World Wide Journal of Multidisciplinary Research and Development

WWJMRD 2016; 2(1): 75-81
www.wwjmrd.com
e-ISSN: 2454-6615

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Spatial inconsistency of the Azores space centre

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Abstract
The Azores play an important role in the general atmospheric circulation, from which the name action centres usually given to it. In Europe during winter and spring, but sometimes in summer also, it moves towards the Iberian Peninsula. These movements cause the depression to move more to the north in summer and bringing sunny weather in England and Central Europe. Several methods are used to elucidate the mechanism of mesoclimates and macroclimates linked to the movement of the Azores. This is the case of the vangeguema method which allows for the study of atmospheric movements that permits for a better fight against major climatic calamities by improving on forecast and elaboration of prevention. Results show that in Africa, the Azores direct sea breezes on the western Atlantic coast and are partly responsible for aridity in the Western Sahara and the summer dryness of the Mediterranean basin. Data analysed over the period from 1973 to 1994 show the existence of monthly as well as annual fluctuations and perturbations. This brings significant structural modifications in the climatic system and even in the seasonal distribution of the amount of rainfall that goes beyond the Atlantic Ocean.

Keywords: Evolution , climate, anticyclone , Azores, latitude, longitude

1. Introduction

The dynamics of the meteorological phenomenon are their instability characterises the state of the atmosphere at different time scales (temperature, wind speed, atmospheric pressure, humidity, etc…). As such, the analysis of the Azores leads to precision on the behavior of climatic indicators in certain regions of the globe. For this reason, the North Atlantic oscillation of through the Azores plays a fundamental role on climate notably in Europe, Africa , etc. (Queney P, 1974) [1]. Comparative studies have been carried out over different periods in the framework of programmes (PNEDC, PREDICAT,…), international meteorological centres (Moscow, Washington, Melbourne, etc.). Data used was acquired from monthly estimates derived from daily observations of the coordinates of Azores centres fom 1873 to 1994. A circumscribed analysis of some work carried out on Azores (from 1973 to 1994) shows the existence of fluctuations and perturbations at a monthly (Amougou Joseph, 1997) [2] as well as annul (Abossolo Samuel, 1997) [3] scales. This leads to profound structural modifications of the climatic systems and even in the seasonal distribution of rainfall beyond the Atlantic Ocean. Due to this, the Azores constitute a principal element in the understanding of the evolution of local and regional climates.

Methodology

Data treatment using the cumulus and the three equi-grading methods resulted in diverse graphs and corresponding tables. This study will show the annual correlation between the latitude and the longitude of the Azores. It will equally show the changes induced in space as a result of the different annual spatial mutations that occurred between 1873 and 1994.

Results

The Azores, an inherent element of the North-Atlantic Oscillation

The Azores are found in the high pressure subtropical zone that extends from longitude 15° to longitude 50° in the Northern hemisphere thus traversing into the temperate zone (figure 3). This high pressure zone plays a determinant role in the stabilization of tropical climates. This distribution is caused by the presence of dry and sinking air that permanently affects regions it crosses over (Sahara region) or seasonally based on the apparent position of the sun- height of the sun (Kazakhstan region) (Christophe C et al., 2003) [4].

The Azores is one of the measurement elements of the climatic character and thermal data (Alain Godard et al, 2002) [5]. Due to its intensity, its mode of variability and its interdependence at a large and short time scale, and surface, it counters the Iceland depression figures 4 and 5). These two elements give a true orientation of climate and make it possible to create atmospheric models in some regions of Europe, Africa and America, in the case where the major physical units of the earth differ in climate and its classification generally giving for major climatic zones (Anthes R et al, 1978) [6].

