This work was partly funded by national funds through the FCT – Fundação para a Ciência e a Tecnologia, I.P.,
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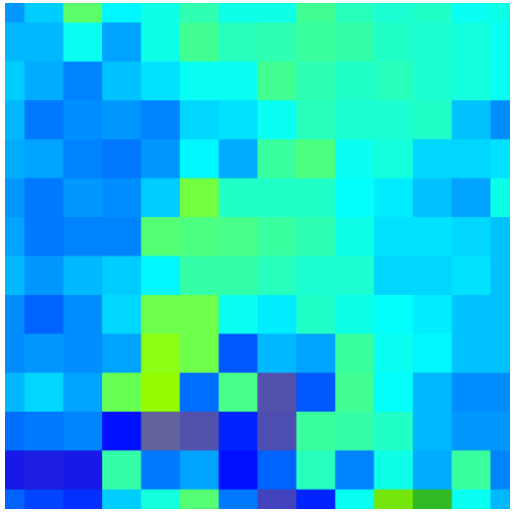
Meteorological forecast approach for use Dynamic Line Rating in operational decisions

Disclaimer: The statements and opinions expressed in this presentation do not bind the organizations participating in the study; LNEG and R&D NESTER

Workshop: 20th September 2022

Introduction

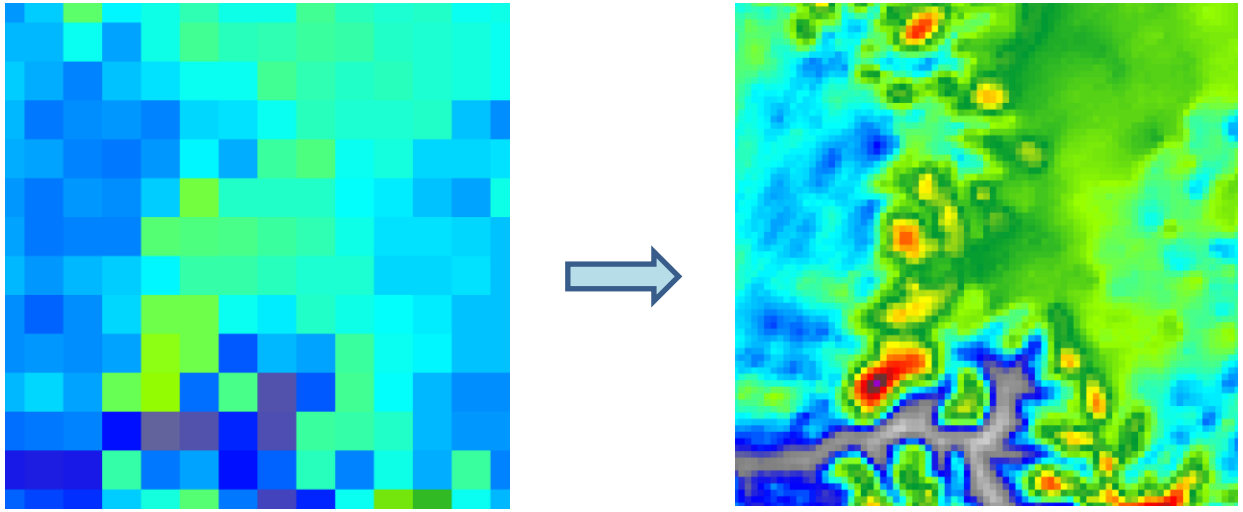
- *Numerical Weather Prediction (NWP*) models, as the ones typically used by meteorological institutes, are crucial to obtain reliable time series of meteorological parameters without installing an extensive and costly network of meteorological stations
  - … but unavoidable systematic errors due, e.g., to the inability of these models to deal with local effects caused by roughness and orography, remain a challenge.
  - Models capable of describing the dynamic behavior of the atmosphere, up to a maximum spatial resolution of 1x1 km.



Wind speed field from a NWP.

Introduction

- To properly account for local effects on the wind speed, statistical or **physical downscaling techniques** of the NWP model results are applied:
  - ✓ Statistical techniques require a considerable number of meteorological stations;
  - ✓ Physical techniques allow working with models (as *computational fluid dynamic – CFD*) with high spatial resolutions (up to 10 meters) → commonly applied to estimate the wind resource.



Wind speed field from a NWP.

Wind speed field from a CFD.

