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Antarctic stratospheric ozone concentration oscillation and rainfall variability in Yaoundé

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Abstract :

Ozone parameters oscillation and climate changes were generally considered as environmental problems with nothing in common except their global consequences and the main role they will play. However, with the knowledge evolution, scientific community is taking conscience that important connections linked them. And these connections will have influences on the climate evolution in some regions of the world. So, this work wants to be an analysis of the climate evolution in Yaoundé in link with the Antarctic stratospheric ozone layer concentration oscillation. During this exercise, we have noticed that there is as much excess years than shortfall years in rainfall in Yaoundé. At the season scale, we observed a pluviometry's increase during the dry season which is accompany by a decrease of rainfall during the rainy season of the same year. In addition, to the distribution by two minimums characterizing the annual rainfall regime, we noticed cases of distribution from one to three minimums. These climatic anomalies present a correlation with the Antarctic stratospheric ozone concentration through various mechanisms. This was confirmed using the Tau-B de Kendall statistic test.

Keywords : pluviometry, Antarctic stratospheric ozone, correlation, Yaoundé.

Introduction

The weather behavior is continuously changing, streams are drying up, harvests are decreasing, forgotten diseases are reappearing, and the rhythm of seasons is changing. The question today is not if there is global warming or not, but what is its scale? This question interest all the regions of the world and particularly Africa which is the more affected and the more vulnerable region of the world by a present and future great climatic variability according to the experts of **GIEC (2007**) [1].

We regularly notice cases of flood, dryness episodes, and tropical cyclones with greater intensity, these cases have more catastrophic effects on tropical Africa and upper latitudes areas. The present study consist to find out if possible about a probable link between the rainfall variability in Yaoundé in tropical area suffering from an intense activity of ozonosphere and the accumulation of stratospheric ozone in the Antarctic pole.

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I. Methodology

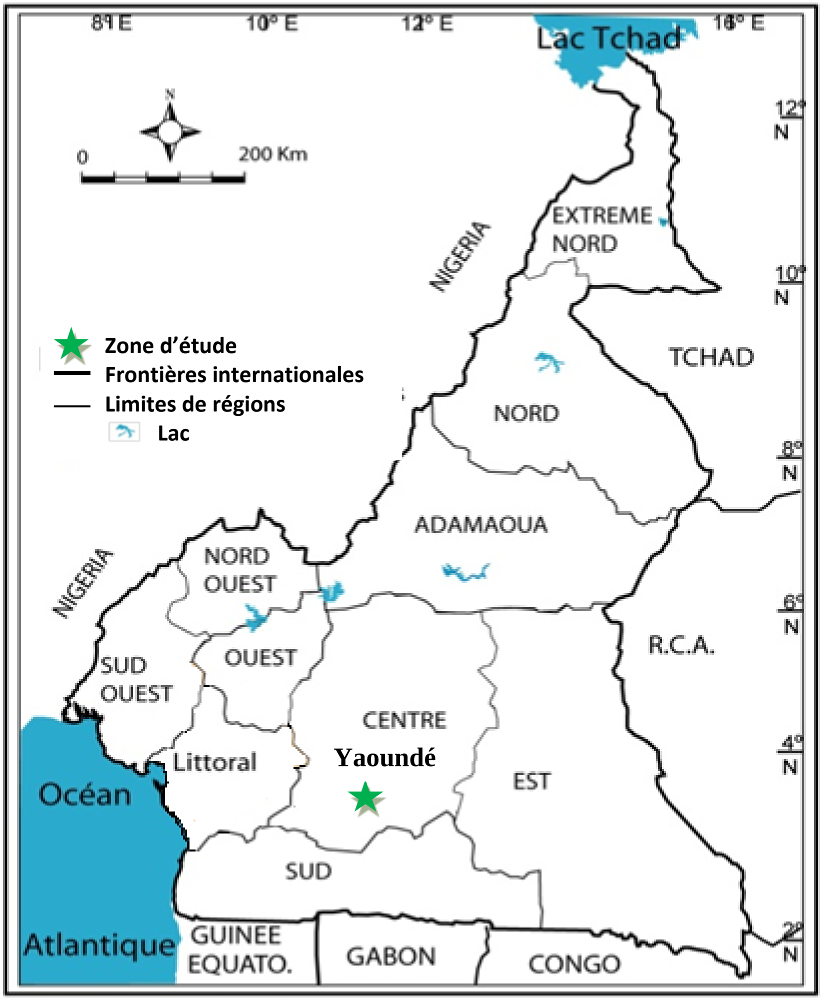
a)-Data

This exercise was elaborated from exploitation of temperature and rainfall daily data converted at a monthly and yearly scale from the Yaoundé meteorological station, available at the national meteorology direction of Cameroon. Some of these data was reanalyzed to provide important indicators. Information about the Antarctic stratospheric ozone was extracted from the document “science et vie” N° 257 [2].

b) Situation of the study area

Yaoundé, political capital of Cameroon and administrative centre of the Center Region of the country is situated between latitude 3°47 – 3°56 north and longitude 11°10-11°45 east (figure 1). Cameroon been situated above equator and at the bottom of the Guinea Gulf between latitudes 13°05 North on the Lake Chad, and 1°36 at the confluence of the Sangha and Ngoko, and between longitudes 8°33 East close to Cross River estuary, and 16°11 East on the Sangha (**Suchel, 1972**) [3].