Concept of the North-Atlantic Oscillation

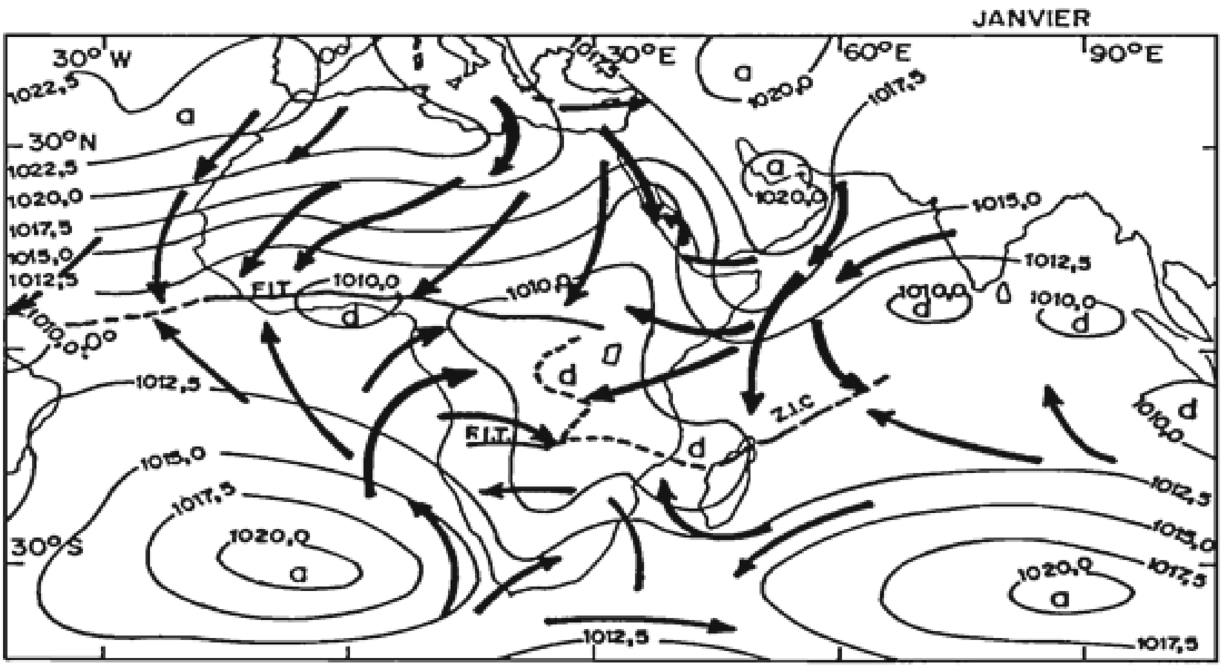
The North-Atlantic Oscillation is a semi-closed system of the distribution of air masses between Arctic or subarctic regions and the tropical or subtropical regions of the Atlantic Ocean in the northern hemisphere (Louis Raynaud, 2003) [7]. Beyond, rotation movements and revolution of the planet bring about modifications in the movement none channeled fluids: Ocean and atmospheric currents. This oscillation is also caused by increase in intensity, contrast between low pressure of the Iceland and high pressure of the Azores (Laurent T, 2003) [8]. The preponderance of continental surface over oceanic surfaces in the mid and high latitudes of the northern hemisphere equally influences these major climatic units. Climatic zoning in this region is characterized by several elements such as the intensities, the coordinates and other characteristics of the Iceland depression and the Azores (Landsea Chris, 2009) [9]. This correlation is mostly shown by link between intensity and the extension of North-Atlantic depression and the Azores generally associated to other activities of the atmosphere and the oceans (Rognon P, 1939) [10].

The annual position of the North-Atlantic anticyclone

The position of the Azores, an element of the North-Atlantic oscillation is determined from the coordinates of the centre anticyclone, convergent and divergent point of different forces (Seifert, 1989) [11]. The geographic structure of the anticyclone is generally made up of a pole, sometimes two poles of the core moving towards several directions: s-w, n-w, s-e, n-e, e, w, s, n. The geographic position of the centre of the anticyclone is expressed by two elements: the longitude and the latitude (Folland Ck. Et al, 1990) [12]. Its temporal and spatial evolution is shown by different curves (figure 1), which bring out its high variability between longitude 20° to 50° and latitude 10° to 40°. This variability includes all characteristics of the average state, and constitutes the structural position of the centre of the anticyclone, mobilizing all its components in their chronological succession (Denis L et al, 1999) [13]. It will be important to significant tendencies through graphical representations. The resulting curves 6 and 7 make it possible to identify a major alternation (positive and negative) from decades to centuries in the latitudes and the longitudes.

