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Extremes temperatures probability distributions functions and ENSO phases

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Abstract

The effect of the El Niño Southern Oscillation (ENSO) on the probability distribution of daily surface minimum air temperature over the temperate region of South East South America (SESA) is investigated. We used daily data for 1931-1996 period from three selected locations: : Paysandú, Mercedes y Estanzuela.

1. Introduction

Many human activities depend on termical daily conditions. Exist termical levels above or below of wich may be produce important economic losses. As application of climatic predictions availables for the region, we selected early o later dates of freeze, as matter of this study.

The Probability Distribution Functions (PDF) Normal or Gaussian is widely and sucesfully used in atmospheric sciences. Variables like extremes temperatures or daily precipitation belong to other category: **extremes events**. The term **extrem event** means the larger o smaller value that take one variable along the serie. Also for extremes values is possible fit one theoretical probability distribution function. The most usual theoretical PDF for this type of data is the Fisher-Tippett type I, also know as Gumbel distribution (E.J.Gumbel,1935).

This work tend to quantify the probabilities of ocurrrence of subfreezing daily temperatures, below 0°C (meteorological frost), at locations of western part of Uruguay, associated to warm or cold ENSO events.

2. ENSO phase

There are several alternative definitions of ENSO events (Trenberth, 1995). Most definitions are based either on atmospheric pressure patterns (i.e. the Southern Oscillation Index or SOI), on sea surface temperature (SST) anomalies in the tropical Pacific Ocean, or on a combination of both. In this research, ENSO events were categorized according to an index developed by the Japan Meteorological Agency (JMA) which has a good performance in identifying the events

Table 1. El Niño and La Niña events between 1930 and 1996 as defined by the JMA

El Niño	1940, 1951, 1957, 1963, 965,1969, 1972, 1976, 1982, 1986, 1987, 1991, 1997
La Niña	1938, 1942, 1944, 1949,1954,1955, 1956,1964,1967,1970,1971,1973,1974,1975,1988
Neutral	1931,1932, 1933, 1934,1935,1936, 1946, 1947, 1959, 1960, 1961, 1979, 1980, 1984, 1993, 1994, 1995

3. METHODOLOGY

3.1 Selection on ENSO phase

Each of 60 years of the lenght series is classified as either an El Niño year, an La Niña year, or neither (a Neutral year) based on the Japan Meteorological Agency (JMA) sea surface temperature (SST) data. Three criteria are established for the categorization of an ENSO year. First, the five month running means of the JMA SST anomalies must be +0.5°C or greater for an El Niño event (-0.5°C for the La Niña event) for at least six consecutive months. Second, the first three months of the ENSO year must be three of the six or more months in this string. Finally, the "string" of the six or more months must begin before the start of any ENSO year (i.e. begin before October).

3.2 Construction of conditioned distributions

We estimated experimental probabilities based on 36 intervals of 1 degree wide, for daily minimum extremes temperatures, for whole year. The same procedure was maked for ENSO phase conditioned series : warm, cold and neutral. Also we estimated the cumulative probabilities, below zero degrees, from experimental and two theoretical PDF (Normal adn Type I of Fisher-Tippet).

4. DATA

We selected available long series of daily data for 1931-1996 period, from three locations: : Paysandú, Mercedes y Estanzuela in South eastern South America.

Station	N°OMM	Latitude (°S)	Longitude (°W)
Paysandú	86430	32°20,9’	58°02,2’
Mercedes	86490	33°15,0’	58°04,1’
La Estanzuela	86532	34°27,4’	57°50.6’

Table N°1. Number, latitude and longitude of selected meteorological stations

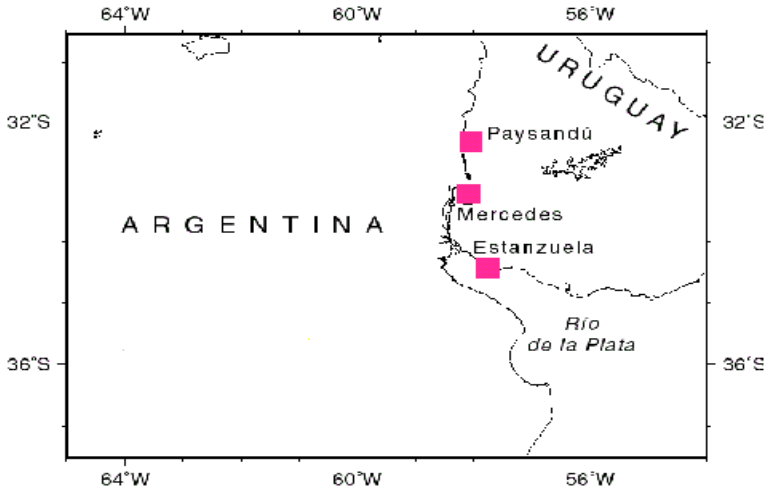


Figure 1. Region of South East South America (SESA) and location of stations (red squares).