This meeting point city is situated less than 300 km away from Atlantic Sea as the crow flies. Located on the South-Cameroonian plateau at an average altitude of 760 m, Yaoundé is a city of hills and valleys, a geographic configuration favorable to flooding. Yaoundé record in average 1600 mm/year of rain, divided in four seasons: November to March for the great dry season, March to June for the small rainy season, from June to August for the small dry season, and from August to November for the great rainy season. In the city, it rains in average 153 days/year. The mean annual temperature is estimated at 24.2°C and the annual range of temperature at 2.4°C (**Abossolo et al, 2015**) [4].



Source: MINATD, 2007

Figure 1 : Location of Yaoundé in Cameroon

c) Treatment

To put fluctuations in rainfall that marked Yaoundé in an obvious place, we have calculated the deviation from mean of our rainfall series long of 31 years (1980-2010), according to the following formula:

Deviation (E) = Pi – $\overline{P}$

where Pi= rainfall of a year i and $\overline{P}$= the normal

After, we have characterized the evolution of the pluviometry distribution calculating for each year the pluviometry proportion for the dry and the rainy season.

In addition, we also calculated the correlation coefficient between the pluviometry parameters of Yaoundé and those recorded in the stratospheric ozone with the goal to put in evidence possible relationship using the Tau-B of Kendall statistic test.

II. Comprehension, storage ; ozone role and links with climate changes*

Ozone (O_3) is an atmospheric gas present principally in the stratosphere between 10 and 50 km of altitude. Its role vis-à-vis living organism is sometimes beneficial and sometimes toxic. The impoverishment of ozone layer in the stratosphere modify radiation process in the atmosphere, provoking in this way an increase in the global warming (**Megie,**

1989) [5]. These changes induce a warming in the troposphere and a drop of temperature in the stratosphere. As the greenhouse effects gases are piling up in the atmosphere, they modify the temperature difference between the different parts of the world and diverse levels of the atmosphere. Atmospheric circulation regimes are in this way impaired, and we have good reasons to believe that these circulation changes can accentuate the variability of climatic parameters (rainfall, temperature, dampness…).

Stratosphere is the atmosphere layer that contains ozone, without which life on earth is almost impossible. Without this ozone, ultra-energetic rays (UV) produce by the sun will destroy any kind of DNA molecule including all life on earth. Some researchers demonstrate today that the black hole of ozone layer modify the atmospheric circulation from poles to equator, increasing the rise of rainfall in the subtropical and upper latitudes regions and on the contrary the drying up in the means latitudes. It is by with the conclusions from these reports that the signature of Montreal protocol in 1987 has regulated and forbidden the use of CFC (chlorofluorocarbon), which are noxious compound destructive for ozone and very used in many industries **(H:\Ozone Depletion Climate Change.pdf**) [6]. Therefore, the climate warming is today a confirmed fact and recognized not only by the scientific community, but also by the States. Also, the evolution of ozone layer and climate warming are connected by many links, particularly their effects on physical and chemical process in the atmosphere and the interactions between the atmosphere and the others components of world ecosystem.

III. Flux outline of air mass and climate in central Africa

Les limites de la migration du front intertropical (FIT) au Nord et au Sud de l’Afrique dépendent des périodes de l’année et du comportement climatique de l’année elle-même (figure 2). Grâce aux variations du front apparaît des types de climat précis tels que le climat équatorial avec ses subdivisions. Le parcours du front nous laisse observer des zones à deux saisons et d’autres à quatre saisons, avec des saisons qui changent partiellement d’une zone à l’autre (**Suchel, 1988)** [7].

The limits of the intertropical front migration in the north and the south of Africa depend on the year period and the climatic behavior of the year itself (figure 2). These variations of front make appear precise types of climate such as equatorial climate and its subdivisions. The front course let us observe areas with seasons from two to four with some changing partially from one area to another.

In addition, the monsoon and the harmattan variation dynamics explain the cimate originality in central Africa and, in particular its coastal climate where the Benguela upwelling conditions the intensity and humidity of the trade wind from southern Atlantic. On other way, the influence of the western Cameroon relief and the Fouta Djalon in Guinea-Conakry and, above all the Congo basin forested mass deeply fashion the seasonal movements. The western branch of intertropical front is then split in two according to its seasonal movement speed. The eastern part of the western branch (central Africa) move faster than the western part (West Africa). **Fontaine (1990)** [8] says that it is due to thermal inertia of Atlantic Ocean in comparison of the one of the Congo forested basin.

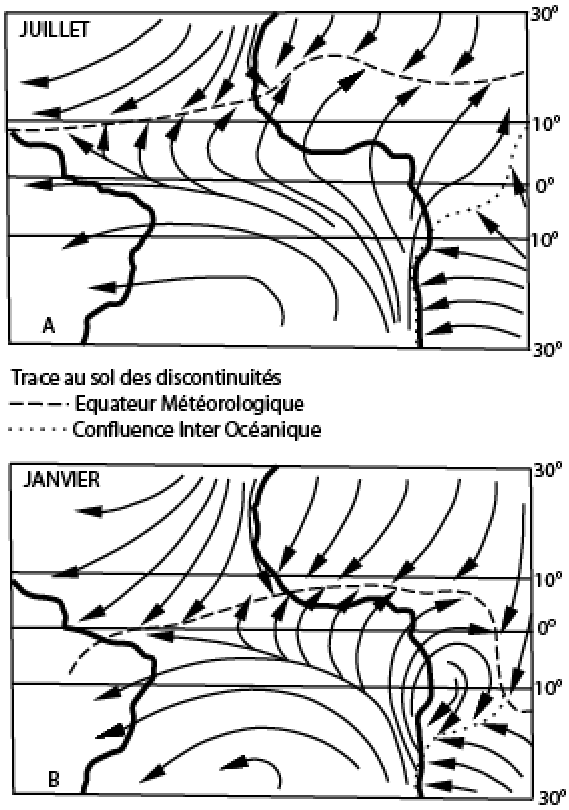


Figure 2: air mass flux in central and western Africa.

