



Study of the impact on offshore wind energy of frequent events with high dust concentration

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PLOCAN Plataforma Oceánica de Canarias



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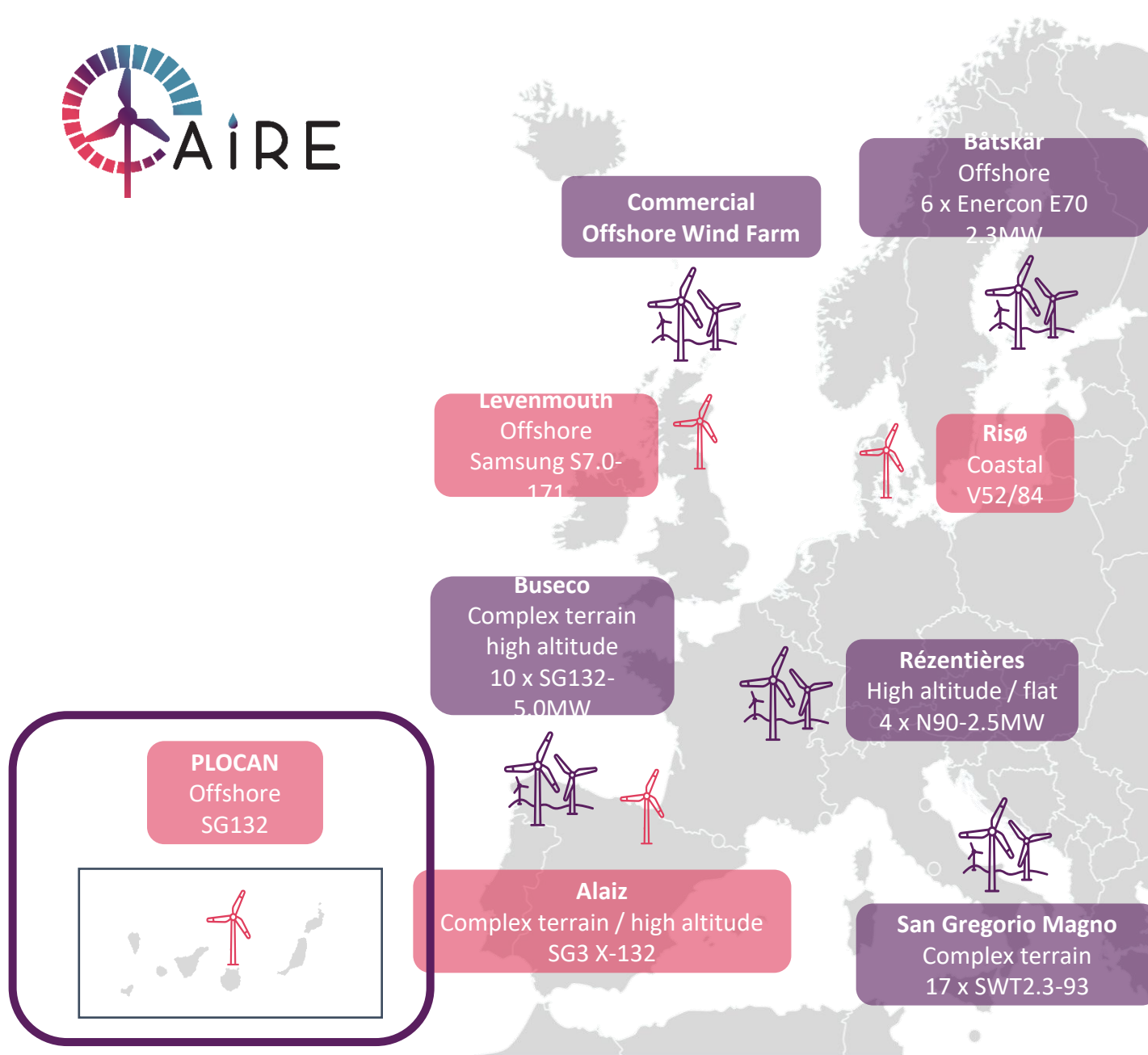


Horizon Europe Project (2023-2026)

How **site location** and **climate conditions** affect wind turbine and wind farm operation and design?

AIRE makes a **holistic approach** to:

- Study the effect that variables such as **precipitation** and **dust** have on wind turbines and wind farms operation.
- Develop new models and tools including the findings of the measurement campaigns
- Improve wind turbine and wind farm design and control.



Wind
Precipitation
Dust
Dust
Wind turbine
operational data

Motivation

- AIRE project aims to develop and improve models and tools to reduce the impact of weather conditions on wind energy
- High **dust concentration** can increase blade roughness and reduce power performance
- Previous works study numerically the effect of sand depositions on airfoil performance



Motivation

- Objective: study **experimentally** the impact of subtropical climate conditions on wind energy efficiency
- We have a test site that receives periodically sand from the Sahara desert.
- A lidar and an air quality station are installed, and data are collected since 2023

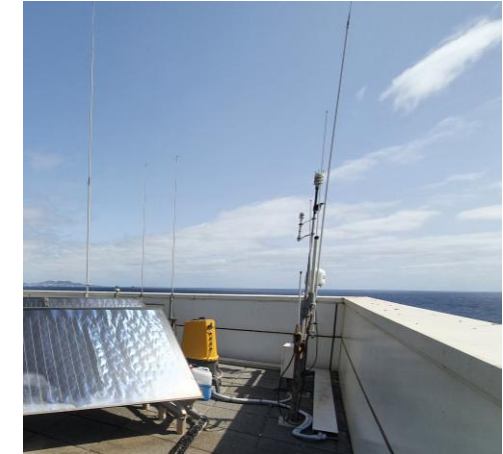
Will high dust concentrations affect wind profile and wind turbine performance ?



