CHyCle 2017

sciforum

First International Electronic Conference on the Hydrological Cycle

12–16 November 2017

Analysis of the variability of water levels of Titicaca Lake

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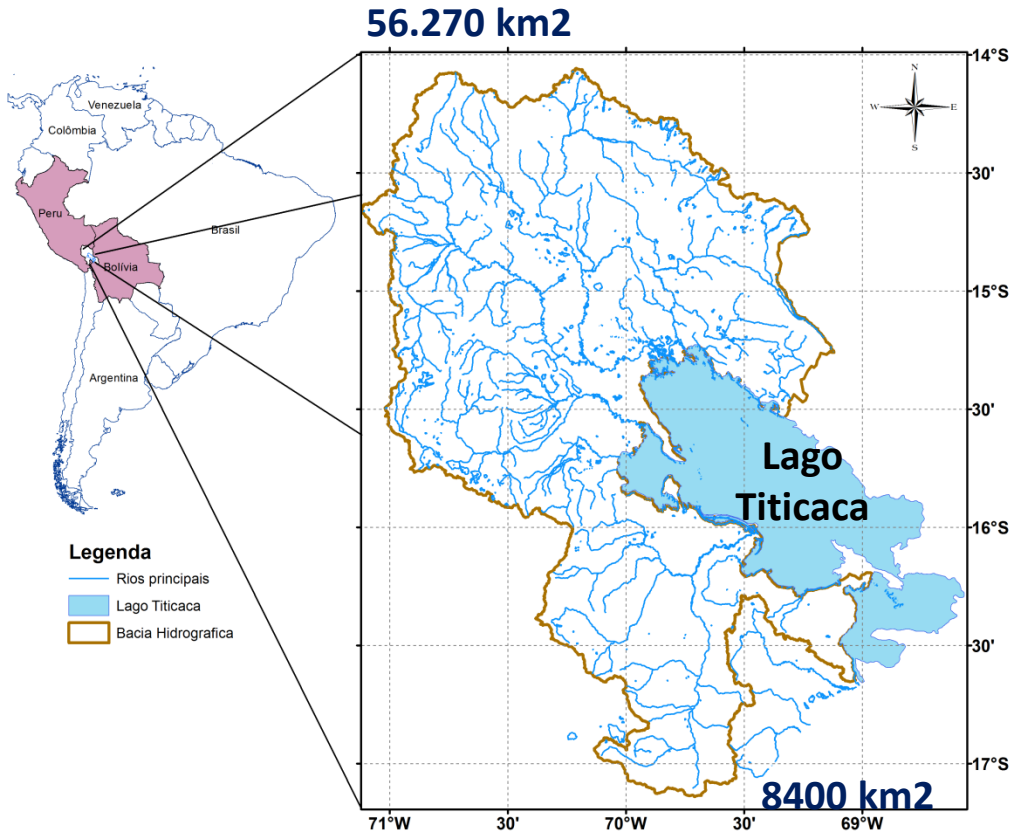
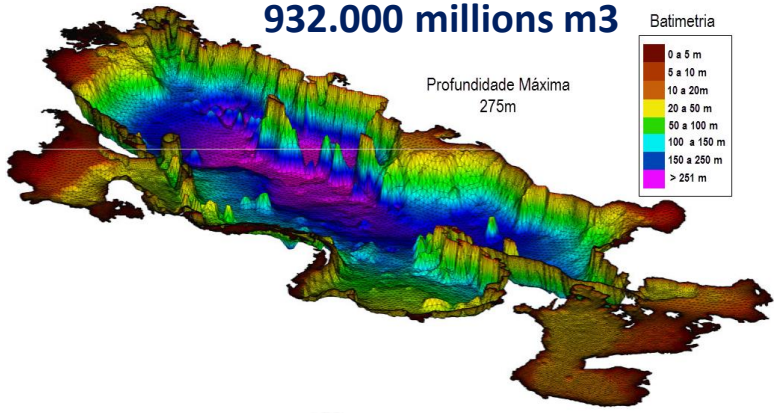
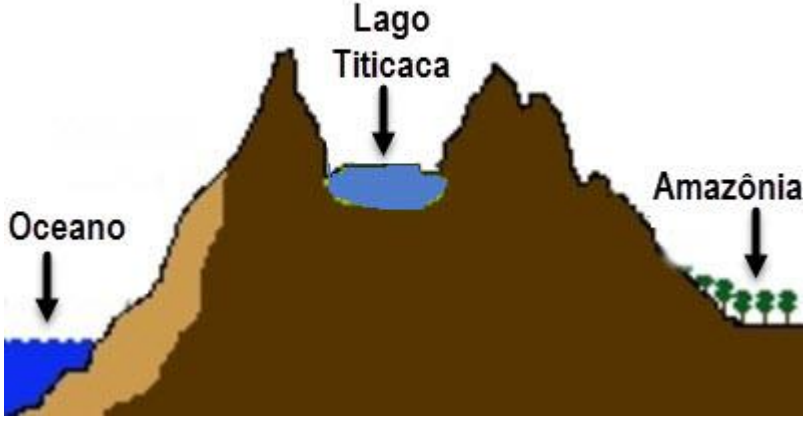
Introducción

