

# Comparison of Correlations Between Wind and Solar Radiation

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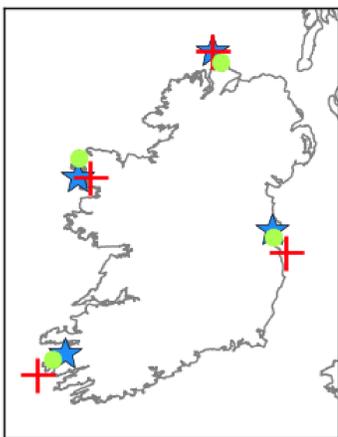
## Introduction

Combining wind and solar power generation has potential to make renewable energy less variable. This is done to take advantage of the fact that it tends to be cloudy when it's windy and calm when it's sunny [1] [2].

Preliminary site assessment for wind and solar power generation is commonly done by making use of reanalysis data. In this study, the correlation between wind speed and solar radiation from two popular reanalysis datasets, **ERA-Interim** and **MERRA2**, have been compared to correlations based on observed data.

## Data

Wind speed and shortwave radiation (SW) observations are analysed from four different stations around Ireland, shown in fig.1.



**Figure 1:** Grid points used for station (●), ERA-Interim (+) and MERRA2 (★) data.

A **reanalysis** is a dataset generated using weather observations

and a modified forecast model to produce a gridded representation of past weather events. **ERA-Interim** is produced by ECMWF and **MERRA2** is produced by NASA.

**Most observations** from the Cabauw Experimental Site for Atmospheric Research, Netherlands, are also used to study the correlations of SW with wind speed at different heights.

## Conclusion

- Reanalysis datasets appear to overestimate the strength of the anticorrelation between 10m wind speed and incoming shortwave radiation at stations in Ireland.
- The two reanalyses studied disagree with one another, especially during summer. This seems to be primarily driven by differences in their representations of solar radiation.
- These differences persist when considering winds which higher up in the atmosphere.

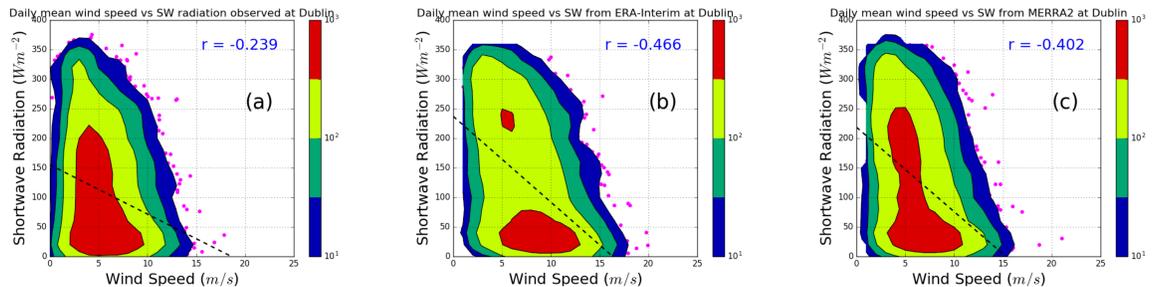
Future work will look to use mast observations over Ireland to continue the analysis of the correlations between SW and wind speeds closer to wind turbine hub heights.

## References

- [1] Philip E Bett and Hazel E Thornton. The climatological relationships between wind and solar energy supply in Britain. *Renewable Energy*, 87:96–110, 2016.
- [2] Yanping He, Adam H Monahan, and Norman A McFarlane. Diurnal variations of land surface wind speed probability distributions under clear-sky and low-cloud conditions. *Geophysical Research Letters*, 40(12):3308–3314, 2013.

## Results: Daily Correlations

Scatter plots of daily mean 10m wind speed vs SW at Dublin Airport are shown in fig.2 for each dataset. The Pearson correlation coefficients for each station and each dataset are given in table.1. The magnitude of the anticorrelation in both reanalyses are greater than the observed correlations at all stations.



