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Weekly cycle in NCAR-NCEP reanalysis surface temperature data

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RESUMEN

Se detectó un ciclo semanal en el campo de temperatura superficial durante el reanálisis de NCAR-NCEP para el área del Atlántico del Norte. Este ciclo consiste de un mínimo en fin de semana para la mayor parte del área estudiada y otro mínimo en media semana para las áreas con cobertura de hielo o nieve.

ABSTRACT

A weekly cycle has been detected in the surface temperature field of the NCAR-NCEP reanalysis for the North Atlantic area. This cycle consists of a minimum in the weekend for most of the studied area and a minimum in the mid-week for areas with important snow or ice cover.

Key words: Weekly cycle, surface temperature, North Atlantic, NCAR-NCEP reanalysis.

1. Why is the weekly cycle of the surface temperature important?

Anthropogenic influences on climate has been detected in several climate variables, such as temperature increases and precipitation enhancement. The presence of weekly cycles in atmospheric variables is a clear manifestation of this anthropogenic influence. A weekly cycle has been observed in surface temperature (Gordon, 1994), in diurnal temperature range (Forster and Solomon, 2003), in the range of air pollution, precipitation and tropical cyclones (Cerveny and Balling, 1998) or in

the atmospheric CO_2 concentration (Cerveny and Coakley, 2002). The weekly cycle of surface temperature is a good tool to diagnose a pattern of behaviour of the greenhouse effect, specially in the urban areas.

This research explores the presence of a weekly cycle in the surface temperature field of the most used atmospheric data in atmospheric research, the NCAR-NCEP reanalysis (Kalnay *et al.*, 1996).

2. Data and method

Daily-mean 2m air temperatures data from NCAR-NCEP on a 1.9º latitude by 1.85º longitude grid box basis are used in this analysis (www.cru.uea.ac.uk). We have analyzed an exploratory area ranging from 90ºW to 90ºE longitude and from 88.5ºN to 10.5ºN latitude (Fig. 1). Then we tabulated daily temperatures anomalies for the seven days of the week. The time series stretched from 1 January 1958 (Wednesday) to 31 December 2001 (Monday), a total of 16071 days. The means of the seven days of the week were calculated. This was done for each grid point, so there are 4074 time series, one for each day of the week. To extract common patterns a cluster analysis was done using as classifying variables the seven days temperature anomalies. A K-means cluster technique was used to do the cluster analysis.

3. Results and conclusions

Two clusters of grid points were selected according to their weekly cycle, the first one (cluster 1) included 765 grid points and the second one (cluster 2) 3009, what represents about 81% of the

Fig. 1. Area used in this study

total analyzed grid points. The typical weekly cycle of each cluster (Fig. 2) was calculated as the mean of the weekly cycles of its members. The weekly cycle of cluster 1 consists of a pattern with a minimum during the mid-week and a secondary minimum on Saturday (Fig. 3), while the cycle of the cluster 2 shows a clearer decrease of the surface temperature during the weekend (anthropogenic signal) (Fig. 4). To confirm the periodicities, ten grid points in several places (inhabited and uninhabited areas) of the map were selected (five of each cluster) and an autocorrelation analysis with seven days lagged was done for each time series. The results show high and significant correlations at 95% significant level for the ten series, ranking from 0.72 to 0.88. To check if these results are statistically significant, a Monte Carlo simulation with 500 random series was done (Livezey and Chen, 1993), being the mean 0.010 and its standard deviation 0.0012, what confirms the significance of the results. Figure 5 shows the positions of points included in both clusters. Although a generalization is difficult, we can observe a different behaviour for areas without snow cover than those with it, areas with significant snow or ice cover present the mid-week minimum.

The most interesting result of this exploratory work is that the data used from the NCAR-NCEP reanalysis present a weekly cycle in surface temperature, a very important variable in the study of anthropogenic signals in the climate. However this study should be checked with sounder analyses and the use of other reanalysis data and geographical areas.

