Energy study of the atmosphere subjected to the influence of squall lines in the sahelan zone using a radiative transfer model.

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05/06/18

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ABSTRACT

The study of the atmosphere under the influence of convective system type squall line (SL) in the Sahelian zone is more important. In this climate zone, where most of the population derives their income from agricultural activities, squall lines are the source of most of the precipitation.We performed a composite analysis of radiosounding data and the model output. The composite analysis here is the cutting time of the dynamic system (SL) associated with atmospheric and meteorological parameters and averaged radiative or in the time class. If the phenomenon we are trying to describe a physical reality, the results of all the averages show a coherent structure.We carry out climatology of an atmosphere subjected to 334 passages squall line of 38 consecutive years (1968-2006) and radiosounding data. The composite analysis showed that the squall lines are systems with a coherent structure.They are composed of two parts: a convective (wind shift between the two and after detection of the disturbance) and another known as layered as Statiform part described by some authors. The radiosoundings are used as input data for the radiative transfer model MODTRAN version 4 revision 3. The spectral model with a resolution of wavelengths ranging from thermal infrared (IR) to ultraviolet (0.2 to 10000.0 μm) through the visible, calculate the diffusion flux and luminance. The outputs of the model subjected to statistical analysis allowed to identify a spectral signature of each category related to a class time. The spectral signatures of the atmosphere reveal a significant difference of structures obtained in the comparison of atmospheric diffusion flux for the different temporal classes. MPM Liebe model that we adapted to our analysis, allowed us to determine the average profiles of the atmosphere radiances under the influence of squall lines. By combining the two models (MODTRAN AND MPM) and by combining them with satellite sounders we showed it was possible to carry out sounding troposphere through neural networks.

Keywords : **Modtran, Squall Line, Radiance, Radiosounding.**

"A Winner is only a Dreamer who hasn't given up" - Nelson Mandela
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outline

- Introduction
- Generality on the Sahelian climate.
- Meteorological characterization of squall lines.
- Radiative transfer equations.
- Spectral signatures of squall lines
- tropospheric sounding using the neural network.
- Conclusions and perspectives

Introduction

- Scientific context

Economic, sociology, politic

Understanding the major mechanisms of climate is dramatically pressing, economics, sociology, politics, in a word life (survival?) Everyday are dependent on the present and future climate.

* African Squall Lines (S.L) provide water.

More crucial for the daily life of the African farmer and rancher, the rainfall during the African monsoon (and in particular those from SLs) provide most of the water needed for agricultural activities.

**The Scientific Campaigns of the last two decades (EPSAT Senegal) and AMMA (Multidisciplinary Analysis of the African Monsoon),

two issues: scientific and societal, have led the scientific community to international research campaigns in this region of the world, the latest being AMMA (Multidisciplinary Analysis of the African Monsoon).

This work is part of this dual problematic, scientific but also societal.

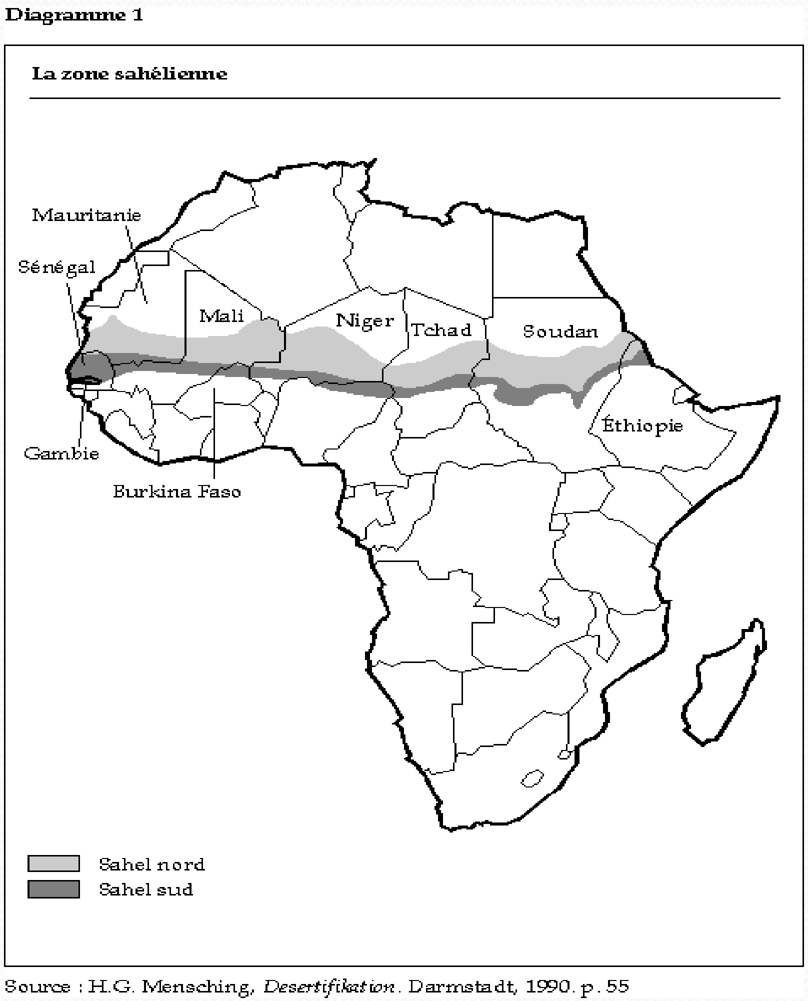
* economics, sociology, politics

The goal is to better understand the functioning of climate mechanisms in the region, particularly for economic planning purposes.

Senegal has made a significant scientific and logistical contribution to this operation, which has taken place over the past decade, but whose analysis of the results continues to date and for a long time, perhaps we hope..

This is an investigaion, same time by terrestrial satellite observations and by modeling, of the climatic characteristics of Sahel during the passage of the SLs in this region.

Generality on the Sahelian climate



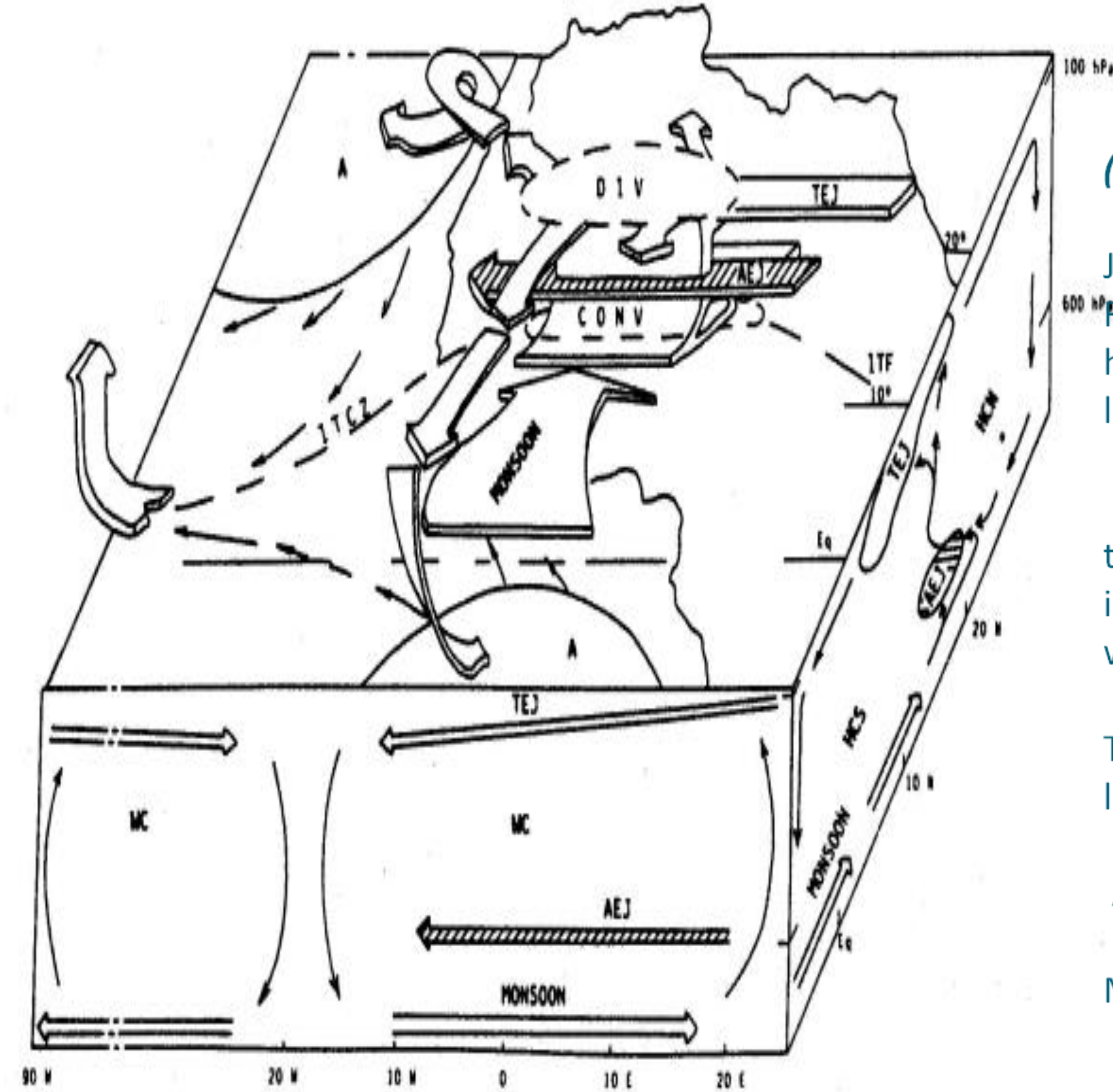
Located between latitudes 11 ° and 15 ° North. A strip of about 5000 km long and 300 km wide located at the southern limit of the Sahara.

Climate, agriculture and lifestyle are relatively unified from one country to another.

The delineation of the Sahel is generally not examined in political or geographical terms, but in terms of the amount of rainfall.

In the north, at the border separating the Sahel from the Sahara, rainfall is of the order of 200 mm per year.

Generality on the Sahelian climate



(white Book, AMMA, 2002)

J-Louis Domergue in 1980 and Françoise Desalmand in 1985 have studied the few factors that lead to this climate situation.

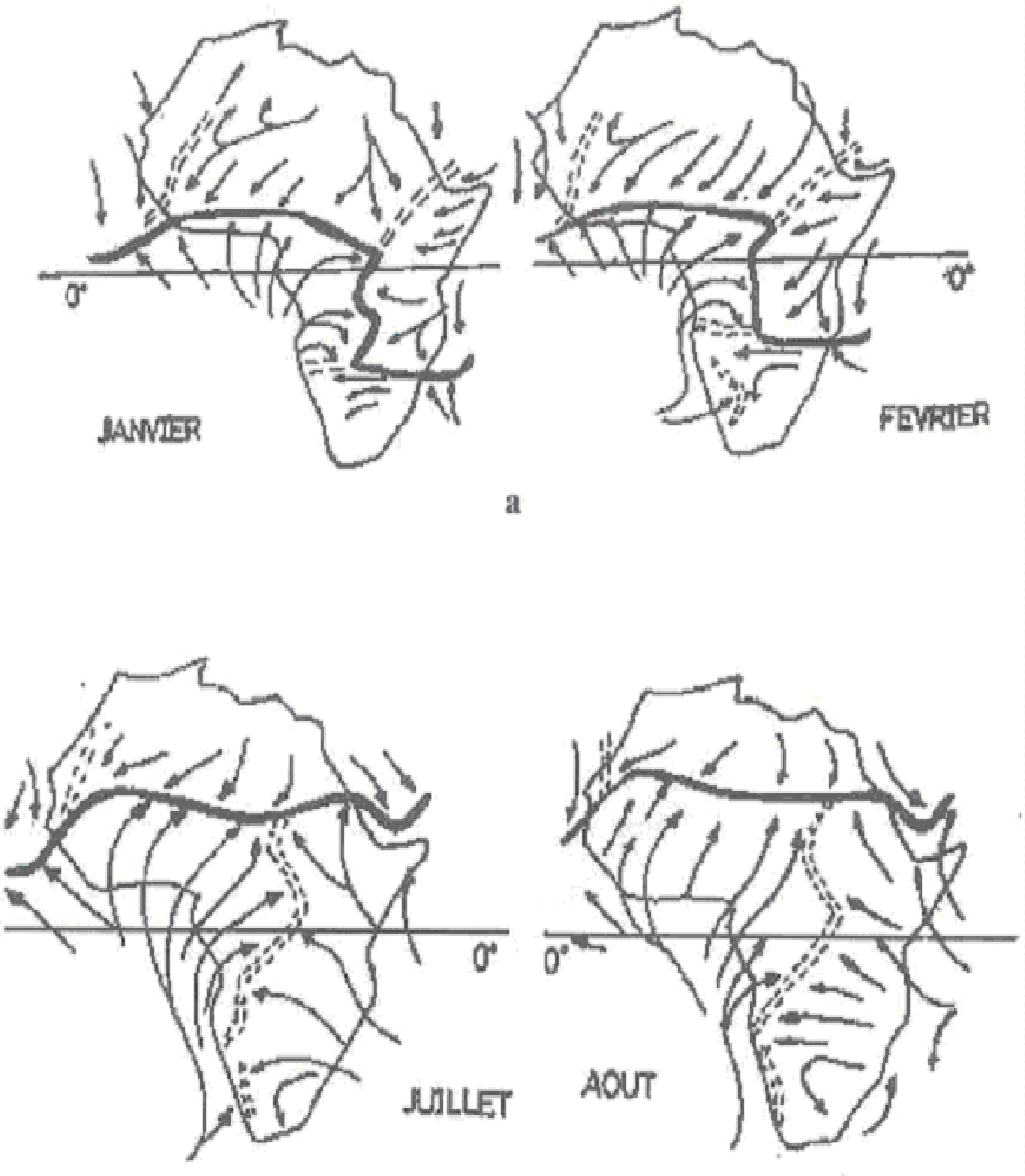
In the Sahel, the transition from the rainy season to the dry season is caused by the circulation of winds on our planet .

TEJ strong wind axis in the high layers,

AEJ in the middle layers,

Monsoon in the lower layers

Generality on the Sahelian climate



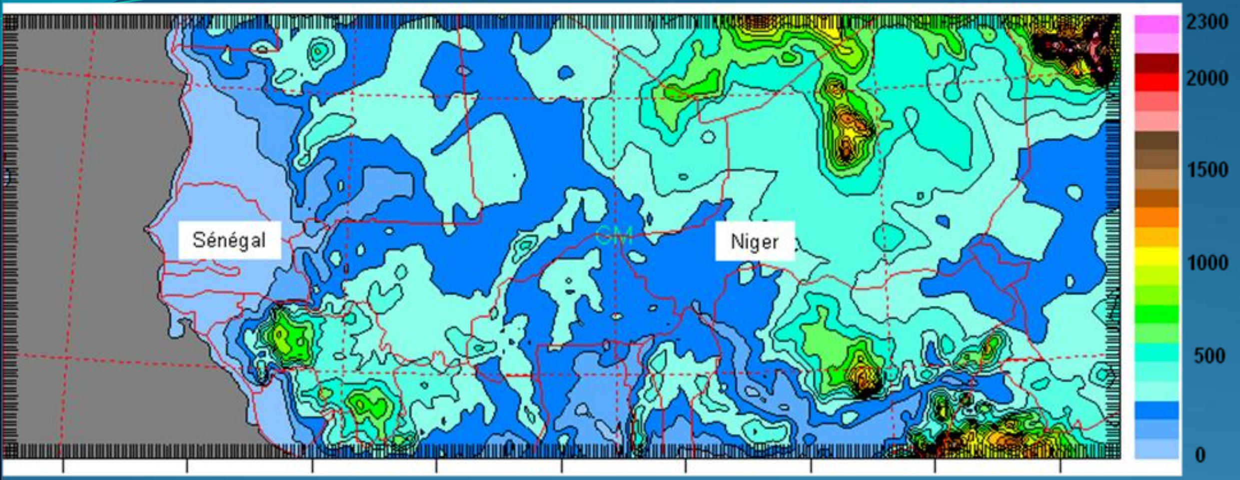
(Bamol, 2003).