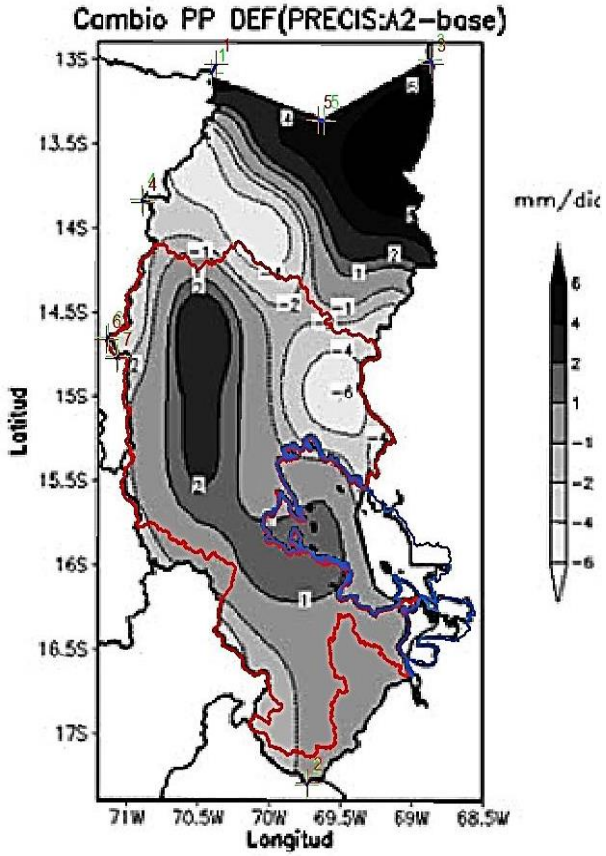


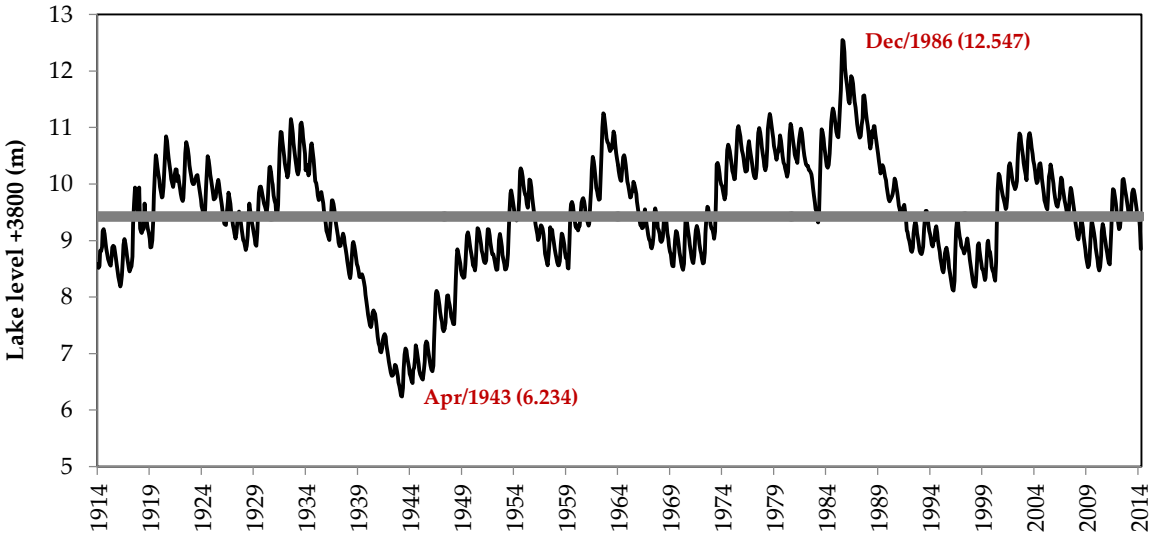




The Peruvian Altiplano Region (PAR), is a geographical area of high plateau morphology, located on the 3810 meters of altitude. Ronchail et al. [1]

