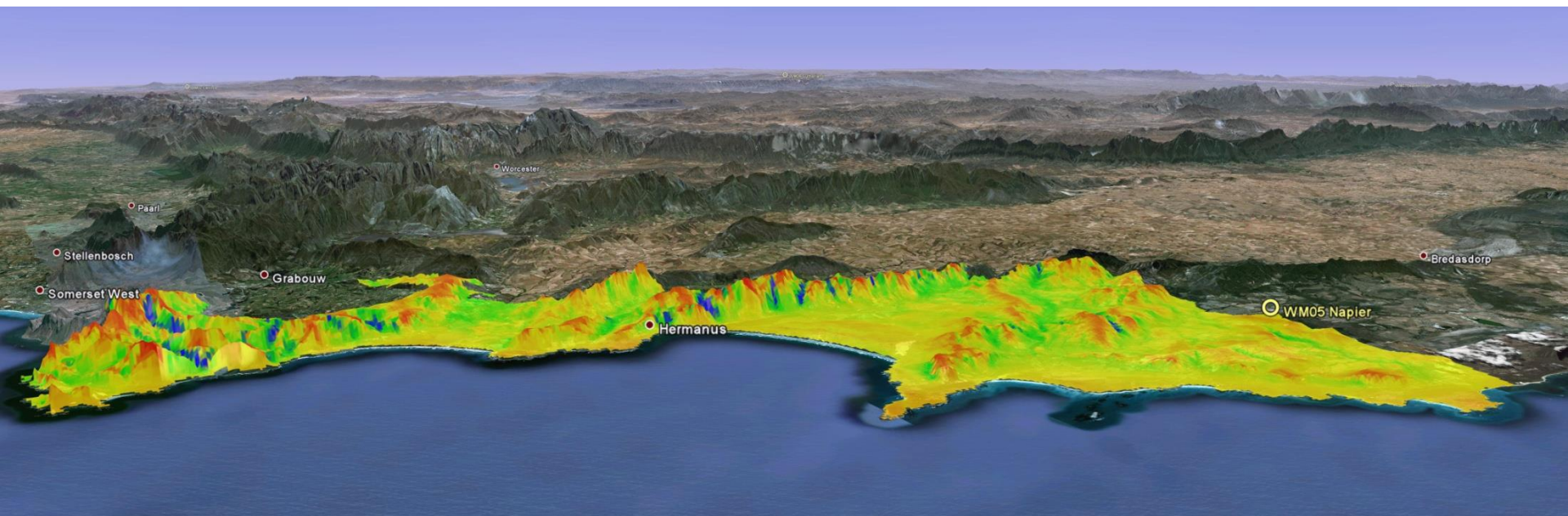


# Wind Atlas for South Africa (WASA)

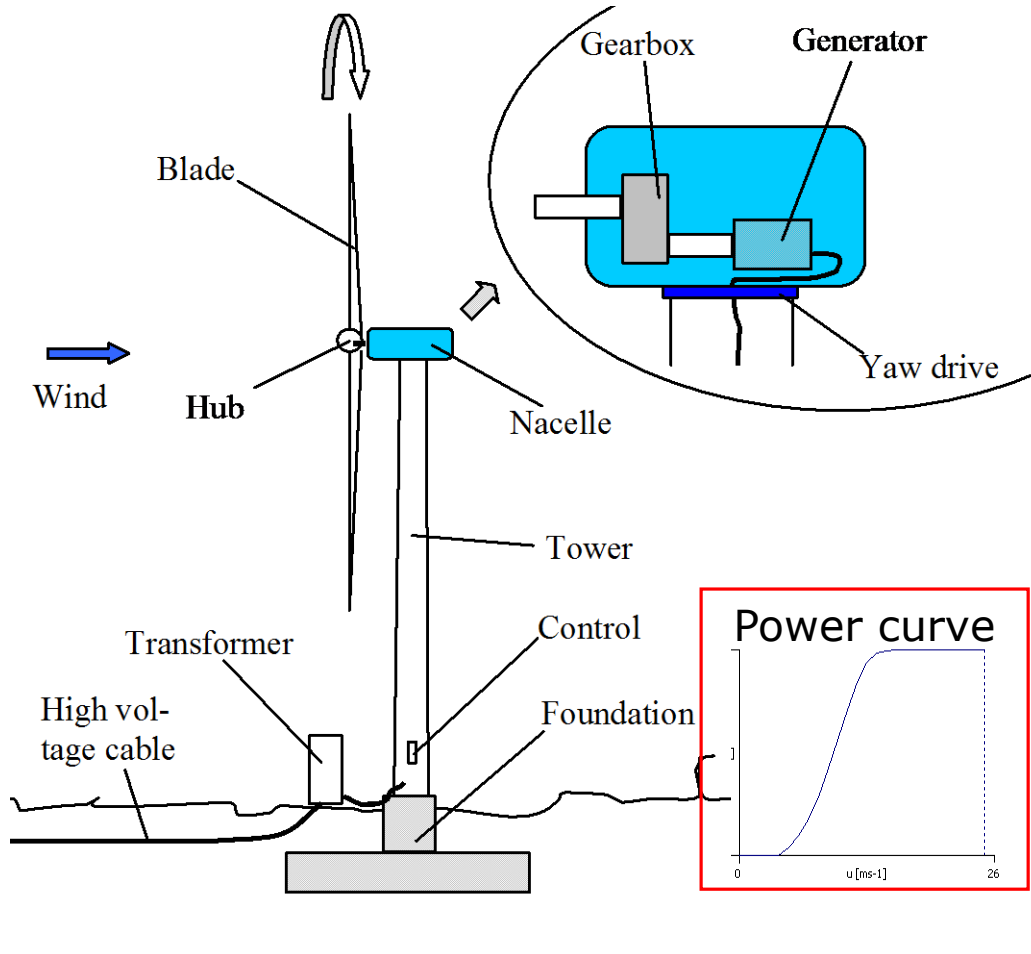
## Overview and Project introduction

WASA Project Team

*08 April 2014, Cape Town, South Africa*



# The wind turbine – size, air mass and speed



## 3 MW wind turbine

Nominal revolutions: 16 rpm

### Weight

Nacelle: 70 t

Rotor: 41 t

Towers: 100 m - 250 t

### Rotor

Diameter: 90 m

Area swept: 6,362 m<sup>2</sup>



Football field: 68 x 105 = 7,140 m<sup>2</sup>

### Mass flux at wind speed of 10 m/s:

$10 \times 6362 \times 1.225 = 77935 \text{ kg/s}$

