Impact of weather regimes on wind power variability in western Europe

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EGU General Assembly 2020

Vienna | Austria | 3–8 May 2020

Universidad Complutense Madrid · IGEO Instituto de Geociencias · Iberdrola

1. Introduction

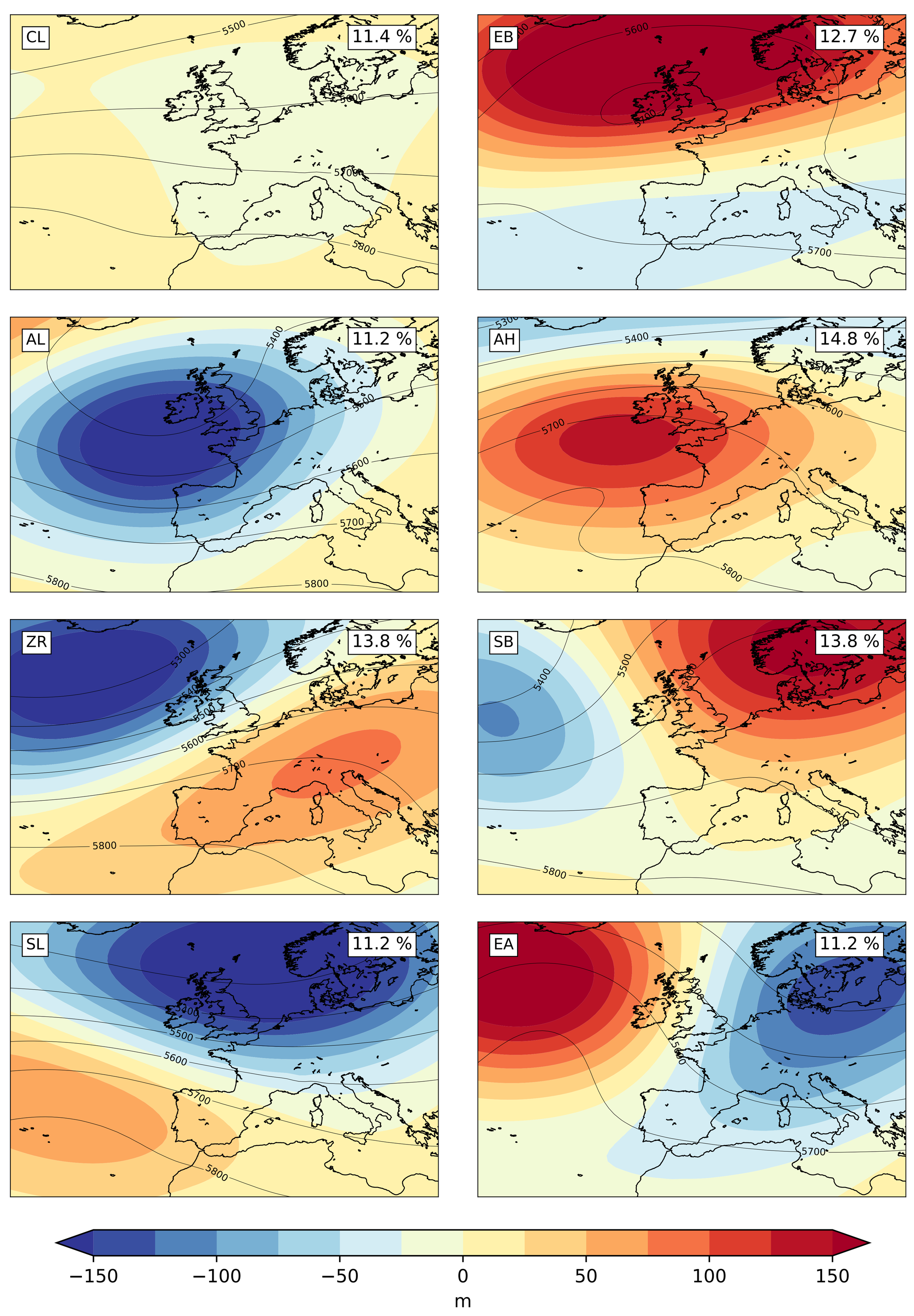
Over the last years, wind power production has become key in the European electricity market. The main meteorological driver of wind energy is wind speed, which mainly depends on the atmospheric circulation and the local orography. Therefore, improving our understanding of the relationships between the large-scale atmospheric circulation and wind power production at the regional scale is required for the evaluation and further implementation of wind energy resources. This study introduces novelty in the assessment of Weather Regimes (WRs) as predictors of wind power variability over the western European façade.

