311

# A new wind atlas for the region “Provence-Alpes-Côte d’Azur”

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## Abstract summary

The French Environment and Energy Management Agency (ADEME-PACA) has asked Meteodyn for elaborating a high-resolution wind atlas (250 m) covering the region “Provence-Alpes-Côte d’Azur” (South-East of France). Basic data come from 14 surface weather stations. Interpolation and vertical extrapolation are performed by combining a micro-scale (Meteodyn WT) and a meso-scale (RAMS) modelling For validation and calibration, 3 years measurements at 33 Météo-France stations are compared to computation results.

## Objectives

The Wind Atlas of the PACA region, furnishes, with an horizontal spatial resolution of 250 m, the following parameters at the heights of 10 m, 50 m, 80m,:

- the yearly mean wind speed
- the yearly mean power density
- the Weibull parameters of the mean wind speed distribution
- the yearly mean turbulence intensity

Also, the atlas gives on a 8 km resolution grid the joint distributions of mean wind speed and directions (every 20 deg) at 80 m height. These data can be used by a wind resource software for preliminary analysis of wind park productions

## Methodology

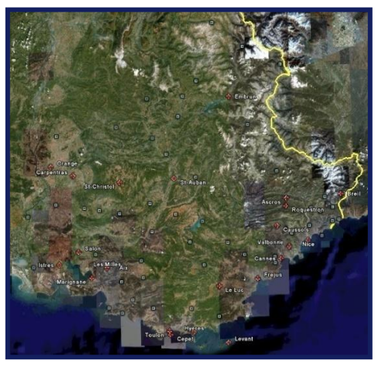
Due to the complexity of the PACA region (mountains up to 3000 m height), the methodology is based on a coupling between meso and micro-scale CFD computations.

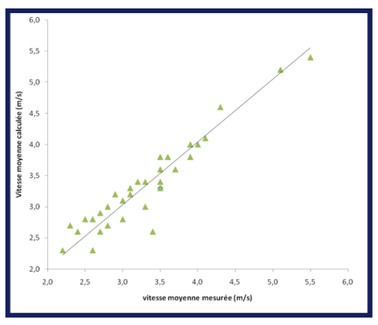
The methodology consists in extrapolating 20 years surface wind measurements at 14 selected weather stations according to the following process:

- Correction of local effects at each basic station and extrapolation of the measurements to a 80 m height
- Estimation of the meso-scale wind at the station (averaged wind speed at 80 m height over a 8km x 8km area)
- Horizontal Extrapolation of the meso-scale wind all over the region (use of meso-scale coefficients computed on the 8 km resolution grid)
- Inside each 8x8 km area, computation of the wind characteristics at a 250 m resolution at 10m, 50m, 80m height

## Validation and calibration

The method is validated and calibrated by using 3 years wind measurements at 33 « target » weather stations (in blue on the map)






**➢ Calculation of 3-yr statistics at 33 sites**

- by direction sectors (20 deg)
- by stability classes

**➢ Calibration**

- link stability/windspeed
- small scale breeze effects
- meso/micro scale embedding

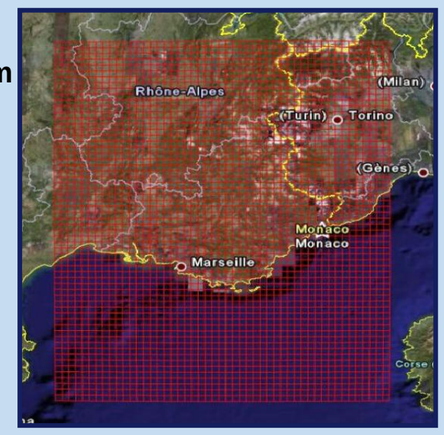
**➢ Validation**

- no bias on mean wind speed
- 7% standard error on mean wind speed
- hourly variations

## Meso-scale modelling


**Grid 1**
**2400x2100km**
**step 32 km**

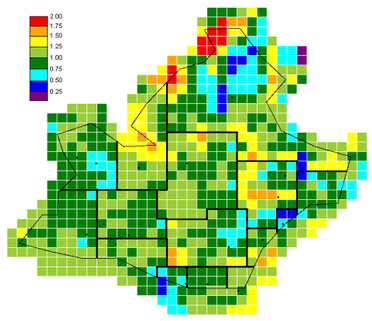
**Grid 2**
**400x500km**
**step 8 km**



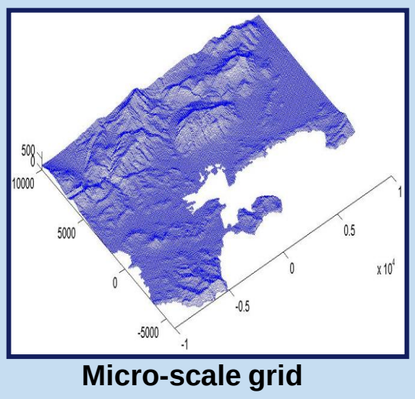

- Simulation period 2005 – 2007 ; time step 3h
- Input meteorological data
  - 6h outputs of the GFS model (1 deg resolution)
  - hourly surface observations (10 weather stations in PACA)
  - rawinsondes, twice a day (4 sites)
  - assimilation data by 3DDA method (RAMS input)
- Two embedded grids (32 km and 8 km steps)
- Meso-scale RAMS model

