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Local and regional effects of large scale atmospheric circulation patterns on winter wind power output in Western Europe

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Recent studies (Brayshaw, 2009, Garcia-Bustamante, 2010, Garcia-Bustamante, 2013) have drawn attention to the sensitivity of wind speed distributions and likely wind energy power output in Western Europe to changes in low-frequency, large scale atmospheric circulation patterns such as the North Atlantic Oscillation (NAO).

Wind speed variations and directional shifts as a function of the NAO state can be larger or smaller depending on the North Atlantic region that is considered. Wind speeds in Ireland and the UK for example are approximately 20 % higher during NAO + phases, and up to 30 % lower during NAO – phases relative to the long-term (30 year) climatological means. By contrast, in southern Europe, wind speeds are 15 % lower than average during NAO + phases and 15 % higher than average during NAO - phases. Crucially however, some regions such as Brittany in N.W. France have been identified in which there is negligible variability in wind speeds as a function of the NAO phase, as observed in the ERA-Interim 0.5 degree gridded reanalysis database.

However, the magnitude of these effects on wind conditions is temporally and spatially non-stationary. As described by Comas-Bru and McDermott (2013) for temperature and precipitation, such non-stationarity is caused by the influence of two other patterns, the East Atlantic pattern, (EA), and the Scandinavian pattern, (SCA), which modulate the position of the NAO dipole. This phenomenon has also implications for wind speeds and directions, which has been assessed using the ERA-Interim reanalysis dataset and the indices obtained from the PC analysis of sea level pressure over the Atlantic region.

In order to study the implications for power production, the interaction of the NAO and the other teleconnection patterns with local topography was also analysed, as well as how these interactions ultimately translate into wind power output. The objective is to have a better defined relationship between wind speed and power output at a local level and a tool that wind farm developers could use to inform site selection. A particular priority was to assess how the potential wind power outputs over a 25-30 year windfarm lifetime in less windy, but resource-stable regions, compare with those from windier but more variable sites.