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Characterization of the atmosphere to the passage of squall lines at Dakar from 1968 to 2006.

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Characterization of the atmosphere to the passage of squall lines at Dakar from 1968 to 2006.

Context of the topic of the article.

Understanding of major climate mechanisms is, of course, a major challenge for the scientific world, but not only for the latter: in the world, and sometimes quite dramatically urgent, economics, sociology, politics, in short the life, (survival?) of all days depend to present and future of the climat.

Context of the topic of the article.

The subject of our present work is squall lines. African squall lines (SL) are a major player in the climate of Africa, north of the equator, particularly in the Sahel, in the sense that these weather phenomena govern the exchange of energy within the atmosphere an important part of the world in large surplus solar energy received (some SL are sometimes responsible for triggering hurricanes thousands of miles to the west, off the coast of Mexico).

Context of the topic of the article.

More crucial for everyday life of the farmer and rancher African rainfall during the African monsoon (especially those from SL) provide most of the water needed for agricultural activities . These two issues: science and society, led the scientific community in international research campaigns in the region, the latest being AMMA (Multidisciplinary Analysis of the African Monsoon).

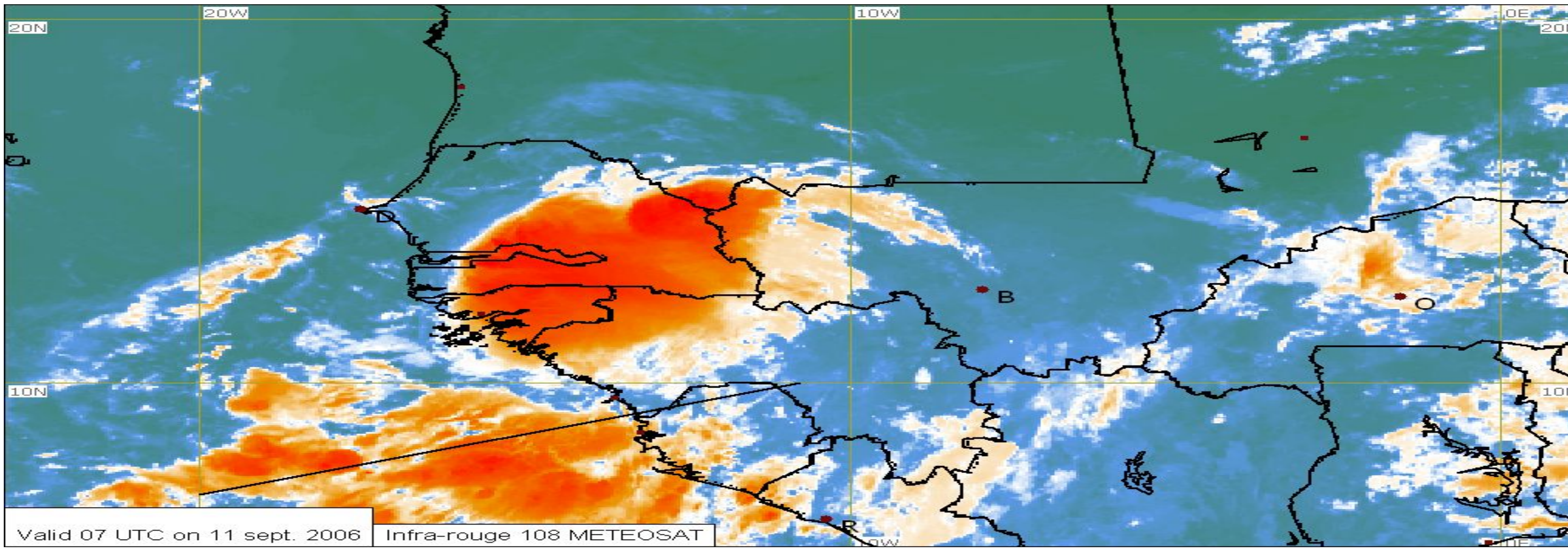
Context of the topic of the article.

This is to better understand how the mechanisms of climatic region, particularly for economic planning. Senegal has made a contribution to both scientific and logistical important in this operation, which took place during the decade just ended, but whose analysis of the results to date and continues for long, perhaps we expect. The thesis project that I wrote is in this double problem, but also social science. This is an investigation, both by terrestrial observations and modeling with the help of the satellite, the climatic characteristics of Senegal during the passage of the LGA on the Dakar region.

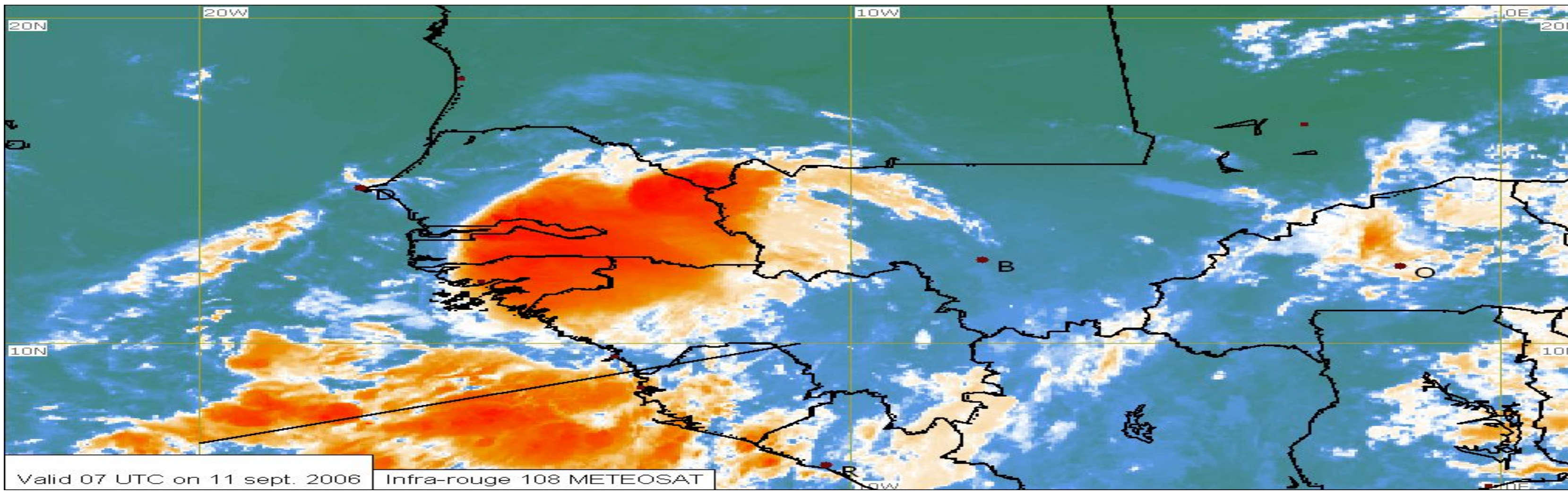
Plan

- Introduction
- Generality of the Sahelian climate.
- squall lines meteorological Characterizations.
- Analysis method (Composite Analysis).
- Validity of the method.
- Results
- conclusion

Introduction



By performing a composite analysis of the vertical profile of humidity, temperature and wind on the basis of radiosounding data and rain gauge Dakar Yoff (Senegal) at 14 ° 44 N and 17 ° 30 W, in the period 1968-2006, we studied exchanges water, heat and momentum within the squall line (SL) and between it and its immediate environment.



A similar analysis has been performed with the re-analysis of NCEP / NCAR for the period 1981-1995 for the specific humidity at a grid point near Dakar, 14 ° N and 17 ° 30 W.

Generality of the Sahelian climate.

The geographical area of the Sahel lies between latitudes 11 ° and 15 ° North. It represents a band of about 5000 km long and 300 km wide located at the southern edge of the Sahara.

Figure 1

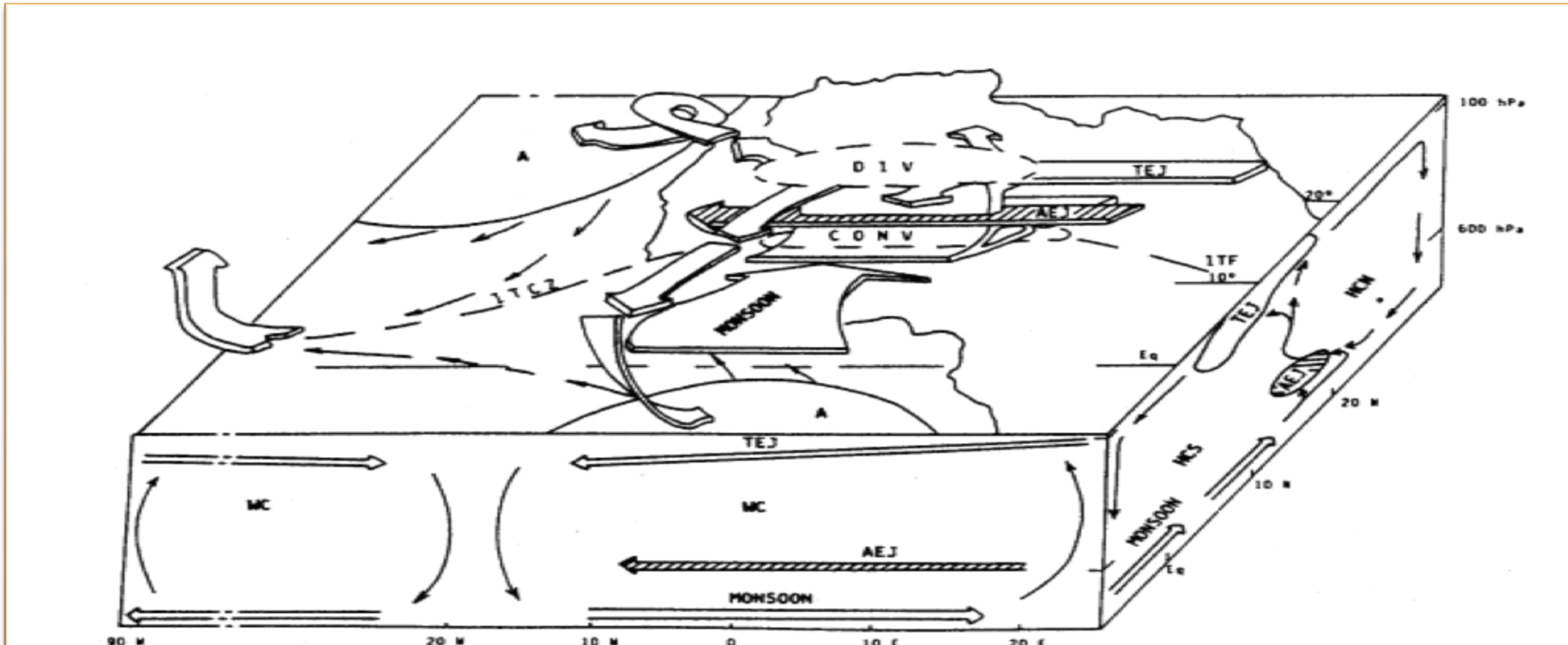


Figure 2 : 3-D illustration of the tropospheric circulation averaged Monsoon West Africa (White Book, AMMA, 2002)