In summer, the sun is upright on the Tropic of Capricorn, in the middle of the Sahara.

The ITCZ zone moves north with a slight delay on the sun until the 15th or 16th parallel, that is, to the regions north of the Sahel.

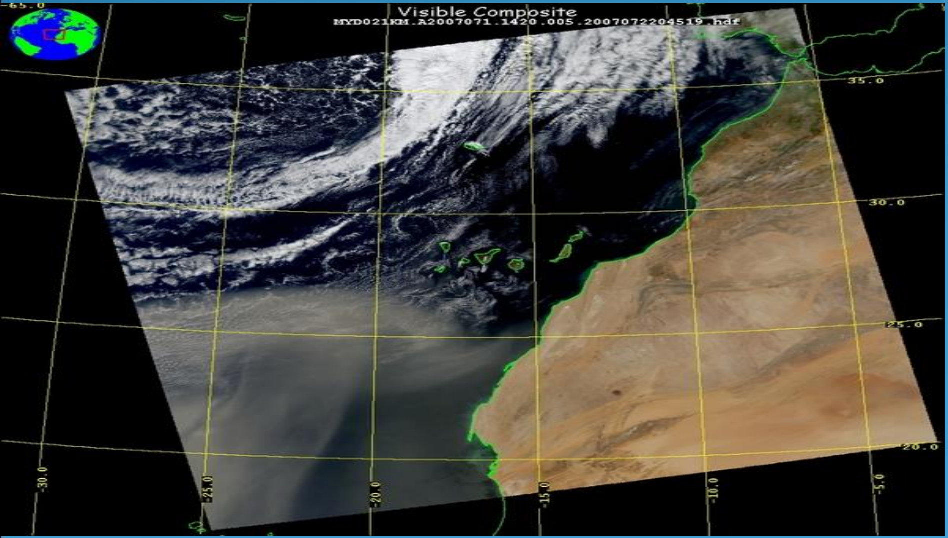
These winds are permeated with moisture passing over the tropical seas of the Gulf of Guinea bringing the long-awaited water to the Sahel.

Generality on the Sahelian climate



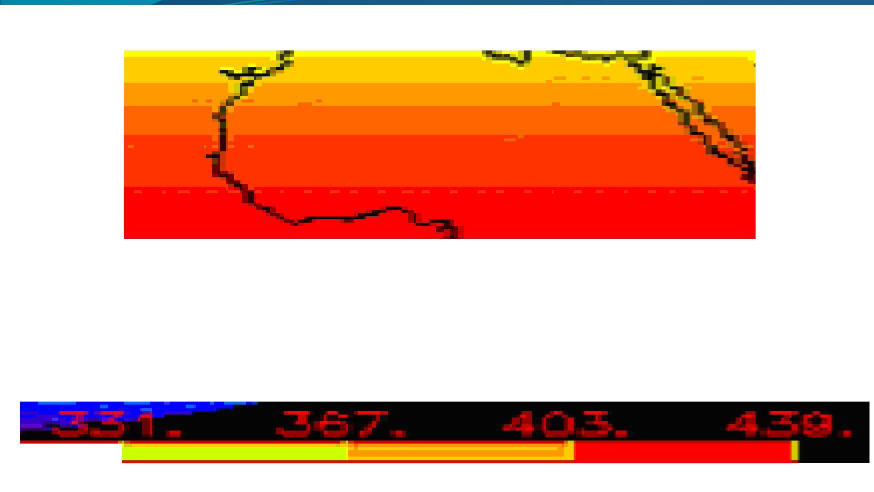
Relief en mètres

Topographic altitude of Africa north of the equator (RAMS database). Obtained from LaMP. In this zone there are also no important reliefs because the topographic altitude is between 200 and 500 meters.

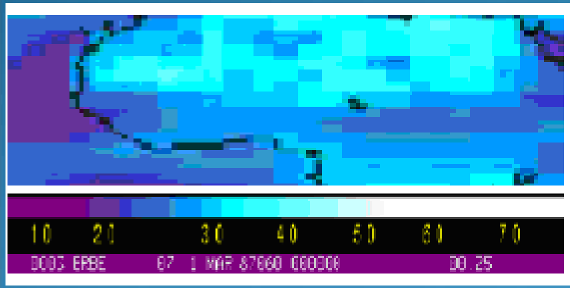


desert aerosol highlighted by the satellite (MODIS image 10 March 2005 morning) .Obtained from LaMP.

Desert aerosols currently contribute about 50% of the total atmospheric aerosol load (IPCC, 1995) and are responsible for the highest optical thicknesses that can be locally observed. The African continent is known to be the largest source, globally, of mineral aerosols, but also aerosols from fires, often related to agricultural practices.



This figure shows that the sahelian zone receives the maximum of solar energy; this is due to its postion relatedto low latitudes.The prposed image represents resultsof measurements of incident solar radiation, above the atmosphere (march 2001), It is observed that the incident energyin the sahelian zone is between 403and 409 w/m^2



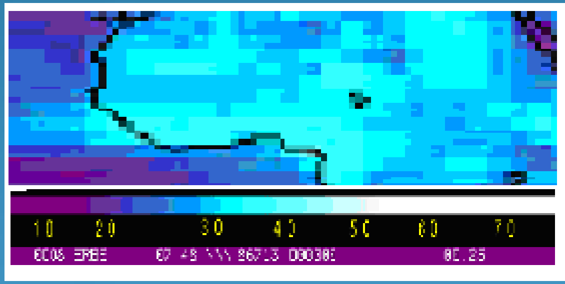
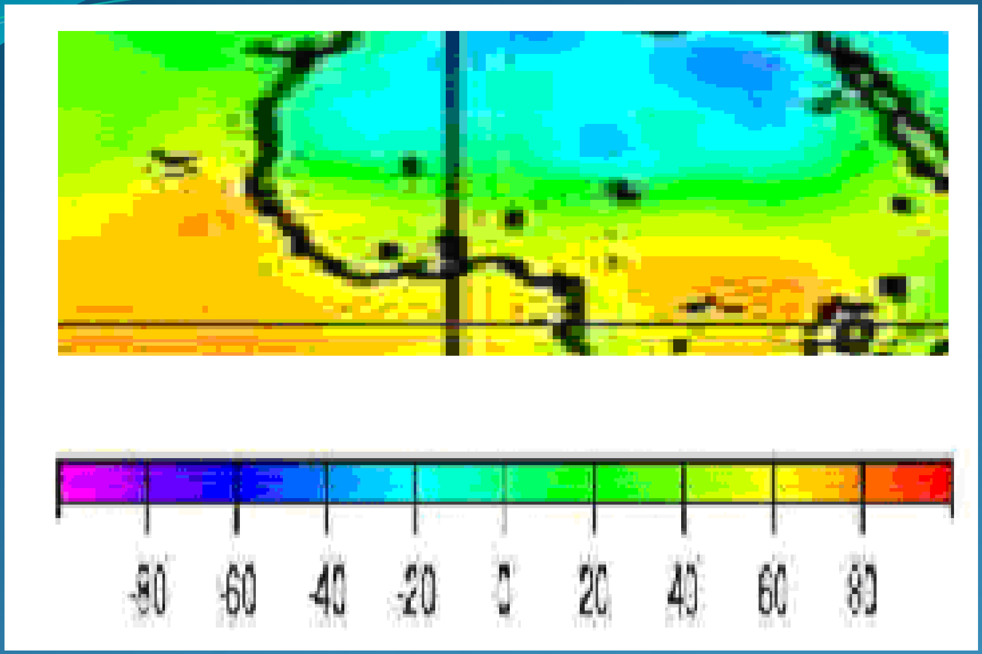


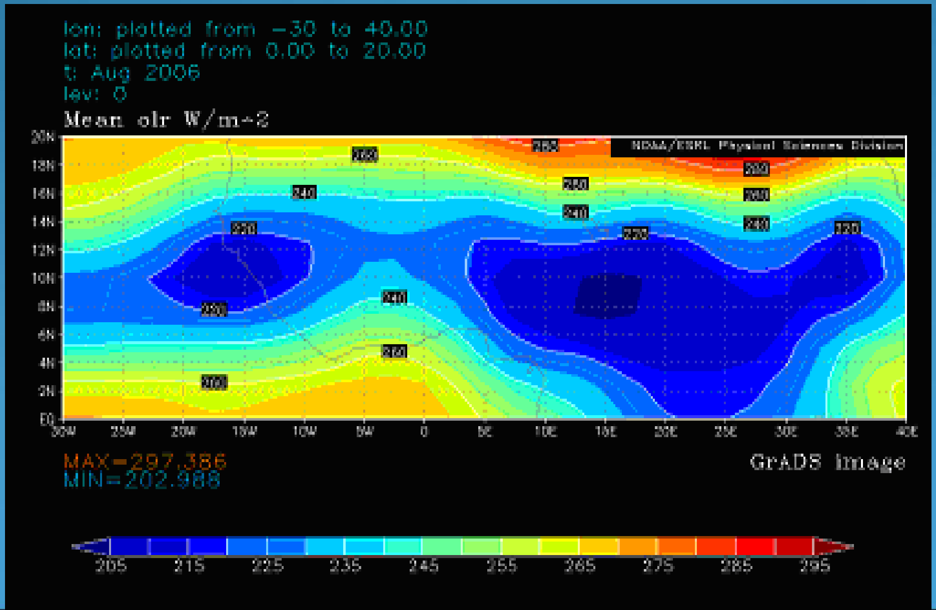
Image source: http://cimss.ssec.wisc.edu/wxwise/homerbe.html.
The figure represents the mapping of the albedo above the Sahel, that is to say the proportion of the incident energy that is reflected by the Earth (atmosphere and surface) to space. Albedo is expressed as a percentage. The average annual albedo of the Sahel varies sharply between January-June (of the order 0.30) and July-September (of the order 0.40), showing the important influence of the clouds. The albedo changes quite clearly in this region following the season.

Generality on the Sahelian climate

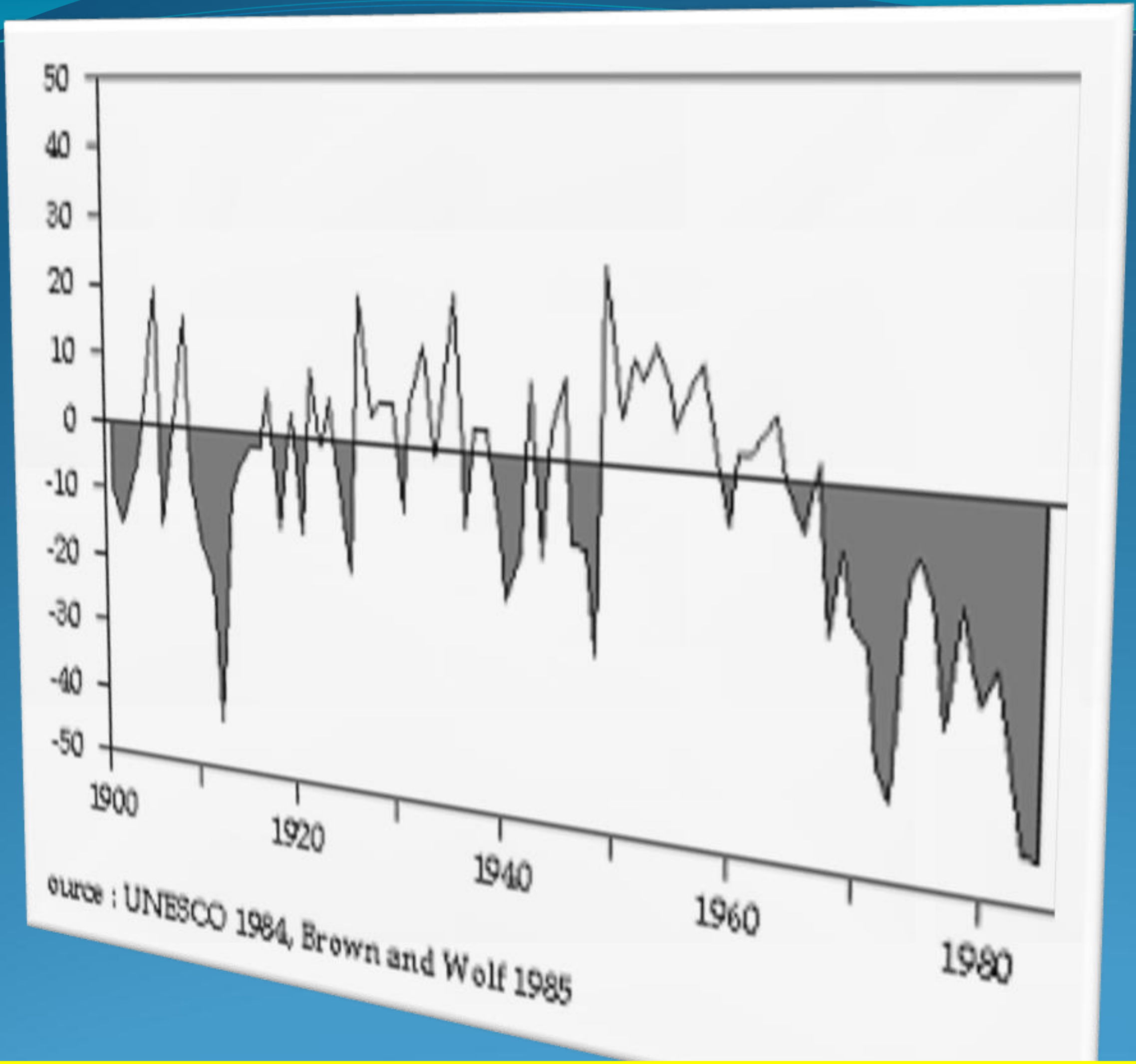


(ERBE) from NASA.

The figure opposite represents the radiative balance (difference between the radiative flux absorbed and the radiative flux emitted) of the Earth in annual average.
For the Sahel, the radiative budget is lower than in other areas.



This figure shows the radiative effect of convective phenomena.
On an annual and long-term basis in which no energy storage and no change in global average temperature occurs, this radiative equilibrium in the Sahelian zone is disrupted by southern transport of the southern flow during the summer.

