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Spatial optimization of an ideal wind energy system as a response to the intermittency of renewable energies?

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The share of renewable energies in the mix of electricity production is increasing worldwide. This trend is driven by environmental and economic policies aiming at a reduction of greenhouse gas emissions and an improvement of energy security. It is expected to continue in the forthcoming years and decades. Electricity production from renewables is related to weather and climate factors such as the diurnal and seasonal cycles of sunlight and wind, but is also linked to variability on all time scales. The intermittency in the renewable electricity production (solar, wind power) could eventually hinder their future deployment. Intermittency is indeed a challenge as demand and supply of electricity need to be balanced at any time. This challenge can be addressed by the deployment of an overcapacity in power generation (from renewable and/or thermal sources), a large-scale energy storage system and/or improved management of the demand.

The main goal of this study is to optimize a hypothetical renewable energy system at the French and European scales in order to investigate if spatial diversity of the production (here electricity from wind energy) could be a response to the intermittency. We use ECMWF (European Centre for Medium-Range Weather Forecasts) ERA-interim meteorological reanalysis and meteorological fields from the Weather Research and Forecasts (WRF) model to estimate the potential for wind power generation. Electricity demand and production are provided by the French electricity network (RTE) at the scale of administrative regions for years 2013 and 2014.

Firstly we will show how the simulated production of wind power compares against the measured production at the national and regional scale. Several modelling and bias correction methods of wind power production will be discussed.

Secondly, we will present results from an optimization procedure that aims to minimize some measure of the intermittency of wind energy. For instance we estimate the optimal distribution between French regions (with or without cross-border inputs) that minimizes the impact of low-production periods computed in a running mean sense and its sensitivity to the period considered. We will also assess which meteorological situations are the most problematic over the 35-year ERA-interim climatology(1980-2015).