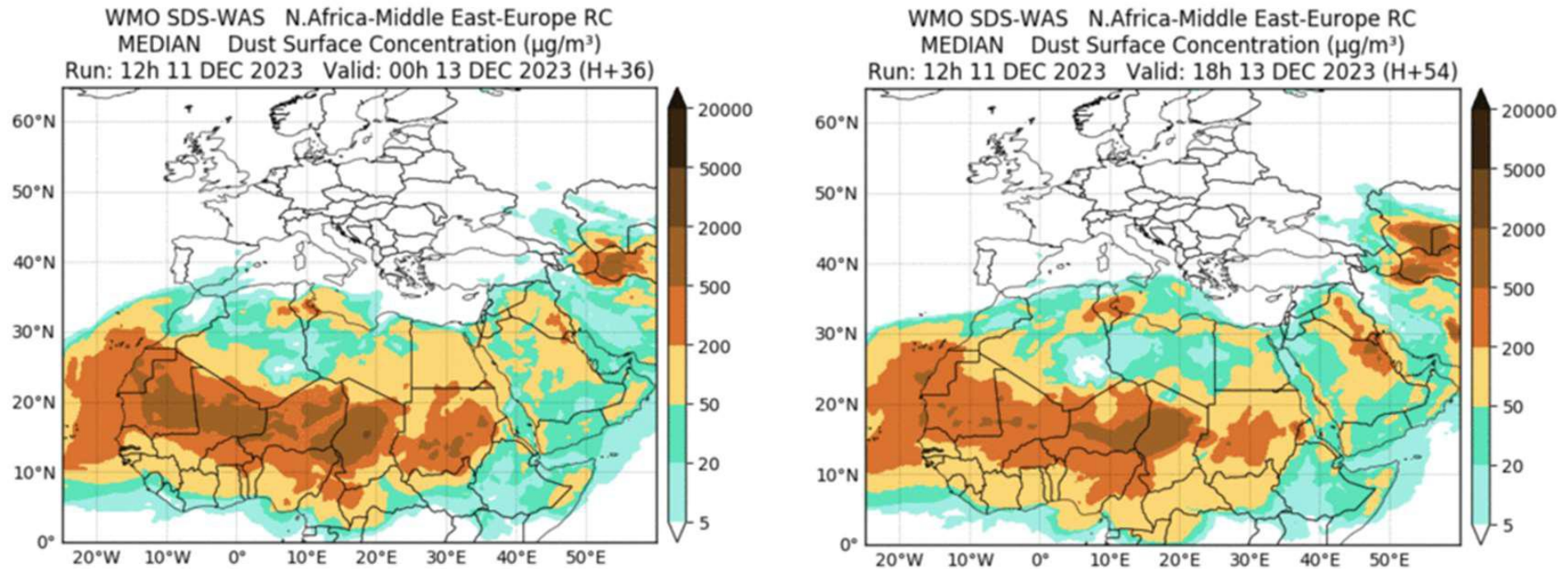
PLOCAN experimental site (5 MW Wind turbine)

Experimental site: PLOCAN (SPAIN)

- Canary islands has frequent events with high dust concentration that comes from the Saharan Desert
- The experimental campaign is performed at PLOCAN's open ocean test site
- Available instrumentation:
 - Air quality station, Kunak air quality monitor model Kunak AIR Pro.*
 - LIDAR, vertical profiling lidar offshore model ZX300M*
- One year 10-minute data



