

Comparison between wind speed observed at 100m height and wind speeds simulated by the WRF and MAR models

Doutreloup S.¹ ; Beaumet J.² ; Breuer C.³ ; Fettweis X.⁴ & Erpicum M.⁵

Evaluating predictive performance of WRF model

In the FLEXIPAC project, our Laboratory of Climatology has to forecast solar radiations, wind and temperature. In this aim, some sensitivity tests were conducted with the WRF model to determine the configuration of the model's physics which simulates the best atmospheric conditions.

During these tests, it appears that wind speeds measured at 10m in two airport weather stations, Liège (#2 in Figure 1) and Zaventem (#3 on Figure 1) are undervalued by the WRF model, while those extracted at 100m from wind productions of Amel wind farm (#1 in Figure 1) and Marbais wind farm (#4 in Figure 1) are largely overestimated by WRF.

In Japan, Shimada et al. (2011) reported similar overestimations of the 100m wind speed with the WRF model forced by NCEP-NCAR. They have concluded that different patterns of the planetary boundary layer proposed in WRF did not allow to significantly correct this bias observed every month of the year.

WRF Domain

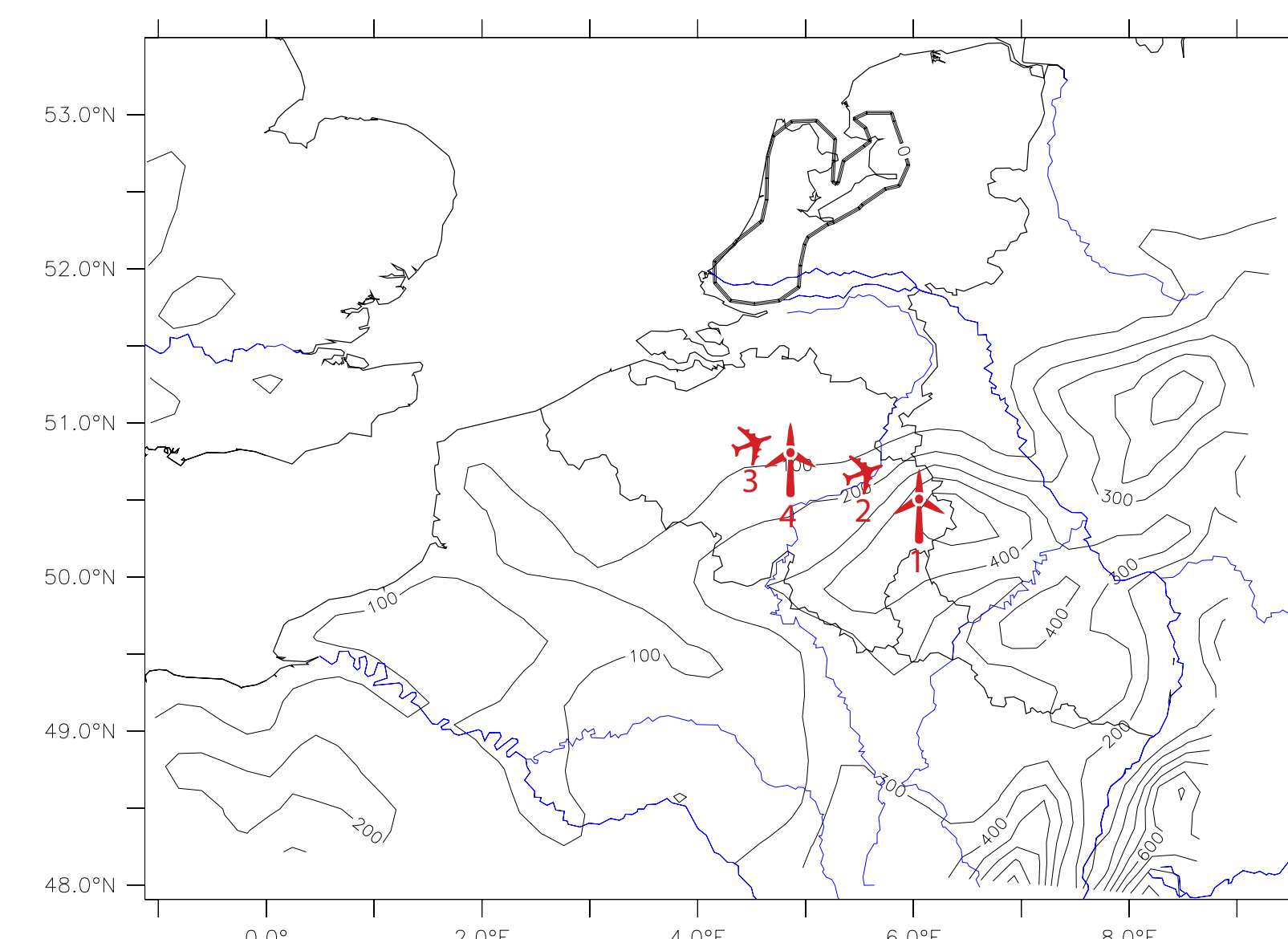


Figure 1 : Localization of two airport weather stations Bierset (#2) and Zaventem (#3), and of the two wind farms Amel (#1) and Marbais (#4). The background of the map is the topography of the WRF model.

