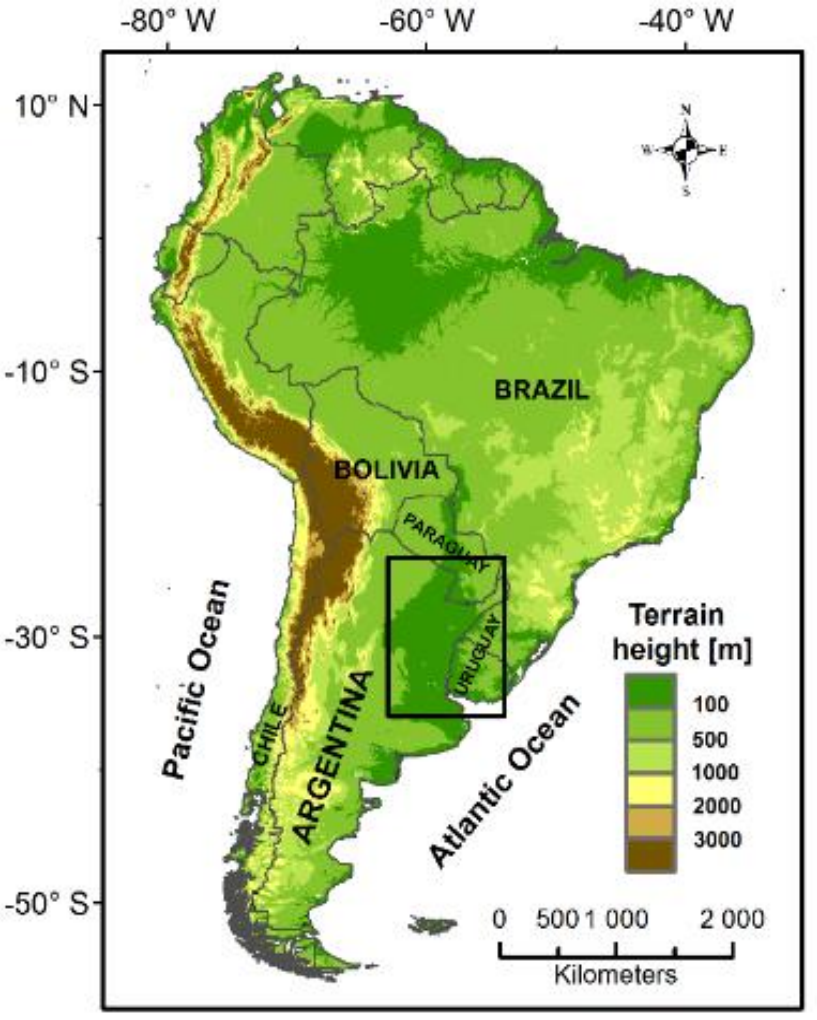
Advanced School and Workshop on American Monsoons: progress and future plans



Variability and changes of daily climate extremes over northeastern Argentina

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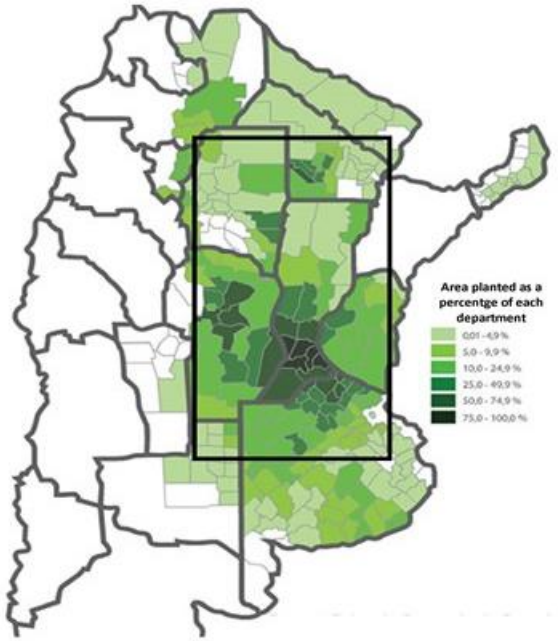
Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)