2. Wind energy resources

1. Normalized wind speeds and capacity factors (CFs) **derived from meteorological fields provided by the ERA-Interim reanalysis** at 0.75° x 0.75° horizontal resolution for the 1979-2018 period.
2. Time series of CFs at the locations of 105 **wind farms operated by Iberdrola** in the UK and Iberia during 1991-2018.

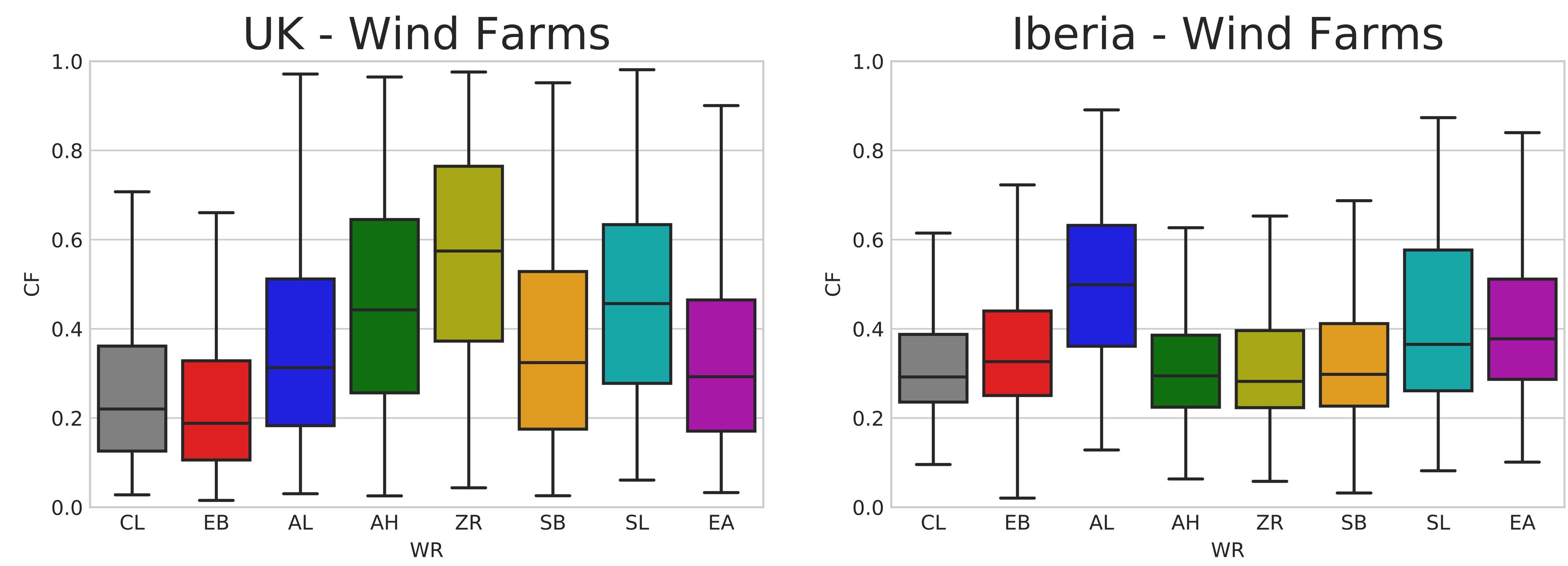
3. Weather Regimes

We have used daily 500 hPa geopotential height (Z500) fields from the ERA-Interim reanalysis for the identification of WRs. The domain (30°W – 25°E, 30°N – 65°N) is substantially smaller than those traditionally used to derive WRs for the North Atlantic-European sector as it only includes the eastern half of the North Atlantic. This amplifies the circulation signal on wind power output for the region of study. A climatology weather regime (CL) is also included to further improve the data partitioning.