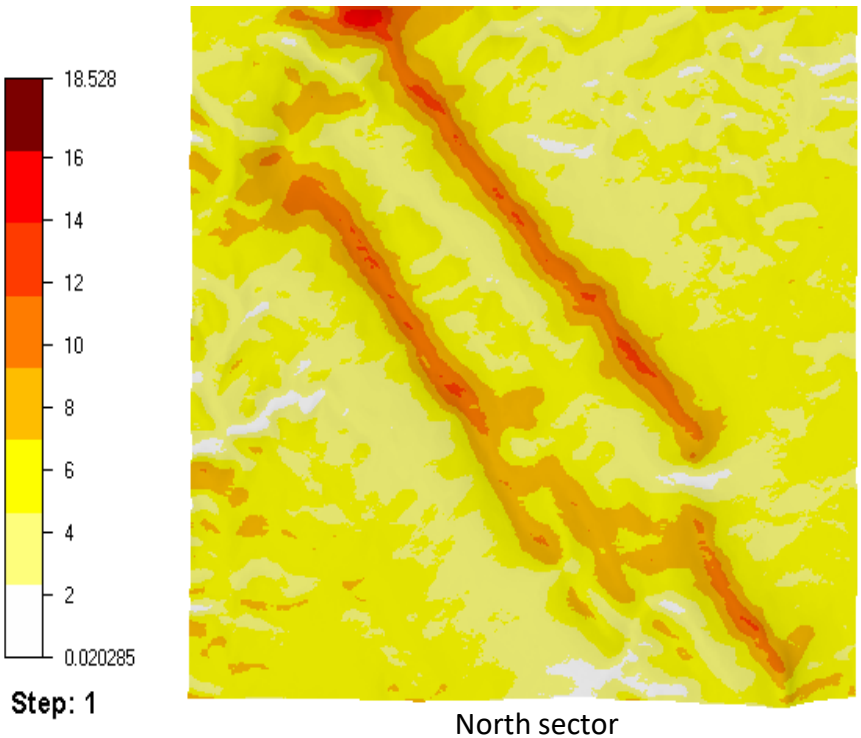
Catalogue-based approach

Power line segment number	Wind direction sector (θ)			
	]345°;15°]	]15°;45°]	…	]315°;345°]
Segment 1	$CF_{WS,1}(\theta)$; $CF_{WD,1}(\theta)$	$CF_{WS,1}(\theta)$; $CF_{WD,1}(\theta)$		$CF_{WS,1}(\theta)$; $CF_{WD,1}(\theta)$
…				
Segment i	$CF_{WS,i}(\theta)$; $CF_{WD,i}(\theta)$	$CF_{WS,}(\theta)$; $CF_{WD,1}(\theta)$		$CF_{WS,1}(\theta)$; $CF_{WD,1}(\theta)$

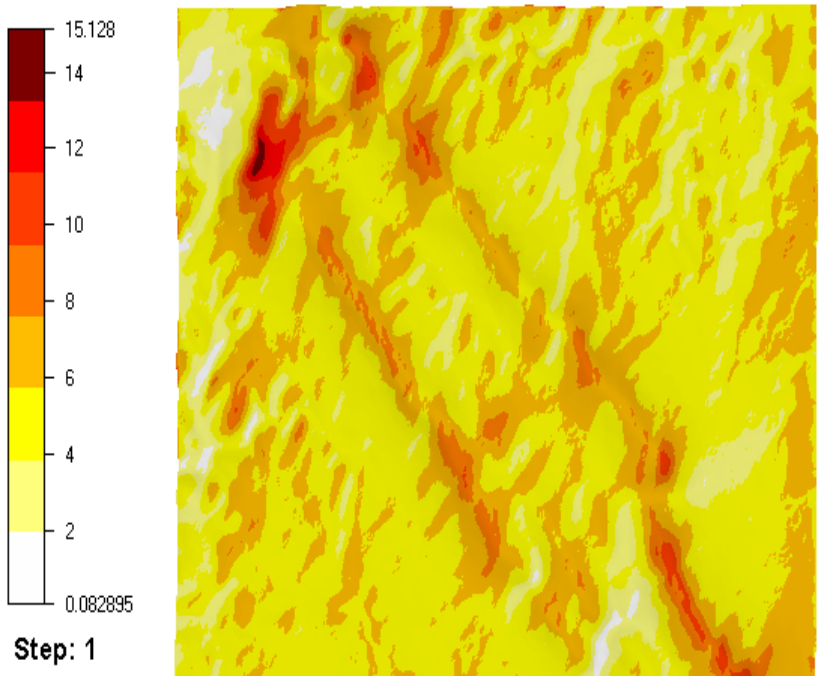
- **Catalogue-based correction factors (CF)** for i) wind speed and ii) wind direction approach were implemented.
- The **CF is scaled based on different wind direction conditions between the location of each power line segment in the CFD** model and that at the virtual time series **data from the NWP**.

Catalogue-based approach

- CFD results for different directional sectors:



North sector

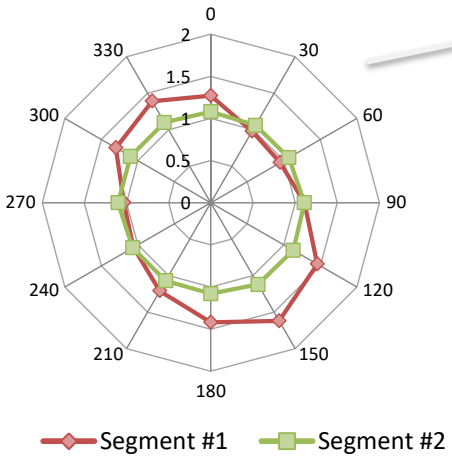


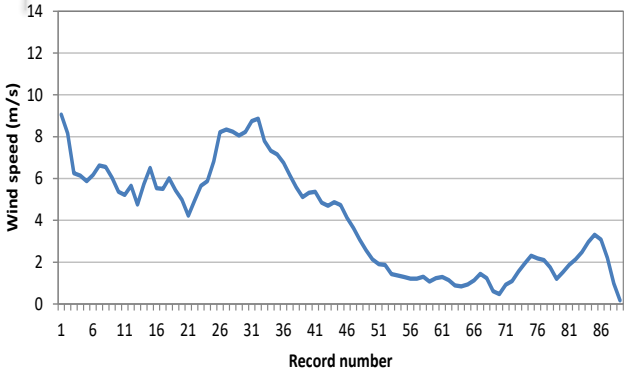
Southeast sector

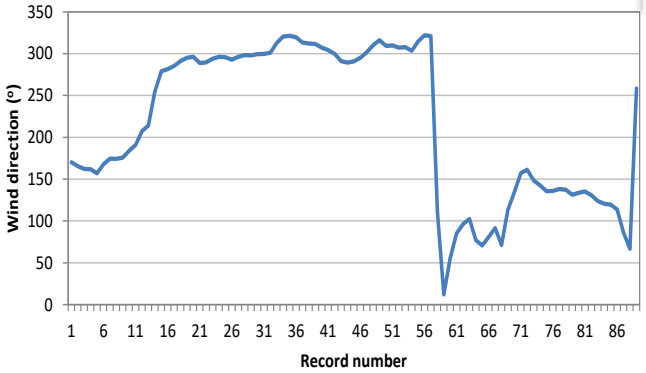
- Wind speed fields show a high dependency on the forcing directional sector.

