Verification of WRF Wind Speeds over South Africa

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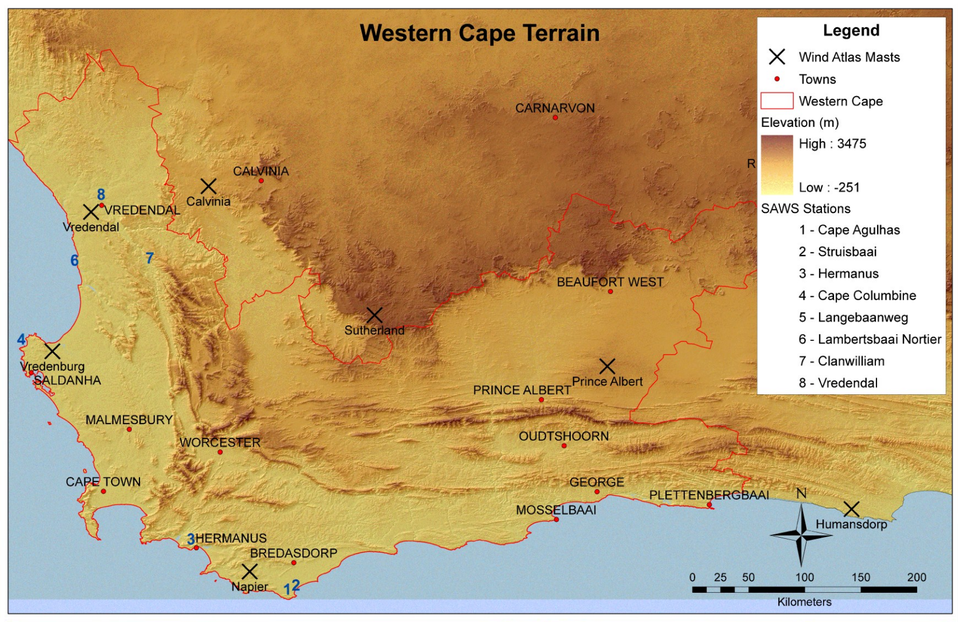
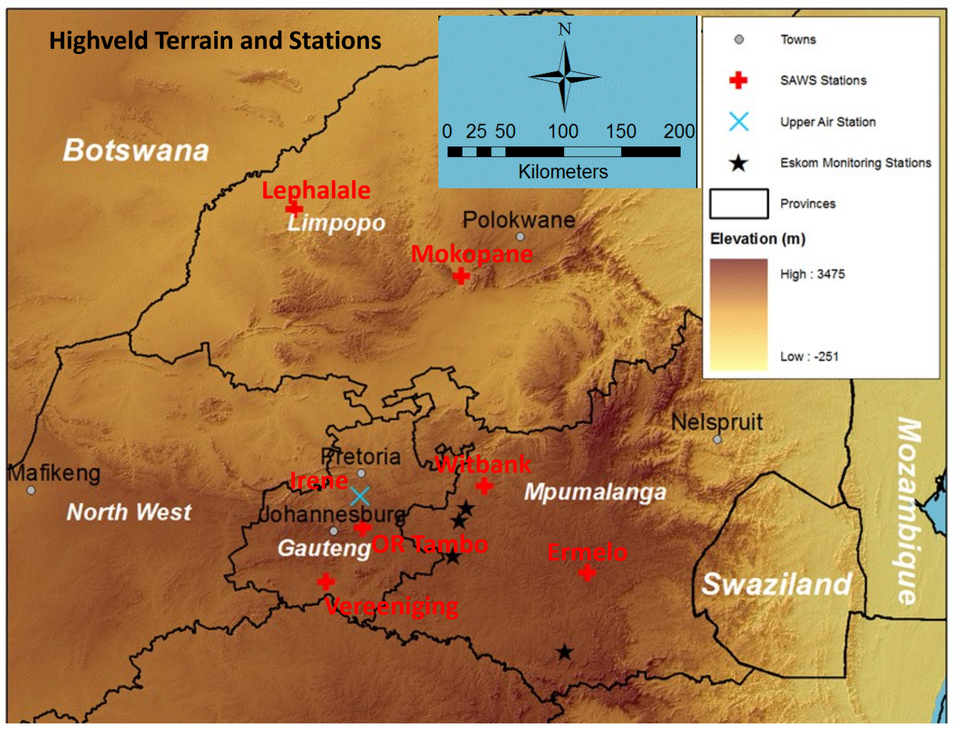
