Future trends of critical extreme events for the Austrian energy system

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DeRisk-E
DERISKING THE AUSTRIAN ELECTRICITY SECTOR TRANSFORMATION TOWARDS DECARBONISATION

Project Overview

- Climate-driven extreme weather events, together with unpredictable geopolitical shocks (e.g. summer 2022), can occur simultaneously and put the power system under pressure.
- The project DeRisk-E aims to assess how Austria´s future decarbonized power system can be designed to ensure robustness against relevant future uncertainties.
- Arising uncertainties are climate impacts, geopolitical risks, demand growth, realization of renewable and grid expansion plans and capital market conditions.
- A Monte Carlo framework, together with an energy system simulation tool (IESopt), will be used to explore the combined effects of these uncertainty parameters.
- To provide accurate climate projections trends, changes in critical extreme events - dark doldrums and heat waves - need to be assessed on a Central European scale.

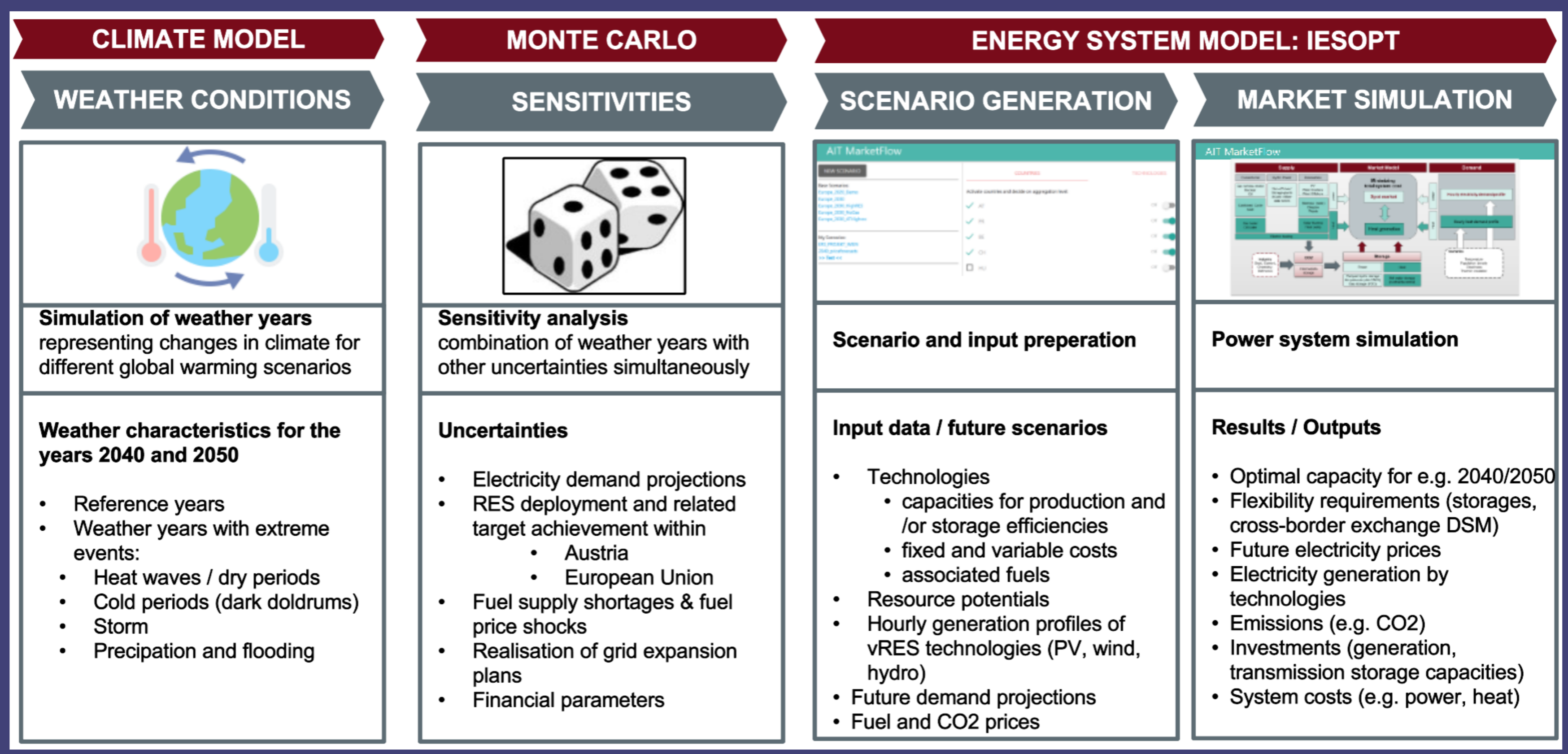

Figure 1: DeRisk-E project overview and workflow.

Methods

To project trends in critical extreme events:

1. The historical dark doldrum (DD) of January 2017 [1] and the heat wave (HW) of July 2022 [2] are assessed by performing a capacity factor (CF) analysis for variable renewable energy sources (VRES) using a variable size of moving average (MA) windows [3] (Figure 2 & 3) .
2. Periods of low CFs are related to meteorological parameters in Central Europe using percentiles in the ERA5-Land data set [4]. Meteorological percentile threshold are derived for such extreme events (Table 1).
3. These thresholds are then applied to a plausibility-filtered CMIP6 climate projection ensemble [5] to assess potential changes in frequency (Figure 4) and length (Figure 5) of DDs and HWs under future Global Warming Levels (GWLs) [6].

Our main findings: dark doldrums (DD) are projected to decrease by up to 77 % in frequency and 0.5 days in length, while heat waves (HW) are projected to increase drastically by up to 163 % and 1.8 days.