Correction factors (CF) for wind speed

$$WS\ Calibrated_i(t) = CF_{WS,i}(\theta) \times WS_{Mesoscale}(t,\theta)$$

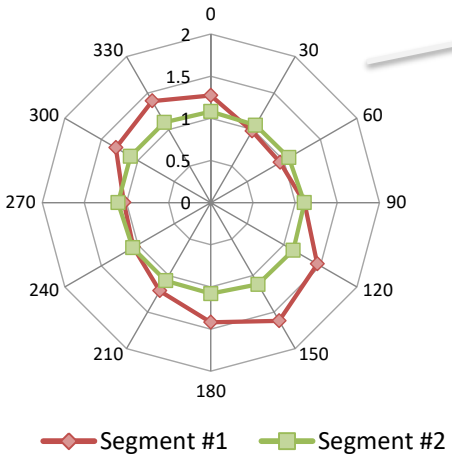


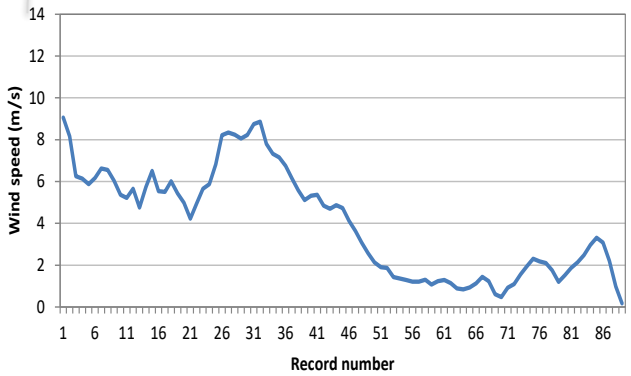


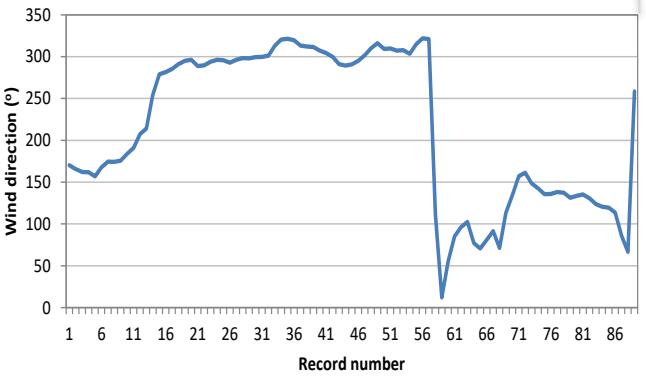


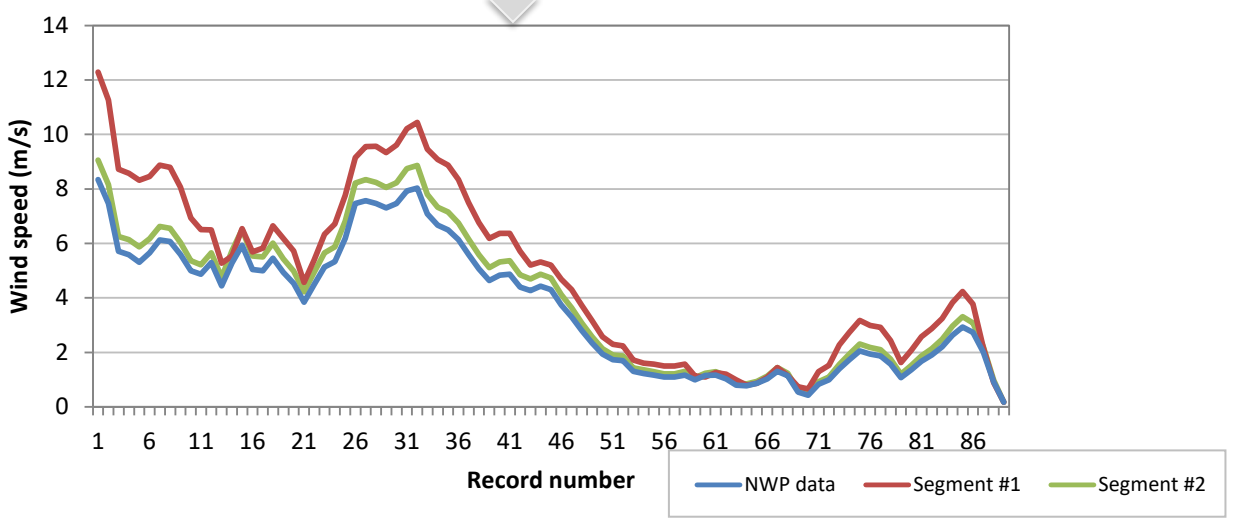