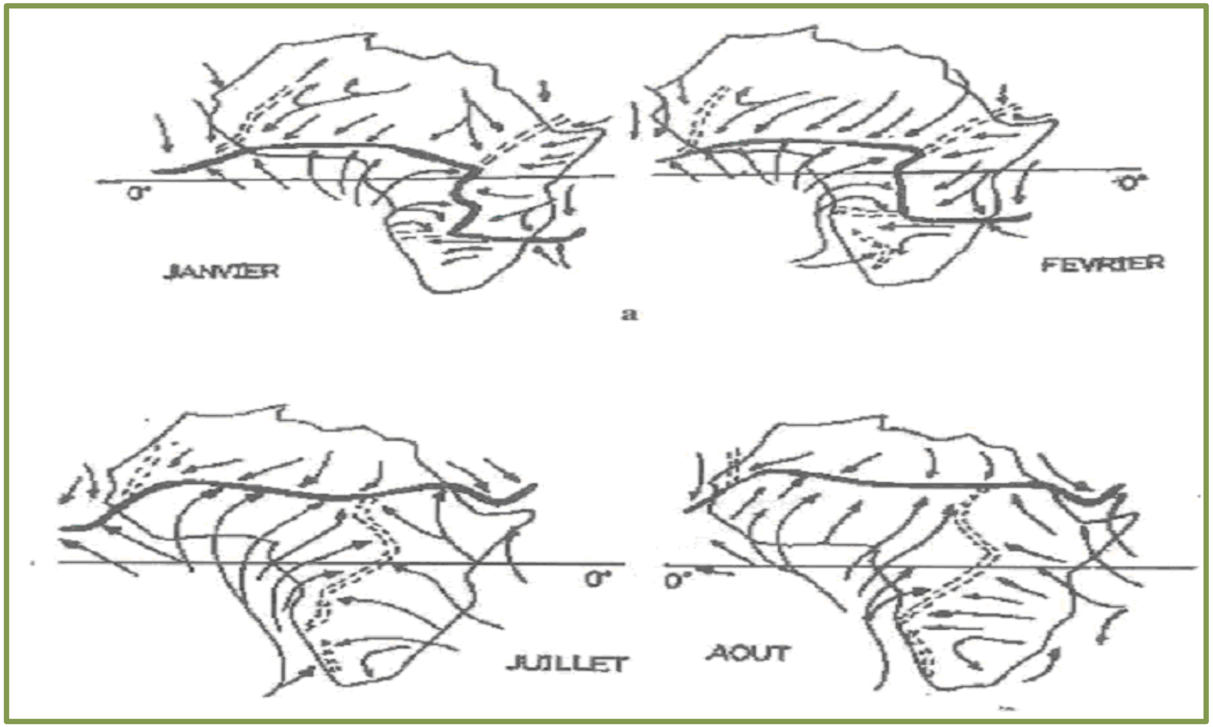
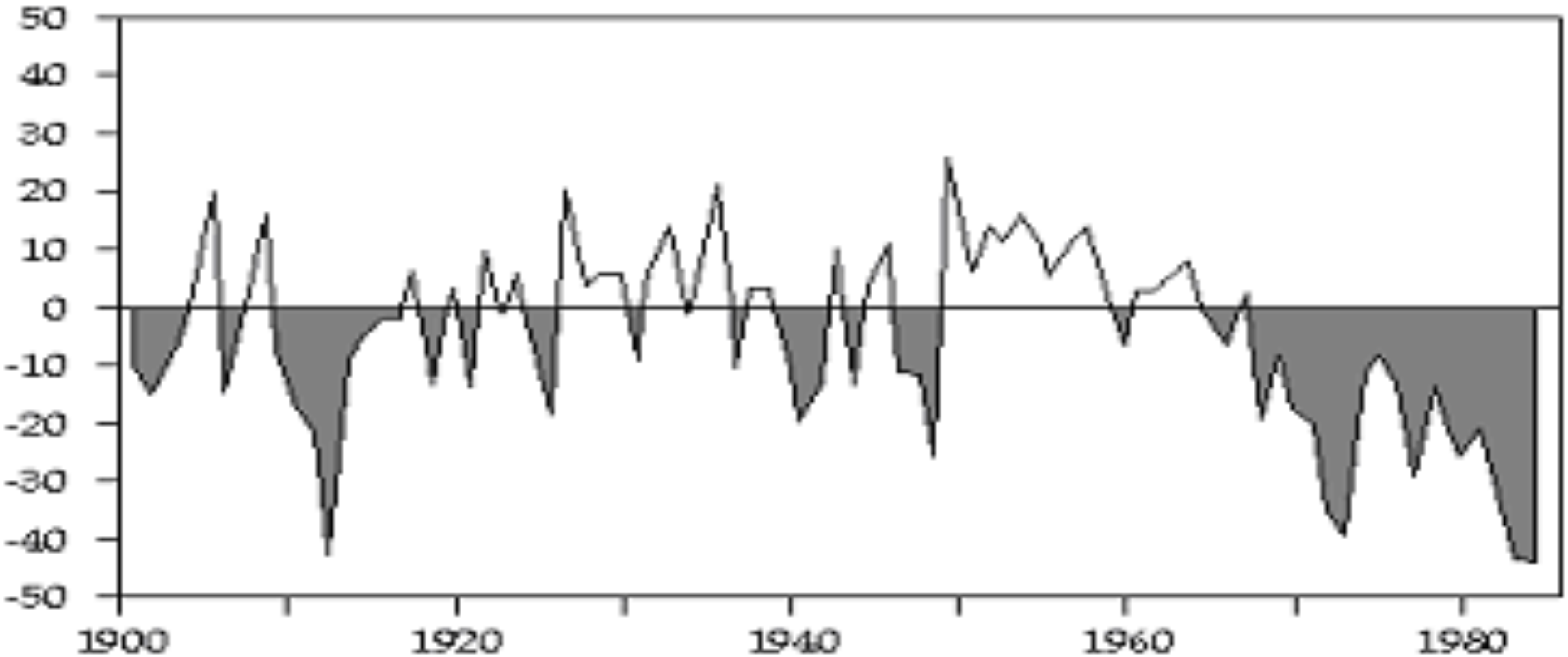


Figure 3 Wind flow and position of the intertropical front (on the ground) (ASECNA 1973).



Source : UNESCO 1984, Brown and Wolf 1985

Figure 4 : variation in rainfall for the entire Sahel area in % relative to the average of 100 years.

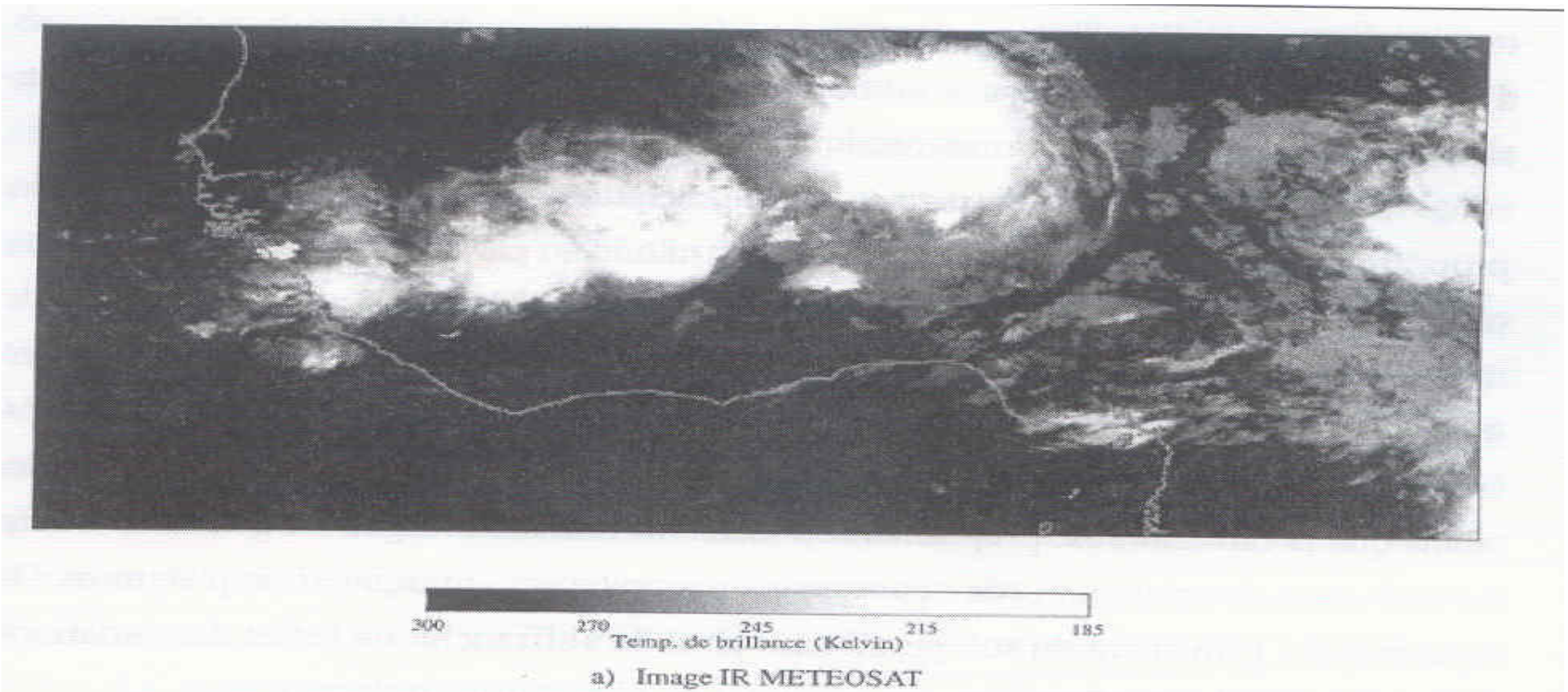


Figure 5 :Samples images of convective systems observed the August first in west Africa. (Adapted from, Kebe 2005).

Generality of the Sahelian climate.

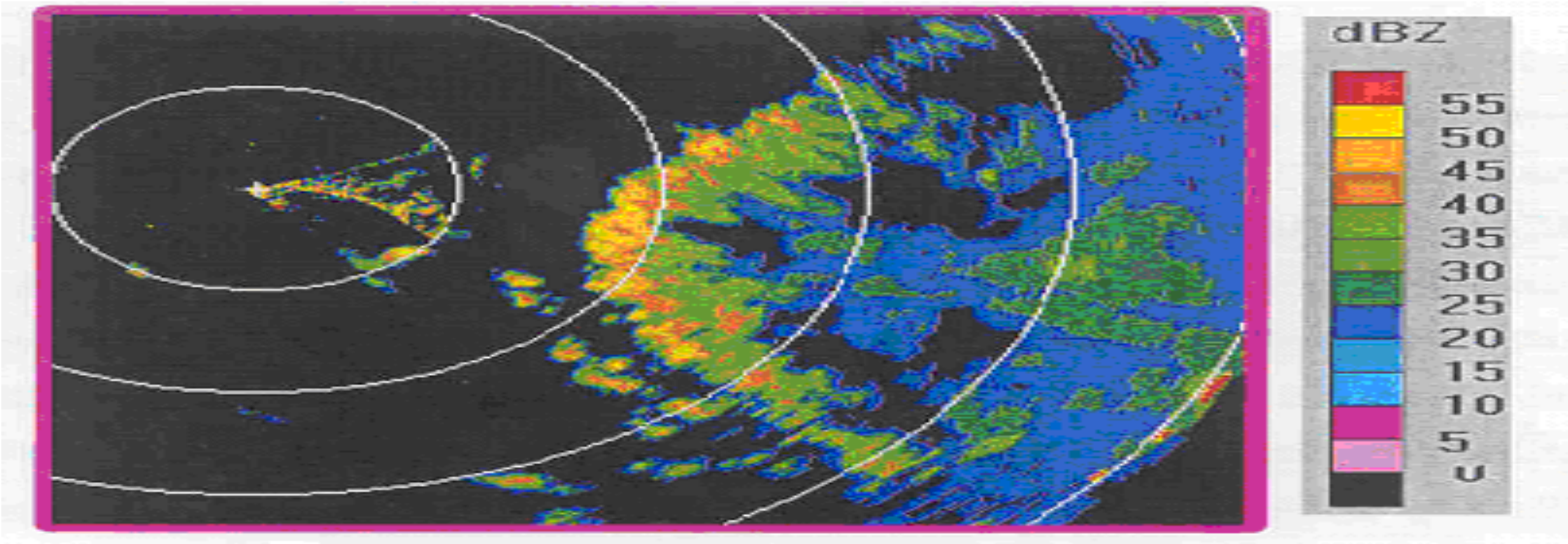


Figure 6 : Radar echoes of squqll line observed in Dakar on 96/7/25
(LPAO-SF, SANAGA) (From Kébé, 2001).

