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OBSERVED TRENDS IN PRECIPITATION AND TEMPERATURE OVER ARGENTINA

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1. INTRODUCTION

Temperature analyses show that the extratropical regions in the Southern Hemisphere, and in particular southern South America, have undergone much less warming than the Northern Hemisphere, even during the winter when the strongest warming is apparent in the NH (IPCC, 2001).

In Argentina precipitation trend shows an increase in most of the country with the maximum values toward the northeast of the region, except into Patagonia were a clear trend is not observed. In this paper trends of precipitation and temperature over 40 year period are analyzed over Argentina.

2. DATA AND METHOD

We use the daily surface maximum and minimum surface stations temperatures from the National Weather Service of Argentina (SMN) over most Argentinean provinces for 1961-2000. We remove from temperature observations the annual cycle at each site, and only consider anomalies.

Temperature anomalies with respect to the 40-year mean annual cycle for each site and each data set have been computed. Trends were computed as changes in decadal averages in the anomalies in order to reduce random errors. The decadal trend averaged over two separate periods (1981-2000, 1961-1980) is computed for every station, with an overall average computed over all the stations.

For precipitation, we also use the daily precipitation data from SMN over most Argentinean provinces for 1961-2000. Since the precipitation varies widely with location, we have introduced a normalization that allows the intercomparison of the precipitation trends in different stations.

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The total precipitation for each station is computed for each of the four decades, and then these values are divided by the total precipitation over 40 years, so that the normalized precipitation over 40 years is 1 for all stations. The trends are computed using normalized precipitation, with the same method as indicated above.

3. RESULTS

The left panel in the Figure 1 shows the 40-year trend for the maximum (top) and minimum (bottom) temperatures for all the location included in this study. The right panel shows the trend for the mean temperature (top) and the diurnal temperature range (DTR) (bottom) at station observations. The decadal trends averaged over two separate 20-year periods (1981-2000 and 1961-1980) are computed for every station and averaged in circles centered in each station site with an average computed over all the stations. Our results suggest that in Argentina (except in Patagonia) the minimum temperature increased over these 40 years by about 0.06°C/decade (areal mean). For the maximum temperature, the observations show a cooling trend of about –0.15°C/decade (areal mean), stronger in the north than in Patagonia.

The 40-year trend of the mean temperature, indicate an overall negative trend, moderate for the observations (-0.04 °C/decade). The diurnal temperature range (DTR), has a very strong negative trend of about -0.21°C/decade (again areal mean), but an increase in DTR in Patagonia. Similar results were obtained by Rusticucci and Barrucand (1974) analyzing changes in extreme temperatures based on seasonal means of daily maximum and minimum values.

The precipitation decadal trend averaged over two separate periods (1981-2000, 1961-1980) is computed for every station, and averaged over all the sites. Figure 2 shows the precipitation trend for each of the four decades: 1961-1970, 1971-1980, 1981-1990 and 1991-2000. In the period 1961-2000, the precipitation trends increase in most of

the country with the maximum values toward the northeast of the region. Also it is not possible to definitively attribute to the precipitation changes, our results suggest that increase in precipitation at least in part would tend to decrease the maximum temperature and increase the minimum temperature, because precipitation contribute to an increase in the heat storage capacity of the surface.

Analyzing each decade separately (Figure 2), the major contribution to the increase of precipitation for the 40 year period, can be observed during the fourth decade (1991-2000), and the minor contribution is observed during the first decade (1961-1970). Note in the fourth decade, precipitation increase in the whole country. The Figure 3 shows a summary of the pattern trends in Argentina. Most of the region precipitation trends are positive, except in Patagonia were a clear trend is not observed.

Regarding annual variation, Castañeda and Barros (2001) studied seasonal precipitation trends over the west of Argentina north of 40° South during the period 1959-1996. These authors show precipitation trends were small in spring, whereas the greatest positive trends occurred in summer.

4. SUMMARY

In this paper trends of precipitation and temperature over 40 year period are analyzed over Argentina. Daily maximum and minimum surface stations temperatures from the National Weather Service of Argentina over most Argentinean provinces for 1961-2000 and precipitation are used. Temperature anomalies with respect to the 40 year mean annual cycle for each site and each data set has been computed. The decadal trend averaged over separate periods (1961-2000) for temperature is computed for every station, with an overall average computed over all the stations.

Our results suggest that in Argentina (except in Patagonia) the minimum temperature increased over this 40 year by 0.06º C/decade (areal mean). The maximum temperatures show a cooling trend in the observations of about -0.15ºC/decade.

The precipitation decadal trends averaged over two 20-years separate periods (1981-2000 and 1961-1980) is computed for every station and averaged over all the sites. Results show precipitation trends with an increase in most of the country with the maximum values toward the northeast of the region, except into Patagonia were a clear trend is not observed. Analyzing each decade separately, the major contribution to the increase of precipitation for the 40 year period, can be observed during the fourth decade (1991-2000).

Also it is not possible to definitively attribute to the precipitation changes, our results suggest that increase in precipitation at least in part would tend to decrease the maximum temperature and increase the minimum temperature, because precipitation contribute to an increase in the heat storage capacity of the surface.