Introducción



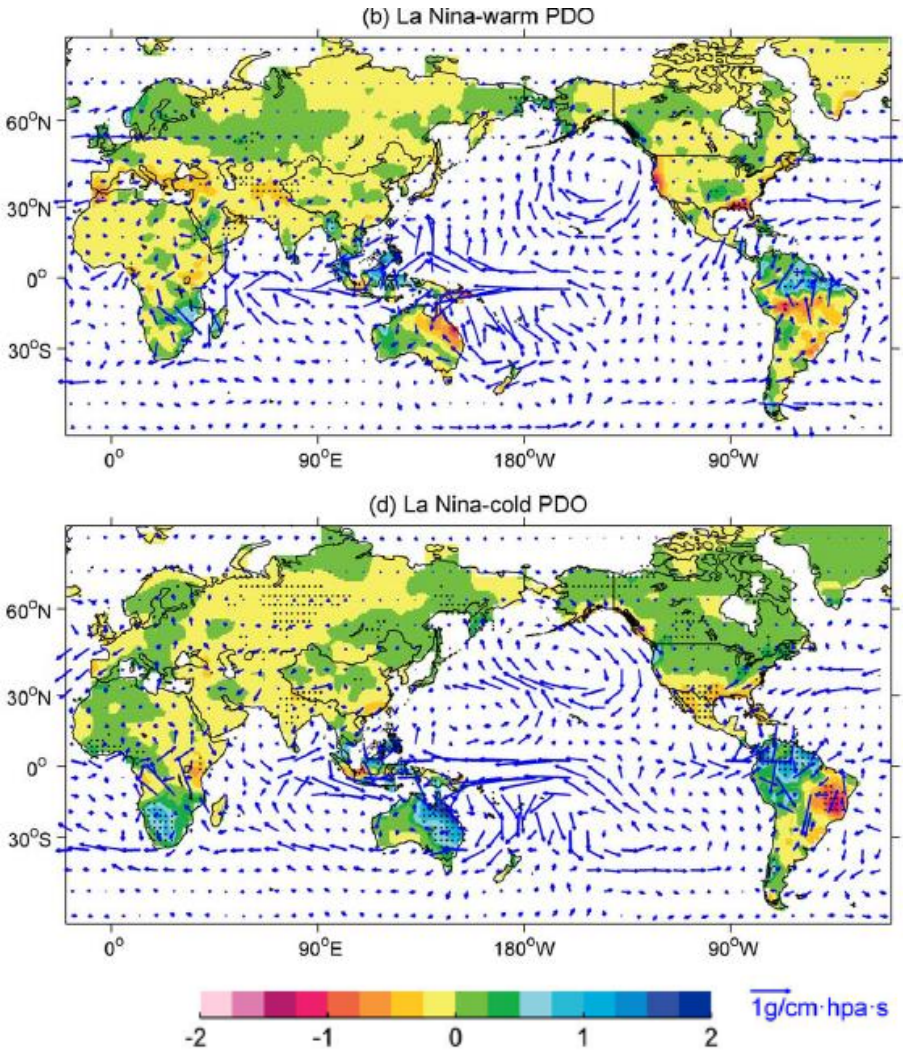


There has been a gradual decrease in TL level in recent years with reference to its normal level, according to the measurements taken by [5], TL level has changed significantly during the twentieth century with a difference of 5 meters between 1944 extremes (3806.7m) and 1986 (3811.6m).

Rainfall may decrease slightly over the PAR, but the patterns are not clearly defined. For example, in austral summer, in the southwestern part of the TL, a decrease of the precipitation up to 6 mm / day is observed [2].

Introducción

Trenberth et al. [9] demonstrated that natural variability, especially El Niño-Southern Oscillation (ENSO), is the primary cause of many episodic droughts around the world. Extensive research has documented ENSO-induced dry–wet anomalies over various regions [10,11,12,13]. However, the typical interannual relationship between ENSO and the global climate is not stationary and can be regulated by the Pacific Decadal Oscillation (PDO) [14,15]. Many studies have revealed that the PDO exerts a modulating effect on ENSO teleconnections over many parts of the world, such as the South America[16], Mexico[17], Australia[18], and East Asia[19,20].



The main objective of the study is to analyze the variability of Lake Titicaca water levels, try to show possible trends and breaks, and relate this variability to the Pacific Decadal Oscillation (PDO) and ENSO events.

