



Quantifying South Africa's wind resource – an update on the WASA project and verification against 2 years of measurements

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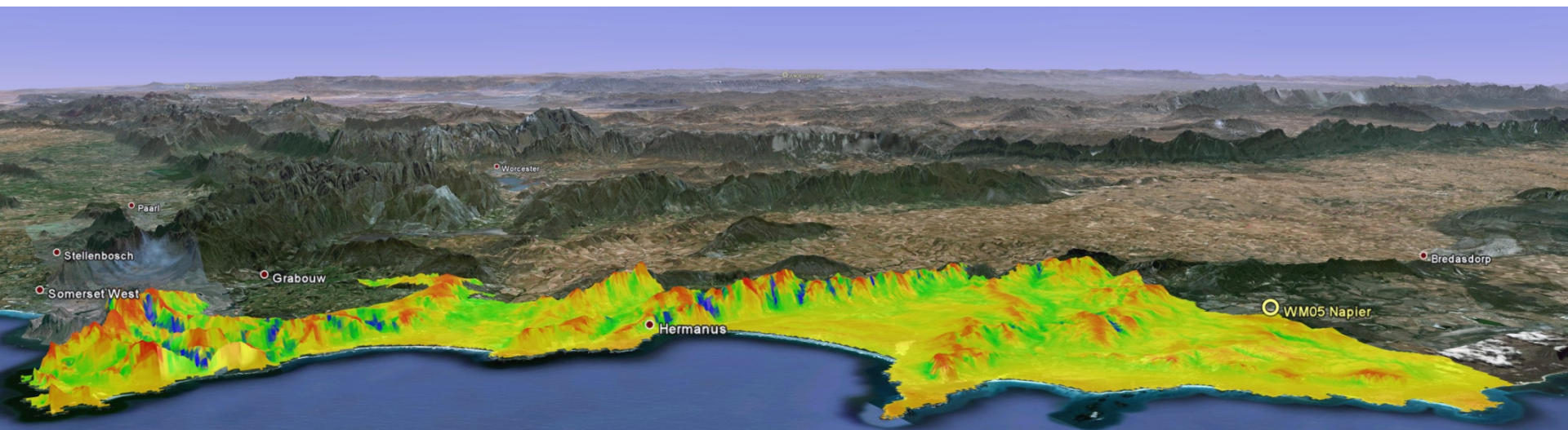
Quantifying South Africa's wind resource – an update on the WASA project and verification against 2 years of measurements

Eugene Mabile, Eric Prinsloo and Steve Szewczuk

CSIR (*Built Environment, Council for Scientific and Industrial Research*)

Niels G. Mortensen and Jens Carsten Hansen

DTU Wind Energy (*Dept of Wind Energy, Technical University of Denmark*)



Outline

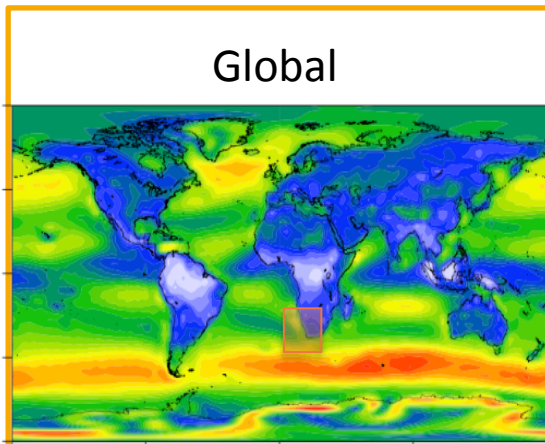
- The WASA Team
- Project overview
- WASA Verified Numerical Wind Atlas (VNWA)
- 2 years of data from the 10 WASA stations
 - Comparison against the first year
 - Update of the OWA for the 10 WASA sites
 - Verification of VNWA against 2 years of data
 - Updated assessment of South Africa's wind resource
- Applications and facilitation
- WASA activities in progress

The WASA Project Team

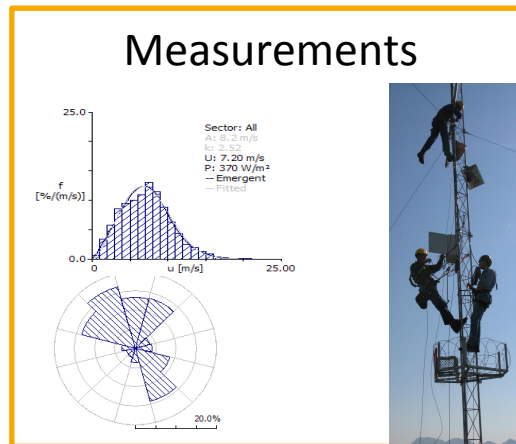
- SANEDI (*South African National Energy Development Institute*)
 - executing agency – contracting the implementing partners
 - coordination and dissemination
- UCT CSAG (*Climate System Analysis Group, University of Cape Town*)
 - mesoscale modelling
- CSIR (*Built Environment, Council for Scientific and Industrial Research*)
 - measurements and microscale modelling
- SAWS (*South African Weather Service*)
 - extreme wind assessment
- DTU Wind Energy* (*Dept of Wind Energy, Technical University of Denmark*)
 - partner in all activities