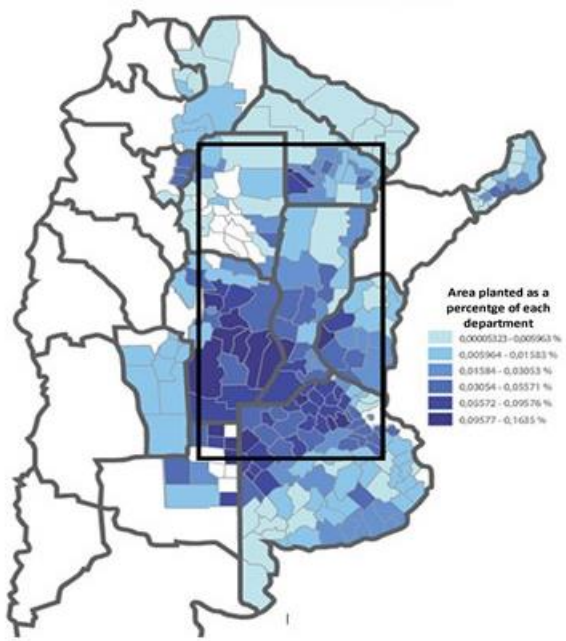
ARGENTINA

Northeastern Argentina

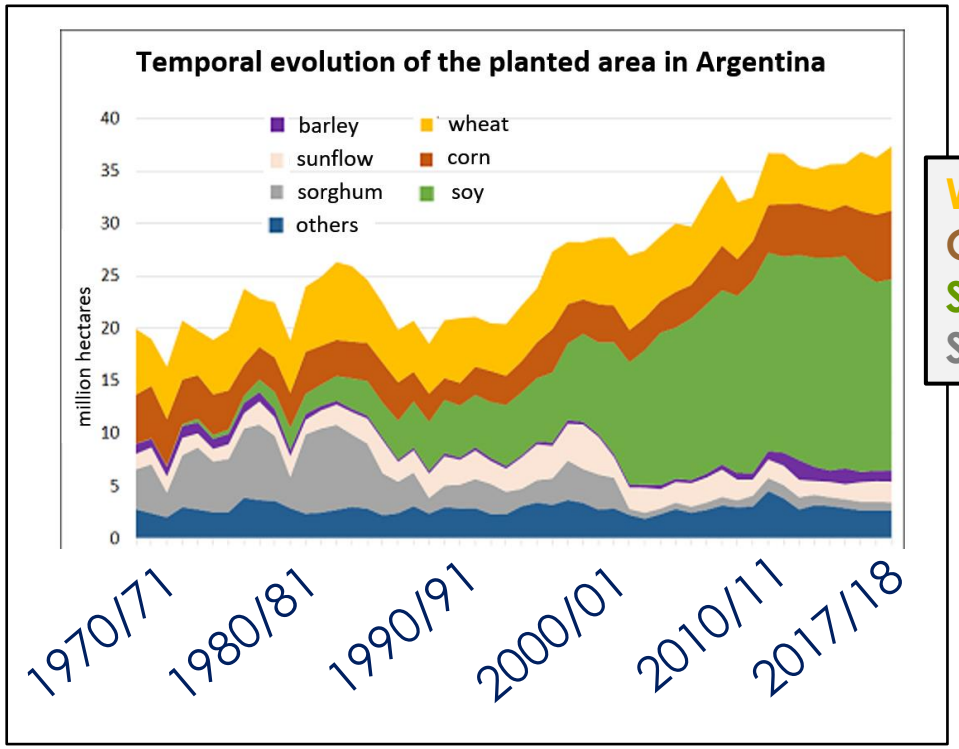
- Has 80% of the country's agricultural production.
- Holds most of the country's population.
- Experiences hydroclimate variability on different time scales and extreme events
- Has high vulnerability to climate extremes of precipitation and temperature.



Area planted with soybean



Area planted with corn



Wheat
Corn
Soybean
Sorghum

Data Source:
Rosario Stock Exchange

Social and economic impacts of climate variability in NE Argentina **(2017-2018!)**

Agriculture

Intense precipitation events lead to extensive flooding

Extreme temperature regimes reduce yields

Human Settlements

Heavy rainfall may exceed the capacity of drainage systems

Heat waves increase the population mortality risk

…Towards southeastern South America it has been detected:

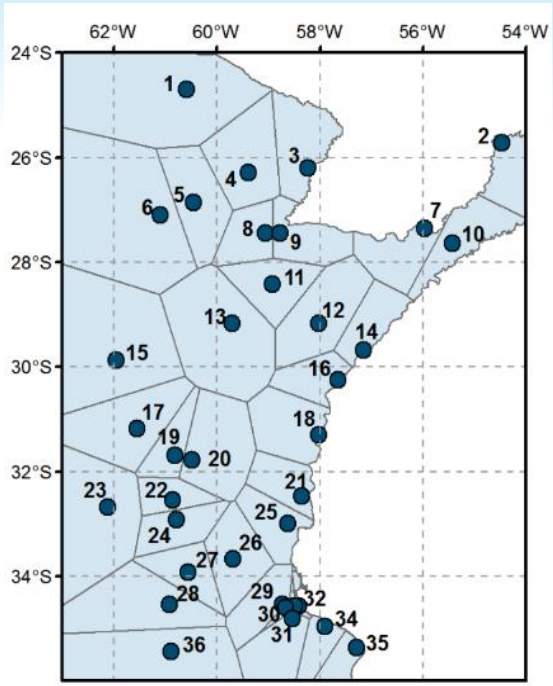
a **warming in temperature extremes** and **an increase of intense precipitation events** (moderate confidence)

Q1: How have daily temperature extremes changed in the recent past?

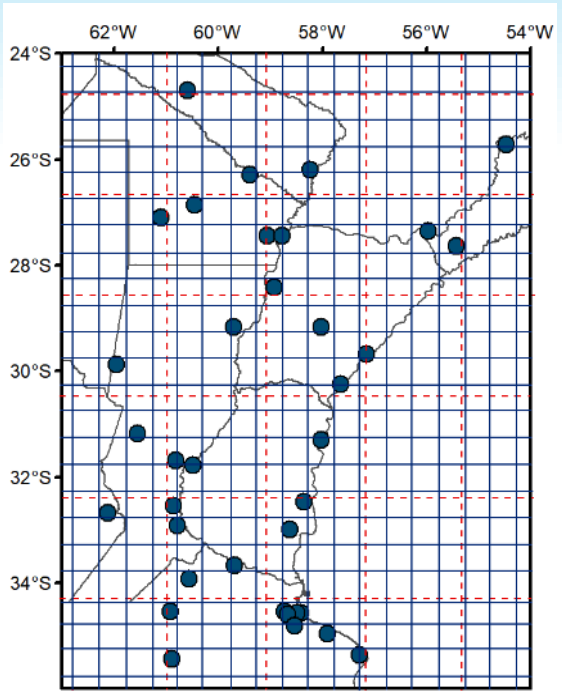
Q2: How have precipitation extremes changed in the recent past?

Q3: Given the sparsity of stations…

Observations



Reanalyses



…to what extent can global reanalyses reproduce the observed variability?

Methods

Indices proposed by the *Expert Team on Climate Change Detection and Indices (ETCCDI)*

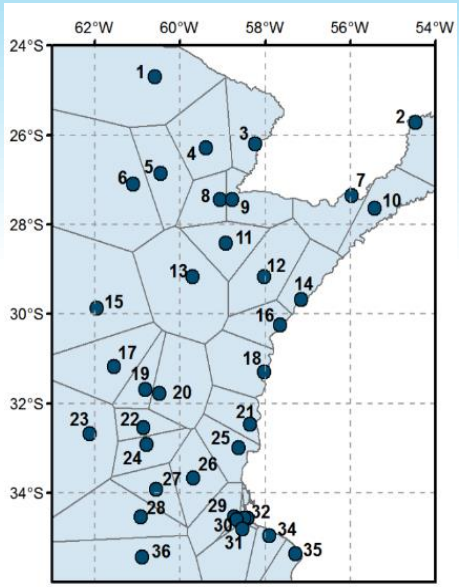
TEMPERATURE-BASED INDICES

	Index	Index Name	Index definition	Unit
Frequency	TX90p	Warm days	Percentage of annual days when $TX_{ij} > TX_{in}90$	% of days
	TX10p	Cold days	Percentage of annual days when $TX_{ij} < TX_{in}10$	% of days
	TN90p	Warm nights	Percentage of annual days when $TN_{ij} > TN_{in}90$	% of days
	TN10p	Cold nights	Percentage of annual days when $TN_{ij} < TN_{in}10$	% of days
	SU25	Summer days	Annual number of days when $TX_{ij} > 25$ °C	days

