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Influence of winter NAO pattern on variable renewable energies potential in Europe over the 20th century

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Integration of Variable Renewable Energy (VRE) sources in the electricity system is a challenge because of temporal and spatial fluctuations of their power generation resulting from their driving weather variables (i.e. solar radiation wind speed, precipitation, and temperature). Very few attention was paid to low frequency variability (i.e. from annual to decades) even though it may have significant impact on energy system and energy market Following the current increase in electricity supplied by VRE generation, one could ask the question about the risk of ending up in a situation in which the level of production of one or more VRE is exceptionally low or exceptionally high for a long period of time and/or over a large area. What would be the risk for an investor if the return on investment has been calculated on a high energy production period? What would be the cost in term of carbon emission whether the system manager needs to turn on coal power plant to satisfy the demand? Such dramatic events would definitely impact future stakeholder decision to invest in a particular energy source or another.

Weather low frequency variability is mainly governed by large-scale teleconnection patterns impacting the climate at global scale such as El Niño – Southern Oscillation (ENSO) in the tropics and in North America or the North Atlantic Oscillation (hereafter, NAO) in North America and Europe. Teleconnection pattern's influence on weather variability cascades to VRE variability and ends up by impacting electricity system.

The aim of this study is to analysis the impact of the NAO on VRE generation in Europe during the winter season. The analysis is carried out over the twentieth century (i.e. from 1900 to 2010), in order to take into account climate low frequency variability, and for a set of 12 regions covering a large range of climates in Europe. Weather variable time series are obtained by using the ERA20C reanalysis and the SCAMP model (Sequential Constructive Atmospheric Analogues for Multivariate weather Predictions, Raynaud et al. 2016).

The analysis is performed for solar, wind and run-of-the river energy sources taken individually. For NAO sensitive regions, results shown important deviations between power generation distributions obtained either for strongly positive or strongly negative NAO events. We also used the optimal VRE combination provided by the 100 % solution project (http://thesolutionsproject.org/). We then discuss over the 12 considered regions the vulnerability to NAO events for the energy mix suggested by the 100 % solution project.

Reference:
Raynaud, D., Hingray, B., Zin, I., Anquetin, S., Debionne, S., Vautard, R., 2016. Atmospheric analogues for physically consistent scenarios of surface weather in Europe and Maghreb. Int. J. Climatol. doi:10.1002/joc.4844