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Projected mean and extreme changes in the hydrology of large southern South American river basins under 1.5ºC, 2ºC and 3ºC global warming above the preindustrial level

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In the Conference of the Parties on its 21st session held in Paris countries have agreed to limit "the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" (UNFCCC, 2015). However, more studies on how such increments in global temperature might impact the regional climate is needed, in order to guide decision makers and water management planners.This study investigates the projected annual and extreme hydrology changes over the Paraná River and the Uruguay River basins for the warming thresholds of 1.5°C and 2°C established in Paris and also for 3°C above the preindustrial level. We also explore the consequences from following a medium or high-emission Representative Concentration Pathway (RCP) to achieve the different warming targets. In order to determine the possible changes in precipitation, evapotranspiration, runoff and river discharges, we use the VIC distributed hydrology model in combination with bias-corrected Global Climate Model (GCM) outputs from the Inter-Sectorial Impact Model Intercomparison Project phase 2a (ISIMIP). Overall, most of the changes over the sub-basins suggest moister conditions with increasing temperatures, which suggests a positive feedback would exist between temperature and precipitation likely accompanied by higher evapotranspiration, moisture availability and precipitation. The comparison of the RCPs indicates that increases in precipitation, evapotranspiration and runoff would be larger under the medium-emission scenario. When the different responses of the various components of the terrestrial water cycle were integrated, results show that variation of annual mean streamflow in all sub-basins range between $\pm$20%. However, in most cases, the sign of the changes highly depends on the RCP chosen to achieve a warming level. In order to quantify and account for potential risk of fluvial flooding or drought over the region we analyzed changes in the probability distribution of streamflow, particularly of the high (95th percentile) and low extremes (5th percentile). The median of the multimodel ensemble show in both basins and for every target and RCP scenario, an increment in the magnitude of the 95th percentile of annual streamflow which suggest a potential increase of flood events.However, in all cases there is a great uncertainty related to the GCM chosen. Results of the change in the other extreme of the probability distribution (5th percentile) in the Paraná River show a decrease in the magnitude, which may indicate a greater potential for drought events, especially when a 3ºC warmer world and RCP8.5 is considered. Changes in extreme low streamflows for the Uruguay River highly depend on the choice of RCP and warming target.
With current emission trends close to the 3°C target, this study might be useful to guide decision makers and water management planners.