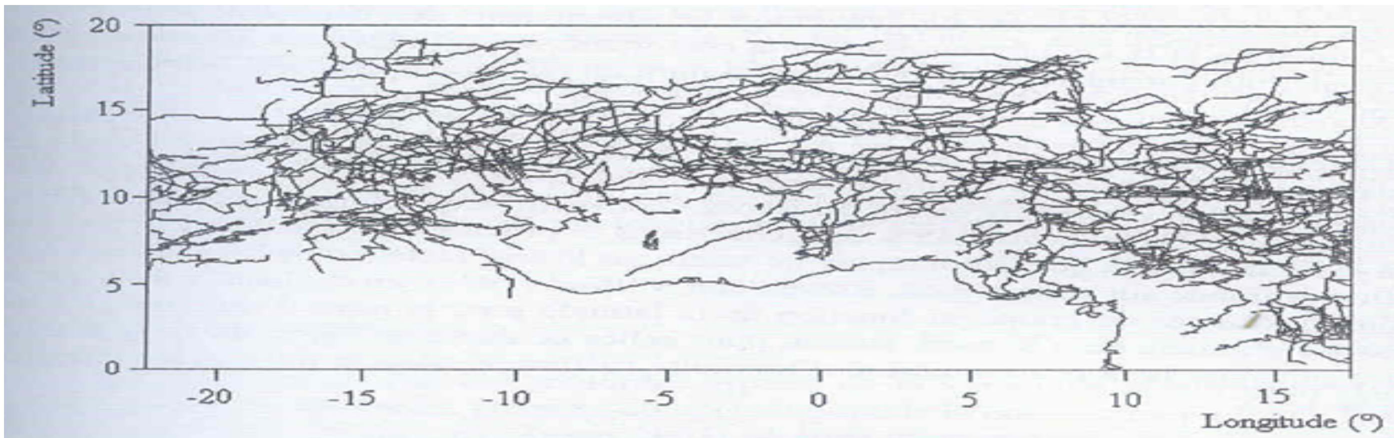


Figure 7. ***MCS Trajectories (from Sall, 2005)***

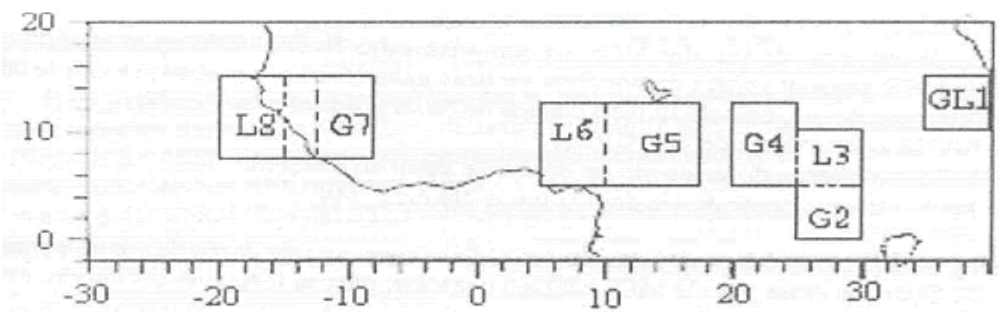


Figure 8. Places of generation (G) and Dissipation (L) of MCS. (From Hodges and Thorncroft, adaoted by Badiane,2007).

Tableau 1:Relative contributions of convective systems with monthly rainfall in the Sahel (Adapted from Morh, Gaye 2002)

	>15° N	10-15° N	< 10° N
Mai	34%	66%	74%
Juin	53%	81%	72%
Juillet	66%	79%	62%
Août	74%	77%	64%
Septembre	73%	82%	70%

Analysis Method

The theoretical support of the study is the composite analysis. This method has been used by and and by many other authors to study the structure of easterly waves. The spatial division of the phenomenon into categories can adapt a template for each event and average these events and, even though their dimensions are different. If the phenomenon we are trying to describe has a physical reality, the results of all averages taken show the weather have a coherent structure. This method is well suited to the phenomena. We adapted this technique for the characterization of SL from setting water like several other authors.

Description of the classes in the composite analysis.

Using soundings launched between 1968 and 2006 at Dakar we have proceeded to a climatological study of the meteorological parameters (Absolute temperature,Wind speed, Wind direction, Relative Humidity) at the passage of SLs. During this period, we have two radiosoundings per day, launched at 1200 TU and 0000TU. After selecting 15 pressure levels (ground, 1000, 950, 900, 850, 800, 750, 700, 650, 600, 500, 400, 300, 200, 100hPa), we performed a composite analysis by regrouping all radio-soundings in different temporal of 2-hours each, for the whole 38 years of data and at all levels.

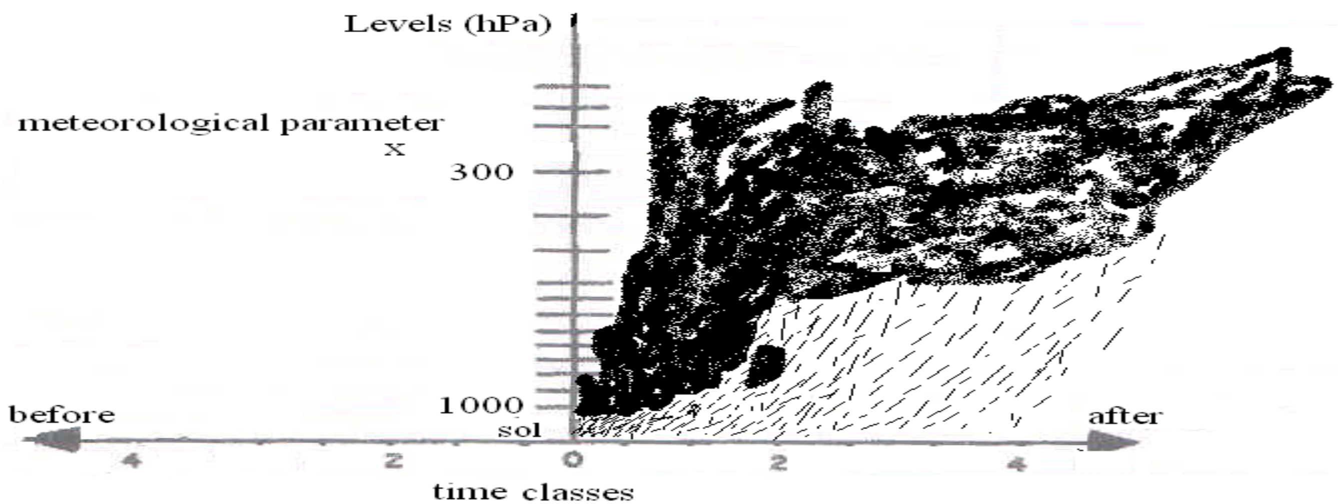


Figure 8

For class i hours before the passage (i = 2, 4, 6, 8, 10, 12), we put all radiosoundings assigned in the time interval between i+1 and i-1 hour before the passage of the SL. For class j hours after passage (j = 2, 4, 6, 8, 9, 10, 12), we put all radiosoundings assigned in the time interval between j+1 and j-1 hour after the passage of the SL. Figure 1: Marking associated with the squall line.

Validity of the method.

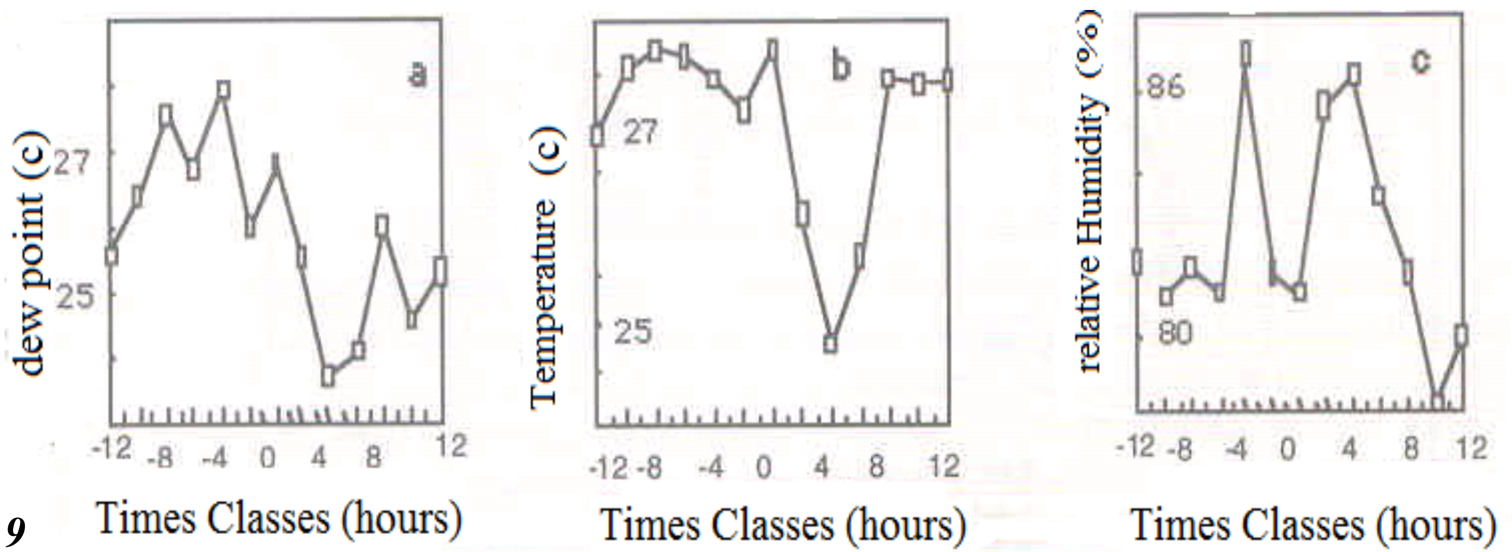


Figure 9
Temporal structures on the ground: a) the dew point, b) the temperature, (c) Relative Humidity (%)
From B. Diop, 1996.

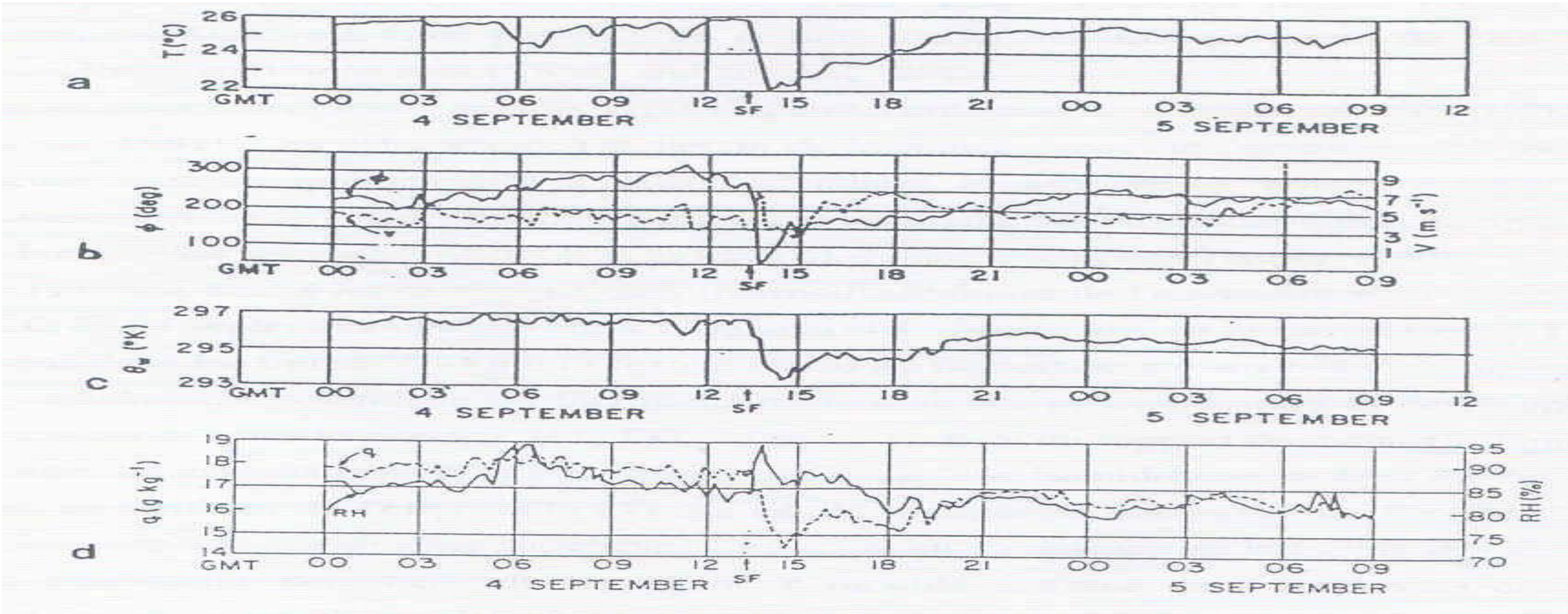


Figure 10: temporal variations in space: a) temperature (° C), b) wind direction (m / s), c) the pseudo adiabatic temperature wet bulb potential (K) and d) specific humidity (g / kg) and relative (%) during the GATE experiment. SF indicates the time of passage of the front of the SL [Houze, 1977].