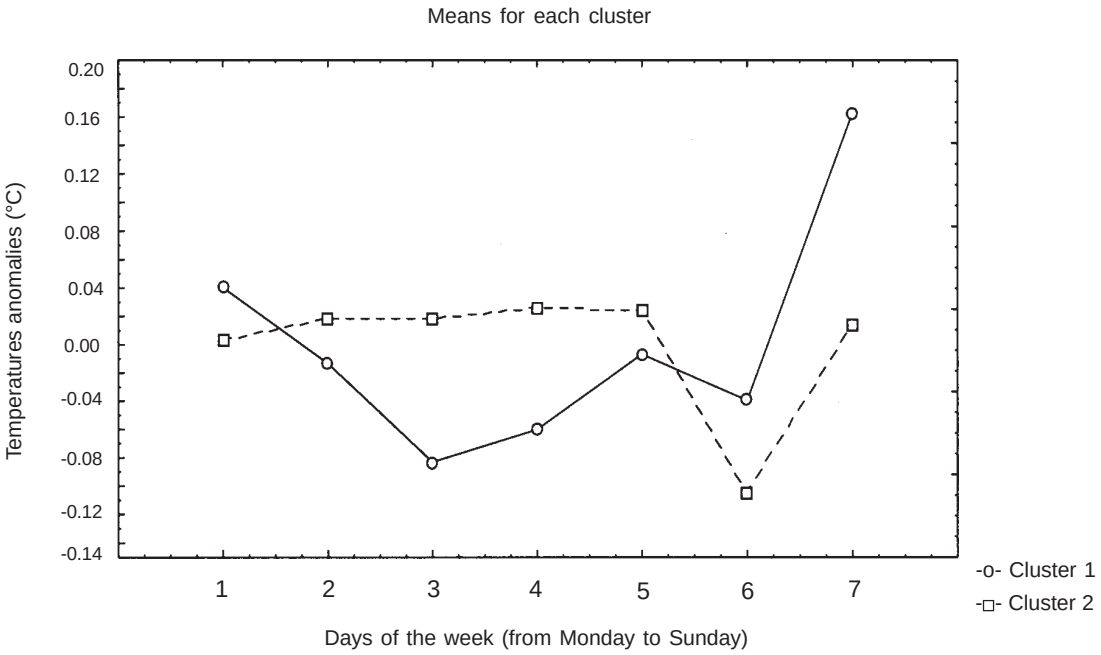

Fig. 2. Weekly cycle of the anomalies of surface temperature for each cluster.

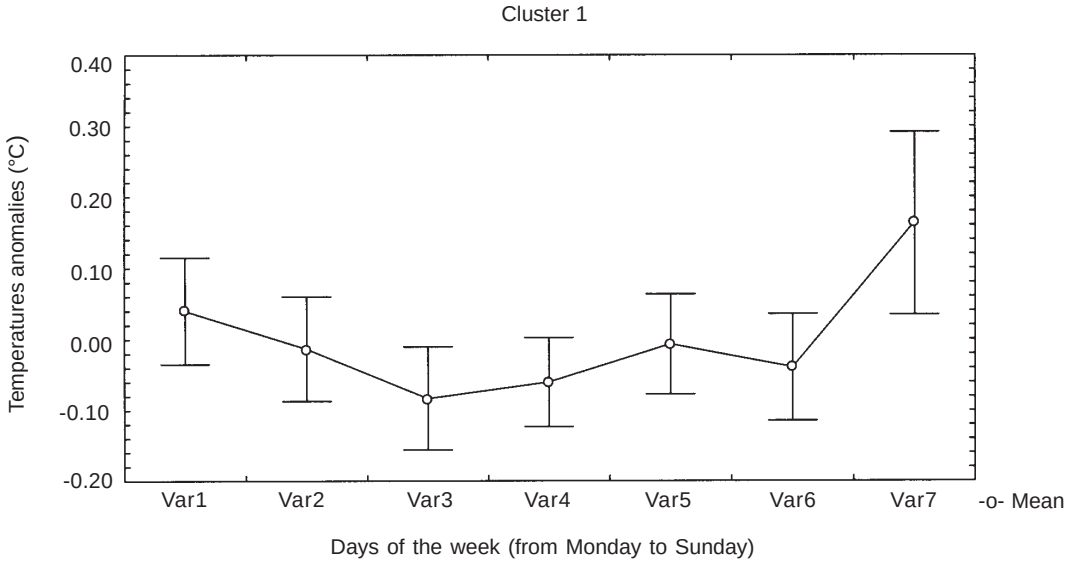

Fig. 3. Weekly cycle of the anomalies of surface temperature for cluster 1 and its standard deviation.