* the original DTU partner (Risø DTU) is part of DTU Wind Energy established Jan 2012

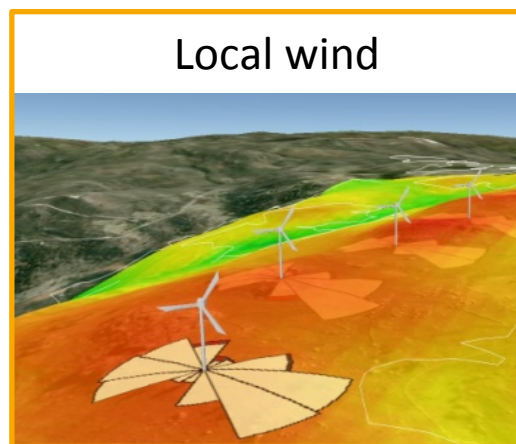
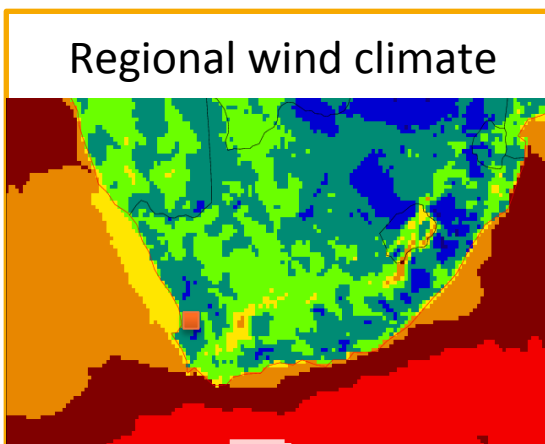
The WASA Project – presented at workshops