Correction factors (CF) for wind speed

$$WS\ Calibrated_i(t) = CF_{WS,i}(\theta) \times WS_{Mesoscale}(t,\theta)$$



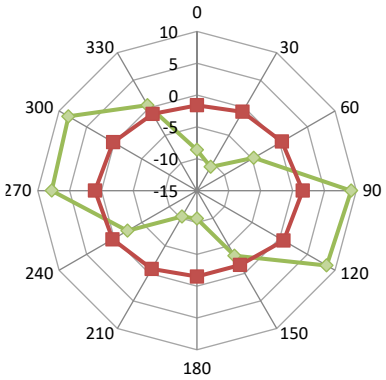


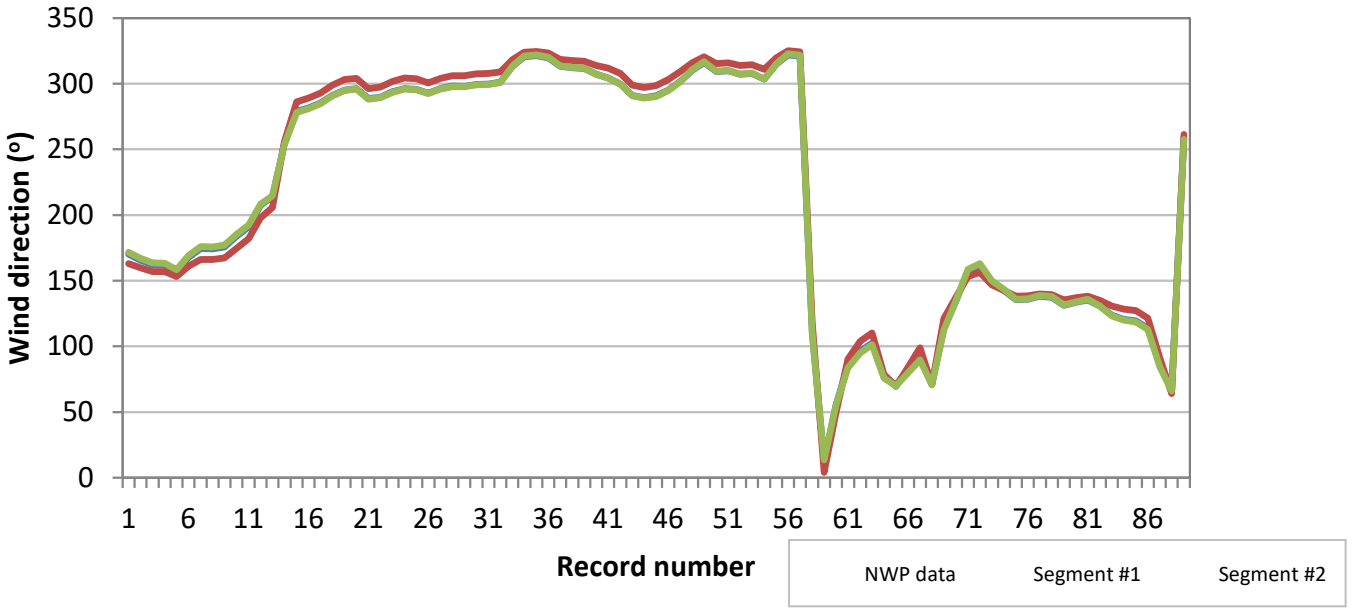




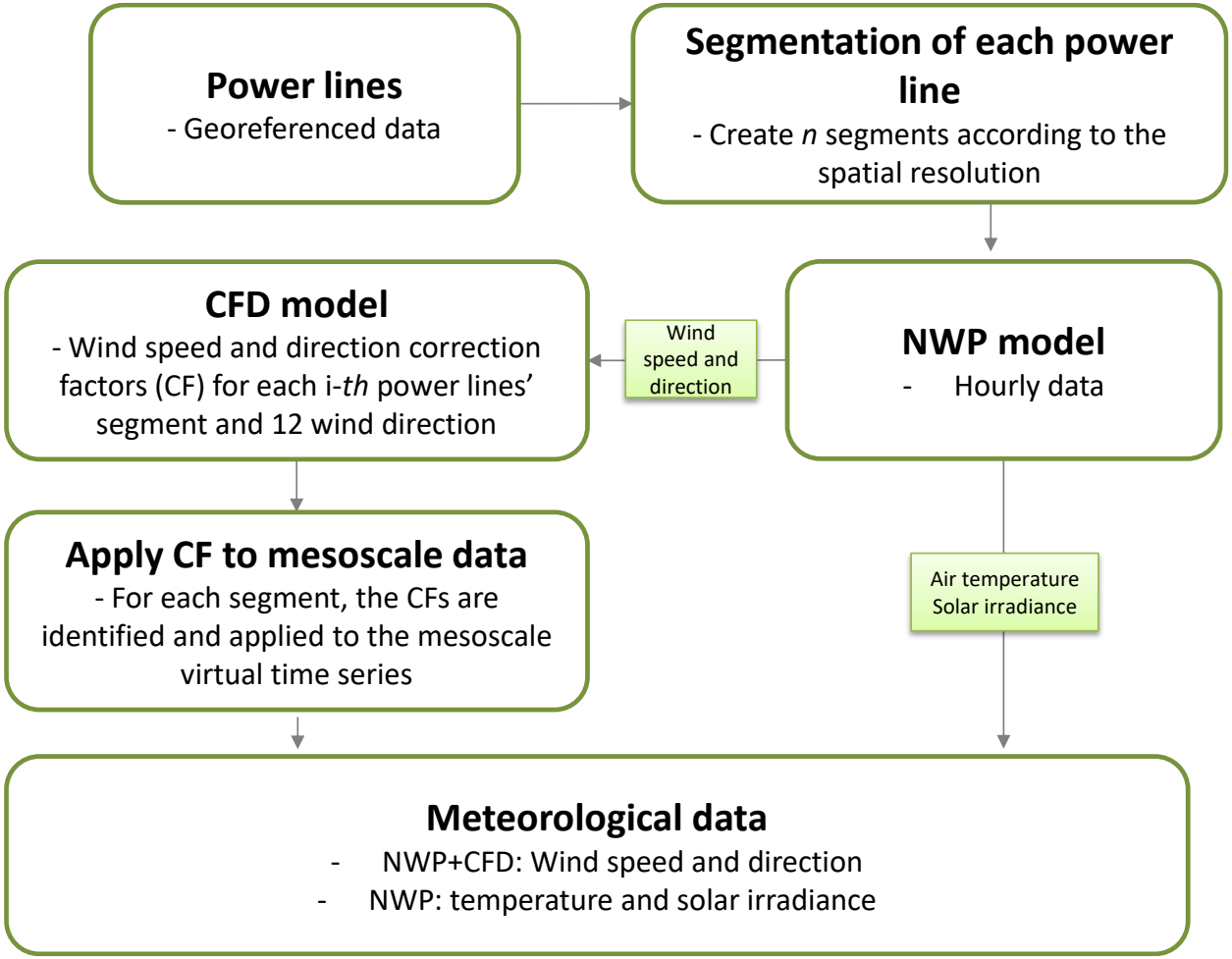
Correction factors (CF) for wind direction