PRECIPITATION-BASED INDICES

	Index	Index Name	Index definition	Unit
Intensity	RX1day	Max 1-day P	Annual max 1-day P amount	mm
	RX5day	Max 5-day P	Annual max consecutive 5-day P amount	mm
	SDII	Simple daily intensity index	Annual P divided by the number of wet days (when P ≥ 1 mm)	mm/day
Duration	CDD	Consec dry days	Max annual number of consecutive dry days (when P < 1 mm)	days
	CWD	Consec wet days	Max annual number of consecutive wet days (when P ≥ 1 mm)	days

Observations



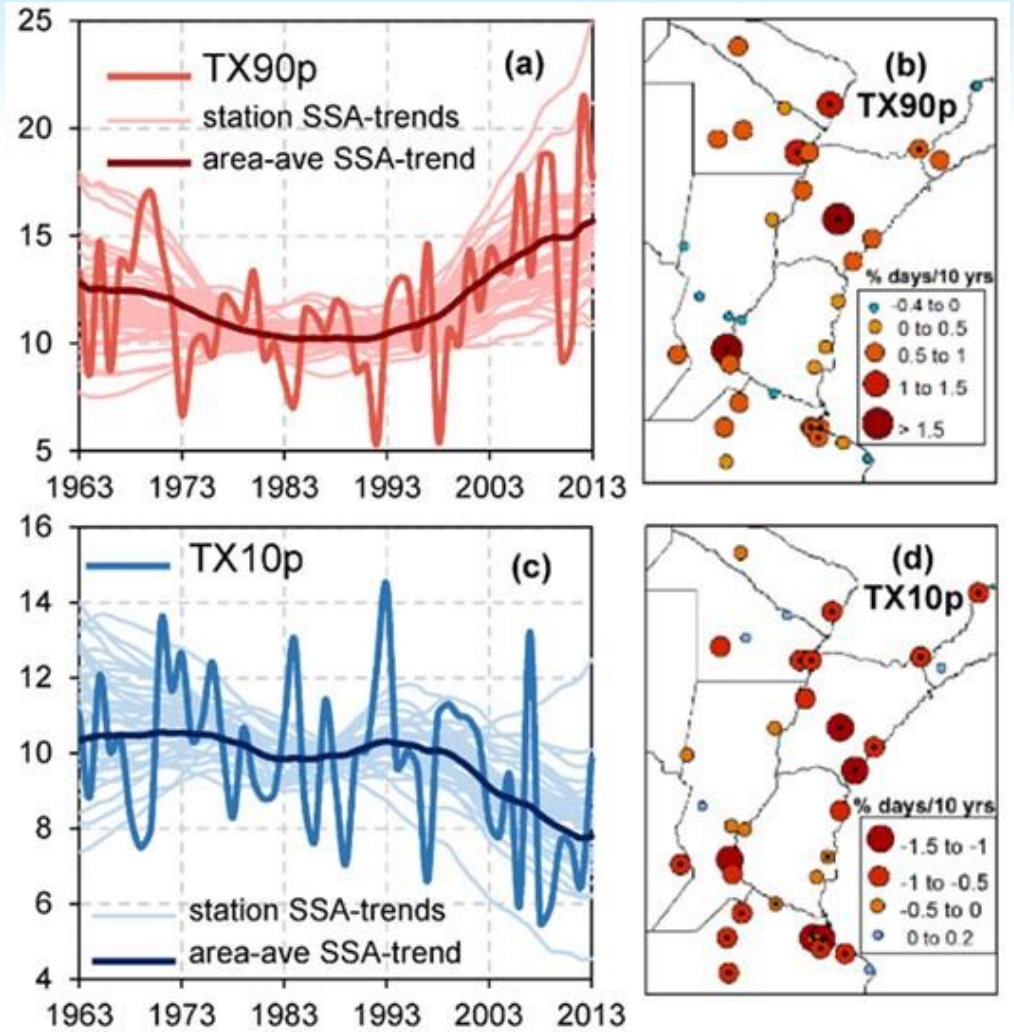
Quality controlled daily data at 36 stations selected for the quality and extent of the records (1963-2013)

1. Trends and leading modes were identified using:
   - Singular Spectrum Analysis and
   - Non-Parametric Linear Trends

2. Skill Assessments of Reanalysis Products

Extremes of maximum temperature

Q1: How have daily temperature extremes changed in the recent past?



warm days*: *Frequency of days when Tmax exceeds the 90th percentile (% of annual days)

