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OSCILLATIONS AND CYCLES OF AIR TEMPERATURE IN SOUTH AMERICA

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Key words: oscillations of air temperature, Laplace spherical functions, tidal potential, cycles of air temperature, ocean currents.

Abstract. This paper is seeking to prove that on the South American continent there are the same cycles of air temperature (almost perfect) as those proven to exist in Europe (Romania), New Zeeland and North America (the U.S.A.) The oscillations and air temperature cycles of South America have their own characteristics, due to the large expansion of this continent in both latitude and longitude. The absence of important mountain chains with longitudinal display allows quick and intense advection of both Antarctic polar and tropical equatorial air masses. As a consequence, huge amplitudes of the air temperatures appear in some regions. An important role in the evolution of air temperature is played by the ocean currents.

Introduction

The cycles of the highest and lowest daily temperatures in Romania, New Zeeland and the U.S.A. and described in the previous papers have been explained by tidal atmosphere cycles generated by the lunar and solar attraction. These causes also stand at the basis of explaining and demonstrating the air temperature cycles of the South American continent. In addition, these oscillations of the air temperature of the South American continent are very similar to those that take place in Africa (in the tropical rainforest climate) and Asia (in the case of the temperate climate). These similar air temperature oscillations represent a demonstration regarding the fact that the Laplace spherical functions can be applied to meteorology.

As in other regions of the Earth, on the South American continent, there are all the cycles with duration of less than a year, but also the cycles with duration longer than a year. In order to describe and demonstrate these cycles, points with a tropical rainforest (Iquistos and Manaus), tropical (Asuncion) and temperate climate (Comodoro Rivadavia) were chosen. In all the situations, the oscillations

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of the air temperature from the West coast of the South American continent differ a lot, compared to those on the East coast, for points situated on the same latitude and in the same periods of the year. All these are explained by the influence of the oceanic current.

1. The cycles of air temperature with less than one year duration.

All the highest and lowest daily temperatures with under a year duration described and demonstrated in other regions of the Earth also exist on the South American continent. The most important are:

1.1. The 14-day cycle:

Almost perfect, this cycle of the highest and lowest daily temperature is attributed to a period of almost 14 days (13. 66 days, half of the tropical period of the Moon – 27. 32 days) in the evolution of the Moon, the celestial body which causes atmospheric tides within the same time. This cycle is proof that the Laplace spherical function ($y = 3\sin^2 x-1$) is also applicable in meteorology.

In figure 1, graphs are presented with the cycles of the highest and lowest daily air temperatures on the South American continent, in points with different types of climate.

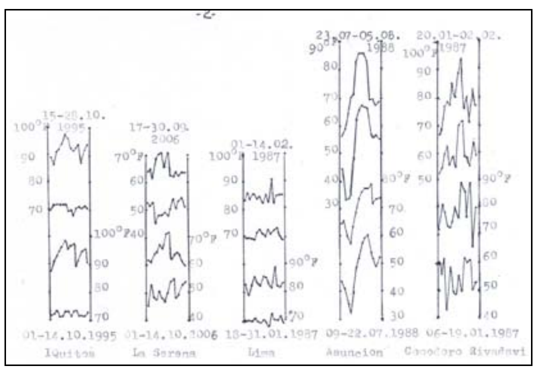

Figure 1 - Cycles of daily maximum and minimum temperatures in the air with the 14- day duration in South America

1.2 The 6-month cycle (about 183 days)

This cycle is mostly due to the 6-month duration (half of the duration of the tropical year = 365.24 days) in the evolution of the Sun, the celestial body which causes the atmospheric tides with the same duration. This cycle represents a second form under which the zonal spherical function can be applied in meteorology. In figure 2, graphs are presented with the evolution of the daily maximum and minimum temperatures in points with different climatic conditions in South America.