Sketching of the concept

Table 2 (figure 1) shows that the centre of the Azores generally moves towards two directions: the East-South-East direction (a) and the West-Nort-West direction (b). When movement is towards direction (a), values of the latitude remain very high (higher than normal) and values of the longitude become small (inferior to the normal). Contrarily, when it is towards direction (b), the phenomenon evolves away from the geographical coordinates but some other modes of orientation are however identified. These ones are either due to the phenomenon of blockage, phenomenon of multiple anticyclone centres or phenomenon of the ridge system that play important roles.



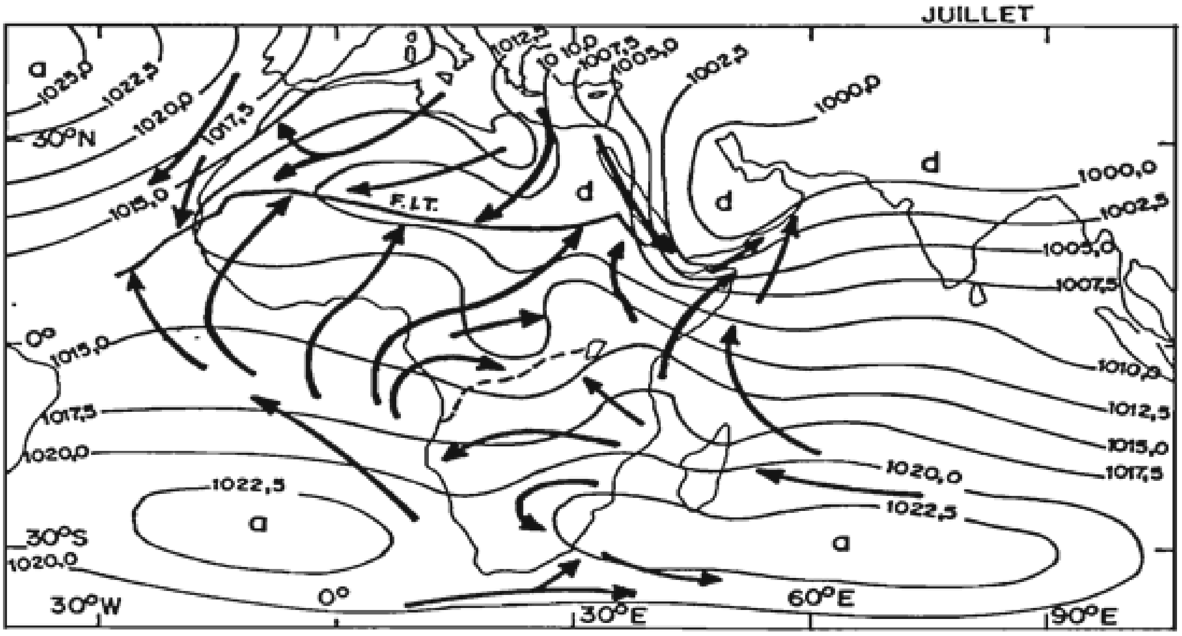


Fig 1: Climate dynamics: circulation of the lower layers (ASECNA, 2010)

Table 1 : Combination between latitude and longitude data from the Azores centre (the three equi-grading method)

	latitude				
longitude	long\latitude	High	Normal	Low	Total
	High	1	7	22	30
	Normal	10	11	24	45
	Low	27	13	7	47
	Total	38	31	53	122

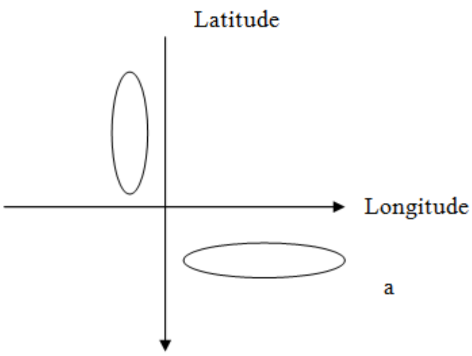


Fig 1: Principal orientation of the Azores

Evolution of the anticyclones between longitudes and Latitudes

Generally between 1973 and 1993, the longitude progressed in the opposite direction to the latitude (figure 2). The trend equations show that the gradient of the longitude is positive while that of the latitude is negative. This divergence is the consequence of breakages between 1930 and 1935 for the two variables.