→ **Calculation of 54x570 « Meso-scale coefficients**

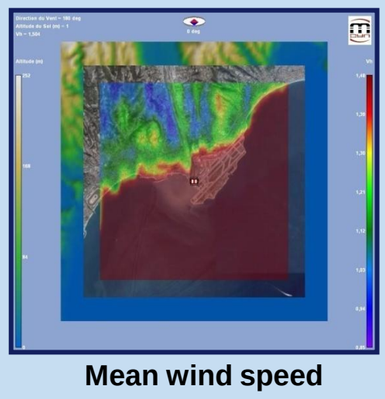
18 directions sectors,
3 stability classes
570 meso-scale points



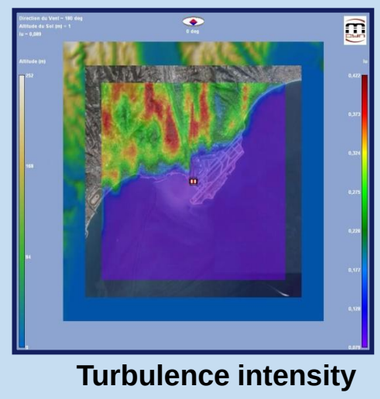

## Micro-scale modelling




**Micro-scale grid**



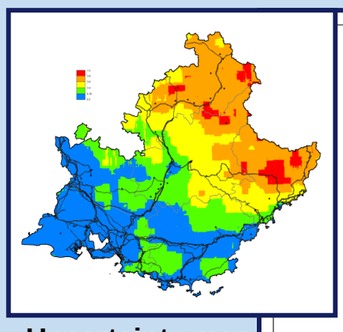
**Mean wind speed**



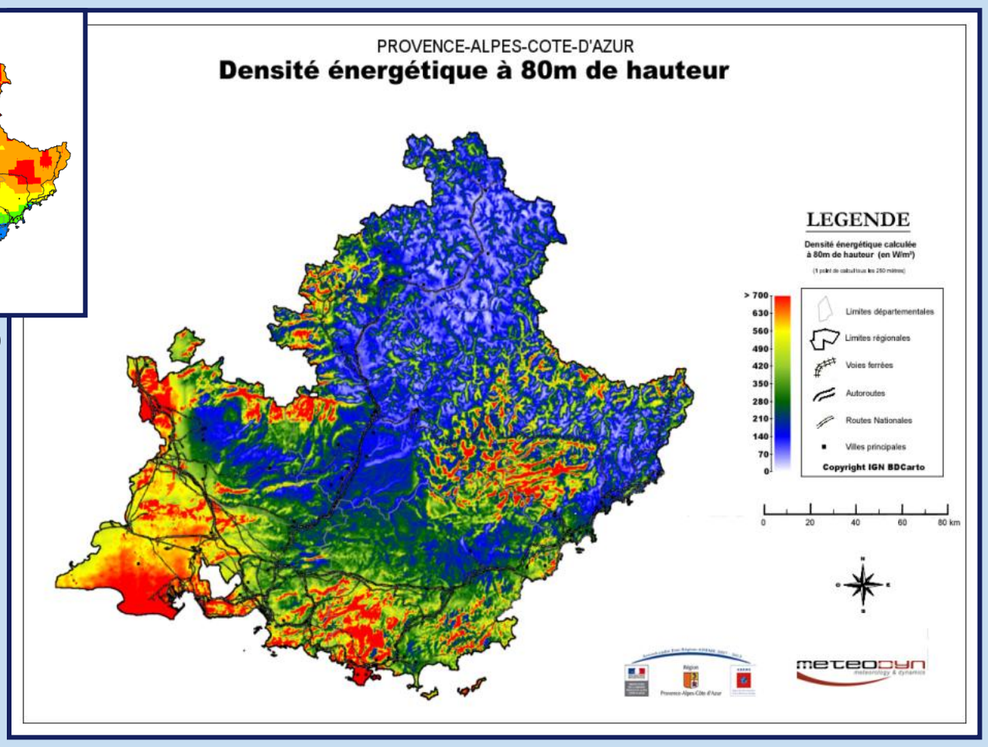
**Turbulence intensity**

- 570 tiles of 10 km x 10 km – horizontal grid step 125 m
- 54 configurations (18 directions – 3 stability classes)
- High resolution computation (50 m) at the weather stations
- Vertical resolution: 4 m – 10 m
- CFD Navier-Stokes code: **Meteodyn WT (see stand nr 1133 – Hall 1)**
- One-equation turbulence model – canopy forest model

## Results



**Uncertainty map**




**Example: Power density at 80 m height**