Mesoscale modeling

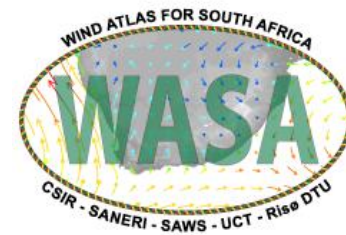


Microscale modeling

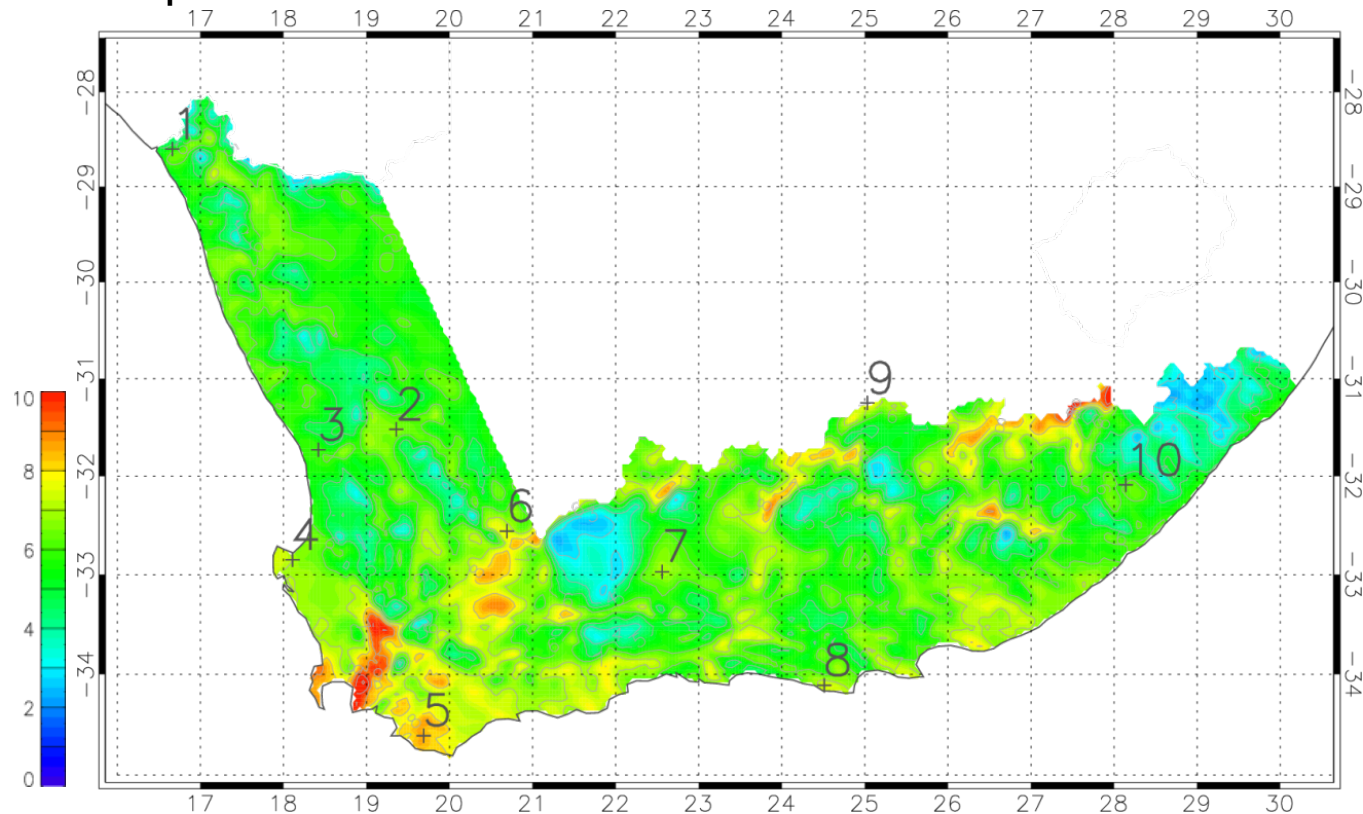


Presentations and links to information are available at the SANEDI web site www.sanedi.org.za

Verified Numerical Wind Atlas for South Africa VNWA launched March 2012



- the KAMM/WAsP method
- verified against 1 year of data
- a map – and much more



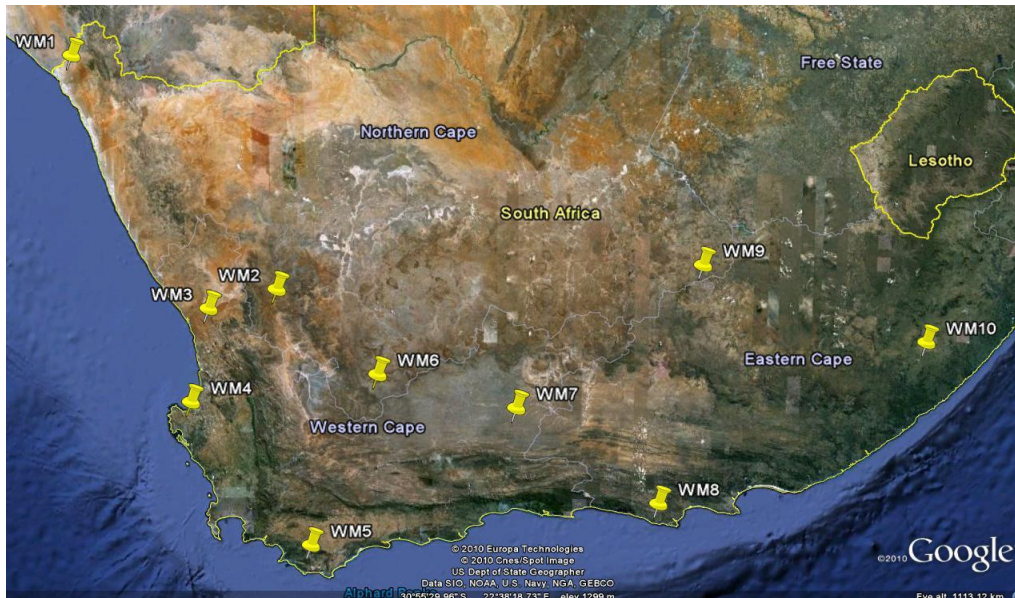
Generalized climatological (30-year) annual mean wind speed [m/s] 100 m above ground level, flat terrain, 3 cm roughness everywhere

10 WASA masts

2 years of data by 30 Sep 2012

Updated report Oct 2012: "Observational Wind Atlas for 10 Met. Masts in Northern, Western and Eastern Cape Provinces"

2 YEARS period 2010-10-01 to 2012-09-30; except WM09 and WM10 for which 1 YEAR is available with data recovery above 90% as indicated.



WASA	$U_{\text{mean}} @$ 61.5m - 1 YEAR	$U_{\text{mean}} @$ 61.5m - 2 YEARS*	ΔU	Data recovery
	(m/s)	(m/s)	%	%
WM01	5.86	6.02	2.7	100
WM02	6.21	6.10	-1.8	100
WM03	7.09	7.09	0.0	100
WM04	6.59	6.65	0.9	100
WM05	8.64	8.57	-0.8	97.9
WM06	7.02	7.13	1.6	100
WM07	6.85	6.87	0.3	100
WM08	7.36	7.38	0.3	100
WM09*	7.58	7.81	3.0	98.1
WM10*	6.55	6.55	0.0	92.4

* Not a 2-years period for WM09 and WM10
 WM09: 2010-09-01 to 2011-07-31 plus August 2012,
 WM10: 2010-10-01 to 2011-09-30.