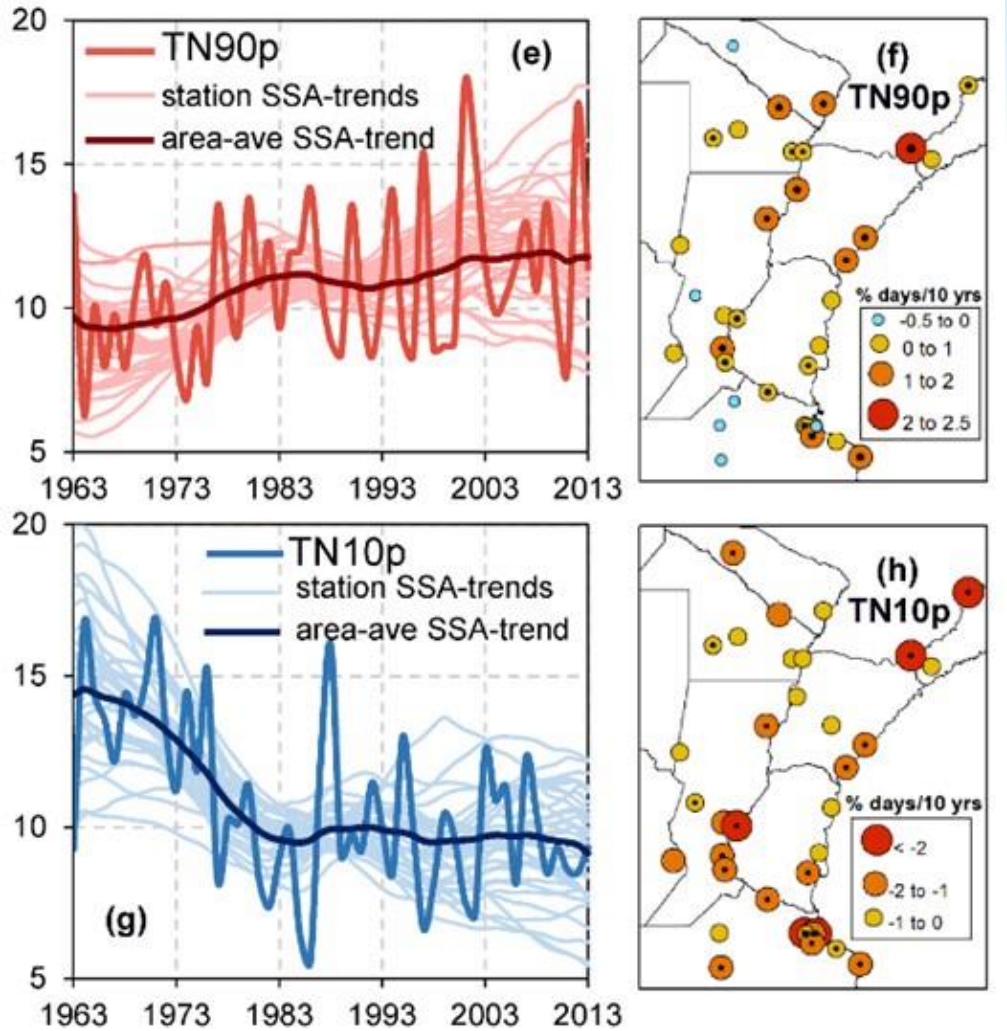
- Important interannual variability (9-yr cicle)
- Increasing since the nineties for most stations

Cold Days*: *Frequency of days when Tmax is below the 10th percentile (% of annual days)

- Decrease in the number of cold days for the most recent 15-20 years in most stations

Q1: How have daily temperature extremes changed in the recent past over northeastern Argentina?

Extremes of minimum temperature



Warm nights: percentage of nights when Tmin was above the 90th percentile

- Positive nonlinear trend
- Dispersion among stations increased after the 90s.

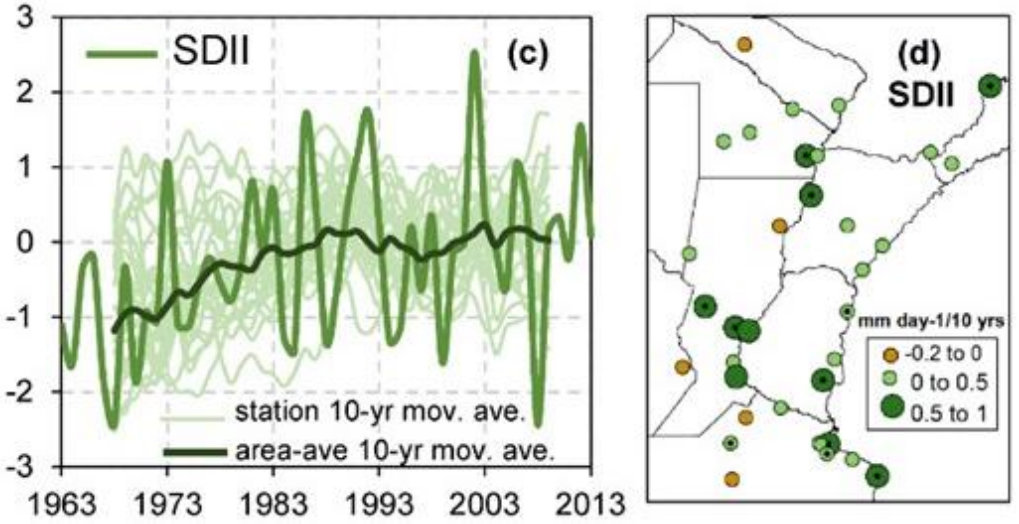
Cold nights: percentage of nights when Tmin was below the 10th percentile.

- Strong decrease of cold nights during the early period. Followed by stabilization
- Significant signal of change in all stations

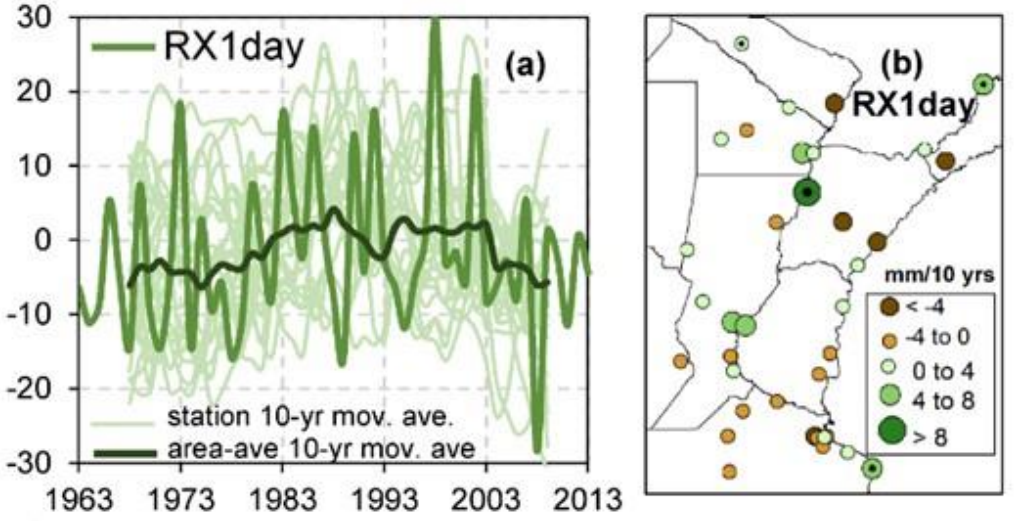
Precipitation-related extremes

Q2: How have precipitation extremes changed in the recent past?