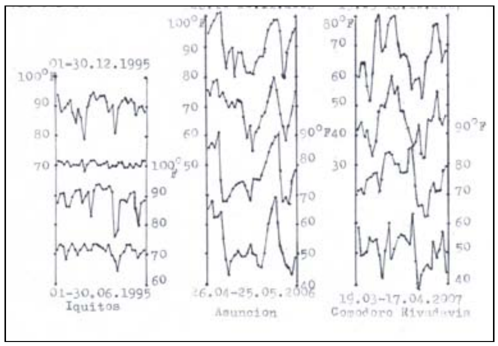

Figure 2 - Cycles of daily maximum and minimum temperatures in the air with the 6-month duration in South America

1.3 The 246-day cycle (about eight calendar months)

The existence of this cycle is due to the fact that in 246 days (about eight calendar months) nine tropical periods of the Moon occur, as the calculation shows: 246 : 27.32 = 9.00. This lunar cycle occurs anywhere in South America.

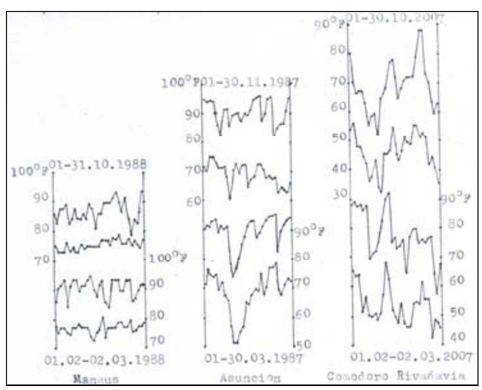

Figure 3: Cycles of daily maximum and minimum temperatures in the air with the 246-day duration in South America

In figure 3, we presented, by graphs, the daily maximum and minimum temperatures' cycles in the air lasting 246 days, in points with different climatic conditions.

2. The cycles of the air temperature lasting more than one year

These cycles of the daily maximum and minimum temperatures are clearer because they represent not only multiples of the Moon's tropical period (27.32 days). At the same time, they are cycles for the other Moon's periods (the anomalistic period = 27.55 days and the synodical period = 29.53days). Obviously, these are tidal cycles, too. Of these, the 11-year cycles, 18-year +11day cycle (Saros's Cycle) and the 19-years cycle (Meton's Cycle) are more important for the South American Continent. There are also other cycles in this category, like those of 23 years, 27 years, 31 years +2 days and the one of 44 years - 7 days etc.

2.1. The 11- year cycle

It is known that there are many cycles in the Sun's activity, the cycle of eleven years being the most important (4017.64 days). This cycle is, at the same time, a tidal one, as this period is also a multiple for the Moon's tropical and synodic periods according to the calculations: 4017.64 : 27.32 = 147.0 and 4017.64 : 29.53 = 136.0. This tidal, lunar and solar cycle is one of the daily maximum and minimum temperatures, too. Picture 4 presents graphs with 11-year cycles of the daily maximum and minimum temperatures registered on the South American continent.

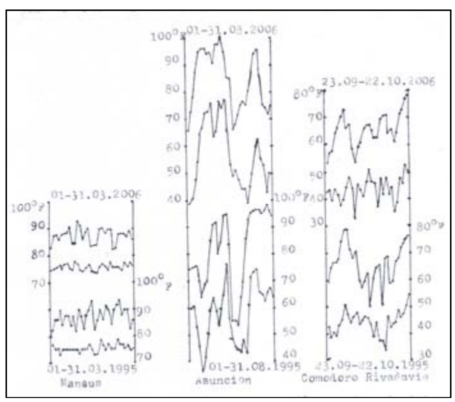

Figure 4: 11-year cycles of daily maximum and minimum temperatures in South America

2.2 Saros's cycle (approximately 6585 days)

This is a monthly cycle because in this period of time take place 241 tropic revolutions (periods); 239 abnormal revolutions and 223 synodical revolutions of the Moon, according to the following calculations: 6585:27.32=241.0; 6585:27.55=239.0 and 6585:29.53=223.0. In fact, this cycle is a tidal one, which, through the Rossby (planetary) waves, is reflected even in the evolution of the daily maximum and minimum temperatures. In figure 5, the Saros cycle is presented through graphs, in the evolution of the daily maximum and minimum temperatures, in three points with different climatic conditions, on the South-American continent.