IV. Importance of the stratosphere in the general atmospheric circulation

Atmosphere is subdivided in nine major successive layers in accordance with the temperature distribution principle (figure 3). One of the main layers, stratosphere, is situated above the troposphere. At this level, temperature reach 100°C at it upper limit in reason of the absorption of the solar radiation by stratospheric ozone. The heat is store up by horizontal movements. In addition, the energy transfer in the stratosphere is happened by radiation, with weak vertical exchange. This absorption provoke gas escape in the heat form, which is going to provoke a rise in the temperature raising from the stratosphere superior underlayer in the intertropical region (**Johan Lorck, 2014)** [9]. This principal underlayer is starting point of jet streams where fast-flowing winds principally have two destinations function of the year: the eastern and the western direction. The winds' maximum speeds can reach 20-30 m/s. the regime of these winds usually alternate with period from 22 to 24 month, it is called stratosphere almost-biennial oscillation. The semiannual oscillation of these particular tropical winds in the tropical stratosphere reaches its maximum at the stratopause. In this principal underlayer, the winds movements are less important than in the troposphere. That why some scientists speak about the stratospheric stillness. The ongoing research carries out by the National Oceanic and Atmospheric Administration (NOAA) shows that the stratospheric steams singularly influence the speed of climate warming. So, the increase in the volume of seams will correspond to the acceleration of the greenhouse effect. On the other hand, the inverse of the volume will lead to a reduction of the speed.

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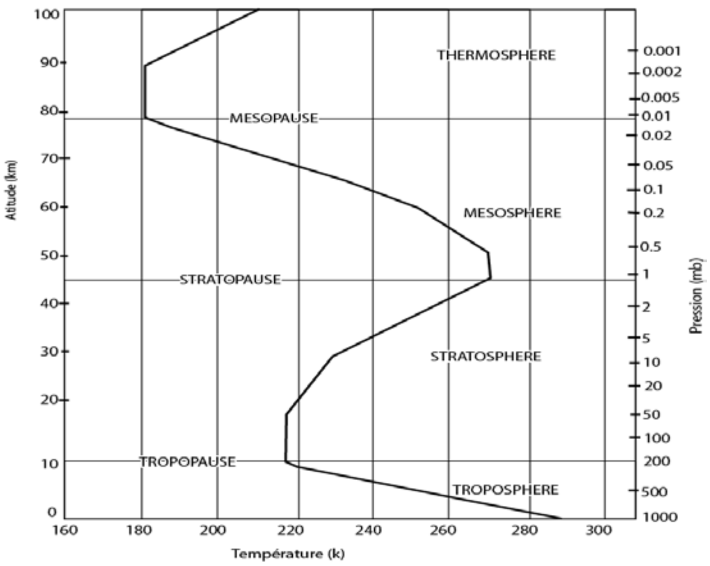

Figure 3 : distribution of earth atmosphere

When sending back a part of this great wavelength radiation on the Earth surface, these gases keep the heat in the bottom layer of the atmosphere and contribute to make hotter. It is because of this greenhouse effect that the mean temperature of the Earth is 33°C higher than it will bad been otherwise, and that the planet can support life. Being so warmed, the air of troposphere is generally hotter in the surface and become cooler with altitude. As hot air is denser than the cold one, it raises and the cold air moves toward the surface to replace it. This simple convective flow is modified by the Earth rotation, surface characteristics and temperature difference between equator and poles. The result is a turbulent atmosphere layer in which air circulates in a complex and varied manner, displacing energy and humidity from one place to another **(H:\Ozone Depletion Climate Change.pdf**) [6].

These ozone strong variations lead to corresponding changes of stratosphere temperature, which in turn induce modifications in the atmosphere pressure and circulation(**Veyring et al, 2010)** [10]**.** Recent informatics simulations done at the Goddard Institute for Space Studies of NASA have shown that changes in the stratospheric circulation can also have influence on the troposphere downward flux, where there can have an incidence on the pressure and circulation regimes. These changes can modify the jet stream position, which govern the meteorological systems trajectory in the troposphere, and that a light shift can considerably modify local climates (**H:\Ozone Depletion Climate Change.pdf**) [6]. This variation can in his turn have an influence the height of convection current in the troposphere, like those who accompany storms, and so probably on their intensity. It could also modify the jet streams position on the planet and so the displacement of meteorological systems (**H:\Ozone Depletion Climate Change.pdf) [**6].