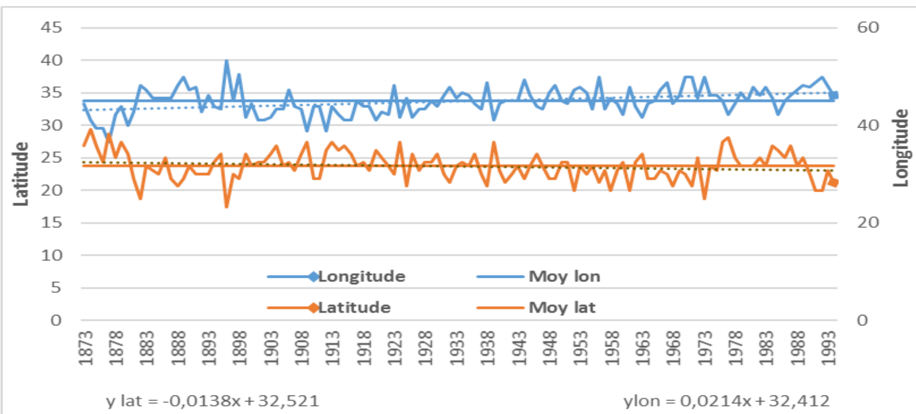


Fig 2: Movement of the geographic position of the Azores from 1873 to 1994

Figure 3 bellow shows in (a) breakage in longitude and in (b) breakage in latitude. Although not quite different, the period of breakage for the latitude is from 1933, while that for the longitude is observed as from 1935. The graph shows that the two variables progressed in opposing directions before and after each breakage, while the longitude progressed in an increasing direction, the latitude progressed in a decreasing direction.

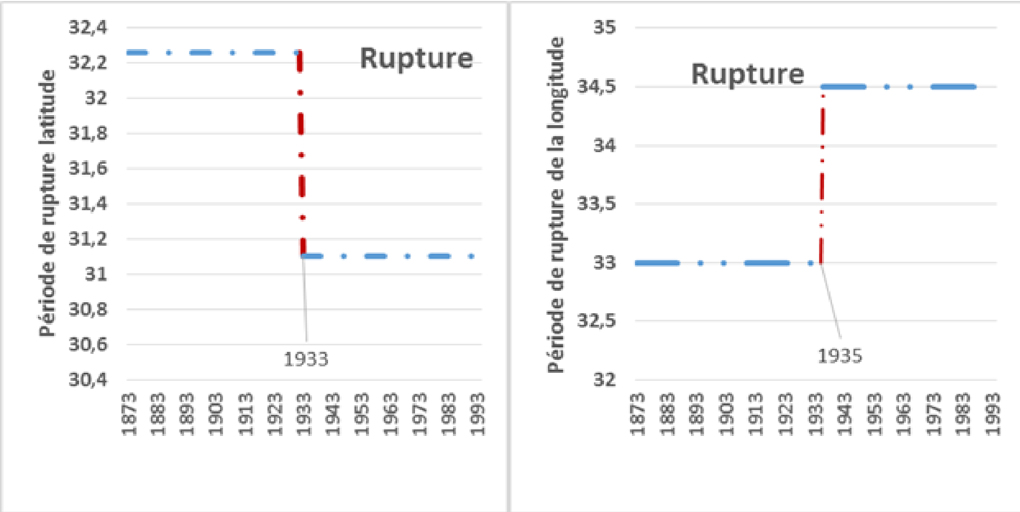


Fig 3: Appearance of rupture in the geographic position of the Azores between 1973 and 1994

Applying the Barakat principle (table 3) on the 122 years of study, more years of surplus (8) than those of deficiency (5) were recorded. Table 3 on the contrary shows a predominance of deficiency year (16) over years of surplus (11).

