P1.9 TREND AND INTERANNUAL VARIATIONS IN AIR TEMPERATURE OVER THE IBERIAN PENINSULA

C. Rodríguez-Puebla,* L.A. García-Casado, M.D. Frías
Universidad de Salamanca, Salamanca, Spain
J. Sáenz and J. Zubillaga
Universidad del Pais Vasco, Bilbao. Spain

1 INTRODUCTION

Much effort has been focused on the analysis of temperature time series in order to identify the causes of trends and other variations. It is also of great interest for predicting statistical properties of temperature for activities, such as agriculture, which are very sensitive to seasonal climate variations. It is well known that atmospheric circulation controls regional temperature changes, and relationships between circulation indices and temperature variations have been obtained in many studies (Hurrel 1996; Maheras and Kutiel 1999; Slonosky et al. 2001; Trigo and Palutikof 1999). The Iberian peninsula (IP) climate is subject to both subtropical and mid-latitude weather systems and the seasonal predictions require better understanding of the links between regional climate and the atmospheric and surface conditions. Therefore, the aims of this paper are to determine: the significant trends in temperature time series; whether or not the trend is present in all seasons; which component of temperature, maximum or minimum, is responsible for the most significant trend and the possible causes of temperature variations to find a potential source of predictability. The results assess significant trends in maximum winter temperature and in minimum summer temperature. These variations are connected with atmospheric Atlantic circulation for winter and sea surface temperature for summer. The relationships are identified in the temporal and spectral domain and the links could be useful for statistical predictions of anomalous temperature regimes.

2 DATA AND METHODS

This study uses the temperature series from different sources as: 1) observations of mean, maximum and minimum recorded at 55 stations irregularly distributed over the IP for the period 1949 to 2000 (Font Tullot 2000), provided by the Meteorological Institutes of Spain and Portugal; 2) observed gridded (0.5x0.5) monthly mean temperatures available through the Climate Impact LINK Project (New et al. 2000) for the period 1949 to 1995; 3) observed gridded (0.5x0.5) monthly mean temperatures interpolated from the Global Historical Climatology Network (Willmott and Matsuura 2001) for the period 1950 to 1999; 4) monthly mean maximum and minimun air temperatures of reanalysis data from the National Centers for Environmental Prediction (NCEP) for the period 1953 to 1999 at 2.5 grid lat-long (Kistler et al. 2001). Reanalysis data of Geopotential and wind from NCEP; sea surface temperature at 2.0 grid lat-lon from the Climate Prediction Center (CPC) and the climate indices from CPC and the Arctic Oscillation. The surface temperature reanalysis data were tested with the observations at stations and gridded because NCEP-NCAR reanalysis data are becoming very useful for climatic studies. The mean annual temperature patterns (Figure 1) obtained with data from different sources were very similar. Chelliah and Ropelewski (2000) also found that reanalysis data and gridded observed temperature were well correlated. However, the patterns of variability measured by the standard deviation are quite different.

The time series of annual temperature anomalies evidence a slight decrease until 1970's and then a tendency to increase up to the present time (Figure 2), which is in agreement with other regional and global studies (Parker et al. 1994; Tett et al 1999). The analysis of temperature evolution by seasons indicates a stronger tendency to an increase in maximum winter temperature (Tmaxw) and in minimum summer temperature (Tmins). Therefore, the results obtained for the Tmaxw and the Tmins were explored.

* *Corresponding author address*: C. Rodriguez-Puebla. Dept. de Fisica de la Atmosfera. Universidad de Salamanca. 37008 Salamanca. Spain. email: *concha@usal.es*

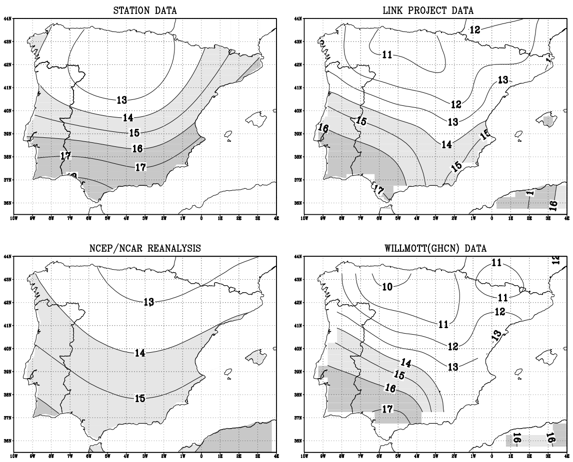

Figure 1: Spatial distribution of annual mean temperature(C).