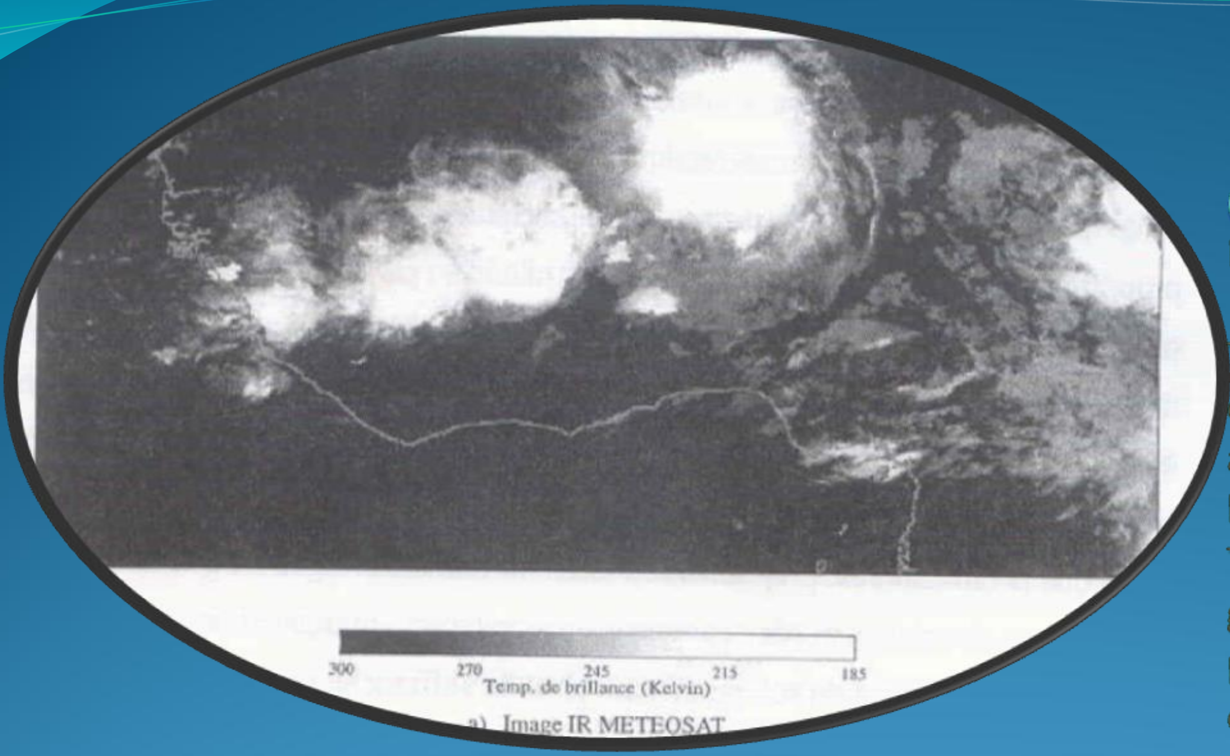


the variability of rainfall in the Sahel since the beginning of the last century. If several dry years follow one another, the nutrition problems become much worse.

We can make up for an unsuccessful year without major problems for the populations, if the food reserves are sufficient.

However, this is not possible if no harvest is made several years in a row, as was the case during successive droughts between 1968 and 1973.

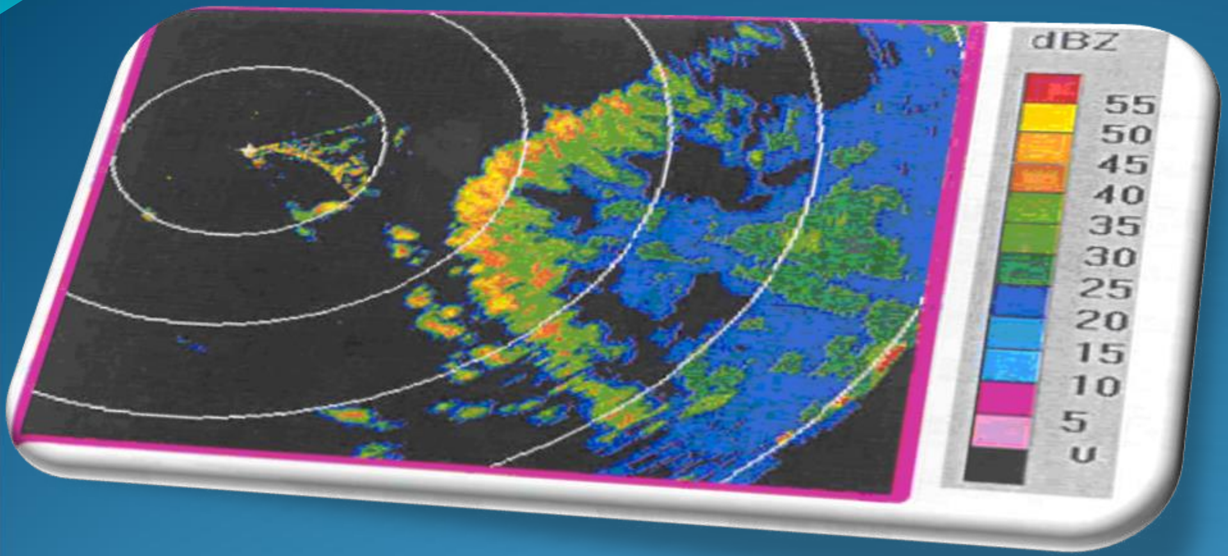
We realized our climatological study from the beginning of 1968 drought series.



(Adapted from Ramage, C. M. F. Kebe, 2005).

The squall lines appear as cloud-shaped clusters of approximately circular, oval or linear shape.
The satellite images give a global view of the MCS and place them in their synoptic context.

SL can be separated from other cloud clusters because it has the following characteristics:
- a clear border at the front
- an area of "clear sky", that is to say without a cloud,
- the back, which often corresponds to the eastern edge of the cloud cluster, difficult to define..



The mesoscale structure seen by the radar generally presents the following aspects:

a variable orientation of north-south mean;

the appearance of a series of cells of intense reflectivities connected by echoes of more moderate intensity;

a strong reflectivity gradient on the leading edge (i.e., the gradient is stronger on the leading edge than on the trailing edge of the convective portion);

elongated cells oriented at 45 ° -90 ° to the line;

Generality on the Sahelian climate

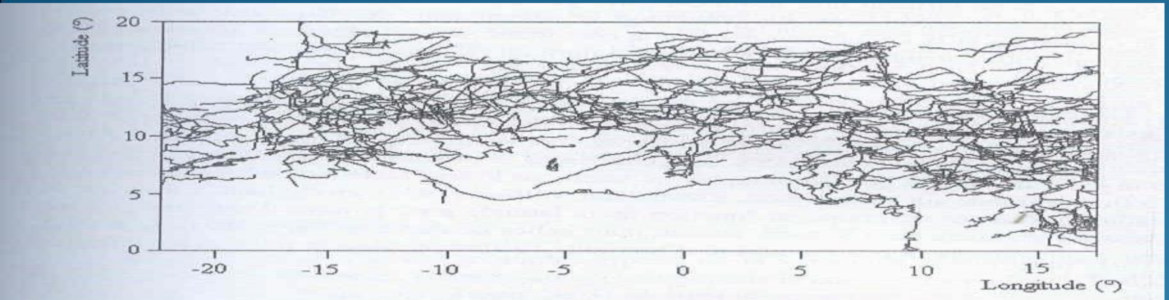
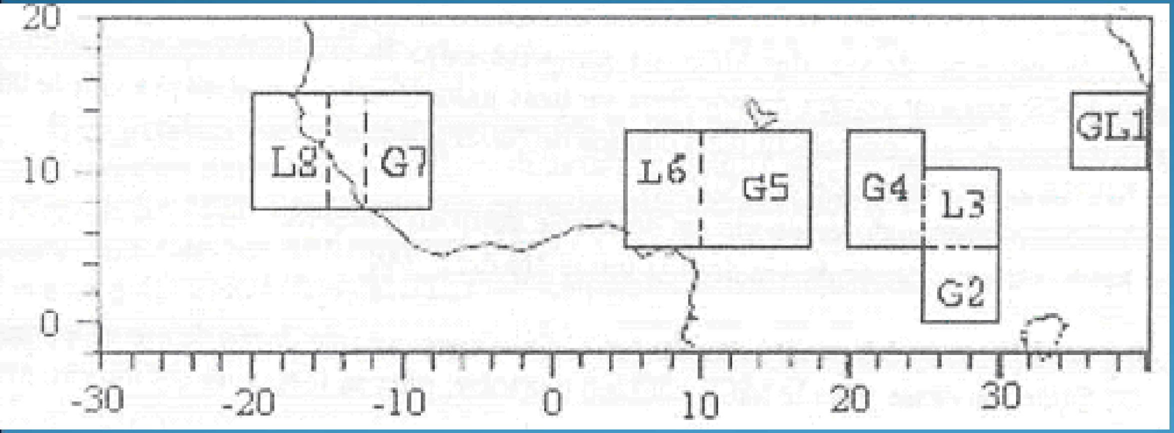


Fig. 2.13 : Trajectoires des MCS (d'après Sall, 2005)



Places of generation (G) and dissipation (L) of MCS observed in the Sahel. The number assigned to the location (based on Hodges and Thorncroft 1997, taken from Badiane, 2007).

Garba Adamou 1992 and B. Diop in 1996 at LPAO-SF studied the Squall Lines.

Their trajectories, their travel speeds and their life span have been well determined in the Sahelian zone (Dhonneur 1987, SALL 2002, Desbois et al., 1988, D'Amato and Lebel, 1998).

The fastest saquall lines are observed on the central Sahel, that is, between eastern Niger and western Mali. Laing et al. 1993 found that the Sahelian squall lines have an average life of 11.5 hours

- The investigations of D. Badiane in his thesis in 2007 and the work of Laurent et al. (1998) estimated that 95% to rain and 80% convective cloudiness in the Sahel. Chong and Hauser, 1989; Houze 1993, 1997; Diop et al. , 1996, estimated that the contributions of the convective part and the stratiform part are 65% and 35% respectively.

- *Table 1.2 relative contributions of convective systems*
- *monthly rainfall in the Sahel (adapted from Mohr, Gaye, 2002).*

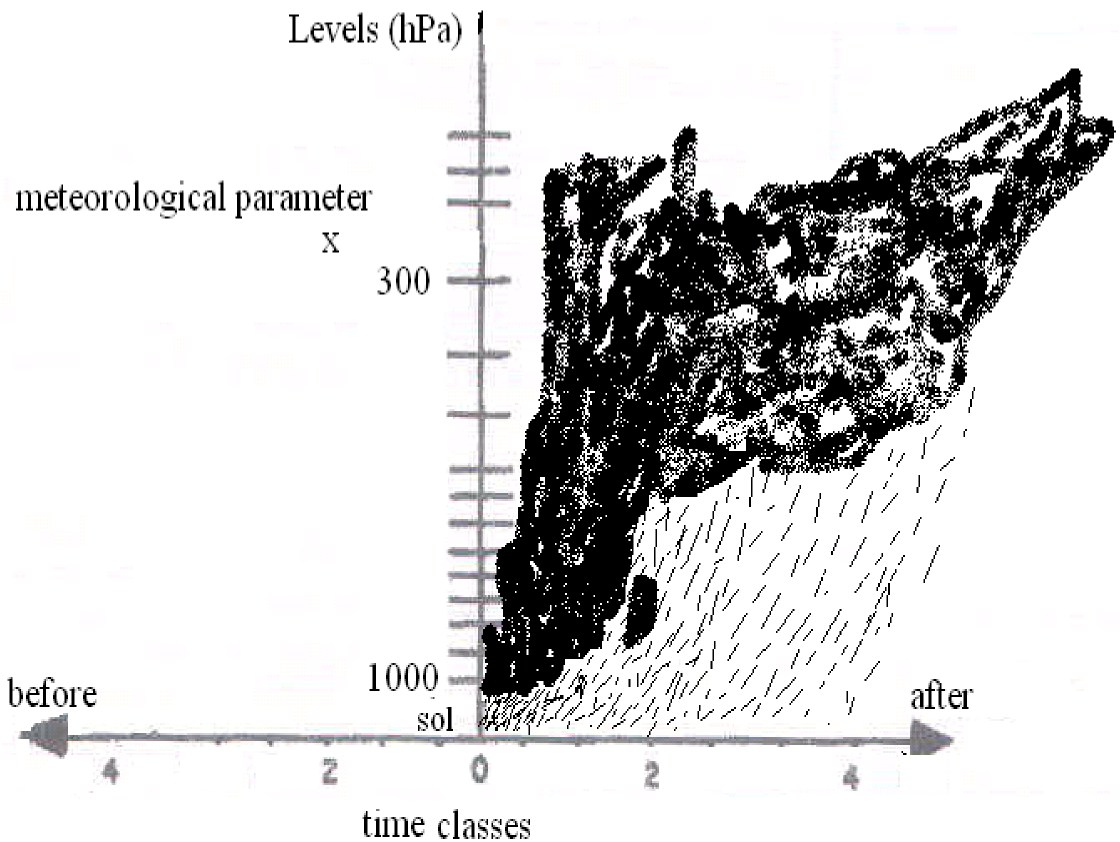
	>15° N	10-15° N	< 10° N
MAY	34%	66%	74%
jun	53%	81%	72%
july	66%	79%	62%
august	74%	77%	64%
september	73%	82%	70%

We characterized the Squall lines using Dakar soundings and from a composite analysis. The theoretical support of the study is composite analysis..

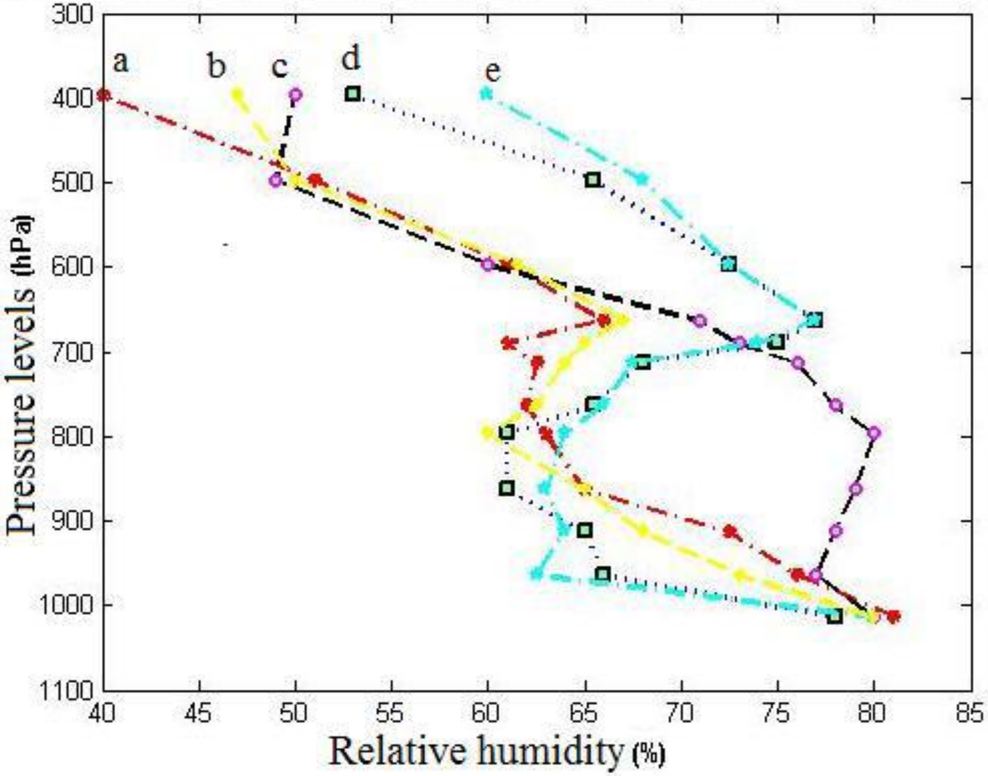
Meteorological characterization of squall lines

This method was used by Reed (1971), and Burpee (1976) and many others to study the structure of the East waves. The spatial division of the phenomenon into categories makes it possible to adapt a template to each event and thus to average these events, even if their dimensions are different. If the phenomenon we are trying to describe has a physical reality, the results of all the averages carried out show a coherent structure. This method is well suited to meteorological phenomena. "We have adapted this technique for the characterization of S.L. from meteorological parameters.