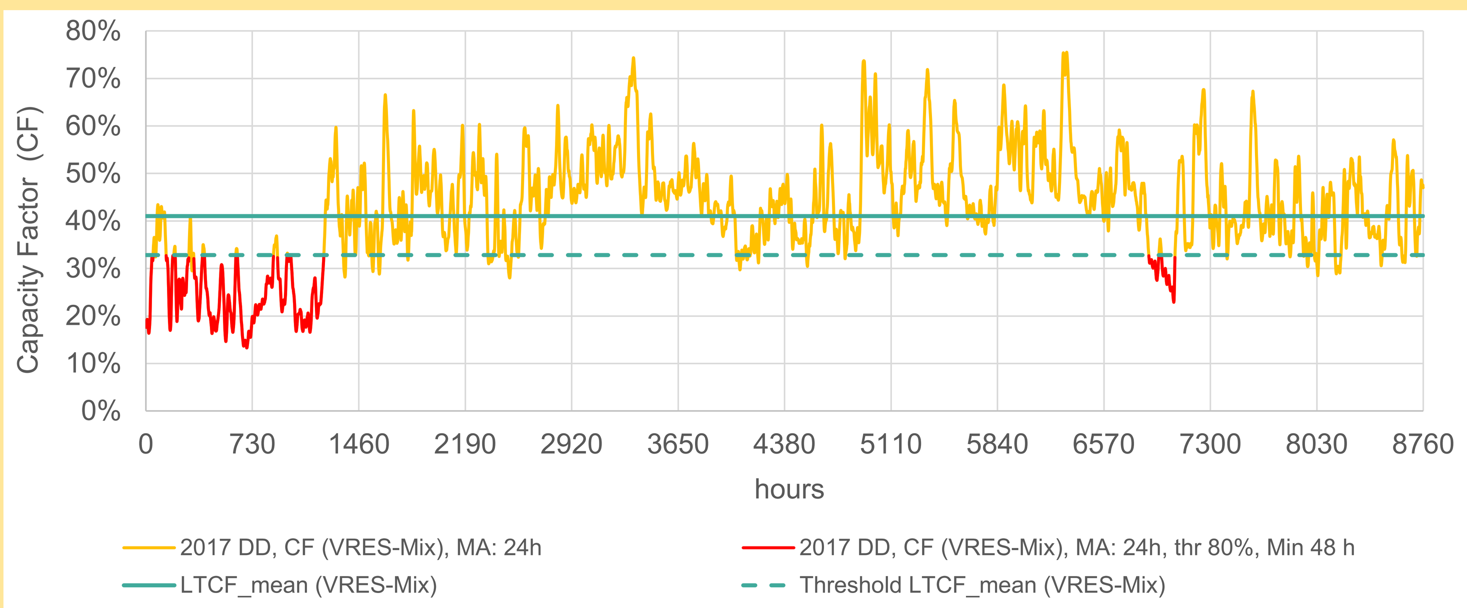

Figure 2: VRES-CF analysis of the DD year 2017. DD periods (red) are detected, when the 1-day-MA of the CF drops below 80 % for at least 2 days.

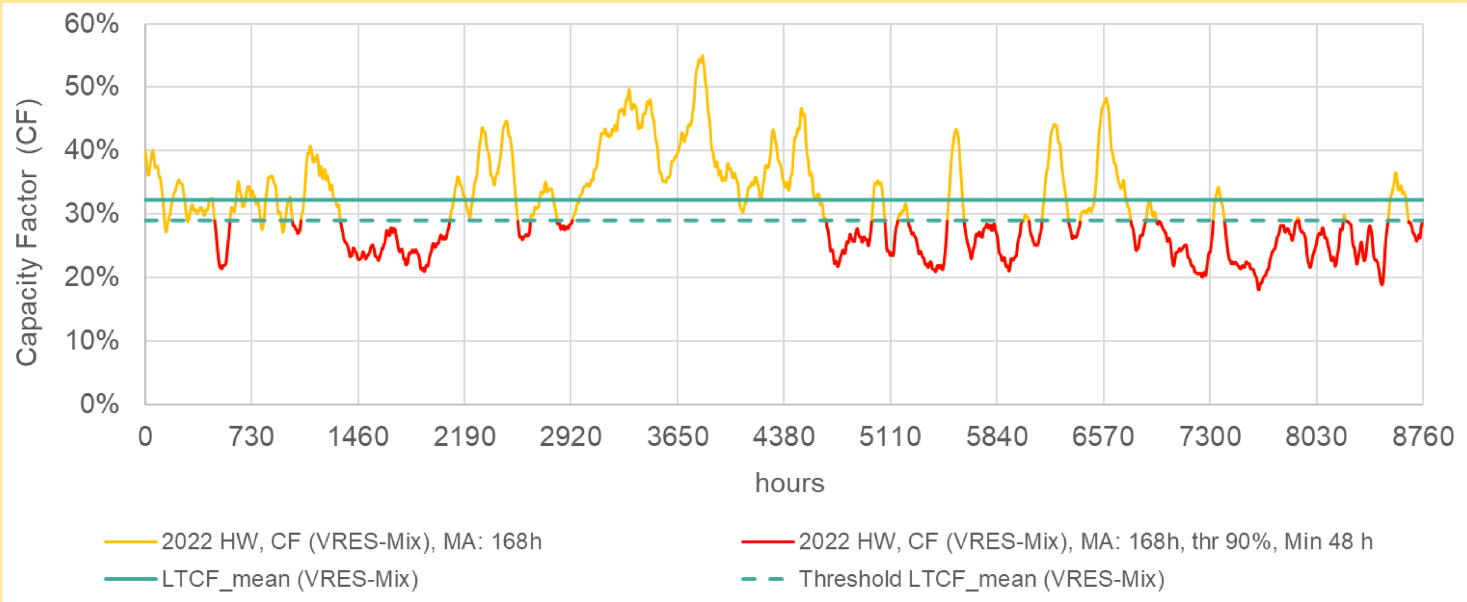

Figure 2: VRES-CF analysis of the HW year 2022. HW periods (red) are detected, when the 7-day-MA of the CF drops below 90 % for at least 7 days.

Extreme Event / Percentile	Temperature	Radiation	Wind Speed	Precipitation	Effective Water Input
Dark Doldrum	< 40 (MA 1d)	negligible	< 40 (MA 1d)	< 33 (MA 7d)	< 20 (MA 30d)
Heat Wave	> 60 (MA 7d)	negligible	< 50 (MA 7d)	< 50 (MA 7d)	< 50 (MA 30d)

Table 1: Derived meteorological threshold percentiles for DD and HW events.