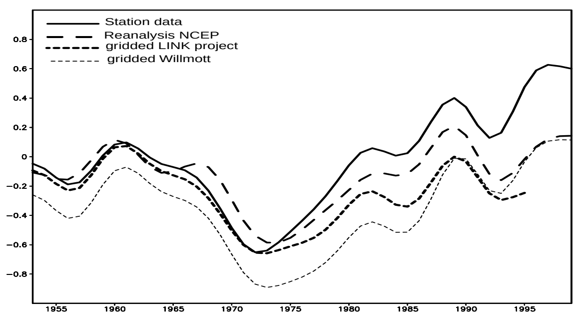

Figure 2: Time series af annual temperature anomalies.

3 RESULTS

To reduce the data dimensionality and to remove some noise variations, the Empirical Orthogonal Functions (EOFs) were obtained. The associated principal component (PC) time series were analyzed to identify trend, anomalous warmer and cooler spells and other interannual variations. The first EOFs of Tmaxw and Tmins, which described 71% and 57% of the total variance, represent mean state and most significant variability of temperature. Table I depicts the correlation coefficients between the first principal component of Tmaxw obtained with the stations $(PC1_s)$ and reanalysis $(PC1_r)$ data, and also with some circulation indices such as the East Atlantic pattern of February (EA2), the Arctic Oscillation of February (AO2) and the Iberian Oscillation Index (IOI) of winter, which is the difference in geopotential at 700 hPa between the areas [5W to 5E and 20N to 30N]-[30W to 20 W and 45N to 50N]. The IOI is proposed in this study to characterize the winter temperature variations over the IP; the dipole was extracted from the composite of geopotential difference at 700 hPa for the four warmer and four cooler years according to PC1 of Tmaxw (Figure 3). The dipole structure was also identified by the correlation map between the first PC of Tmaxw and the geopotential at 700 hPa.

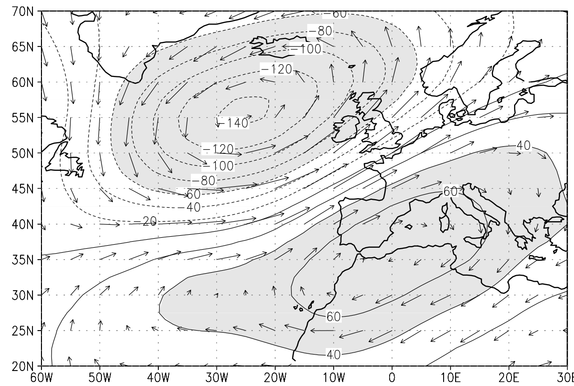

Figure 3: Composite of 700 hPa difference for the four warmer and four cooler years according to PC1 of Tmaxw.

TABLE I: Correlation coefficients between $PC1_r$ (reanalysis data) and $PC1_s$ (station data) of Tmaxw and other indices explained in the text.

	$PC1_s$	$EA2$	$AO2$	IOI
$PC1_r$	0.91	0.62	0.34	0.83

Figure 4 shows the PC's of Tmaxw, obtained with the reanalysis and station data, and the IOI. The three time series show an increase trend, mesured by the Mann-Kendall Z test that are: $PC1_s = 3.9$, $PC1_r = 2.4$, $IOI = 2.8$.

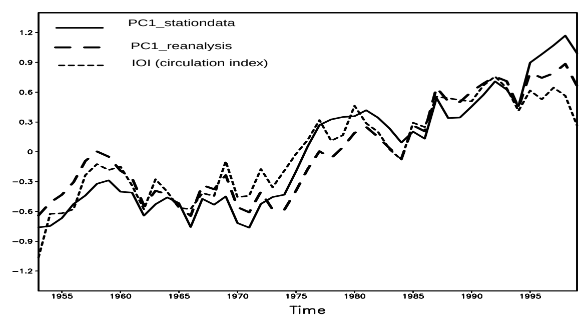

Figure 4:Time series of Tmaxw PC's and IOI.

