Application of reanalysis datasets for calculating a new and global wind resource atlas including high-resolution terrain effects

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Summary:

The global wind atlas will
• provide wind resource data accounting for high resolution effects
• use microscale modelling to capture small scale wind speed variability
• use a unified methodology
• verify the results in representative selected areas
• give comprehensive uncertainty estimates
• publish the methodology to ensure transparency

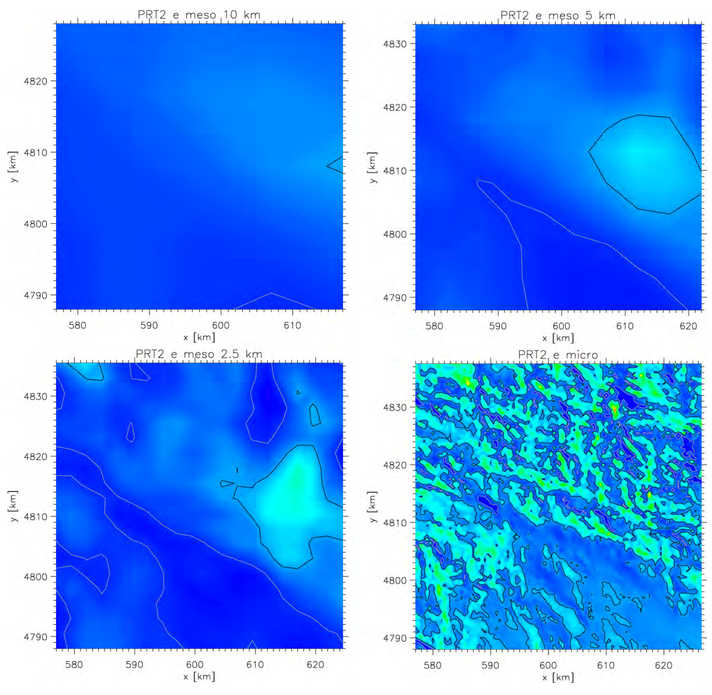
It will be applied for aggregation and upscaling analysis and energy integration analysis for energy planners and policy makers

Motivation:

Currently, policy makers and energy planners have only coarse scale global wind resource dataset for their decision-making needs. The use of coarse resolution reanalysis datasets has the serious shortcoming that the wind energy resource is underestimated, as small scale spatial variability of winds is missing. This missing variability means that a large part of the wind resource is not included. Crucially it is the windiest sites that suffer the largest wind resource errors; in simple terrain the windiest sites may be underestimated by 25%, for complex terrain the underestimate can be 100%.

The importance of resolution is illustrated below:
Wind power density at 50 m calculated at different resolutions

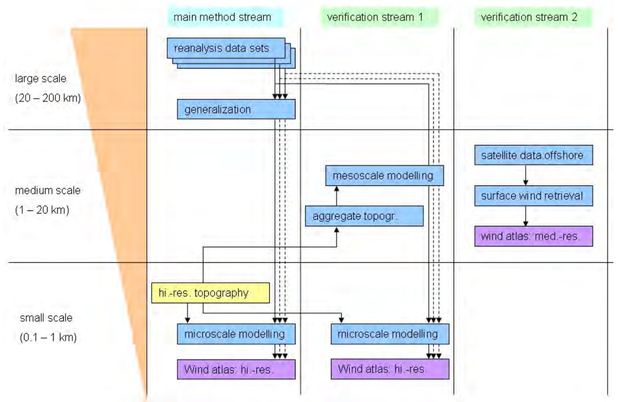
10 km 324 W/m^2 378 W/m^2 | 5 km 328 W/m^2 398 W/m^2



2.5 km 323 W/m^2 410 W/m^2 | 0.1 km 505 W/m^2 641 W/m^2

mean power density of total area
mean power density for windiest 50% of area

Project overview:



Data:

Product	Model system	Horizontal resolution	Period covered	Temporal resolution
ERA Interim reanalysis	T255, 60 vertical levels, 4DVar	~0.7° × 0.7°	1989-present	3-hourly
NASA – GAO/MERRA	GEOS5 data assimilation system (Incremental Analysis Updates), 72 levels	0.5° × 0.67°	1979-present	3-hourly
NCAR CFDDA	MM5 (regional model)+ FDDA	~40 km	1985-2005	hourly
CFSR	NCEP GFS (global forecast system)	~38 km	1979-2009 (& updating)	hourly

