

## FRONTAL ZONE ON THE NORTH-EAST OF BRAZIL

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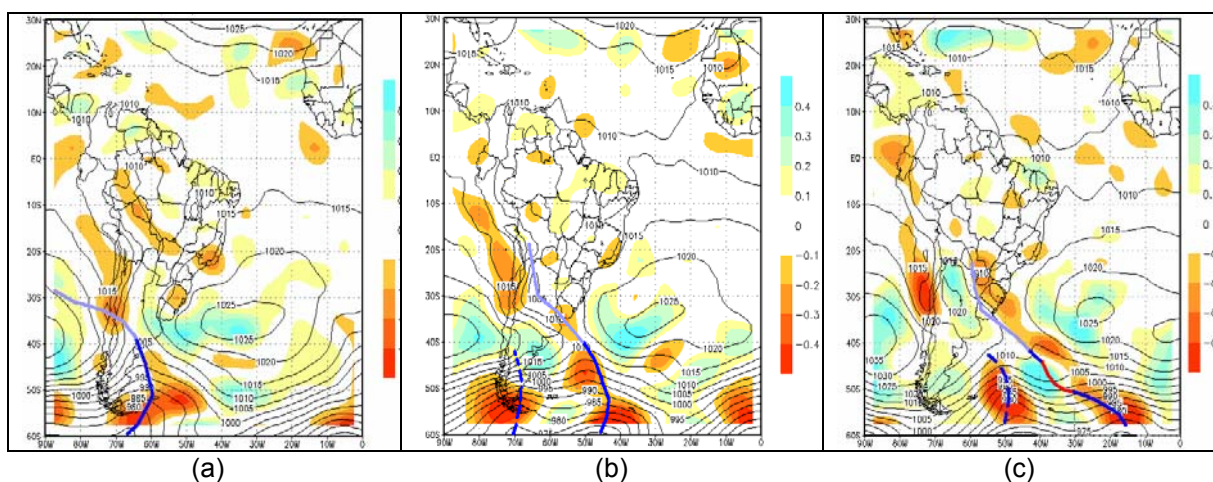
Principal synoptic systems, associated with precipitations on North East of Brazil (NEB), are Upper Tropospheric Cyclonic Vortices, Easterly Waves, Wave Disturbance in the field of Trade Winds and Frontal Zones. The frontal zones are associated with extratropical baroclinic lows and are the principal mechanism of the weather changing at the South America (SA). A few frontal zones pass through NEB; only 20% of all fronts observed on Brazil, reach the NEB (KOUSKY, 1979; KOUSKY & FERREIRA, 1981; Gemiacki, 2005 and CLIMANÁLISE, 2003). The fronts in NEB can't be identified by temperature variation, but high humidity and wind direction variation show the frontal passage. The frontal zones are associated with intensive convection on the all tropical regions of SA and with adverse meteorological phenomenon on NEB.

The aim of this investigation is the mechanisms study of the frontal zones penetration into tropical region up to Alagoas State (latitude 10°S). Two mechanisms were described and the examples of both mechanisms are presented. The first example shows the conditions of the frontal passage from south of SA. The second and third examples present the frontal zones formation near NEB, which were associated with cyclonic vortex at the atmospheric middle levels.

*The first frontal event* was observed during 30 October to 5 November 2003 and front have passed through all SA. The frontal zones identification was elaborated by different methods: by classic synoptic method, by satellite images and using non conventional parameters, such as thermal advection, vertical movements, virtual potential temperature and equivalent potential temperature. The reanalyse NCEP/NCAR data were used at the six levels. The frontal parameters modification during frontal pass through SA was analyzed by radiosond and conventional data on three meteorological stations on east coast of Brazil at 30, 20 and 10°S.

Synoptic systems evolution and frontal zones dislocation are presented in figure 1:

- initial position of extratropical baroclinic low with cold front on the south of SA;
- cold front interaction with thermal low on the north of Argentina and first secondary front (first cold air vortex) formation;
- coalescence beginning of cold and secondary fronts and instantly occlusion process;
- second secondary front (second cold air vortex) formation behind the cold front;
- cyclogenesis on the principal cold front;
- localization of the principal and second secondary cold fronts before secondary instantly occlusion process;
- secondary instantly occlusion process;
- frontal position near the Alagoas State.