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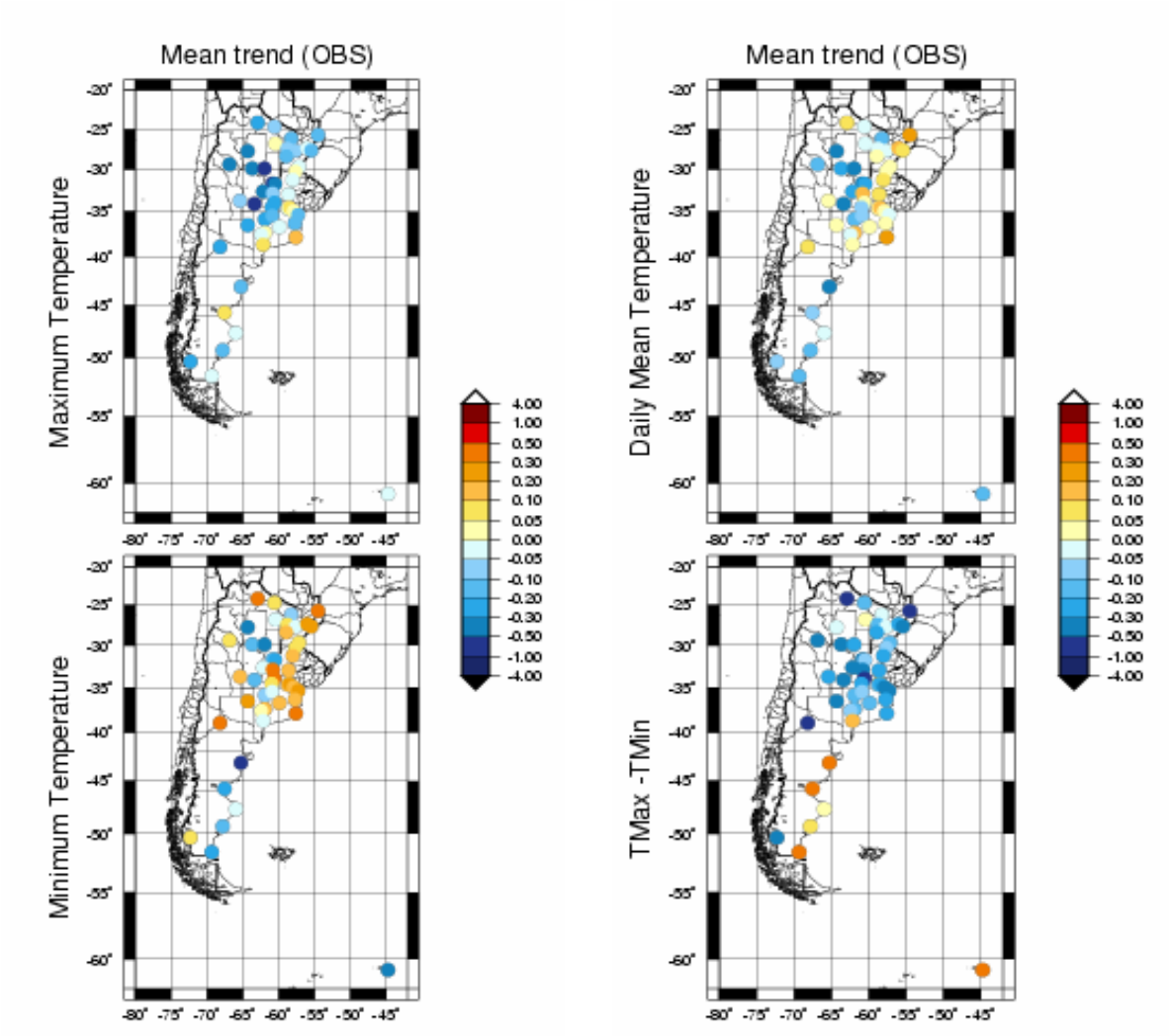

Figure 1: Trends of the surface maximum temperature between 1960 and 2000 (left) and trends of daily mean temperature (right) are shown in the top panel. In the bottom panel trends of the surface minimum temperature (left) and DTR (right) are shown.