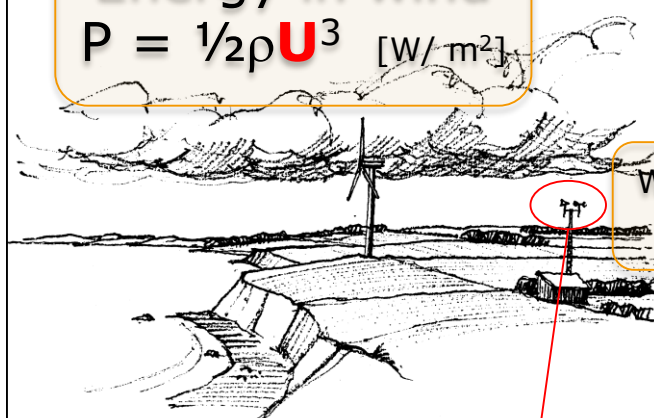
at air density of 1.225 kg/m<sup>3</sup>

# Economics, uncertainties and optimization

Wind provides the income in cost-benefit

- Investment costs
- Operation and maintenance costs
- Electricity production  $\sim$  **Wind resources**
- Turbine lifetime
- Discount rate
- **Environmental benefits**

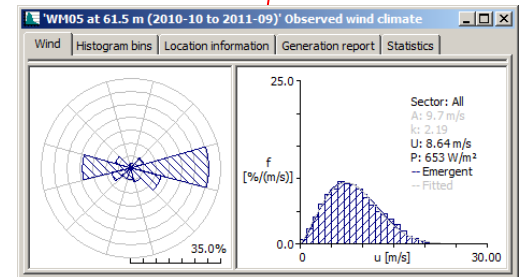
Energy in wind  
 $P = \frac{1}{2}\rho U^3$  [W/ m<sup>2</sup>]



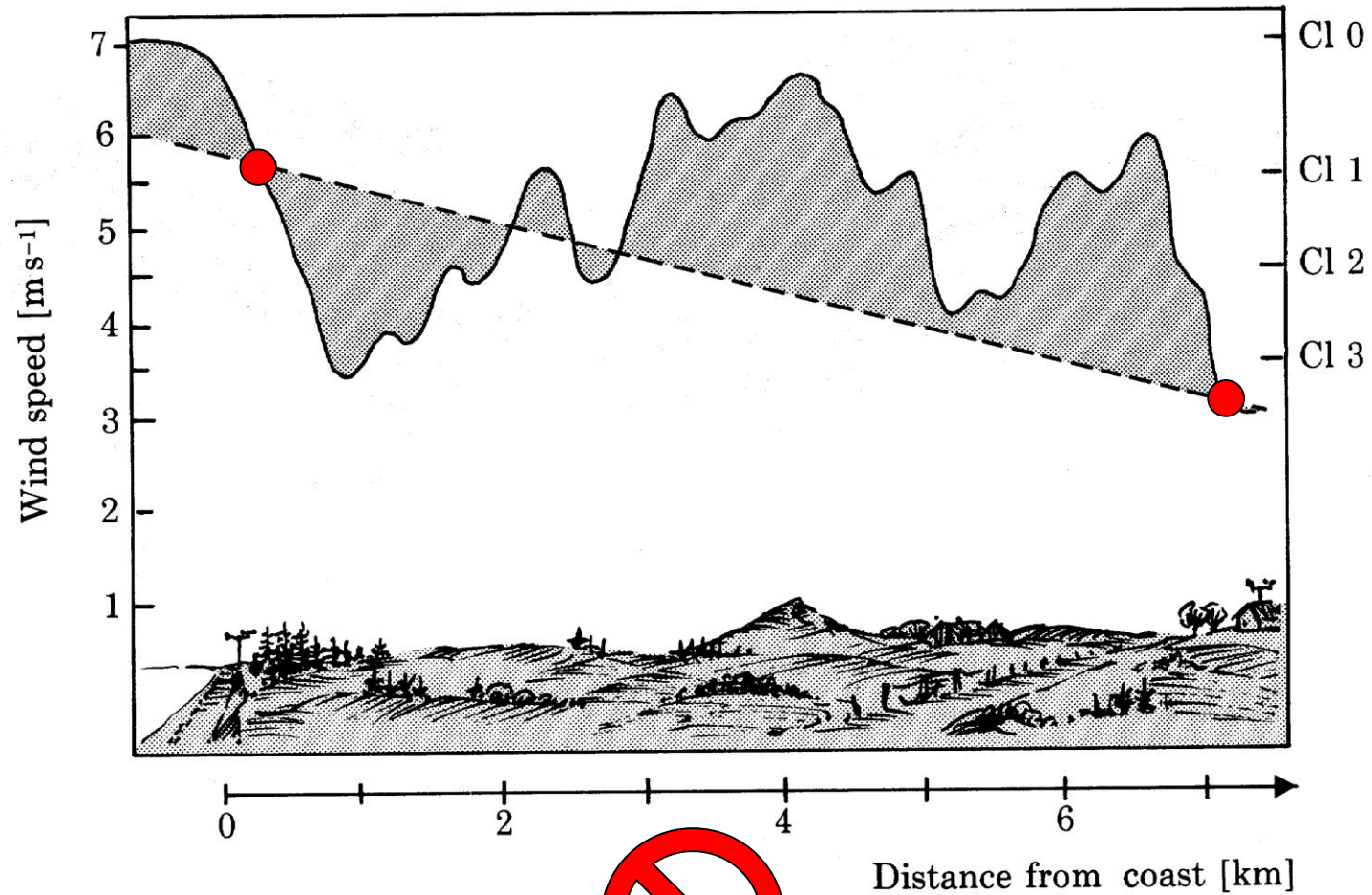
Wind speed  
**U** [m/s]

