

# **Temperature trends in Argentina (Southern Hemisphere) and Spain (Northern Hemisphere) during the dimming and brightening periods**

## **Introduction**

Wild (2012) reported that from 1950s to mid 80s a “global dimming” occurred in the Earth, reaching less solar radiation to the Earth due to an increase in the aerosol emissions to the atmosphere. This reduction in solar radiation cooled the Earth, which counteracted the warming due to a greenhouse gases increment. This fact contributed to a rejection of global warming along the dimming period. However, from mid 80s the aerosol quantities were reduced, making an increase in solar radiation (global brightening period) which increased the temperature in addition with the greenhouse gases. The aerosol changes in Northern Hemisphere were stronger in Northern Hemisphere than in Southern Hemisphere, therefore temperature trends in the mentioned periods should be found in both hemispheres.

The main object of this work is to observe and quantify the temperature trends in Southern Hemisphere and Northern Hemisphere during the dimming and brightening periods. Moreover other interesting periods will be analyzed.

## **Data and places**

In order to obtain enough temperature data from both hemispheres, all data from Argentina (90 stations) and Spain (40 stations) have been obtained. The downloaded data have been the available monthly temperature.

## **Results**

The anomalies of the monthly temperature of each location have been calculated by normalization with the period 1951-1980, considering that 30 years is enough for it. The normalization has been done just only the series have not more than two data lacked in the 1951-1980 period. Once obtained the anomalies series of each station, they have been averaged for Argentina and Spain (using all available anomalies series in each country). If there are not at least three locations to make the country average, then the average value will be not considered. The Spanish and Argentinean monthly anomalies have been annual average, and finally, two temperature anomalies series have been obtained. Figure 1 (upper) shows the yearly evolution of the two series, and an increase in temperature can be appreciated in the last decades.

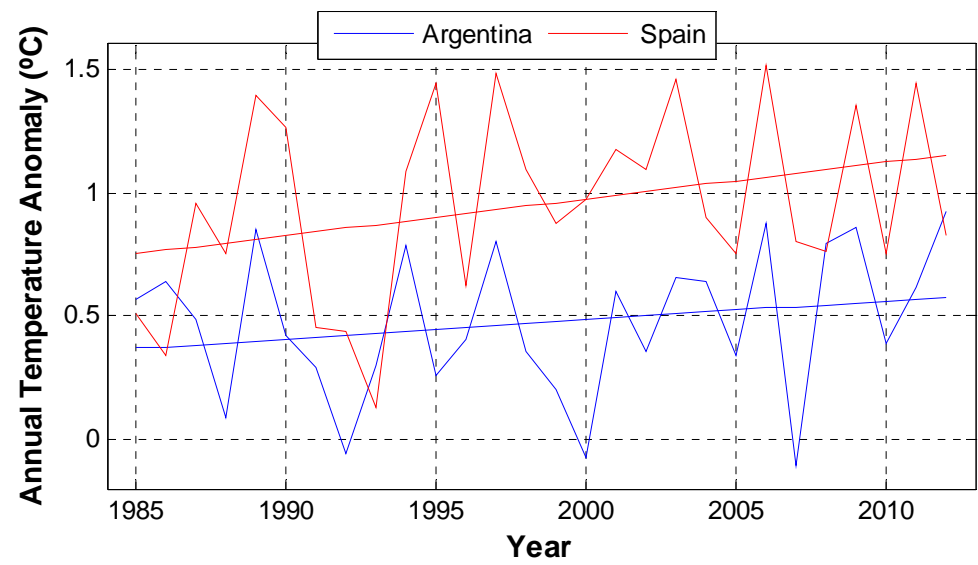
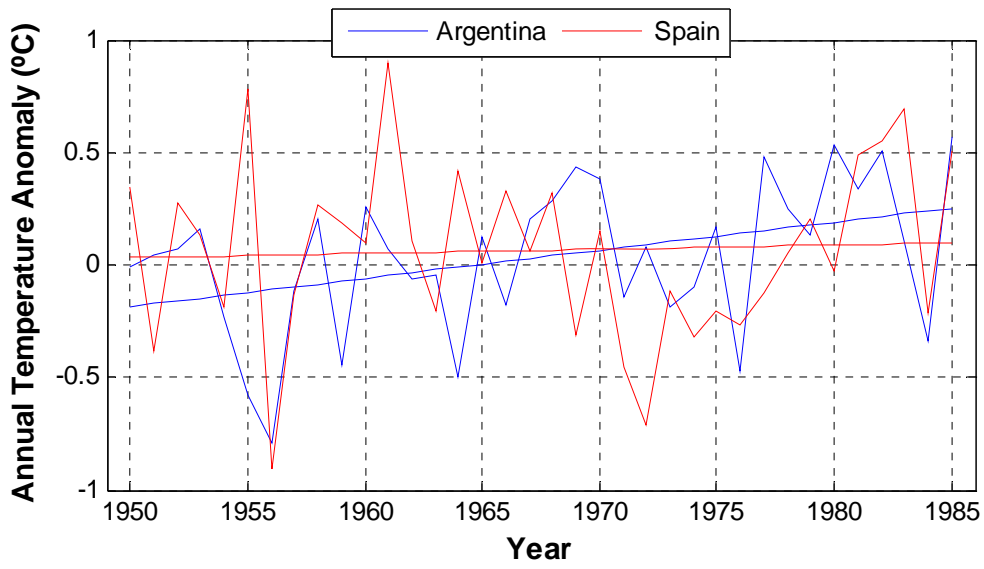
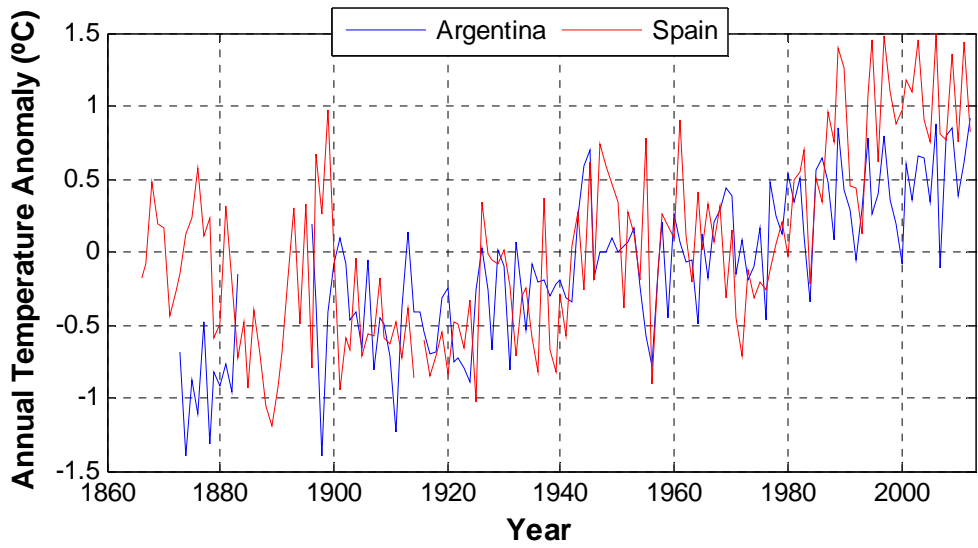