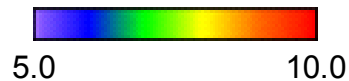
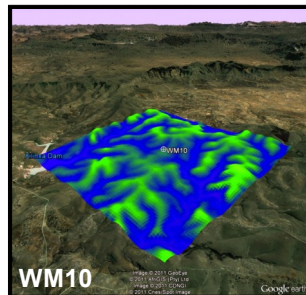
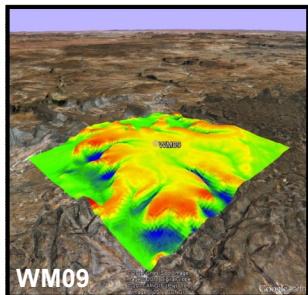
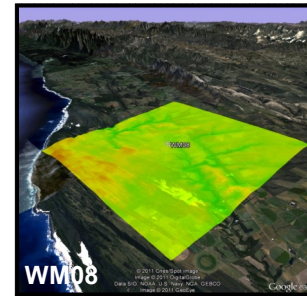
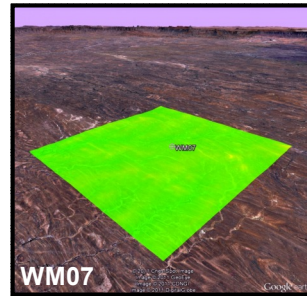
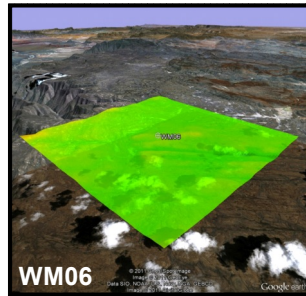
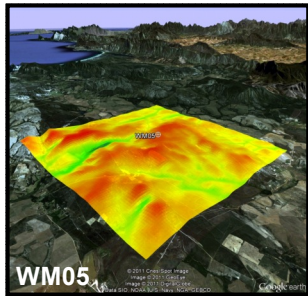
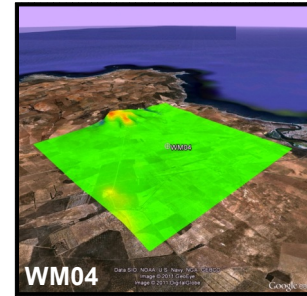
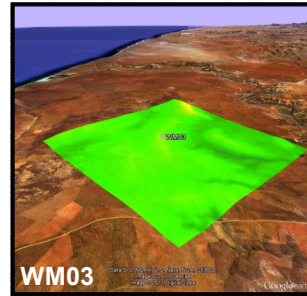
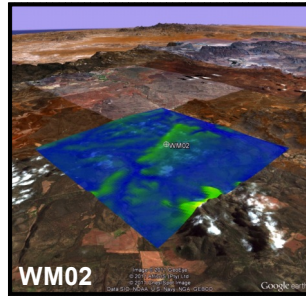
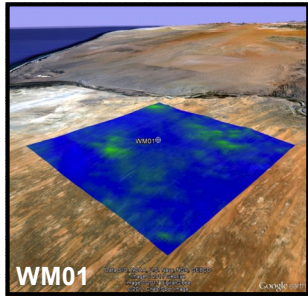
VNWA verified against 2 years of WASA data

Numerical wind atlas (NWA) compared to observational wind atlas (OWA)
 Generalized annual mean wind speed at 100 m, $z_0 = 3$ cm [m/s]

	NWA 30YEARS	NWA 1YEAR	Ratio NWA1Y/30Y	OWA 1YEAR	Error NWA-OWA1Y	OWA 2YEARS	Error NWA-OWA2Y
WM01	5.11	5.33	104%	6.16	-13.47%	6.34	-15.93
WM02	6.59	7.01	106%	6.62	5.89%	6.50	7.85
WM03	6.02	6.63	110%	7.19	-7.79%	7.19	-7.79
WM04	6.98	7.19	103%	7.33	-1.91	7.39	-2.71
WM05	8.07	8.35	103%	8.99	-7.12	9.00	-7.22
WM06	7.24	7.24	100%	7.44	-2.69	7.55	-4.11
WM07	6.58	6.61	100%	7.45	-11.28	7.48	-11.63
WM08	7.17	7.66	107%	7.71	-0.65	7.72	-0.78
WM09	7.58	7.58	100%	7.5	1.07	7.72	-1.81
WM10	5.93	6.09	103%	6.32	-3.64	6.32	-3.64
			104%	mean error	-4.16	mean error	-4.78