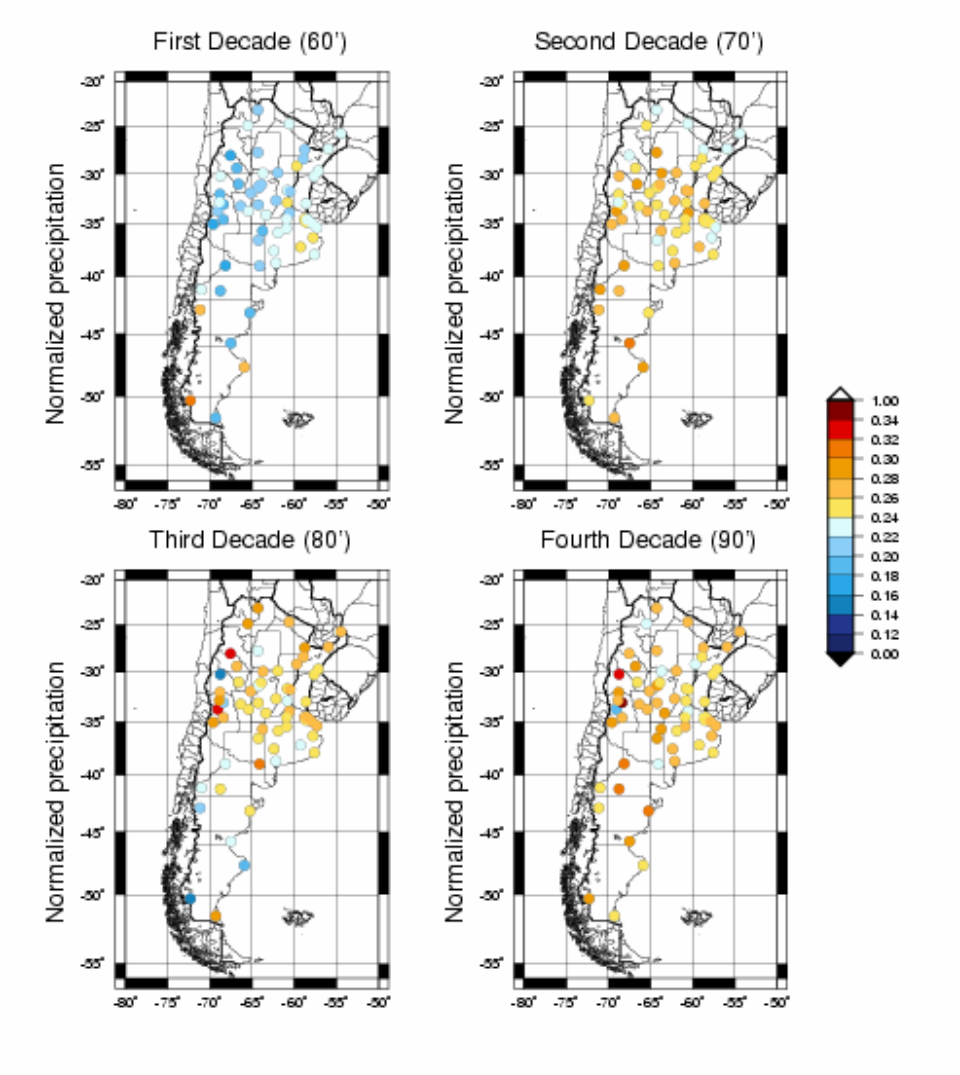

Figure 2: Precipitation trend for each of the four decades: 1961-1970, 1971-1980, 1981-1990 and 1991-2000.

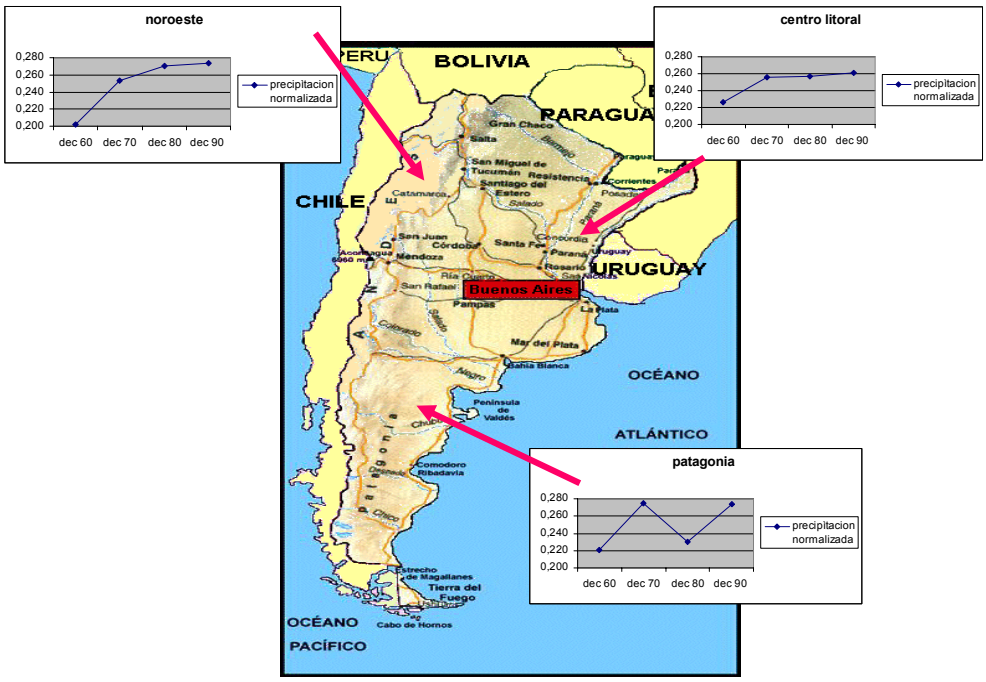

Figure 3: Patterns of precipitation trends in Argentina.