The general circulation pattern will be modified following the terrestrial air expansion which, heated tend to rise toward atmosphere upper layer. Cold air masses converge toward atmosphere lower layers. A distribution of atmospheric flux is observed (figure 4). To this

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end, temperature differences appear between diverse points of Earth and diverse atmosphere regions creating displacements of air masses (currents and winds). From then on, appears low and high pressure areas **(Michou and al, 2011)** [11]. Then, equatorial areas receive more energy than polar areas (figure 5). There is therefore air masses exchange from equator toward poles and vice versa. The thermal contrast between poles and geographic equator is clearer during austral winter. It is close to 61°C in the northern hemisphere and 75 in the southern hemisphere and 27°C in the north and 29°C in the south during summer. These exchanges are modify in their movement by the presence of oceans that constitutes thermal accumulators and principal generators of clouds and others phenomena such as Earth rotation, and engender diverse and varied movements (**Tchernia, 1978**) [12].

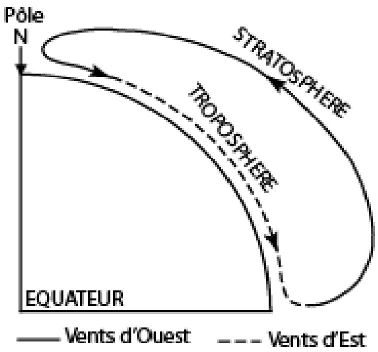

Figure 4: Hadley 1 Schema according to Dhonneur (1985): winds deviation des on the ground toward the west in the direction poles-equator due Coriolis force.

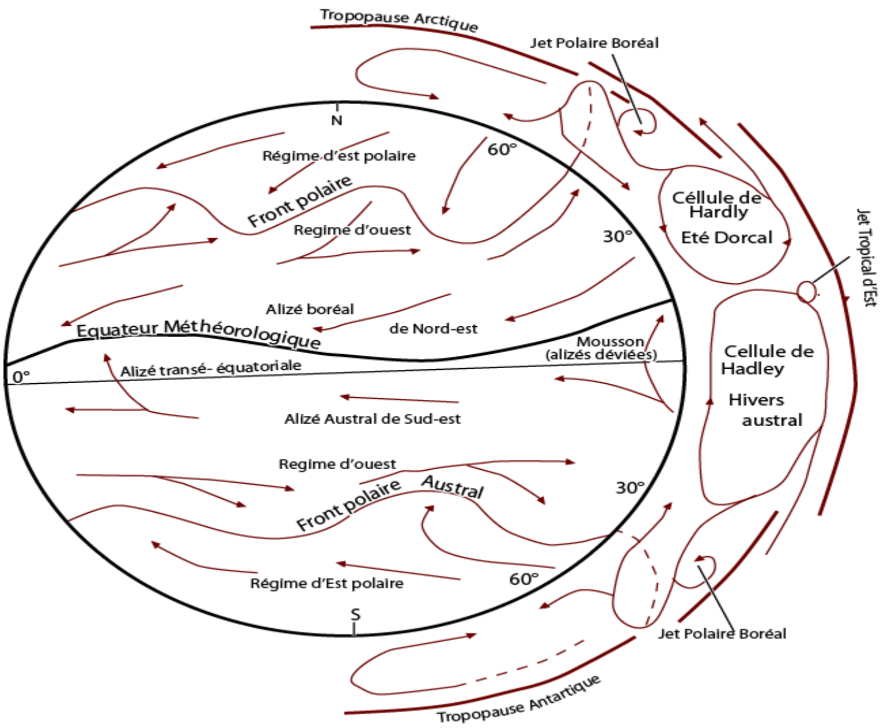

Figure 5 : Palmen Schema (1950) according to Dhonneur (1985)

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The ozone reduction is a distinct problem from the one of climate changes due to the increase of greenhouse effect gases. These two phenomena are frequently confused, but they differ by their causes and consequences. Indeed, climate changes are the consequences of the increase of greenhouse effect gases while the ozone reduction comes from the presence of chlorine, bromine and nitric species that are not in the first point greenhouse effect gases **(Galus, 2003**) [13]. The consequences of the first one concern change in the temperature on the surface, rainfall regime and the occurrence of extreme events. The second is the consequence of the increase in the sun ultraviolet flux at the ground level. It appears very difficult to mix up over the two phenomena.

However, the complexity of atmospheric interactions and the exchanges atmosphere-ocean is such that mutual influences are inevitable among many processes. The reduction of the Antarctic ozone concentration has affected the oceanic surface climate in the southern meteorological hemisphere. The surface winds changes on the high and medium latitudes of the southern meteorological hemisphere during austral summer, consequence of ozone black hole, have contribute to the warming observed in the Antarctic peninsula and the cooling of high plateau. The wind changes have also lead to regional rainfall changes, the increase of sea ice sheet around Antarctic and the warming of southern ocean. All these evolutions cannot be explained by the increase of greenhouse gas effect. But this situation would not persist beyond few decades by the fact of the closure observed these last years in the ozone and the increase of greenhouse effect gas.

V. Geographic position of Cameroon situated above the geographic equator and the influences of Antarctic stratospheric air masses

By it geographic position a bit above equator, the Coriolis principle and the Hadley 1 and 2 schemas submit Cameroon to the almost permanence of Antarctic air masses (figure 6). Antarctic plays a major role on the climate of the entire southern hemisphere up to the level of equator on which depends in great majority the climate of Yaoundé, due to its proximity. Stratospheric winds from East and West with speed around 20-30 m/s reach the entire Cameroon.