Dust events, examples



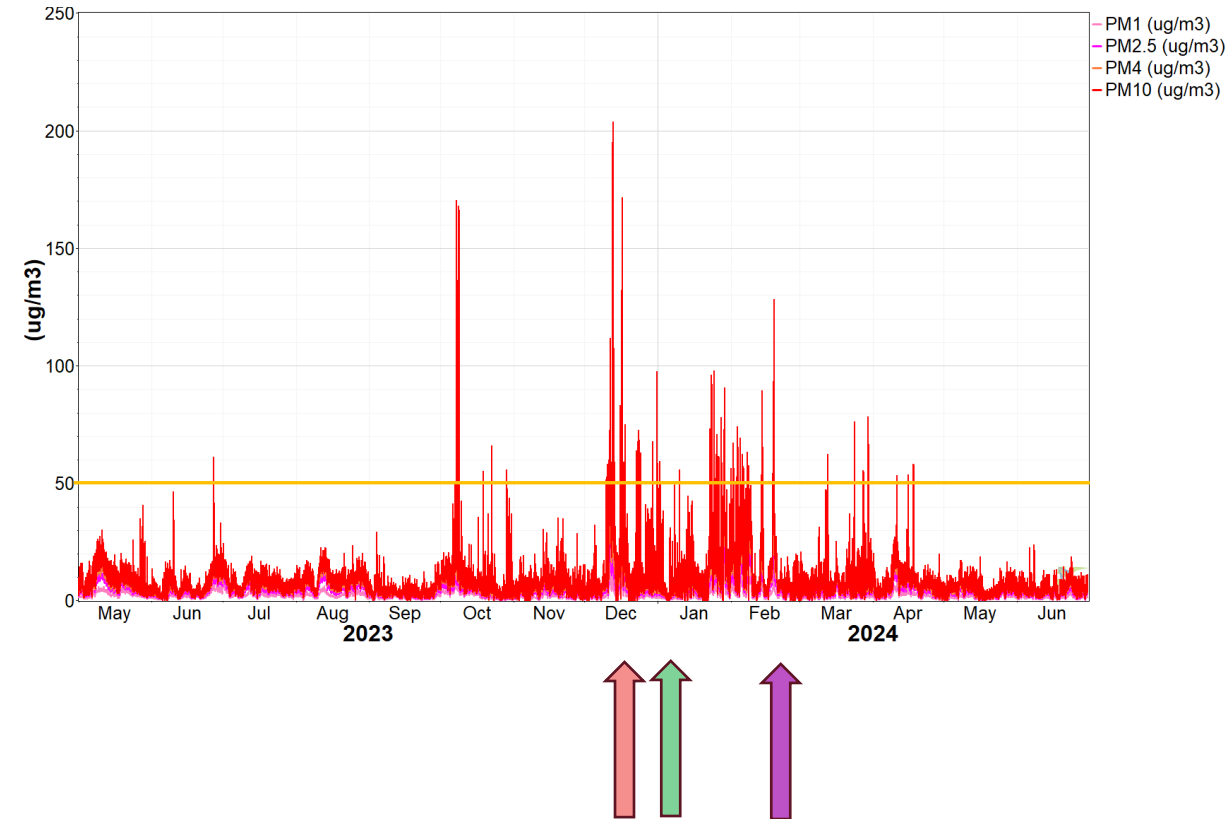
Results of MONARCH (median in $\mu\text{g}/\text{m}^3$) for 13 December 2023 at 00h UTC (left) and 18h UTC (right). Sand and Dust Storm Warning Advisory and Assessment System Regional Center for Northern Africa, Middle East and Europe (SDS-WAS NAMEE RC), jointly managed by