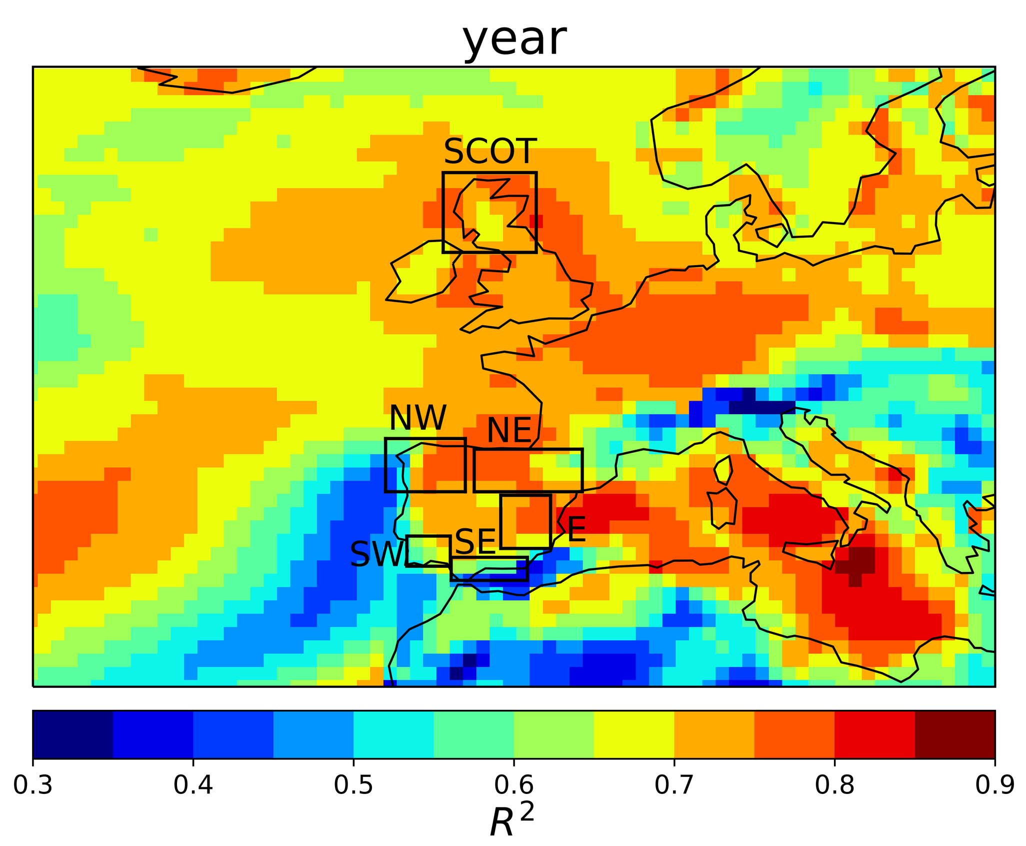


4. Relationships between WRs and wind production

We have examined the impact of the WRs on the CF distributions of the UK and Iberia. In the UK, ZR, SL and AH stand out over the rest, whereas in the case of Iberia, AL, SL and EA present high CF values. SL is the only pattern associated with relatively high wind power production for both regions. On the other hand, CL yields low production in both regions.



5. Modeling wind power production with WRs



R^2	spr	sum	aut	win	year
SCOT	0.70	0.53	0.80	0.73	0.85
NW	0.70	0.40	0.71	0.71	0.80
SW	0.66	0.63	0.48	0.63	0.66
SE	0.34	0.44	0.16	0.40	0.42
NE	0.69	0.43	0.74	0.60	0.78
E	0.68	0.52	0.81	0.59	0.80

We have modelled the monthly mean CFs using a multilinear regression model (MLRM) on the monthly frequencies of occurrence of each WR

