Geophysical Research Abstracts
Vol. 14, EGU2012-3065, 2012
EGU General Assembly 2012

The North Atlantic Oscillation and the Wind Power in the Iberian Peninsula

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Great investments have been devoted in recent years to promote the development of wind farms in the Iberian Peninsula (IP) and a massive increase of wind power (WP) installations is expected within the coming years. Accurate resource evaluation is essential for the success of such large economic efforts. However, long-term observations are still scarce, which hampers to account adequately for the natural variability of the resources, and leave out many areas. Regional climate models constitute a useful tool to bridge this gap, providing lengthy, high-resolution and comprehensive datasets which are physically consistent and enable to tackle ambitious scientific challenges from a holistic perspective.

The aim of this work is to assess the impact of the North Atlantic Oscillation (NAO) on the WP over the IP. For that, we use a hindcasted regional climate simulation spanning from 1959 to 2007 with a homogeneous spatial resolution of 10 km over the whole IP and the surrounding water mass areas. The analysis is made at monthly time scale and focuses on the extended winter (October to March months). Overall, our results confirm previous findings, i.e. negative NAO phases promote windy westerly flow west of the IP. However, our thorough assessment still yields pristine insights thanks to the unique opportunity provided by the high resolution and the spatial coverage of the hindcasted database, which, for instance, permits to extend the study offshore, where the WP is gaining market, and to evaluate the NAO-impact at different altitudes.

The results, robustly supported by actual production records, show that negative NAO phases enhance, in general, near-surface wind speed about 20% with respect to positive NAO events. In terms of WP, such a NAO-impact could represent a difference of around 40%. Moreover, we show that the NAO impact on WP increases progressively as we go from near-surface to higher levels, growing up to 60% at around 100 m height. This further emphasizes the main role of the NAO regarding WP, since the tendency is to place the wind turbines the highest the best (because the windiest). Some exceptions appear in particular areas and months though, with increased wind speed during positive NAO phases. Both, the general behavior and the exceptional cases, are well explained taking into account the NAO-impact on the wind direction and the orography of the IP, as it can be nicely recognized by zooming in over the areas showing the most interesting or striking signals.

Additionally, we investigate the complementarity of the NAO-impact on WP and solar energy production, which is nowadays emerging and receiving a spectacular boost in the IP. The patterns of the NAO-impact on the amount of solar radiation reaching the surface resemble the NAO-impact patterns on WP, showing opposite sign and similar values of variation in the potential production of solar energy between negative and positive NAO events. This suggests that an optimized common design of both, wind farms and solar plants, could minimize the NAO-impact on the total energy production.