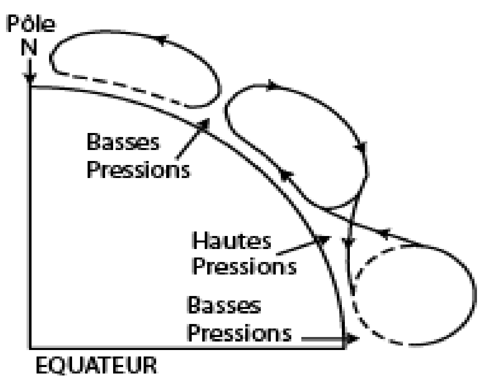

Figure 6: Hadley 2 schema – upward and downward areas giving rise to high and low pressure areas

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VII- Results and analysis

Climate evolution in Yaoundé-Cameroon from 1980 to 2010

Excepted from month of February that records the highest temperature (31.4°C) and the month of July the coolest (23°C), the monthly temperature remains constant in Yaoundé all over the year (figure 7a).

At the year scale, mean temperatures have increase in Yaoundé as shown in figure 7b. This increase is as valuable for the maxima temperature as the minima. The annual mean for the study period is 24.2°C, with maxima of 29.2°C and minima of 19.3°C. The increase observed is mostly due to the period 1993-2010 that record surplus of 1.7°C for maxima temperatures and 0.5°C for minima in comparison with the period 1972-91992.

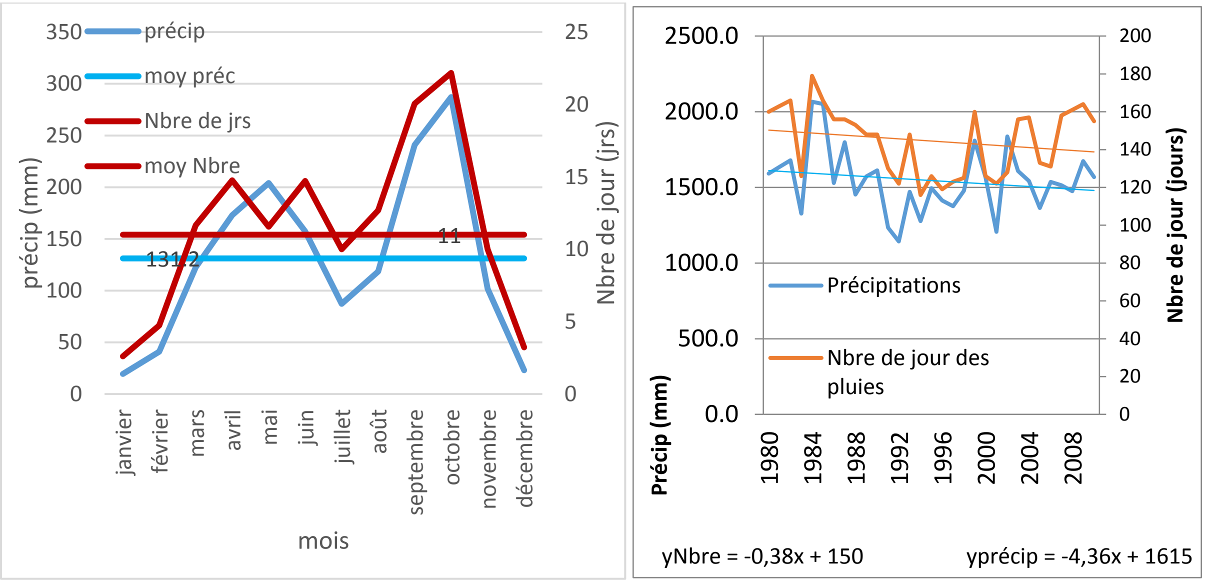

Figure 7: monthly mean evolution of pluviométry (a); annual rainfalls and number of days for annual rains (b) in Yaoundé.

Proportion of years per regime observed in Yaoundé from 1980 to 2010

It is a bimodal regime that dominate the pluviometry in Yaoundé (table 1), with a long dry season between the months of December and February and a short dry season in the month of July. For this regime, the long rainy season lasts four months from August to November while the short goes from March to June.

Table 1 : proportion of years per regime observed in Yaoundé from 1980 to 2010

Regimes	Monomodal	Bimodal	Trimodal	Total
Percentages	10%	82%	8%	100%
Years	05	41	04	50

Yaoundé receives in mean 1546 mm of rain per year spread over 147 days in mean per year. On the contrary to the two rainy seasons in reduction, the short dry season has increased

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during the study period (figure 8a). These results confirmed those obtained by **Abossolo et al** (2014) [4] that were noticing for the period 1945-2000 a regular increase of rainfall during the dry season while there were decreasing during the three others observed seasons.

Figure 8b shows that the part of the long dry season drops progressively while the short dry season is increasing during the same period. The annual mean is 84mm of rains during the long dry season and 85.6mm during the short dry season. At the same time, the part of the two rainy seasons is simultaneously declining.