SDII (anomalies): average of accumulated precipitation in rainy days (Intense precipitation events)



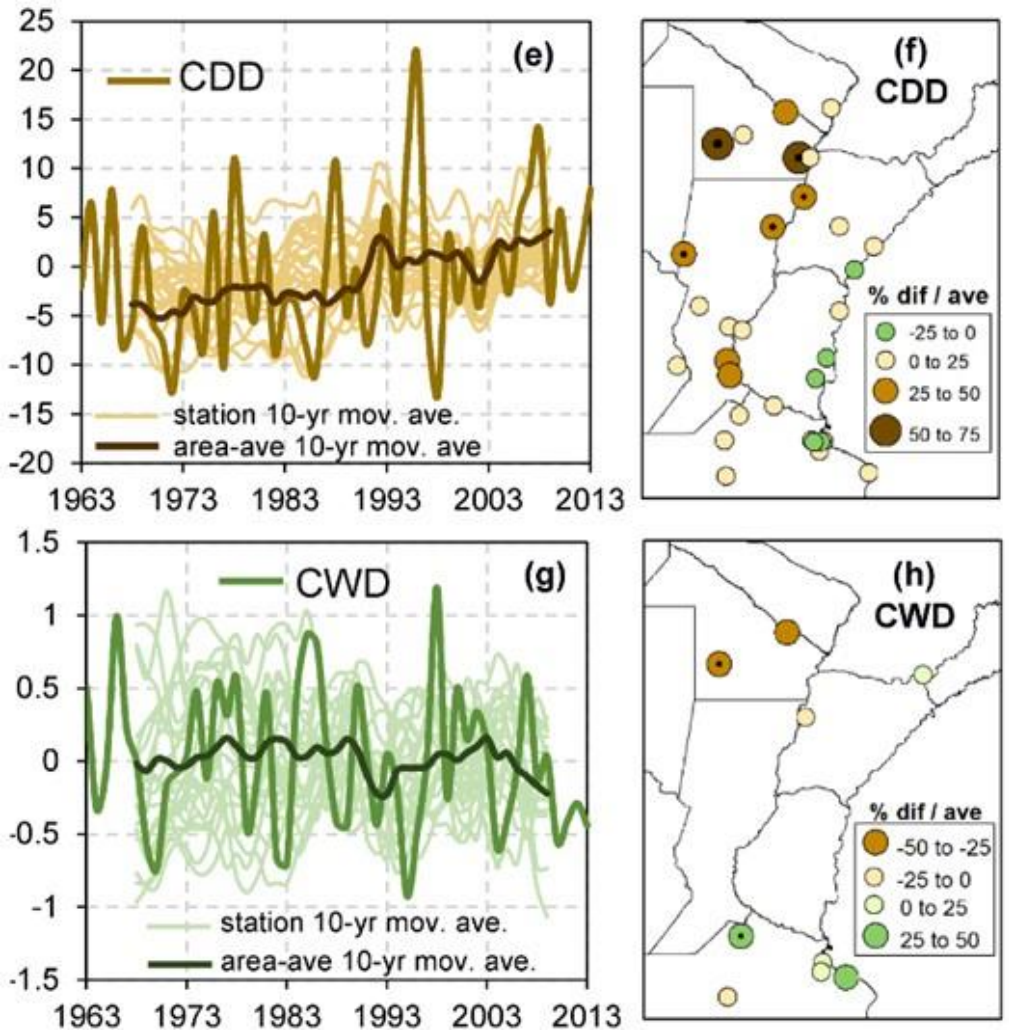
RX1day (anomalies): Annual maximum 1-day precipitation amount



- dispersion in the time series of all stations suggests a large spatial and temporal variability in intense precipitation events.
- precipitation intensity has increased since the early 1970s
- large interannual variability (ENSO -2.5- to 5-yr periodicities)

Q2: How have precipitation extremes changed in the recent past over northeastern Argentina?

Duration of dry and wet spells



Maximum annual consecutive dry days (dry spells)

- Dry spell duration has been increasing in recent decades
- Depending on the station, the duration of dry spells increased by 1 to 5 dry days per decade

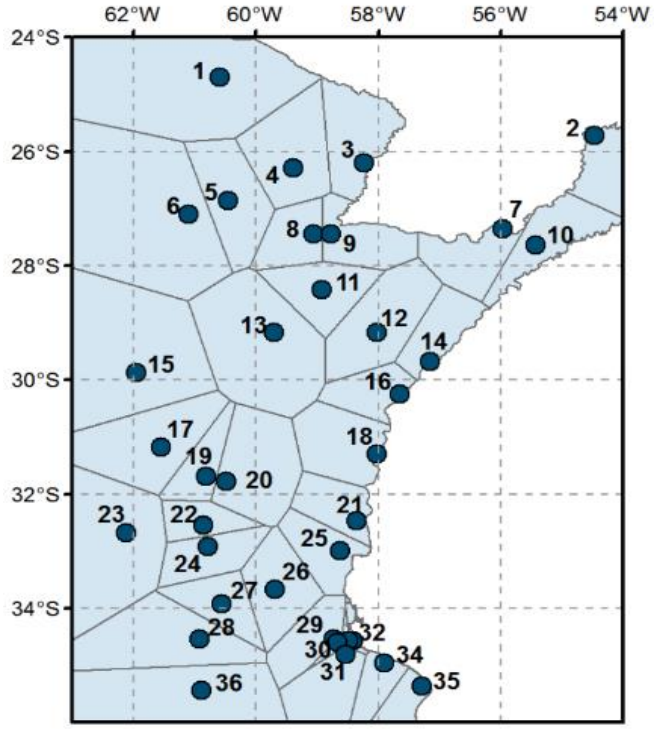
Maximum annual consecutive wet days (wet spells)