5% error on speed  $\rightarrow$  15% error on energy

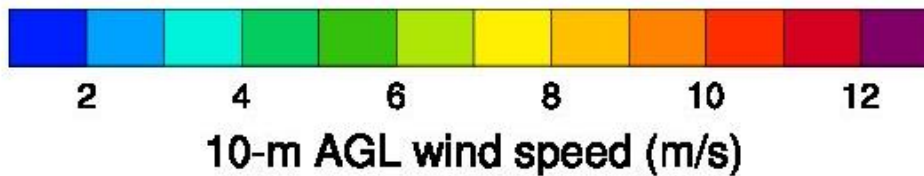
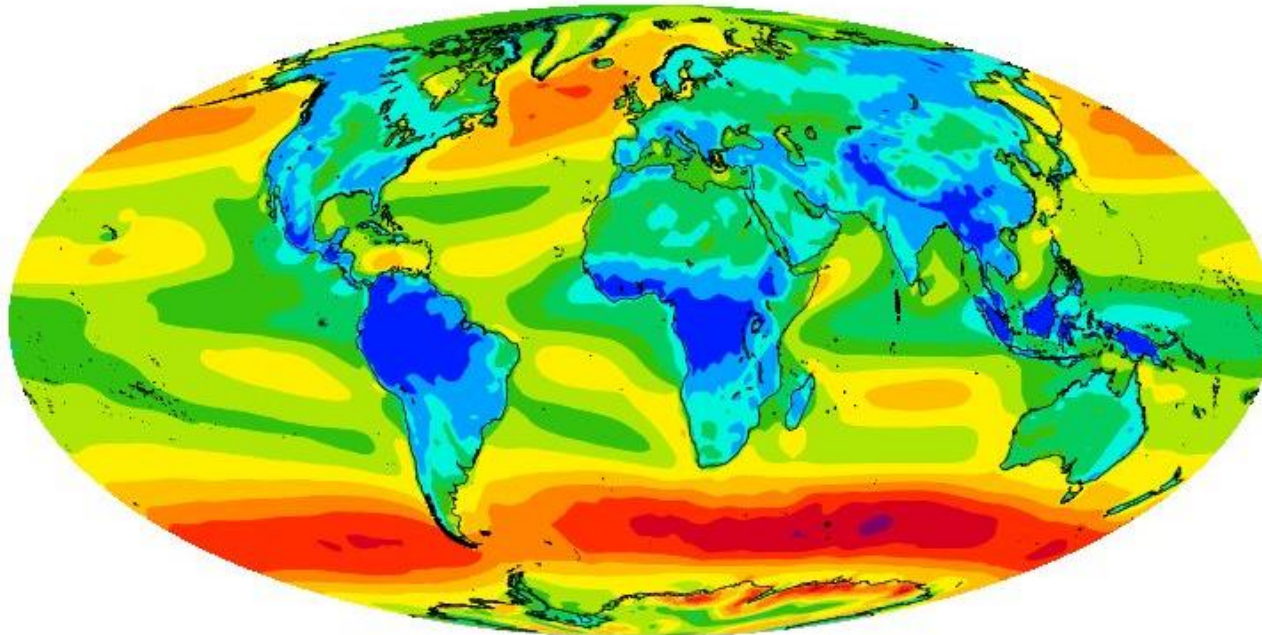
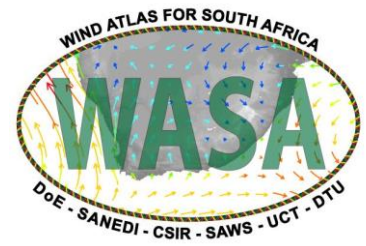
Modelling is necessary and it must be good



