorological situation could be explained by simple statistical model, and what is rest have to be of the special focus for meteorological experts' analysis.

2. DATA SOURCE AND METHODOLOGY

We use two types of data for the one-day precipitation forecast for the Maceio region. First set of data are the conventional surface meteorological data obtained by meteorological stations (Zumbi dos Palmares airport, Pao de Asucar and Palmeira dos Indios) for five years on period of 1/1/2003–31/12/2007 (1461 observations).

The daily meteorological data are following: precipitation (PR, mm/24h), maximum and minimum values of temperature, atmosphere pressure, humidity and day time of its observations, also 24 hours' averages of temperature, atmosphere pressure, humidity, wind, direction of the maximum wind, its velocity and time of its observation.

Second set of data presents the synoptic systems. These systems were analyzed daily using different products (jet streams at the low, middle and high levels, temperature and omega) of NCEP reanalysis and infrared satellite images.

We use linear regression models (see Fedorova et al. 2008) an nonlinear Tobit model (Greene, 2007) for the precipitation forecast.

For the Tobit model we compare two sets of regressors: first consist of only ground observations and the second one additionally include the satellite data,

Also, we compare predictive power of the models for the point and average precipitation forecasts.

3. RESULTS

Best point precipitation forecast with only ground observations data reveal fairly low predictive power ($R^2 = 0.22$) (Fedorova et al., 2008).

Use of the nonlinear Tobit model and the satellite synoptic data increase the predictive power of the model to $R^2 = 0.27$.

Binary choice Probit model (Greene, 2007) for the yes/no precipitation forecast gives 800 correct forecasts out of 1285 observations (approximately 62%). But for the practical usage the forecast of the precipitation volume is, of course more important.

Our experiments with regressions demonstrated that the satellite synoptic data at Maceio are not important for the precipitation forecast at the Alagoas regions which are not close to the Maceio city.

It is why we concentrated on the forecast of the average weighted precipitation volume over the 4 stations close to Maceio city (fig. 1): Maceio, Coruripe, San-Sebastian, Gomes with the corresponding "optimal" weights 0.232, 0.267, 0.293 and 0.208.

Table 1 presents the comparison of the two tobit models: first for the point forecast of the precipitation volume for the Maceio and second — for the forecast of average precipitation volume at the Maceio area.

The patterns of synoptic scale systems, associated with weak and intensive precipitation, were elaborated. The rain (April - July) and dry periods are observed in Alagoas State by climatological data. During studied period the days number with precipitation

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more than 0,1 mm were higher between March and August.

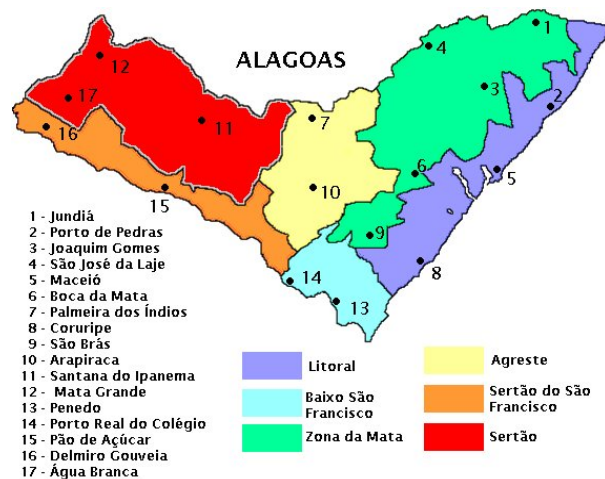


Figure 1. Map of the Alagoas state of Brasil.

Factor	Point forecast	Average forecast
	Coeff.	Coeff.
Constant	0.95***	1.03***
SEASON	0.46***	0.29***
TDROP	-0.14***	-0.10***
HPRMAX	0.86***	0.59***
LOG(MACEIO+1)	0.29***	0.52***
DIRECTZ	0.0084***	0.0033***
SYS200_2	-0.42***	-0.15*
SYS1000_6	-0.30***	-0.21***
SYS1000_7	0.12	0.073
SYSGLOB8	0.19	0.32**
R ²	0.27	0.59

***, ** and * — significant at 1%, 5% and 10% level.

Table 1. Comparison of the tobit models for point and average precipitation volume forecast. All explanatory variables (regressors) are related to the previous day, dependent variable is tomorrow's precipitation. The regressors (factors) at the models are: SEASON — indicator of the period April–August, TDROP — maximum temperature change over the day, HPRMAX — time of observed maximum precipitation, LOG(MACEIO+1) — logarithm of the precipitation, DIRECTZ — deviation of the direction of the wind from 125°, most popular direction of the wind at Maceio, truncated at 60°; synoptic systems: SSYS200_2 — Upper Tropospheric Cyclonic Vortex (at the level 200 hPa), SYS1000_6 — Difffluence at the level 1000 hPa, SYS1000_7 — Confluence at the level of 1000 hPa, SYSGLOB8 — mesoscale convective complex.

4. CONCLUSION

1) Satisfactory results did not obtained by statistical classical methods using only conventional meteorological data.

2) The predictive power of the models increase after the synoptic satellite data are included.

3) The predictive power for the average region Maceio precipitation forecast is significantly higher than the predictive power of the point precipitation forecast. At the same time for the agriculture needs the average precipitation forecast is more important.

4) SYSGLOB8 — mesoscale convective complex was unimportant for the point forecast, but is important for the average precipitation forecast.

5. ACKNOWLEDGEMENTS

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