- High interannual variability

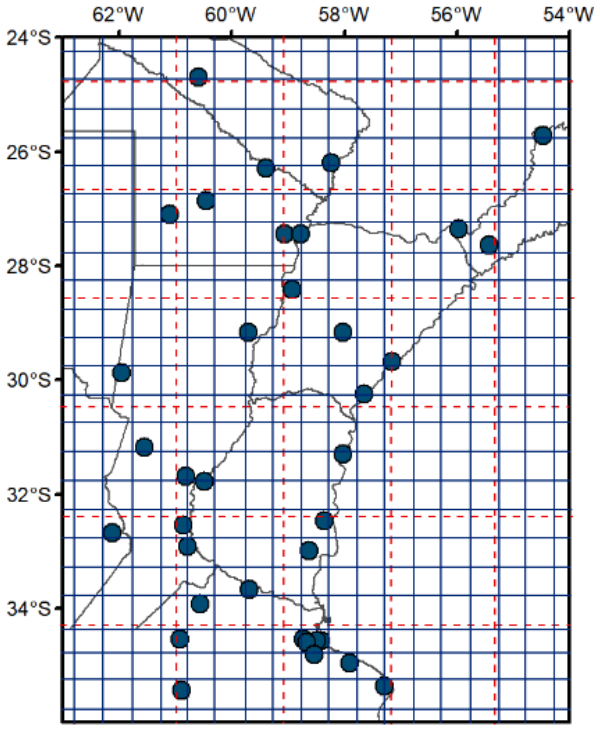
Given the sparsity of stations…

…to what extent can global reanalyses reproduce the observed variability?

Observations



Reanalyses



NCEP2
Spatial resolution
1.875 º lat x 1.904º lon

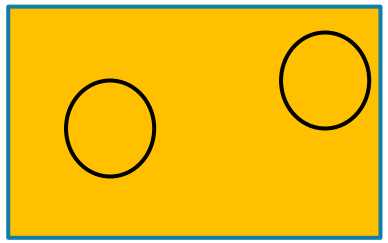
ERA-Interim
Spatial resolution
0.5º lat x 0.5º lon

TEMPERATURE-RELATED EXTREMES IN REANALYSES

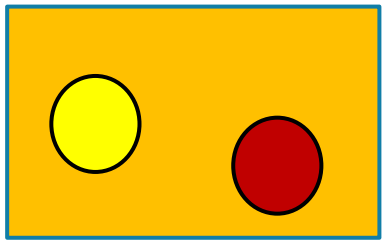
Annual number of days when Tmax exceeds 25° C (Summer days, SU25)

Climatology

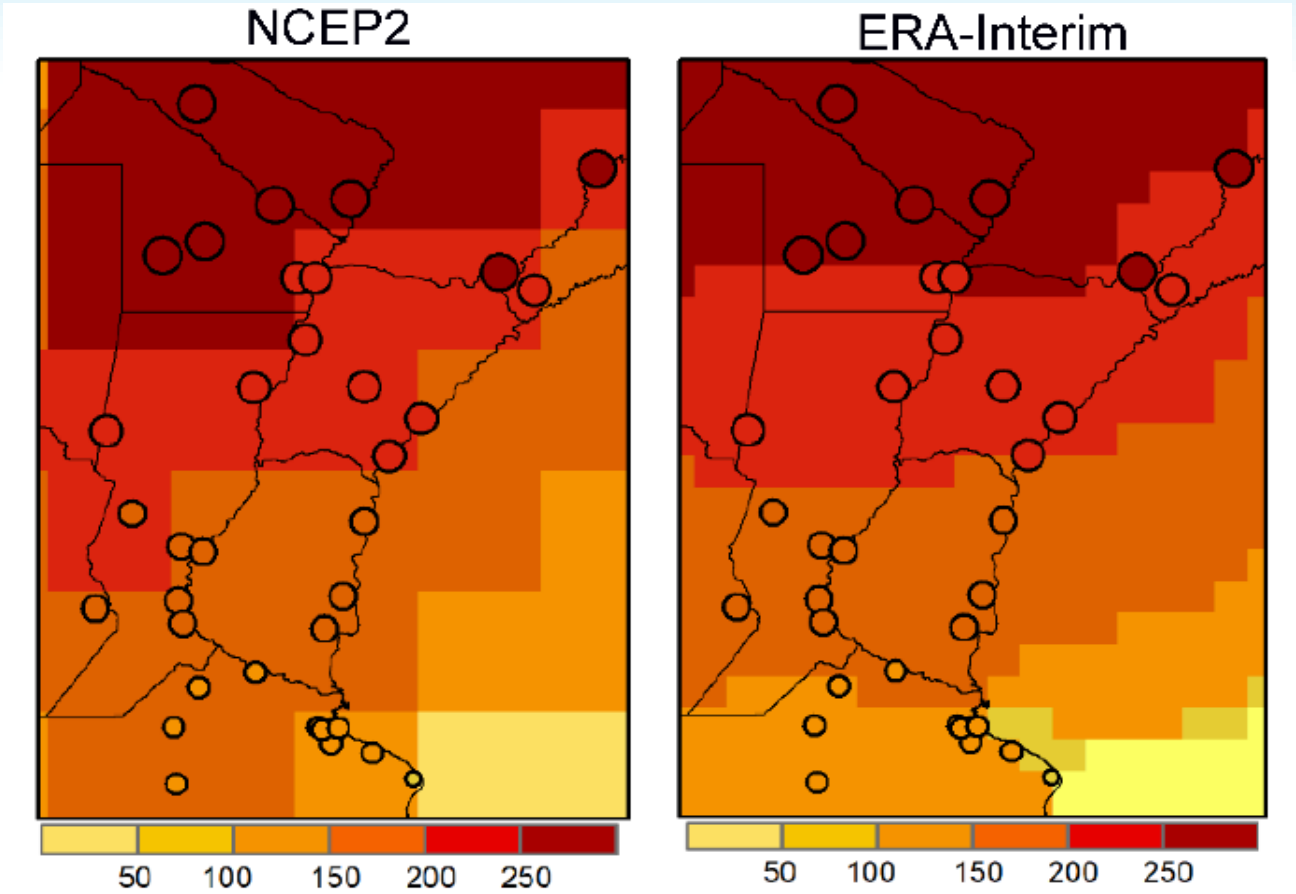
Circle: **Station value**
Background: **Reanalysis field**



