

Memo: Accuracy of Wind Speeds in Copernicus Regional Reanalysis for Europe, CERRA

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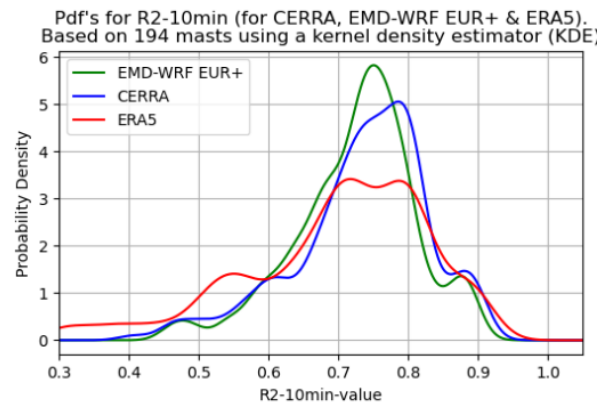
Introduction

How accurate is the CERRA data when used for renewable energy modelling? How does it benchmark against other widely used mesoscale datasets? This note gives a hint by analysing some important metrics, R^2 correlation and distribution-bias, from almost 200 tall and high-quality meteorological masts from within the Pan-European area.

Approach

Wind speeds obtained from CERRA data have been evaluated by comparing against mast-measurements. The approach is to:

- Limit to masts with 100m wind speed > 5.50 m/s (from GASP)
- Wind speeds taken from top anemometer with limitation on mast-heights to the range from 80m to 120m
- Statistics (mean, std) on important metrics for all masts and all 3 datasets (CERRA, EMD-WRF EUR+ & ERA5):
 - *Wind speed correlation, 10 min + day, R2*: Correlation on 10-minute wind speeds and daily averaged values
 - *Wind direction, MAE*: Sample statistics on wind direction error (in degrees)
 - *Bias - Avg. wind speed*: Bias in annual average mean wind speed (in m/s)
 - *Wind distribution – CV-error*: Error in coefficient of variation (in percent)



KDE probability density of 10min R^2 correlations for wind speed. Based on almost 200 masts.

Results – Selected Metrics – almost 200 masts in all terrains

The table below summarizes the statistics for the R^2 -correlation histogram shown in the figure above and the other metrics.

Statistics 194 masts	Dataset		
	CERRA	EMD-WRF EUR+	ERA5
<i>Wind speed, 10 min, R²</i> mean(R^2) ± std(R^2)	0.73 ± 0.10	0.73 ± 0.09	0.70 ± 0.14
<i>Wind speed, daily average, R²</i> mean(R^2) ± std(R^2)	0.88 ± 0.07	0.89 ± 0.06	0.85 ± 0.11
<i>Wind direction, MAE [deg]</i> mean(MAE) ± std(MAE)	36 ± 11	36 ± 11	38 ± 12
<i>Bias - Avg. wind speed [m/s]</i> mean(BiasWS) ± std(BiasWS)	-1.0 ± 0.8	0.2 ± 0.7	-1.3 ± 1.2
<i>Wind distribution, CV error [%]</i> mean(CV error) ± std(CV error)	-0.8 ± 6.6	0.5 ± 6.6	-1.0 ± 8.5

Legend: green – best performance, blue = second-best, red – worst performance

Findings

- *R²-correlation*: The two mesoscale datasets CERRA and EMD-WRF EUR+ performs equally well. ERA5 has a lower R^2 -correlation than the other 2 datasets.
- *Wind direction*: The CERRA, EMD-WRF EUR+ and ERA5 datasets have an equal performance – and are very similar.
- *Bias in annual wind speed*: CERRA and ERA5 has a quite large average by bias' in mean wind speeds. The ERA5 bias can be explained (large negative bias) due to the missing mesoscale-effects. The negative bias in CERRA is likely due to a coarser model spatial resolution 5.5km in CERRA vs 3km in the EMD-WRF EUR+.
- *Wind distribution, CV error*: EMD-WRF EUR+ is best performing (coefficient of variation is closely linked to Weibull k).
- *Generally*: The CERRA mesoscale data has a satisfactory performance and is suitable for renewable energy applications.

Endnotes

Read more on the CERRA and the other datasets at the windPRO wiki and knowledge-base:

- CERRA: <https://help.emd.dk/mediawiki/index.php?title=CERRA>
- Other datasets: https://help.emd.dk/mediawiki/index.php?title=Category%3AWind_Data