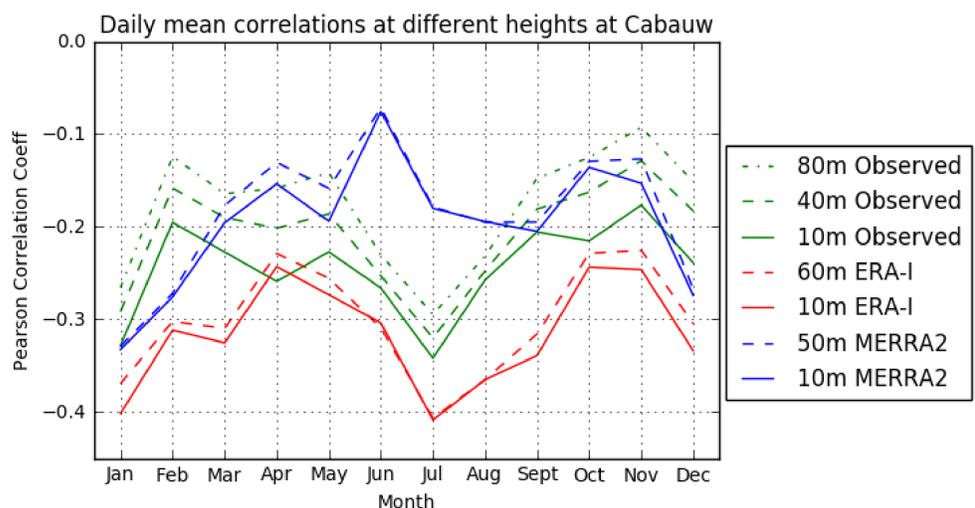
**Figure 2:** Scatter plot of daily mean 10m wind speed and SW, with best-fit line and Pearson's correlation coefficient, at Dublin Airport for (a) Observations, (b) ERA-Interim and (c) MERRA2.

	Belmullet	Dublin	Malin Head	Valentia
Observations	-0.276	-0.239	-0.340	-0.301
ERA-Interim	-0.407	-0.466	-0.461	-0.435
MERRA2	-0.383	-0.402	-0.446	-0.358

**Table 1:** Correlation coefficient between daily mean 10m wind speed and SW.

## Results: Monthly Correlations of Daily Means

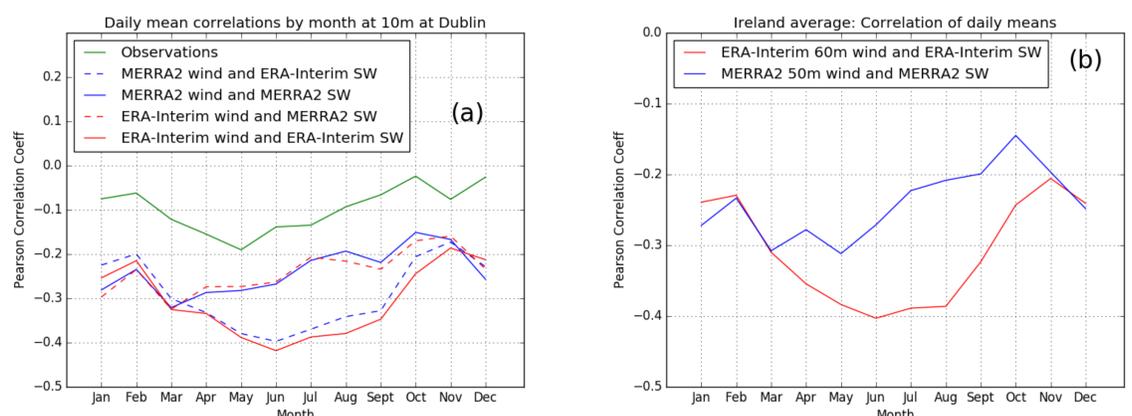
Data from Cabauw was used to assess the correlations between SW and wind speeds at different heights and how they compare to reanalysis data, fig.3. Correlations of SW with observed winds are seen to vary more with height than the reanalyses. Generally there are greater differences in the correlations across datasets than between different heights within the same dataset.



**Figure 3:** Monthly correlations of daily mean wind speed and SW at different heights from Cabauw, Netherlands for observations, ERA-Interim and MERRA2.

At 10m at Dublin Airport, fig.4(a), the strength of the anticorrelations for both reanalyses are greater than observed values for every month. The monthly correlations for the two reanalysis datasets vary differently through the year, especially in summer.

In fig.4(b), for winds further away from the surface, the differences between the reanalyses persist in a similar manner to fig.3.



**Figure 4:** Monthly correlations of daily SW and daily mean wind speed, at (a) 10m and (b) 50m/60m, for observations, ERA-Interim and MERRA2.

## Acknowledgements

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