the State Meteorological Agency and Barcelona Supercomputing Center.

Dust events: days under study



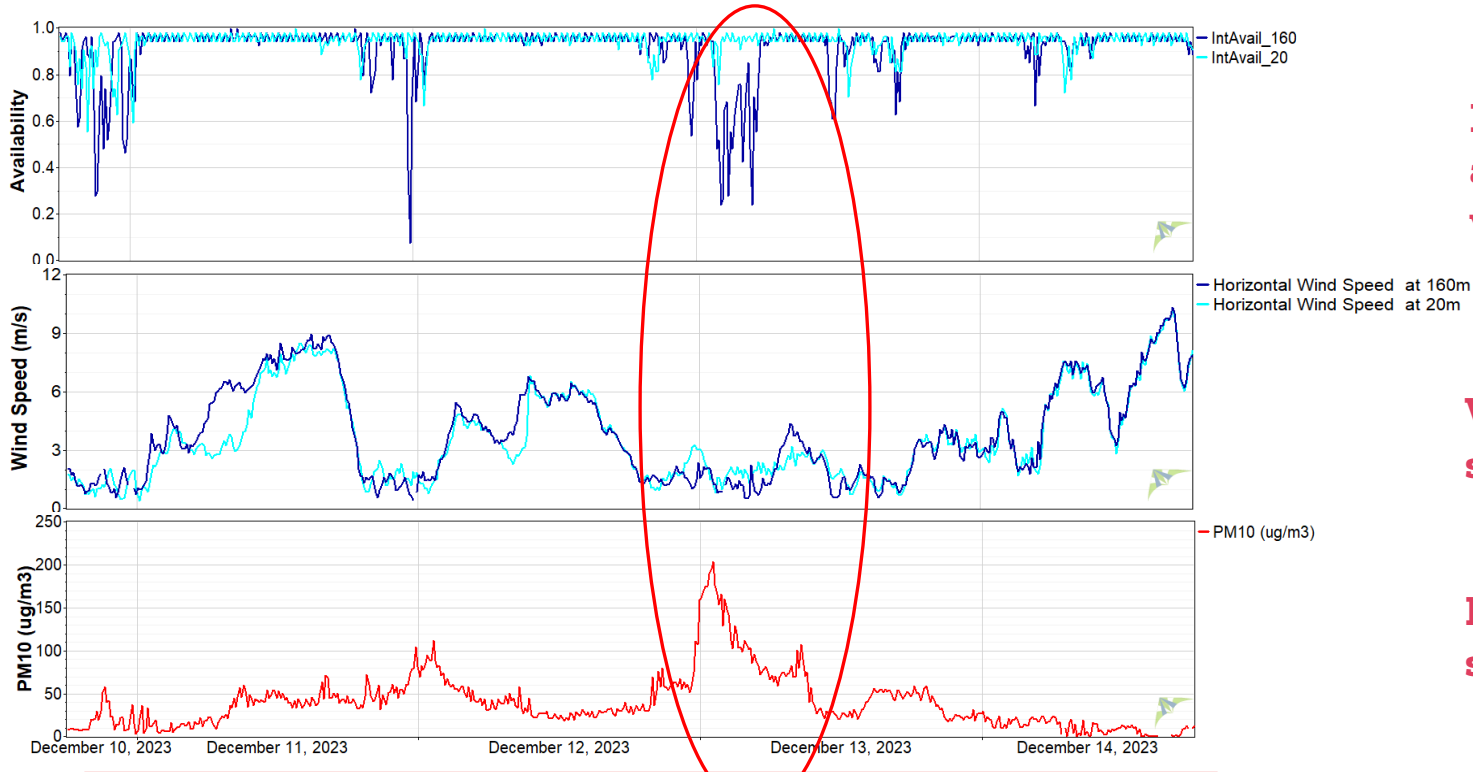
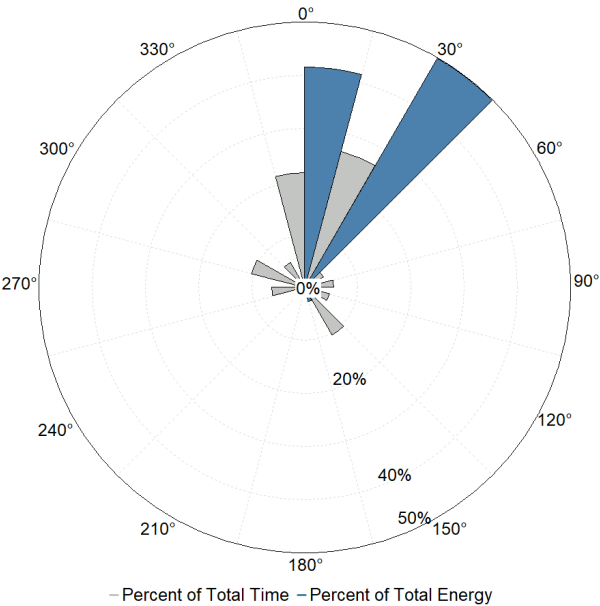
- From May 2023 to June 2024, 21 African dust intrusion events were identified in the Canary Islands
- Two days of special relevance have been selected:

- 1 **13th December 2023** in which the maximum PM10 value was recorded at the PLOCAN station (203.83 $\mu\text{g}/\text{m}^3$)
- 2 **19th February 2024**, where the Canary Islands "swallowed" by a large plume of dust from the Saharan Desert (PM10 of 128.42 $\mu\text{g}/\text{m}^3$)
- 3 **16th and 17th December 2023**, (PM10 of 140 $\mu\text{g}/\text{m}^3$)



RESULTS

13th December 2023



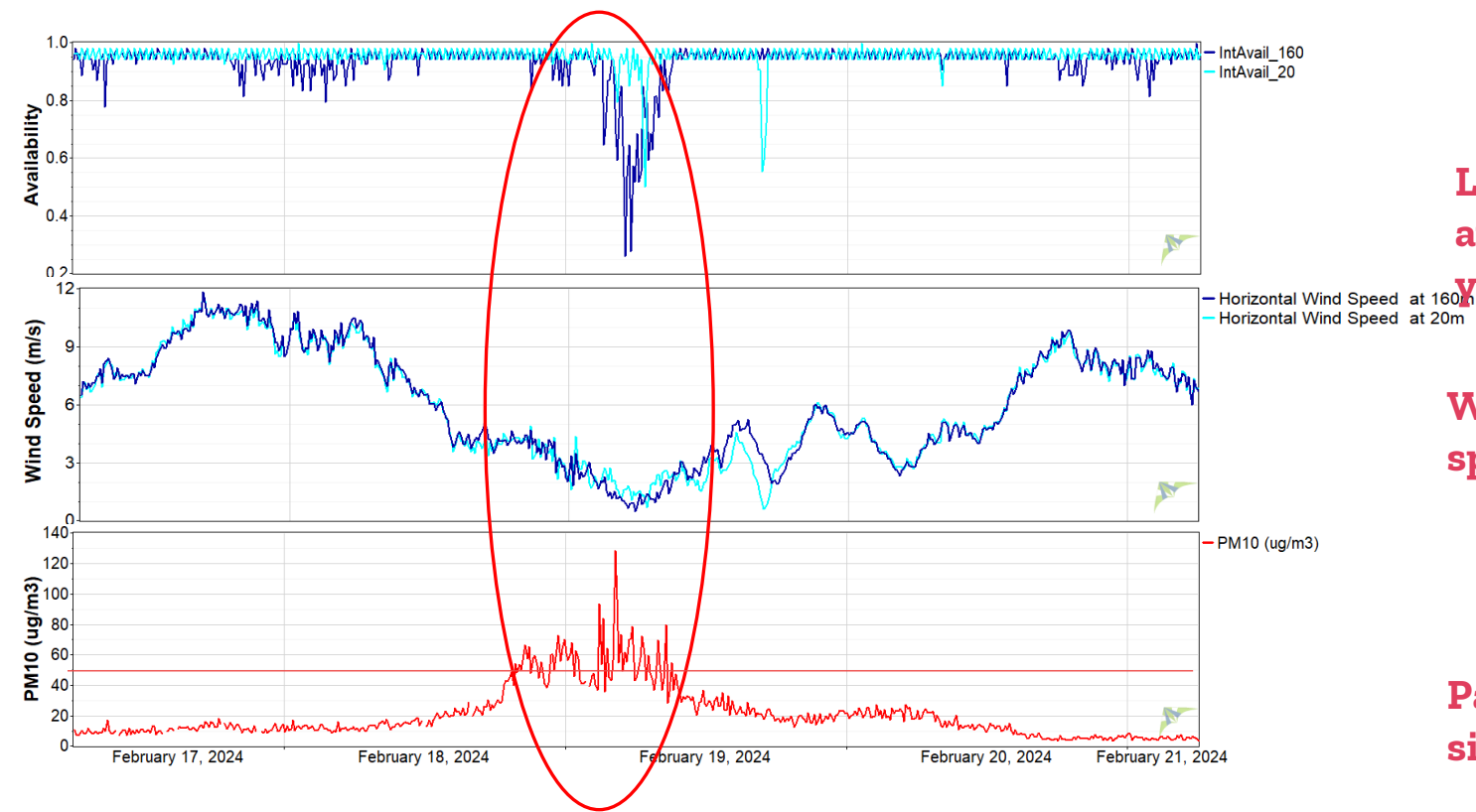
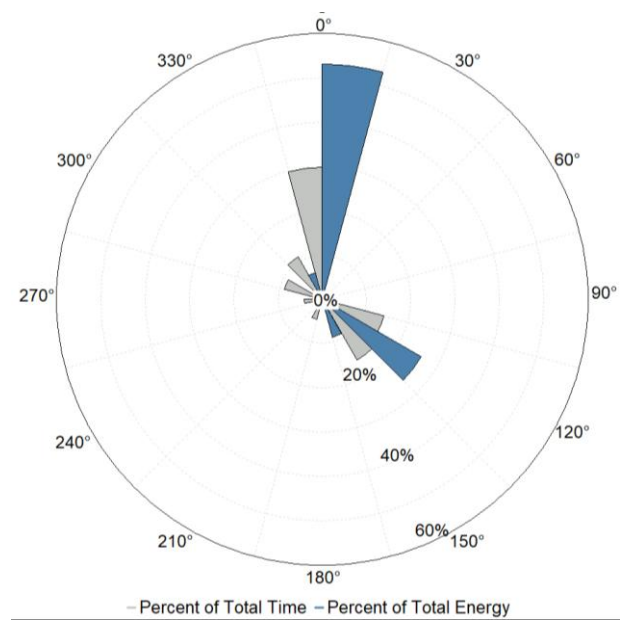
Lidar
availability