$$WD\ Calibrated_i(t) = CF_{WD,i}(\theta) + WD_{Mesoscale}(t,\theta)$$



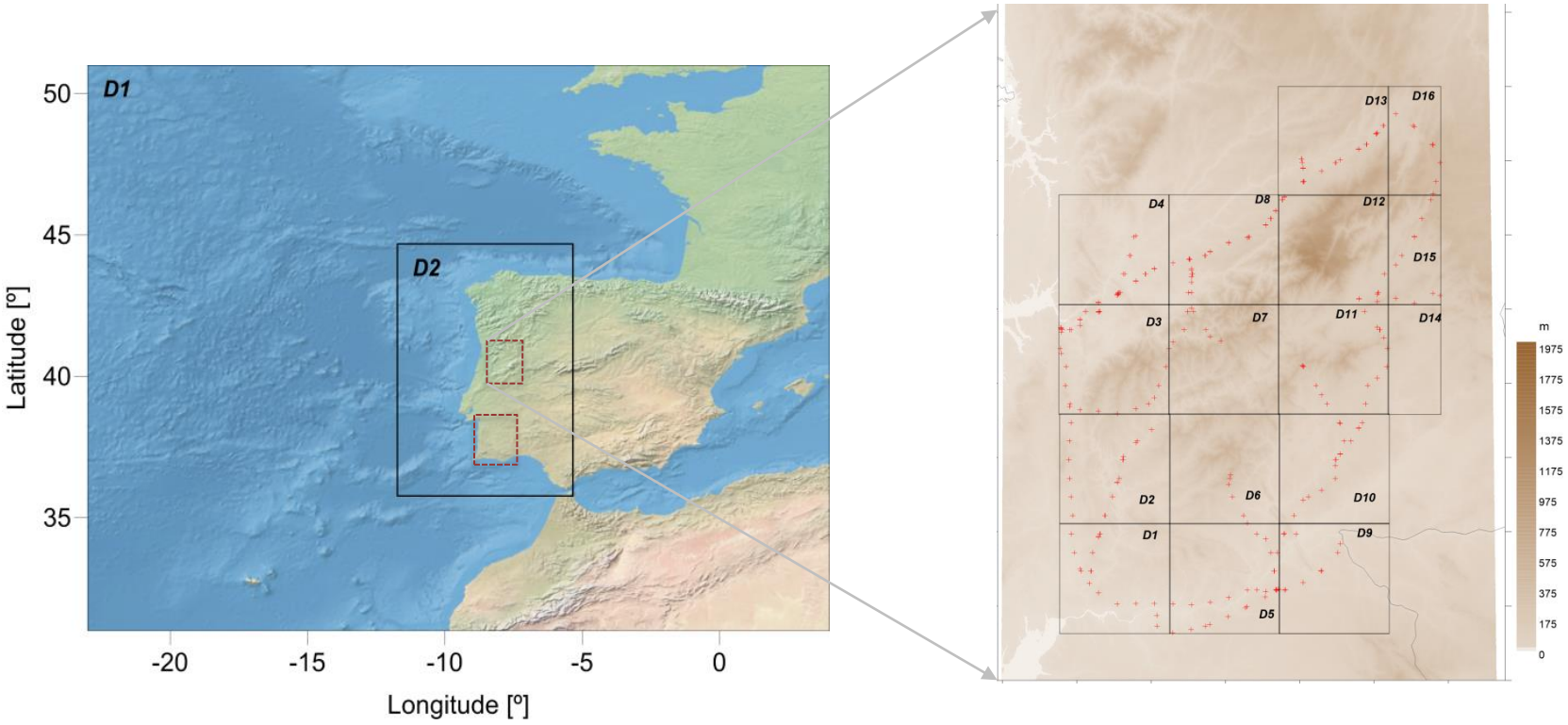


Methodology – main steps



- Data were obtained for 25 meters above ground level.

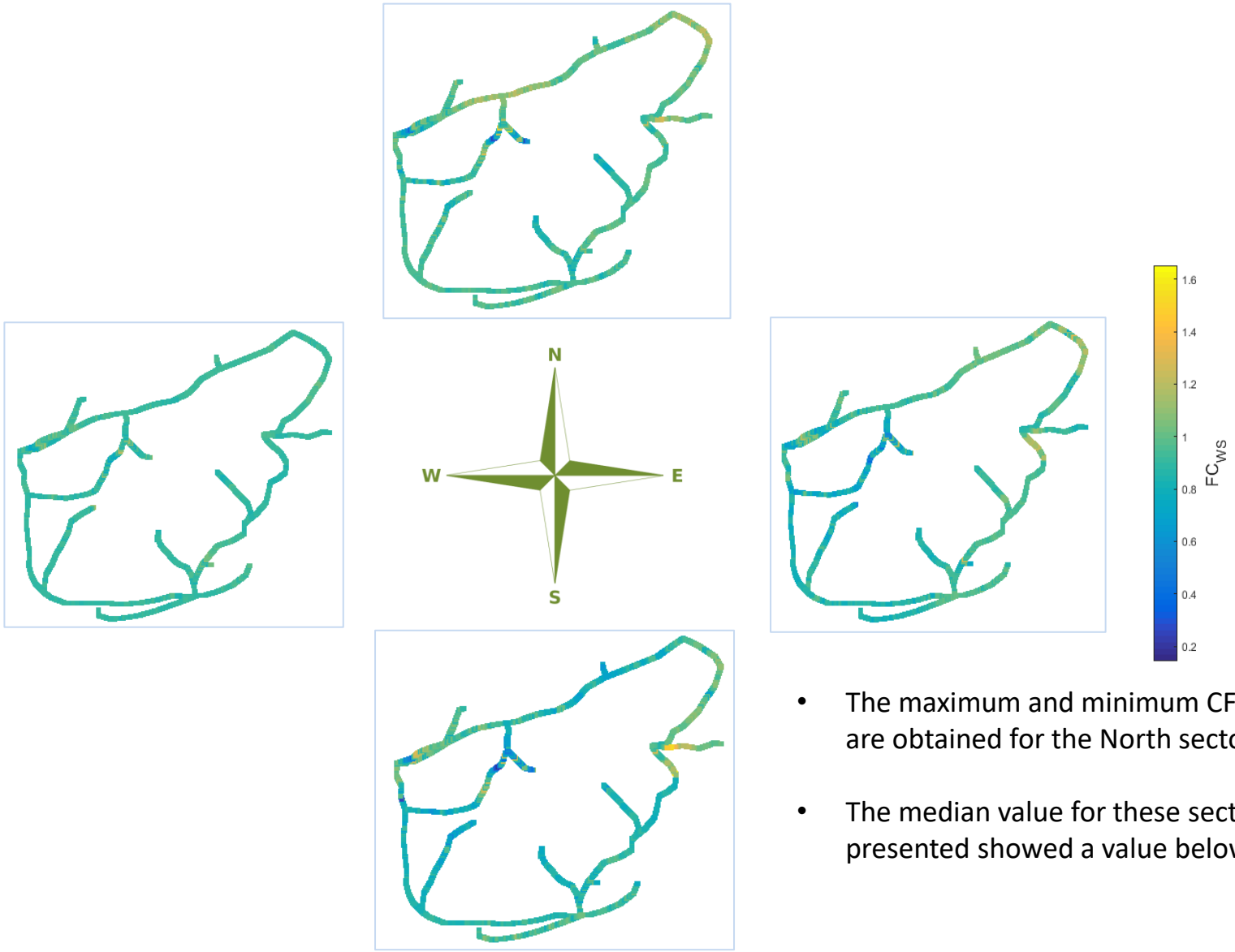
Domains of simulation (NWP-CFD coupling)



NWP: Fifth generation model (MM5) model
Domains: D1 – 15 km; D2 – 3 km
Hourly resolution

