Spatial Resolution Optimization for Wind Forecast

Jorge Palma

Ana Rosa Trancoso

Prof. Delgado Domingos

Secção de Ambiente e Energia
Departamento de Engenharia Mecânica
Instituto Superior Técnico
Grupo 30

Objectives

- Provide wind forecast for Eolic Parks
- Find the best spatial resolution with the lowest computational cost.

Methodology

- Validation of MM5 wind output
- Verification of the need of running a more refined diagnostic model (CALMET)

Why use CALMET?

- MM5 has a high computational cost when used at very high resolution without a corresponding increase in precision.

- CALMET allows very fine spatial resolution and more precise orography and land cover at a reduced computational cost.

- CALMET is a diagnostic flow model developed in U.S.A for EPA and used in long range pollutant dispersion. It is based on potential flow, taking into account orography and land cover with well tested parameterizations.

- CALMET may be seen as a kind of interpolator, physically based, for MM5 Output.

CALMET makes easy the prognostic of very detailed wind fields with spatial resolutions of the order of 100m.

Why use CALMET?

- However, reducing the spatial resolution of MM5, decreases the precision and quality of input to CALMET, *so the question is:*

What combination of spatial resolutions in MM5 and CALMET gives the best results at the lowest computational cost?

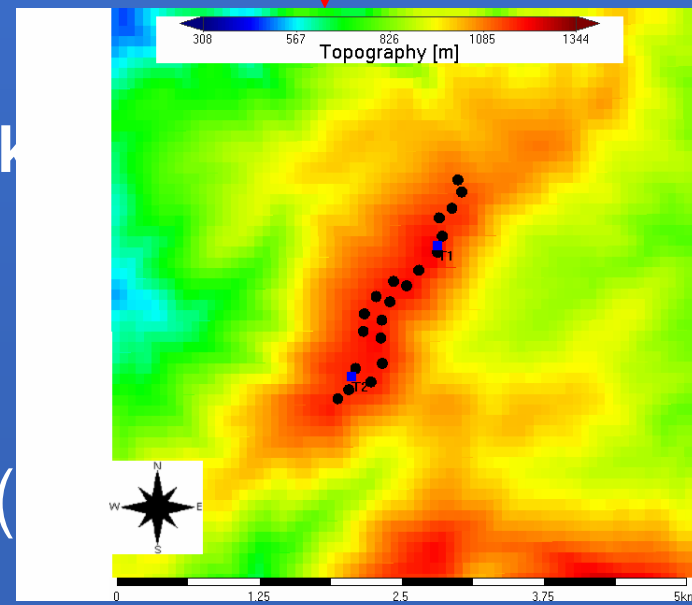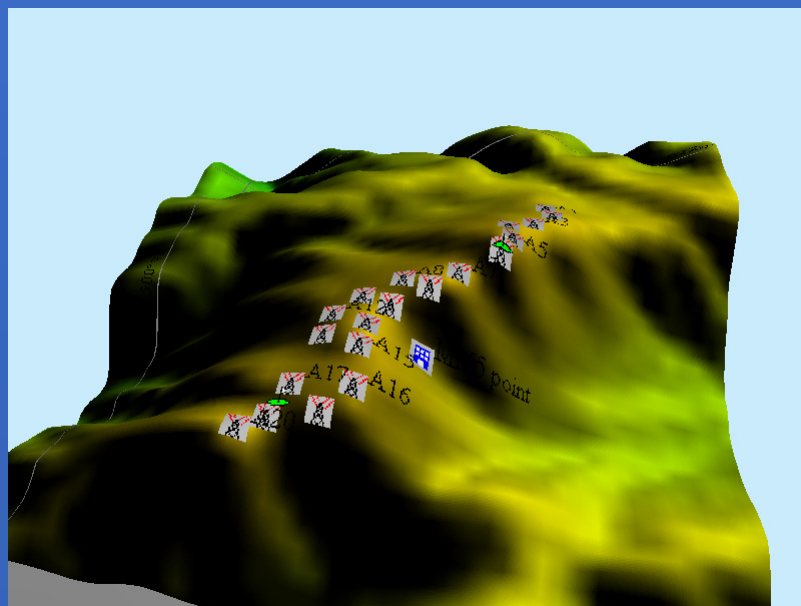This presentation shows some preliminary results of ongoing work to answer this question.
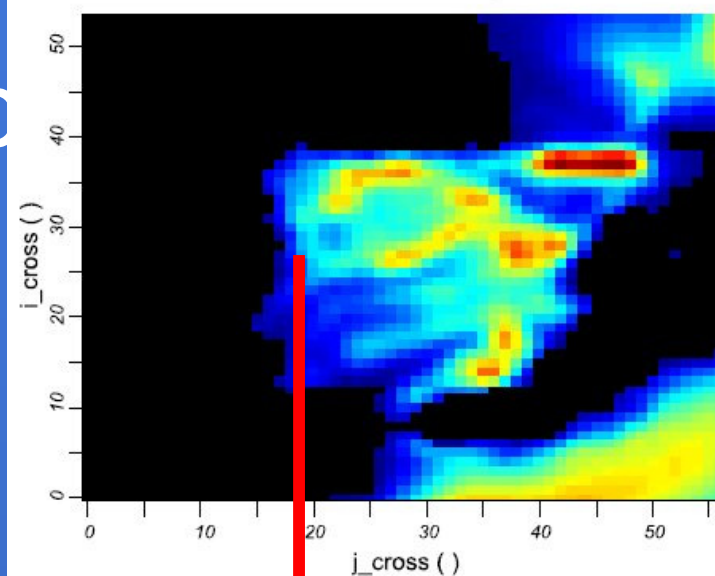
Simulation Co