Observational Wind Atlas (OWA)

database and report available through
wasadata.csr.co.za/wasa1/WASAData



Wind speed at 80 m above ground level

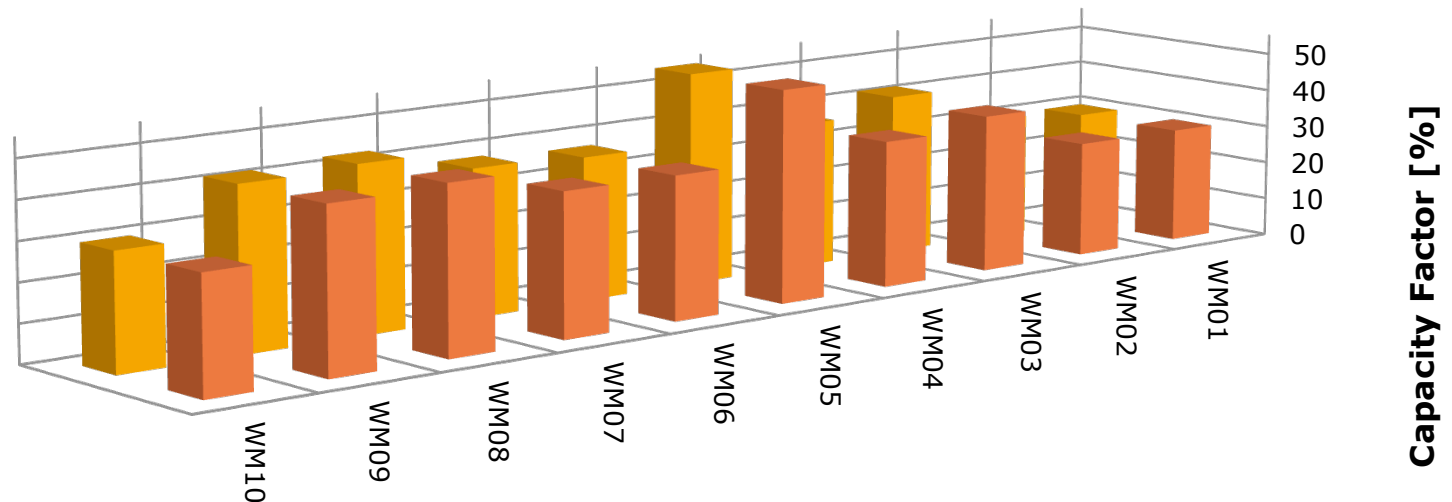
WASP resource grids from Observational Wind Atlas

- 10 x 10 km² grid
- 100 meter grid spacing

Capacity Factors in SA

Predictions for 1 WTG on 10 WASA sites - 1 year and 2 years

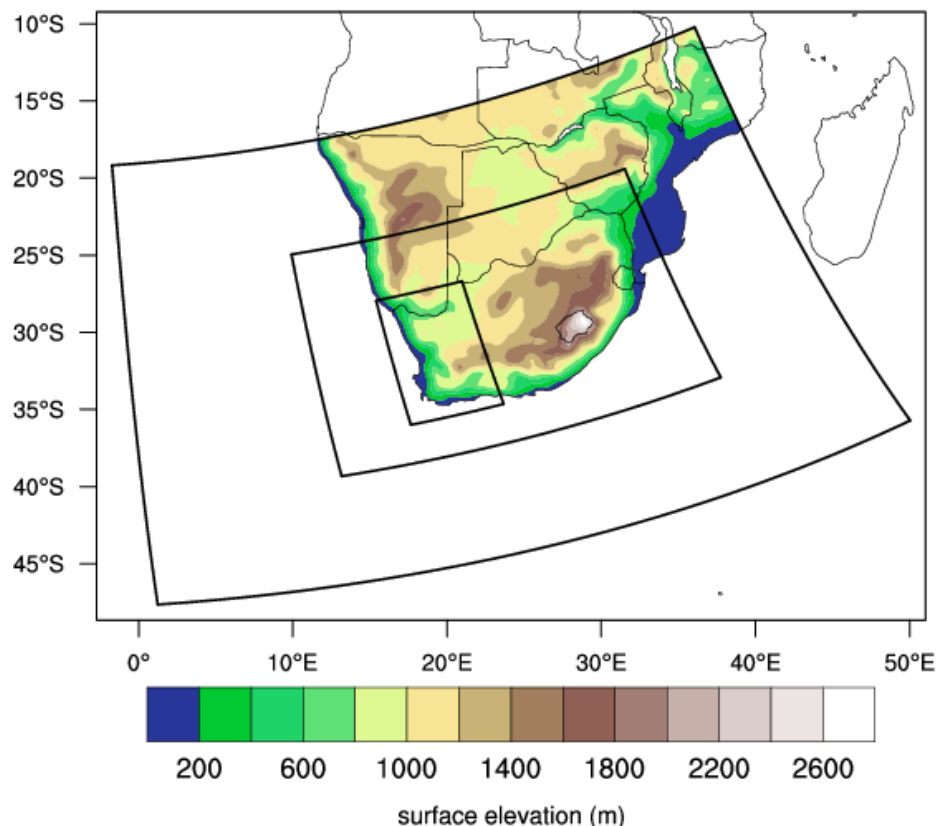
- Theoretical values, assuming 100% availability, no wakes, no losses
- Note that WASA masts are for model verification and not at windiest sites