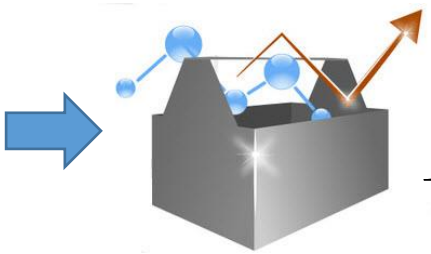
Experiments

Analysis of the lake level

Levels*
Precipitation**
PDO(±)
ENOS(±)

Data

(*) 1914 – 2014
(**) 1969 – 2014



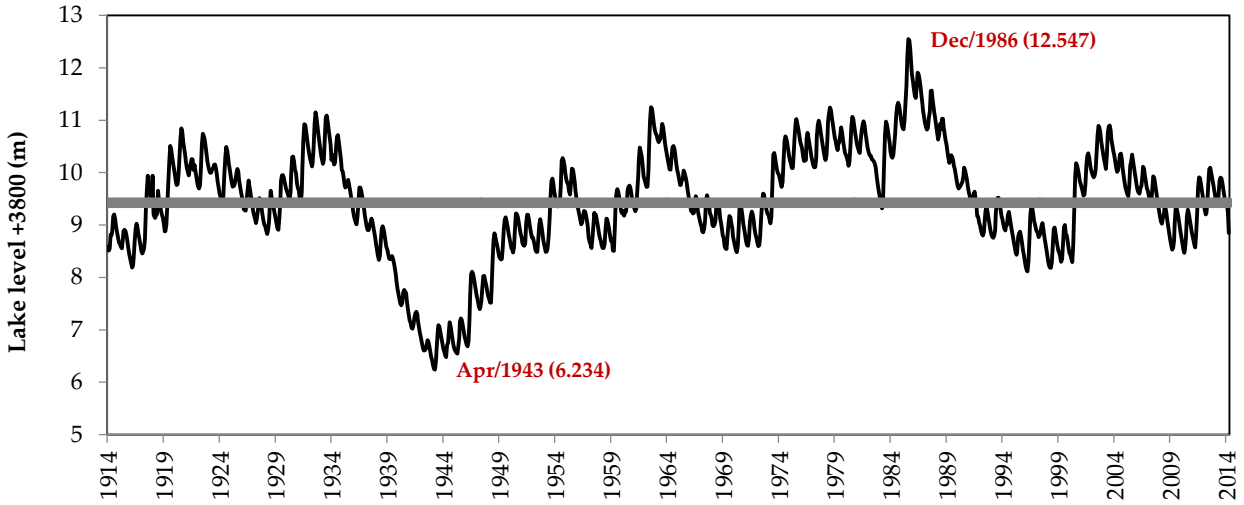
Spectral Analysis
Variability of the lake level

Composition Analysis
Precipitação - ENOS(±)

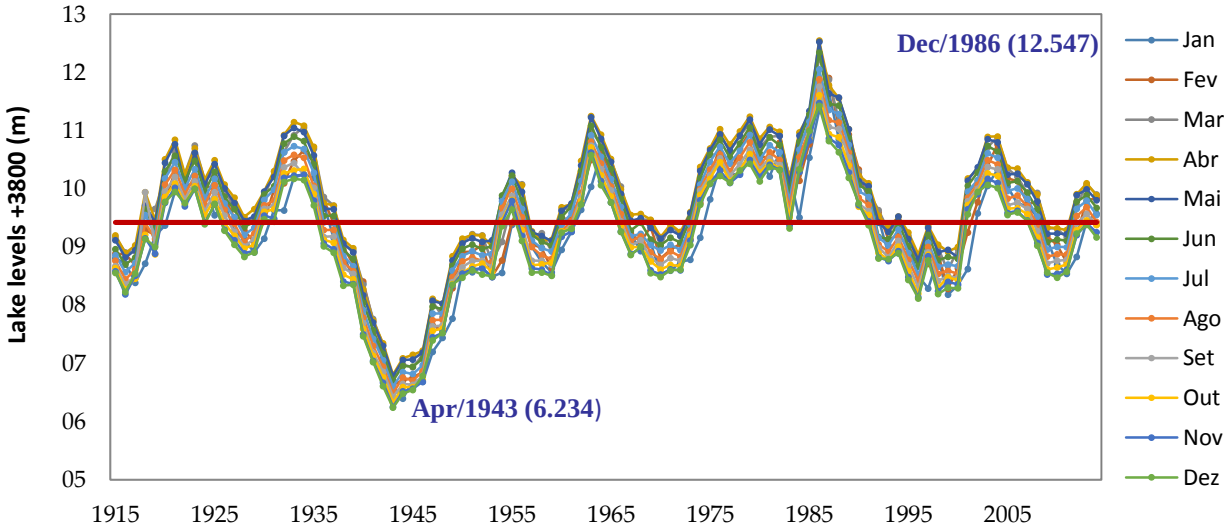
Establish a relationship between the PDO and Lake Levels