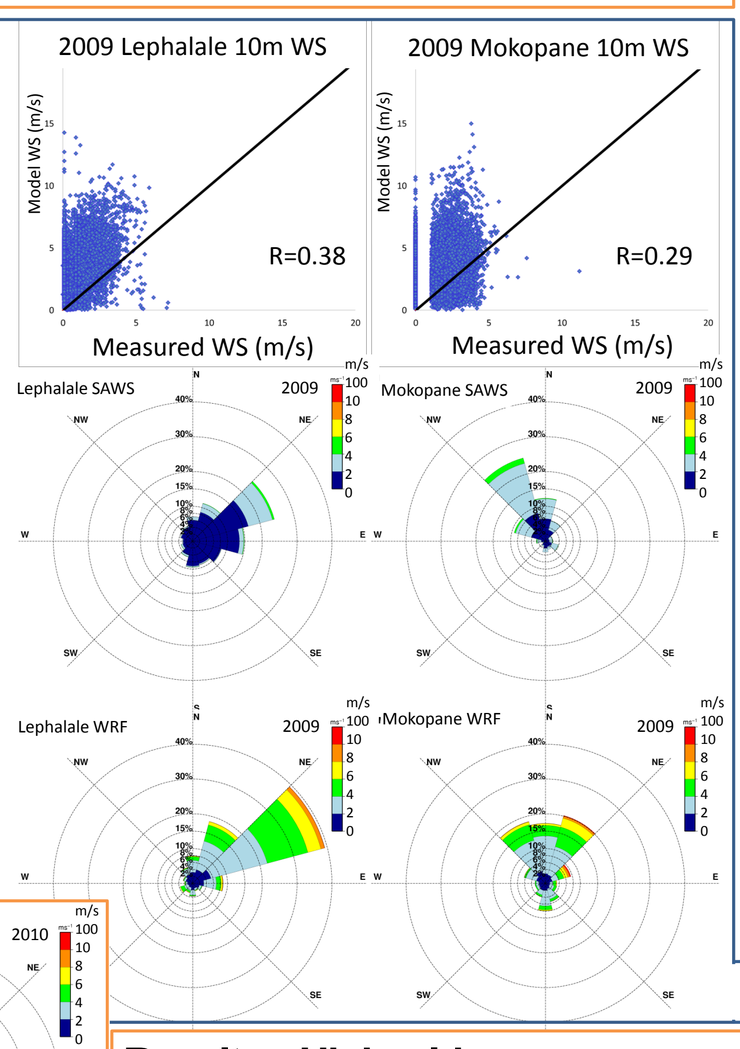
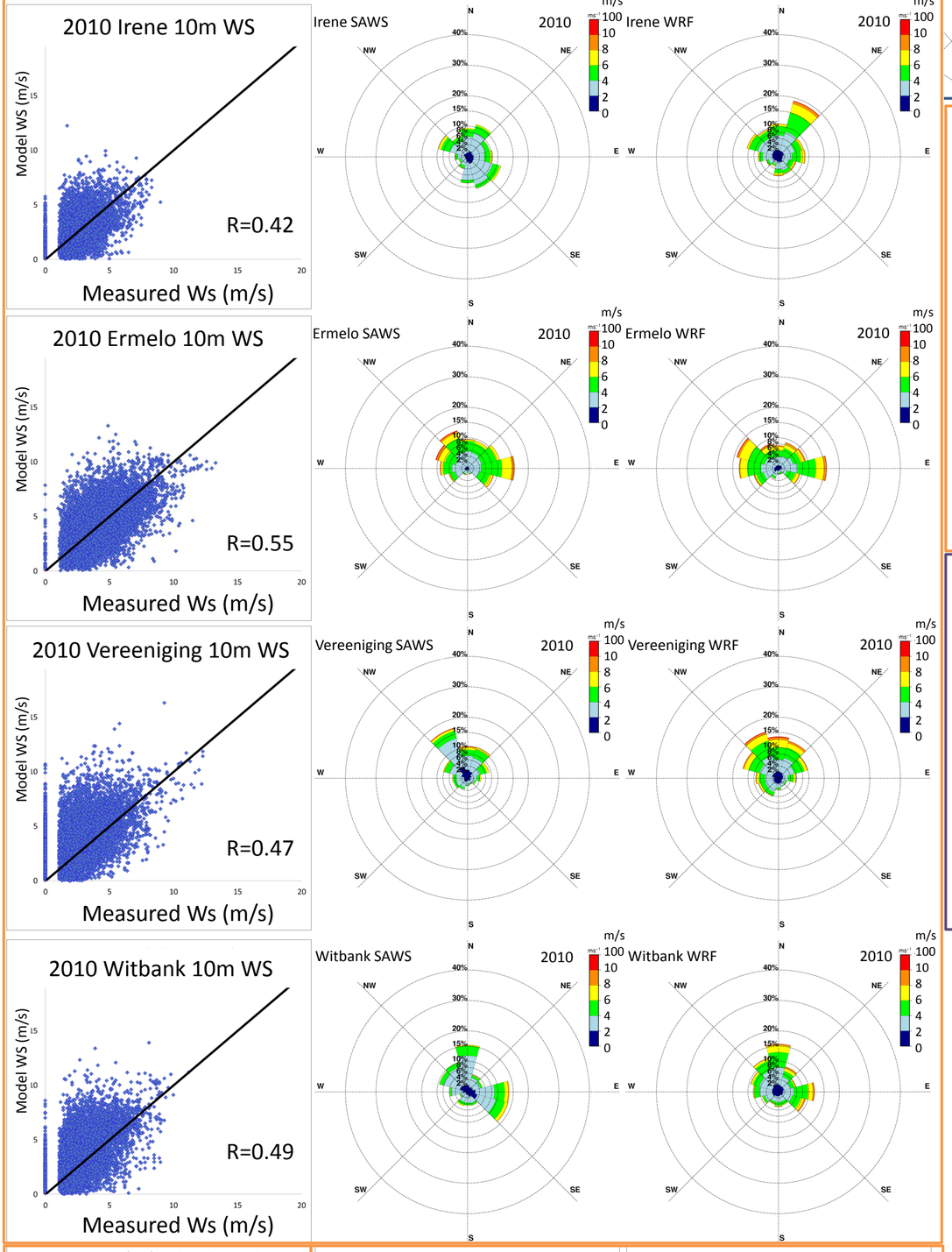