Annual wind speed at 100m height in Amel

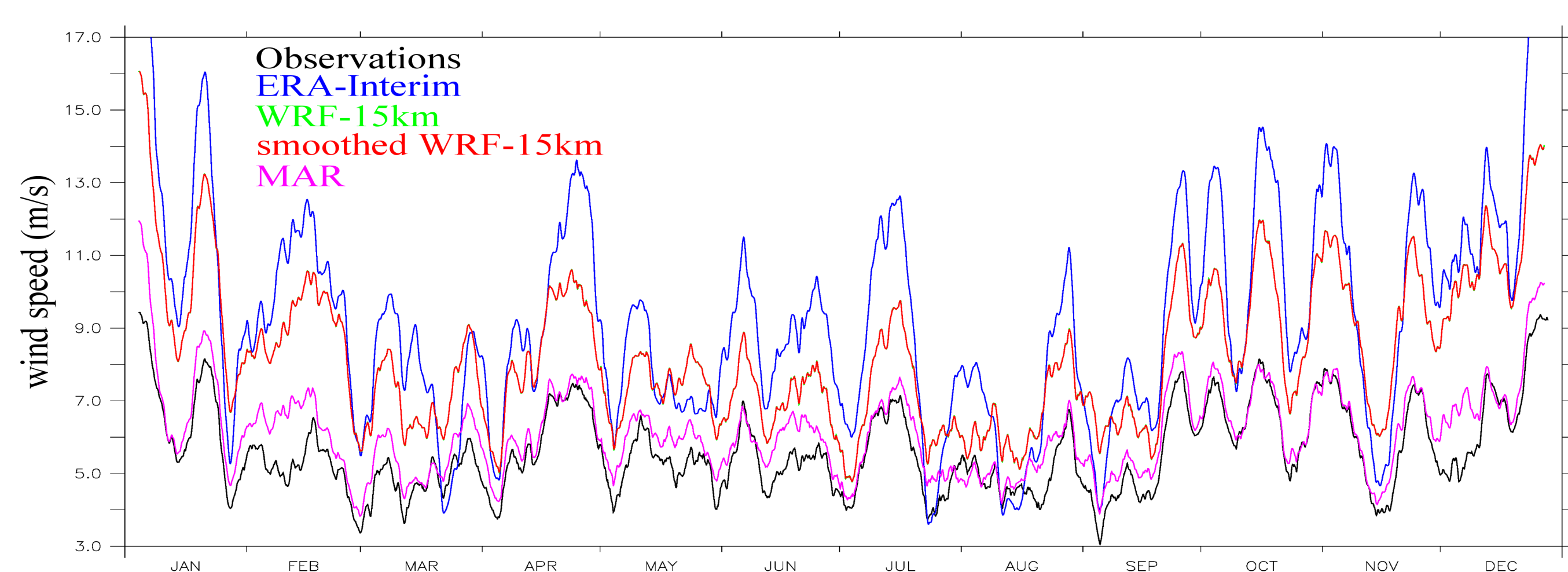


Figure 2 : Comparison of 7-days running mean observations (black) with ERA-Interim reanalysis (blue), WRF at 15km resolution (green), smoothed WRF at 15km (red) and MAR model (purple) for the wind farm of Amel during the period from January 2012 to December 2012

Models configurations

WRF model v.3.4. (Skamarock, 2008)

Horizontal resolution : 15km
Vertical resolution : 28 levels (10 below 1 km)
Temporal resolution : 1 minute
Domain : 1°W à 8°E et 48.5°N à 53.5°N
Boundary forced every 6h by ERA-Interim reanalysis
Developped by the WRF Community

MAR model v.3.3. (Fettweis, 2013)

Horizontal resolution : 10km
Vertical resolution : 24 levels (7 below 1 km)
Temporal resolution : 1 minute
Domain : 0.5°W à 8.3°E et 48.4°N à 53°N
Boundary forced every 6h by ERA-Interim reanalysis
Developped by our Laboratory of Climatology (ULg)

Comparison & Main findings

To confirm the Shimada's hypothesis, four tests are performed. For each one (see Table below), we compare the WRF model with :

1) ERA-Interim reanalysis

WRF model (green curve on Figure 3) significantly improves the results compared to the ERA-Interim reanalysis (blue curve on Figures 2 & 3).