5. RESULTS

5.1 Temperature anomalies associated with ENSO phases

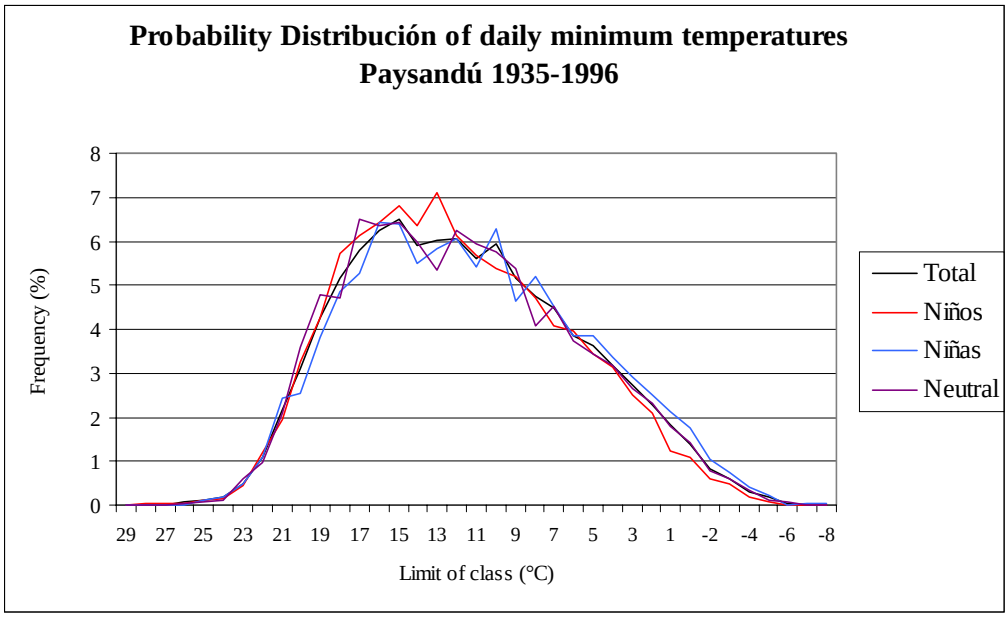
The anomalies observed in the precipitation tend to condition the anomalies of extreme temperatures. The analysis of the warm ENSO phase signal on mean minimum temperatures shows

significant positive anomalies during autumn and early winter May (0) to Jul (0) and also appear positive anomaly during early summer December (0) to January (1).

Opposite to warm ENSO phase, the cold phase on mean minimum temperature shows a little significant negative signal during early winter May (0) to Jul (0). The core of summer period December (0) and January (1) shows significant positive anomalies of minimum temperature in Mercedes and Estanzuela.

5.2 Conditioned distributions on ENSO phase.

Given what appears to be a strong, symmetric effect of ENSO on the variance, one may ask what features of the distribution are associated with these changes. Potentially, increased variance could be associated with greater temperature ranges than "normal" (i.e. with changes in kurtosis), greater deviations in one direction (i.e. changes in skewness), changes in both, or changes in neither.
Figure 2 shows the PDF of the daily minimum temperature based on all 60 years for a Paysandu and Estanzuela that has a strong conditioned on ENSO phase. .