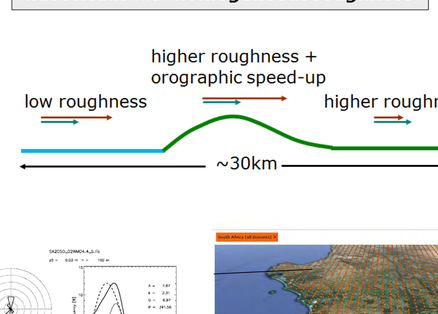
Candidate reanalysis data sets

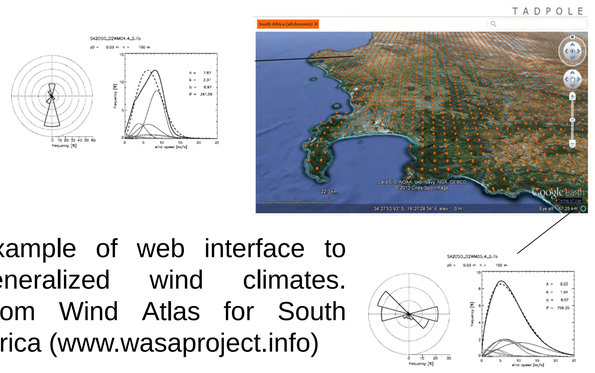
Elevation
Shuttle Radar Topography Mission (SRTM), version 2.1, released 2009 resolution 90 m
ASTER Global Digital Elevation Model (ASTER GDEM), version 1, released 2009 resolution 30 m

Land cover
ESA GlobCover, version 2.1, released 2008, resolution 300 m

Candidate topography data sets

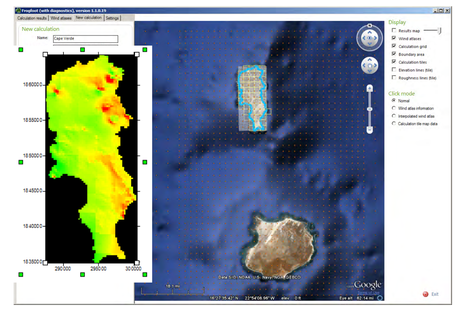
Generalization of wind climates:



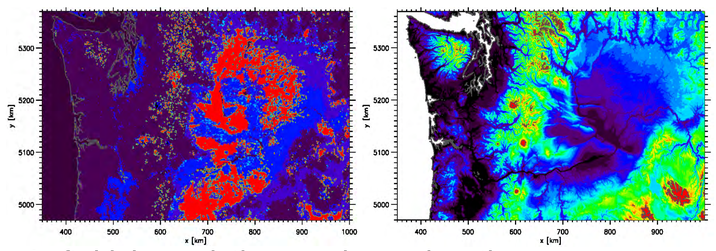


Example of web interface to generalized wind climates. From Wind Atlas for South Africa (www.wasaproject.info)

Application of generalized wind climate at microscale:

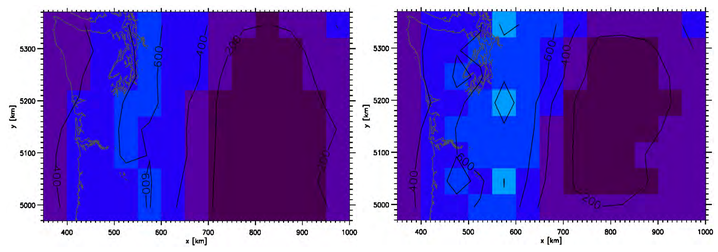


Demonstration: Power density and sub-grid scale wind speed variance for Columbia Gorge

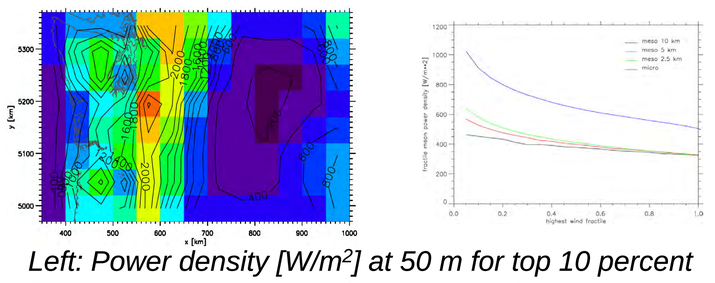


Left: high resolution roughness length
Right: high resolution elevation

Power density [W/m^2] at 50 m based on 50 km wind data

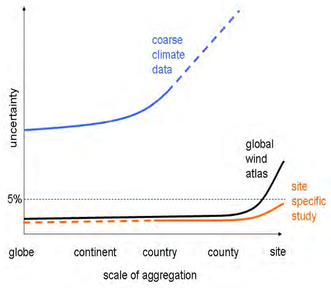


Left: sub-grid scale wind speed variance not included
Right: sub-grid scale wind speed variance included



Left: Power density [W/m^2] at 50 m for top 10 percent
Right: Areal distribution of wind power (example)

Verification:
The uncertainty of the new wind climate dataset will be determined via test regions, by comparison to dynamic downscaling with mesoscale modelling and by comparison to observations such as synthetic aperture radar (SAR) derived estimates and in situ measurements.



Uncertainty will be assessed as a function of spatial aggregation. It is expected that the uncertainty on point data will be larger than that of site dedicated assessments, but the uncertainty will be reduced at levels of aggregation appropriate for energy planning, and importantly much improved relative to what is used today.

DTU Wind Energy
Department of Wind Energy

Global Wind Atlas
Calculating global wind resources accounting for high resolution effects and making it available for all
Part of a CEM initiative
EUDP 11-II 64011-0347

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