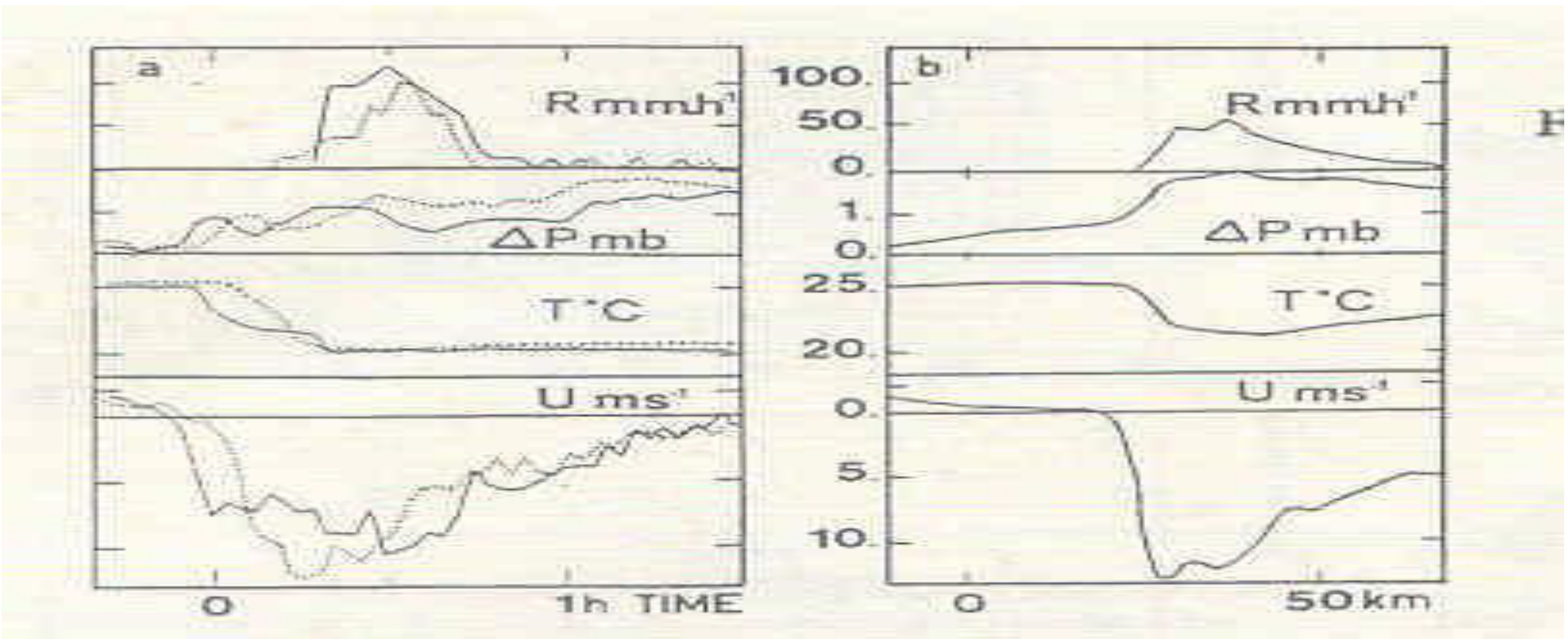


Figure 11: Comparison of surface parameters observed (a) and simulated (b) of a squall line COPT81. [Reprinted from Redelsperger , *J. L., and al,* 1988)].

Results

We identified 334 passages of SL and examined the profiles of the mean parameters of the atmosphere from the radiosounding associated with them. To study the water exchange of the 47 atmosphere under the influence of SL, we used the relative humidity derived from radiosounding, cloud cover and rainfall data obtained from the observation notebook and monthly climatological table of the Agency of National Meteorology of Senegal. These data are combined with SL We compared the results of the humidity soundings from a grid point of NCEPT / NCAR near Dakar.

$$\text{Average : } \bar{\mathrm{ff}} = \frac{1}{n}\sum_{i=1}^{n} \mathrm{ff}_i$$

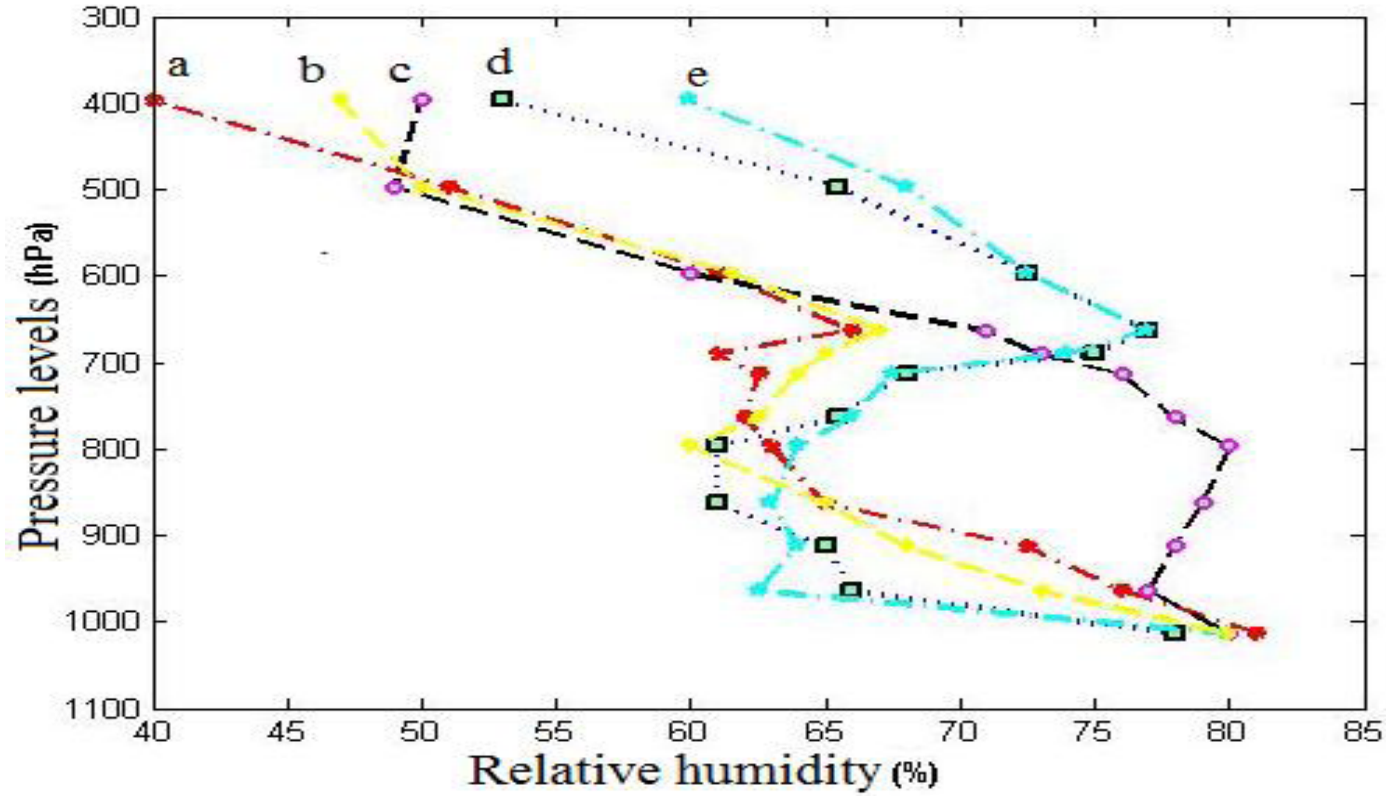
$$\text{Variance : } \sigma^2{}_{\mathrm{ff}} = \frac{1}{n}\sum_{i=1}^{n} (\mathrm{ff}_i - \bar{\mathrm{ff}})^2$$

$$\text{Standard deviation : } \sigma_{\mathrm{ff}} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (\mathrm{ff}_i - \bar{\mathrm{ff}})^2}$$

ff meteorological parameter

Table 2: Statistics on the ground dynamic parameters associated with the passage of LG.

Statistic	Duration of the wind shift	speed	Direction
Average	12,5 min	13m /s	10°
Variance	$5(\text{min})^2$	$4(\text{m /s})^2$	$(4°)^2$
Standard deviation	2.24min	2m/s	2°



a- at the passage b-average of summer c-2 hours after
d-4 hours after e - 6 hours after

Figure 12: humidity profiles of the average of the classes and the average summer (1968-2006).

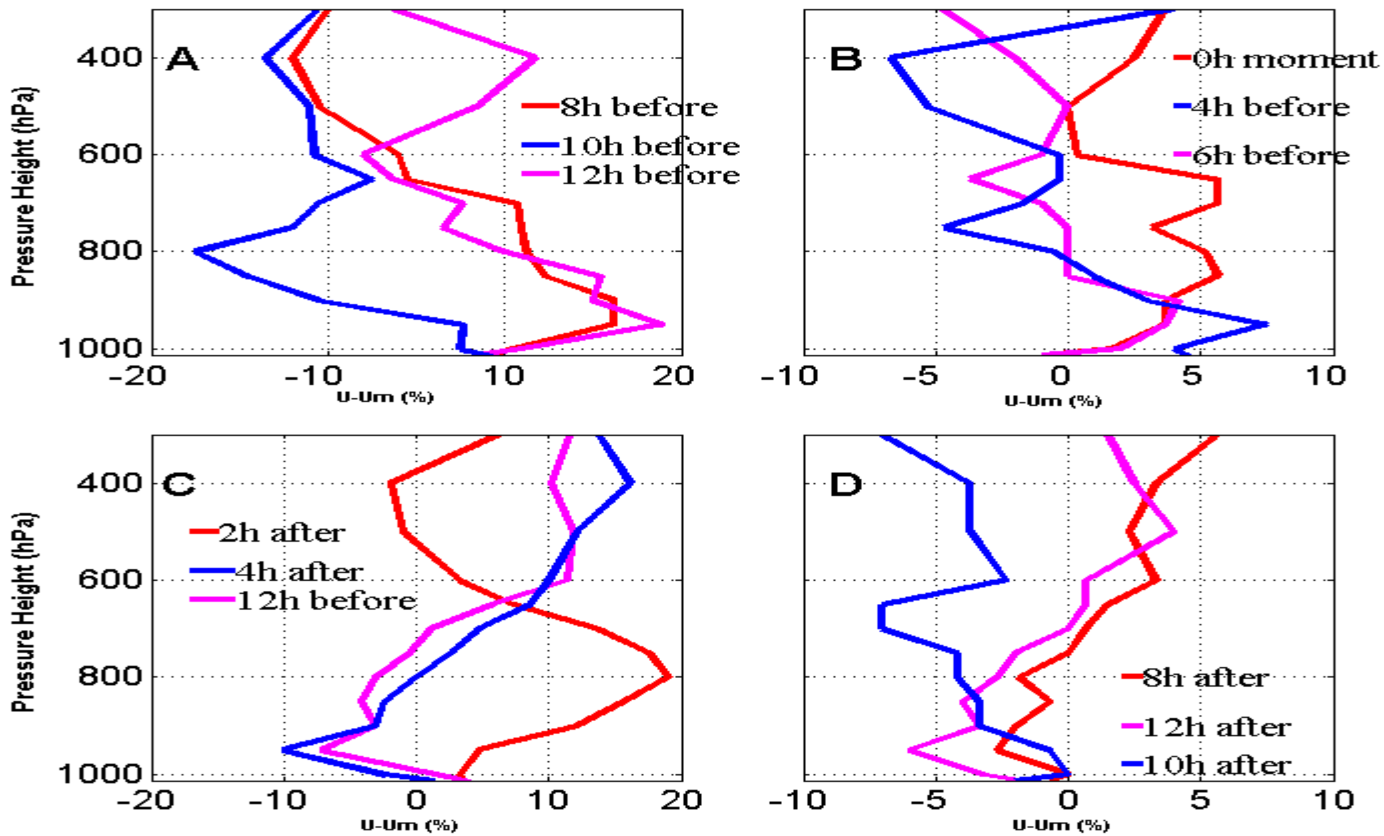


Figure 13: difference of humidity profiles from the average of the class and the average summer (1968-2006). U (humidity of the class); Um (summer average of the humidity)

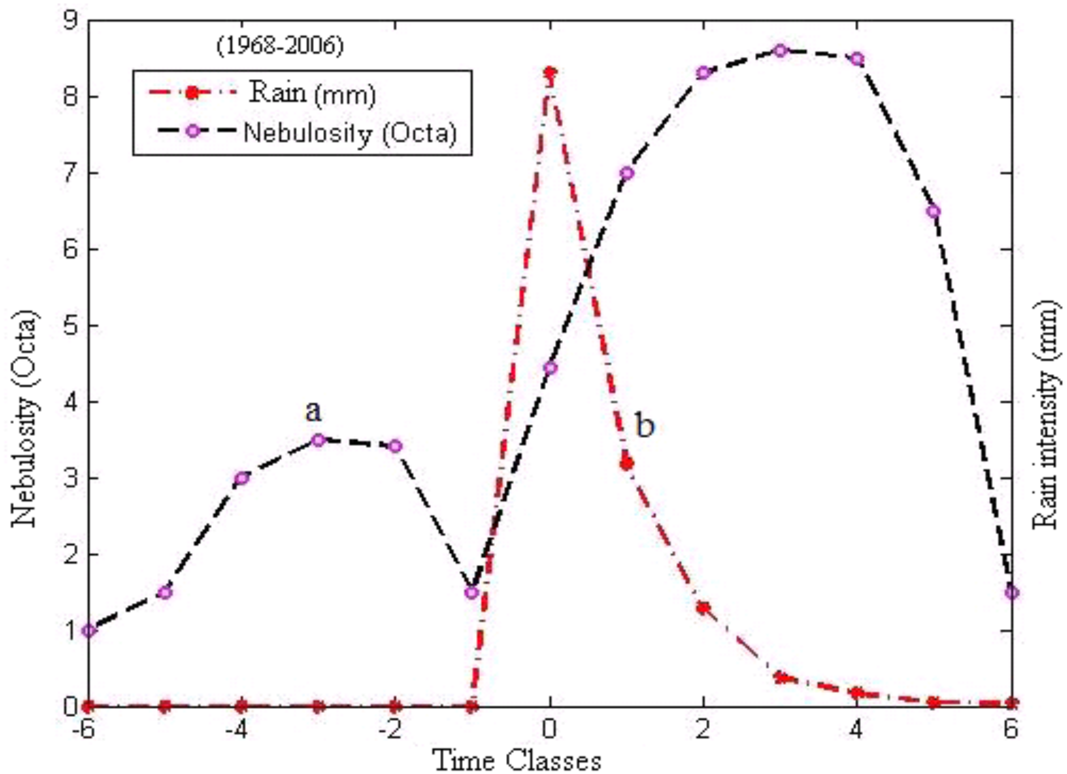


Figure 14: a) mean cloud cover before, during and after the passage of the SL. b) rain associated with the average SL.