Results

3.1. Level of Lake Titicaca

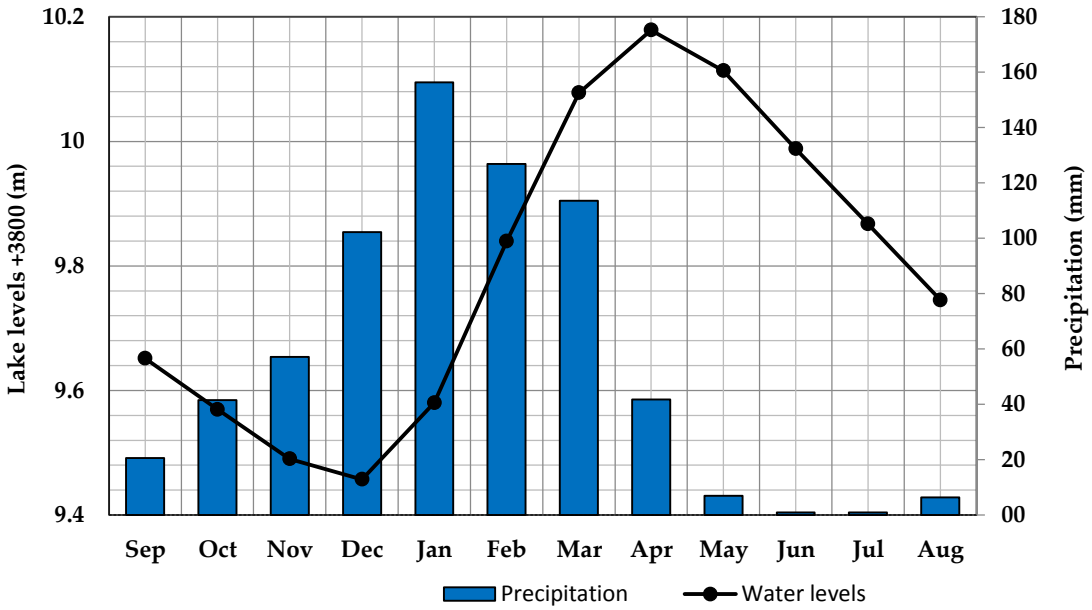


3.2. Lake level fluctuations

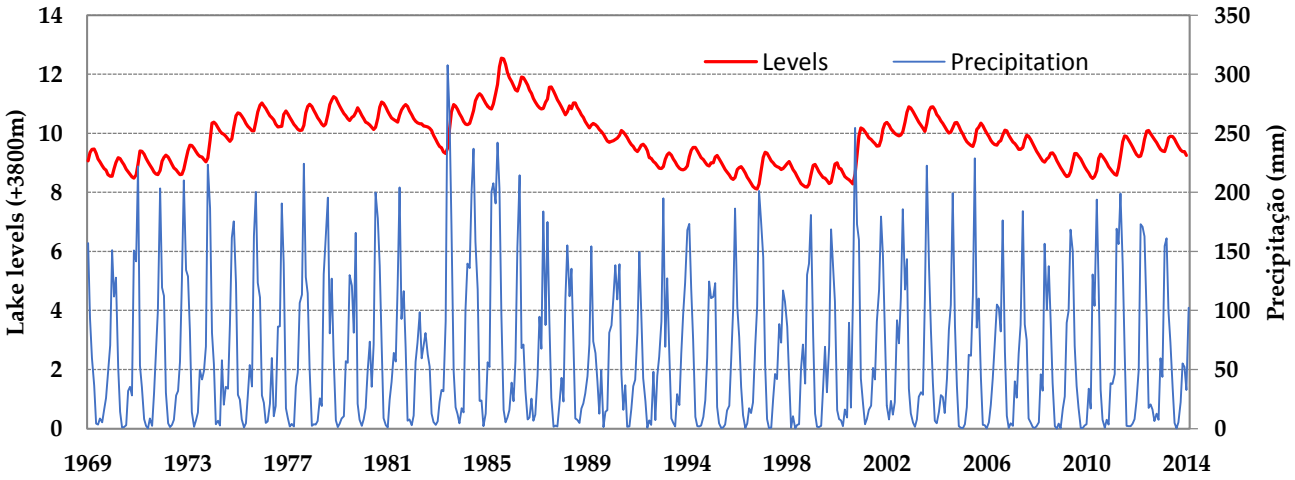


Results

