

Climate data selection for multi-decadal wind power forecasts

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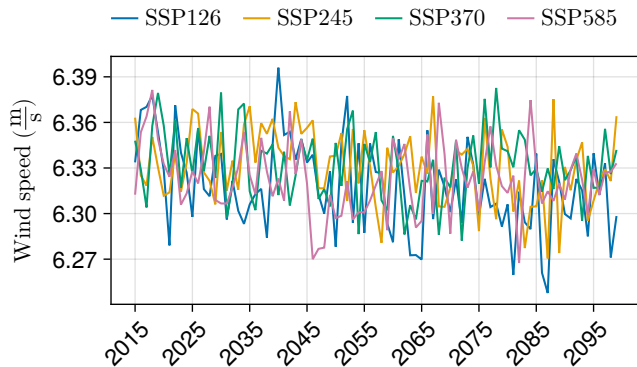
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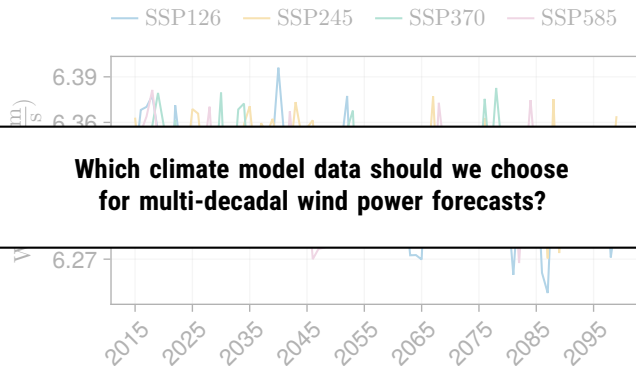
Climate change may impact long-term wind power generation

Data from MPI-ESM1-2-HR



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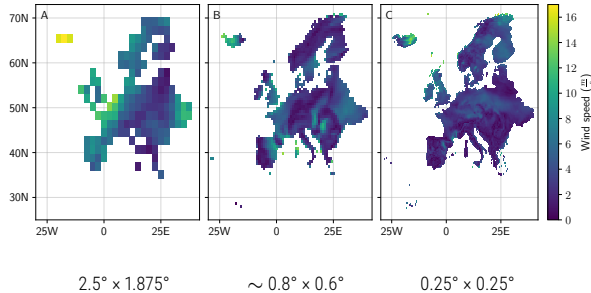


Climate model choice matters

Higher spatial resolution $\nRightarrow$ better prediction

Climate model data differs

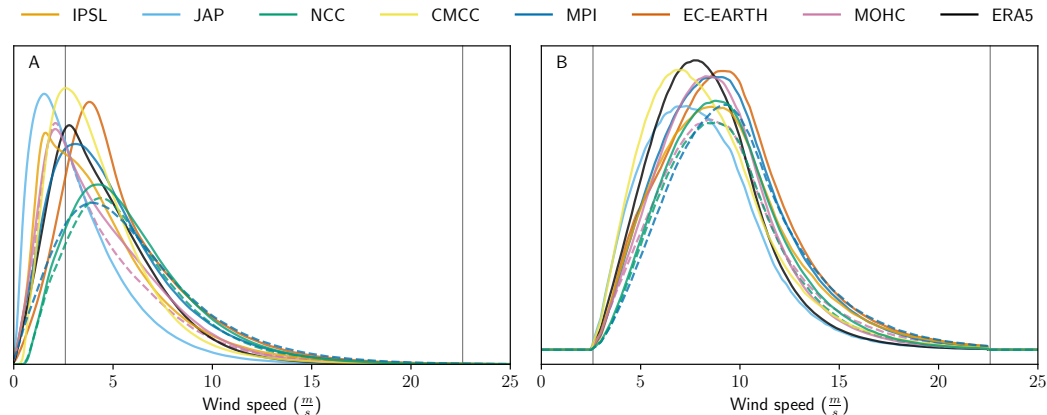
And not just in spatial resolution...



- Data sources
 - 10 GCMs from CMIP6
 - RCMs from CORDEX with CMIP5 global boundary models
 - ERA5 as reference
- Historical runs
- Continental Europe domain

Which climate data best represents wind speeds?

Wind power depends non-linearly on wind speed – the full distribution matters, not just the average.

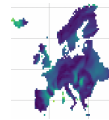


KDEs of wind speeds (A) and the corresponding generated wind power density (B) for all time steps and grid points.