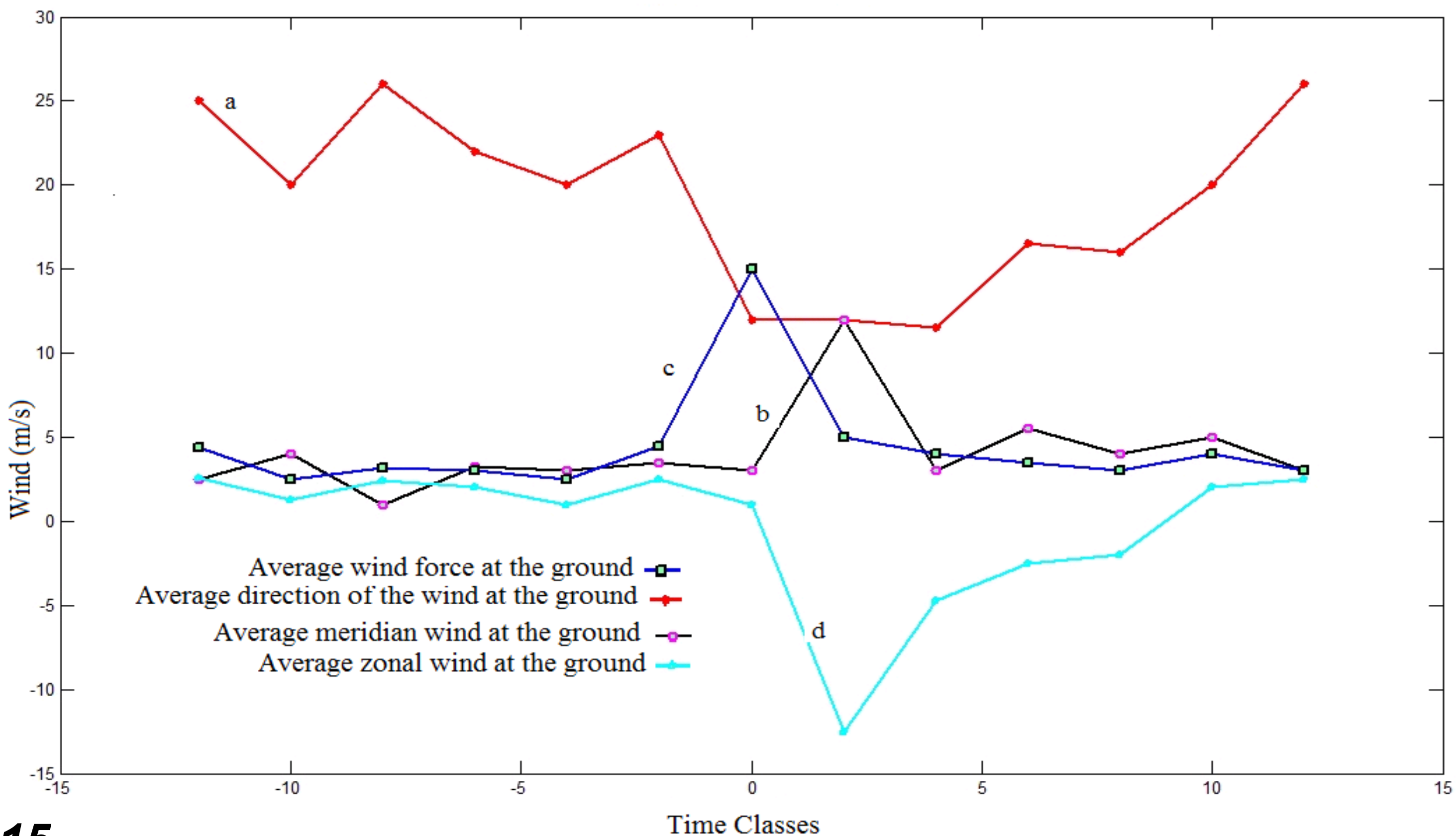
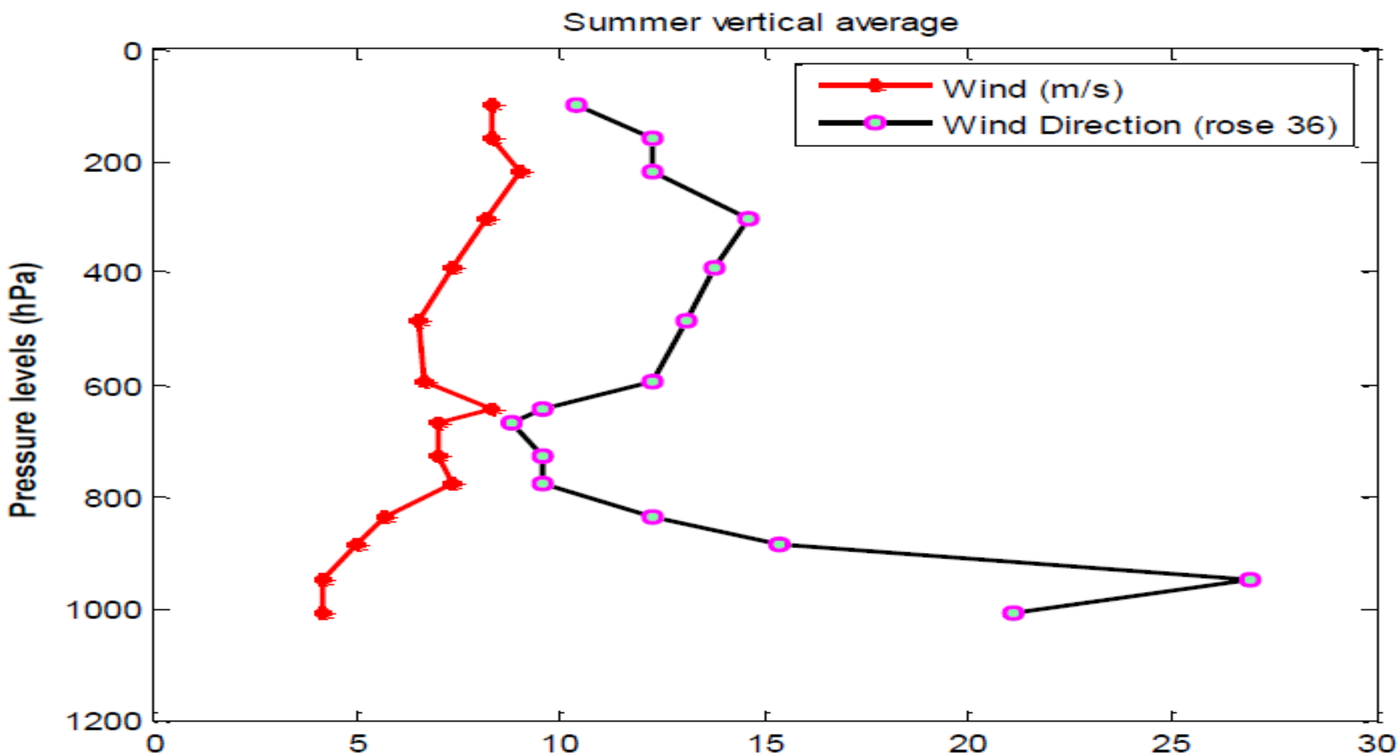


Figure 15

Average wind structures on the ground (1968-2006)



Summer vertical average
Wind (m/s)
Wind Direction (rose 36)
Pressure levels (hPa)
0
200
400
600
800
1000
1200
0
5
10
15
20
25
30

Figure 16

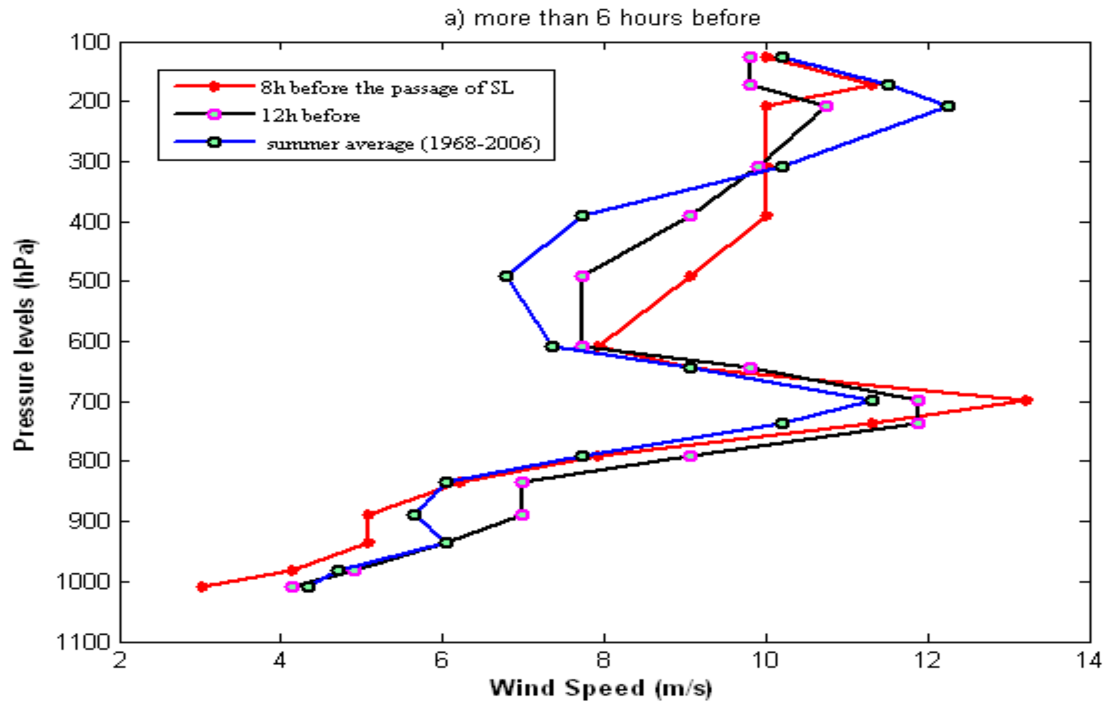

a) more than 6 hours before
8h before the passage of SL
12h before
summer average (1968-2006)
Pressure levels (hPa)
Wind Speed (m/s)
100
200
300
400
500
600
700
800
900
1000
1100
2
4
6
8
10
12
14