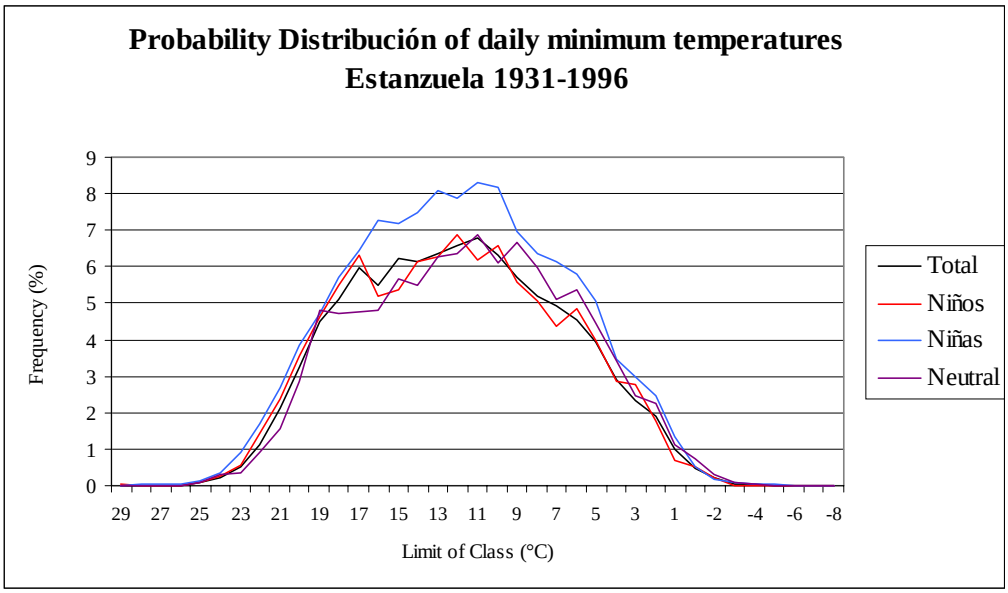


Figure 2. Empirical probability distribution in Paysandú and Estanzuela.

6. DISCUSSION AND CONCLUSION

The anomalies associated to cold ENSO phases on minimum temperatures shows a small significant negative signal during the winter and significant positive anomalies are observed in the core of the summer period.

The greater separation between phases of ENSO ocurr at Paysandú, the northern one. The conditioned distributions during warm phase, show a skewness to large values (positive) while the cold phase show skewnwess to lower values (negative). The best fit between theoretical and experimental distributions is obtained with Gumbel distribution. This results are useful for climate prediction and for economic evaluation of risk associated to winter crops, in order to consider ENSO phase.

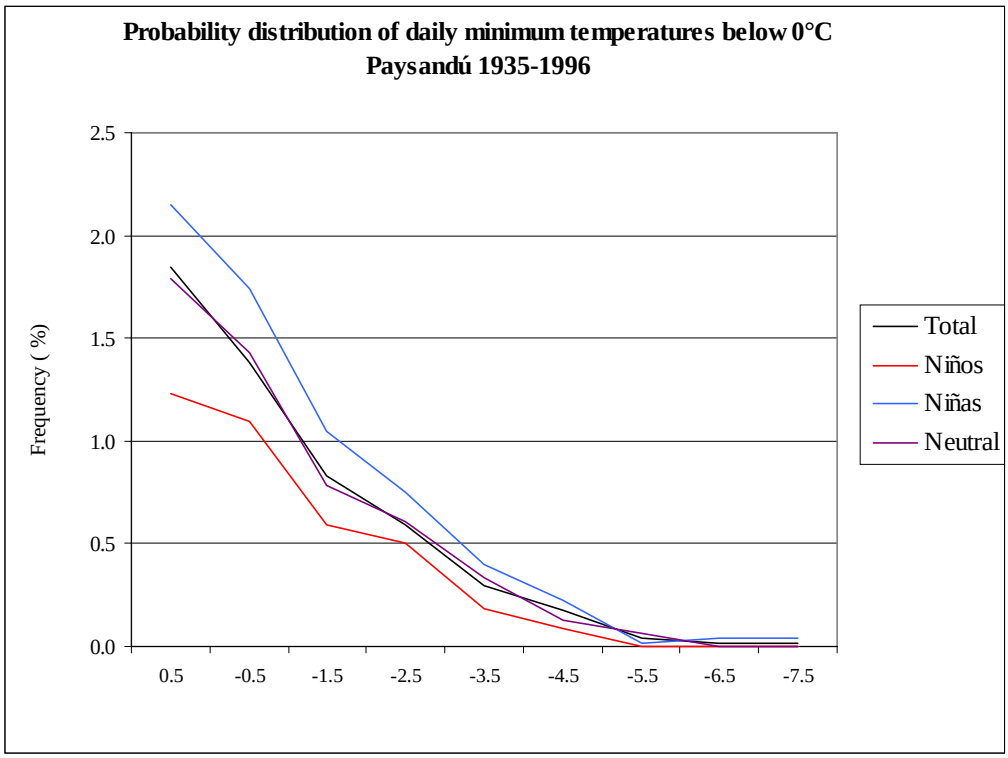


Figure 3. Empirical Probabilities of daily minimum temperatures below 0°C at Paysandú

References

Bidegain M. y P. Krecl; 1998; Anomalías de la temperatura en superficie en el Sureste de Sudamérica (Uruguay) asociadas al Fenómeno ENSO. Anales del VIII Congreso Latinoamericano e Ibérico de Meteorología. Brasilia. Brasil.

Chen,W.Y., and Van den Dool, H.M. 1997. `Asymmetric Impact of SST Anomalies on the Atmospheric Internal Variability over the North Pacific', *J. Atmos. Sci*,**54:** 725-740.

Dixon, K.W. and Harnack, J.P. 1986. `Effect of intraseasonal circulation variability on winter temperature forecast skill', *Mon. Wea. Rev.*,**114**: 208-214.

Downtown,M.W. and Miller, K.A. 1993. `The freeze risk to Florida Citrus, Part II, Temperature Variability and Circulation patterns', *J. of Climate*,**6**: 364-372.