Table 2: Surplus longitude of the Azores from 1987 to 1994 (Barakat method)

Form	class	Estimation	Years	Total
Surplus years	Pi > pm+e	Pi >36,74	1889,1896, 1898, 1944, 1970, 1971, 1973, 1992	08
Normal years	Pm-e<Pi<pm+e	30,7<pi<36,74	1873, 1874, 1878, 1879, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1989, 1890, 1891, 1892, 1893, 1894, 1895, 1897, 1899, 1900,1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1010, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1972, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1993, 1994	109
Deficiency year	Pi<pm-e	Pi <30,7	1875, 1876, 1877, 1880, 1909	05

Table 3: Deficiency Latitude of the Azores from 1980 to 2010 (Barakat method)

Form	class	Estimation	Years	Total
Surplus years	Pi > pm+e	Pi >34,69	1873, 1874, 1875, 1879, 1904, 1912, 1913, 1914, 1915, 1924, 1977	11
Normal years	Pm-e<Pi<pm+e	28,65 <pi<34,69	1876, 1877, 1878, 1880, 1881, 1884, 1885, 1886, 1887, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1905, 1906, 1907, 1908, 1909, 1010, 1911, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1926, 1927, 1928, 1929, 1930, 1931, 1933, 1934, 1935, 1936, 1937, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1957, 1959, 1960, 1962, 1963, 1964, 1965, 1966, 1967, 1969, 1970, 1972, 1974, 1975, 1976, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1993	95
Deficiency year	Pi<pm-e	Pi <28,65	1882, 1883, 1888, 1896, 1925, 1932, 1938, 1956, 1958, 1961, 1968, 1971, 1973, 1991, 1992, 1994	16

It is shown from the Barakat principle (table 4) that the only case where the longitude is lower than normal while the latitude is higher than normal represents 20%. The second significant case is when the longitude is above normal while the latitude is below normal representing 15.38%.

Table 4: Constance in the annual latitude of the Azores from 1980 to 2010 (Barakat method)

Longitude / Latitude	Below normal (IN= e-p)	Normal (N)	Above normal (SN= e+p)	Total
Below nromal (IN= e-p)	0%	84,61%	15,38%	26
Normal	2,22%	97,77%	0%	90
Above normal (SN= e+p)	20%	80%	0%	5

Decennial position of the geographic position of the Azores

In the decennial scale, apart from the 9th decade, which simultaneously represents the two variables next to each other (figure 4) the other decades record a longitude always progressing in an opposing direction to the latitude.