# Measurements and Linear interpolation - NO



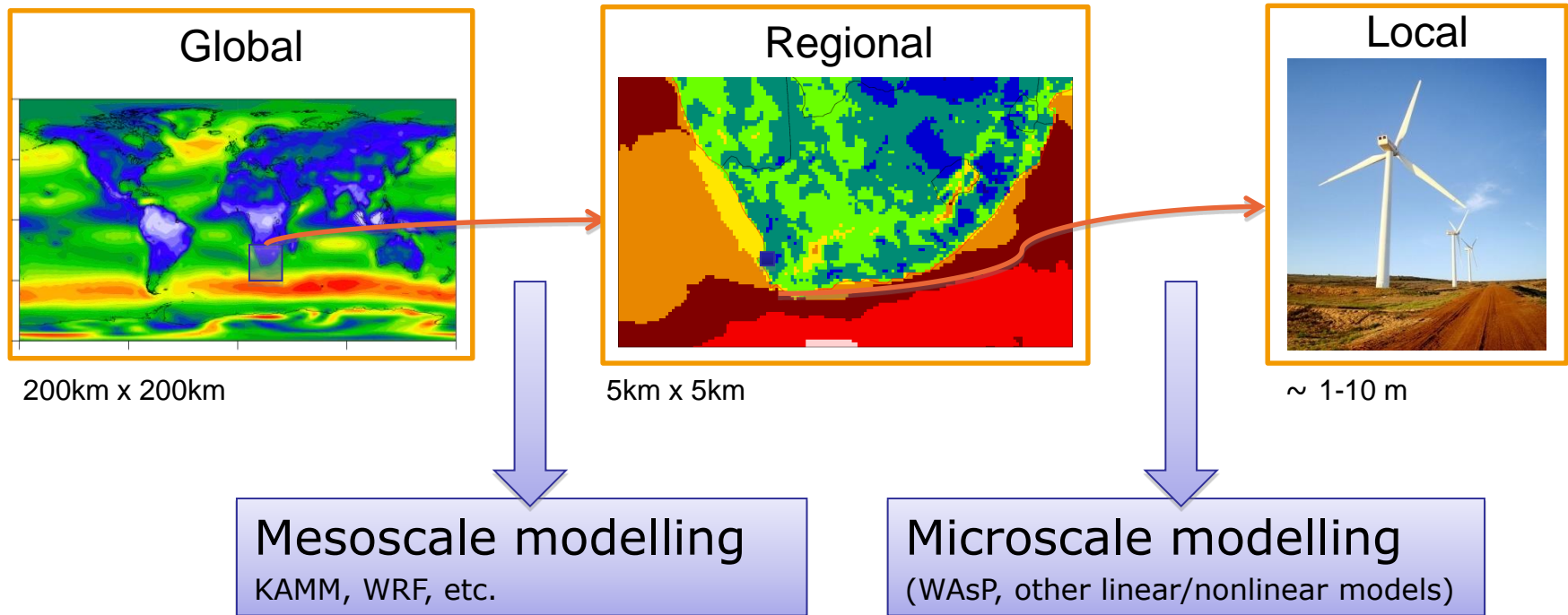
# Traditional climatology and global models (GCM) do not provide the answer



Source: European Center for Medium Range Weather Forecasting (ECMWF) - ERA Interim reanalysis

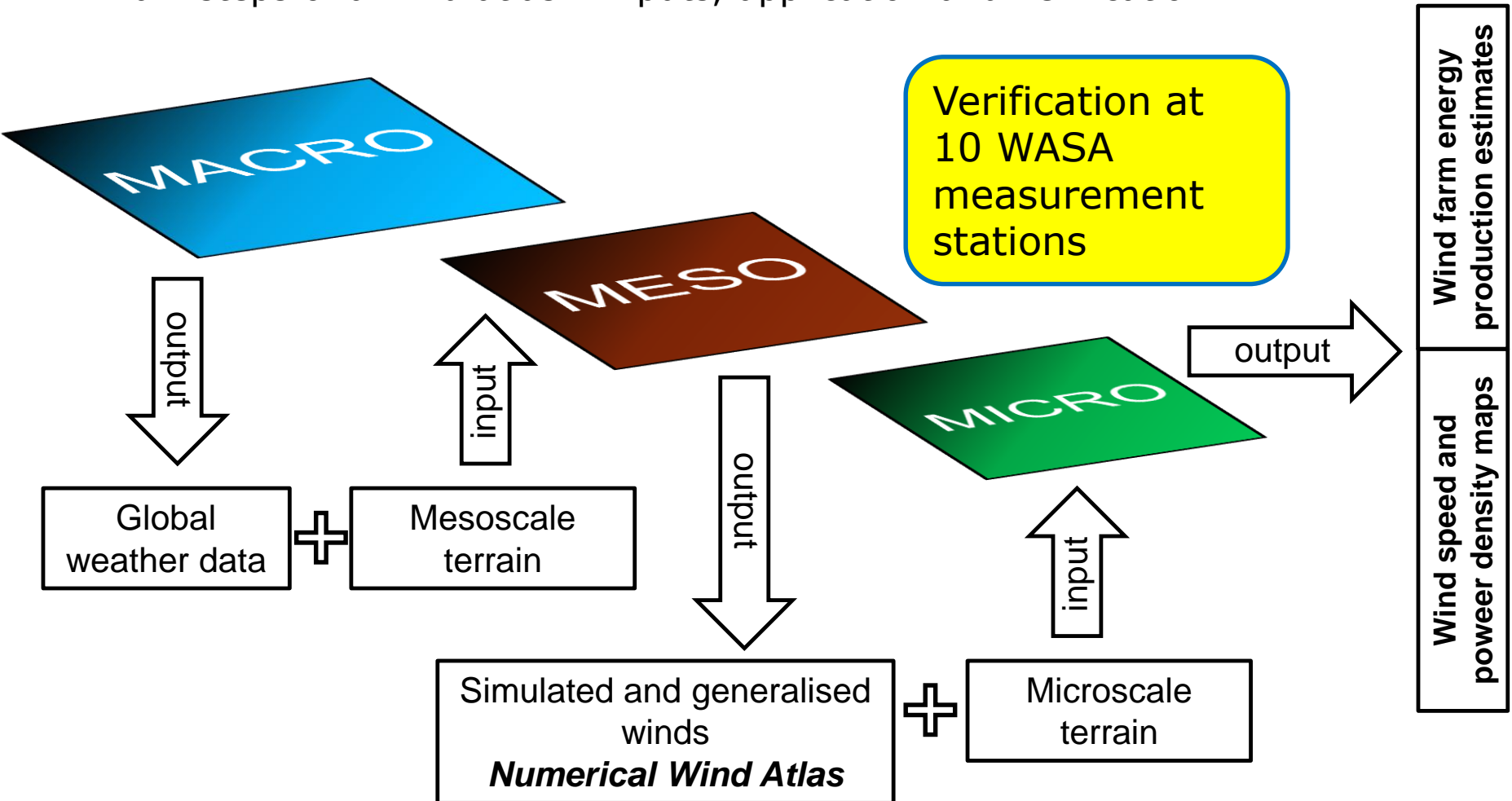
# Modelling - Wind Atlas and resource assessment