Figure 17

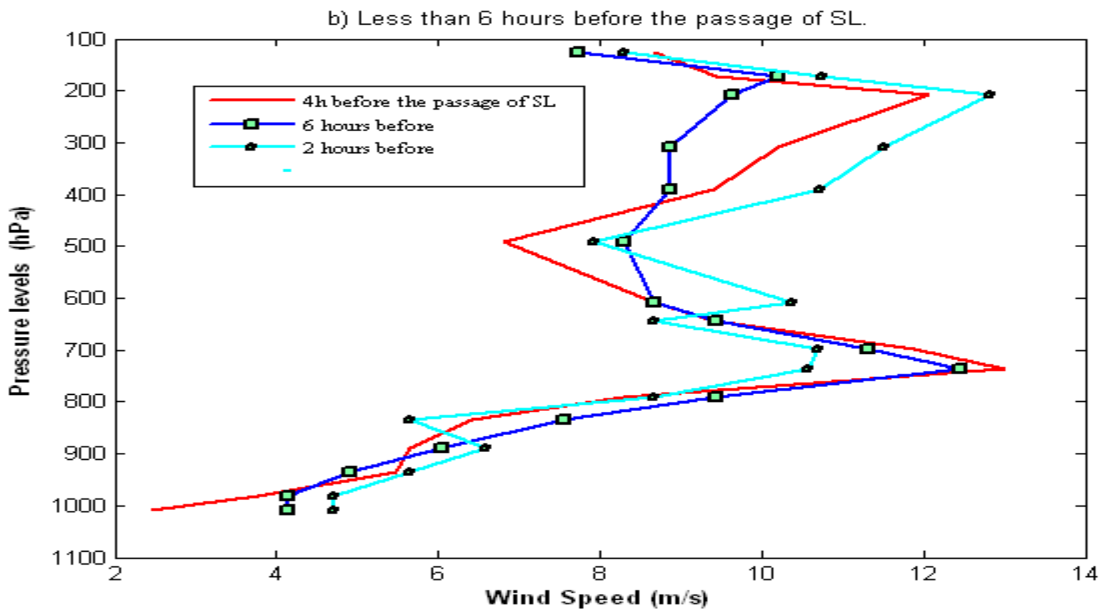
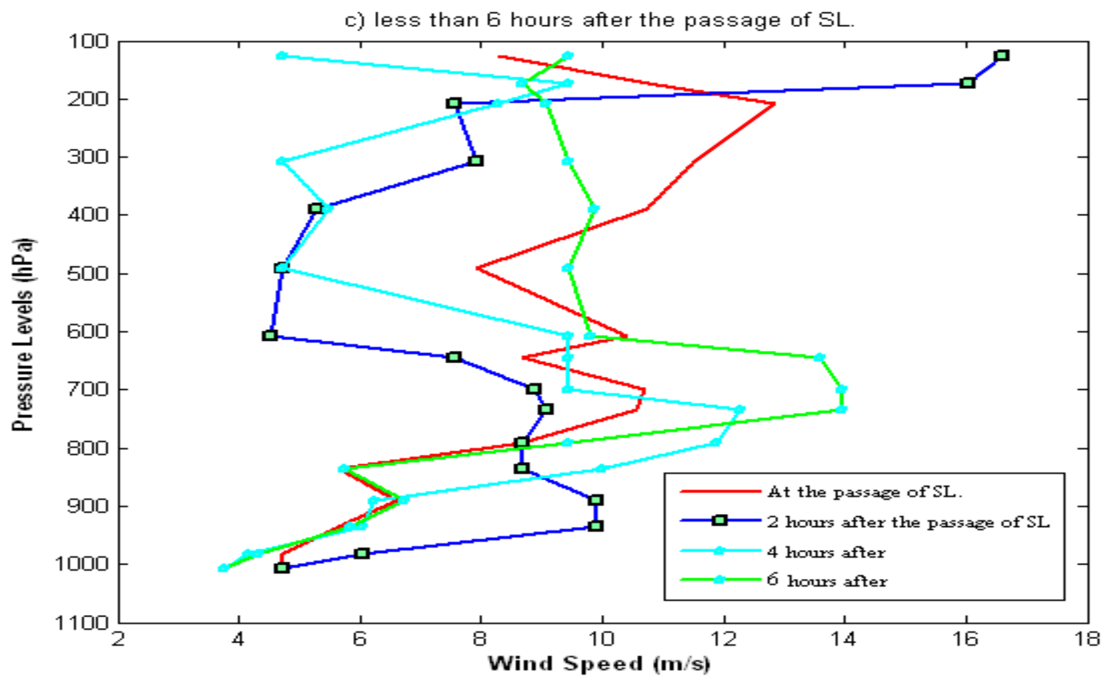

b) Less than 6 hours before the passage of SL.
4h before the passage of SL
6 hours before
2 hours before
Pressure levels (hPa)
Wind Speed (m/s)
100
200
300
400
500
600
700
800
900
1000
1100
2
4
6
8
10
12
14

Figure 18


c) less than 6 hours after the passage of SL.
Pressure Levels (hPa)
Wind Speed (m/s)
At the passage of SL.
2 hours after the passage of SL
4 hours after
6 hours after

4

Figure 19

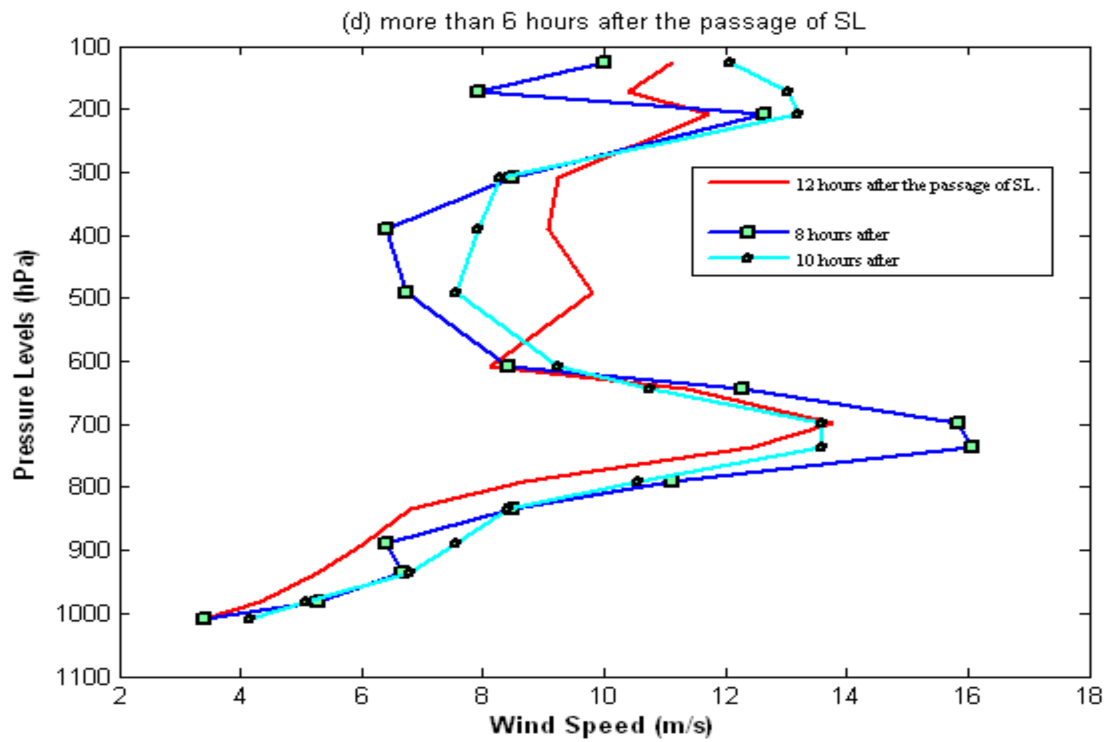

(d) more than 6 hours after the passage of SL
Pressure Levels (hPa)
Wind Speed (m/s)
12 hours after the passage of SL.
8 hours after
10 hours after
100
200
300
400
500
600
700
800
900
1000
1100
2
4
6
8
10
12
14
16
18

Figure 21

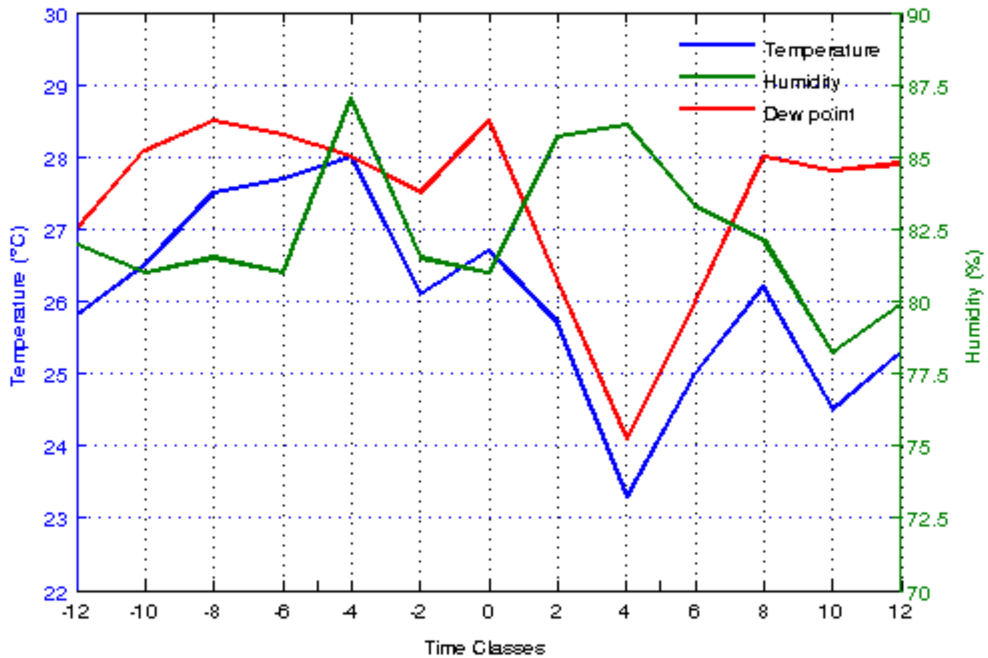

Temperature
Humidity
Dew point
Temperature (°C)
Humidity (%)
Time Classes
30
29
28
27
26
25
24
23
22
90
87.5
85
82.5
80
77.5
75
72.5
70
-12
-10
-8
-6
-4
-2
0
2
4
6
8
10
12

Figure 22

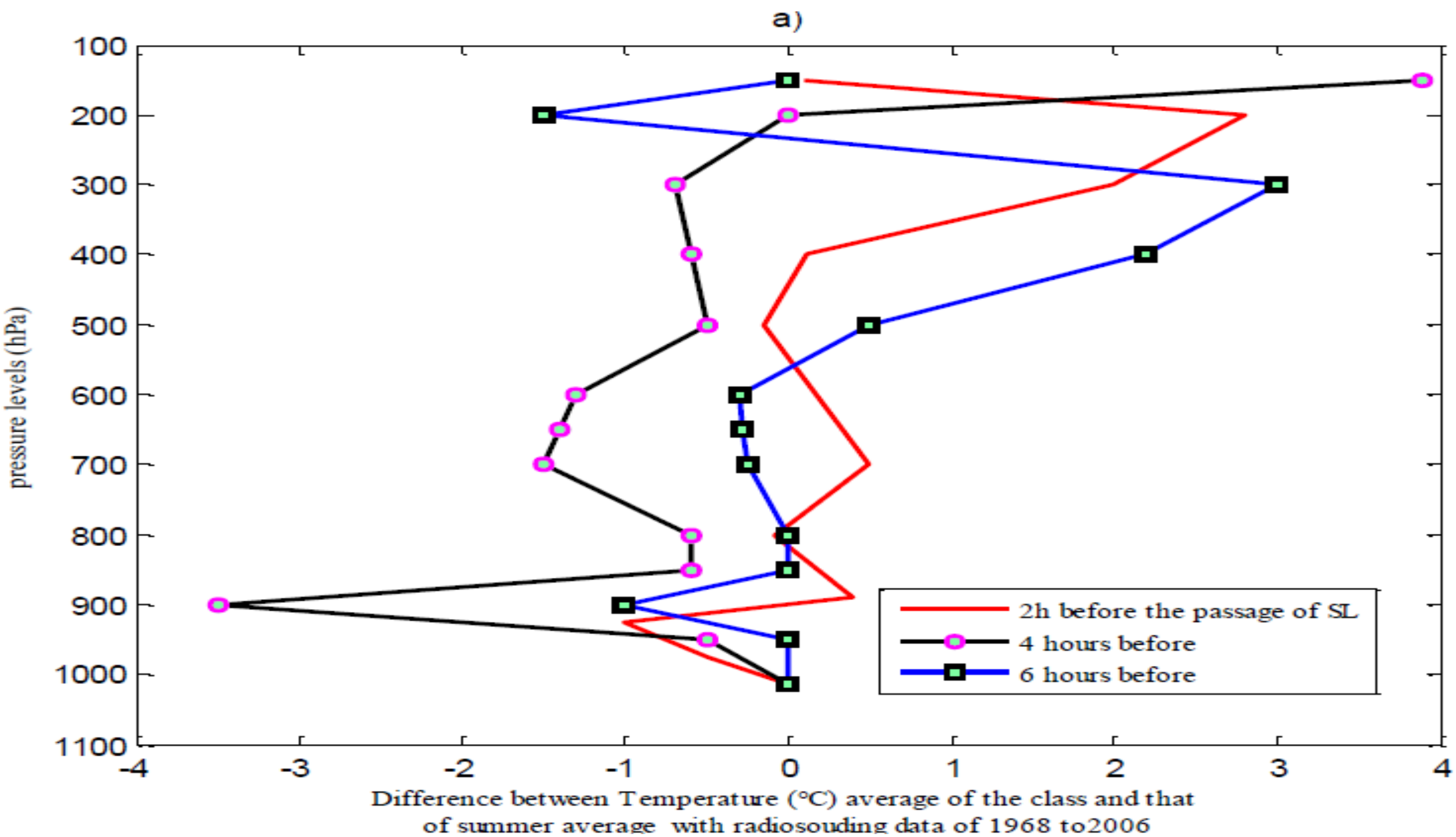

a)
pressure levels (hPa)
100
200
300
400
500
600
700
800
900
1000
1100
-4
-3
-2
-1
0
1
2
3
4
Difference between Temperature (°C) average of the class and that
of summer average with radiosouding data of 1968 to2006
2h before the passage of SL
4 hours before
6 hours before