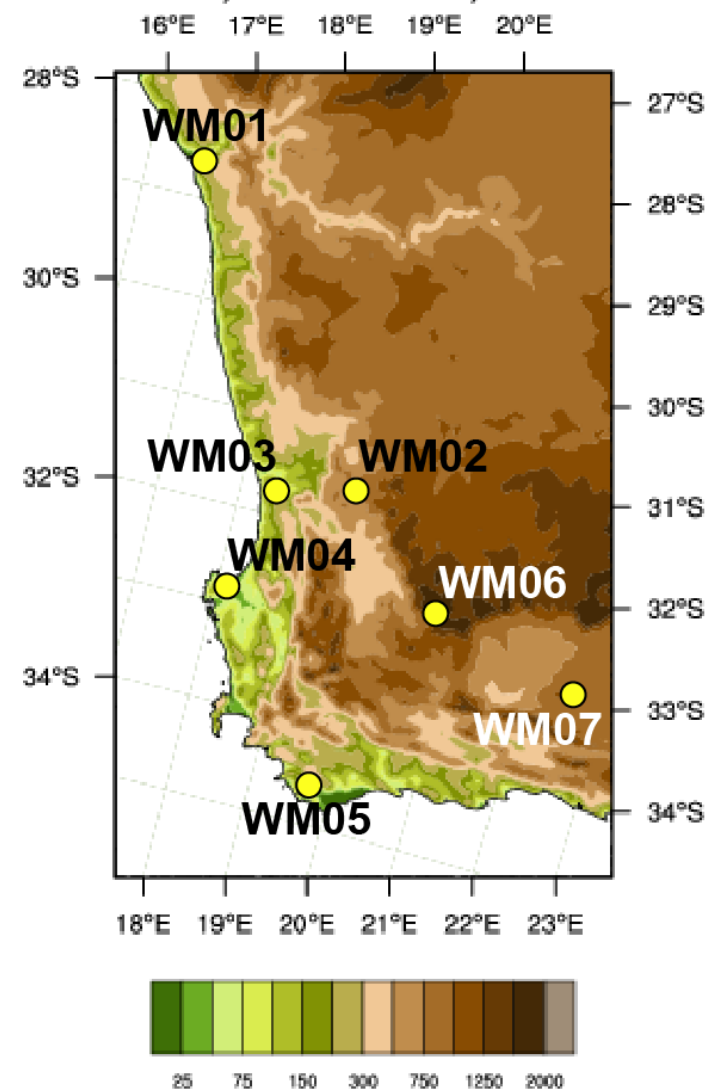
	WM01	WM02	WM03	WM04	WM05	WM06	WM07	WM08	WM09	WM10
■ 2-MW YEAR 1	30	32	42	38	55	37	38	43	42	30
■ 2-MW YEAR1+YEAR2	30	30	41	38	55	37	37	43	42	30

WRF Simulations over South Africa

WRF, DOMAIN 1, $\Delta x=36.0$ km



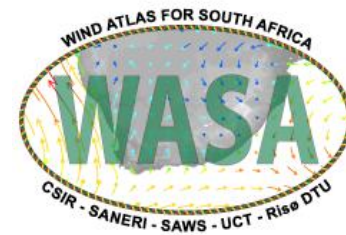
WRF, DOMAIN 3, $\Delta x= 4.0$ km



WRF V3.2.1 – 36/12/4km domains
October 2010 - September 2011

What is the difference between KAMM and WRF

- **KAMM (1st WASA VNWA)**
 - “steady-state” simulations from 100+ wind situations (initial conditions)
 - each initialized with a single vertical representation of the atmosphere
 - boundary conditions: uniform land and sea temperatures
- **WRF (2nd WASA VNWA)**
 - “sequential” simulation that provides time-series for each grid point
 - initialized with a 3D state of the atmosphere
 - boundary conditions: interactive land + time-varying sea surface temperatures



WASA data on www.wasa.csir.co.za



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CSIR online

Welcome to our online database of meteorological data.