- ## MM5:
  - 30 vertical layers (1st ~10km)
  - 1-way nesting of domains

Topography [m]

Spatial Resolution Details

MM5 - 27km

CALMET - 100m

Topography [m]
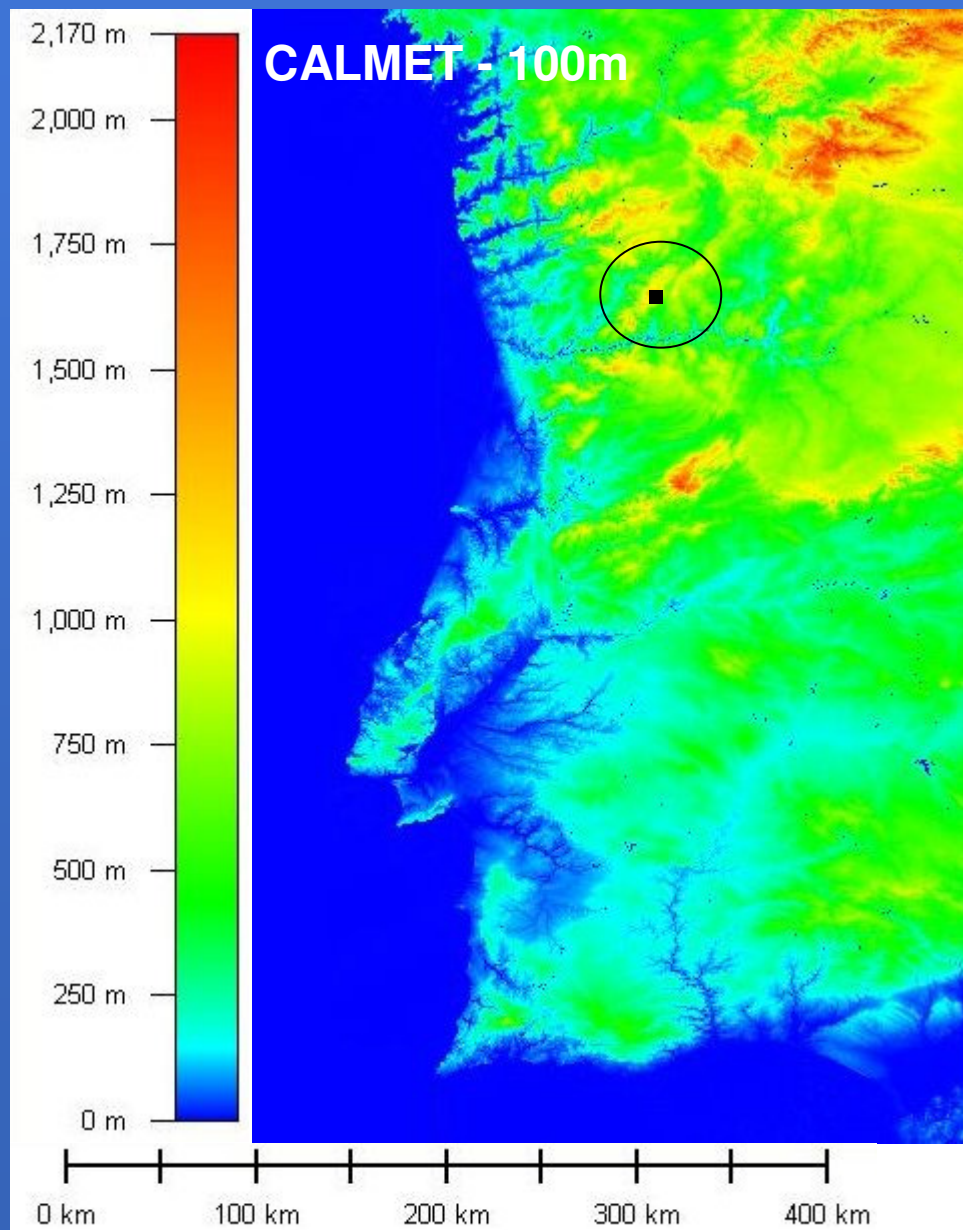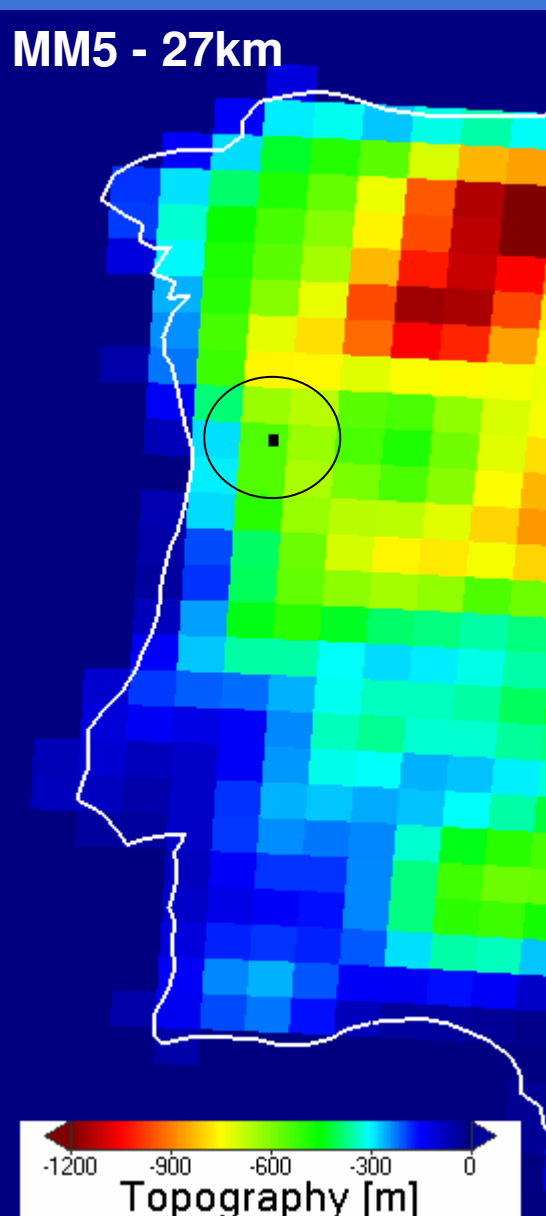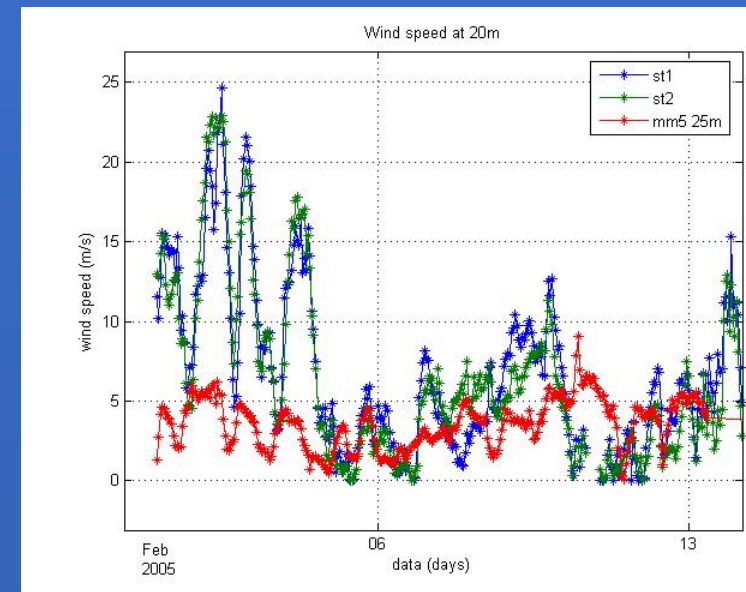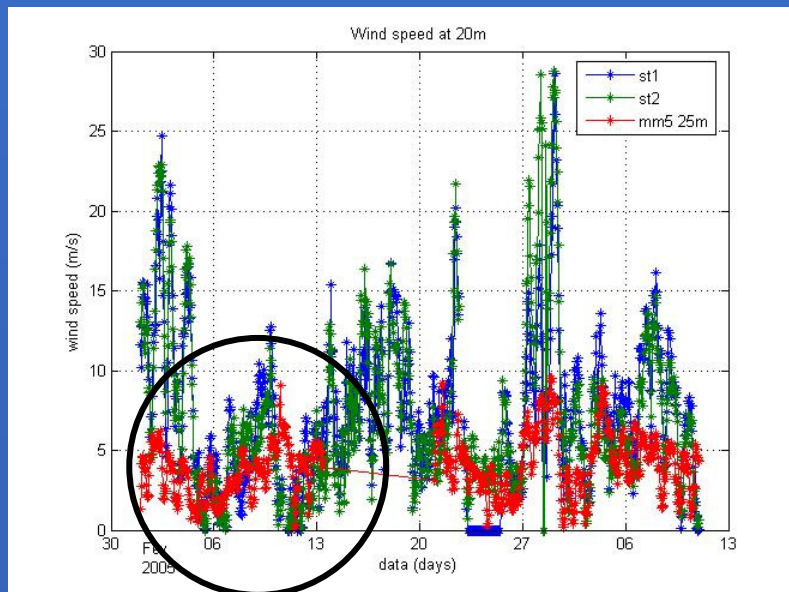
MM5 wind speed

