1. INTRODUCTION

Climate change (CC) is an alteration of the natural state of the climate that generates disturbances in all systems, so these tend to seek new state(s) of equilibrium that can present a great deal of variability. This is why the Intergovernmental Panel on Climate Change (IPCC) has developed scenarios that aim to account for the effects of CC by representing the total radiative forcing calculated for the year 2100 and including the net effect of Greenhouse Gases (GHGs), air pollutants and land use changes (Van Vuuren et al., 2011). Based on this, the main objectives of the study are to provide a projection and simulation of the water balance in the ChSs, as well as to evaluate the processes that control and are responsible for the advance or retreat of glacial fronts and ice mass thinning. For this, we use General Circulation Models (GCM) coupled with climate change scenarios RCP 4.5 & 8.5.

2. STUDY AREA

The Southern Ice Field (ChSs, by its acronym in spanish) is one of the largest continental ice sheets, representing a source of water for the entire globe. It extends from 40°S to 51°S, covers an area of 16,800 km² and is formed by 49 glaciers distributed in the southern territory of Chile (25%) and in the Patagonia of the Argentine Republic (15%).

3. OBSERVATIONS

This study considers three analysis periods, in the historical period (T1: 1970-2005) we used records from climatological stations (Fig. 1). For the near future (2006-2050) and far future (2051-2100) future projections, we use statistical downscaling results from the GCMs.

4. METHODOLOGY

4.1. GCM

The model selected to carry out the simulations is HadGEM3-GC3.3 (MPI-ESM), a model widely used in climate change studies. The model was run for 2100 under RCP 4.5 and 8.5 scenarios.

4.2. STATISTICAL DOWNSCALING

Statistical downscaling is a method to generate climate projections from GCMs that can be better fitted to local conditions. In this study, we use two downscaling methods (Pai et al. 2012) and 20 climate stations from Chile.

5. RESULTS

5.1. WATER BALANCE

In the southern ice sheet, the water balance is a critical parameter for assessing changes in the ice sheet mass balance. The balance equation for the ChSs is as follows:

\[
S = P - R - PET
\]

Where:
- \(S\) = water balance
- \(P\) = precipitation
- \(R\) = runoff
- \(PET\) = potential evapotranspiration

5.2. EVALUATION & PROJECTIONS

Evaluation of the balance in the historical period in the zone of current and future projections.

5.3. CONCLUSIONS

Both models, when evaluated in the previously mentioned scenarios, indicate that the ChSs present an warming of greater or lesser degree according to the scenario, for which reasons the ice mass that makes up the ChSs will follow the behavior it has experienced up to now and will continue to detach itself.

The values of the runoff coefficient range between 0.75 - 1. Values higher than 1 are due to the uncertainty in their climatic projections. In this way, the different GCM and RCP scenarios were applied, in addition, methodology applied has uncertainty in its structure (downscaling methods and estimated variables).

Finally, both models indicate a 30% deficit in precipitation by 2050, with gradual decreases for the next decades which are likely to induce significant glacial mass reductions across the study domain.

REFERENCES


Fig. 1 Surface area covered by the ChSs obtained from Landsat 5-8 satellites and analyzed in Geographic Information Systems. The green line marks the surface at the year 2005, while the red line shows the retreat of the glacier and the five main increases at the year 2015. These effects can be associated with increases in sea level (Hastenrath et al., 2005), changes in evapotranspiration rates, decrease in precipitation, among other effects generated by the CC.