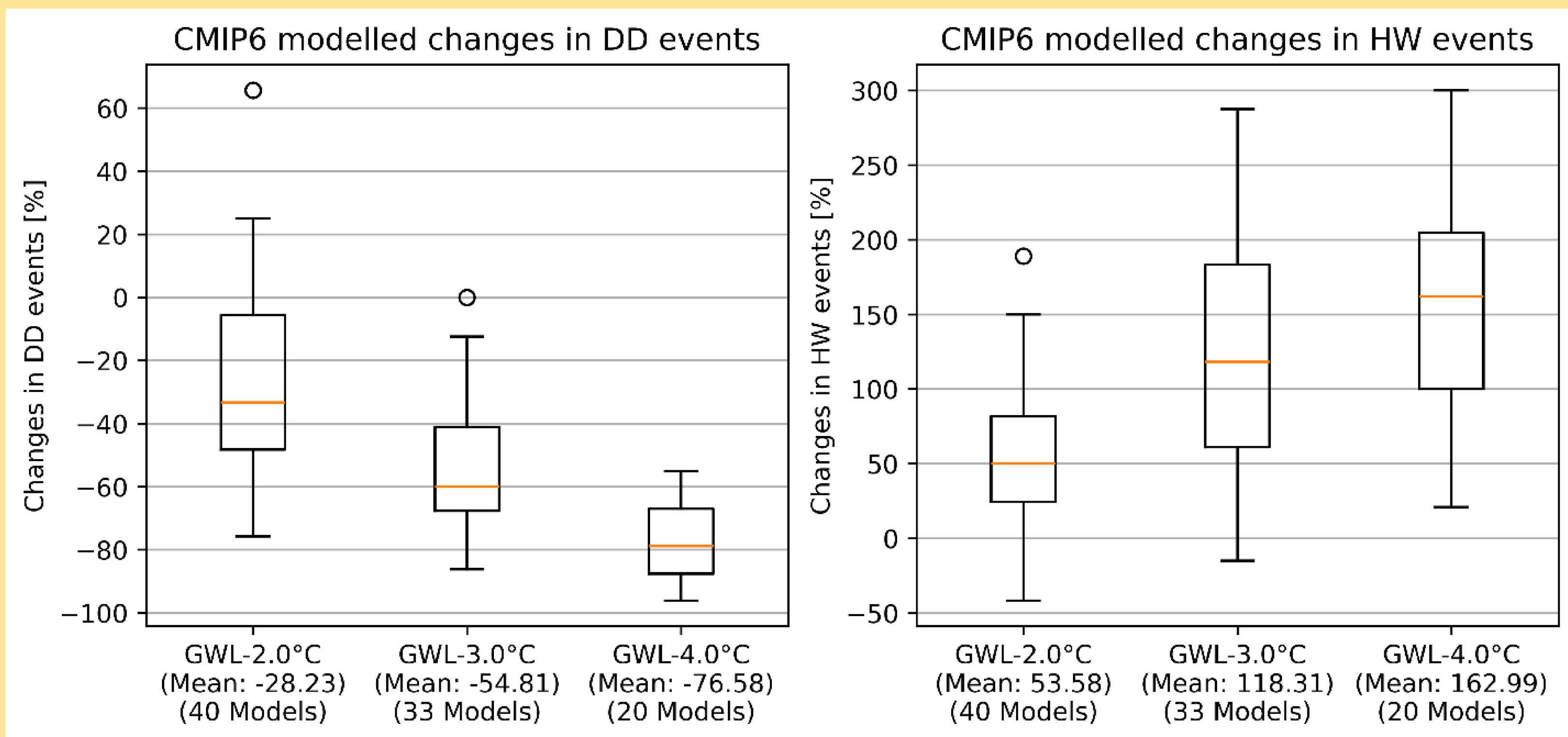

Figure 4: Projected changes in DD (left) and HW (right) frequency for different GWLs in % to the observed occurrences (DD: 29.0 , HW: 17.0) in the historical period (2001-2020, GWL-1.0°C).

