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DANGEROUS FOG ANALYSES AND FORECAST IN THE MACEIO AIRPORT, BRASIL

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ABSTRACT
A small airplane fatal accident has occurred near Maceio Airport, on the coastal region on 26 July 2007. Low visibility in the intensive fog has provoked this accident. Weather forecast analysis, published in the local and central Brazilian newspapers during 2007, showed fog forecast absence during whole year. A study of the fog formation causes was elaborated using the high and low resolution satellite data, radar data, different products of NCEP reanalysis data and high resolution regional MM5 model simulation. The trade winds with a weak cyclonic curvature at the low levels have generated the humidity convergence at the superficial layers up to 850hPa on the coastal region. An anticyclonic circulation at the middle and higher levels and weak ascendant motion (by NCEP data) supported a weak convection development. The low levels clouds on the continental region and convection development over ocean were confirmed by the radar and satellite data. A thermal inversion near surface level (up to 150m) and descendent movement at the middle and high levels were identified by MM5 model. Fog formation was simulated by PAFOG model. The conventional airport observations have shown the minimal visibility of 200m between 4 and 7a.m. Moreover visibility less than 1000m between 4 and 7a.m. with the minimal visibility of 136m was simulated by PAFOG model.

Keywords: fog, fatal accident, PAFOG model.

1. INTRODUCTION

Fog was not observed frequently on the northern coast of Brazil; only one – two events per year were registered (Fedorova et al, 2008). At the same time rare meteorological stations don´t present complete information about the phenomenon.

A small airplane fatal accident has occurred near Maceio Airport on 26 July 2007 (figure 1). Low visibility in the intensive fog has provoked this accident.

Figure 1 Airplane fatal accident near Maceio Airport on 26 July 2007

Weather forecast analysis, published in the local and central Brazilian newspapers during 2007, showed fog forecast absence during whole year.

Fog/stratus formation on the northern coast of Brazil is associated, in general, with Wave Disturbance in the Trade Winds (WDTW) (Fedorova et al., 2008). The fog /stratus clouds were observed only together with altostratus and cumulus clouds in this tropical region. No stable layers in the vertical profiles were registered and the humid layer was very narrow in all studied cases.

The main research goal is the investigation of the fog formation causes, which provoked this fatal accident. The study results can support short-term weather forecasting in Maceio city (9°S, 36°W), Alagoas State on the northern coast of Brazil.

A forecast model (PAFOG) was developed by Bott and Trautmann, for radiation fog and low-level stratiform clouds in Germany (Bott and Trautmann, 2002). This model testing for intense fog formation event in the tropical region is the second goal of the study.

2. DATA SOURCE AND METHODOLOGY

The hourly conventional meteorological data (relative humidity, air temperature, dew point temperature, wind direction and velocity, pressure) at the Airport Station were used for the fog identification. The satellite and radar

information show the clouds types and synoptic scale systems near the study region.

The NCEP reanalysis date and MM5 model result (by Institute of Atmospheric Science, Federal University of Alagoas -UFAL) were used for synoptic scale systems description, vertical profiles simulation and as initial data for PAFOG model.

The WDTWs identification was elaborated by using streamline maps and vorticity at low levels (1000 and 925hP) and satellite images according to Molion and Bernardo (2002).

The PAFOG model input data are presented in 4 sections.
Section 1:
geographical data (latitude, longitude and altitude of meteorological station);
ground (ground type by Bott & Trautmann, 2002);
vegetation (height and covering);
meteorological station data (pressure; air and dew point temperatures and relative humidity at the 2m; temperature at the ground; visibility).

Section 2: cloudiness at the low, middle and high levels.

Section 3: radiosonde data (pressure; air and dew point temperatures; geostrophic wind velocity; level).

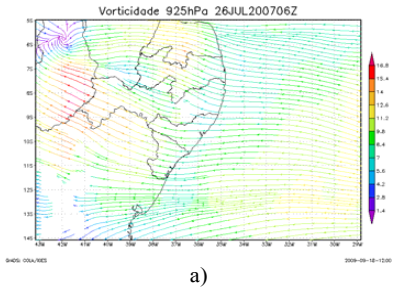
Section 4: ground temperature and humidity at different depth.

The PAFOG model was used for forecasting of the fog formation with 24h antecedence. The hourly conventional meteorological data were used as input for Sections 1and 2. Because of radiosonde data absence in the Maceio region, the MM5 model data were used in Section 3. The input data for Section 4 was constant (UV=0,25) because of the absence of any information (observational and by model).