Abstract: We run WRF at 3km resolution using GFS as input for two regions of South Africa: the Western Cape and the Highveld. The Western Cape represents a baroclinic atmosphere, is adjacent to a cold ocean current and is characterised by complex terrain. The Highveld typically has a barotropic atmosphere, is in the interior and is generally flat terrain. We evaluate wind speeds from WRF against observations in both regions. Wind direction is modelled well for both regions. However, evaluation of wind speed produces mixed results. WRF consistently over predicts wind speed at 10m over the Highveld.





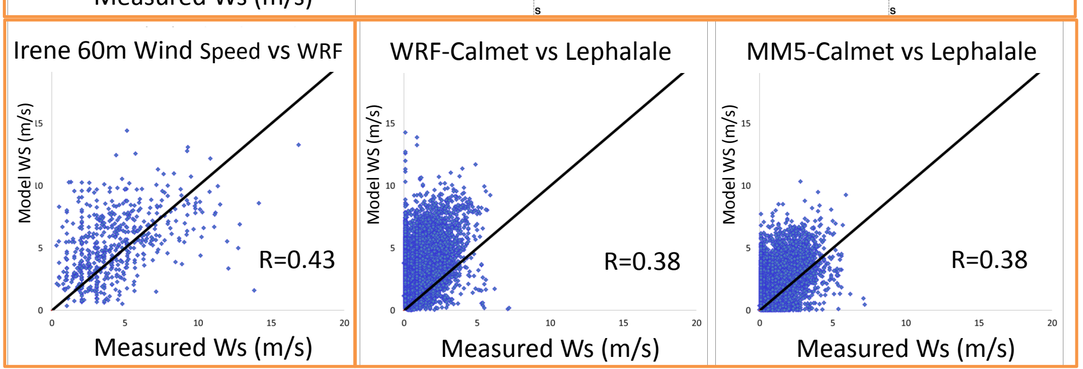


Table 1: Mean error of wind speed based on annual average. Negative values represent over prediction.

Station Name	Observed Wind Speed (Avg. Value)	Modelled Wind Speed (Avg. Value)	Error %
Western Cape 60m 2011			
Calvinia	5.935	6.125	-3.208
Napier	8.411	7.374	12.334
Sutherland	6.986	7.153	-2.391
Vredenburg	6.597	6.002	9.013
Vrendenhal	6.995	5.716	18.285
	Mean Error (bias) %		**6.807**
Western Cape 10m 2011			
Calvinia	4.477	4.412	1.451
Napier	6.233	5.145	17.460
Sutherland	5.217	5.348	-2.508
Vredenburg	4.678	4.423	5.460
Vrendenhal	5.396	4.131	23.451
Struisbaai	4.993	5.629	-12.741
LangebaanWeg	3.879	3.902	-0.612
	Mean Error (bias) %		**9.063**
Highveld 10m 2010			
Irene	3.035	3.591	-18.349
Vereeninging	2.533	3.803	-50.173
Witbank	2.959	3.626	-22.547
Ermelo	4.225	4.329	-2.455
	Mean Error (bias) %		**-23.381**

The Problem: Although WRF models wind direction well, wind speed is over predicted for the Highveld region as indicated by the windroses for two stations in Figure 1 and mean error in Table 1 where negative represents over prediction.

Figure 1

Results: Highveld: 10m: The Highveld has a higher number of points above the trend line and lower correlation coefficients than the Western Cape. WRF consistently over predicts wind speeds at 10m a.g.l. However, WRF does represent wind direction well as demonstrated in the windroses.

60m: WRF over predicts at 60m for the single upper air station at Irene in the Highveld domain.

MM5: A comparison of MM5 (4km) data against WRF indicates that MM5 also over estimates wind speed for the Highveld region, although to lesser extent. This suggests that the over prediction is inherent in both models and not in factors like grid resolution or input data.

Discussion and Conclusions: Both regions were run with the same parameterisation schemes. This suggests that the parameterisation schemes perform better in the Western Cape and that further testing is needed to determine the best schemes for the Highveld. GFS wind speeds at 10m a.g.l better represent observed data than the WRF results, ruling it out as a source of error. Further evaluation of surface characteristics like LULC and surface roughness will be needed as well as obtaining more observed upper air data (whether remotely sensed or measured *in-situ)*.

Results: Western Cape: WRF performs well for wind speeds at 60m a.g.l, slightly underestimating high wind speeds. This is visible in the tailing off of the 60m scatter plots below. Similarly at 10m a.g.l WRF performs well but slightly under predicts wind speeds.