3.3. Annual increase in the level of Lake Titicaca.

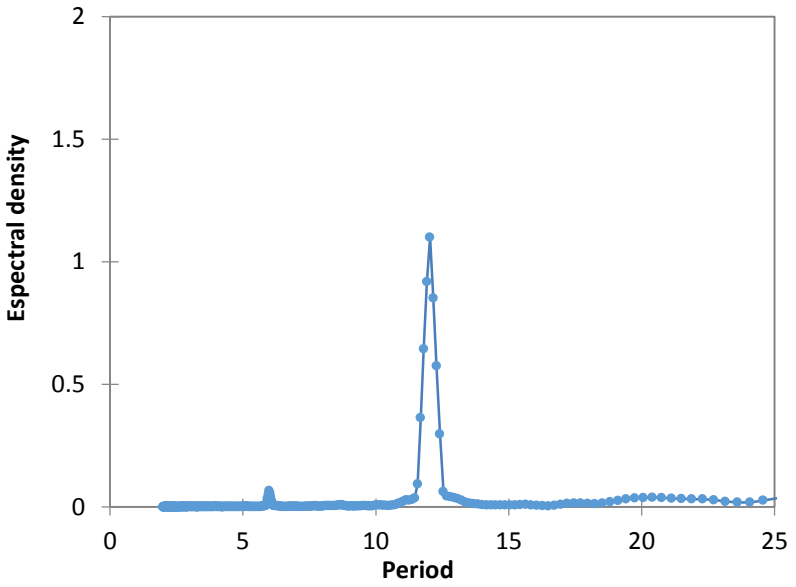


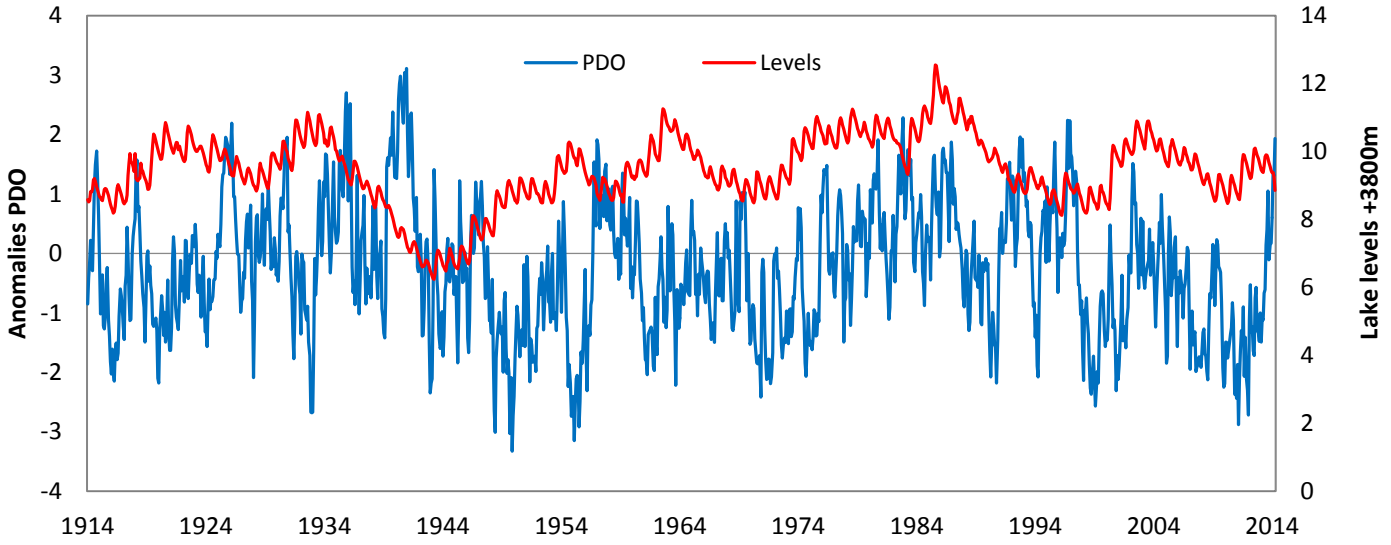
3.4. Relationship between water levels and rainfall in the basin.