Meteorological characterization of squall lines



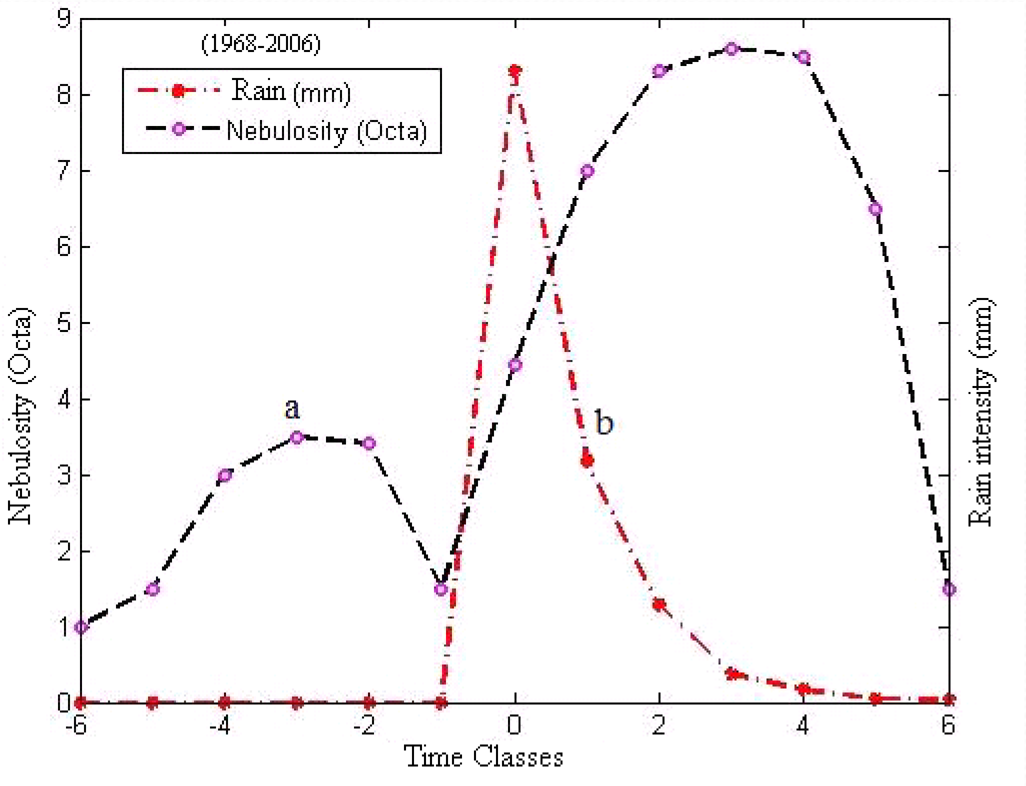
The detection of the line of the aquall line by the wind jump corresponds to the zero class. Two hours after the jump of the wind we have class 2h after



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

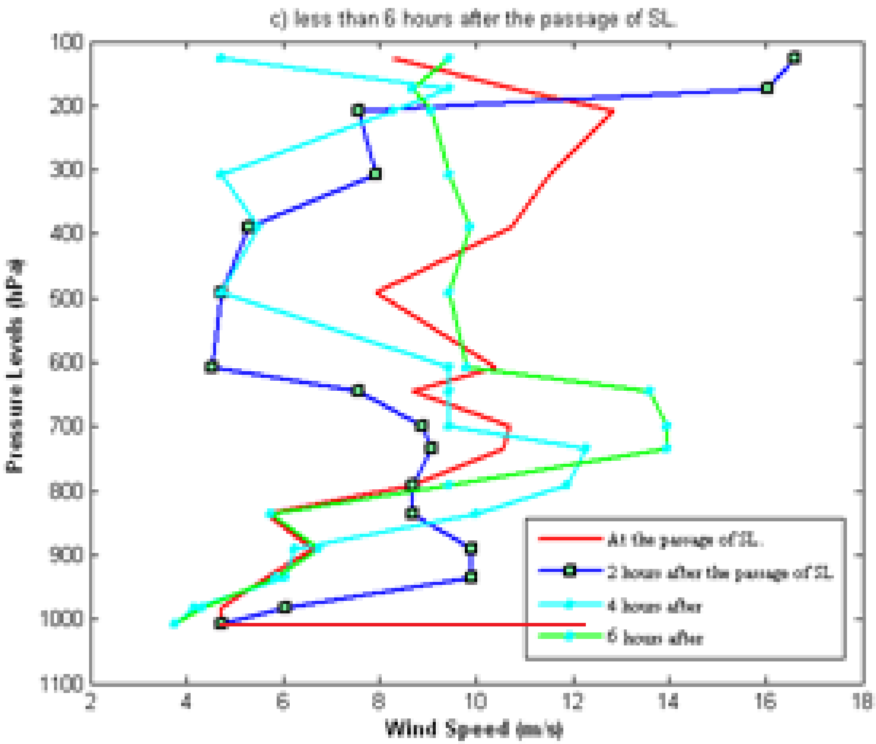
This figure shows at the time of the passage of SL,
the atmothere is wetter in the very low levels (1000-800 hPa) Compared to the summer average.
On the other hand, it is less between 800 and 750 hPa,
At the level, the two profiles present almost the same pace.
Humidification is noter in 800-500 hPa , at 4 and 6 hours after

Meteorological characterization of squall lines



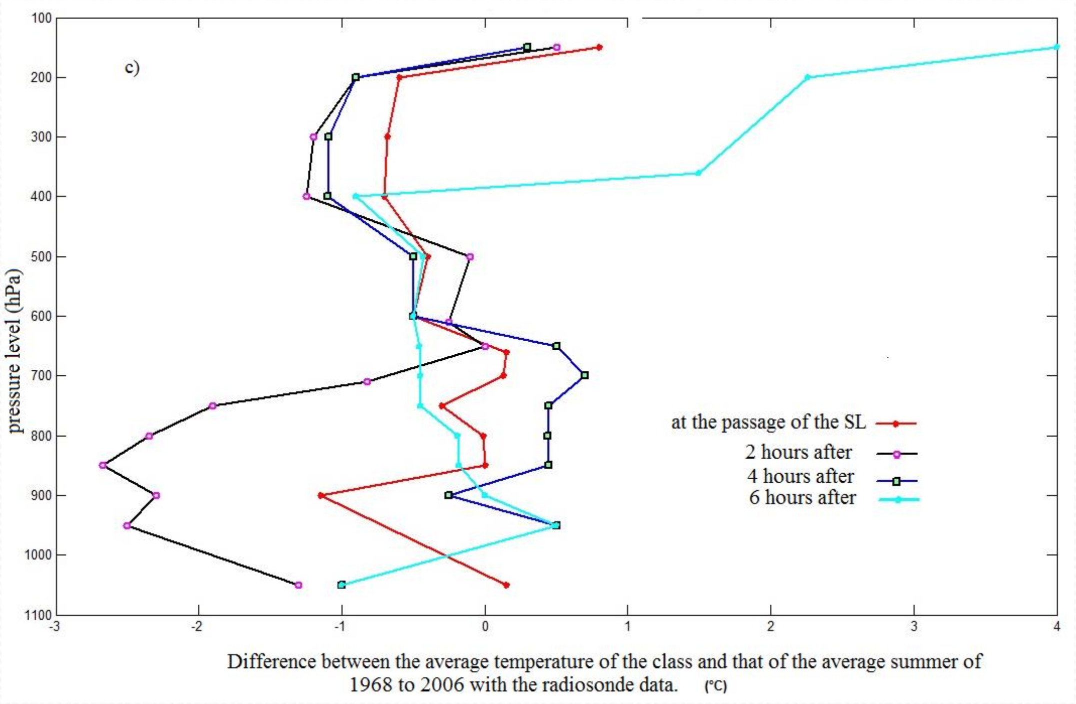
The figure indicates that most SL Precipicipition is of convective origine and is concentrated in the convective portion consisting of vigourous deep convective cells, The convective part of S.L lasts about 2 hours on average. In this figure it note that the most important cloudness is late compared to the convective rain.

Meteorological characterization of squall lines



The vertical profile of the wind direction indicates an east wind between 700 and 650hPa (east flow) and a westerly wind between 1000 and 800hPa (monsoon flow).

Difference between the average temperature of the class and the summer average from 1968 to 2006.



Meteorological characterization of squall lines

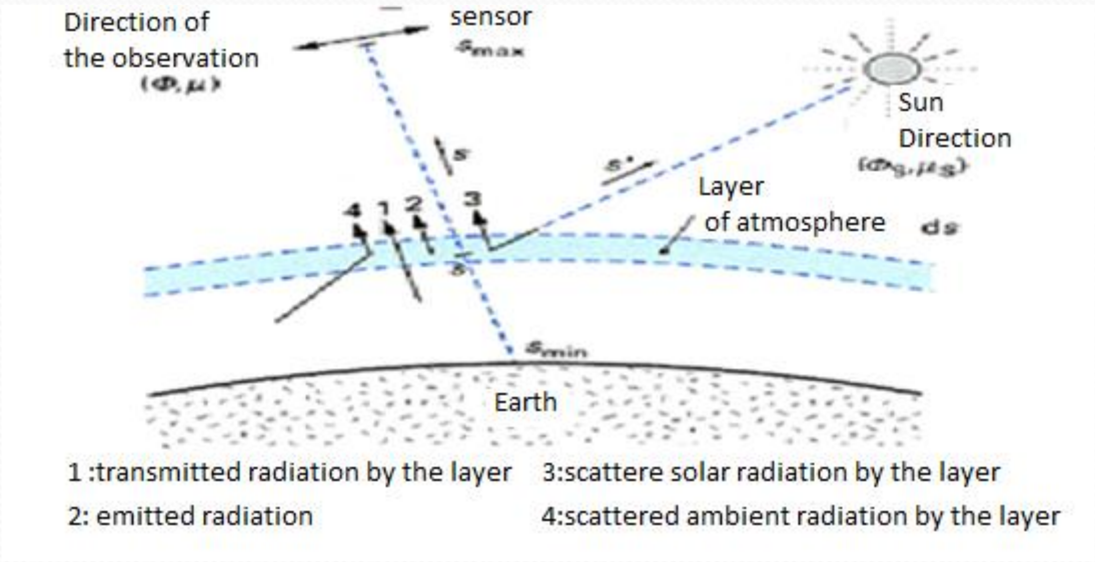
First conclusion

When S.L. passes, the characteristics of the atmosphere are:
- a strong cooling in the layer below 600hPa
- a strong humidification in the 850-700hPa layer
- a strong east wind at 700 hPa between 4 hours and 6 hours later.

This climatological study also shows the categorization of S.L. in time class that we will use for the energy study of the atmosphere subjected to these disturbances.

Radiative transfer equation

Considering an atmospheric slice of thickness ds between the sensor and the ground, there are four distinct elements in the elementary layer contribution to the global radiation perceived by the sensor.



Radiative transfer equation

Atmospheric radiation.
The atmosphere is one of the most constraining parasitic sources for optronic systems, by its diffusion of ambient radiation in the visible and near infrared, and by its own emission in the far infrared.

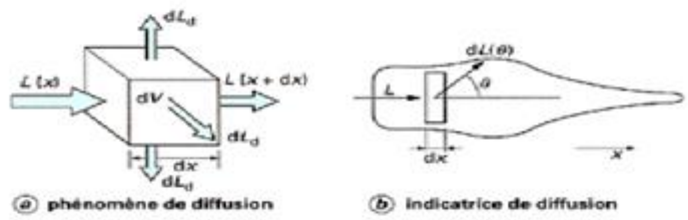
The calculation of these effects is complex and involves a number of physical parameters: transmission, absorption, diffusion, etc.

Radiative transfer equation

Atmospheric diffusion

The atmospheric diffusion of the radiation by the medium consists of an interaction between a fraction of the photons of this radiation and the atoms and / or molecules of the medium, which has the effect of an angular redistribution of this radiation fraction.

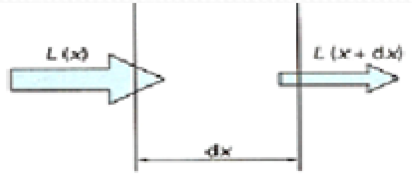
$$dL_d(\lambda, x) = \beta(\lambda, x)L(\lambda, x)dx$$



Diffusion par le milieu de propagation

Radiative transfer equation

The absorption of radiation by the atmospheric medium consists of an interaction between the photons of the radiation and the atoms or molecules of the medium.



$$L(\lambda, x + dx) = L(\lambda, x) - dL_a(\lambda, x)$$

Radiative transfer equation

Calculation code for radiance and irradiance

Calculation of radiative energy fluxes is done using MODTRAN4 (Gail, A. et al) MODTRAN4 Version 3 Revision 1. MODTRAN (Berk et al, 2003) has been used as a moderate spectral model of standard radiative transport for US Air Force (USAF) with wavelength resolution ranging from thermal infrared (IR) to ultraviolet (0.2 to 10,000.0 mm) to visible.

The spectroscopy of MODTRAN4 Version 3 Revision 1 (Mod4v3r1) uses the detailed database HITRAN (High-resolution TRANsmission Molecular Absorption Database) Rothman et al, 1992; Rothman et al, 1998, which identifies the spectroscopic properties of atmospheric molecules in order to accurately calculate the transfer (transmission, absorption, etc.) of radiation..

It is a question of studying in the following,

the average spectral radiances of a convective

atmosphere in Sahelian summer.

Spectral signatures of squall lines

Data

- Diop B. et al in 1994, 2006 and Sow B.A. in 2005, showed after a composite analysis followed by a statistical study the atmosphere subjected to a S.L. type disturbance could be categorized in class of 2 hours. The MODTRAN model uses the constituents of a tropical atmosphere obtained from the Ontar Corporation report for aerosols (Gail A. et al., 1996).