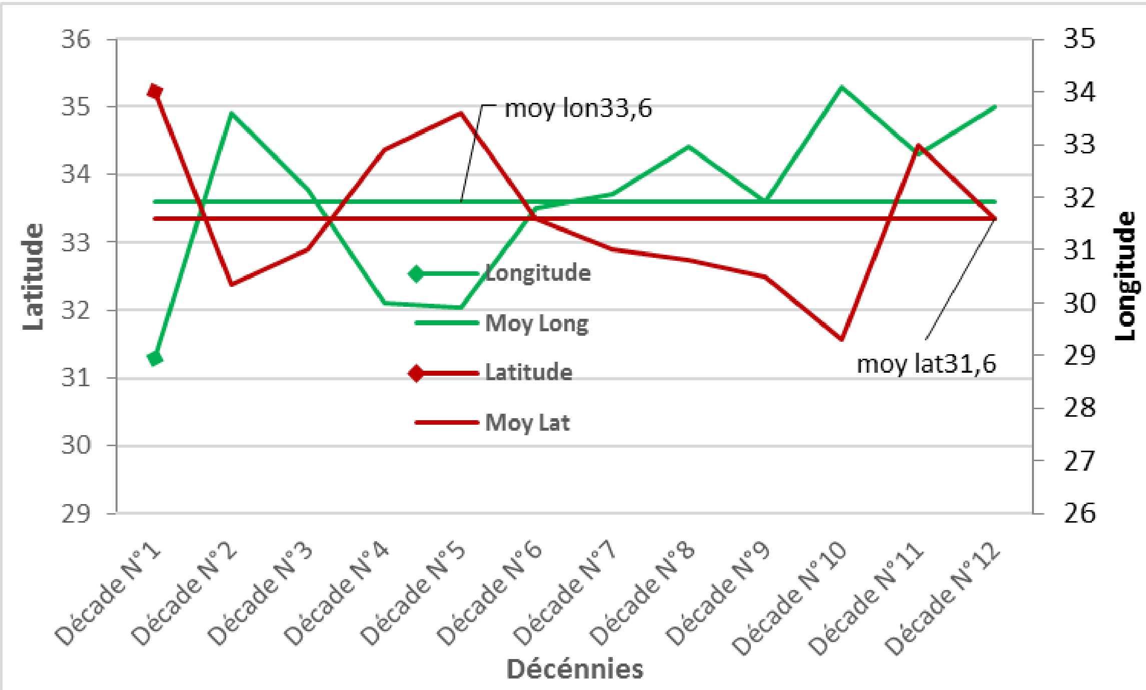


Fig 4: The decennial position of the Azores from 1973 to 1994

Annual variation in the geographic position of the Azores from 1973 to 1994

The identification of the annual variability of the Azores is done through analysis annual data from the latitude and the longitude. The annual cumulation of geographic positions (figure 5) opposing positions at times, at times position next to longitude and latitude, which move between longitude 45° Nord and latitude 45° West. This dynamics that seems to be cyclical experiences a period of breakage and decline characterized by the existence of three well defined cycles:

- First cycle between 1973 and 1900 ;
- Second cycle from 1901 to 1976
- Third cycle from 1977 to 1994.

All along these cycles, there appears an actual repeat between the latitude and the longitude during the first and the second cycles. In the third cycle from 1977 to 1987, the two variables progress along each other.

On the positive phase, the latitude shows predominance of forms that are opposing to the longitude, 49 of 57 cases are recorded. The 8 other cases correspond to a period of variability induced by a movement of the anticyclone centre to the Southeast. At this point the transfer of oceanic air masses from the North towards the tropics intensifies anomalies in African regions with strong trade winds making the harmattan to be very active. From hence, the inter-tropical front (I.T.F) is blocked in itd progression to the North, a phenomenon certainly linked to the South Atlantic anticyclone. These different winds are really constant and are significantly regular on the surface of the earth's planet.

On the negative phase of the latitude, their impacts are opposing on the whole, the transfer is not very fast and the progress of the anticyclone is well distinct and moves towards the North. However, there exist some minor modifications in the position of the centre of the anticyclone. This can be explained either by an increase in temperature on the ground, that of the air and the ocean or still by an increase in carbon dioxide in the atmosphere.

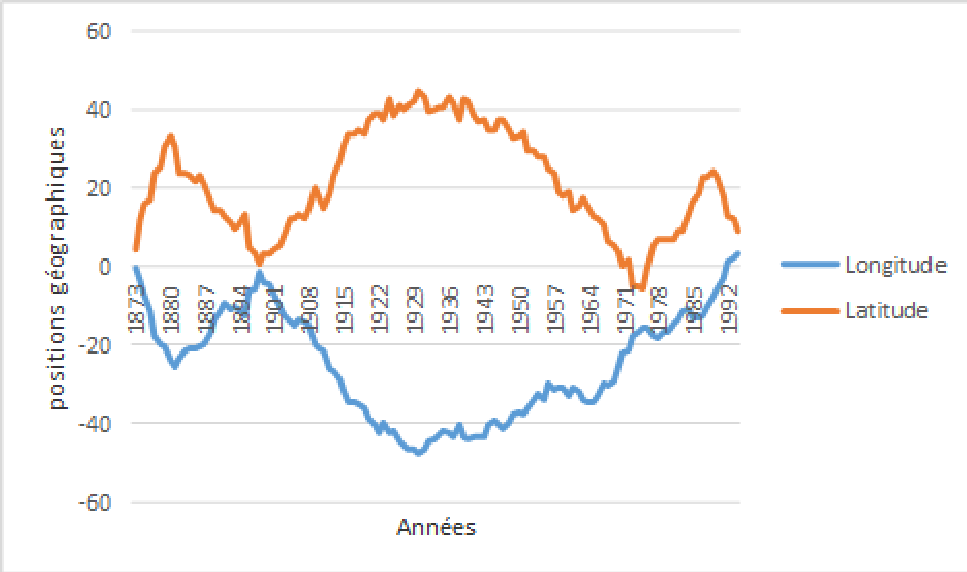


Fig 5: Dynamics of the annual geographic position of the Azores from 1873 to 1994

The average characteristics of the Azores vary between 37°72' for the longitude and 31°67' for the latitude (table 4). Over the 122 years observed, the longitude recorded its minimum value in 1877, being 27°54' while its maximum value was registered in 1898 corresponding to 37°91'. The latitude instead registered its maximum value of 39°17' in 1898 and its minimum value of 23°33' in 1896.