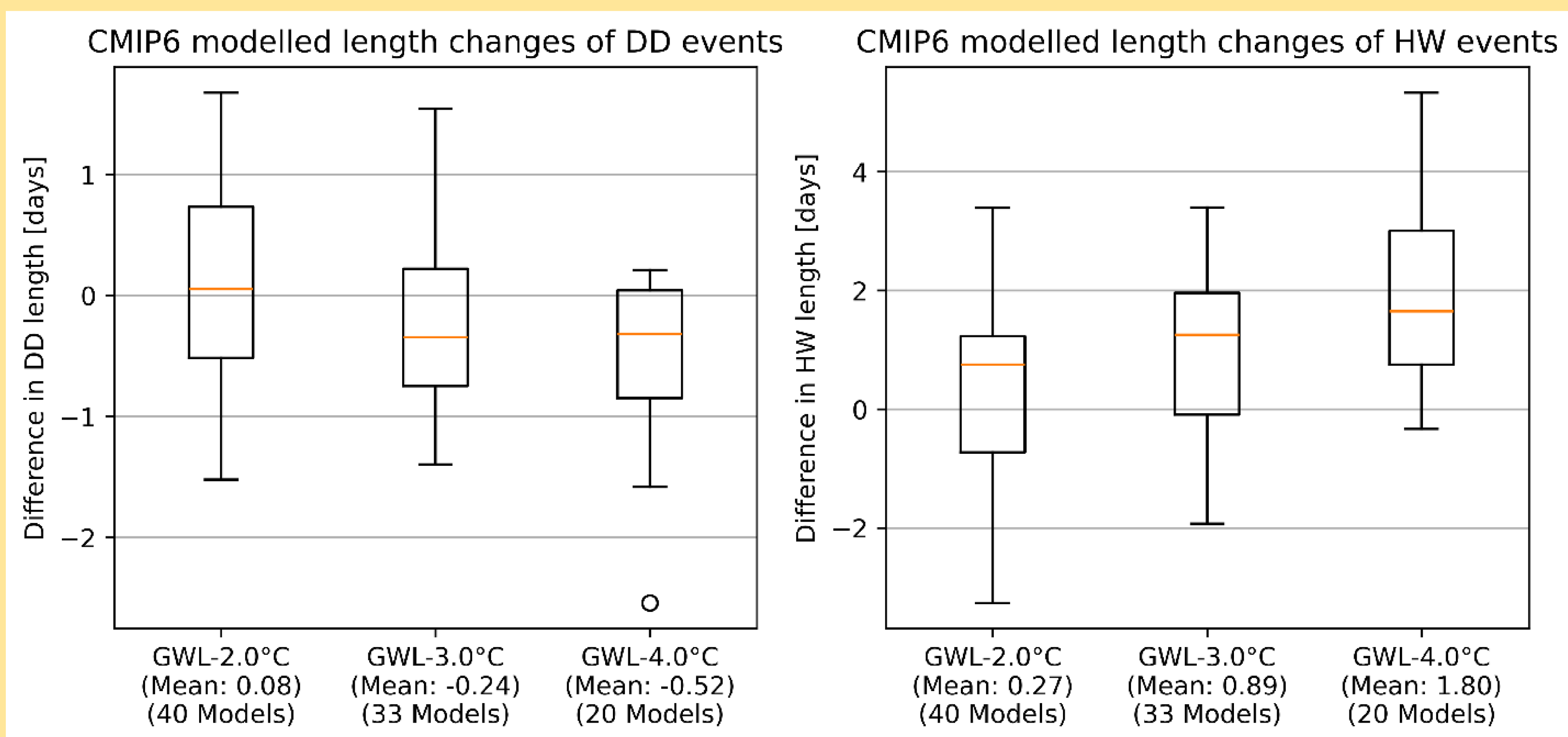

Figure 5: Projected changes in DD (left) and HW (right) length for different GWLs in days to the observed average lengths (DD: 4.5, HW: 10.8) in the historical period (2001-2020, GWL-1.0°C).

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