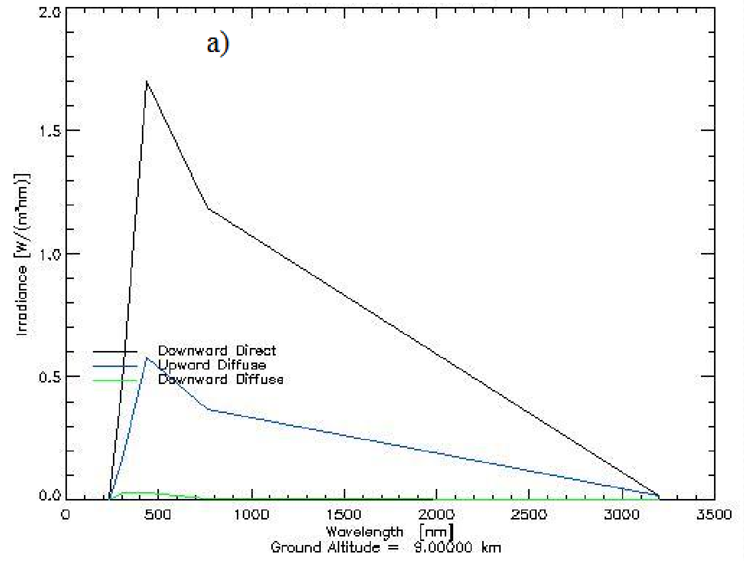
Spectral signatures of squall lines

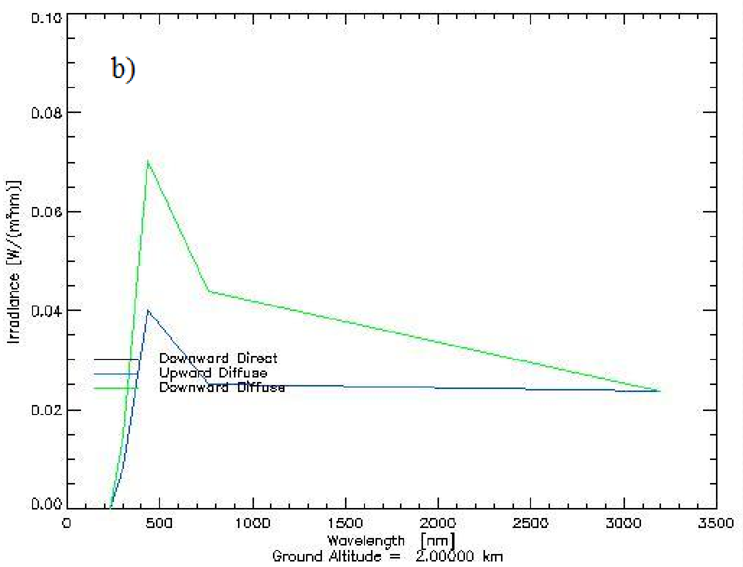
Results obtained

The results we got for: :

- Meteorological visibility on the ground varies up to 23 km according to the TCM (Monthly Climatological Table).
- An atmosphere subject to deep convection

Spectral signatures of squall lines

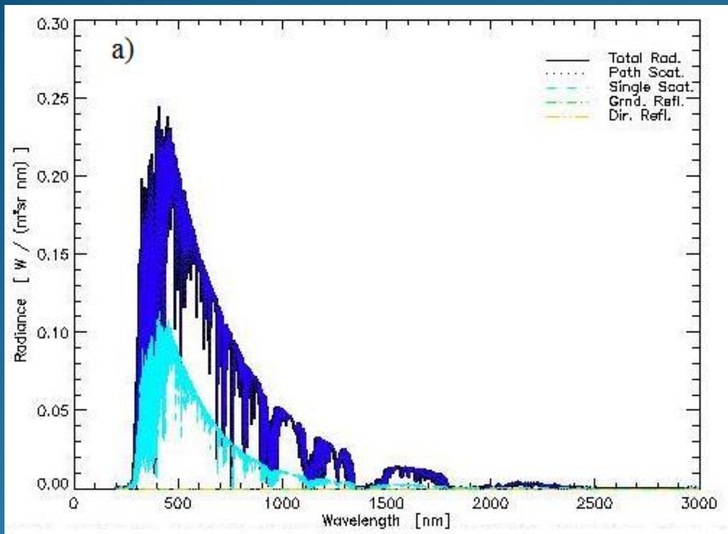


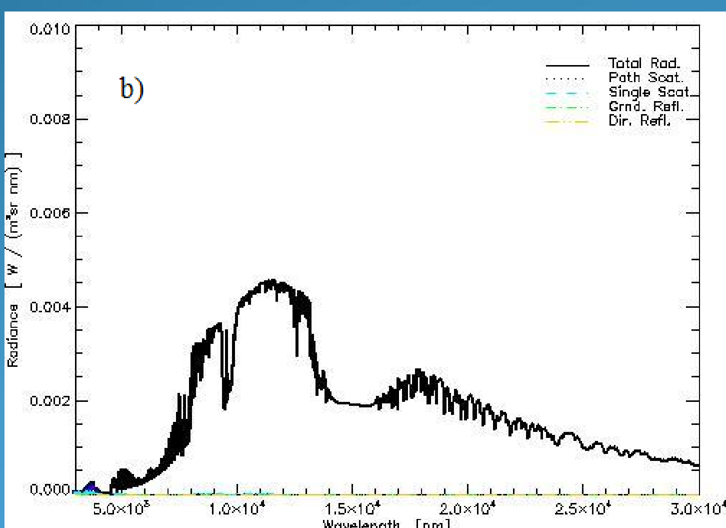


For a daytime atmosphere.
For the zero hour class corresponding to the wind jump (detection of the squall line). The following results are obtained:

- Figures (a and b) show calculated flows, as a function of wavelength. For this spectral domain, it concerns 200 to 3000 nm, essentially atmospheric diffusion Ld.A, at the 9 km level (figure a) at the level; 2 km (Figure b). We note the effect of altitude, the downward flow and more important than the upward flow. The direct solar flux is practically nil at 2 km (700 hPa). Electromagnetic waves are essentially absorbed by the rainy atmosphere.
- At 9 km (~ 300 hPa) we have the direct flow in more

Spectral signatures of squall lines

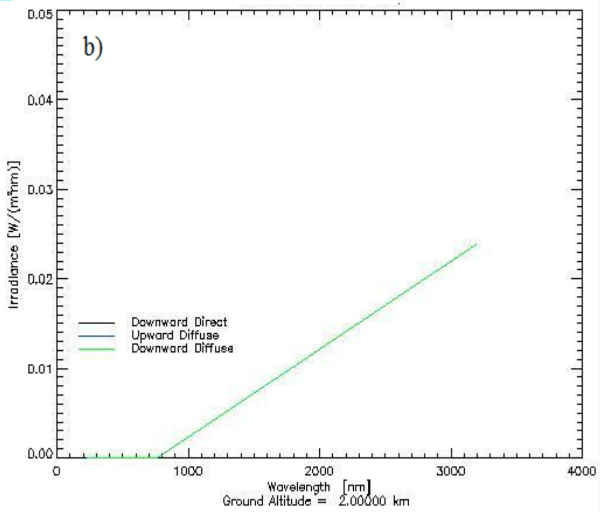


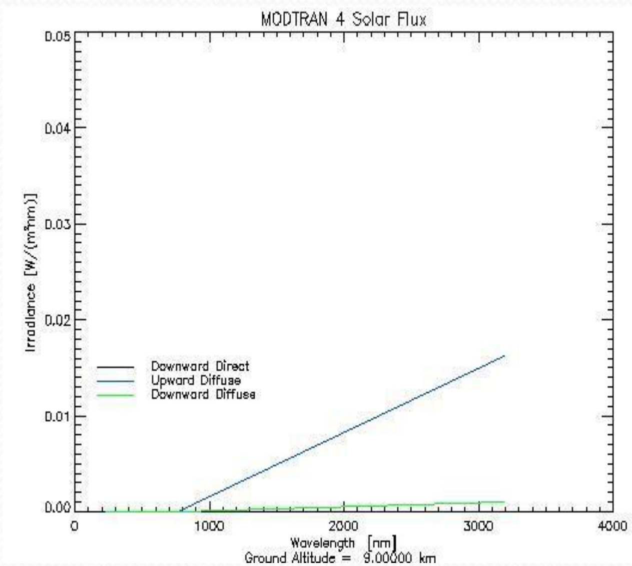


For a diurnal atmosphere(zero-class) Figures (a and b) show the observed radiances, as a function of wavelength. For this spectral range, 200 to 30000 nm, LdA atmospheric scattering is between 200 and 2500 nm; between 5000 and 30000 nm..

we show the structure of the radiance within a diurnal atmosphere in the presence of a convective disturbance. Figure a shows the total radiance profiles and the reflectivity of the ground over the range of wavelengths between 450 nm and 1560 nm. The maximum radiance is around 480 nm. In Figure b, there is a maximum maximum around 1.2 104 nm equal to 0.0043 w / m^2.sr.nm; secondary maxima among which that of 0.9 10^{-4} w / m^2.sr.nm.

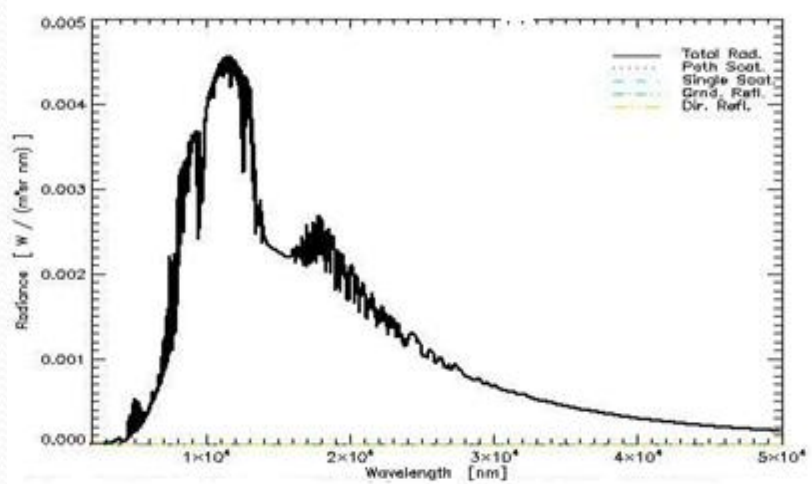
Spectral signatures of squall lines





- **Night atmosphere (class zero)**

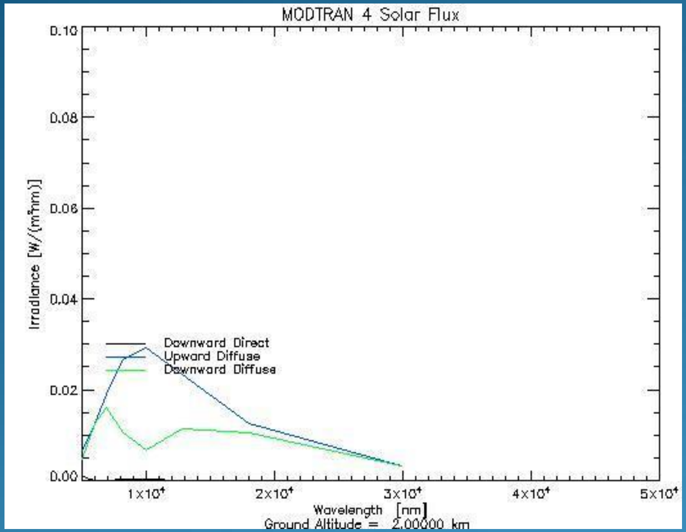
  This is the passage of a squall line during the night, with radiosondages coinciding with the passage of S.L. Figure (a and b) shows the calculated flows, as a function of wavelength. For this spectral domain, it concerns 200 to 3000 nm, essentially atmospheric diffusion $L_{d,A}$, at the level 2 km (a) and at the level 9 km (b).

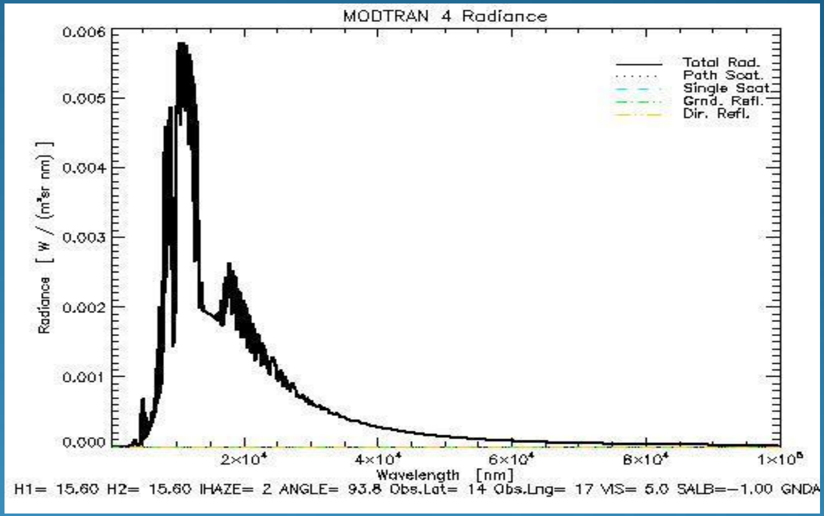


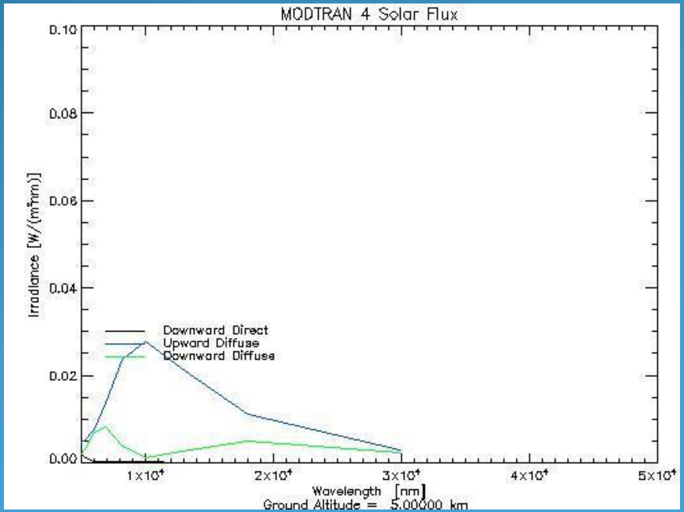
The Figure above, we find the peak of the radiance maximum around 1.2 10^4 nm

Spectral signatures of squall lines

Radiance and irradiance Night (Class 2 hours before the wind shift)







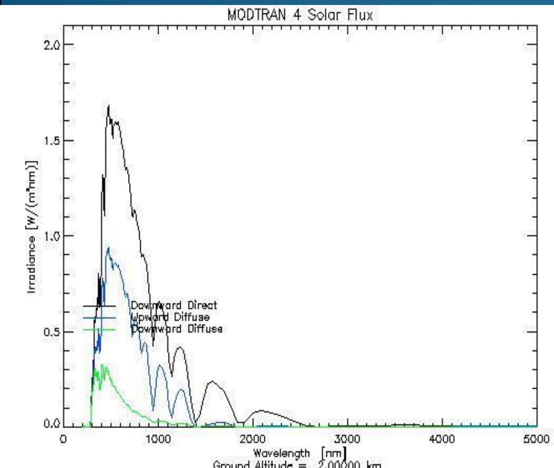
We note an inversion of the upward diffuse flow

1. 10^4 nm, for downward flow on the other hand there appear two inversions one to 1. 10^4 and the other to

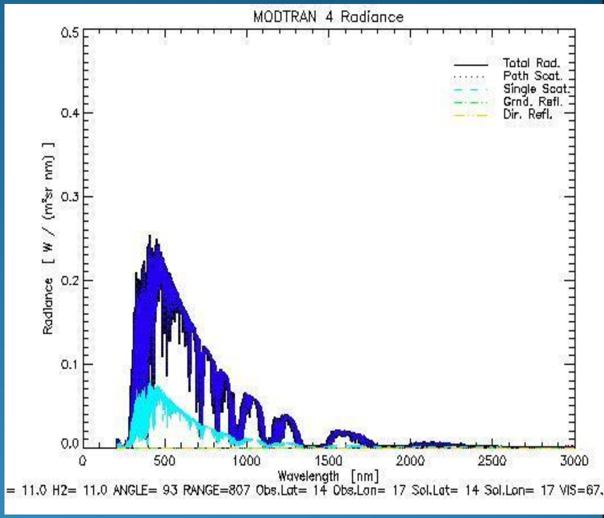
1.3 10^4. As of 2.3 10^4 we have an equality of the two flows and goes down to 3. 10^4 nm. The radiance has the same spectral structure as for structures previously seen in the band defined by 10000 - 100000 nm. It is only the intensities of the radiance that have changed.