Rean and Obs have ***similar values***



Rean and Obs have ***different values***

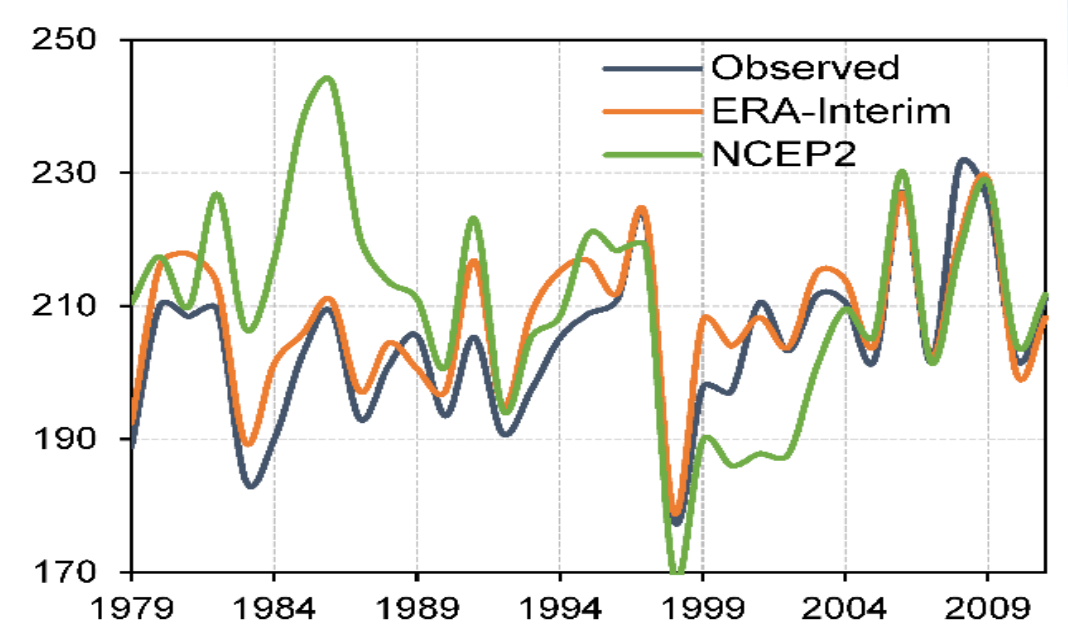


NCEP2 overestimates spatial field

Era-Interim remains close to the station values

TEMPERATURE-RELATED EXTREMES IN REANALYSES

Annual number of days when Tmax exceeds 25° C (Summer days, SU25)