Downscaling from global reanalysis data

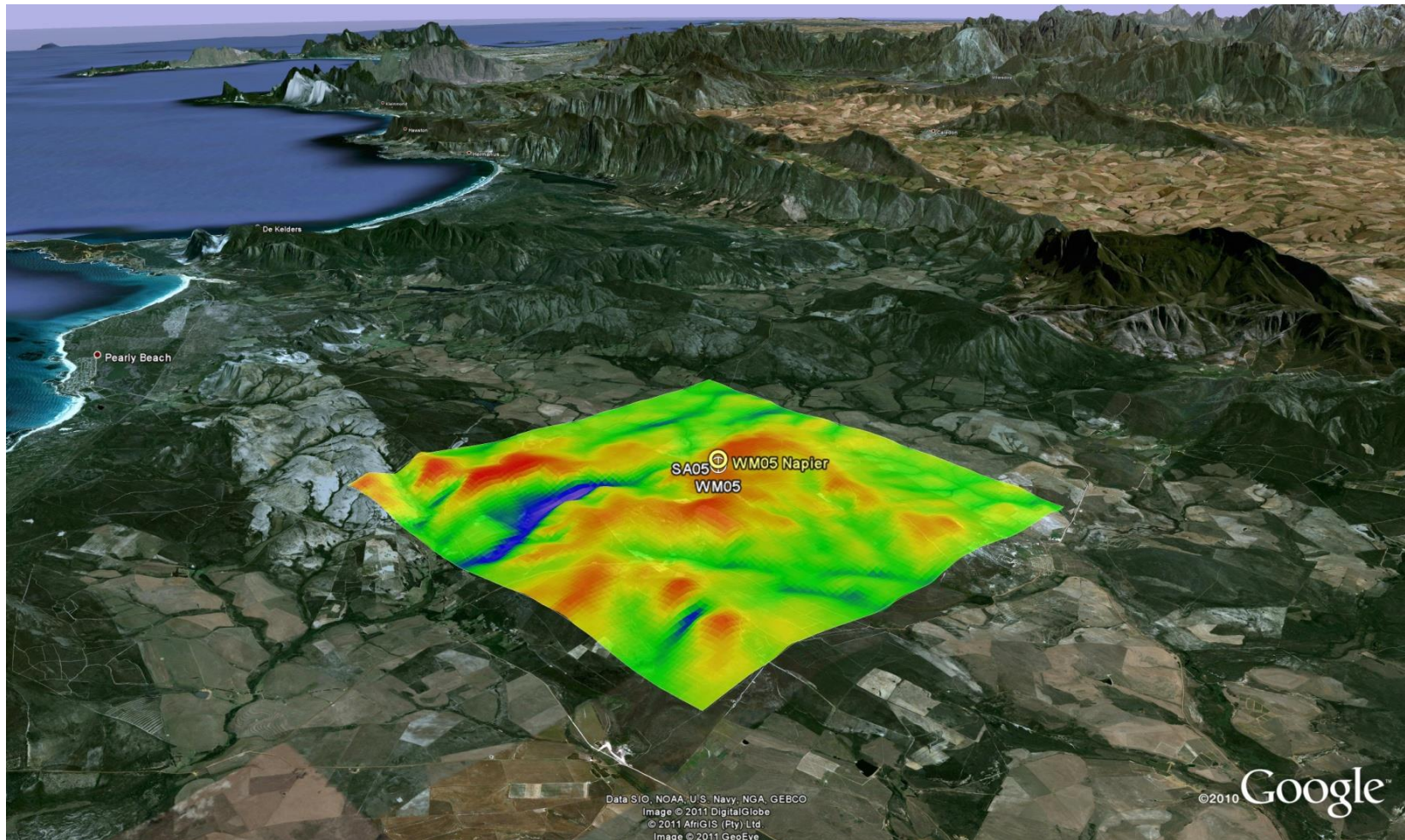


# Modelling scales and making a wind atlas

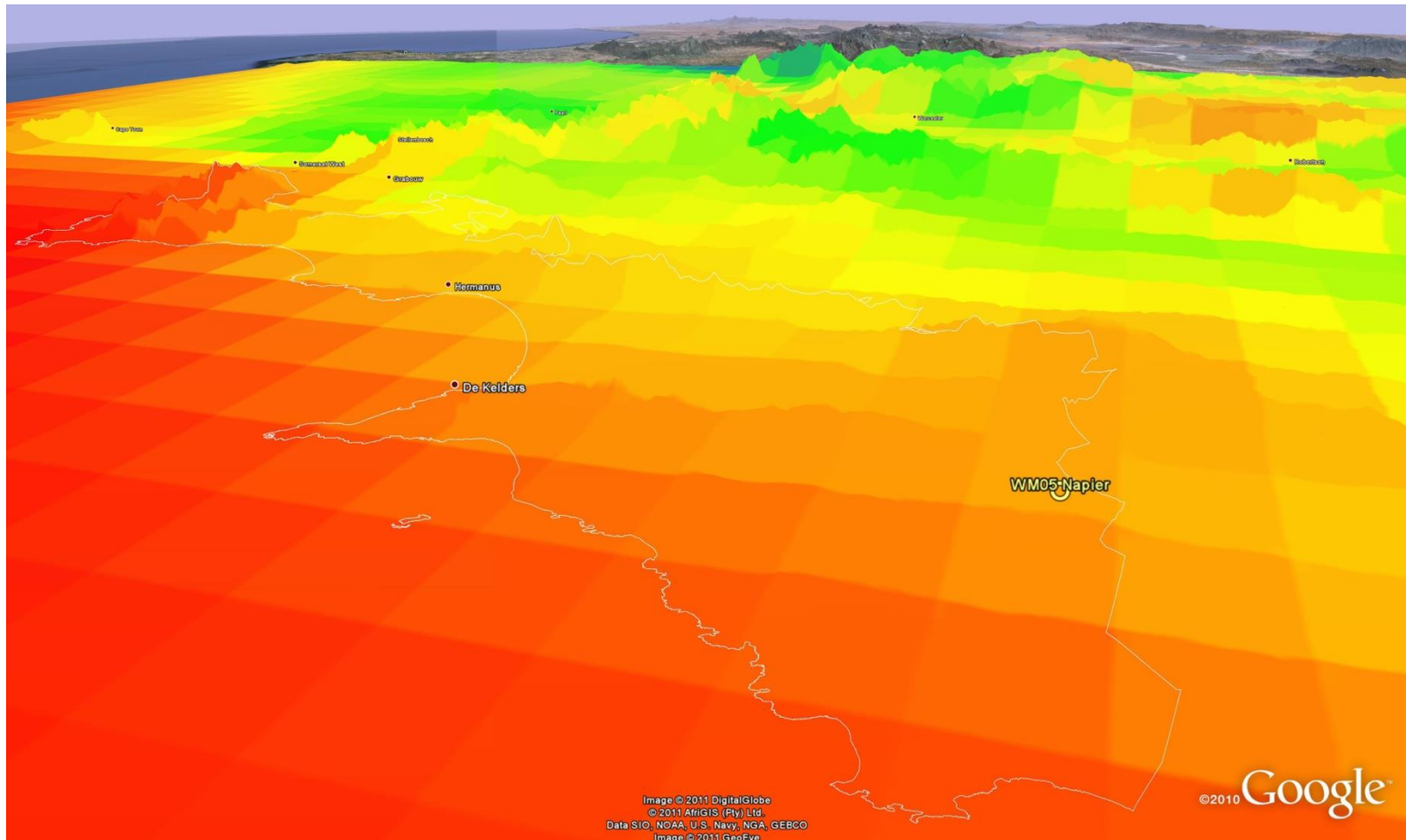
Main steps of a wind atlas – inputs, application and verification