Evaluating wind speed distributions

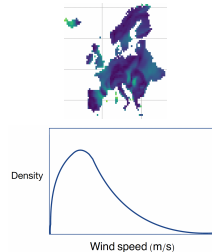
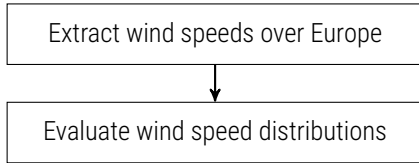
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Extract wind speeds over Europe



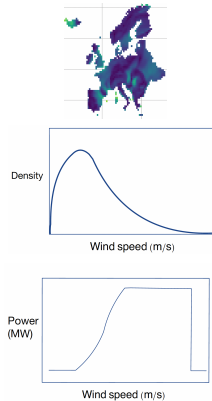
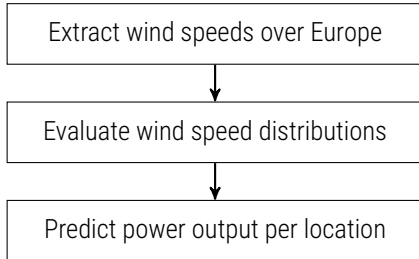
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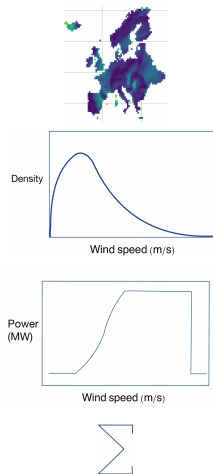
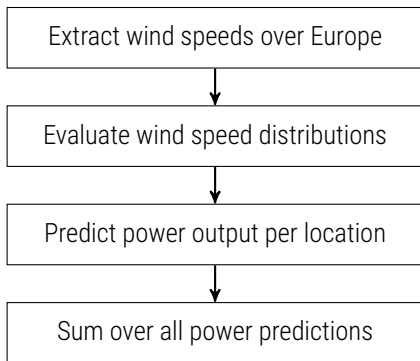
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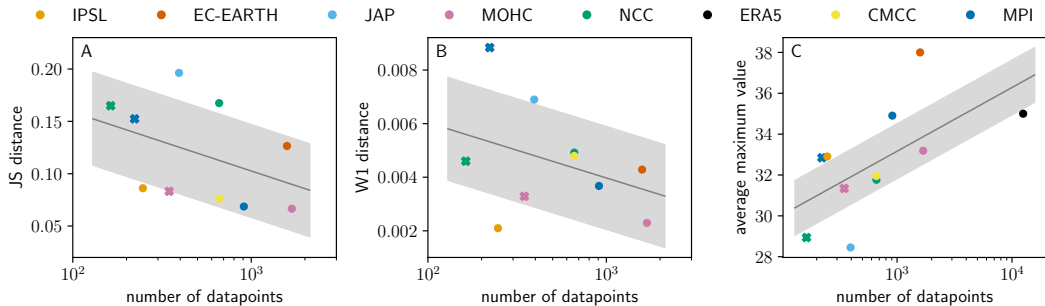
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Trends with spatial resolution

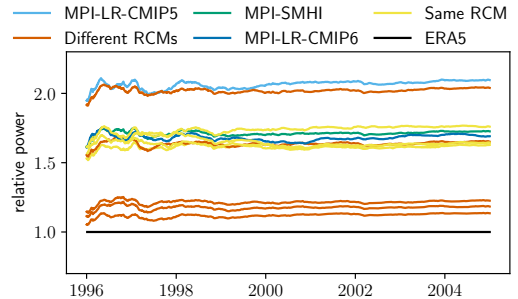
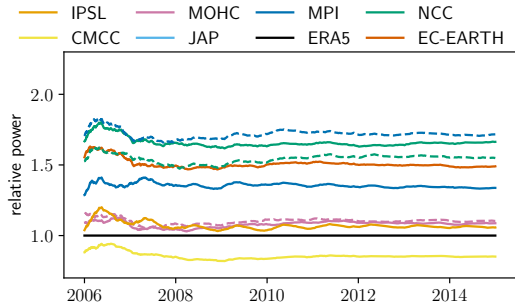
The maximum value simulated increases with spatial resolution, all other trends are not significant



Regression of distributional metrics (A & B) and maximum wind speeds (C) with grid resolution.

Choice of GCM and RCM is influential

Higher spatial resolution $\Rightarrow$ better prediction



wind speed $\rightarrow$ cumulative wind power $\rightarrow$ average over all grid cells $\rightarrow$ relative to ERA5

Choose your model wisely!

Climate data selection for multi-decadal wind power forecasts (Morelli et al., 2025)

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Feel free to reach out:
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