2) a simulation of the WRF model run at a spatial resolution of 5km

Increasing spatial resolution does not provide a significant improvement of results.

	Bierset (10m)			Zaventem (10m)			Amel (100m)			Marbais (100m)		
	Bias	RMSE	R ²	Bias	RMSE	R ²	Bias	RMSE	R ²	Bias	RMSE	R ²
ERA-Interim	3,56	4,23	0,61	1,43	1,91	0,65	3,77	5,40	0,55	3,02	4,04	0,72
WRF-15km	-0,66	1,51	0,57	-0,14	1,29	0,61	2,71	3,69	0,58	2,30	3,25	0,64
WRF-5km	-0,83	1,56	0,59	-0,23	1,27	0,61	2,36	3,42	0,55	2,23	3,18	0,65
WRF-15km F6	-0,66	1,44	0,60	-0,14	1,19	0,63	2,71	3,57	0,60	2,30	3,08	0,67
WRF-5km F6	-0,83	1,50	0,62	-0,23	1,18	0,65	2,37	3,26	0,58	2,23	3,00	0,69
MAR	-0,57	1,29	0,67	-0,06	1,10	0,68	0,56	1,65	0,59	-0,06	1,68	0,63

3) a smoothed simulation (6-hours running mean) of the WRF model

Smoothed simulation (red curve on Figures 2 & 3) slightly improves the results. This means that the variability created by the WRF model deteriorates the results.

4) MAR model

MAR model (purple curve on Figures 2 & 3), which is a regional atmospheric model, simulates significantly better wind speed observations at 10m and 100m compared to the WRF model, suggesting that observed biases in the wind speeds are due to the WRF model itself and not to the data forcing.