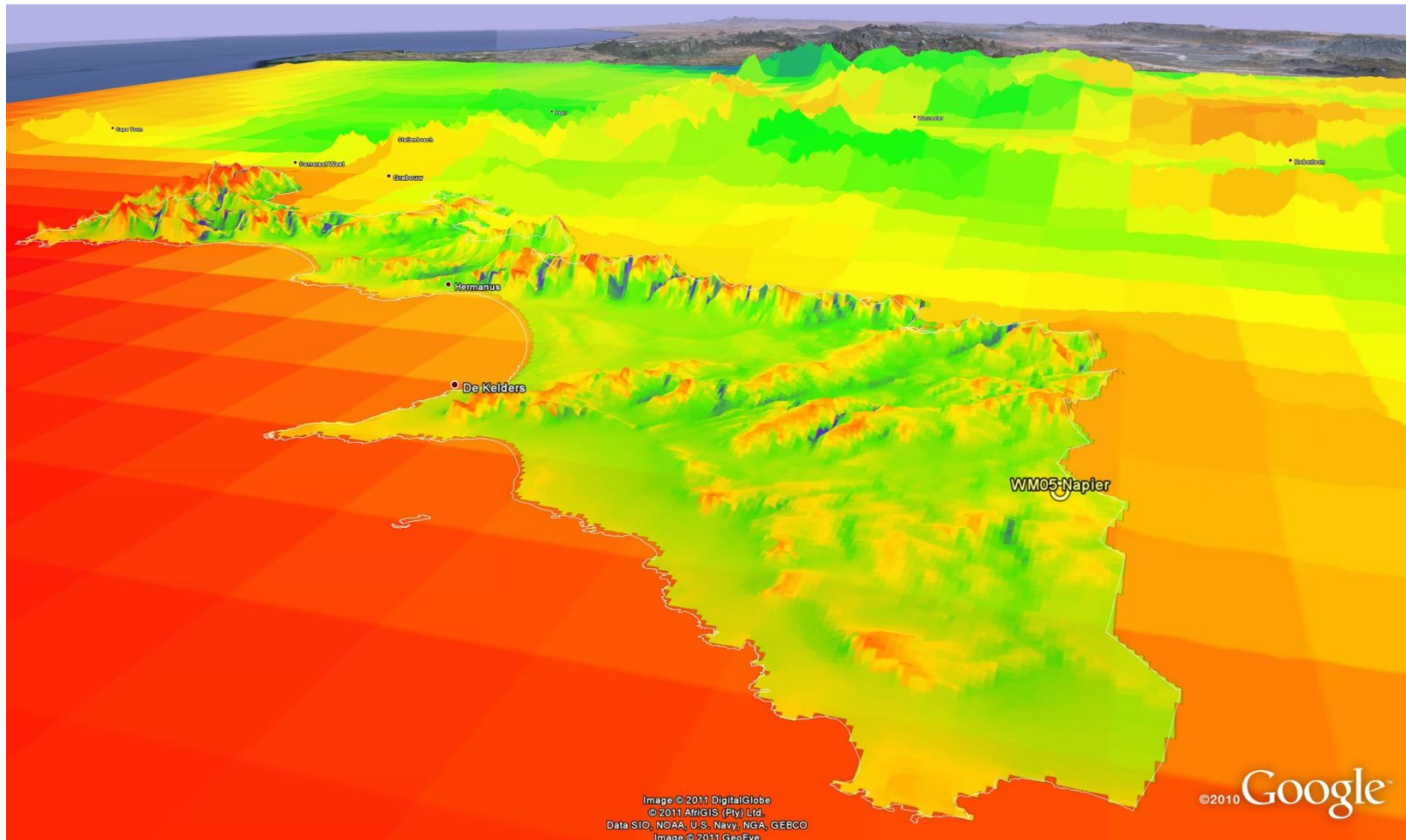
## Measurement based wind resource - microscale



