Geophysical Research Abstracts
Vol. 19, EGU2017-995, 2017
EGU General Assembly 2017

Linking climate variations with the hydrological cycle over the semi-arid Central Andes of Argentina. Past, present and future, with emphasis on streamflow droughts.

Juan Antonio Rivera (1,4), Diego Araneo (1,5), Olga Penalba (2,3), and Ricardo Villalba (1)

(1) Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET - CCT Mendoza), Mendoza, Argentina (jrivera@mendoza-conicet.gob.ar), (2) Departamento de Ciencias de la Atmósfera y los Océanos, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina, (3) Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Argentina, (4) Facultad de Veterinaria y Ciencias Ambientales, Universidad Juan Agustín Maza, Mendoza, Argentina, (5) Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Cuyo, Mendoza, Argentina

In the Central Andes of Argentina (CAA, located between 28° and 38°S), an arid to semi-arid region, the irrigation and a variety of socio-economical activities are highly dependent on river streamflows. Permanent and semi-permanent rivers originate mainly from snowmelt and glacier ablation, enabling the development of large agricultural oasis and the construction of numerous dams and reservoirs for irrigation and power generation. Most of its 2.5 million inhabitants and the main economic activities are located in a small irrigated fraction of the territory, where the variations in the timing and amount of water resources largely determine the socio-economic vulnerability of the region. In this context, the links between climatic variability and the hydrological cycle were assessed considering daily streamflow records from 21 streamgauges in the main rivers of the study area. Principal component analysis of annual hydrographs from 1931 to 2015 allowed to discriminate between precipitation- and temperature-related components associated with variations in snow accumulation (51% of variance) and advances/delays of the streamflow annual peak (16% of variance), respectively. The components related to intraseasonal variability account for 7% and 6% of variance, respectively, mixing both precipitation and thermal factors. The contribution of the precipitation-related component was the main driver of the 2010-15 streamflow drought conditions, although the thermal contribution was relevant during specific seasonal drought events. Based on an empirical decomposition methodology we identified the main modes of streamflow drought variability, which are linked to El Niño-Southern Oscillation on interannual time scales and the Pacific Decadal Oscillation (PDO) for the decadal variations. This result shows the influence of the tropical Pacific Ocean in the development of streamflow drought conditions and its relevance for potential predictability of hydroclimatic variations over the region. Nevertheless, recent studies indicate that, besides the contribution of La Niña and PDO signals, anthropogenic climate change could be responsible for the development of regional extreme drought conditions. In fact, reconstruction of CAA hydroclimate based on centennial-long tree-ring records shows a recent declining precipitation trend that is also evident over North Patagonia (38°-45°S) reconstructions, unprecedented in the last ∼400 years. This decreasing trend can be linked to the broadening of the sub-tropical dry zones as a displacement of the descending arm of the Hadley Cell circulation, a phenomenon likely forced by increased greenhouse gas concentrations, although its underlying mechanisms still not well understood. The assessment of future drought conditions based on a CMIP5 multi-model ensemble forced under two scenarios (RCP4.5 and RCP8.5) shows an expected increase in the number of drought events, with a decrease in the mean drought duration and non-significant changes in mean drought severity, although these results have a high range of uncertainty and are dependent on the future time horizon and selected scenario. Moreover, projected temperature trends will shift the streamflow peak from summer to late spring, in combination with a decrease in snow accumulation that will decrease the annual cycle amplitude. Both factors will likely change the hydroclimate of the semi-arid Andes, calling for new and improved water management practices over the region.