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Dynamical downscaling of daily mean surface circulations over complex terrain

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The surface wind field variability plays a major role in a variety of phenomena operating at the regional scale such as the dispersion of pollutants over a region, the production and transport of dust due to wind erosion or the wind resource evaluation. An accurate surface wind field simulation is therefore an issue of interest for a wide range of applications. This is specially challenging over complex terrain areas wherein the surface wind field can present a high complexity as a consequence of the strong influence that orography produces over the large scale flows through channeling, forced ascents, blocking, etc.

The present study analyzes the capability of a WRF dynamical downscaling to reproduce the climatological surface circulations over a complex terrain region located in the northeast of the Iberian Peninsula. The complete ERA-40 reanalysis period is attempted to be simulated at a high horizontal resolution, 2 km, to reasonable capture the complexity of the terrain and at a time provide a reasonable long simulated period to robustly evaluate the influence of the large scale over the surface flow simulation. Currently, the simulation spans from 1978 to 2005. The evaluation focuses on the accuracy displayed by the simulation to reproduce the climatological flow of the six typical wind patters (WPs) identified with observations over the area in a previous work, and in exploring the ability of the downscaling in representing the WPs circulations subjected to specifics large scale forcing conditions.

The spatial structure of the surface circulations is reasonably well reproduced at most of the WPs. The downscaling shows a general tendency to overestimate the wind speed at the valleys and to underestimate it at the mountain tops. The underestimation at the windiest sites (mountains) and the overestimation at the less windy locations (valleys) lead to a reduction of the spatial variability of the downscaled wind speed field. This behavior is at least partially related to the smoother orography used in the simulation.

The skill of the downscaling to reproduce the WPs under representative sea level pressure patterns over the Iberian Peninsula is evaluated to understand the influence of the large scale forcings in the performance of the simulation. For a given WP, there is not a pressure pattern under which the downscaling clearly outperform the accuracy displayed by the rest of pressure patterns. Limitations to reproduce the large scale structure in some of the synoptic situations lead to inaccurate downscaled winds. This suggests that the expected improvement obtained with a high spatial resolution in the dynamical downscaling may be at least partially hampered if the large scale cannot be appropriately represented.