[To the list of projects...](#)

[To the map of projects...](#)

[To the download page...](#)

[Guide to accessing and viewing the Wind Atlas for South Africa](#)

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User statistics to date

- 1039 registered users from 45 countries
- 747 users are active
 - 26710 downloads
 - 50% private companies
 - 75% RSA

10 WASA site measurements – the database

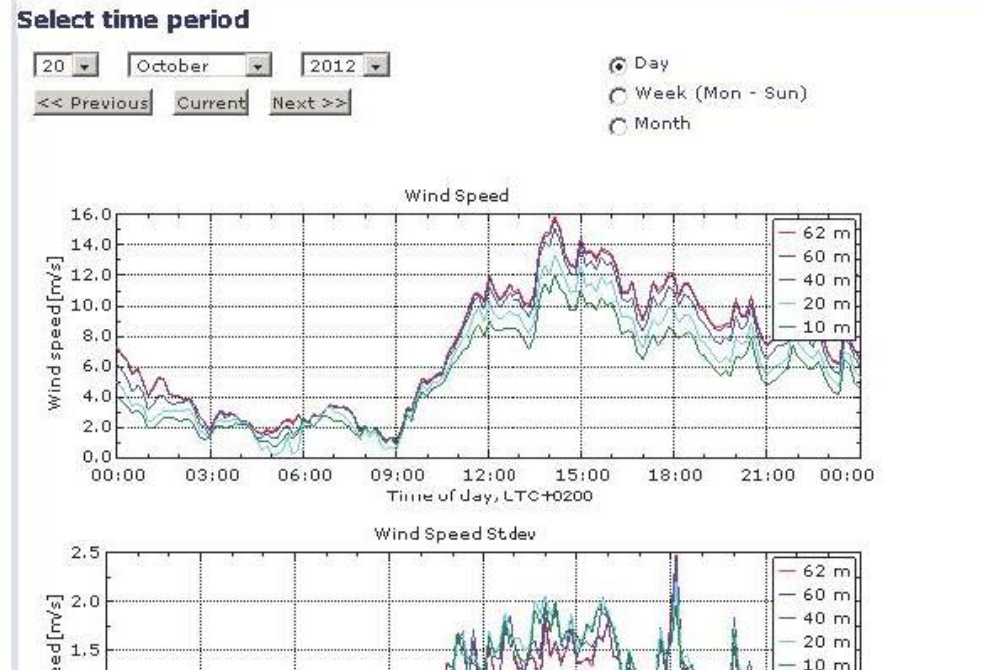
WM05 graphs [page 1]

Latest update 2012-10-22 13:40:00

[Project overview](#)

In the WASA web site

- Online graphics are available with less than 30 minutes delay.
- Timeseries of data are available from the 10 WASA masts for each month within 2 weeks after the end of the month.

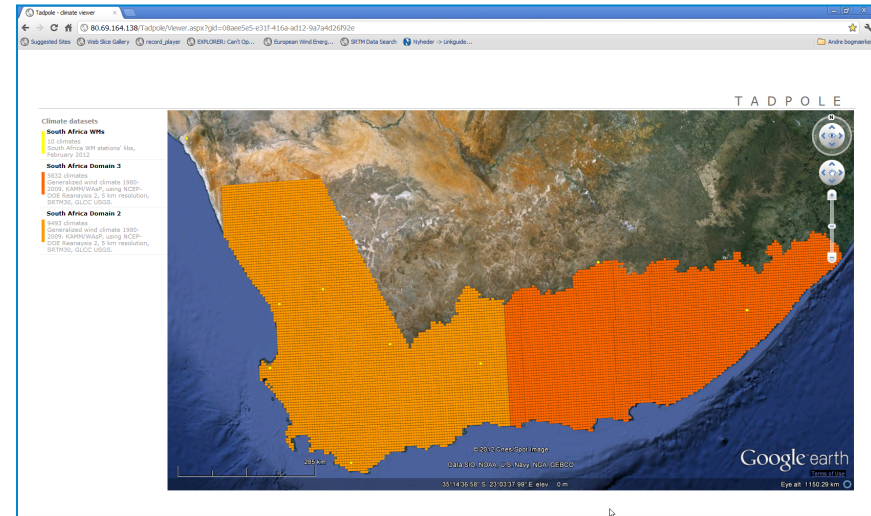


VNWA – the database

In the WASA modelling domain wind climate data is available every 5 km × 5 km – corresponding to approximately 15000 virtual masts

VNWA data are available through a graphical interface (Tadpole)

Guide on how to get data and the VNWA is now available online from the main web page.