## Mesoscale simulation results

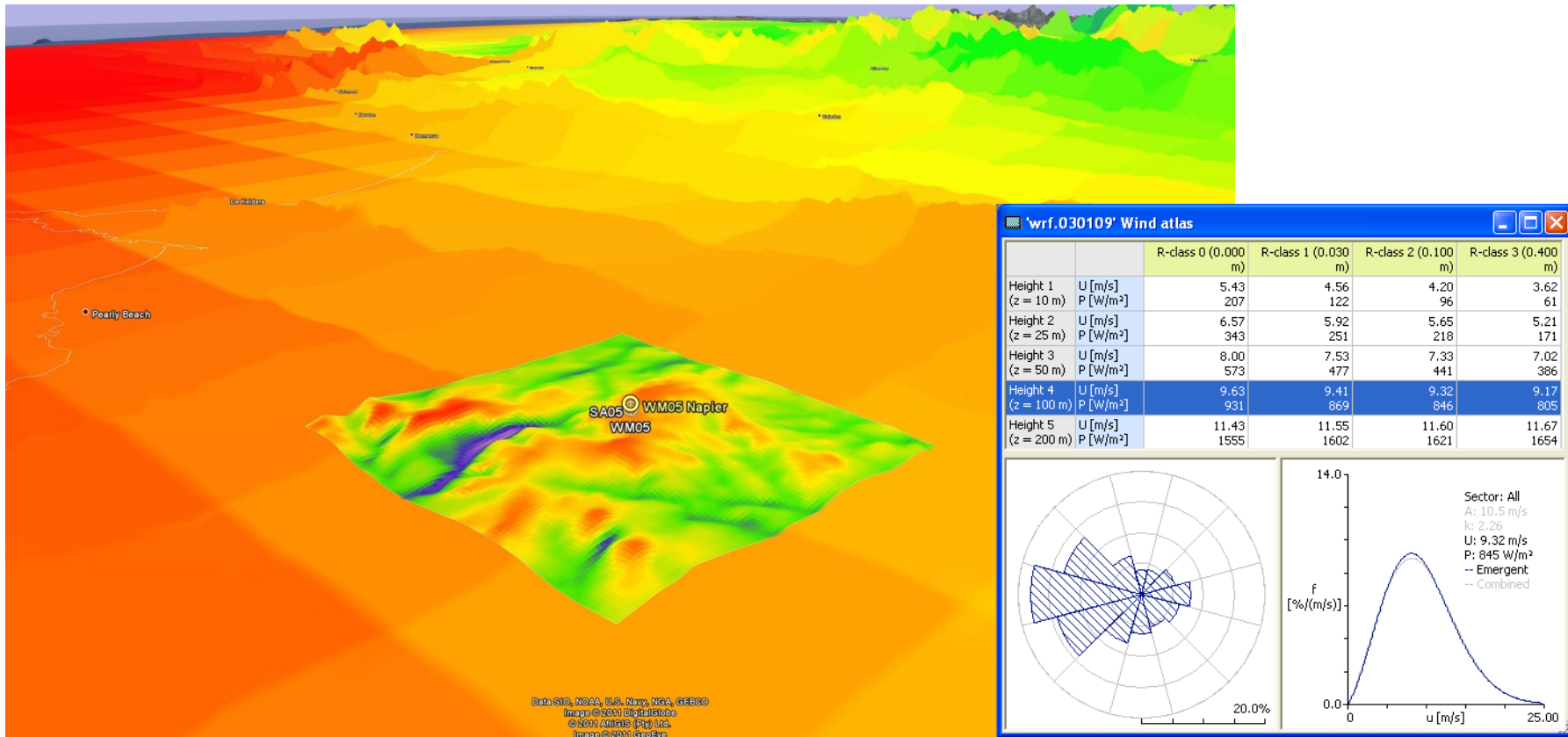


## Meso- and microscale results



# What is a wind atlas?

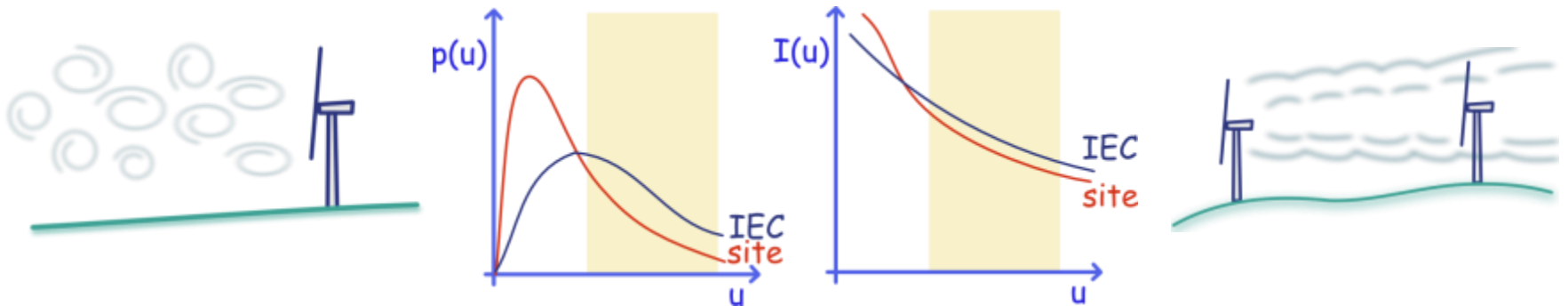
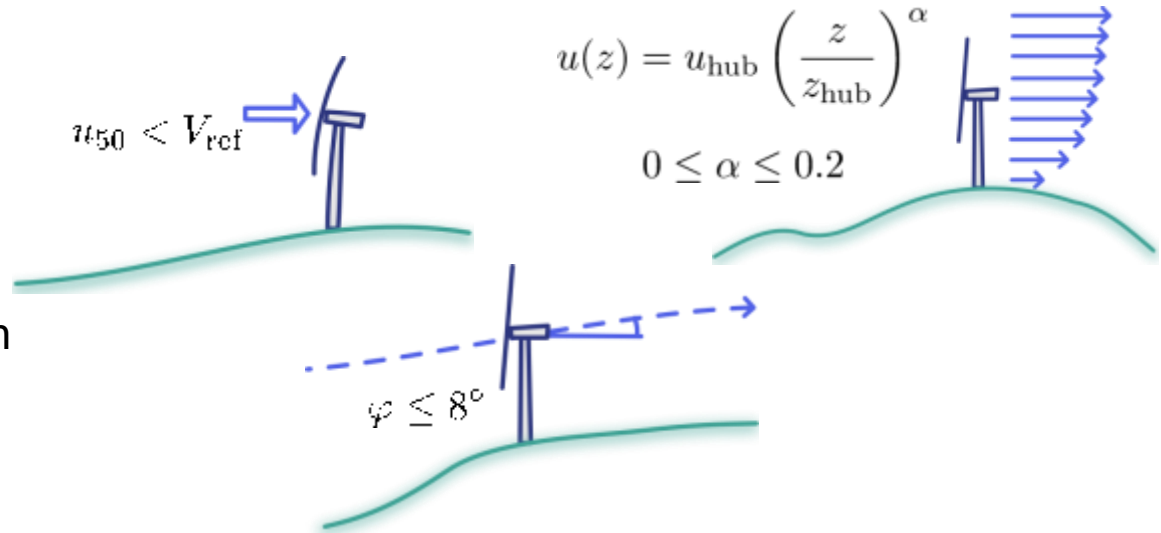
A wind atlas is a generalized set of information about the wind at a given location, containing wind speed and direction information for a region

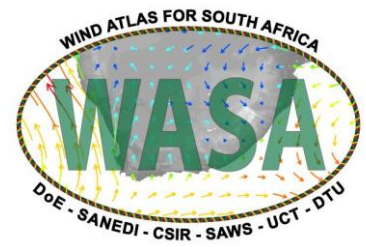


# IEC 61400-1 site assessment rules

## Checklist

- Extreme winds
- Vertical wind shear
- Flow inclination
- Turbulence
- Wind-speed distribution





# WASA project overview

## Work Packages

### WP1 – Mesoscale wind modelling

Downscaling from global datasets to regional data (KAMM and WRF)

### WP2 – Wind measurements

10 high quality WASA met stations for verification of modelling – online data access

### WP3 – Micro scale wind modelling

Observational Wind Atlas at WASA met stations for verification of WP1

### WP4 – Application for wind resource assessment

Workshops, applications, tools, guidelines, training, cases and access for users

### WP5 – Extreme winds

Application for estimation of an extreme wind climate of South Africa

### WP6 – Documentation and dissemination

Publications, web sites and seminars