Table 4: Characteristics of the Azores

	Nbre of years	Minimum	Maximum	Average	Standard deviation
Longitude	122	27,50	37,91	33,72	3,02
Latitude	122	23,33	39,17	31,6735	2,9604

The Spearman confirmation test (table 5) indicates a correlation of 9.936. This is a good test confirming that there exist a dynamic links between the geographic position of latitudes and of the longitudes of the Azores in the Atlantic Ocean. This correlation indicates that the geographic position of the two variables respond to the same cause-effect principles, since the movements of one leads to the positioning of the other.

Table 5: Spearman correlation test

		Longitude	Latitude
Longitude	Spearman correlation	1,000	
	Sig. (bilateral)		
	N	122	122
Latitude	Spearman correlation	0,007	1,000
	Sig. (bilateral)	0,936	0,0
	N	122	122

Causes of the spatial variations of the centre of the Azores

The interaction Atlantic Ocean and atmosphere is one of the principal causes of monthly and annual dynamics of the Azores. The regular movement of the anticyclone results from the reinforcement of the Western winds that provokes the cooling of the oceans and the warming of the continents. A thermal contrast is created between the ocean and the continent during the negative anomaly phase of the longitude. On the other hand, during the positive anomaly phase of the longitude at the tropics, the intensity of the trade winds caused by reinforcement of the intensity of the Azores leads to the cooling of the continents and acceleration of evaporation from the surface of the North Atlantic Ocean. The thermal contrast between the ocean and the continent then reduces. Studies on Azores have shown that in Europe when the intensity at its centre is very high in winter, the storm line extends to the northern part of Europe corresponding to a climate that is at the same time mild and humid and in the south the weather is generally dry and cold. Still in winter, an inverse phenomenon is produced when the pressure of this anticyclone weakens, the storm line moves to southern Europe and is accompanied by abundant rainfall.

Different studies seem to indicate that some modifications in the inter-annual and monthly fluctuations in the position of the centre of the Azores result from a combination with other centres of action. To that is added the impact of other physical and astronomical phenomena.

Discussion

High pressure atmospheric zones are most often characterised by an isobar system having maximum pressure in the centre, generally at more than 1013hPa on the land. The rotation direction is linked to the Coriolis force, in the case of the Azores which is a dynamic

anticyclone that moves clockwise, thus showing its circulation. Just as in other high pressure zones, the Azores simultaneously moves with the geographic position of the longitude and the latitude.
One of the characteristics of the Azores is its displacement in the direction of the longitude and latitude. The works of Richard L (1985) [14] indicate that it is in addition displaced to towards the West with altitude. In other words, and in relationship to the general circulation West to East in the northern hemisphere for example, the altitude section of the system will always have a delay period in relation to the low layer sections of the atmosphere. According to Isnard H (1952) [15] undulations from jet currents lead to the creation of anticyclone ridges towards the high latitudes, which favours the down movement of thalwegs towards low altitudes. At certain moments, it reinforces depressions and they become storms.
The position of the Azores over the Atlantic gives it the protecting function for man. This is noticed in the months of July where it is found "at its lowest level". This is a very withdrawn position over the Atlantic, which for some researchers is attributed to the El Nino phenomenon. Contrarily to the month of July, in August, the atmospheric circulation changes and the weather are sunnier.
The inconsistency of the Azores participate in "*the natural variability of climate"*, the anticyclone increases in latitude and at times in longitude (Chris Landsea, 2009) [9].

Conclusion
The Azores move in the North-East or South-East directions monthly and annually. Several methods have been used to illucidate the mesoclimate and macroclimate mechanisms linked to the movement of the Azores. This is the case of the vangeguema method which allows for the study of atmospheric movements that permits for a better fight against major climatic calamities by improving on forecast and elaboration of prevention. It is for this reason that diverse long and medium term methods of weather forecast have been developed thanks to digital simulators that made it possible to better define the North-Atlantic oscillation, its variability, its nature, its importance and its distribution. However, research on the Azores needs to be intensified in order to come out with more precise models that will facilitate the amelioration of our forecasts.

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