Results

3.5. Relationship between PDO , ENSO and water levels in the basin.





Results

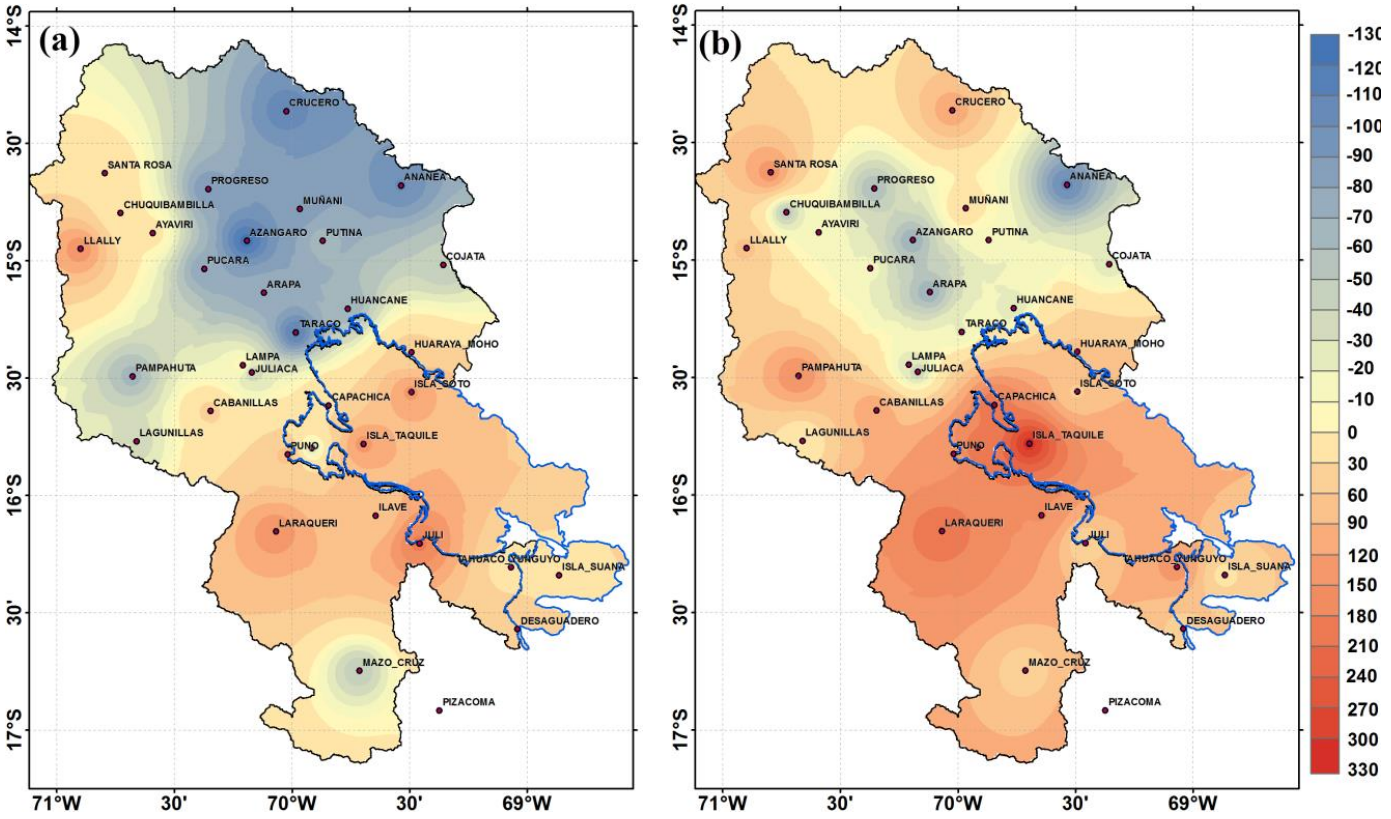


Figure 9. Anomalies of precipitation compositions for the moderate (a) and very strong (b) El Niño event. The color bar shows precipitation anomalies in millimeters. Vertical axis indicates the latitudes and the horizontal axis refers to the lengths, both in degrees (°).