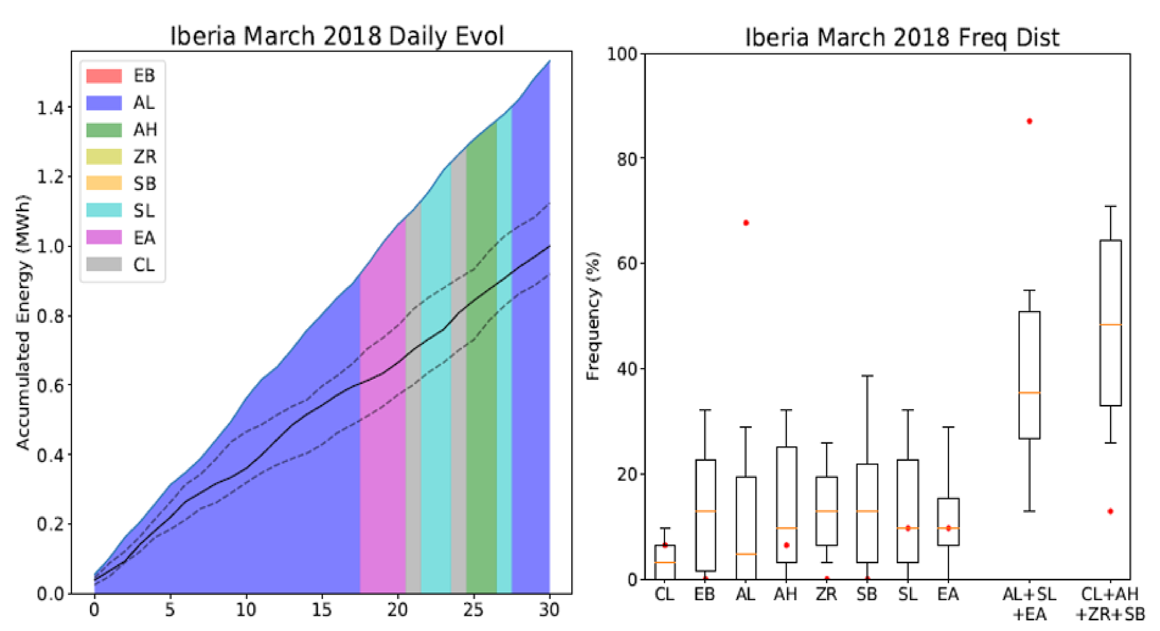
ERA-Interim reanalysis

- Large spatial variability across Europe
- R^2 values up to 0.7–0.8 over Iberia and northwestern/central Europe
- Reanalysis datasets do not resolve local features. Wind farm assessment is required.

Wind Farms (table)

- The MLRM is slightly more skillful over Scotland than for most Iberian sub-regions in all seasons
- Poorest performance in SE Iberia
- Poorest performance in summer

6. Case study



We have examined an event with outstanding production over Iberia associated with the occurrence of a sudden stratospheric warming (Ayarzagüena et al., 2018). The prevalence of WRs associated with high production (AL + SL + EA) occurred almost 90% of the days in March 2018, suggesting that the use of WRs can help understand the day-to-day variability of wind power production during specific episodes of anomalous wind.

7. Conclusions

In this work, wind power output has been related to a customized set of WRs in order to explore their skill to drive wind power variability in the UK & Iberia. Compared to previous assessments, our approach has resulted in improved capability to reproduce the evolution of wind energy resources over the western European façade, including periods of anomalous production which are challenging for capacity planning in electricity generation. **For further details see Garrido-Perez et al.(2020)**

References

[1] **Garrido-Perez, J. M., Ordóñez, C., Barriopedro, D., García-Herrera, R. and Paredes, D., 2020.** ***Impact of weather regimes on wind power variability in western Europe.*** **Applied Energy, 264, 114731.**

[2] Ayarzagüena, B., Barriopedro, D., Garrido-Perez, J. M., Abalos, M., de la Cámara, A., García-Herrera, R., Calvo, N. and Ordóñez, C., 2018). *Stratospheric connection to the abrupt end of the 2016/2017 Iberian drought.* Geophysical Research Letters, 45(22), 12-639.