Comparison sample

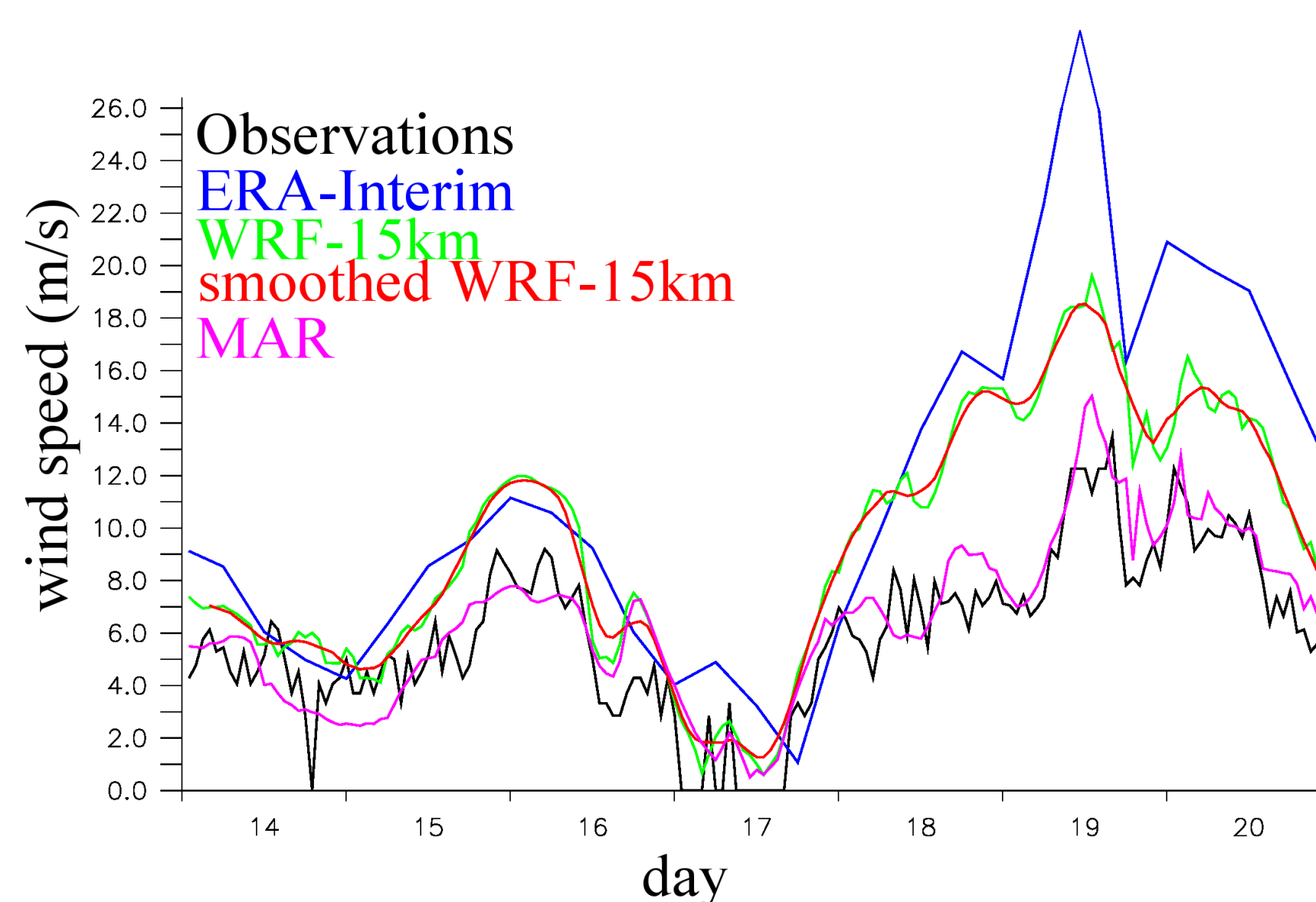


Figure 3 : Comparison of observations (black) with ERA-Interim reanalysis (blue), WRF at 15km resolution (green), smoothed WRF at 15km (red) and MAR model (purple) for the wind farm of Amel during the period from 14 January 2012 to 19 January 2012

References

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Perspectives

We will study the behavior of other meteorological variables within the lower layers to verify whether the use of MAR model remains more relevant than WRF model for these variables.