BOREAS: Combinando conocimientos de predicciones y proyecciones climáticas para incrementar la resiliencia del sector energético español frente a la variabilidad y el cambio climático

BOREAS: Blending knowledge from climate predictions and projections to make the Spanish energy sector more resilient to climate variability and change

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RESUMEN

Spain is legally committed to carbon neutrality by 2050 but remains heavily dependent on imported energy and fossil fuels. Although greenhouse gas emissions fell by 35% between 2005 and 2023, renewables accounted for only 24.6% of energy consumption in 2024. To meet climate targets, Spain's green transition prioritises rapid expansion of wind and solar energy. Spain has a high potential for renewable energy generation, which could significantly reduce dependency on fossil fuels and, under appropriate infrastructural and regulatory conditions, support energy exports. In this context, the BOREAS project aims to support the sustainable and climate-resilient development of renewable energies. To this end, we explore the climate information needs of a range of stakeholders (mainly energy companies but also climate information providers), including indicators relevant for decision-making in the energy sector at different timescales. Among other aspects, BOREAS project produces monthly forecast outlook webinars aimed at energy providers, offering updates on recent climate conditions and upcoming subseasonal and seasonal forecasts of energy-relevant variables. At decadal timescales, a comprehensive comparison of statistical downscaling methods is being carried out. High-frequency energy-related indicators, including wind and solar capacity factors, are calculated alongside combined metrics to assess the complementarity of both energy sources, with results showing generally higher predictability for solar energy. In parallel, BOREAS develops strategies to merge climate predictions and projections into coherent climate information products, with successful examples of seasonal-to-decadal blending already demonstrated (doi.org/10.5194/esd-17-41-2026). This will overcome the issue of having inconsistent predictions due to using different sources of climate information for different timescales. We also work with future climate projections, exploring uncertainties in wind power generation in Europe with CMIP6 models. Beyond delivering tailored climate information, we explore predictability gaps in energy-relevant variables such as wind and precipitation. At seasonal timescales, we conduct process-based evaluations to understand how the model representation of specific physical processes (e.g., Tropical Atlantic SST and SLP variability, ENSO) in seasonal forecasting systems can be linked to the observed surface wind and precipitation over Northeast Brazil. At seasonal-to-decadal timescales, we enhance wind prediction skill over the Americas by subsampling ensemble members that best predict modes of internal variability such as the El Niño-Southern Oscillation.