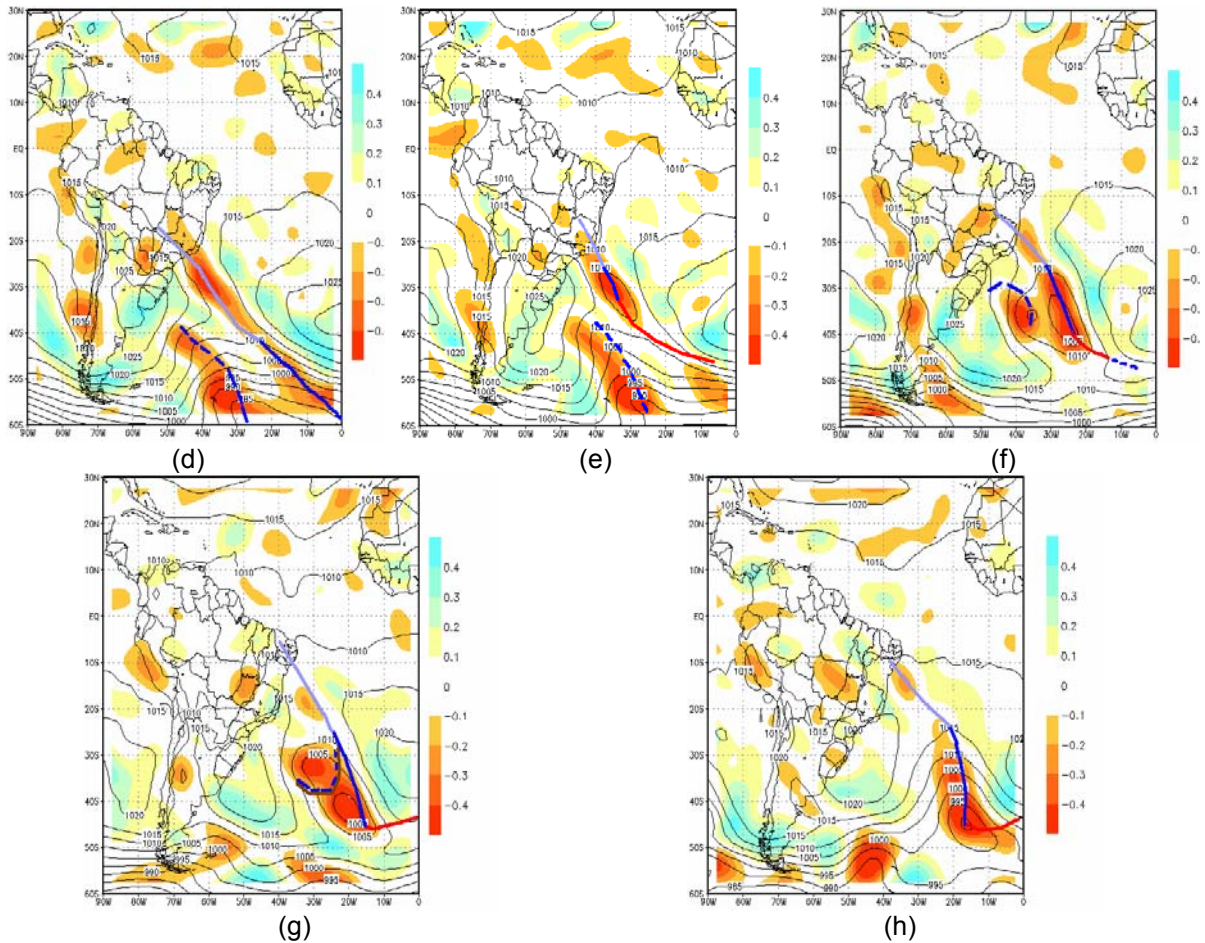


Figure 1- Maps of pressure (black line) and relative vorticity at the level 925 hPa (colour) for the important moments of the front passage from SA south: (a) 30/10/2003, 00 UTC, (b) 30/10/2003, 18 UTC, (c) 31/10/2003, 18 UTC, (d) 02/11/2003, 12 UTC, (e) 02/11/2003, 18 UTC, (f) 03/11/2003, 12 UTC, (g) 04/11/2003, 12 UTC e (h)05/11/2003, 12 UTC. Red line presents a warm front; blue line - a cold front; dots blue line - a secondary cold front; violet line - a cold front identified by satellite and unconventional parameters. Source: NCEP.

The second frontal event was observed during 15 to 20 May 2003. The reanalyse NCEP/NCAR data (stream lines, relative vorticity, pressure) were used at the ten levels.

