An European wide meteorological data set suitable for electricity modelling (supply and demand) for actual climate and climate change projections

Energiesystem- und Klimamodellierung
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Motivation

For the modelling of electricity production and demand, meteorological conditions are becoming more relevant due to the increasing contribution from renewable electricity production. But the requirements on meteorological data sets for electricity modelling are quite high. One challenge is the high temporal resolution, since a typical time step for modelling electricity production and demand is one hour. On the other side the European electricity market is highly connected, so that a pure country based modelling does not make sense and at least the whole European Union area has to be considered. Additionally, the spatial resolution of the data set must be able to represent the thermal conditions, which requires high spatial resolution at least in mountainous regions. All these requirements lead to huge data amounts for historic observations and even more for climate change projections for the whole 21st century. Thus, we have developed an aggregated European wide data set that has a temporal resolution of one hour, covers the whole EU area, has a reasonable size but is considering the high spatial variability.

Method

The meteorological data for the historical period and for bias correction of the climate scenarios are taken from ERA 5 land [1]. This data set has a temporal resolution of one hour and a spatial resolution of ~ 11 km. For the variable temperature, the resolution was further increased to 1 km, using a high-resolution digital elevation model and a constant vertical lapse rate of 6.5 °C per km. For climate projections two Euro-CORDEX models [2] have been used where also hydrological run-off scenarios are available [3]. Following variables are considered:

- Temperature
- Wind speed
- Global radiation
- River run off

With additional information from COSMO-REA 6 [4], the wind speed was converted into wind power and for hydro power the JRC hydro-power plants data base was used to convert river run off into hydro power production.

The climate change scenarios are bias corrected with the Quantile Delta Mapping method [5] and all variables are temporally disaggregated from daily to hourly data except the river run off, which is used on daily time step. Temperature, wind speed and radiation are interpolated to a 1 km raster for every hourly time step and then weighted aggregated to the NUTS regions. The weighting is based on population density for temperature and radiation. For wind and hydro power, the power plant locations are used.

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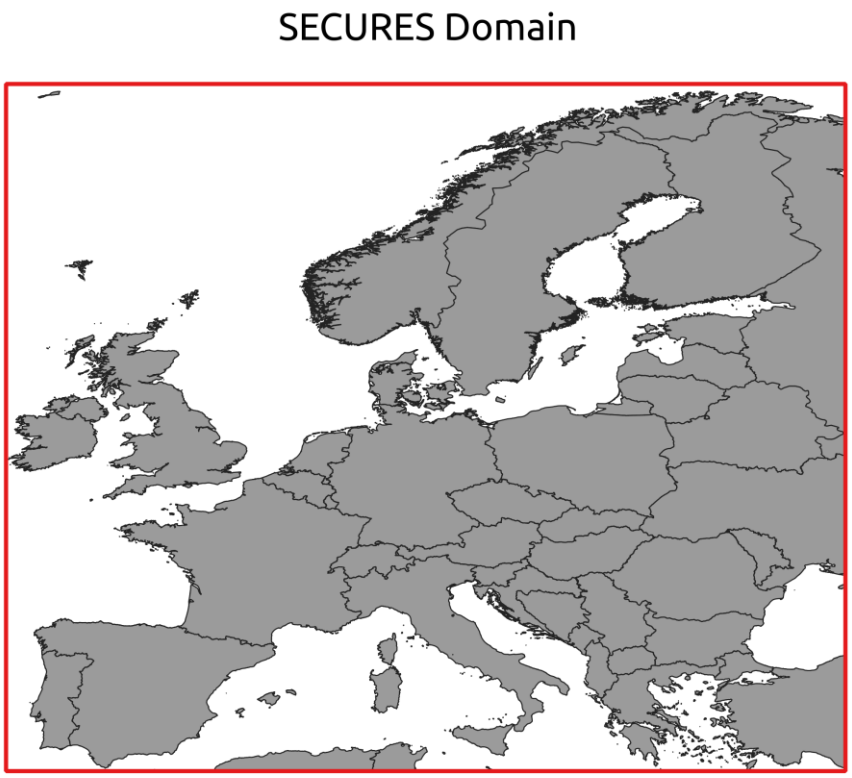

Figure 1: Domain used for data preparation. The hourly meteorological data are aggregated with individual weightings to NUTS regions (NUTS0, NUTS 2 for Europe and NUTS 3 for Austria).

Results and conclusions

The meteorological data set for Austria and Europe for the historical period and climate change projections fulfills all relevant criteria for energy modelling. It has a hourly temporal resolution, considers local effect up to a spatial resolution of 1 km and has a suitable size, as all variables are aggregated to NUTS regions. Additionally meteorological information from wind speed and river run-off is directly converted into power productions, using state of the art methods and the current information on the location of power plants. Within the research project SECURES this data set has been widely used for energy modelling and the results are very promising. The data set will be made available for free usage after finishing the still ongoing research project.

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Literature

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