Wind
speed

Particles
size

RESULTS

19th February 2024



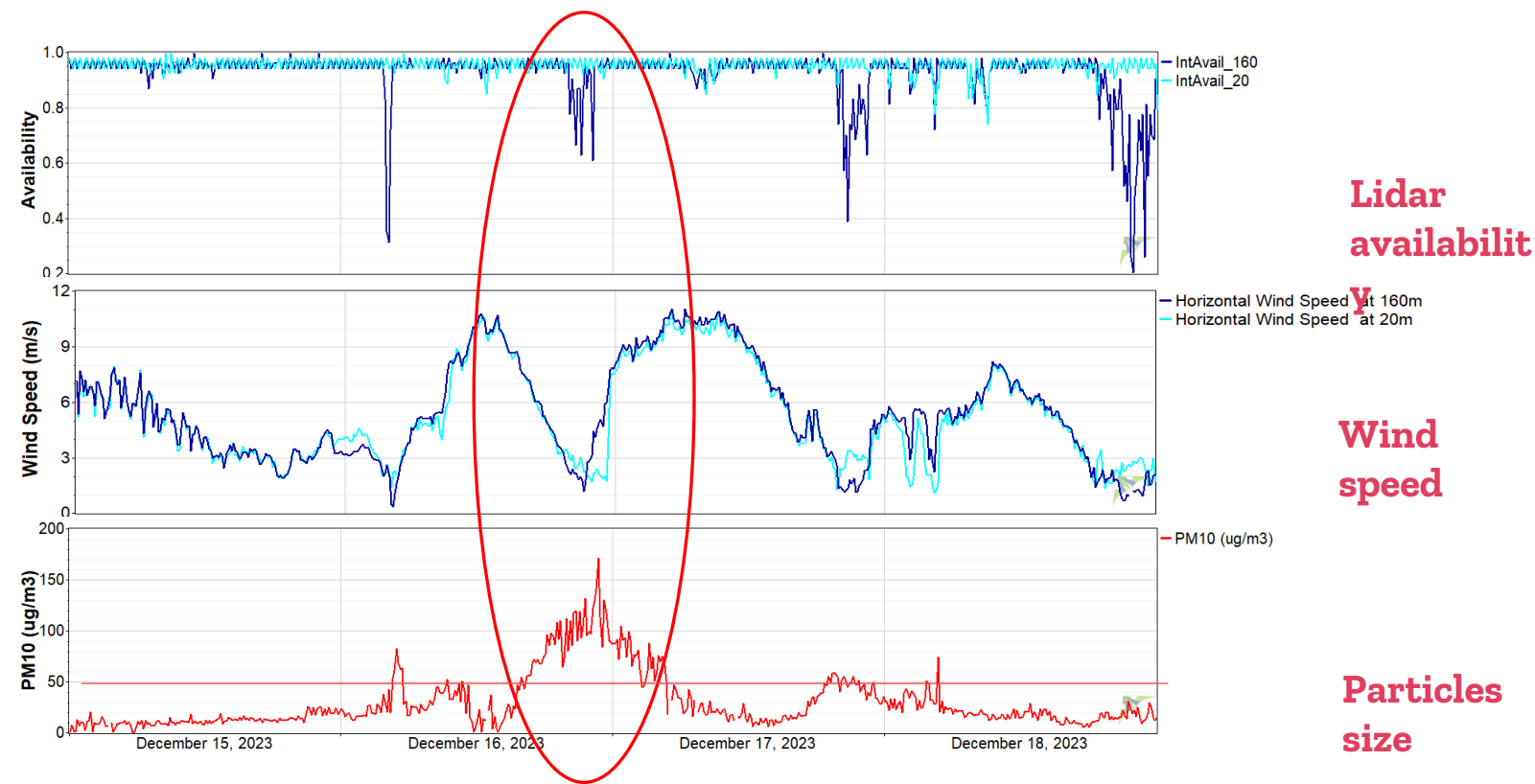
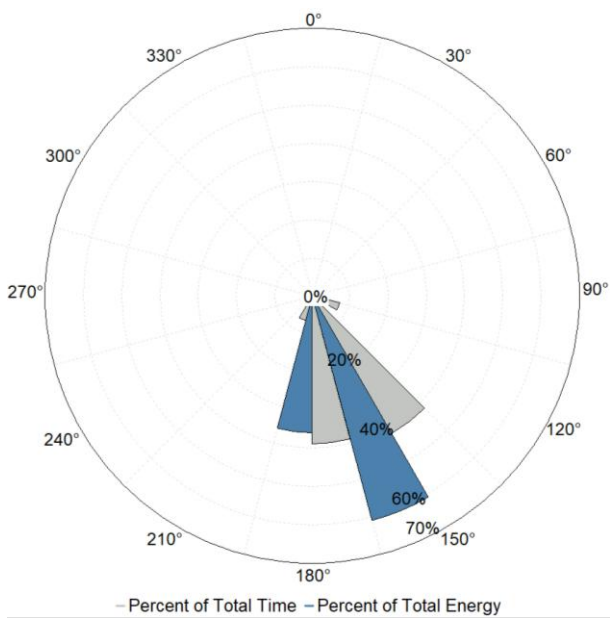
Lidar
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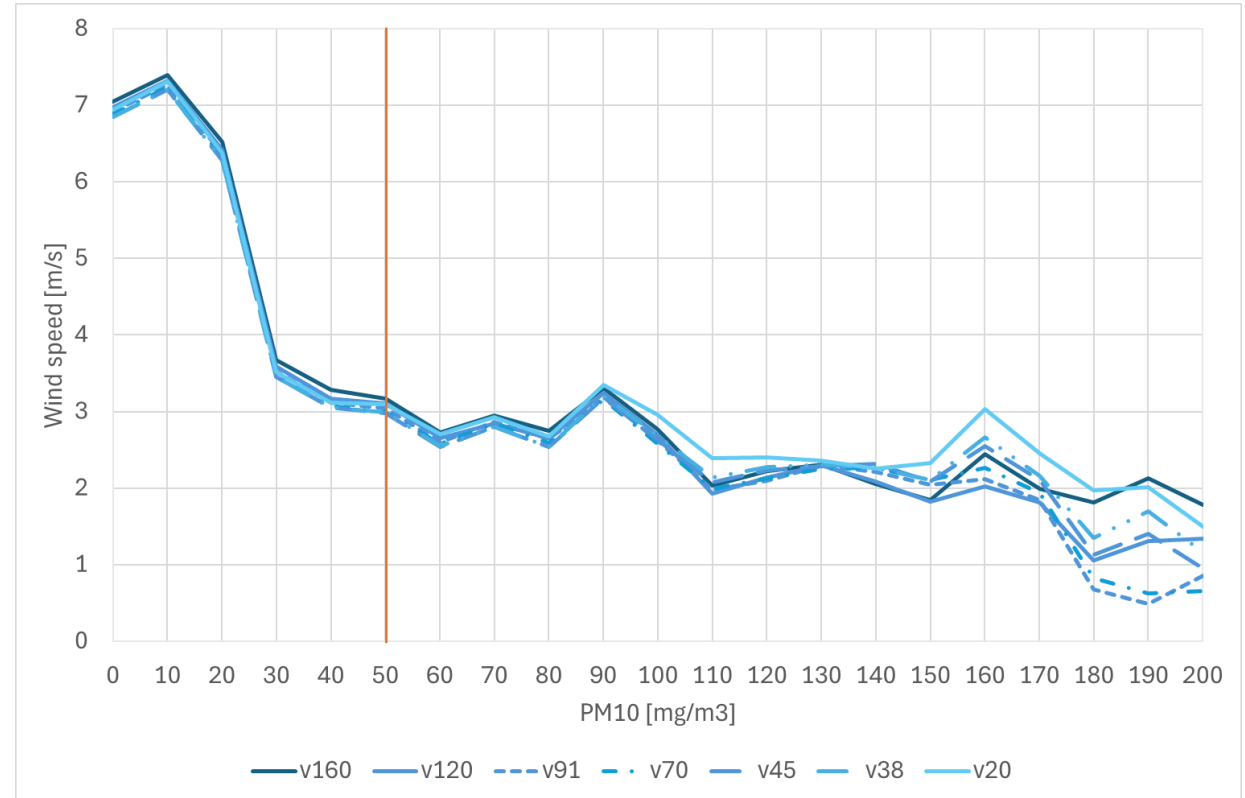
RESULTS