Faragó T., R.W.Katz. 1990. Extremes and design values in Climatology. WCAP-14. WMO/TD N°386. 1990.

Fisher, R.A. , L.H.C. Tippet. 1928. Limiting form of the largest or smallerst numbers of a sample. Proc.Cambridge Philos.Soc., 24, 180-190.

Gershunov, A. and Barnett, T. 1998. `ENSO influence on intraseasonal extreme rainfall and temperature frequencies in the contiguous United States, observations and model results', *J.of Climate*, **11**:1575-1586.

Gumbel E.J. 1935. Les valeurs extrêmes des distributions statistiques. Annales de l'Institut Henri Poincaré, Vol IV, fasc.2 pag 115.

Gumbel E.J. 1942. On the Frecuency Distribution of Extreme Values in Meteorological Data. Bull.Amer.Met.Soc. Vol.23 N°3 Pag 95-105.

Hansen, J.W., Jones, C.F., Kiker, A.W. and Hodges, J. 1999. `El Niño-Southern Oscillation Impacts on Winter Vegetable Production in Florida', *J. of Climate*,**12**: 92-102.

Jenkinson, A.F. 1954, The Frecuency distribution of the annual maximum (or minimum) values of meteorological elements. Quart.J.R.Met.Soc., Vol 81, 158-171.

Karl, T.R. Knight, R.W., and Plummer, N. 1995. `Trends in high-frequency climate variability in the twentieth century', *Nature*,**377**: 217-220.

Kiladas,G.N. and Diaz,H.F. 1989. `Global Climatic anomalies associated with extremes in the Southern Oscillation', *J. of Climate*,**2**: 1069-1090.

Mearns,L., Katz,R. and Schneider,S. 1984. `Extreme High-Temperature Events: Changes in their Probabilities with Changes in Mean Temperature', *J. of Climate and Appl. Met.*,**23**:1601-1613.

Mote, T.L. 1996. `Influence of ENSO on maximum, minimum and mean temperatures in the Southeast United States', *Phys. Geog.*, **17**: 497-512.

Nakamura, H. 1996.'Year-to-Year and Interdecadal Variability in the Activity of Intraseasonal Fluctuations in the Northern Hemisphere Wintertime Circulation', *Theoretical and Appl. Clim.*, **55**:19-32.

Noel, J. and Changnonm, D. 1998. `A Pilot Study Examining U.S. Winter Cyclone Frequency Patterns Associated with Three ENSO parameters', *J. of Climate*,11:2152-2159.

Palmer, T.N. and Mansfield, D.A. 1986. `A study of wintertime circulation anomalies during past El Niños events using a high resolution general circulation model. II. variability of the seasonal mean response', *QJRMS*,**112**: 639-660.

Plummer, N. 1996. `Temperature variability and extremes over Australia - recent observed changes',*Austr. Met. Mag.*,**45**:233-250.

Rayner, N.A., Horton, E.B., Parker, D.E., Folland, C.K., Hackett,R.B.'Version 2.2 of the Global sea-ice and Sea Surface Temperature data set, 1903-1994', September 1996, Climate Research

Technical Note 74 (CRTN74), Hadley Centre for Climate Prediction and Research, Meteorological Office, London Road, Bracknell,Berkshire RG12 2SY.

Rogers, J.C. and Yersavich, A. 1988. `Daily air temperature variability associated with climatic variability at Columbus Ohio', *Phys. Geog.*,**9**: 120-138.

Ropelewski, C.F. and Halpert, M.S.1986. `North American Precipitation and temperature patterns associated with El Nino/Southern Oscillation', *Mon Wea. Rev.*,114, 2352-2362.

Ropelewski, C.F. and Jones, P.D. 1987. `An extension of the Tahiti-Darwin Southern Oscillation Index', *Mon. Wea. Rev.*, **115**:2161-2165.

Takle, E.S. and Mearns, L. 1995. `Midwest temperature means, extremes and variability: analysis of observed data'. in Carmicheal, Geregory R, Folk,G. and J.L. Schnoor (eds) Preparing for global change: a midwestern perspective. Amsterdam, the Netherlands, SPB Academic Publishing, p 127-132.

Waylen P.R. 1988. Statistical Analysis of Freezing Temperatures in Central and Southern Florida. J. Of Climatology, Vol.8, pag 607-628.

White, G.H. 1989. `Skewness, kurtosis and extreme values of Northern Hemisphere geopotential heights', *Mon. Wea. Rev.*, **208**: 1446-1455.

Wolter, K., Dole, R., and Smith, C. 1999. `Short-term climate extremes over the continental U.S. and ENSO. Part I: Seasonal temperatures', *J. of Climate*, in press.