Results

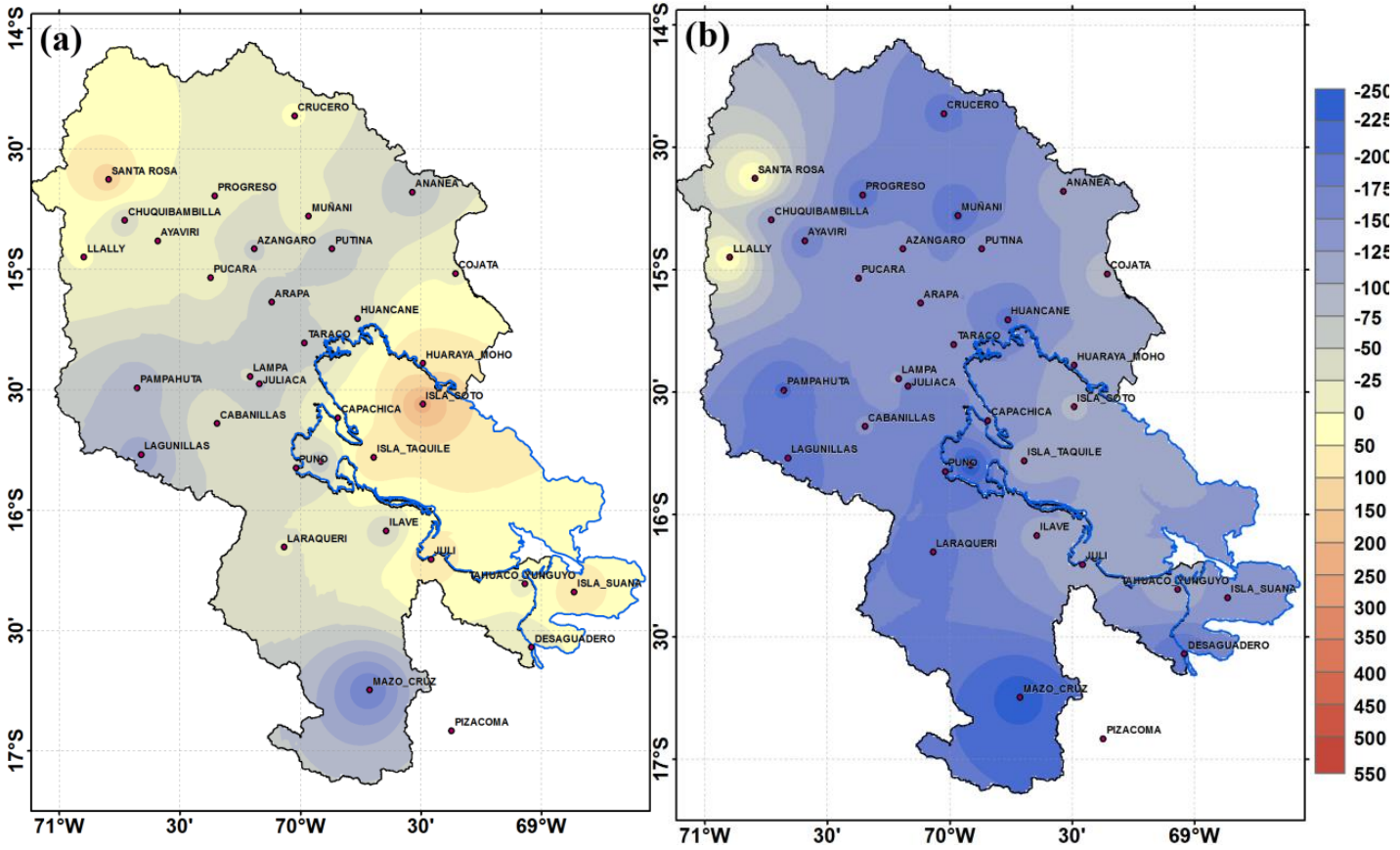


Figure 10. Anomalies of precipitation compositions for the La Niña event moderate (a) and strong (b). The color bar shows precipitation anomalies in millimeters. Vertical axis indicates the latitudes and the horizontal axis refers to the lengths, both in degrees (°).

Discussion

The studies carried out by Ronchail et al. They show that Lake Titicaca has a frequency variability which is associated with the thermal conditions of tropical oceans. To this we can add the results obtained in the present research work. Where can be demonstrated the relationship that exists between the PDO and the ENSO with the variability of the water levels of Lake Titicaca. Ronchail et al affirm that the growth of the lake level occurs when there are La Niña events and when the northern tropical Atlantic ocean is cooler than normal.

In our case, it has been shown that for La Niña strong events there are precipitation anomalies and in front of La Niña events there are positive anomalies northeast of Lake Titicaca.

For El Niño events (moderate and strong) the analysis of compositions shows positive precipitation anomalies in the central part of Lake Titicaca.

Conclusions

From the analysis of the behavior of Lake Titicaca, for the period from 1914 to 2014 by spectral analysis of the TL, show a period of variability of 12 years that was associated with the PDO climate index. The results indicate an inverse relationship between TL and PDO, with the increase in NLTs being related to the negative phase of PDO. Likewise, the behavior of precipitation in the ENSO events was evaluated by means of composition analysis since the precipitation is related to the variation of the TL.

The analysis showed negative precipitation anomalies in most of the RAP in the El Niño years, on the other hand for La Niña years, precipitation anomalies were positive. Thus, in the positive phase (negative) of the PDO, with a higher probability of positive phase (negative) ENSO events, precipitation presents negative (positive) anomalies that may be associated with the decrease (increase) in TL.

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