The effect of heatwaves and drought on surface wind circulations in the NE of the Iberian Peninsula during the summer of 2003

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Climate effects on wind patterns

The **drought and heatwave** that affected **Europe** in the **summer of 2003** produced enormous socioeconomic implications The anticyclonic conditions and **a deficit of soil moisture availability (SMA)** led to the **extremely high surface air temperatures** registered.

The **influence** that this extreme situation produced **in the surface wind circulations** in the NE of the Iberian Peninsula **is analyzed.**

Research strategy

The **originality** of our research relies on the combination of a **long term period of study (from 1992-2004) with a very fine spatial scale resolution in modeling and observations**.

Encompass the interactions between all the important atmospheric scales of motion with topographic and land use conditions which are the crucial elements in determining the wind patterns near the surface.

Observational evidence

The wind cycle for the summer of 2003 shows lower values and falls outside of the climatological range of variability (Fig 1a). Inspired by this finding, the main objective of this study is to analyze the relative contribution of the large scale circulation and the dry soil conditions to the abnormally low wind speeds observed.

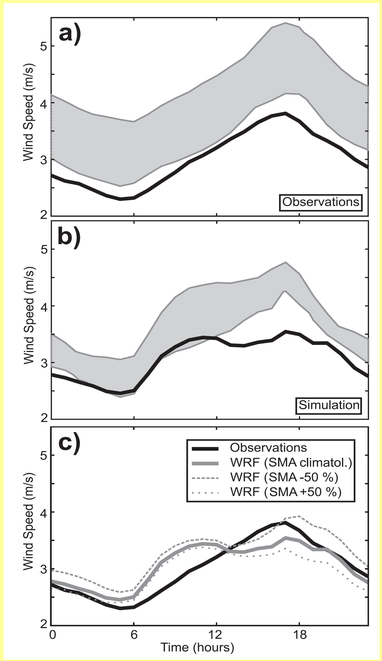


Fig. 1. (a) Mean daily cycle of the spatially averaged wind speed observed at the 41 stations during Summer 2003 (black line). The gray shaded area represents the range of variations of the mean daily cycles calculated with the wind speed observed during the twelve independent summers from 1992 to 2004 (excluding 2003). (b) Same as panel a but calculated with the WRF simulation that imposed the climatological soil moisture during the years 1992 to 2004. (c) Mean daily cycle of the regional wind speed during 2003 calculated with observations and the different WRF simulations (see legend).

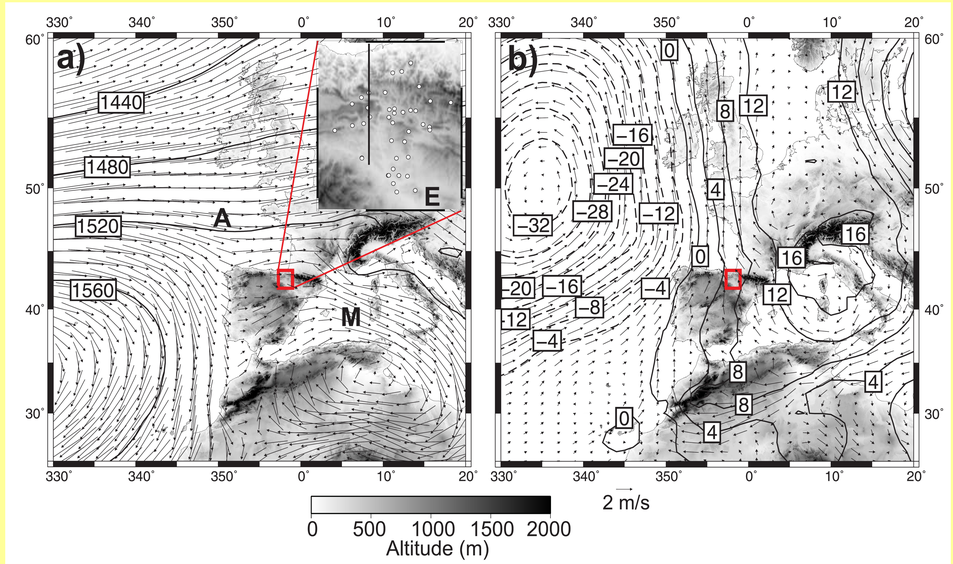
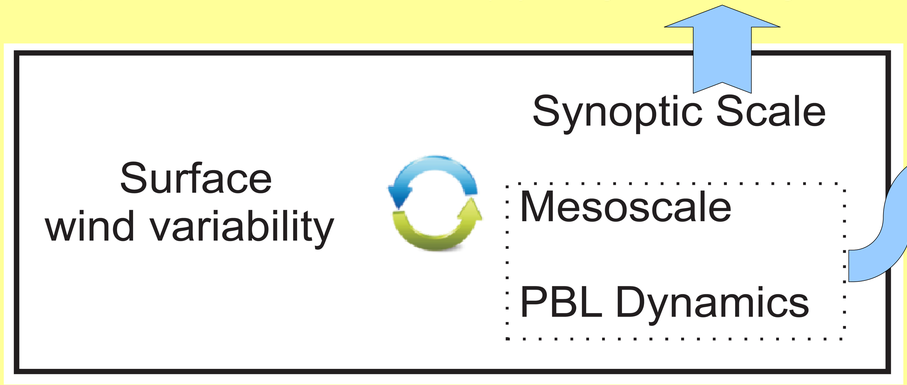