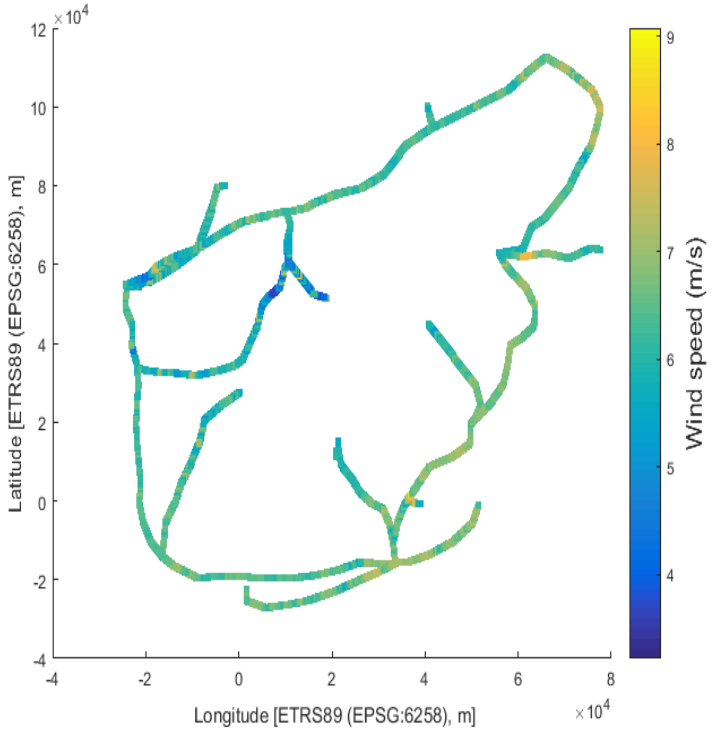
CFD: WindSim software
Several domains (due to limitation in the maximum number of cells of the software) with 30 meters spatial resolution.

Results – Wind speed CF

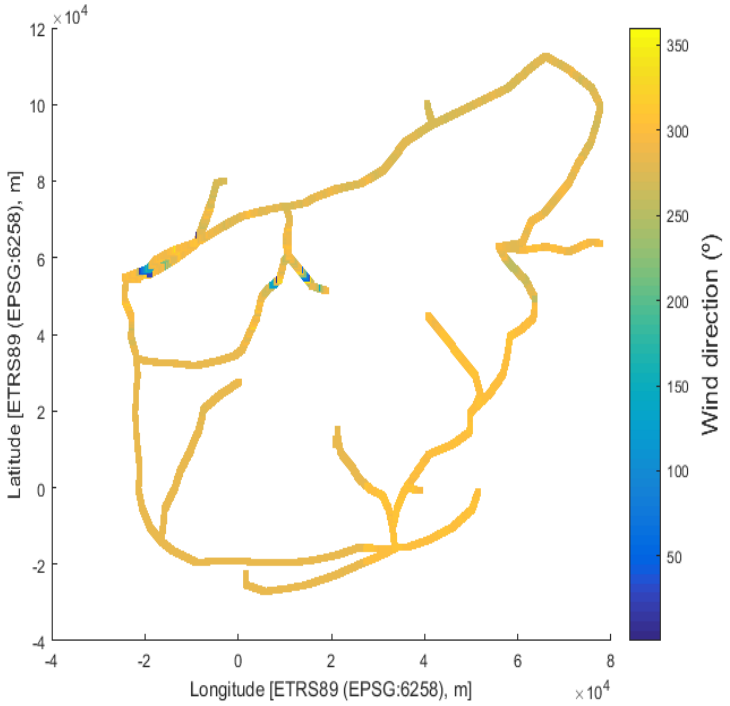


- The maximum and minimum CF values are obtained for the North sector.
- The median value for these sectors presented showed a value below 1.

