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The influence of the North-Atlantic Oscillation on Variable Renewable Energy penetration rate in Europe

Baptiste Francois
CNRS, LTHE, GRENOBLE, France (baptiste.francois@ujf-grenoble.fr)

The on-going transition to low-carbon economy promotes the development of Variable Renewable Energies (VRE) such as wind-power, solar-power and hydro-power. The European Climate Foundation now typically dates for 2050 optimistic scenarios with close to 100 % renewable energy in Europe. When considering 100 % renewable scenarios, backup generation is needed for stabilizing the network when variable renewable energy sources such as wind, solar or run-of-the river hydropower are not sufficient for supplying the load. Several studies show that backup generation needs are reduced by dissipating power densities either in space through grids and time through storage.

To our knowledge, most of these published studies were carried out using field measurements collected at meteorological and hydrological stations and over relatively short time period (less than 10 years). By using short period of times, such studies somehow disregarded the space and temporal variability of VRE power generation that could be induced by larger-scale climate variability patterns.

This study investigates the influence of the North Atlantic Oscillation (NAO) on the VRE penetration for a set of 11 regions in Europe and Tunisia, and over 1980-2012 time period. These regions are located along two climate transects, the first one going from the Northern regions (Norway, Finland) to the Southern ones (Greece, Andalucía, Tunisia) and the second one going from the oceanic climate (West of France, Galicia) to the continental one (Romania, Belorussia). For each of those regions, we combine data from the Weather Research and Forecasting Model (wind speed, solar radiation; Vautard et al., 2014) and the European Climate Assessment & Dataset (temperature, precipitation; Haylock et al,. 2008) for estimating solar-power, wind-power, run-of-the-river hydro-power and the electricity demand over a time period of 33 years.

For each region, we analyze seasonal differences in penetration rates of wind-, solar- and hydro-power and between positive and negative phases of the NAO index. We then discuss about opportunities of combining different VRE within the same region and among neighbor regions for limiting backup generation needs during both positive and negative NAO phases.

References:
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