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Temporal and spatial variations in wind speed correlation: A comparative analysis of ERA5 and MERRA2 reanalysis data for the last decade

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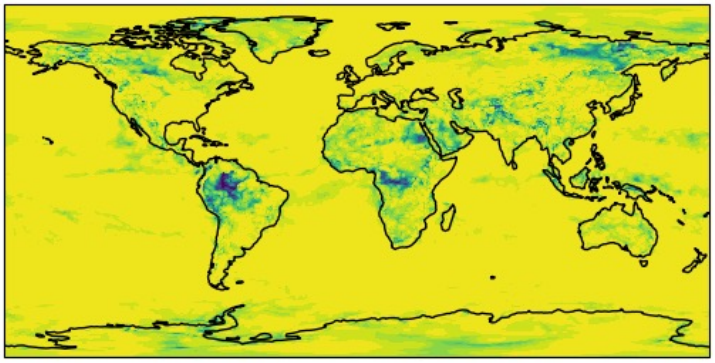
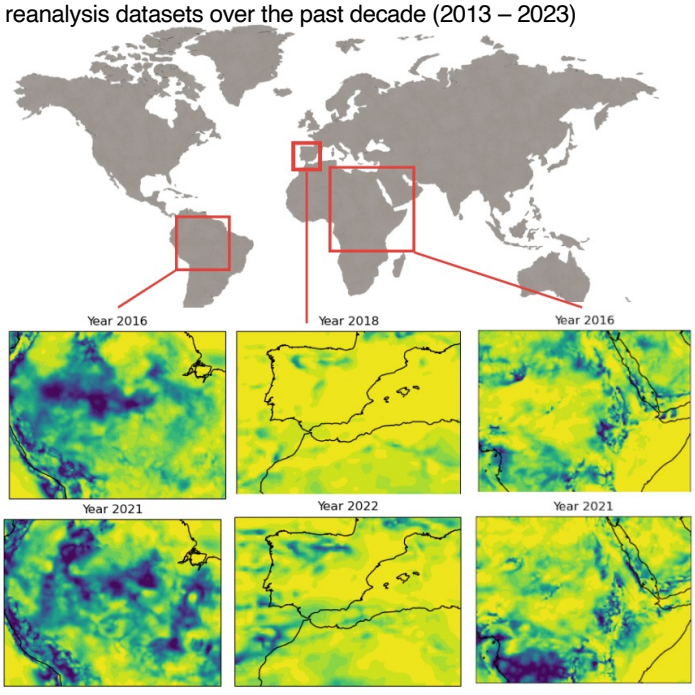
ERA5 and MERRA2 exhibit significant divergences in wind speed for some regions of the world.

- Ensuring wind speed data consistency across reanalysis datasets is crucial for accurate wind resource estimation. This study focuses on the correlation of **monthly mean wind speeds** between **ERA5** and **MERRA2** reanalysis datasets over the past decade (2013 – 2023) examining these correlations on a global scale.
- This analysis uses the **coefficient of correlation** (R^2) as a key metric to evaluate the correlation between ERA5 and MERRA2 datasets. By generating global R^2 maps, we identify regions with high and low correlations, providing insights into the spatial distribution of consistency between these reanalysis products.
- Our analysis highlights the complexity of wind speed correlations between ERA5 and MERRA2 datasets. Some regions show strong agreement (R^2 close to 1.0) while other areas reveal significant discrepancies, particularly in regions with complex terrain or variable climatic conditions.



Global map of the R2 correlation coeficient between ERA5 and MERRA2 monthly averages for the whole decade 2013 - 2023



Three regions with different patterns for different years, on the left the Amazon region, on the centre the Iberian Peninsula and on the right the Red Sea and East Africa

- The spatial analysis reveals regional differences in wind speed correlation between ERA5 and MERRA2 datasets. **Amazon** region shows significant variation in R^2 values across different years. In **2016**, correlations are relatively low across much of the region, reflecting discrepancies in the datasets ability to capture the dynamics of the atmospheric system. By **2021**, inconsistencies persist, particularly in regions with complex topography such as the **Andes**.
- Similarly, in **Europe**, correlations vary from year to year. While **Iberian Peninsula** shows relatively strong agreement in **2018**, discrepancies are more pronounced in **2022**, suggesting shifts in the datasets' alignment over time.
- In **East Africa**, particularly around the **Great Rift Valley**, persistent low R^2 values across most years suggest a fundamental limitation of reanalysis datasets in capturing wind speed dynamics in this region.
- The temporal analysis highlights how correlations can fluctuate throughout the year, further emphasizing the need for careful consideration when using reanalysis data for wind resource assessments. These findings highlight the need to account for **dataset inconsistencies**, as they can significantly affect wind energy projections in certain regions.

- **References**: Lacave, O. et al. "*MCP studies with reanalysis models: get a forecast of the uncertainty and complexity without observational data* " EWEA 2015

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