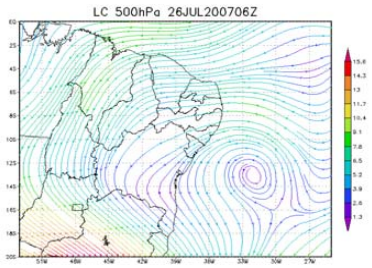
3. RESULTS

3.1 Intensive fog formation conditions

An intensive fog was associated with the weak trough and WDTWs formation at the low levels (figure 2a). An anticyclonic circulation at the middle levels helps to humidity accumulation near the surface (figure 2b).



a)



b)

Figure 2 - Streamlines at the 925 hPa (a) and 500hPa (b) near Alagoas state on 26 July 2007, 06UTC. Source: MM5, UFAL

Radar data presented the convection line development over the ocean, parallel to beach and the convection absence near the Airport (figure 3).

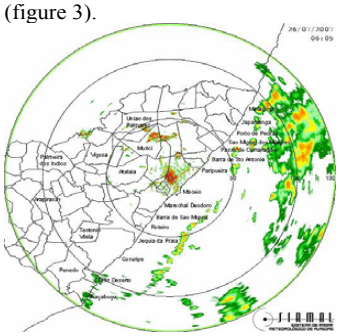


Figure 3- Radar data with radius 130km around the Airport on 26 July 2007, 06UTC.
Source: SIRMAL, UFAL

Omega vertical section show a weak ascendant movement below 900hPa near the Airport and intensive ascendant movement near beach, some kilometers over the ocean (figure 4). These data confirmed the radar information.

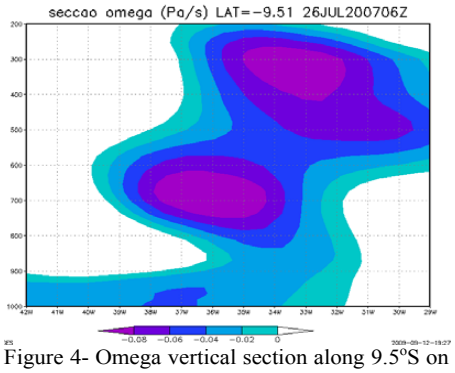
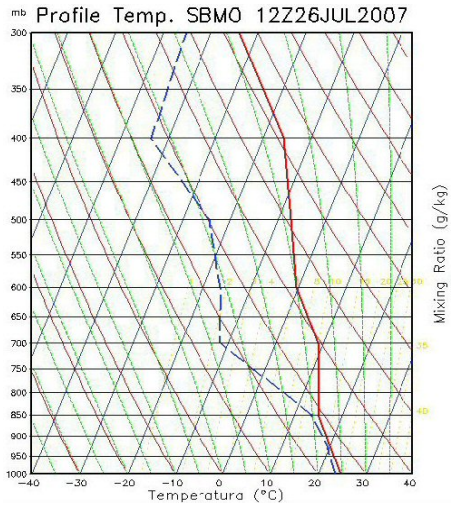


Figure 4- Omega vertical section along 9.5ºS on 26 July 2007, 06UTC. Source: NCEP

An absence of any thermal inversion or stable layer near the surface was observed by NCEP reanalysis data (figure 5a). A thermal inversion near the surface level (up to 150m) was identified by MM5 model (figure 5b).



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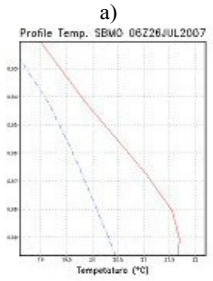
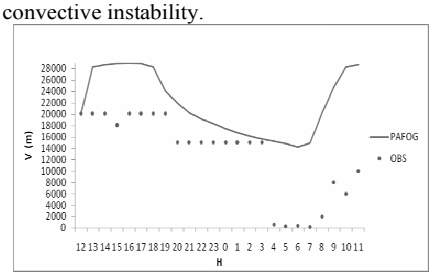


b)