The localization of cyclonic vortex at the different levels is shown at the table 1. The cyclonic vortex was formed at the 850hPa level and then was more intensive at the levels of 600 and 500hPa.

TABLE 1 - Cyclonic vortex localization at the different levels during 15 to 20 May 2003. X show the more intensive vortex level. Source: NCEP.

Vortex position by stream lines						
days, hors UTC/ levels (hPa)	15 12	16 12	17 00	18 12	19 12	20 12
200						
250						
300						
400					X	
500		X	X	X	X	X
600		X	X	X	X	
700		X	X	X	X	
850	X		X			
925						
1000						

The frontal zone was formed on 15 May and was more intensive on 16 May, 12UTC (Figure 2). The middle levels vortex and frontal positions were confirmed by stream lines and relative vorticity maps (Figure 2) and

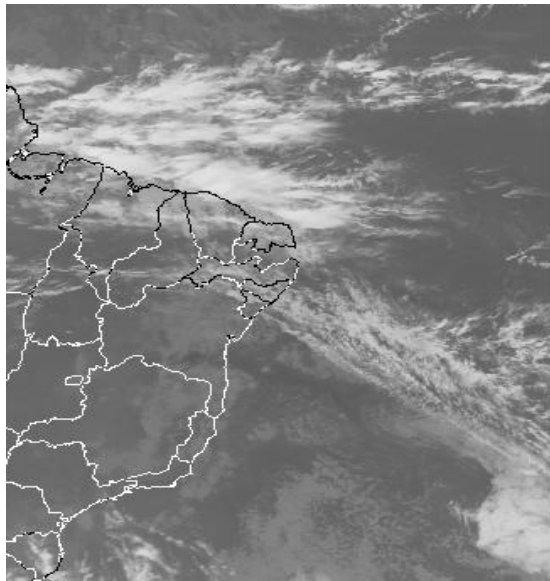


Figure 2- Satellite images in infrared channel from GOES, 16 May, 2003, 12UTC. Source: CPTEC/INPE.

also by satellite images in infrared channel (Figure 3). The surface pressure maps show the surface low absence. The frontal zone was associated with atypical (near the NEB) Jet Stream at the upper levels.

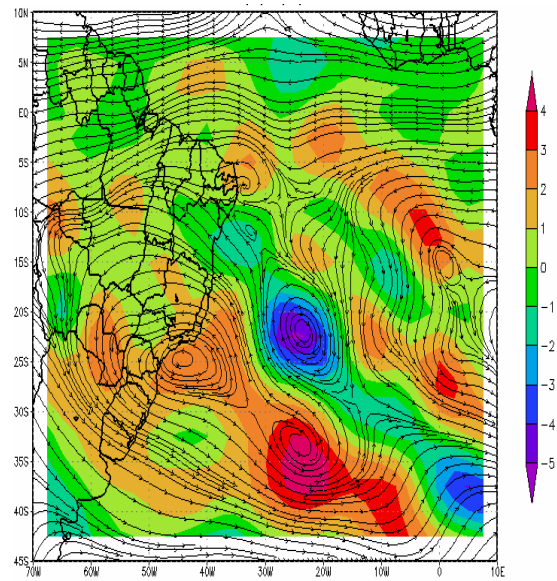


Figure 3- Stream lines (black lines) and relative vorticity ( $\times 10^{-5} \text{s}^{-1}$ , colours) at 600hPa level, 16 May 2003, 12UTC. Source: NCEP.

The third frontal event was observed during 12 to 20 August 2004. The cyclonic vortex with the frontal zone was formed at the 925hPa level on 12 August, 00UTC. Then the cyclonic vortex was more intensive at 850hPa and 600hPa levels during all life time period (Table 2). The more intensive cyclonic circulation (relative vorticity up to  $5 \times 10^{-5} \text{s}^{-1}$ ) and intensive frontal zone were observed on 14 August, 12UTC (Figures 4 and 5). The highest vortex was registered on 15 August, 12UTC between

700 and 200hPa and more intensive cyclonic circulation was localized at the level 600hPa. Then the vortex has lost the intensity and was observed at the level 600hPa during five days up to 20 August. The infrared images have confirmed the vortex position from 12 up to 17 August (Figure 4) and then the cloudless was observed. The atypical (near the NEB) Jet Stream has accompanied this front during all time period.

TABELE 2 - Cyclonic vortex localization at the different levels during 12 to 20 August 2004. X show the more intensive vortex level. Source: NCEP.