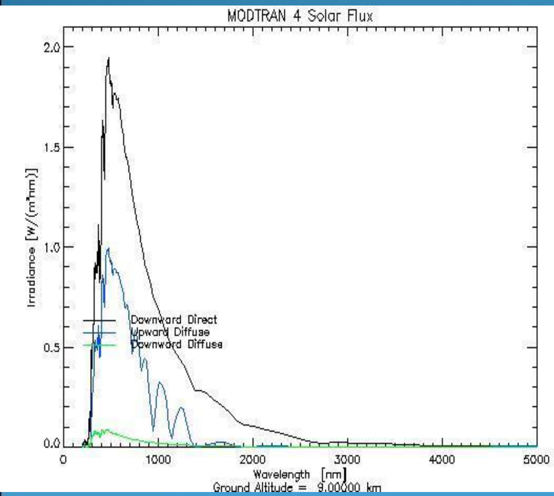
Spectral signatures of squall lines

Irradiance et Radiance Diurne 2 h before

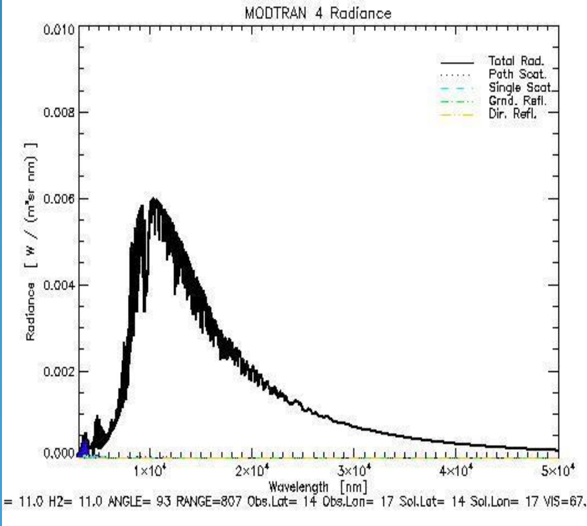


Flow at 2 km and at 9 km For direct downward flow; it decreases with altitude for all wavelengths. It is more important in the interval 300-900 with a maximum at 500nm.

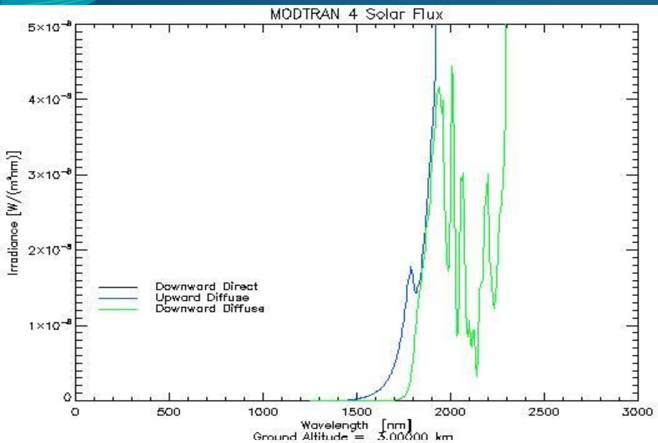


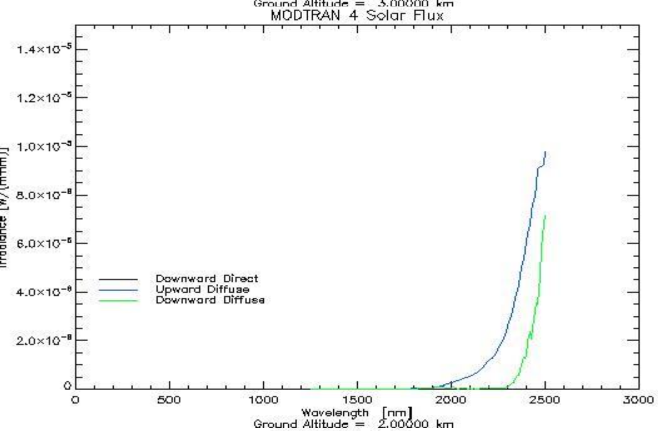


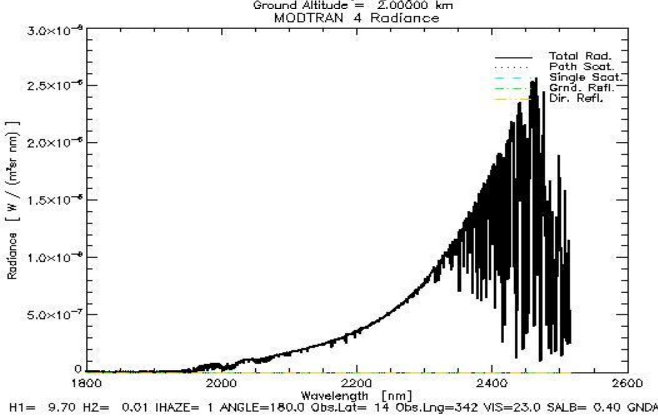
The figures (on the right) show the spectrum of calculated radiances, as a function of the wavelength. It is for this spectral range, 10000 to 100000 nm, L_{dA} atmospheric diffusion.



Spectral signatures of squall lines







Irradiance and Night Radiance 2 hours after

Figures show the observed fluxes as a function of wavelength. For this spectral domain, it concerns 200 to 3000 nm, essentially L_{dA} atmospheric diffusion, at the

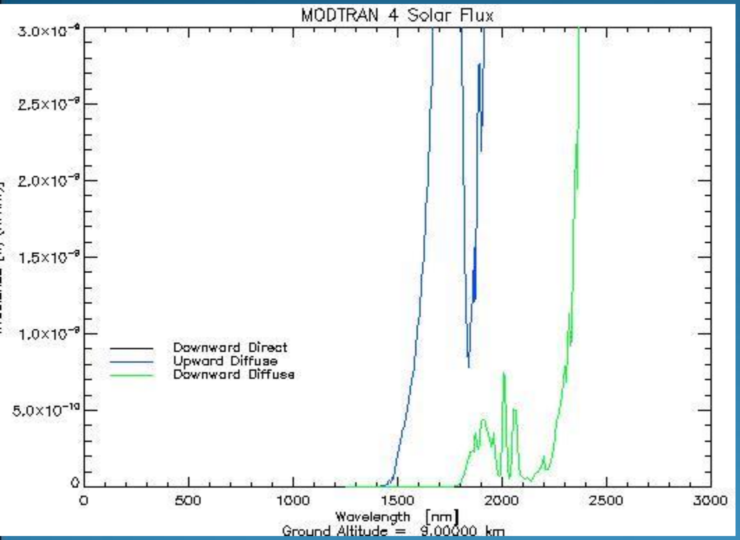
1 km level (with irradiance between 5.10^{-5} and 3.10^{-7}) (b irradiance between 5.10^{-5} and

3.10^{-7}).

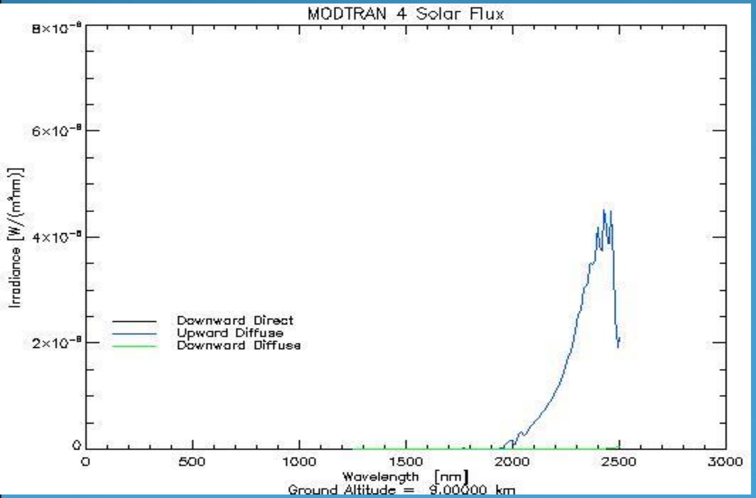
The highly fluctuating nature of the layer of descending irradiance is observed in the 1900 and 2250 nm spectral windows.

the spectrum of radiances is calculated according to the wavelength. It is for this spectral domain, 10000 to 100000 nm, of atmospheric diffusion L_{dA}

Spectral signatures of squall lines

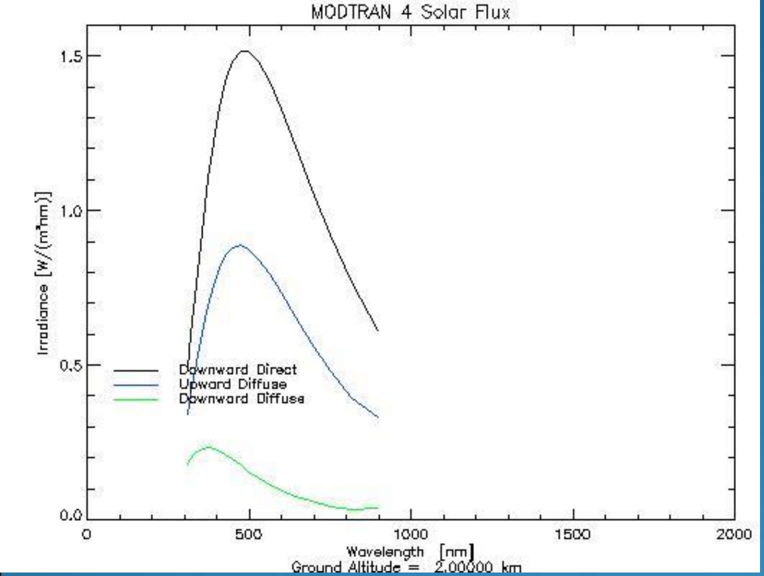


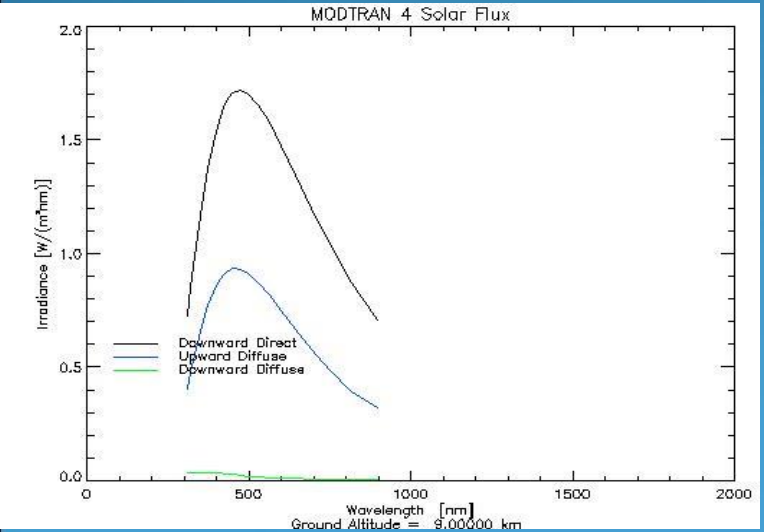
Irradiance at night 9 km 2 hours after. The highly fluctuating nature of the atmosphere is noted at all levels



At 9 km the downward diffuse flow is very low between 1500 nm and 2000 nm

Spectral signatures of squall lines



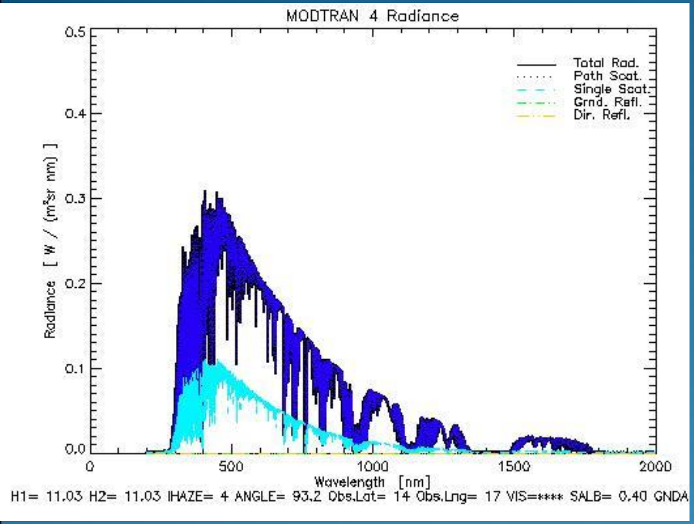


Irradiance diurnal at 2km and 9 km 2h after.

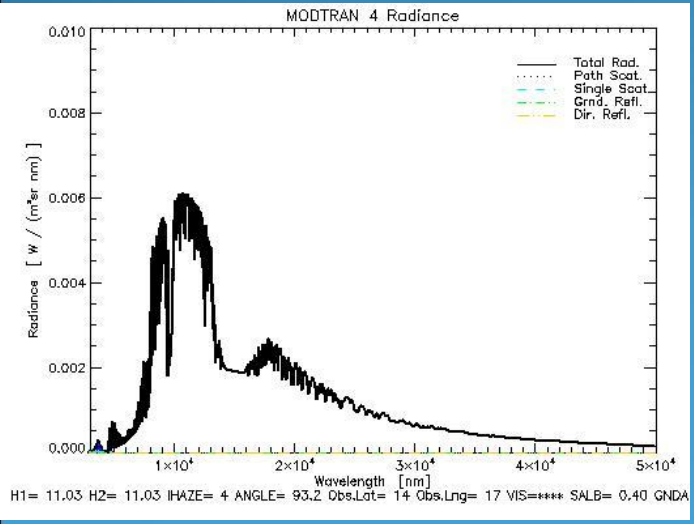
The configuration of the spectrum noted in the figures shows a diffuse flux descends very low compared to the other flows, which is attenuated with altitude.

The rising diffuse flux has a max around 500 nm. The downward direct flux has a spectral growth followed by a decrease with a max at 500 nm; overall it is constant with altitude at all wavelengths.

Spectral signatures of squall lines

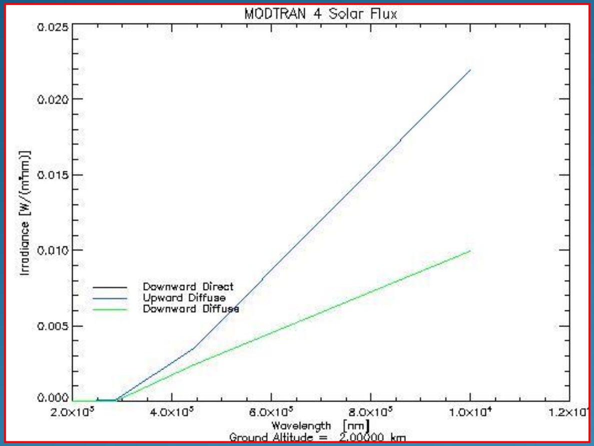


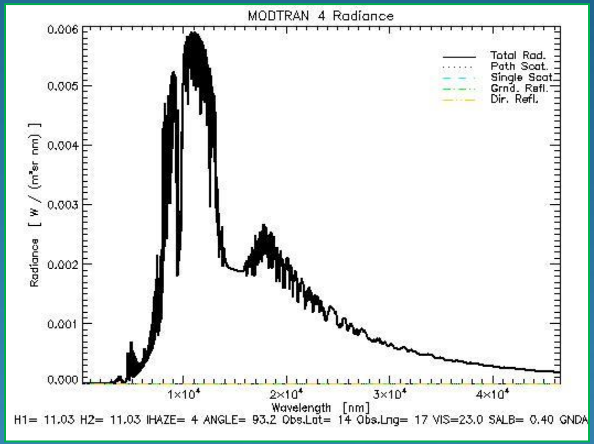
daytime radiance 2h after.