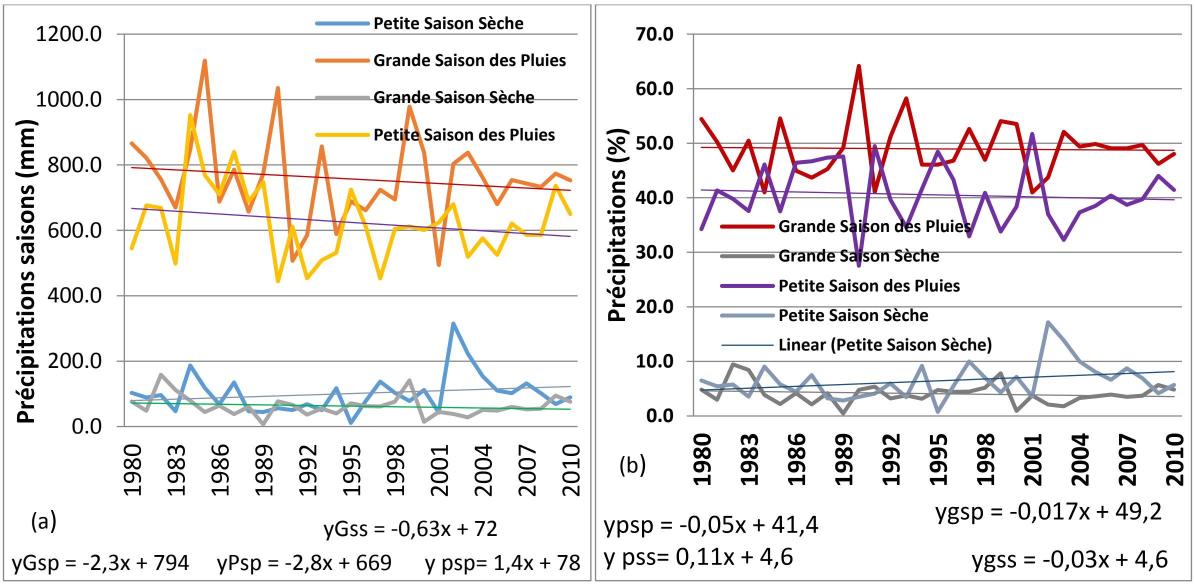

Figure 8: rainfall evolution (a) for each season observed and the part of rainfall for each season (b) in Yaoundé.

Tableau 2 : distribution of seasons in Yaoundé from 1980 to 2010

Saisons	Grande saison des pluies	Petite saison des pluies	Grande saison sèche	Petite saison sèche
Moyenne annuelle	747,4	661	84	85,6
Maximas	1120	953	170	315
Minimas	494	499	7	11

Figure 9 attests a progressive but contradictory rhythm between rainfalls during the long dry and short rainy seasons in Yaoundé and the recorded Antarctic stratospheric ozone concentration. The difference between the trends shows that the ozone increase quickly while the rainfalls quantities decrease on the two observed seasons.

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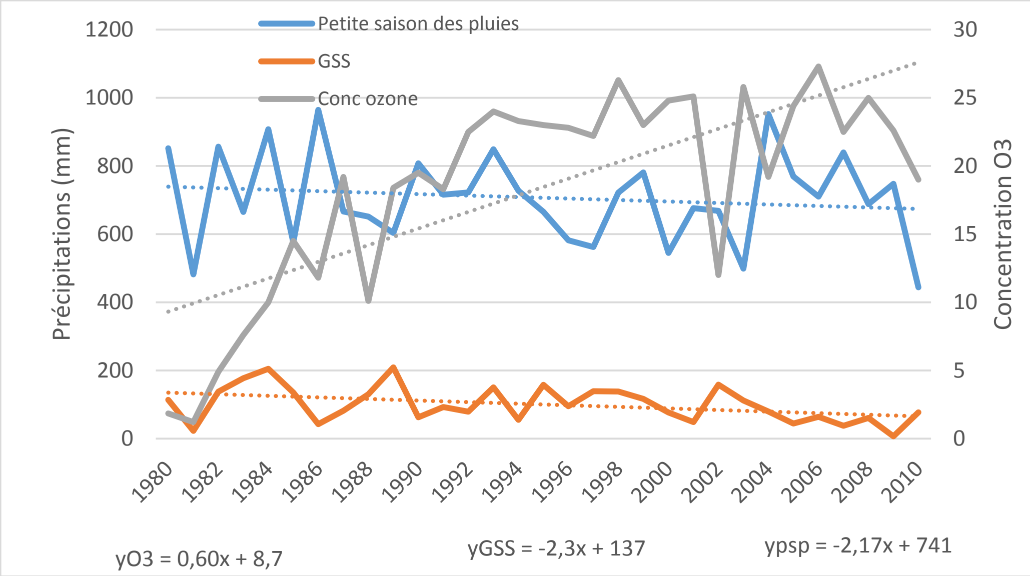

Figure 9: evolution Curves of rainfalls quantities during the long dry and the short rainy seasons in Yaoundé and Antarctic stratospheric ozone concentration from 1980 to 2010.

Correlation between climatic elements and Antarctic stratospheric ozone concentration from 1980 to 2010

The Barakat method (table 3, 4, 5, 6, 7) permits us to identify the years of rainfall risks during two identified seasons. This method shows that Yaoundé record as many shortfall years as excess years during the period 1980 to 2010.

