Metrics for assessing climate change impacts on European resource adequacy

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Objective & background

The energy system is changing. This is due to the increased uptake of renewable energy sources, like wind and solar power, changes in electricity demand due to increased use of heat pumps and electric vehicles, and due to changes in the climate driving the weather dependent parts of the system. Assessing all these dynamic changes adequately is no small feat.

Scientific evidence and new regulations from the European energy regulatory body ACER have led to the development of a new pan-European climate database (PECDv4.0) for the energy sector that allows climate change compatible assessments [1]. The new PECDv4 uses the ERA5 and the EURO-CORDEX database and combines this with state-of-the-art energy conversion models, to gain a highly detailed representation of historic, current, and projected energy-climate. Incorporating the new database in studies by European transmission system operators will be difficult due to the complexity of the energy system models (ESM) involved. A different approach is thus needed.

We will present three metrics that can be used to assess the impact of weather under a changing climate. With these metrics climate stress events can be identified.

Method

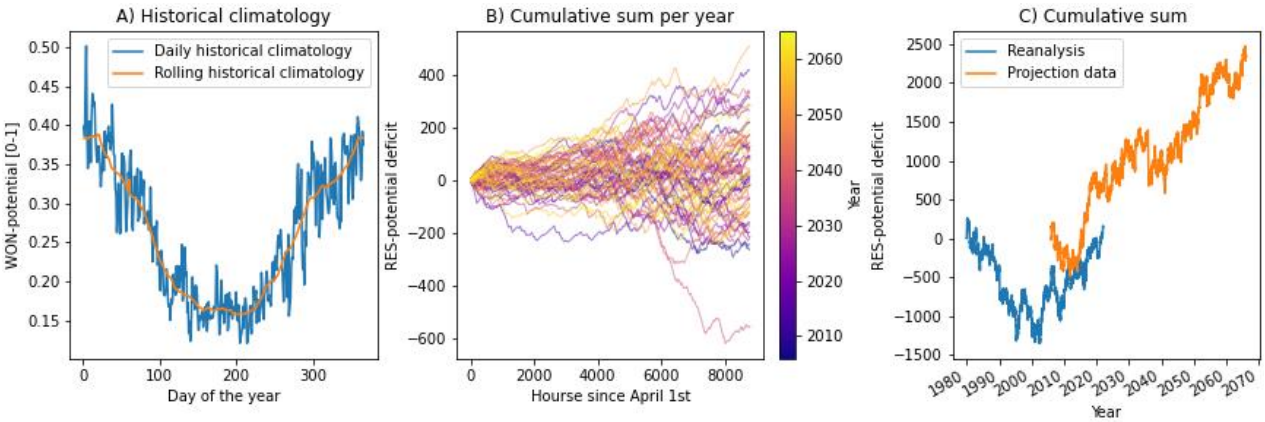
The first metric is based on the link between unserved energy and a classification of the large-scale flow in Europe (weather regimes) [2]. By looking at decadal variability in the occurrence and persistence and assessing how they change under climate change, the impact of large-scale flow on local renewable energy resource availability can be quantified.

The second metric can be used to analyze slow and small changes in renewable energy resource availability over time. We use an adapted definition of the daily climatology to determine the deficit of the renewable energy resource potential (RES-potential deficit) w.r.t. this climatology (see Figure 1A). By looking at the yearly cumulative RES-potential deficit and by starting on April first an energy drought metric could be obtained that is analogous to the precipitation deficit (see Figure 1B). By looking at long-term changes in the cumulative deficit, periods of potential renewable energy resource 'droughts' can be identified. For a specific region the change in the average slope of the cumulative sum over time between the historic and projected period could be assessed, as shown in Figure 1C for the north-west of the Netherlands.

Finally, if we have time left, we will present the third metric, the correlation distance the renewable energy resource availability. Correlation distance can be used as a method to visualize to what extent the renewable energy generation between regions is correlated, and to assess the average use of transmission in times of system stress for a given location.

Principal findings

For both the link between weather regimes and the cumulative sum of renewable energy resource deficit we observe large interannual to decadal variability. While some regions show a clear climate change signal in some of the metrics, large differences between regions are observed. We will present the metrics and a consistent assessment of them for all regions in Europe.



1. Dubus, Laurent, D. J. Brayshaw, D. Huertas-Hernando, D. Radu, J. Sharp, W. Zappa, and L. P. Stoop. 'Towards a Future-Proof Climate Database for European Energy System Studies'. Environmental Research Letters 17, no. 12 (21 November 2022): 121001. https://doi.org/10.1088/1748-9326/ACA1D3.
2. Wuijts, R.H., L.P. Stoop, J.Hu, A. Haverkamp, W. Zappa, J.M. van den Akker, G. van der Schrier, M. van den Broek. 'Linking unserved energy to weather regimes'. In submission to: Earth's future (2023)