Fig. 2. (a) Mean geopotential height at 850 hPa (contour lines) and mean horizontal wind (arrows) for the summers within the 1992 - 2004 period. (b) Anomalies for the summer of 2003. Both calculated using the ECMWF data. The red rectangle highlights the location of the area of study and the inset in panel a shows the location of the 41 observational sites (circles) and the location of the cross-section displayed in Figure 3 (black straight-line).



Main research findings:

Heatwaves and droughts are able to modify the surface wind variability. Both the circulations induced by the synoptic scale and the mesoscale can potentially contribute to these variations. In the region under study and for the summer of 2003, **the large scale is the major responsible for the abnormally low wind speeds observed which are 22 % lower** than during the reference period (1992-2004).

Changes in SMA can be responsible for **modulations of the mesoscale circulations** that can introduce **regional wind speed changes** that differ **up to 20 %** (18 UTC). **Land-atmosphere interactions** can potentially play an **important role controlling the surface wind climate through the smallest scales of motion**.

An appropriate simulation of the soil state is therefore necessary in order to have reliable estimates of the surface wind circulations of current climate or climate change scenarios.

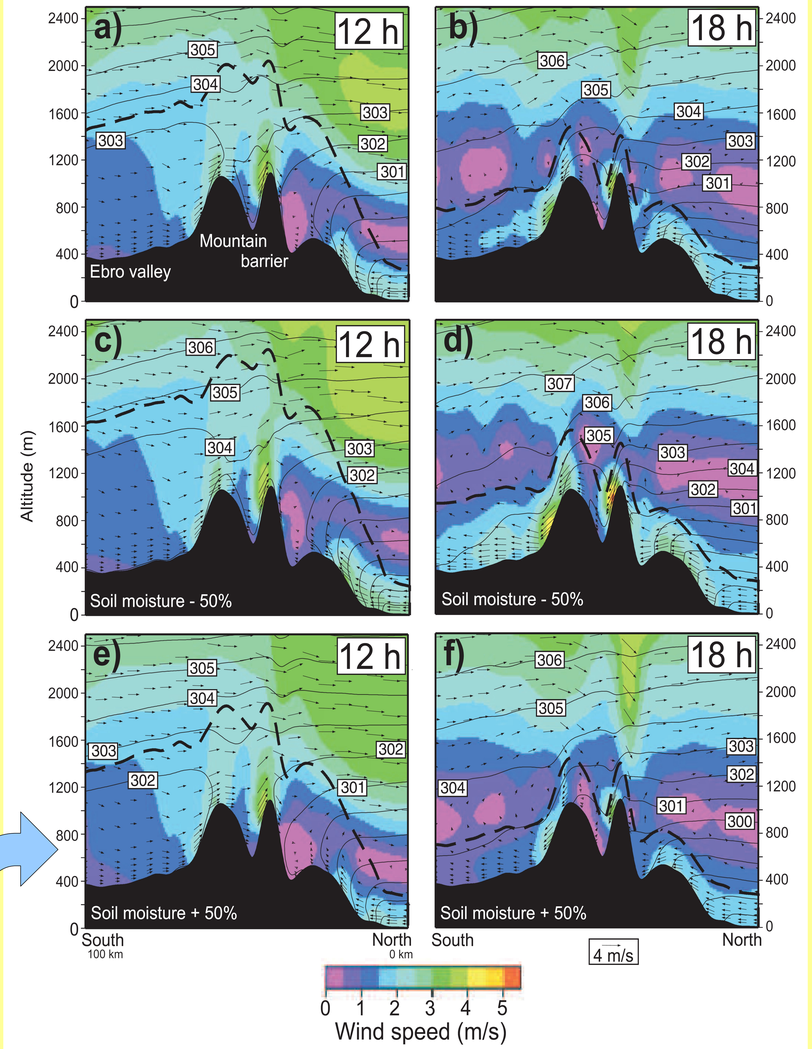


Fig. 3. South-North cross section showing the mean v and w wind components (arrows) and potential temperature (contour lines) at 12 (left panel) and 18 (right panel) UTC for the summer of 2003 (June, July and August). The mean v wind component has been highlighted (shaded). Averages are calculated with the high horizontal resolution WRF simulations, 2 km, performed with different SMA: climatological values (first row), 50 % drier (second row), and 50 % moister (third row). The dashed lines represent the PBL height.

References

Jiménez, P. A., J. Vilà-Guerau de Arellano, J. F. González-Rouco, J. Navarro, J. P. Montávez, E. García-Bustamante and J. Dudhia, 2011: The effect of heatwaves and drought on surface wind circulations in the NE of the Iberain Peninsula during the summer of 2003. *Journal of Climate*, **24**, 5416-5422.

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