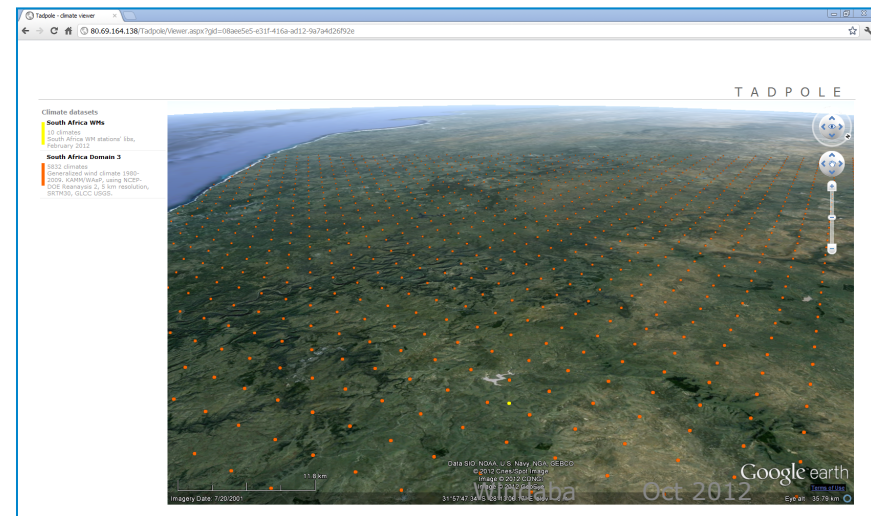


9. Click on the wind atlas grid point closest to your area/point of interest.



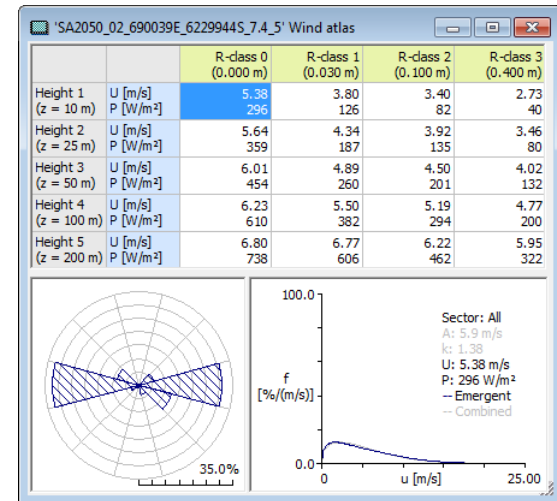
10. Download the .lib file and save on your hard disk

14 Wind Atlas for South Africa project



Working with WASA Files

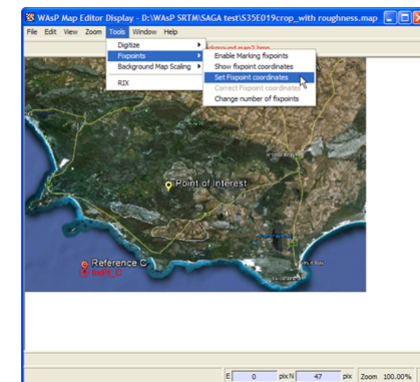
- The WASA data can be used by most commercially available flow model software.
- WASA wind atlas data (*.lib files)
 - Download from Tadpole
 - Read and display in any appropriate software, e.g. WASP unlicensed
 - Copy of values to other software is possible, a.o. MS Excel
 - Actual flow modelling requires licensed tool and trained modeller



- Guide to Working with WASA Files

The guide is not intended to make a user who has no knowledge of flow modelling an expert in flow modelling.

14. The next step is to enter the reference point coordinates. *Tools\Fixpoints\Set Fixpoint coordinates.*



WASA project – next 18 months

- Meteorological data
 - 3 complete years of wind data
 - Long-term reanalysis data sets
- Topographical data
 - Test global and South African land-cover databases
 - From land-cover to roughness length
- Microscale modelling
 - Atmospheric stability (WAsP 11)
 - High resolution wind resource mapping for large area
- Mesoscale modelling
 - Dynamical downscaling to better describe climatology (WRF)
- Updated Numerical Wind Atlas and model-based Extreme Wind Atlas

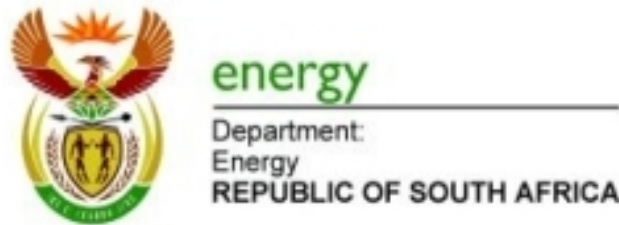
Acknowledgements

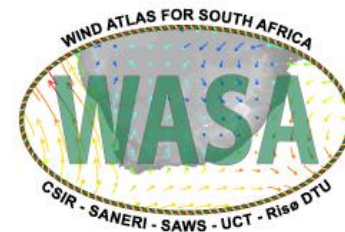
The Wind Atlas for South Africa (WASA) project is an initiative of the South African Government - Department of Energy (DoE) and the project is co-funded by

- UNDP-GEF through South African Wind Energy Programme (SAWEP)
- Royal Danish Embassy

WASA Project Steering Committee:

DoE (chair), DEA, DST, UNDP, Danish Embassy, SANEDI





Further information

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energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA



Wind Atlas for South Africa

Western Cape and parts of Eastern and Northern Cape