Table 3: Rainfall constancy during the long dry season in Yaoundé from 1980 to 2010 (Barakat Methode)

Form	classes	Estimation	Year	Total
Excess years	Pi > pm+e	Pi > 94,8	1982, 1983, 1999	03
Normal years	Pm-e<Pi<pm+e	30,4<pi<94,8	1980, 1981, 1984, 1985, 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, 2010	25
Shortfall years	Pi<pm-e	Pi < 30,4	1989, 2000, 2003	03

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Tableau 4: Rainfall constancy during the short rainy season in Yaoundé from 1980 to 2010 (Barakat Methode)

Forme	classes	Estimation	Year	Total
Excess years	Pi > pm+e	Pi > 111,9	1982, 1983, 1999, 2009	04
Normal years	Pm-e<Pi<pm+e	50,3<pi<111,9	1980, 1984, 1985, 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2010	24
Shortfall years	Pi<pm-e	Pi < 50,3	1981, 1989, 2000	03

Tableau 5 : Antarctic stratospheric ozone concentration deficit from 1980 to 2010 according to the Barakat method deficit

Form	classe	Estimation	Year	Total
Excess years	Pi > pm+e	Pi >25,87	1998, 2006	02
Normal years	Pm-e<Pi<pm+e	1344<pi<1747	1985, 1986, 1987, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2007, 2008, 2009, 2010	23
Shortfall years	Pi<pm-e	Pi <11,03	1980, 1981, 1982, 1983, 1984,1988	06

Tableau 6: Rainfall during the long dry season and antarctic stratospheric ozone concentration from 1980 to 2010 (Barakat method)

Ozone (O_3) / rainfalls	Below the normal (IN= e-p)	Normal (N)	Above the normal (SN= e+p)	Total
Below the normal (IN= e-p)	100%			100%
Normal	10,71%	82,14%	7,14%	100%
Above the normal (SN= e+p)	100%			100%

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Tableau 7: rainfalls during the short rainy season and antarctic stratospheric ozone concentration from 1980 to 2010 (Barakat method)

Ozone (O_3) / Rainfalls	Below the normal (IN= e-p)	Normal (N)	Above the normal (SN= e+p)	Total
Below the normal (IN= e-p)	50%	50%		100%
Normal	12,5%	79,16%	8,33%	100%
Above the normal (SN= e+p)	33,33%	66,66%		100%

Making a difference for the short rainy season and long dry season (table 8), it brings out significant and positives differences for the simultaneous shortfall years, i.e. 50% simultaneous shortfall. Positives differences are also identified for the cases of simultaneous excess and shortfall years, and vice versa. These observed differences demonstrate the significant impact of Antarctic stratospheric ozone on the long dry season in comparison to the short rainy season in Yaoundé during the study period.

Tableau 8: Differential between the long dry season and the short rainy season

Differential (PSP-GSS)	Below the normal (IN= e-p)	Normal	Above the normale (SN= e+p)
Below the normal (IN= e-p)	50%	50%	0
Normale	-1,9%	2,98%	-1,19
Above the normale (IN= e-p)	66,67%	-66,66	0

(PSP= the short rainy season; GSP= long dry season)

The evolution of cumulative curves (figure 10) shows that rainfalls on the two studied seasons evolve at an almost synchronic rhythm but, in the opposite way to the one of Antarctic stratospheric ozone concentration. In a general way, it comes out from this assessment that apart from the period 1995 to 2002 that know an exceptional evolution, when the Antarctic stratospheric ozone concentration is reducing, quantities of rainfalls are in relative increase in Yaoundé.

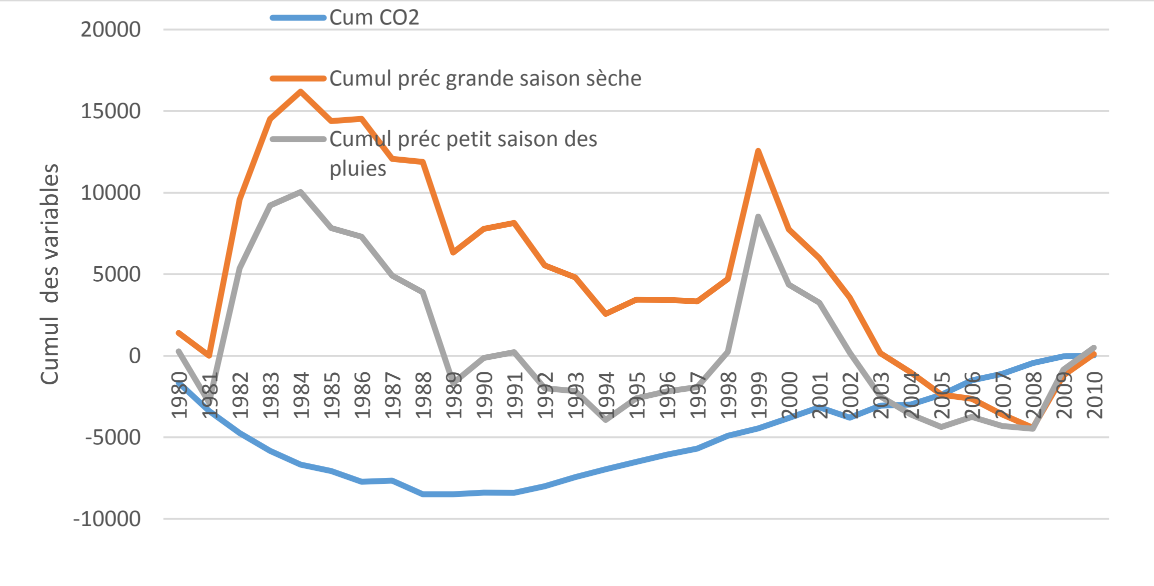

Figure 10: cumulative curve of rainfalls quantities in Yaoundé and Antarctic stratospheric ozone concentration from 1980 to 2010.