Figure 23

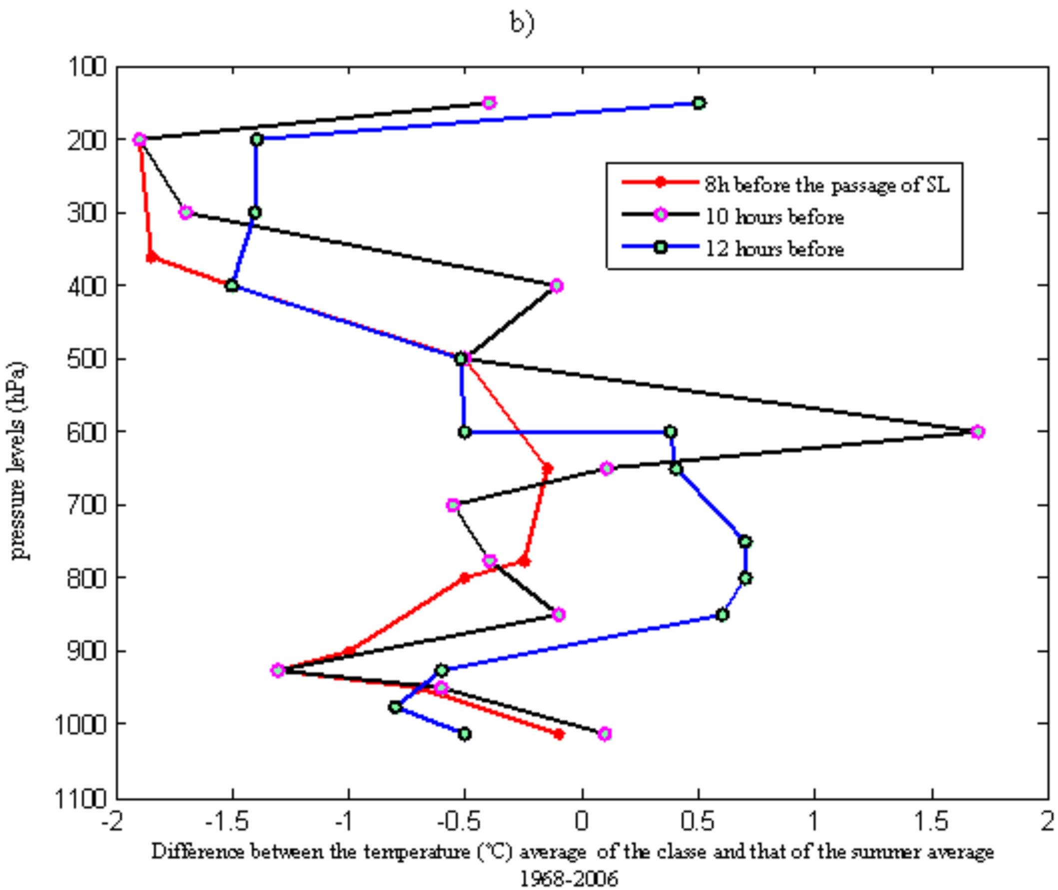

b)
8h before the passage of SL
10 hours before
12 hours before
pressure levels (hPa)
100
200
300
400
500
600
700
800
900
1000
1100
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Difference between the temperature (°C) average of the classe and that of the summer average 1968-2006

Figure 24

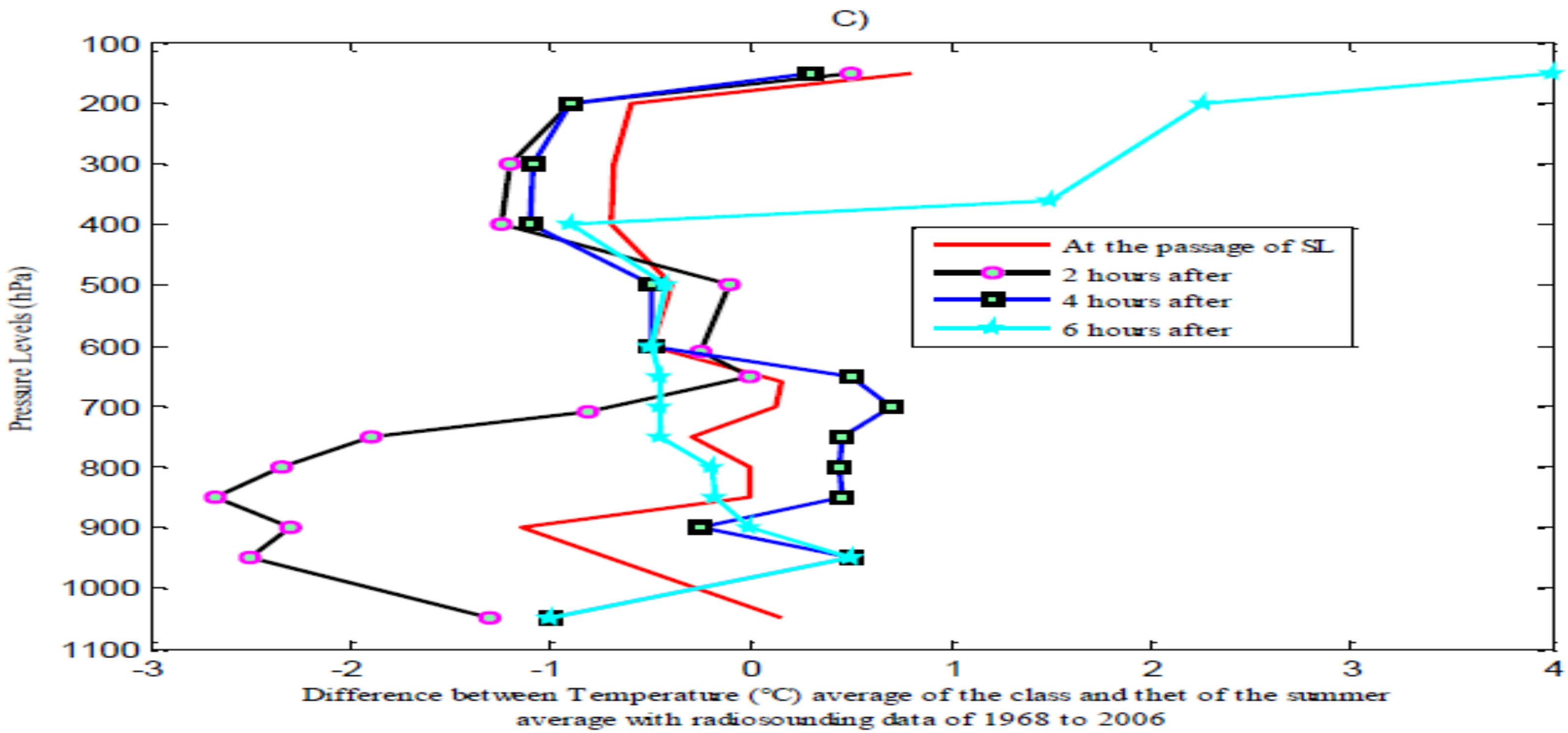


Figure 25: Difference between the average temperature of the class and that of the average summer of 1968 to 2006 with the radiosounding data. Average profiles: (a, b) before the passage of SL, c) after the passage of SL.

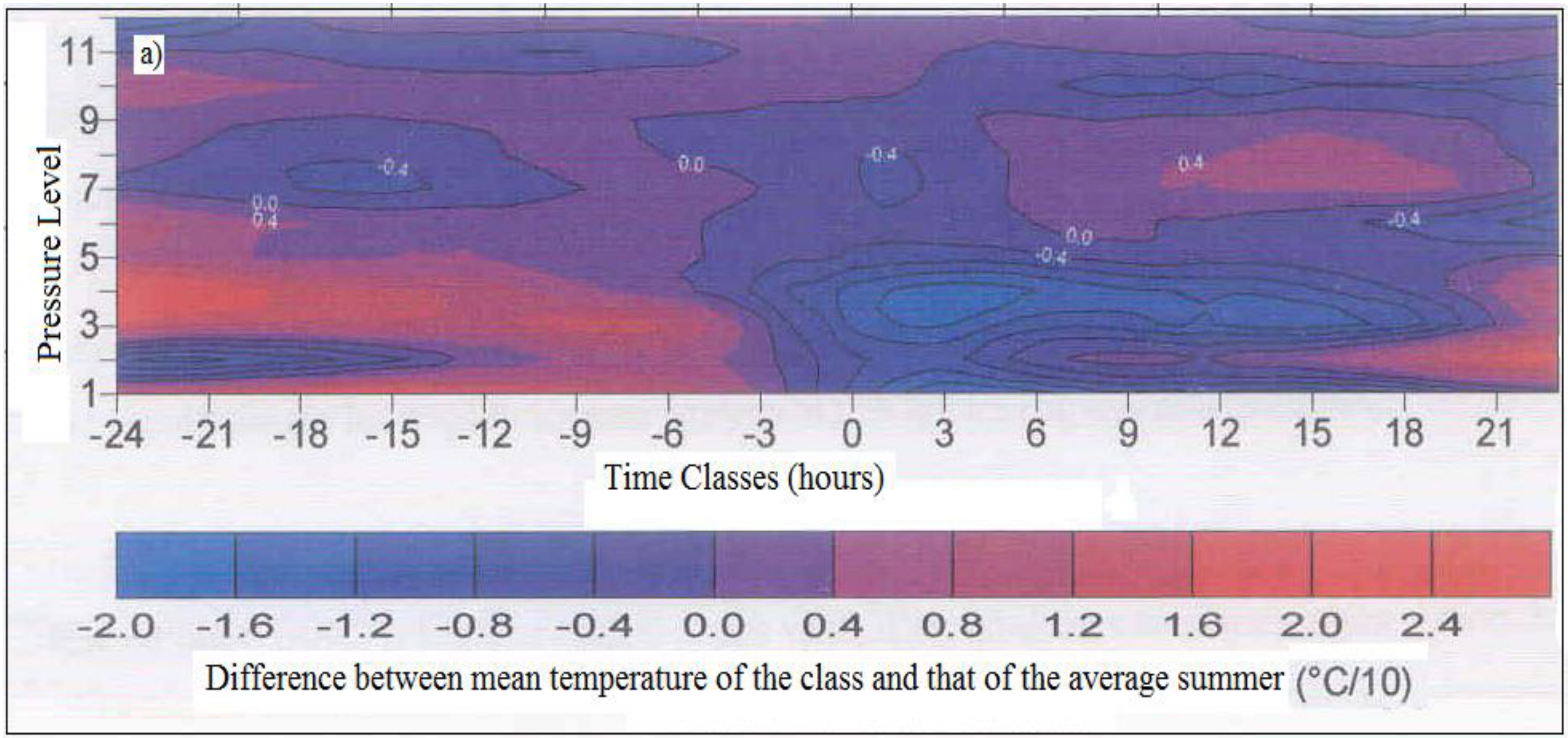


Figure 26 a: Profiles of the deviations of meteorological parameters with NCEP/NCAR data. (Sow B., 2003)

