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Introduction: There are few studies about extreme temperature events in Southeastern South America (SREX, 2009), although these events generate human health impacts and big economical losses. Southeastern South America is one of the major agricultural production regions worldwide. Particularly in Uruguay, agricultural production represents a high percentage of the GDP and, in the last 15 years there has been a significant increase in the area used for that economic activity. Based on previous studies that showed a negative trend in the occurrence of warm days (TX90) during summer (DJF) and a negative trend of cold nights (TN10) during autumn (MAM) and winter (JJA) (Renom, 2009; Donat et al., 2013, etc), the aim of this study is to detect if these observed trends are correlated with changes in heat waves and frost days.

Data and methodology:

We used a high quality daily maximum (Tm) and minimum temperature (Tn) database from 11 meteorological stations in Uruguay, covering the period 1950-2009. The figure shows the location of the stations analysed. Observed trends were calculated using the non-parametric Sen method (Sen, 1968) and the statistical significance was assessed at the 5% level.

Definitions:

- **FROST DAY (FD)**: When the daily minimum temperature is below 0°C.
- **FROST PERIOD (FP)**: Covers from the date of the first to the last frost recorded for each time series. The common frost period extends from May to September.
- **HEAT WAVES (HW)**: We define a heat wave based on maximum and minimum temperature as follows. Based on an autocorrelation analysis a 5-day window was used to determine the daily 90th percentile of each temperature series, from December to February for the period: 1950-2009. A HW was defined when during 3 or more days maximum temperature and minimum temperature above the 90th percentile, only interrupted by more than one day where one of the variables does not fulfil these conditions.

Heat Waves (Dec-Jan-Feb)

For the HW analysis we work with 6 stations, because of missing data in temperature series.

- The daily long-term 90th percentile shows the evolution during summer time to define a HW.
- The interannual variability shows a very low number of cases and no significant trend was detected in the frequency of occurrence.
- Considering the persistence of HWs, overall an event doesn’t persist more than 4 days. Just 2 events that lasted for 5 and 6 days were detected in sixty years.
- We also explore the intensity of HW considering the °C above the 90th percentile, only of the maximum temperature. Large positive deviations tend to correspond to La Niña years (blue arrows).

Conclusions:

- Overall few cases of HW were detected for the analyzed period. It is important to mention that during the last decade no more than 2 events were observed.
- The long-term trends for FD does not present a clear spatial behavior, but all stations present more occurrence of FD during the first two decades compared with the last ones. On the other hand an increase in the occurrence is detected during the 90s.
- Considering the intensity, no changes were detected in the persistence, but some stations presents more events with T below -2°C during the last decade.
- Two of the stations that present a negative trend in FD. Considering the FP, Paysandu shows a clear negative linear trend, while Rocha presents clear decadal variability. Moreover, while Paysandu presents an increase in the occurrence of FD, but a decrease in the FP, Rocha does not present a clear change in FP.

Frost Days (May-Jun-Jul-Aug-Sep)

Although frost events are expected to occur only during winter time, they generate large agricultural losses (ex. forestry, citrus, etc). We analysed different aspect that characterize them.

- The long term trend analysis doesn’t show a clear spatial behavior. Only 2 stations show a negative trend and one a positive.
- We also compute the seasonal trends of cold nights index (TN10), because in Uruguay the 10th percentile of the minimum temperature is above 0°C so the frost days are included in this index. We didn’t found a clear correlation in the trends detected between both indices, although our results show that during the first 10 decades (1950-1970) occur 15 to 20 events, while in the last decades (1980-2000) no more than 10 events are observed.
- Regarding the frost intensity, we analysed the consecutive frost days (CFD) index, which shows that the usual length is around 2-4 days. The decadal analysis shows that during the first decades events lasting 4-5 days were common, while in the last decades isolated events were detected.
- We also study the intensity considering the occurrence of events in different ranges of temperature: [0,1], [1,2] and below -2°C. Overall, during the 90s there are more events below -2°C, while during the 2000s although there were less events in the coastal stations they are more intense.

In order to detect if there exist decadal differences between regions we considered Rocha and Paysandu stations that present a negative trend in frost days. Considering the FP Paysandu shows a clear negative linear trend, while Rocha presents clear decadal variability. Moreover, while Paysandu presents an increase in the occurrence of FD, but a decrease in the FP, Rocha does not present a clear change in FP.