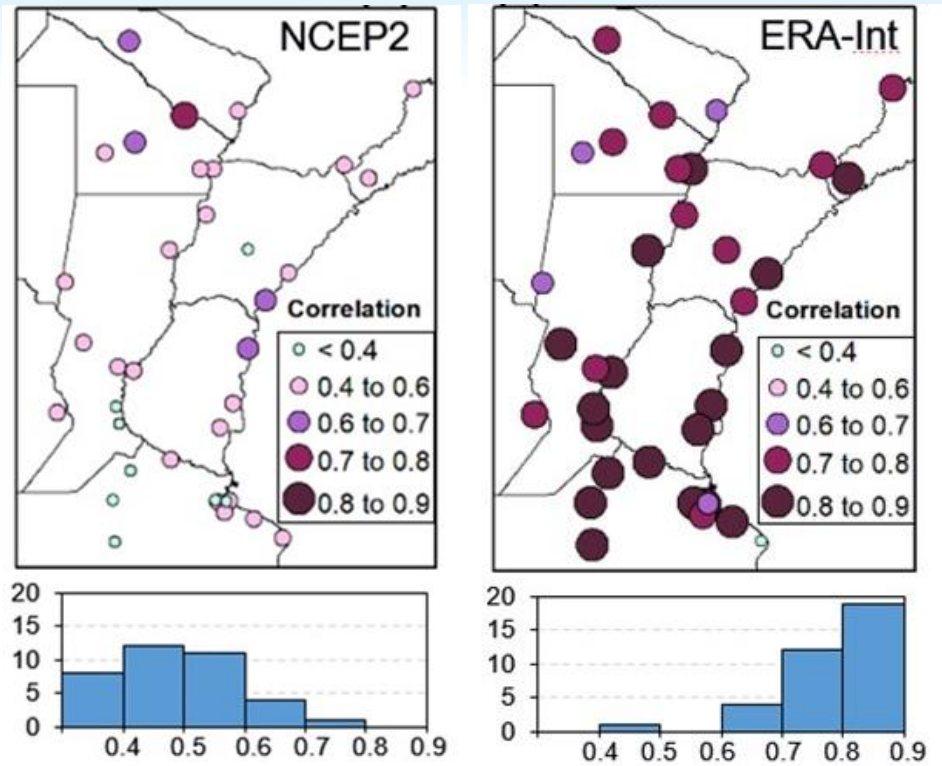


NCEP2 overestimates spatial field and temporal variability

R(NCEP2) = 0.5

R(ERA-Int) = 0.9

Correlations



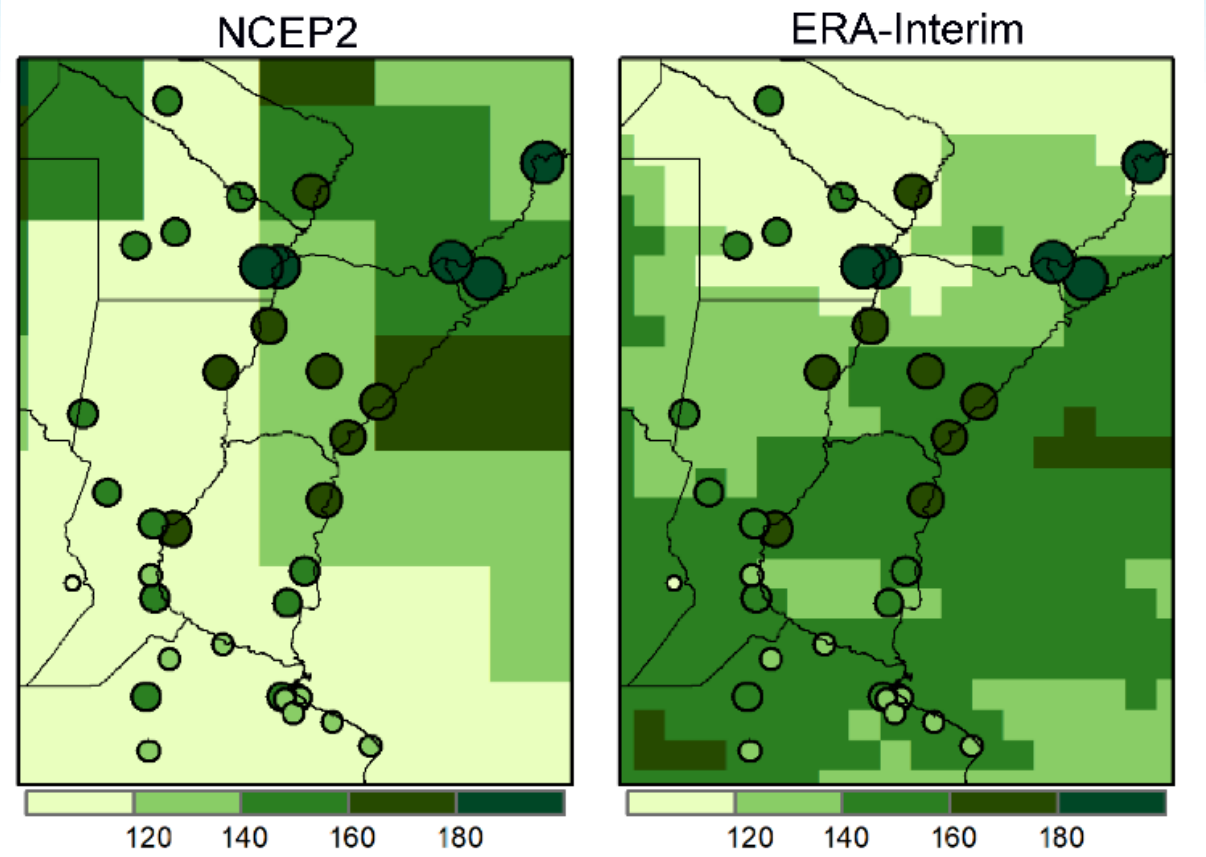
0.4 < r < 0.6 for NCEP2

ERA-Interim achieves the better performance (r > 0.7)

PRECIPITATION-RELATED EXTREMES IN REANALYSES

Annual maximum 5-day precipitation amount (RX5day)

Climatology

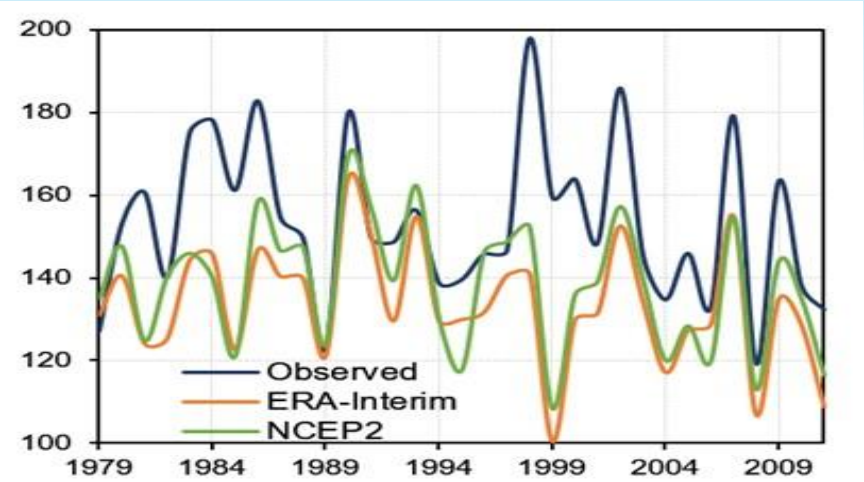


Both reanalyses fail to recognize the spatial gradient of observed RX5day

PRECIPITATION-RELATED EXTREMES IN REANALYSES

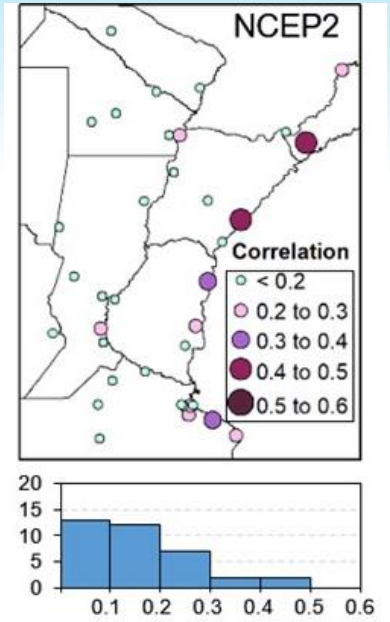
Annual maximum 5-day precipitation amount (RX5day)

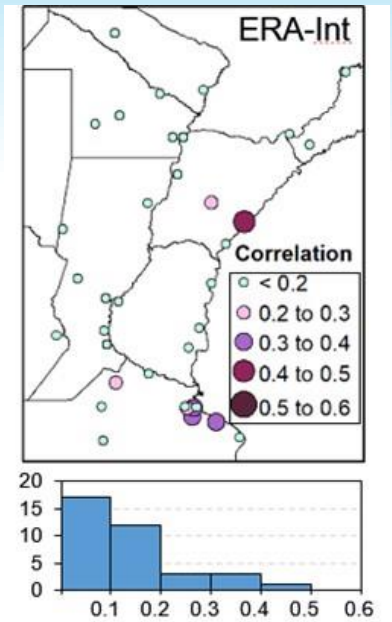
Correlations



r = 0.65 for both

Underestimation





Reanalysis do not represent observed variability of RX5day

r < 0.2 for both

The two reanalyses represent extreme precipitation events with **large biases**.

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*** in northeastern Argentina.

CONCLUSIONS

- The changes in daily temperature extremes reveal a trend towards warmer conditions over northeastern Argentina. Warm days and warm nights increased and cold days and cold nights decreased.

- Since the 1990s, *warm days have been increasing* while cold days have been decreasing. In turn, longer duration heat waves (related to dry spells) are slowly but steadily increasing.

- Intense precipitation is highly influenced by interannual variability and has increased gradually since the 1970s. The increased intensity of extreme precipitation events has led to severe floods affecting agriculture and human settlements.

- Although reanalyses would be expected to add information for climate extremes in areas of scarce observations like northeastern Argentina, they still need to be used with great caution and as a complement to observations.

- The two reanalysis studied here were unable to reproduce precipitation extremes. Better performance is achieved for temperature extremes, in particular with the ERA-Interim reanalysis.