Results – Average fields

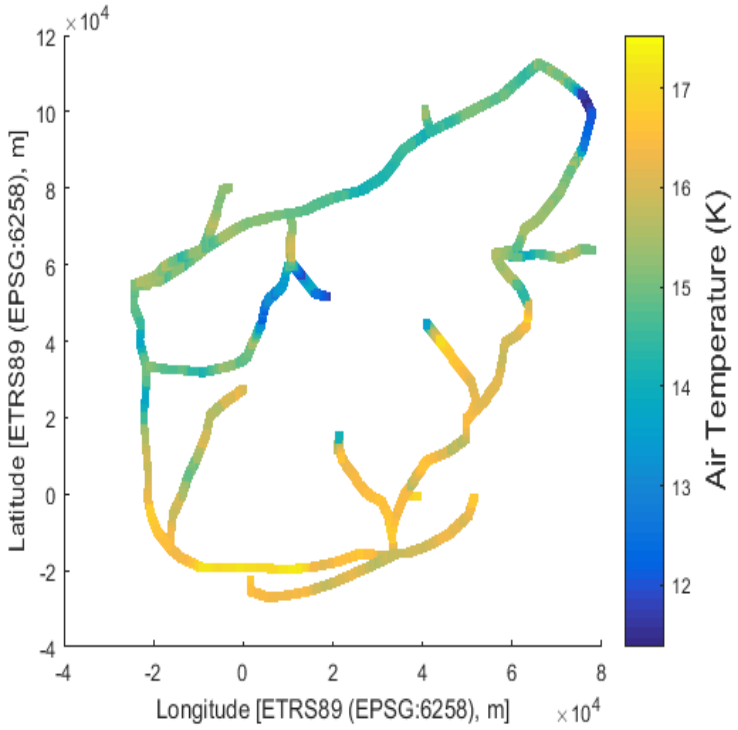


Average wind speed

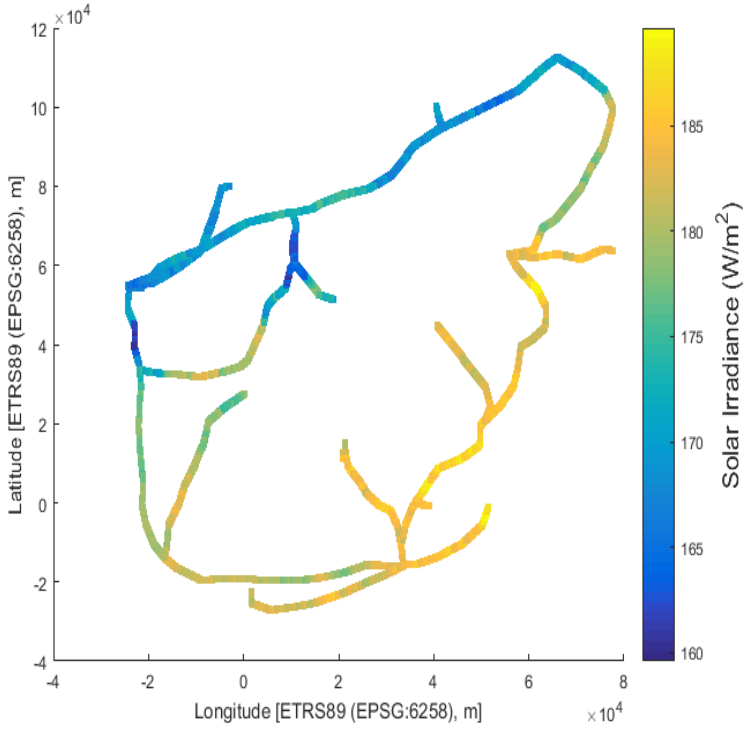


Average wind direction

Results – Average fields



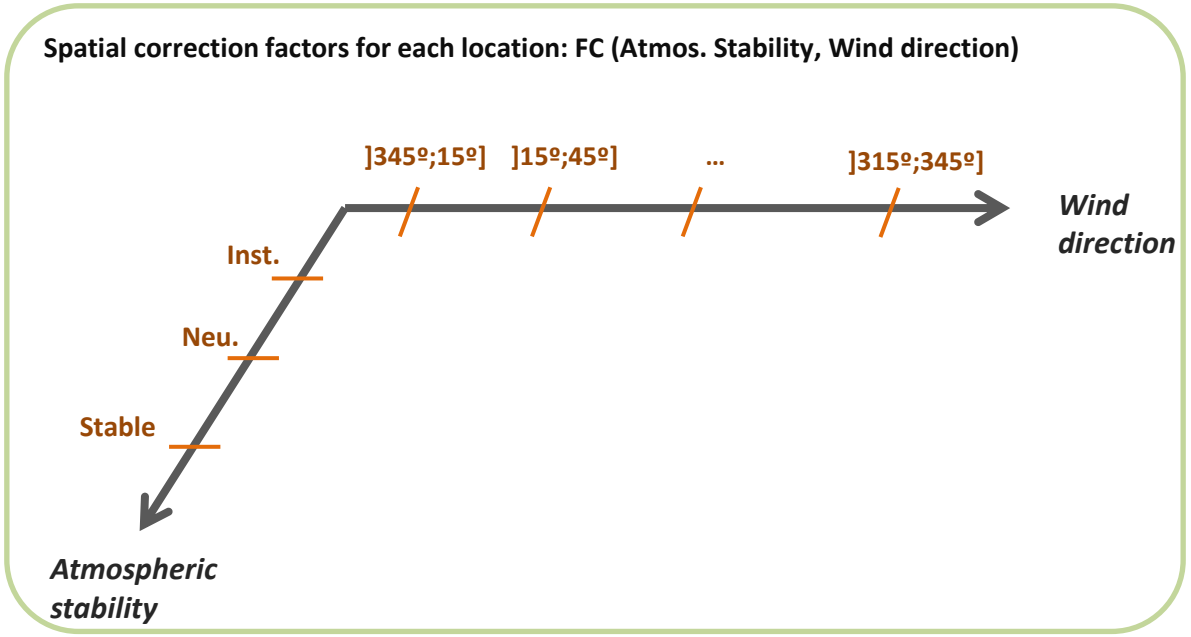
Average air temperature



Average solar irradiance

Final remarks

- **The methodology** implemented **enables** to provide data for **supporting the day-ahead market** operational decisions.
- A **full validation of the methodology** is still **required.**
  - As the approach was only partially validated using data from Perdigão experiment (near 25 anemometric stations available).
- The identification of the **benefits** of **other relevant meteorological parameters** (e.g., atmospheric stability) should be assessed to improve the results obtained using catalogues.



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Further information available at: https://optigrid.lneg.pt

(Deliverable D2.2 - Meteorological forecast data – Coupling NWP and CFD Modeling. Merging the datasets)

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