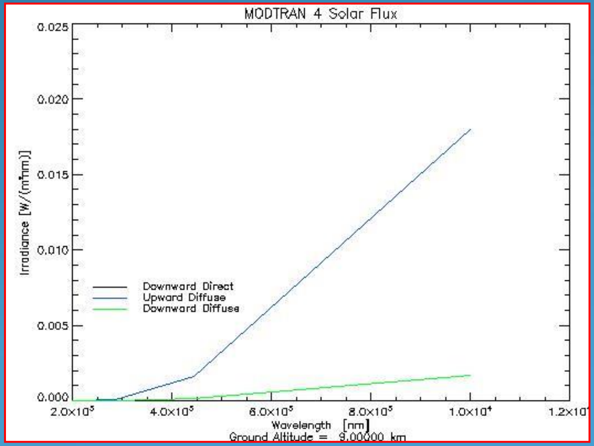


The figures show the spectrum of calculated radiances, as a function of the wavelength. It is for this spectral domain, 10000 to 100000 nm,,

Irradiance –radiance nocturne 4 h apres





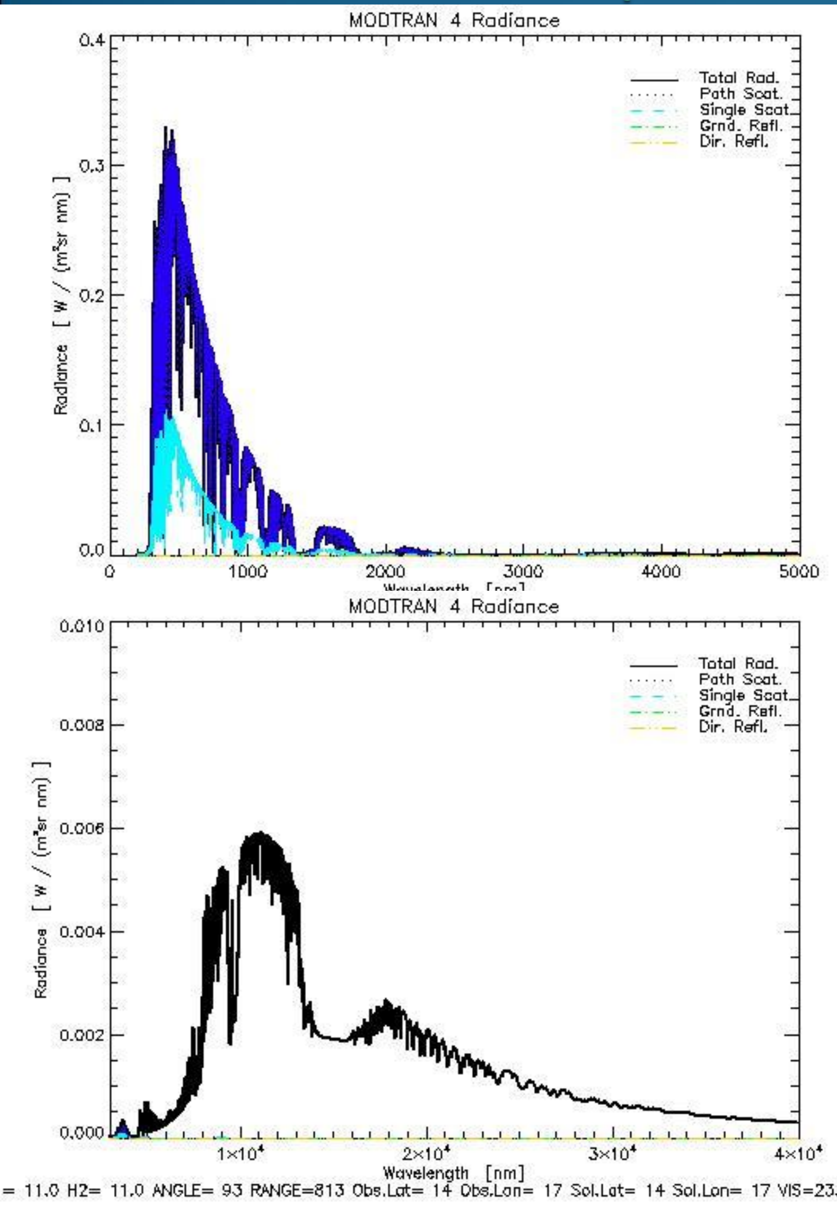


The figures show the calculated flows, as a function of the wavelength. For this spectral domain, it concerns 200 to 3000 nm, mainly LdA atmospheric diffusion, at the 9 km level and at the 2 km level.

The figure above shows the spectrum of observed radiances, as a function of the wavelength. It is for this spectral range, 10000 to 100000 nm, LdA atmospheric diffusion.

Signatures spectrales des lignes des grains^2

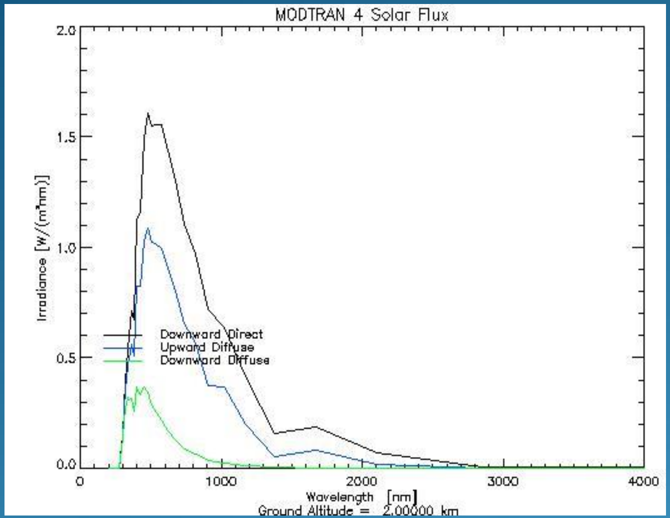
Radiance diurne 4h Apres



The figure above shows the total radiance profiles and the reflectivity of the ground over the wavelength range between 450 nm and 1560 nm. The maximum radiance is around 480 nm. With a value of the order of 0.245 w / m^2.sr.nm. On the bottom figure, there is a maximum maximum around $1.2\ 10^4$ nm equal to 0.0043 w / m^2.sr.nm; secondary maxima among which that of $0.9\ 10^{-4}$ w / m^2.sr.nm.

Spectral signatures of squall lines

Daytime irradiance 4 hours after



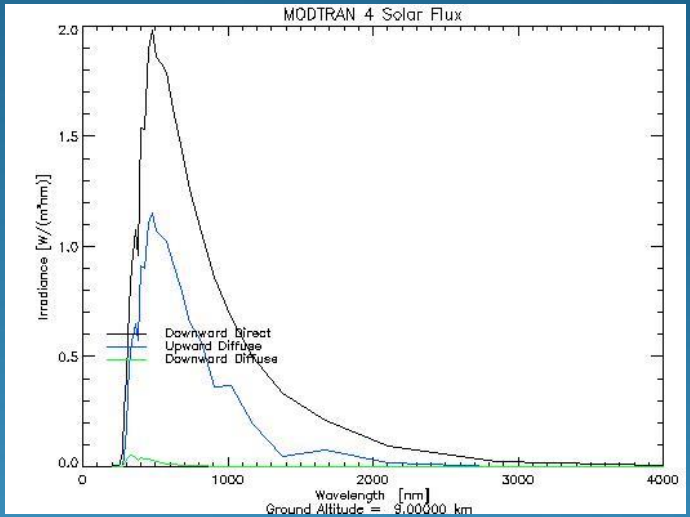


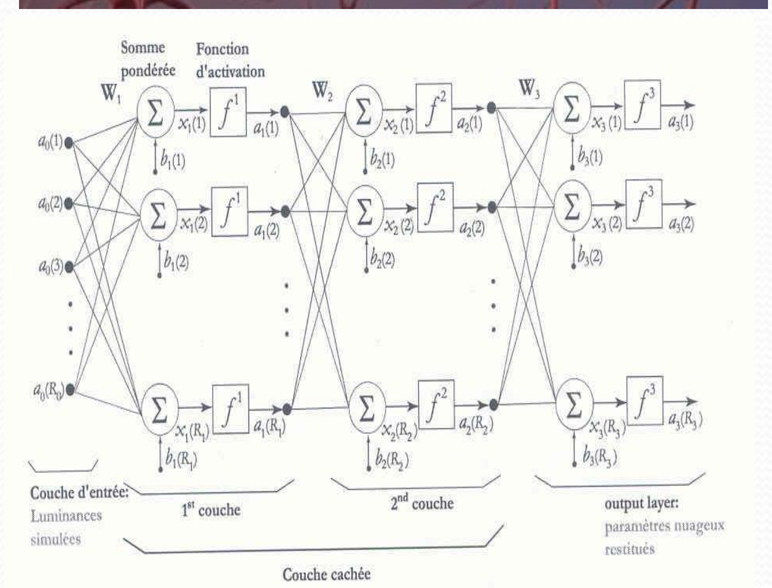
Figure for 2km and Figure for 9 km successively shows a diffuse flow, which is held at 11 km. The rising flux has a max around 500 nm, a small plateau around 1000 nm and a secondary max 1700 nm. The downward direct flow has a spectral growth followed by a decrease at 500 nm; overall it increases with altitude at all wavelengths while maintaining their profiles.

Spectral signatures of squall lines

Second conclusion

We have just shown that the spectral radiative profiles vary according to the position of the sounding according to whether we are in the convective part (up to 2 hours after the detection of the S.L) or in the stratiform of the S.L. The spectral signatures of the The atmosphere reveals a significant qualitative difference in the structures obtained when comparing atmospheric diffusion fluxes for different time classes.

Tropospheric sounding using the neural network



Sounding with the neuron network

From neurons to formal neurons.

The history of formal neurons goes back to cybernetics, in the forties, when biologists, physicists, mathematicians and engineers came together to try to simulate, with the help of electronic components, biological, physical, or even social. In technical terms, formal neurons are automata that characterize, by a mathematical definition, what we imagined to be, at the time of cybernetics, the function of neurons in our brain, namely the memorization of information elementary binary.

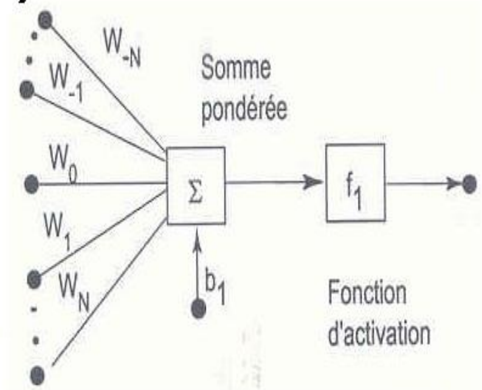
Tropospheric sounding using the neural network

Neuronal methods are increasingly used in atmospheric physics (Escobar in 1992, Krasnopolsky et al 2003a, 2003b), whether for the simulation of complex processes or restitution problems. These techniques have advantages in solving some of the problems encountered in the atmospheric sciences: they can approach complex functions with several variables without knowing exactly the form of these functions (Denison et al., 2002); they are fast, flexible if the problem to be treated has been well analyzed (Cheng and Titterington, 1994).

Tropospheric sounding using the neural network

The multilayer perceptron The multilayer perceptron is one of the most used types of neural network because it allows, thanks to its numerous connections, to realize nonlinear associations between two vectors. A neuron has N inputs and an output. At each entry is associated a weight Wi. The first operation performed is a weighted sum weighted by the weight vector W of the input data, to which a bias b is added. we thus obtain, if X represents the N components of the input vector:

$$a = \sum_{i=1}^{N} W_i X_i + b_i$$



A cette somme est ensuite appliquée une fonction f_1 appelée fonction d'activation ou fonction neurone. Différentes fonctions peuvent être appliquées, leurs choix dépend de la complexité du réseau que l'on utilise ; elles peuvent être :

- Des fonctions linéaires : Y = $Y = \alpha x + \beta$ avec α et β
- Des fonctions seuils : Y - $\begin{cases} 1, si\ a \geq 0 \\ 1, si\ \leq 0 \end{cases}$
- Des fonctions sigmoïdes : Y = $\frac{2}{(1+e^{-2a})-1}$

La sortie $Y = f(\sum_{i=1}^{N} W_i X_i + b_i)$

Tropospheric sounding using the neural network

Using the neuron network.

The neural network is a type of parametric model that allows to create a nonlinear association between inputs and outputs. To achieve this association, the different coefficients of the network must be adjusted. This adjustment is achieved by minimizing the differences between the calculated outputs corresponding to known inputs and the true output values. Once the examples have allowed the adjustment of the network coefficients, a test phase is needed to evaluate the network performance. The use of neuronal methods is therefore divided into three phases:

- Construction of the learning base, that is to say obtaining the input-output pairs;
- Learning the neural network that corresponds to the adjustment of the different coefficients of the neural network;
- generalization which consists of evaluating the performance of the neural network using data that were not used during the learning phase.

Tropospheric sounding using the neural network

DATA

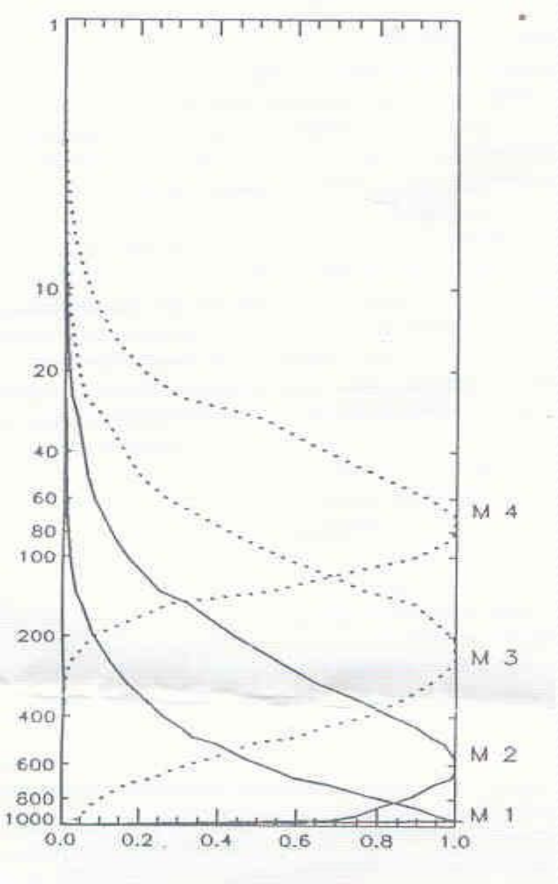
- ***Radiances measured by the satellite. NOAA14 HRPT data are acquired at LERG (ISRA / UCAD).***

- Radiances calculated by MPM Model (Millimeter-wave Propagation **Model**)
- Specific humidity obtained from radiosoundings
- MSU Channels (Microwave Sounding Unit)
- Levels of atmospheric pressure

Tropospheric sounding using the neural network

Table: MSU sonar MSU channels that measure radiances in the microwave domain to calculate atmospheric moisture profiles.

MSU	1	2	3
Fréquencies (GHz)	50.31	53.73	54.96
levels (hPa)	1010	700	300



The weight functions for an MSU instrument show that the energy contribution for each instrument channel comes from a considerable thickness of atmosphere with significant overlap between adjacent channels. Each channel therefore represents a layer and not a specific level.

MPM (Millimeter–wave Propagation Model)

- MPM

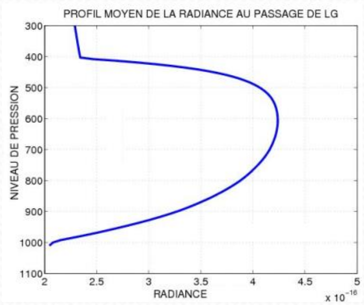
MPM makes the calculations that in the field of microwaves, the code is open so adaptable unlike MODTRAN. It calculates rising and falling radiances at the peaks of the atmosphere.

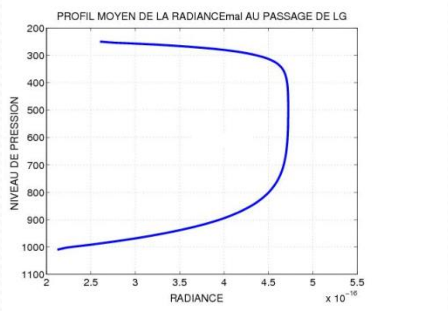
- Modified MPM

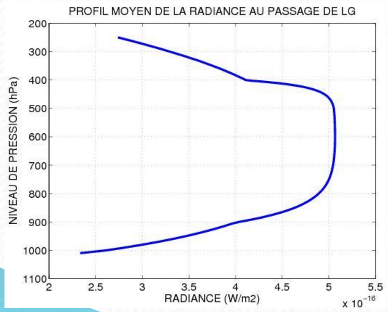
We modified it to calculate the radiance in an inner layer.