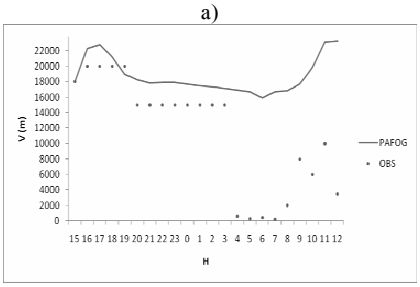
Figure 5 – Vertical profiles of air temperature (line) and dew point temperature (dashed line), constructed by NCEP data (a) and in the low levels by MM5 model (b; axis y in σ) on 26 July 2007, 06UTC. Source: NCEP, MM5-UFAL

3.2 Forecast by PAFOG model with the cloudiness data

The visibility forecasts with 16-13h antecedence were lower than observed (figure 6a,b). Initial date for them used atmospheric parameters during maximal heating and maximal convective instability.



a)



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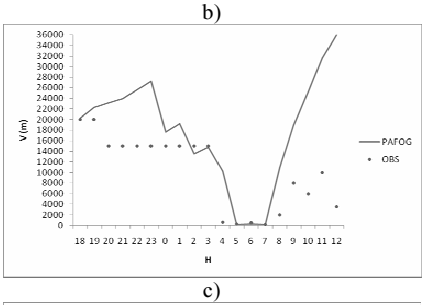

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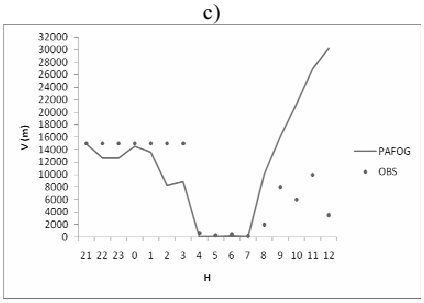


d)

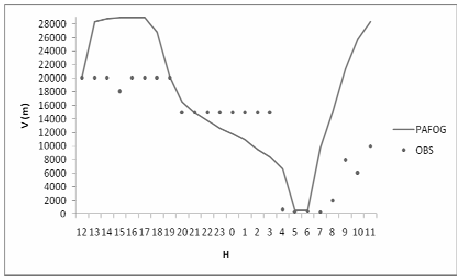
Figure 6 – Visibility by observational data (points) and by PAFOG model forecast (line) on 25-26 July 2007. The forecast with 16, 13, 10 and 6h antecedence are presented at the figures a, b, c and d, respectively.

Forecast with 10h antecedence shown better result (visibility 132m between 5 and 7h local time) (figure 6c). Forecast with 6h antecedence was the best with low visibility (136m) between 4 and 7a.m. At the same time forecasted visibility after fog was higher than observed (figure 6d).

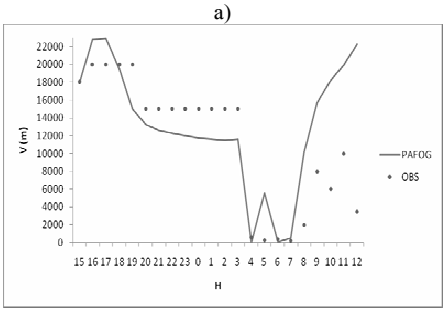
3.3 Forecast by PAFOG model for clear sky

Because of the forecast by the PAFOG model did not show satisfactory result with beginning data during maximal convective instability time, the model was tested for situation without cloudiness. The results were much better and fog formation and visibility fall were forecasted similarly to the observational data (figure 7).

After the fog event, a visibility forecast did not show satisfactory results. The model predicted a finish of the low visibility period (visibility predicted was 16-22km). But the observational data presented the haze (visibility < 2000m) up to 8h and then a visibility variation between 8 and 10km



a)



b)

Figure 7 – Visibility by observational data (points) and by PAFOG model forecast (line) on 25-26 July 2007. The forecast for clear sky with 16 and 13h antecedence are presented at the figures a and b, respectively.

4. CONCLUSION

The intensive fog, witch provoked fatal accident near Maceio Airport, was formed by next principal causes:
1) wind velocity was decreased brusque during the change of daily sea breeze (from east) to land night (from north west); the visibility in this moment decries from 15 km to 1.5km during 1 hour;
2) existence of the stable superficial layer (weak thermal inversion up to 925hPa by MM5 model);
3) weak ascendant movement at the low levels and weak descendant movement between 800 and 700hPa and at high levels by MM5 model.
All theses processes help to humidity accumulation at the low levels.

Fog forecasting by the PAFOG model presented a satisfactory result with 10h antecedence. Fog was not predicted with the beginning data during maximal convective instability time. These beginning data presented a good result for clear sky situation.

5. ACKNOWLEDGEMENTS

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