- 2 meteorological stations measure at 20m and 40m
- Compare with D2 (~27km) for February and March 2005

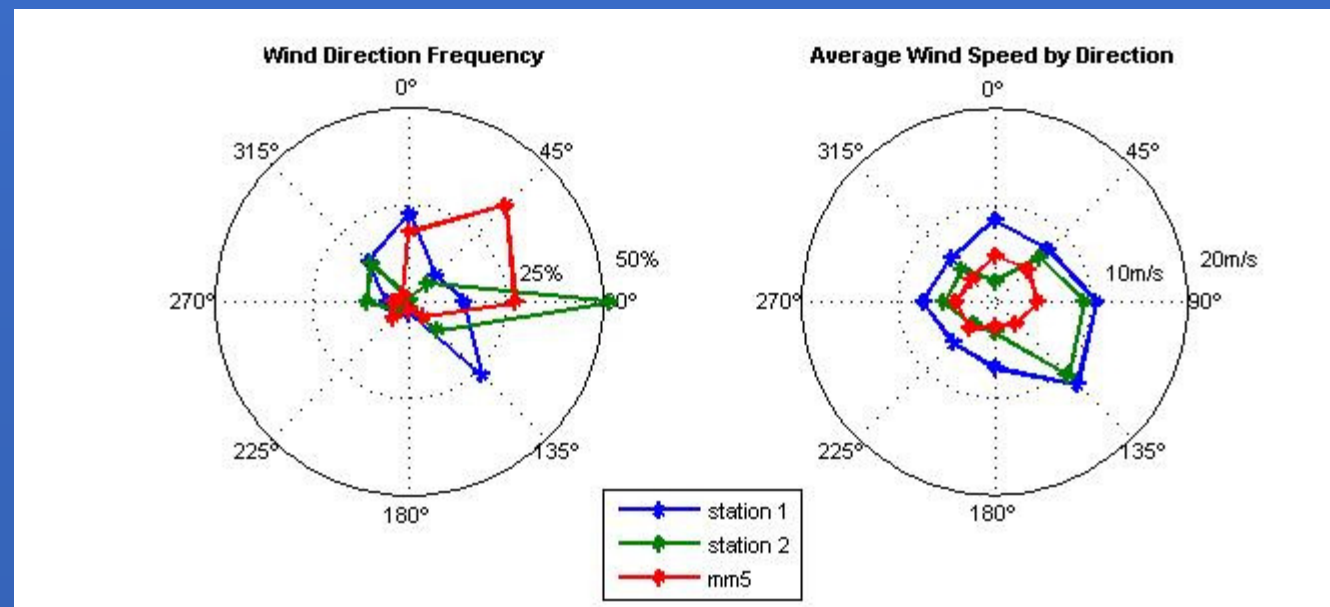Under-estimation of wind speed (at both levels)