Tropospheric sounding using the neural network

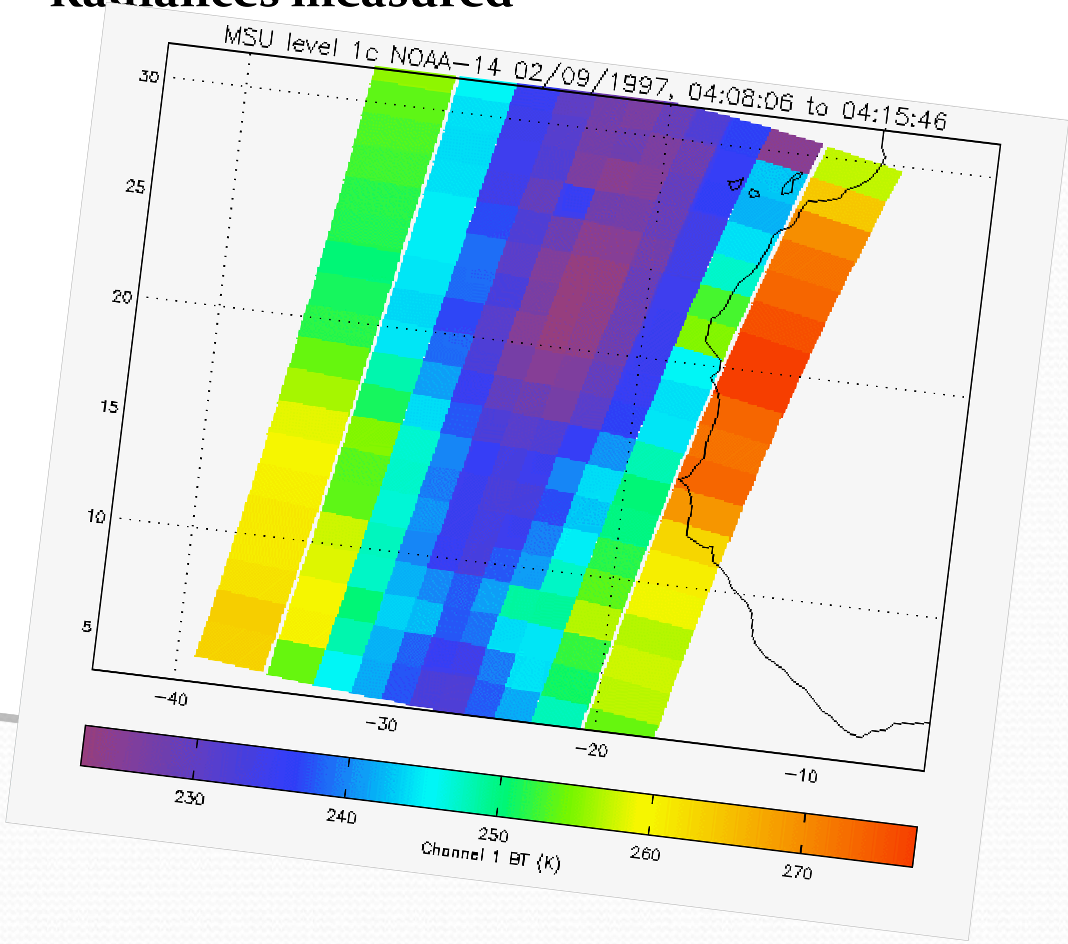
Radiances are calculated at class 0.



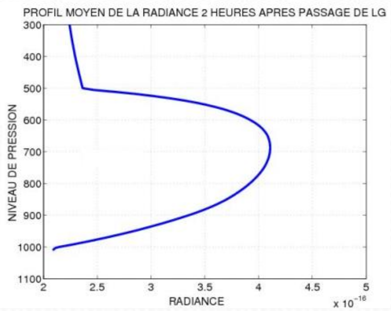


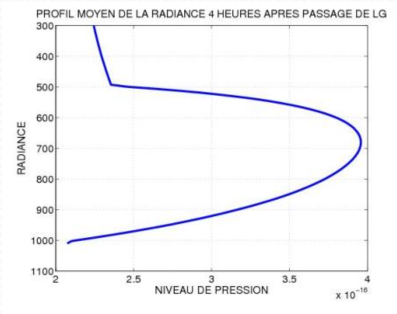


Radiances measured

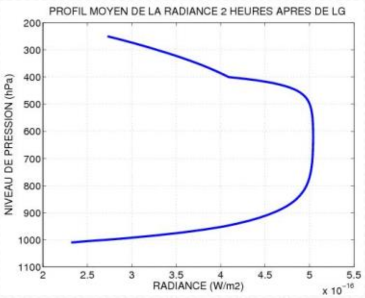


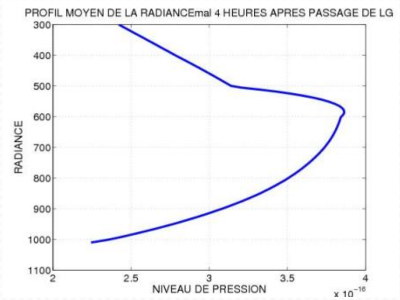
Tropospheric sounding using the neural network



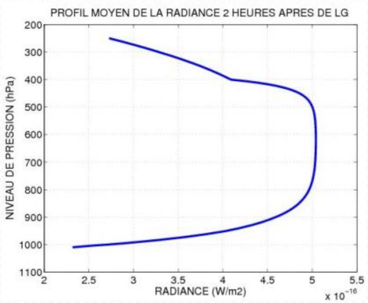


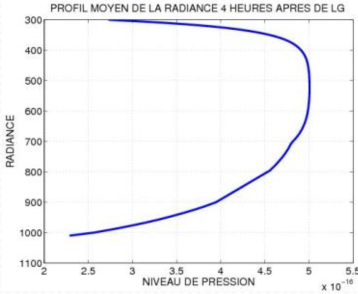
Mean radiance profile 4 hours after passage of L.G.a) 50.31 GHz; b) 53.73z; c) 54.96 GHz (right)



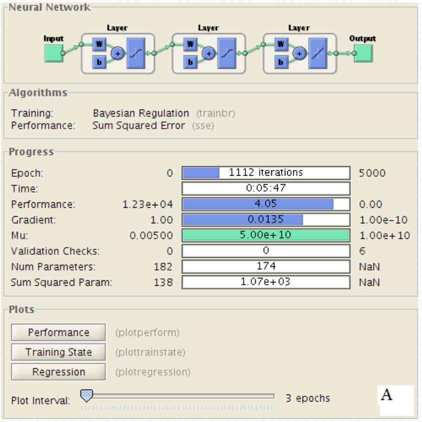


Average radiance profile 2 hours after passing L.G. a) 50.31 GHz; b) 53.73z; c) 54.96 GHz (left)

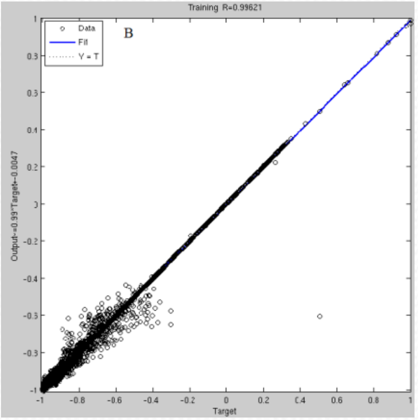


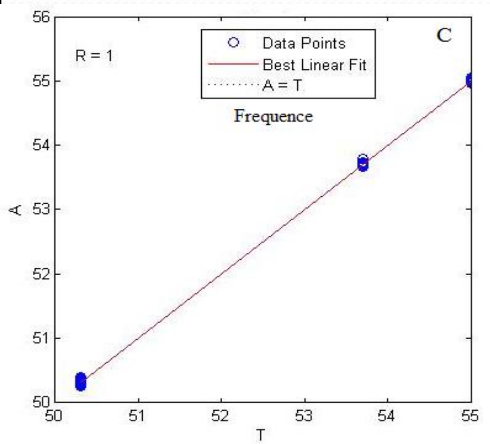


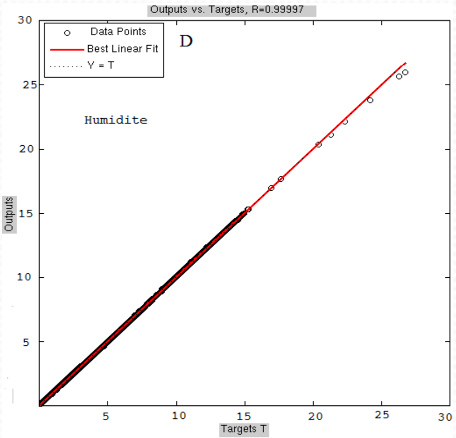
Tropospheric sounding using the neural network



Learning the neural network. We have two outputs, so we made two regressions. The results are shown in the figures. These two outputs seem to follow the targets reasonably well, and the R values are close to 0.9.







Tropospheric sounding using the neural network

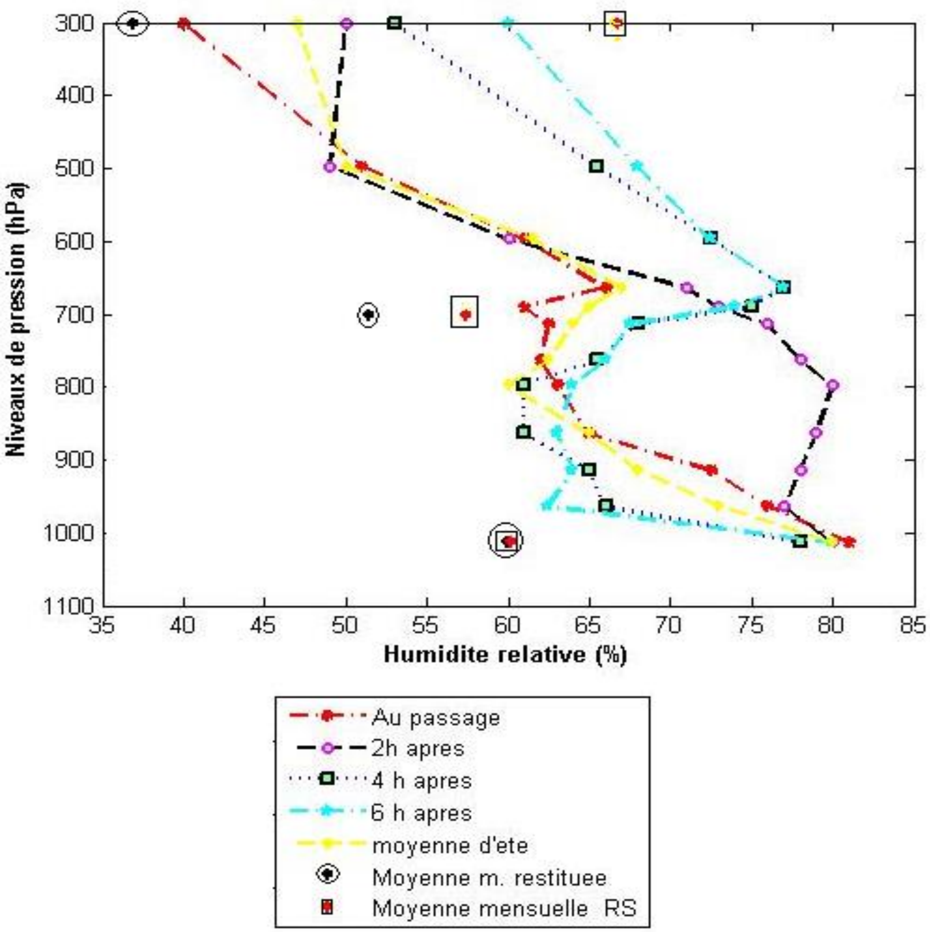
Table: the return of the specific humidity for the orbit 1413788 of September 30, 1997 obtained at 3:15 pm 11 seconds.

Levels (hPa)	Restitution	Rs network de 12 h	RS : monthly average sep 97	Summer average
1010	16.44	16.67	17.33	20.96
700	6.67	7.33	6.53	6.99
300	0.4	0.05	0.38	0.35

Table : the return of the specific humidity for the orbit 1413788 of September 20, 1997 obtained at 3:25 pm 46 seconds.

Levels (hPa)	Restitution	Rs network de 12 h	RS : monthly average sep 97	Summer average
1010	20.1	19.12	17.33	20.96
700	9.01	10.26	6.53	6.99
300	0.1	0.72	0.38	0.35

Tropospheric sounding using the neural network



the specific humidity is converted into relative humidity.

The profiles observed are the averages obtained from the radiosondages of Dakar over the period 1968 -2006.

The monthly average of radiosondes is that of September 1997.

The monthly average of the restitution is the average taken from the orbits of September 1997.

It can be seen that the monthly average of the restitution is close to the monthly average of the radiosoundings in low levels. For the 300 hPa level, the values are further away.

Third conclusion

The results obtained, on simulated data, for the inversion of the MSU data are on the whole very good. This technique (of the neural network) has also been applied to the problem of rapid modeling of radiative transfer and the composite analysis method shows a low minimization of the results, especially at the level of 300hPa. The method mainly emphasizes an ability to simulate channels probing the concentration of variable constituents such as atmospheric water vapor, which is a highly nonlinear problem and therefore poorly understood by the classical approach of linearization around an approximate solution.

Conclusion and Outlook

In the Sahelian West African zone, most of the population lives on agro-pastoral activities. There is a virtual absence of a tropospheric radiosonde station in this climatic region.

Digital simulation solutions of the Sahelian cloudy atmosphere and "satellite surveys are to be promoted.

The squall lines produce the essential precipitation in the Sahel.

This work enabled the validation of numerical prediction models on the one hand, and the validation of meteorological parameters derived from satellite surveyors on the other hand.

The climatological study of meteorological parameters has highlighted the interactions between S.L. and its environment.

A composite analysis followed by a statistical treatment was used to compare the dynamic fields calculated with the radiances measured.

The first studies we conducted on this theme were made with LOWTRAN.

MODTRAN provides an improvement over simple broadcasting. Compared to the results of calculations with this code, it is important to note that the radiance profiles obtained vary according to the position of the sounding according to whether one is in convective part (up to 2 hours after the detection of the SL) or stratiforme of the SL

Conclusion and Outlook

The spectral signatures of the atmosphere reveal a large difference in the structures obtained when comparing atmospheric diffusion fluxes for different time classes.

The radiative transfer codes that we used Modtran and modified MPM-Liebe allowed us to make comparisons with satellite observations.

We used a method of inversion of the equation of radiative transfer based on the technique of neural networks with backpropagation of the error.

The results obtained, on simulated data, for the inversion of the MSU data are on the whole very good.

Conclusion and Outlook

This technique has also been applied to the problem of modeling and rapid calculation of radiative transfer, and the composite analysis method shows a low minimization of results, especially at the level of 300 hPa.

The method emphasizes above all an ability to simulate channels sounding the concentration of variable constituents such as atmospheric water vapor, which is a highly nonlinear problem and therefore poorly understood by the classical approach of linearization around an approximate solution.

Conclusion and Outlook

With the comparisons made between the radiosonde measurements and the measurement data with the NOAA 14, we have opened a path towards the satellite tropospheric sounding in convective atmosphere in the Sahelian zone. The advent of sounders and the improvement of the fast calculations of the radiative transfer equation suggest an appreciable gain in the quality of the restitution (tropospheric sounding in the Sahelian zone).

"A Winner is only a Dreamer who hasn't given up" - Nelson Mandela

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