Geophysical Research Abstracts
Vol. 15, EGU2013-1740, 2013
EGU General Assembly 2013
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On the application of the Principal Component Analysis for an efficient climate downscaling of surface wind fields

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With the purpose of efficiently and reliably generating long-term wind resource maps for the wind energy industry, the application and verification of a statistical methodology for the climate downscaling of wind fields at surface level is presented in this work. This procedure is based on the combination of the Monte Carlo and the Principal Component Analysis (PCA) statistical methods. Firstly the Monte Carlo method is used to create a huge number of daily-based annual time series, so called climate representative years, by the stratified sampling of a 33-year-long time series corresponding to the available period of the NCAR/NCEP global reanalysis data set (R-2). Secondly the representative years are evaluated such that the best set is chosen according to its capability to recreate the Sea Level Pressure (SLP) temporal and spatial fields from the R-2 data set. The measure of this correspondence is based on the Euclidean distance between the Empirical Orthogonal Functions (EOF) spaces generated by the PCA (Principal Component Analysis) decomposition of the SLP fields from both the long-term and the representative year data sets. The methodology was verified by comparing the selected 365-days period against a 9-year period of wind fields generated by dynamical downscaling the Global Forecast System data with the mesoscale model SKIRON for the Iberian Peninsula. These results showed that, compared to the traditional method of dynamical downscaling any random 365-days period, the error in the average wind velocity by the PCA's representative year was reduced by almost 30%. Moreover the Mean Absolute Errors (MAE) in the monthly and daily wind profiles were also reduced by almost 25% along all SKIRON grid points. These results showed also that the methodology presented maximum error values in the wind speed mean of 0.8 m/s and maximum MAE in the monthly curves of 0.7 m/s. Besides the bulk numbers, this work shows the spatial distribution of the errors across the Iberian domain and additional wind statistics such as the velocity and directional frequency. Additional repetitions were performed to prove the reliability and robustness of this kind-of statistical-dynamical downscaling method.