16th-17th December 2023



Wind speed and particles concentration

- All analyzed data from May 2023 to June 2024
- **Mean** wind speed is below 3 m/s
- The wind turbine was not in operation

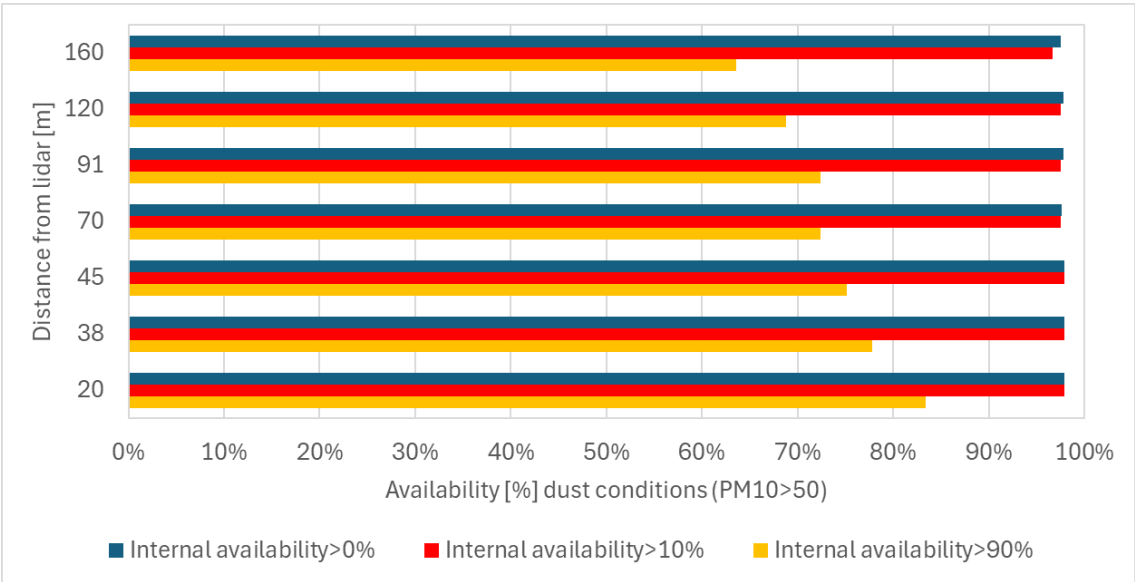
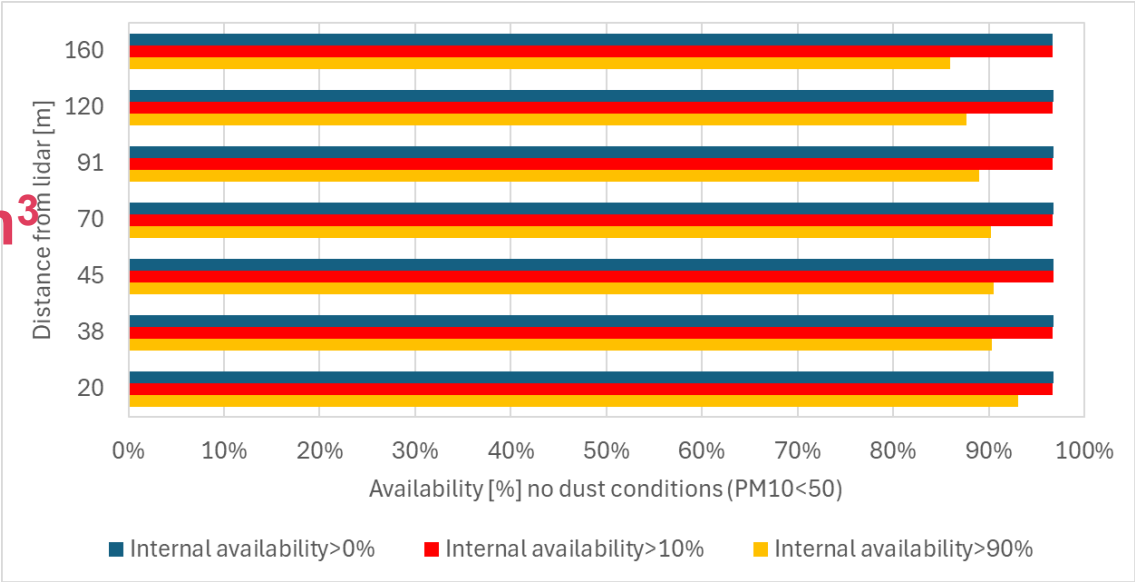