2.3 Meton's cycle (approximately 6940 days = 19 years)

This cycle is a solar one, because it includes a large number of years and also a large number of tropic and synodical revolutions of the Moon, according to the following calculations: 6940:27.32=254.0; 6940:29.53=235.0. Being a tidal cycle, it is reflected through the Rossby (planetary) waves in the evolution of the daily maximum and minimum temperatures in the air. In figure 6, the cycle of Melton (19 years = 6940 days) is presented in graphs, in the evolution of the daily maximum and minimum temperatures on the South-American continent, in three points situated in different climatic conditions.

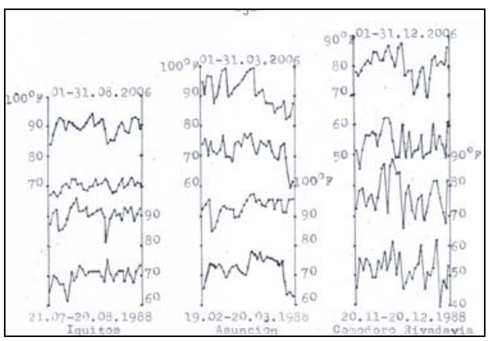

Figure 5: Saros's cycle in the evolution of daily maximum and minimum temperatures in South America

The analysis of the previous situations shows that the temperature cycle problem is complex, especially in the case of those with duration of over one year, because they are linked. Thus, the difference between Meton's cycle (19 years = 6940 days) and Saros's cycle (18 years +11 days=6585 days) is of 355 days, according to the following calculation: 6940-6585=355 days. This period is part of the cycle category lasting less than one year. Calculations show that 355:27.32 days (the tropical duration of the Moon) = 13.0 and 355:29.53 days (synodical period of the Moon) =12.0. In this situation, this cycle is tidal. Like others tidal monthly cycles, through Rossby waves, this cycle is reflected in many situations also in the evolution of daily maximum and minimum temperatures. In South America, this cycle occurs in all regions, regardless of weather conditions. The graphs in figure 7 demonstrate the existence of this cycle on the South American continent.

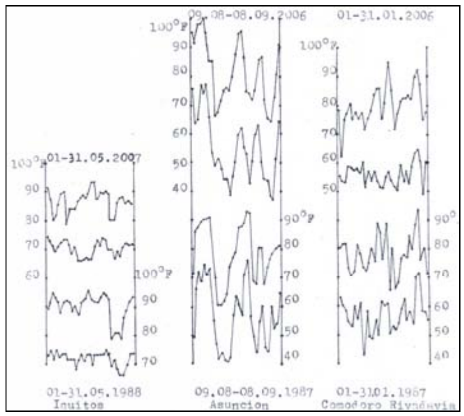

Figure 6: Meton's cycle in the evolution of daily maximum and minimum temperatures in South America

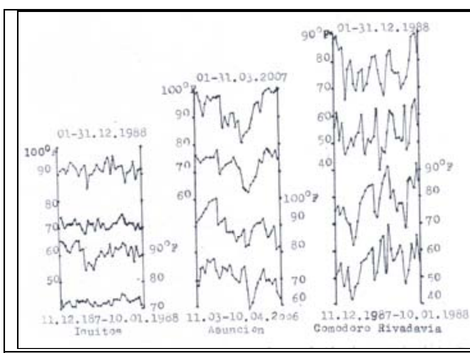

Figure 7: The 355-day cycle in the evolution of daily maximum and minimum temperatures in South America

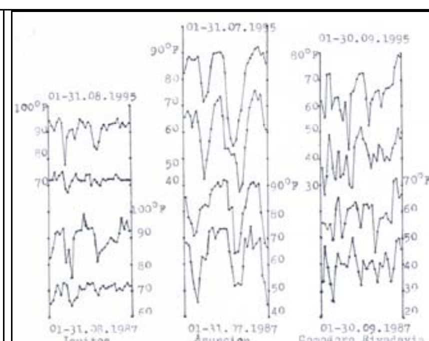

Figure 8: The 8-year cycle in the evolution of daily maximum and minimum temperatures in South America

If we consider the difference between Meton's Cycle (19 years = 6940 days) and the 11 year cycle (4018 days), the 8 year cycle (approximately 2922 days) will result. This cycle is also a monthly one, because it represents a multiplication of the tropical (27.32 days) and synodical (29.53 days) periods of the Moon. The calculations show that 2922:27.32=107 and 2922:29.53=99. This cycle is a tidal one and it is reflected in the daily maximum and minimum temperatures.

