EMS Annual Meeting Abstracts
Vol. 9, EMS2012-282, 2012
12th EMS / 9th ECAC

Implementation of spectrum analysis in mesoscale modeling for wind energy assessment studies

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Spectral analysis of wind speed is a key parameter for the characterization of the physical processes generating the fields. Especially, the mesoscale power spectrum is an important measure of accuracy of wind forecasting and extreme wind estimation for modern wind farms, which are of the size of tens of kilometers.
In complex terrain, the wind power spectrum has shown a -5/3 slope in the mesoscale range, similar to that over flat terrain. However the amplitude of power spectrum in complex terrain is higher than that over flat terrain. In this study we propose to evaluate mesoscale model response to this deviation at different scales. Using simulation of the Iberian Peninsula and data experiments, we first identify the difference in wind kinetic energy spectrum between a hilly region in Spain and an offshore domain nearby the Portuguese coast.
A powerful tool to determine the interaction between complex terrain and the wind variability is the use of 2D Fast Fourier transform applied to terrain height. From previous studies this analysis proved to be efficient in finding the proper model grid resolution for the representation of the wind variability in highly non homogeneous terrain. This technique is initially applied to mesocale circulation within the Navarra region and at a second stage at higher resolution in an area encompassing CENER's test Site in Alaiz mountain.