Analysis of teleconnection between the Arctic Oscillation and South American cryosphere reduction

- Preliminary Results -

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Introduction

The cryosphere in South America is a very important resource because it is the main source of water for 85 million inhabitants distributed in Colombia, Ecuador, Peru, Bolivia, Chile and Argentina [1-2]. To know the effects due to global phenomena such as arctic oscillation (AO) in the reduction of the cryosphere in this region, we proceeded to analyze sources of reanalysis information (ERA-40; NCEP/NCAR Reanalysis) and high resolution snow cover (MOD10 500m) from Moderate-Resolution Imaging Spectroradiometer (MODIS). Several linear adjustments were made to observe how snow cover variations (Y) responded to variations in AO (X_1), surface temperature (X_2) and snow precipitation (X_3) (see the following equation):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

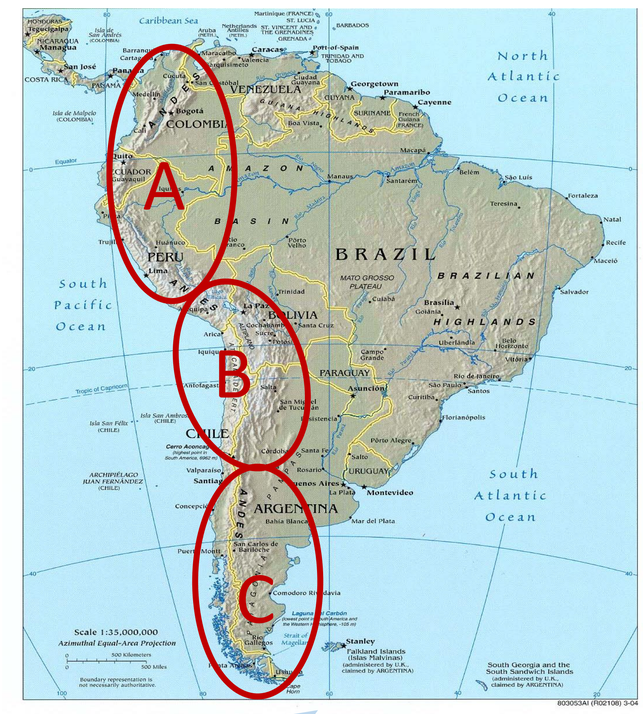

Fig. 1 Map of South America. On the western side is the Andes mountain range that has been divided into three zones: tropical Andes (A), Central Andes (B) and Southern Andes (C)

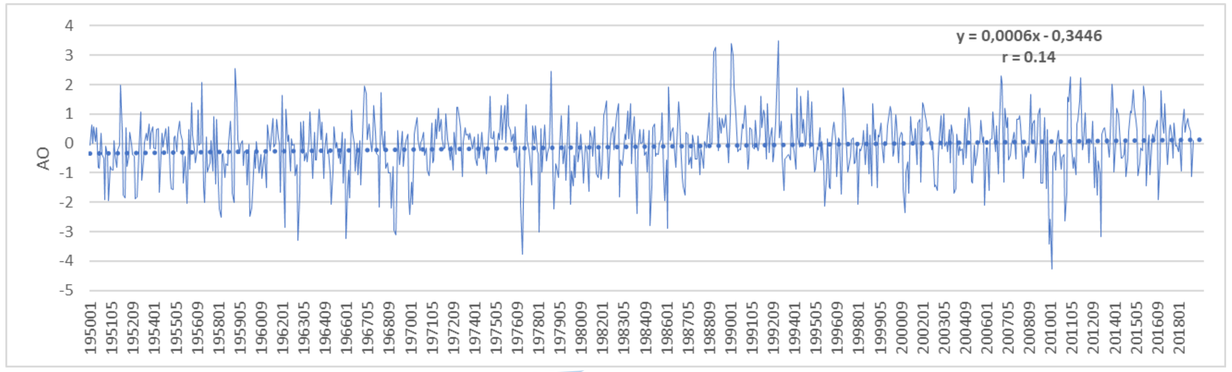

Fig. 2 Monthly variations of YEAR from January 1950 to December 2018. Dotted line represents the trend line.

Study region

The Andean Mountains are the longest continental mountain range in the world (shown in fig. 1), forming a continuous highland along the western edge of South America. The Andes also have the 2nd most elevated highest peak of any mountain range, only behind the Himalayas. The range is 7,000 km (4,300 mi) long, 200 to 700 km (120 to 430 mi) wide (widest between 18° south and 20° south latitude), and has an average height of about 4,000 m (13,000 ft). The Andes extend from north to south through seven South American countries: Venezuela, Colombia, Ecuador, Peru, Bolivia, Chile and Argentina.

AO Vs. the South American cryosphere

The AO is a phenomenon that affects the global circulation [3]. The data of its positive and negative phases show a small positive trend (shown in Fig. 2). Then a multiple linear regression was performed to observe how snow decrease on South America and responded to this trend and to changes in temperature and snow precipitation in the Andes mountain range.