The graphs in figure 8 represent the 8-year cycle in the evolution of the daily maximum and minimum temperatures on the South American continent.

If a more detailed analysis of some graphs, which represent daily maximum and minimum temperature cycles is done, we notice that in areas with tropical climate (Asunción) and in those with temperate climate (Commodore Rivadavia), the amplitudes of the thermal oscillations are bigger compared to the ones in the equatorial area (Iquitos and Manaus). It also results that in both tropical and temperate climate, the cycles are clearer than those in the equatorial area. This can be explained by the existence of the equatorial calms in which the advection of air masses with other origins is done slower.

In the following, we will demonstrate the application of Laplace spherical functions in meteorology, especially in the equatorial and temperate climate in South America.

The spherical sectorial function Laplace ($y=\cos^2 x \cos 2H$) shows us that two points on Terra, near the Equator (0 latitude) have the same tidal potential if they have a longitudinal difference of 90 grades between them. In this situation are the Iquitos (South America) and Brazzaville (Africa) points.

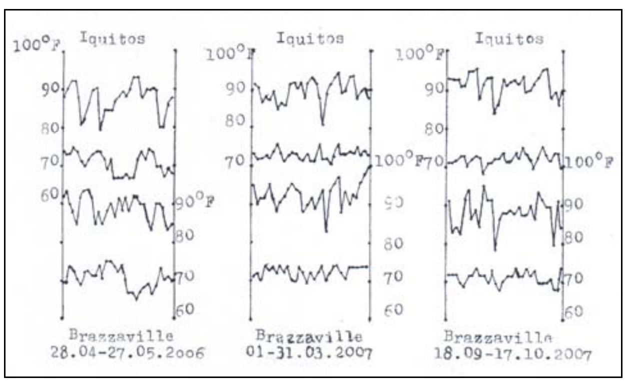

Figure 9. Similarities in the evolution of daily maximum and minimum temperatures between Iquitos (South America) and Brazzaville (Africa)

The graphs in figure 9 demonstrate that the daily maximum and minimum temperature evolution in Iquitos and Brazzaville in three different periods is very similar. The analogy can be observed not only in the daily amplitudes of temperature value, but also in the moments when the main warm and cold advections are produced. All these are due to the fact that the tidal potential identical in those two points is being reflected also in the daily maximum and minimum temperature evolution.

The tesseral spherical function Laplace (y=sin2xcosH) shows that two points located on Earth, around the 45°N parallel and the 45°S parallel have the same tidal potential, if there is a longitudinal difference between them of 180°. The Comodoro Rivadavia (South America) and Beijing (Asia) points are in this situation. The identical tidal potential of the two points is also reflected in the evolution of the daily maximum and minimum temperatures. The graphs of figure 10 show the similarities between the two points in the evolution of the daily maximum and minimum temperatures, in three different periods.

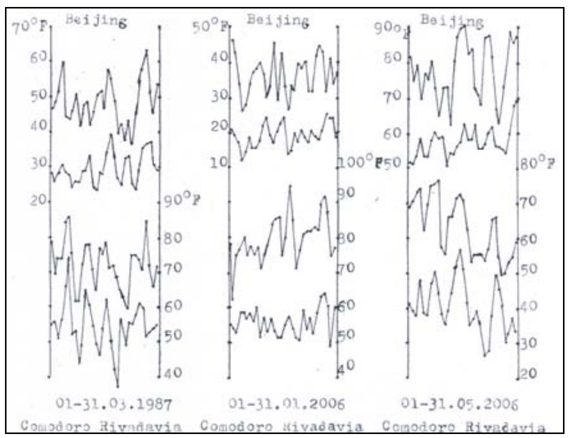

Figure 10. Similarities in the evolution of daily maximum and minimum temperatures between Comodoro Rivadavia and Beijing points.