MM5 wind direction

- Comparison at 40m
- Wind predominant directions are different for each station (complex topography)
- SE winds have the highest speeds
- MM5 does not comply with measured wind direction
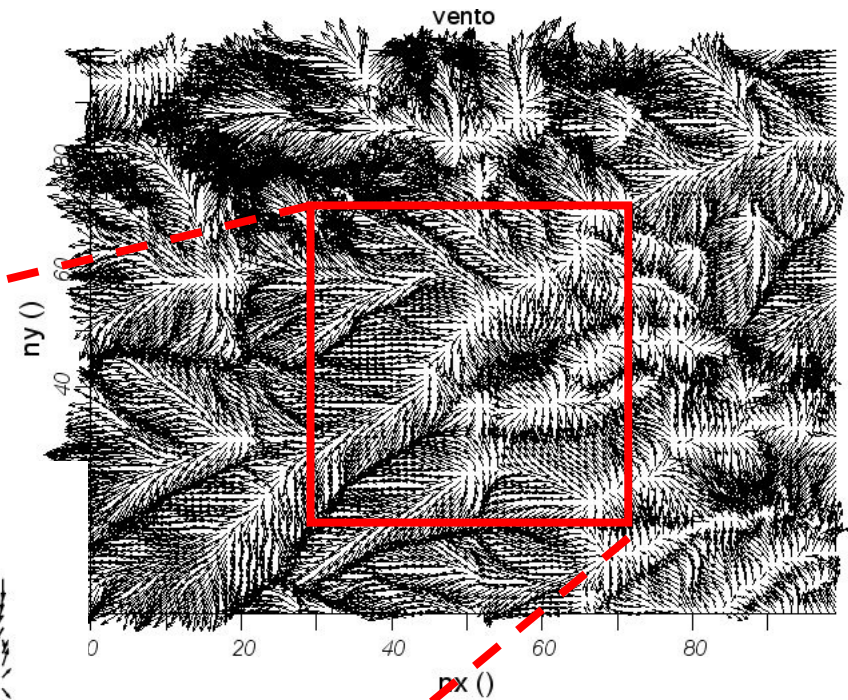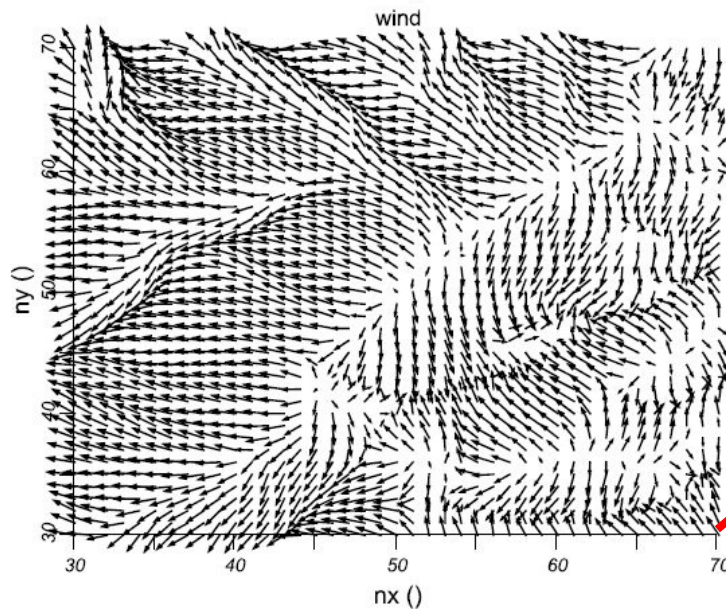- **May CALMET improve results?**