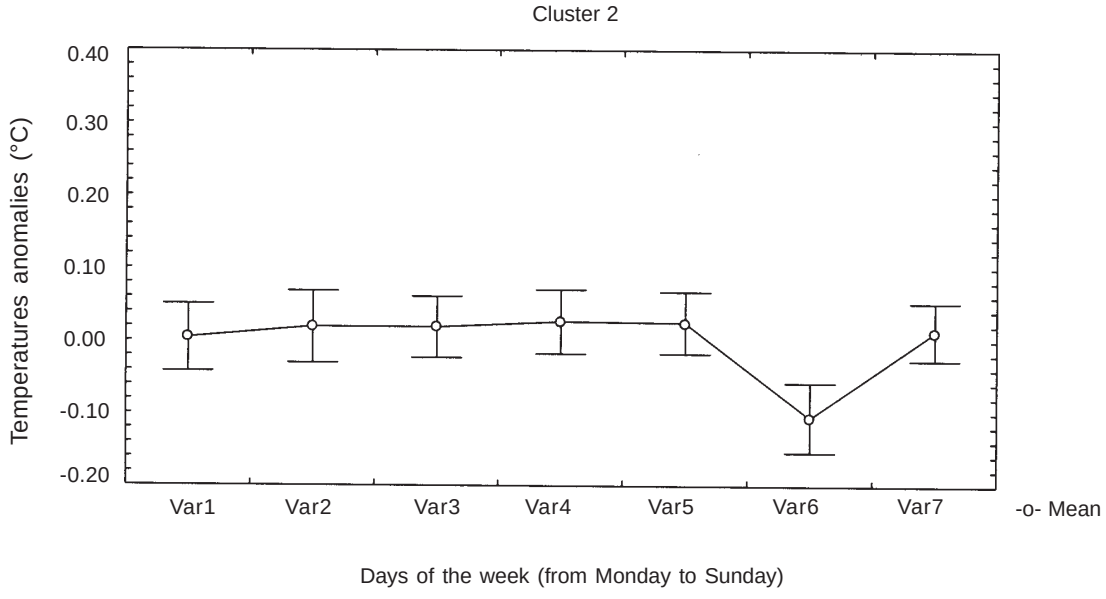

Fig. 4. Weekly cycle of the anomalies of surface temperature for cluster 2 and its standard deviation.

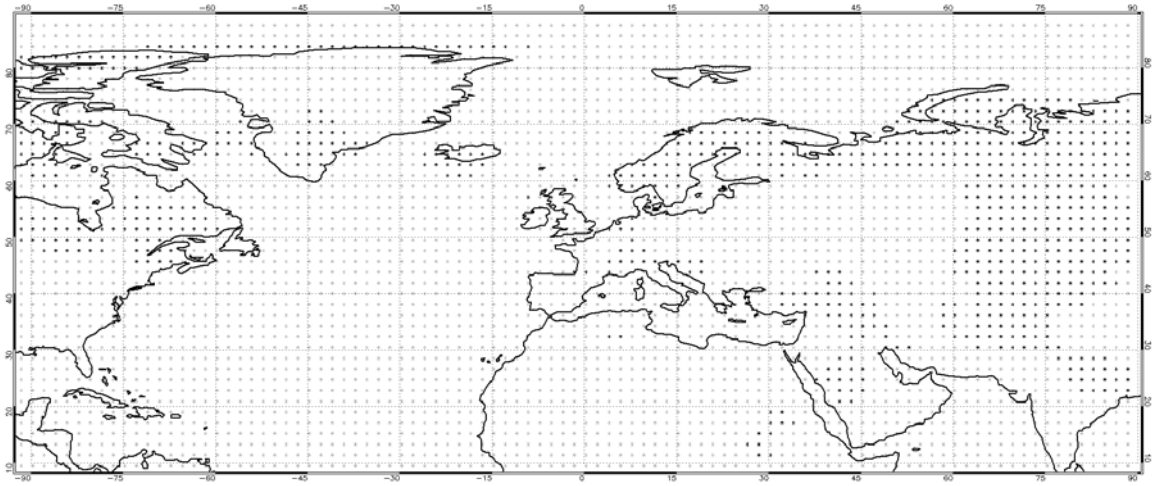

Fig. 5. Positions of grid points for each cluster (dark points, cluster 1; all others, cluster 2)

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