Both the sectorial spherical function and the sectorial tesseral function could have been analyzed for other periods, too.

The influence of ocean currents on the evolution of daily minimum and maximum temperatures is also obvious in South America. So, points located at the same latitude but situated on the west coast, where the Peru (cold) current acts, have much different daily minimum and maximum temperatures (lower), compared with those of the east coast, where the south Equatorial current and the Brazil current act, both transporting warm water. In figure 11, there are graphs with oscillations of the daily minimum and maximum temperatures at points located at the same latitude but positioned on the west coast (Quito and Antofagasta) and, also, on the east coast (Macapa and Rio de Janeiro).

It can be observed that, both in the equatorial aria (Quito and Macapa) and in the tropical aria (Antofagasya and Rio de Janeiro), there are obvious differences in temperature. On the east coast (Macapa and Rio de Janeiro), the temperatures are much higher. On the contrary, daily thermal amplitudes are much higher on the west coast (Quito and Antofagasta).

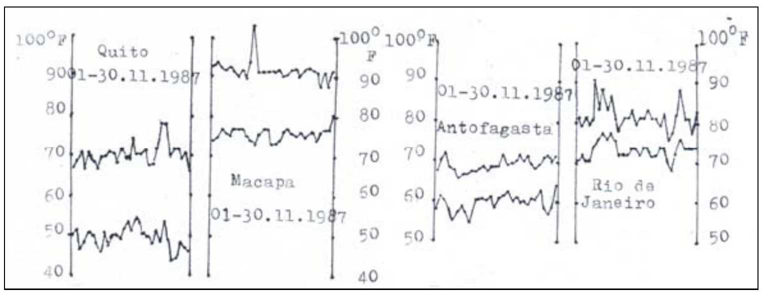

Figure 11. Comparison between west and east coasts regarding the daily minimum and maximum evolution of temperatures in November 1987.

In the evolution of the daily minimum and maximum temperatures of the west coast of South America, in many situations the phenomenon called "El Ninio" appears. Every year, around the winter Solstice, when the astronomical austral summer starts, warm waters of the Pacific Ocean reach up to the coasts of the Peru and Ecuador, causing a change in atmospheric circulation, which results in the occurrence of prolonged drought periods. Meteorologists have found that increased droughts in Peru (between 10º and 20º north latitude) coincide in time with those of India (between 10º and 20º south latitude). To this symmetry to the Equator, a longitudinal symmetry of 75ºwest and 75º east to the meridian of 0º (Greenwich) also adds up. This is another demonstration of the application of the Laplace spherical functions in meteorology.

Conclusions

By analyzing the minimum and maximum temperatures in the air, recorded in South America, the following conclusions can be reached:

- all the cycles described in Europe, New Zealand and the SUA are also found on the South American continent;
- those cycles are not perfect, because neither astronomical (solar, monthly and solar months) nor tidal cycles which generate them are perfect;
- absence of main mountain ranges with longitudinal arrangement allows intense advection of the polar and Antarctic air masses, but also of those of tropical and equatorial air masses.

- the cycles with the highest frequency are: the 11- year cycle, the Saros cycle and the Meton cycle, in the case of the cycles with a period of over one year and the ones of 14 days, 6 months and 365 days, for the cycles with a period shorter than a year.
- the similarities in the daily minimum and maximum temperature evolution between Inquitos (South America) and Brazzaville (Asia), as well as the ones between Comodoro Rivadavia (South America) and Beijing (Asia) represent a demonstration of the way the spherical functions Laplace can be applied in meteorology.
- the influence of the cold or hot oceanic currents of the West Coasts and the East Coasts of South America is highlighted by the important thermal differences.
- knowing these cycles in the evolution of the daily minimum and maximum temperatures, weather forecasts can be elaborated, on long term (over 10 days) for the South America.

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