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Long-term climate change effects in the European offshore wind energy

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Climate change and offshore renewable energy sector are connected by a double nature link. Even though energy generation from clean marine sources is one of the strategies to reduce climate change impact within next decades, it is expected that large scale modification of circulation patterns will have in turn an impact on the spatial and temporal distribution of the wind fields. Under the WINDSURFER project of the ERA4CS initiative, we analyse the climate change impact on marine wind energy resource for the European offshore wind energy sector. Long-term changes in specific climate indicators are evaluated over the European marine domain (e.g. wind power density, extreme winds, operation hours) as well as local indicators (e.g. gross energy yield, capacity factor) at several relevant operating offshore wind farms.

Adopting an ensemble approach, we focus on the climate change greenhouse gases scenario RCP8.5 during the end of the century (2081-2100 period) and analyze the changes and uncertainty of the resulting multi-model from seven high resolution Regional Climate Models (RCM) realized within Euro-Cordex initiative (EUR-11, ~12.5km). ERA5 reanalysis and in-situ offshore measurements are the historical data used in present climate.

Results indicate a small decrease of wind energy production, testified by reduction of the climatological indicators of wind speed and wind power density, particularly in the NW part of the domain of study. The totality of the currently operating offshore windfarms is located in this area, where a decrease up to 20% in the annual energy production is expected by the end of the century, accompanied by a reduction of the operation hours between 5 and 8%. Exceptions are represented by Aegean and Baltic Sea, where these indicators are expected to slightly increase. Extreme storm winds however show a different spatial pattern of change. The wind speed associated to 50 years return period decreases within western Mediterranean Sea and Biscay Bay, while increases in the remaining part of the domain (up to 15% within Aegean and Black Sea). Finally, the estimated variations in wind direction are relevant on the Biscay Bay region.