Figure 1: Annual temperature anomalies in Argentina and Spain for different periods. The solid line indicates a linear fit.

Figure 1 (middle and down) also shows the anomalies for the dimming and brightening periods with the linear trends. In Northern hemisphere the trend in the dimming period is null, but not in Southern (positive trend). On the other hand, the increase is higher in the Northern than in Southern for the brightening. The trends calculated using the Theil-Sen estimator, their 95% confidence interval (95CI), and the p-value (useful to determinate statistically significance of the trend) calculated by the Mann-Kendall nonparametric test (Gilbert, 1987) are in Table 1. The trend in Argentina ( $0.13^{\circ}\text{Cdc}^{-1}$ ) in the dimming is practically statistically significant with a confidence of 99%, but in Spain is near zero and not significant. The trend in Spain ( $0.13^{\circ}\text{Cdc}^{-1}$ ) is higher than in Argentina ( $0.08^{\circ}\text{Cdc}^{-1}$ ) in the brightening, and both are statistically significant with a confidence higher than 70% but lower than 15%.

Table 1: Temporal trends and their 95% confidence interval (95CI) in different locations and periods.

Location	period	Trend ( $^{\circ}\text{Cdc}^{-1}$ )	95CI	p-value
Argentina	(1950-1985)	0.134	(0.020:0.245)	0.01086
Spain	(1950-1985)	0.012	(-0.154:0.177)	0.9457
Argentina	(1985-2012)	0.082	(-0.099:0.2956)	0.2772
Spain	(1985-2012)	0.131	(-0.112:0.358)	0.1728

## Conclusions

The results confirm the effect of changes in aerosols (dimming and brightening) on temperature in both hemispheres, and the existence of a global warming.

## References

- Gilbert, R. O. (1987), Statistical methods for environmental pollution monitoring, Van Nostrand Company, Hoboken, N. J., 320 pp.
- Wild, M. (2012), Enlightening global dimming and brightening, Bull. Amer. Meteor. Soc., 93, 27–37, doi:10.1175/BAMS-D-11-00074.1.