Vortex position by stream lines										
days, hors UTC/ levels (hPa)	12 00	12 12	13 12	14 12	15 12	16 12	17 12	18 12	19 12	20 12
200					X					
250					X					
300				X	X					
400				X	X	X				
500			X	X	X	X		X		
600			X	X	X	X	X	X	X	X
700	X	X	X	X	X	X	X			
850	X	X								
925	X									
1000	X									



The precipitations were observed in all frontal events over all State regions. In Litoral and Zona da Mata regions precipitations were more intensive (an average 19mm/24h and

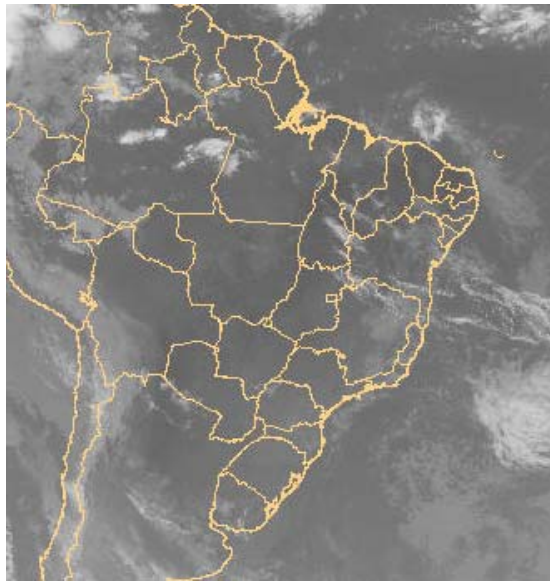


Figure 4- GOES satellite infrared images, 14 August, 2004, 12UTC. Source: CPTEC/INPE.

*The conditions* (first mechanism) of the frontal zone dislocation from south of AS up to Alagoas are following:

- 1) initial Baroclinic Low position to the south of 60°S;
- 2) frontal through interaction with a warm core barotropic low at the North of Argentina;
- 3) formation of two vortices at the cold air after cold front;
- 4) occurrence of the instant occlusion was observed twice;
- 5) appearance of the cyclogenesis process at the principal cold front near 30°S;
- 6) interaction of the frontal through with the through of inter-tropical convergence zone;
- 7) appearance of two jet streams at 25°S and 55°S;
- 8) high level anticyclone centre over South America dislocation to East.

*The second mechanism* of the frontal zone penetration up to Alagoas State is a Baroclinic Lows formation at the middle levels over Atlantic ocean near 20-25°S. The vortices duration were four and nine days. The vortices formation was associated with weak (near 30m s<sup>-1</sup>) Jet Stream near NEB. The frontal zones, associated with this Lows, passed slowly over east cost of NEB.

Wind speed and direction, pressure, equivalent potential temperature, relative

maximal values up to 39,2mm/24h). In others regions precipitations less than 5mm/24h were registered.

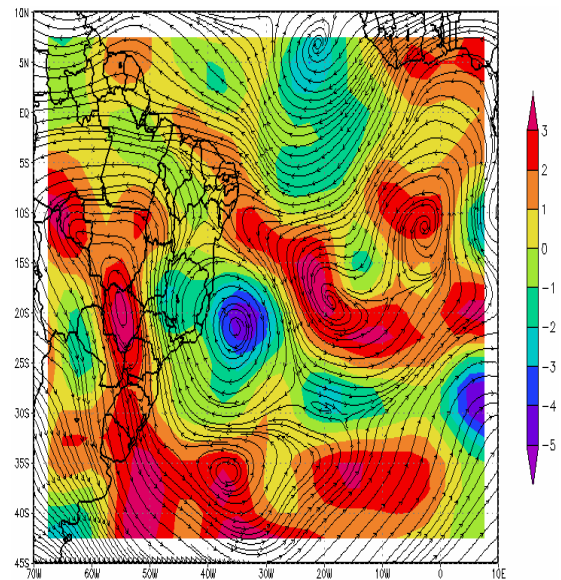


Figure 5- Stream lines (black lines) and relative vorticity ( $\times 10^{-5} \text{s}^{-1}$ , colours) at 600hPa level, 14 August, 2004, 12UTC. Source: NCEP.

humidity and precipitations were presented more significant variations during frontal zone passage, but not any temperature variations were observed. The precipitations up to 40mm/24h were associated with the frontal zones in Alagoas State. Some precipitations were registered in all State regions, but more intensive ones were observed in the coastal regions.

#### REFERENCES

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