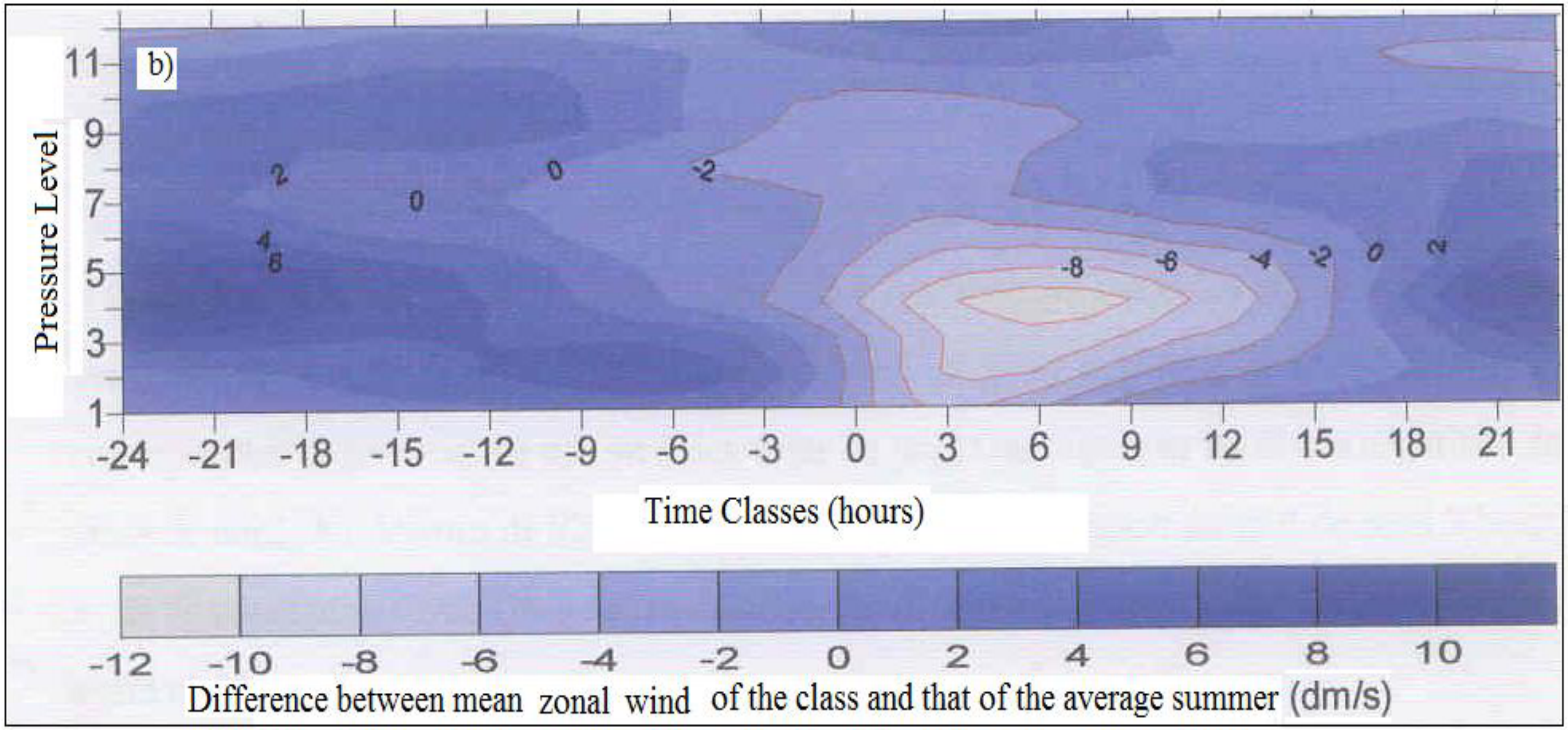


Figure 26 b: Profiles of the deviations of meteorological parameters with NCEP/NCAR data. (Sow B., 2003)

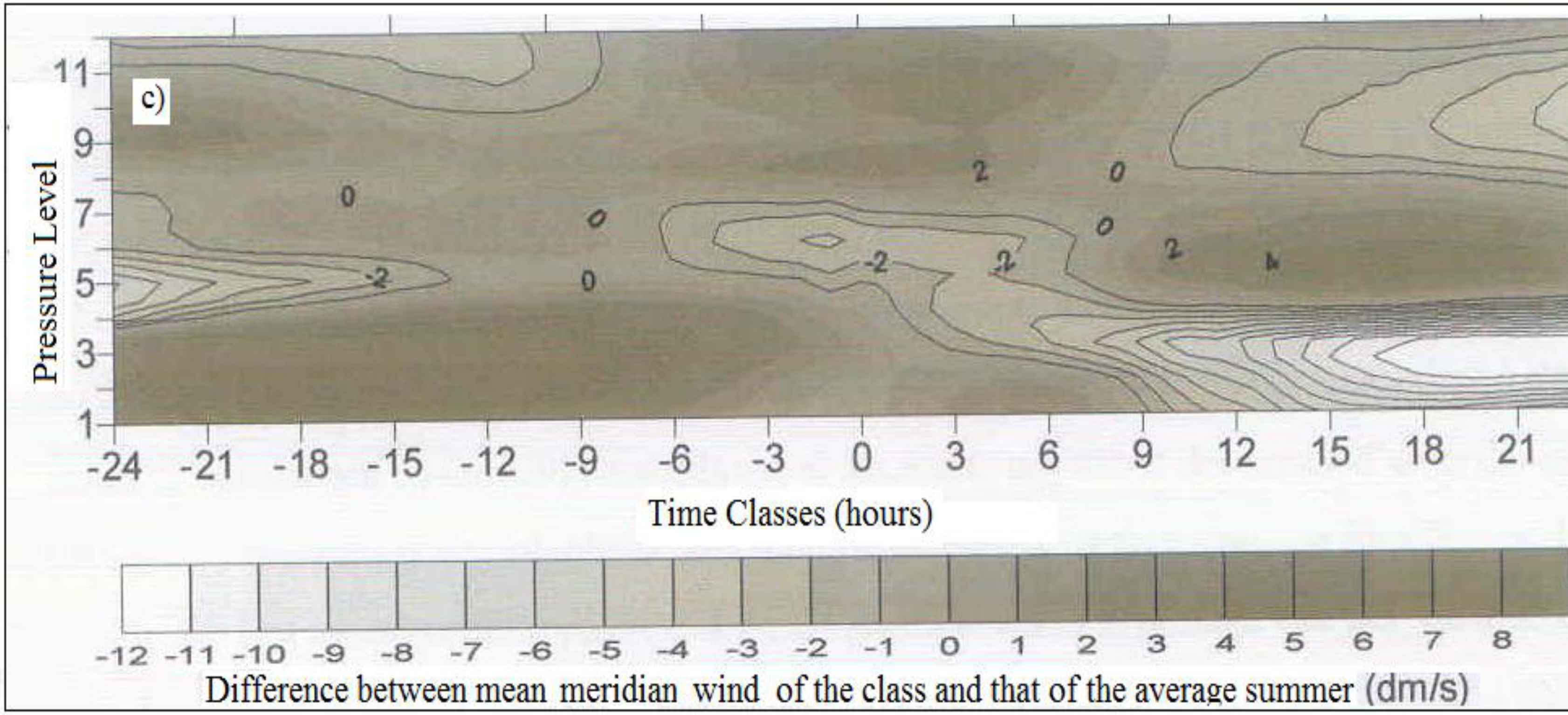


Figure 26 c: Profiles of the deviations of meteorological parameters with NCEP/NCAR data. (Sow B., 2003)

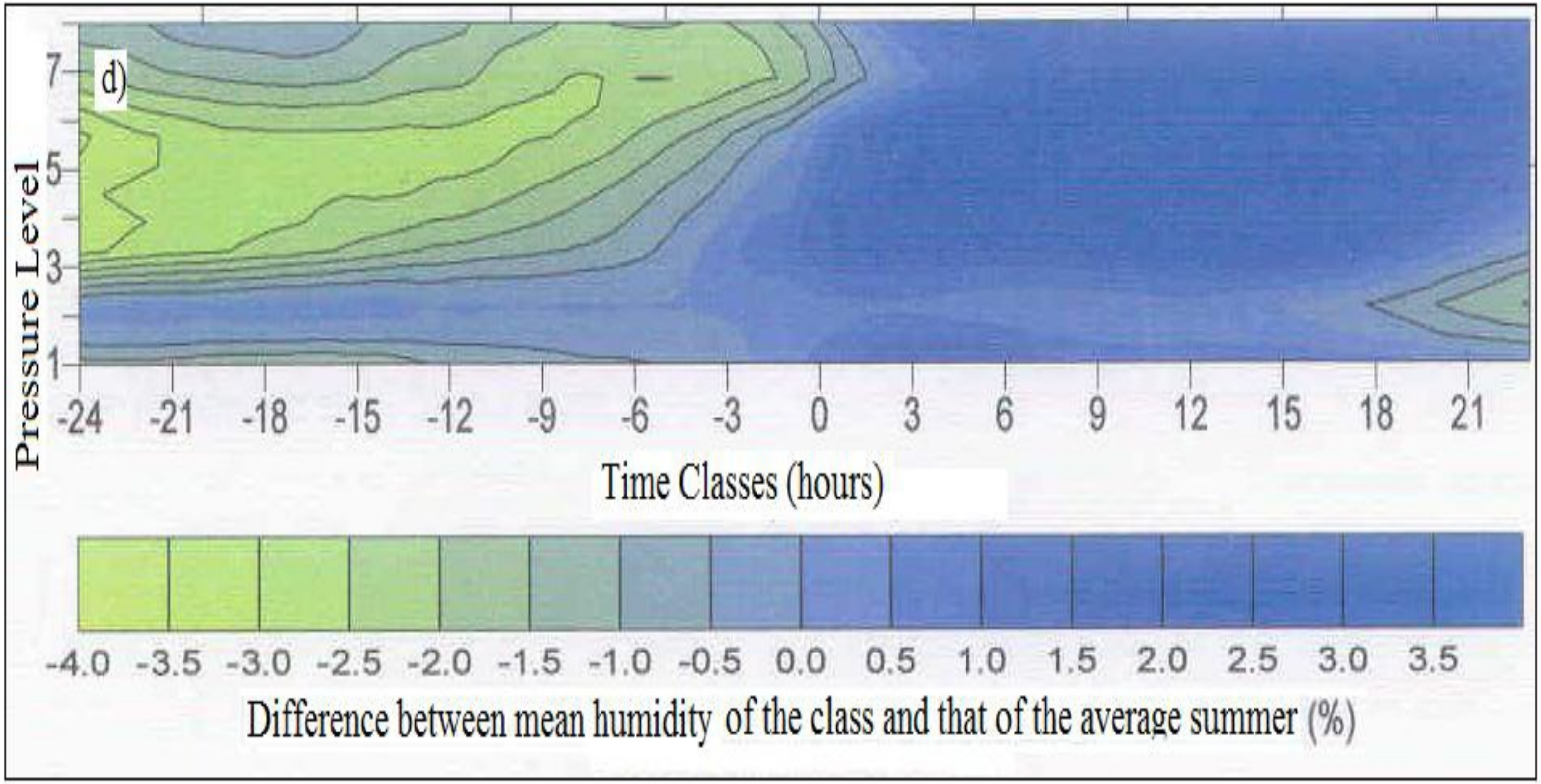


Figure 26 d: Profiles of the deviations of meteorological parameters with NCEP/NCAR data. (Sow B., 2003)

Conclusion

By performing a composite analysis of the vertical profile of humidity, temperature and wind on the basis of radiosounding data and rain gauge Dakar Yoff (Senegal) at 14 ° 44 N and 17 ° 30 W, in the period 1968-2006, we studied exchanges water, heat and momentum within the squall line (SL) and between it and its immediate environment.

A similar analysis has been performed with the re-analysis of NCEP / NCAR for the period 1981-1995 for the specific humidity at a grid point near Dakar, 14 ° N and 17 ° 30 W.

A statistical study of clouds and rain, combined with the composite analysis of moisture profile showed that the precipitations generated by the squall line (SL) are mainly from the convective part.

79% of the rain are provided by convective part of SL.

With less than ten hours before the passage of the squall line, there is an increase in relative humidity in the lower layers of the atmosphere.

The passage of this, the humidity is maximum in the layer 700-600 hPa. After its passage, humidity decreases gradually in the lower and middle layers.

Analysis of the results obtained on the basic parameters of the data with NCEP / NCAR shows that the vertical distribution of the atmosphere is disturbed at the passage of a SL;
the composite analysis yielded 48 temporal classes. The state of the atmosphere during the 24 hours preceding the passage of SL is characterized by:

- A net warming at 700hPa up to 6 hours before;

- A significant crowding in the layer 850-700 hPa up to 13 hours before;

Conclusion

-A west wind at 925 hPa between 10 and 5 hours before;

-An increase in wind speed at 700hPa up to 15 hours before.

- During the passage of SL, the characteristics of the atmosphere are:

- A strong cooling in the layer located below 600hPa;

-A noticeable humidification in the layer 850-700hPa;

- A strong east wind at 700 hPa between 4 hours and 9 hours later.

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Thank