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Variability and changes of daily extremes over northeastern Argentina

E. Hugo Berbery (1), Miguel Lovino (2), Omar Muller (2), and Gabriela Muller (2)

(1) University of Maryland, Earth System Science Interdisciplinary Center/Cooperative Institute for Climate and Satellites, College Park, United States (berbery@umd.edu), (2) Centro de Variabilidad y Cambio Climático, Facultad de Ingeniería y Ciencias Hídricas, Universidad Nacional del Litoral, Argentina

Climate in northeastern Argentina poses great challenges to the population that needs to cope with extreme events. Climate variability and changes are leading to an increased vulnerability which in turn can produce unprecedented disasters. This study investigates the long-term changes and interannual variability of daily temperature and precipitation extremes, discusses their impacts on agriculture and human settlements, and assesses to what extent global reanalyses reproduce the observed variability. Climate extremes are characterized in space and time by relevant indices, like those proposed by the Expert Team on Climate Change Detection and Indices. The leading modes of variability were detected with spectral analysis, and their spatial distribution was assessed through nonparametric trends.

The results confirm that temperature extremes are changing towards warmer conditions. Since 1990 the number of warm days has been increasing, while the number of cold days has been decreasing. Likewise, warm and cold nights show a significant signal of warming, although the trend seems to be stabilizing in recent decades. The duration of heat spells increased while cold spells decreased in recent decades. At present, heat spells almost double the frequency and duration of cold spells. Longer heat spells are associated with longer dry spells impacting a region where intense agricultural activity is rainfed. Changes in temperature regimes are important for agriculture when the spells agree with the crops' critical periods. The growth periods of maize and sunflower are sensitive to the increase of warm days, leading to a reduction of their yields. On the other hand, the decrease in cold nights shortens crops' critical growth periods reducing wheat and barley yields. Likewise, the decrease of cold days may reduce the flowering and yield of winter wheat. More relevant for health, the longer duration of heat waves may increase the population mortality risk by heat strokes and produce more frequent collapses of energy systems.

Intense precipitation events in most of the region increased steadily since 1970. The intensity and frequency of annual maximum 1-day and 5-day precipitation events increased from the 1970s to the 2000s, stabilizing in recent years. The increased intensity of heavy precipitation events constitutes a growing risk for urban settlements where heavy rainfall may exceed the capacity of drainage systems, causing significant infrastructure losses and, in the most extreme cases, deaths. Intense precipitation events in the predominantly flat agricultural plains lead to extensive waterlogging with significant economic impacts due to loss of crops and decreased livestock productivity.

A similar analysis based on reanalysis data (ERA-Interim and NCEP2 reanalysis) reveals mixed results. ERA-Interim can recognize temperature extremes in time and space, while the older NCEP2 presents systematic biases. Both reanalyses reproduce dry spells and the annual maximum 5-day precipitation with large biases, which are particularly noticeable at each observation station. Although reanalyses would be expected to add information for climate extremes in areas of scarce observations, they still need to be used with great caution and only as a complement to observations.