Results and discussions

The results show (shown in Table 1) that the AO is responsible for 28% of the decrease of the snow cover (2000 to 2018), being this the biggest influence in the north of South America where the Tropical Andes is located (zone A). This relationship dramatically decreases towards Southern South America.

These results are also related to surface temperature increases in the Tropical Andes (shown in Fig. 3 and Fig. 4). The results would indicate an increase in temperature in zone A due to the strengthening of trade winds that reach this area as a result of the greater occurrence of positive phases of the AO (shown in Fig. 5).

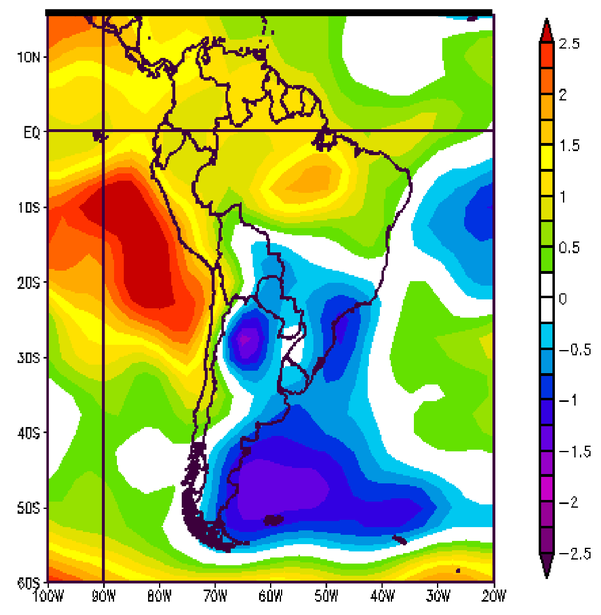

Fig. 3 Composite anomaly 1981 – 2010 climatology. 850mb Air Temperature (°C) NCEP/NCAR Reanalysis. This figure include the years from values in Time Series for AO

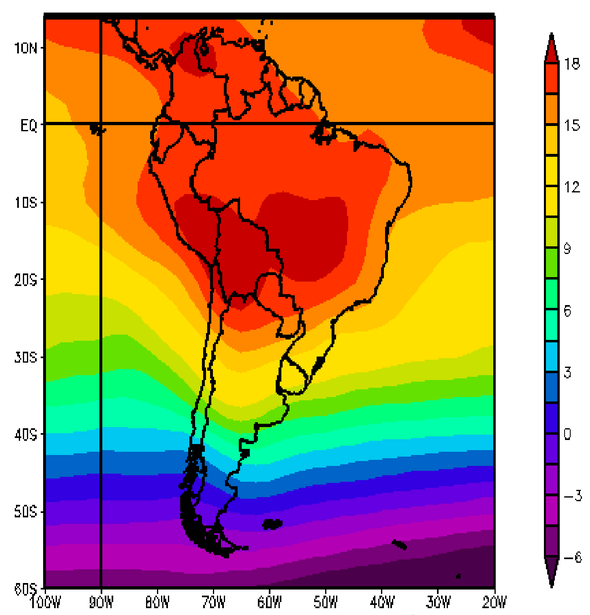

Fig. 4 Composite mean 1981 – 2010 climatology. 850mb Air Temperature (°C) NCEP/NCAR Reanalysis. This figure include the years from values in Time Series for AO

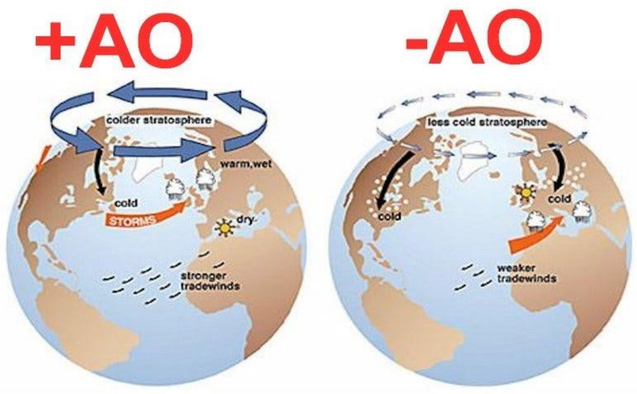

Fig. 5 Schematic of what the 2 phases of the AC. Positive phase is related to stronger trade winds and the negative phase with weak trade winds. Source: https://nsidc.org/cryosphere/icelights/2012/02/arctic-oscillation-winter-storms-and-sea-ice

Future research activities

Future activities include expanding analysis with data from local meteorological stations and analyzing more phenomena that are related to the decrease in snow cover, for example, the ENSO and Antarctic Oscillation.

Table 1. Contribution percentage to Snow reduction of each parameter for the Reanalysis and zones analyzed using the multiple regression model

Zone	AO	Temperature	Snow precipitation	R^2
A - Tropical Andes	**28**	39	33	78
B - Central Andes	**7**	41	52	65
C - Southern Andes	**4**	58	38	47

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