The non parametric test of Tau-B of Kendall evaluates the independence degree of the ozone on the rainfalls quantities recorded during a year. It evaluates the temporal or spatial variability similarity degree of two data series. The null hypothesis of Pearson test is a null correlation coefficient, β=0. This hypothesis is accepted if the p-value of the test is above the threshold of 5%. It comes out from this test a positive correlation coefficient i.e. an implication of 0.15% between the ozone concentration and the temperature in Yaoundé (table 9).in addition, the same test shows that ozone concentration has more influence during the long dry season, i.e. with a determination coefficient of 16% (table 10).

Table 10 : Tau-b kendall statistic Test from 1980 to 2010

		Grande sais sèche	Pte saison des pluies	Pte saison sèche	Grde saison des pluies	Concentration ozone
Grande sais sèche	Corrélation de Pearson	1,000				
	Sig. (bilatérale)	,				
Pte saison des pluies	Corrélation de Pearson	-0,026	1,000			
	Sig. (bilatérale)	0,888	,			
Pte saison sèche	Corrélation de Pearson	0,060	0,193	1,000		
	Sig. (bilatérale)	0,749	0,297	,		
Grande saison des pluies	Corrélation de Pearson	0,116	0,170	0,144	1,000	

	Sig. (bilatérale)	0,534	0,362	0,441	,	
Concentration ozone	Corrélation de Pearson	-0,427	-0,078	0,123	-0,239	1,000
	Sig. (bilatérale)	0,017	0,678	0,508	0,195	,
	N	31	31	31	31	31

** La corrélation est significative au niveau .01 (bilatéral).

Table 10: Antarctic stratospheric ozone concentration implication degree on climatic variables in Yaoundé from 1980 to 2010

Variables Rxr = r^2 (%)	Ozone
rainfalls in long dry season	18%
rainfalls in short rainy season	0,6%

VI. Discussion

L'**OMM** [15] demonstrates that the ozone impoverishment provoke a negative radiation forcing on climate in 2011, that is an indirect effect of cooling. It is probable that the modification of ozone concentration is responsible, in mean at the globe scale, of radiation forcing of about -0.15 ± 0.10 W m^{-2}. Numerous works on the ozone hole and the jet streams migrations reveal that it impacts on global climate. Works of **Lane E. Wallace (2008)** [14] have show the modification of these currents sometimes lead to a modification of convection areas in the tropics and the global climate. These observations attest the tight link that exist atmospheric circulation and the rainfall rhythm in the equator. The work of the world meteorology organization (**OMM, 2011**) [15] demonstrates the hole in the ozone layer is an annual phenomenon that occur in winter and spring due to extreme cold temperatures that reign in the stratosphere , and the presence of noxious substances for ozone.

Meteorologists of the Pennsylvania State University emitted the hypothesis according to which if the black hole continues to close itself, the jet stream will redirect toward the North, excepted if the greenhouse effects gases have a greater influence than the ozone supply. This observation pushes **Markus Rex et al (2012)** [16] to establish the proportion of elements that enter in the ozone layer formation and to demonstrate that the level of chlorine were higher than the “normal” in areas more affected by the ozone disappearance. According to **Markus Rex and al (2012)** [16], the almost permanent presence of hydroxyl in the atmosphere, which is the molecule that ensure the elimination of atmospheric pollution before reaching the stratosphere. According to this author, the hole in the hydroxyl shield amplifies the ozone layer destruction, and the worst is that it impacts on the earth climate. Similar studies done in the arctic by **INSI (2011**) [17] demonstrate that the conditions are not yet met to observe an important reduction of ozone, since the winter temperatures are higher than in the southern pole.

Research on ozone dynamic remain fragmented in Africa and deserve to be explored. Few works have been realized in austral Africa where it is establish that the ozone layer impoverishment could be one of the quick and abrupt temperature changes. It is demonstrate that during austral spring, the ozone hole above Antarctic is maximal and, provoke cooling in the stratosphere which in turn engenders changes in the winds dynamics that displace the atmospheric center of actions.

Conclusion

The ozone layer protects the earth against ultraviolet rays from sun without which life is almost impossible. It is responsible of the atmospheric streams, notably jet streams in the southern hemisphere during dry seasons in the case of tropical zone, it sometimes lead to the modification of rains regime. The geographical position of Cameroon just above the equator, by the Coriolis principle is permanently submitted to the influence of Antarctic air masses that play a capital role on the equator climate and even the one of the entire southern hemisphere. This is only possible because of the regular displacement of stratospheric air masses which speeds are between 20 and 30 m/s with the direction East and West. These important air masses added to the regular displacement of intertropical front reach Yaoundé and its area, provoking a deep variability of local climate sometimes accompanied by a disturbance of traditional rainy regimes. Positives differences are also identified for the cases of simultaneous excesses and shortfall years, and vice versa. These observed differences show the primacy of the impact of Antarctic stratospheric ozone on the long dry season in comparison to the short rainy season in Yaoundé during the study period.

The study based on the climate variability in Yaoundé in rapport with the anomaly of the stratospheric ozone is a contribution, although modest, to the comprehension of global climatic phenomena and, that affect local climates. This analysis try, although fragmented open the way of an exploration that, to be more precise, should take in consideration a set of associated factors in a more complex system.

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