LIDAR availability

PM10<50µg/m³

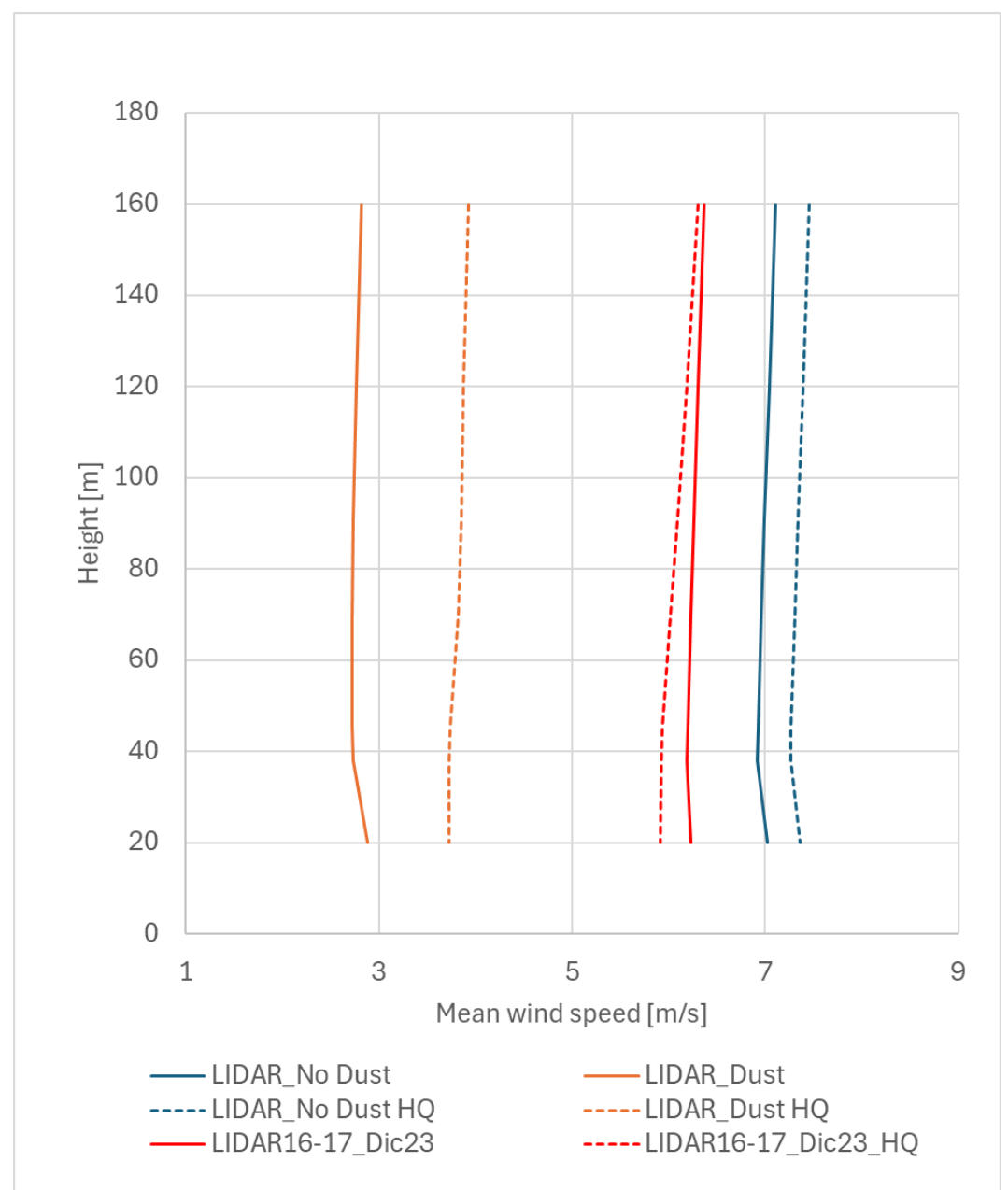
Lidar availability drops considerably for all the heights when dust events are present.

PM10>50µg/m³



Wind profiles

- In general, at high concentrations of particulate matter in the air ($PM_{10} > 50$) **wind speeds are much lower** than in situations where this does not occur.
- The **shape of the vertical wind profile is maintained** in both haze and non-haze situations.
- In general, when the internal availability of all LIDAR levels is higher, the mean wind speeds are also higher.



Conclusions & Future work

- In general, episodes of **high particle** concentration in the Canary Islands occur at **low wind speeds**, so in these situations the wind turbine is at a standstill.
- The internal availability of the lidar is reduced in situations of high concentrations of particles in the air.
- In one year of records, only one episode has been detected with speeds above 5 m/s, in which the predominant wind direction was from the southeast → **extend the study to other sites**
- **Blade status** is inspected using drones and replication resins → SCADA data are being analyzed to see the effect of dust deposits on the **power production**



Thank you



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