Table II depicts the correlation coefficients between the PC of Tmins obtained from reanalysis data, the station data, the North Atlantic Oscillation of July (NAO7), and the SST for the area [20W to 10W and 25N to 45N], or the Iberian SST Index (ISST). This center of action (Figure 5) was recognized by obtaining the composite SST map for the four warmer and four cooler summer years and it was also identified by correlation between the first PC of Tmins and the SST over the Atlantic region.

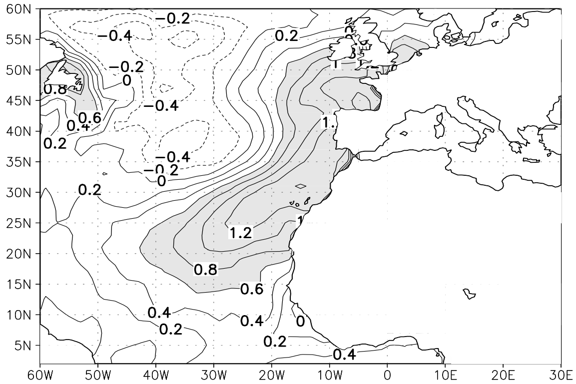

Figure 5: Composite of SST difference for the four warmer and four cooler years according to PC1 of Tmins.

TABLE II: Correlation coefficients between $PC1_r$(reanalysis data), $PC1_s$(station data) of Tmins and the indices NAO7 and ISST.

	$PC1_s$	$NAO7$	$ISST$
$PC1_r$	0.90	0.46	0.73

Figure 6 shows the evolution of the PCs of Tmins and the ISST, the time series indicate an increasing trend since 1975 and the Mann-Kendall Z tests are: $PC1_s = 3.3$, $PC1_r = 2.3$, $ISST = 1.4$.

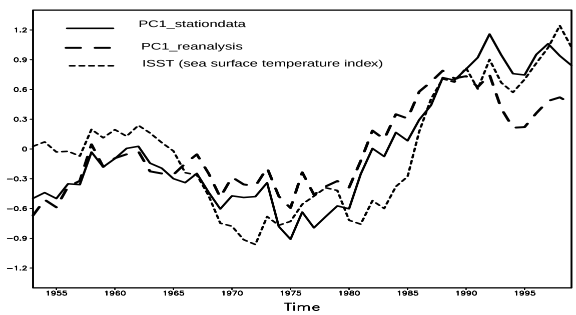

Figure 6: Time series of Tmins PCs and ISST.

The IOI and ISST indices would be useful for predicting extreme temperature anomalies in winter or summer respectively by means of downscaling techniques. The association between the variability of indices and temperature over the Iberian peninsula is obtained with the heterogeneous correlation maps between the indices and the temperature time series. Previous papers (Saénz et al. 2001a,b) found that ithe main temperature variations over the IP are associated with EA but they are not associated with NAO. In this paper we propose the Iberian Oscillation Index (IOI) to downscale anomalous maximum temperature in winter, and the Iberian sea surface temperature (ISST) to downscale minimum temperature in summer. The Energy balance and water cycle are being investigated to explain the different seasonal temperature behavior.

ACKNOWLEDGMENTS

We wish to acknowledge: The Spanish and Portuguese Meteorological Institutes; The Climate Impacts LINK Project on behalf of the Climate Research Unit (UK); The NCEP/NCAR for the reanalysis data (USA); D.W. Thompson for the Arctic Oscillation; The CPC (USA) for the teleconnection indices; Willmot et al. for the GHCN data; Reynolds and Smith for the SST. The *Comisión Interministerial de Ciencia y Tecnología, Programa Nacional,* project CLI99-0845-CO3-02 and *Colaboración de de la Consejería de Educación y Cultura de la Junta de Castilla y León y de la Unión Europea (Fondo Social Europeo)*, Project SA57/99 for supporting this research. We appreciate the help of Diane I. Garvey for the English review. GrADS software was used for drawing the Figures.

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