MM5 D2 (~27km)
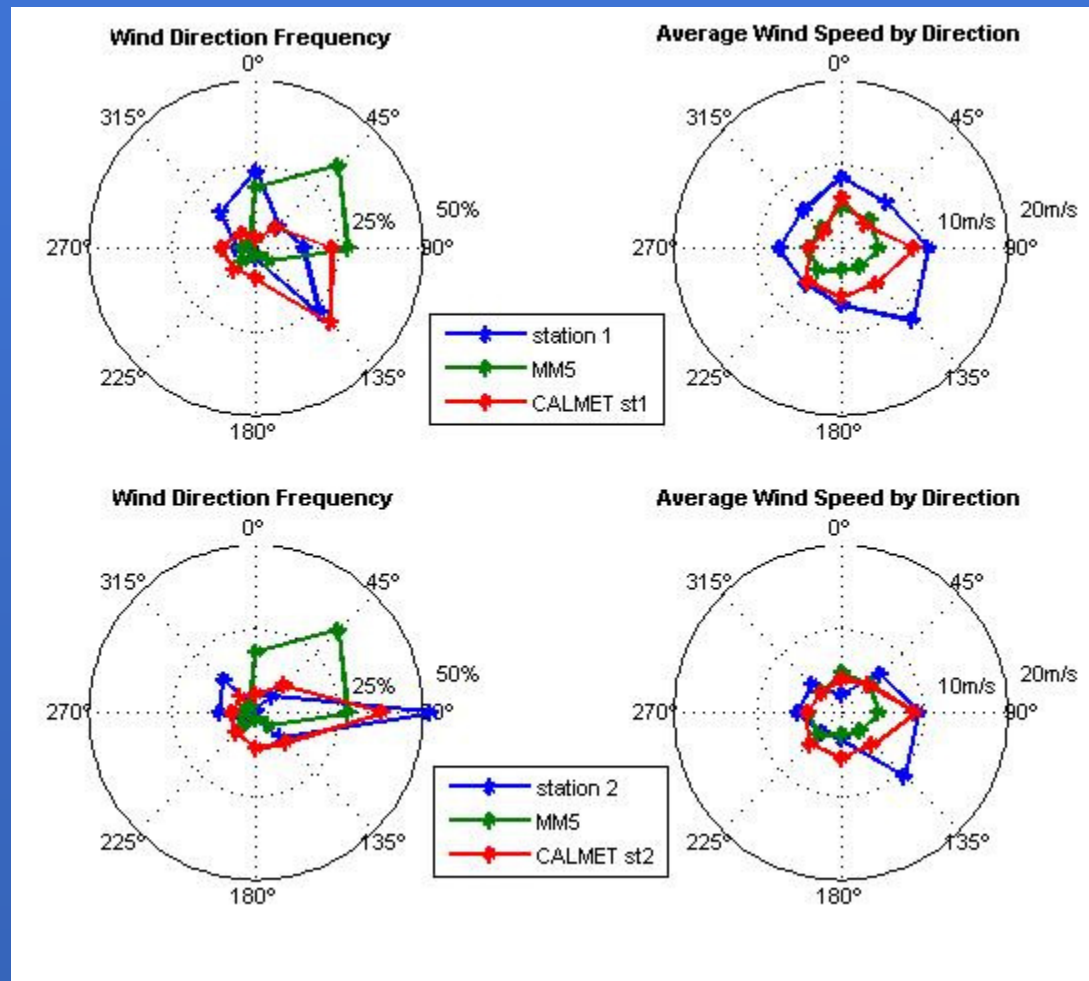
CALMET from MM5 D2

- CALMET integrates the orography details into wind

CALMET from MM5 D2

- Improves wind direction and intensity forecast

- Different results for the 2 stations

Conclusions

- MM5 is a well tested model but is computationally heavy.

- CALMET is computationally light and can diagnostic winds for high spatial resolution, but needs correct boundary conditions.

- MM5 can provide the correct boundary conditions.

- With boundary conditions given by MM5, 27km:

    - CALMET simulates the predominant wind directions.

    - Both models underestimate wind speed.

Future Work

- Increase MM5 spatial resolution (9km, 3km 1km), and input results into CALMET (100m).

- Verify the best relation quality of results/ computational cost to determine adequate spatial resolution.

- Use several case studies, with different orography patterns.

- Use annual data.

INSTITUTO SUPERIOR TÉCNICO

Spatial Resolution Optimization for Wind Forecast

Jorge Palma

Ana Rosa Trancoso

Prof. Delgado Domingos

Secção de Ambiente e Energia
Departamento de Engenharia Mecânica
Instituto Superior Técnico
Grupo 30