



# STANDARDIZED ASSESSMENT OF METEOROLOGICAL DATA FROM FINO PLATFORMS

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# Content



- 1) Introduction - FINO-Wind research project
- 2) Faster availability – Data quality check with Validatf
- 3) Better data – Wind speed correction for FINO1, 2 and 3 mast effects
- 4) Outlook - Wake field situations at FINO1, 2 and 3
- 5) Conclusions

# 1) FINO-Wind research project



- funded by ***Federal Ministry for Economic Affairs and Energy*** and ***Projektträger Jülich***



- December 2012 – April 2016

- joint research project, coordinated by ***Deutscher Wetterdienst***



- Project homepage: <http://www.dwd.de/finowind>

# 1) FINO-Wind research project

- develop standards to validate wind data from the FINO masts → quality validation tool
- estimate external influences
- to improve the comparison of the wind conditions measured at these platforms
- to establish a consistent archive of the data in the FINO database of the *Federal Maritime and Hydrographic Agency (BSH)*
- will improve the knowledge of the marine ambient conditions at the three locations
- to develop proposals how to design measurement structures and analysis methods accordingly



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## 2) Faster availability – Data quality check with *Validatf*



### *Validat*

- new comprehensive quality checking routine
- is subdivided into separate modules with ever more stringent criteria, separated for every element

### History:

- originally developed and operationally used by the DWD since years to validate marine meteorological data
- system based on the high quality control tool (hqc) as well as on a data validation and data completion system
- project FINO-Wind provided new challenges
  - Validat has been completely revised and adjusted to the new purposes of profile measurements: ***Validatf***

# Checking Routine *Validatf*

- value range depends on the element in question, defined beforehand in an external configuration file
- after the successful completion of every sequence, the data are assigned standardized quality flags

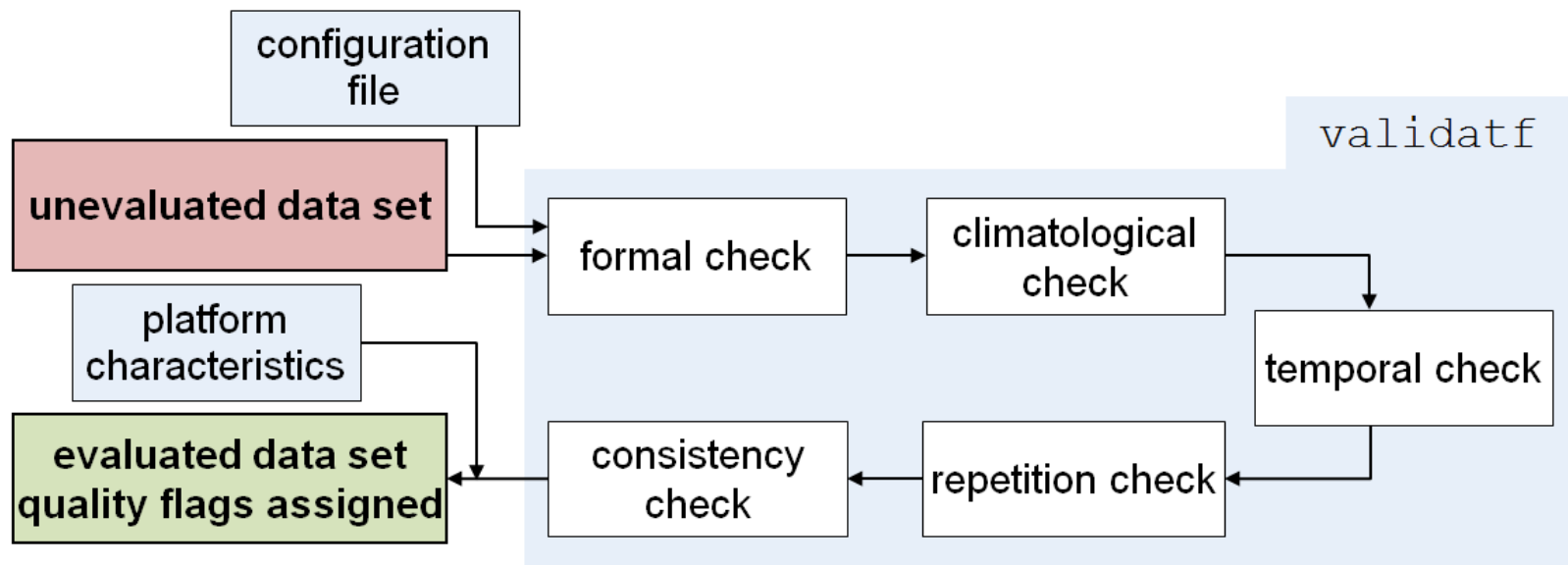


Figure: Sequence of data validation checks in Validatf

# Validatf - Modules

- **Formal check:** Are there any forbidden characters?

- ✓ value ranges are valid worldwide

wind direction 0 ... 360°

wind speed 0 ... 60 m/s

air temperature -50 ... 60° C

air pressure 860 ... 1055 hPa

- **Climatological check:** Is the value reasonable with regard to climate range of the area?

- ✓ based on 30-year climatology of ERA\*-Interim reanalysis
- ✓ climatology boundaries defined for every parameter, geographical position of the platform and month of the year

#	Min	Max	Avg	Stdd	DateMin	DateMax
01	-87	112	41	3.14	19870111	20070109
02	-68	106	36	2.94	19960209	20020202
03	-48	128	49	2.35	19870304	19890328

\*) ERA-Interim is a global atmospheric reanalysis from 1979 to present. It is produced with a 2006 version of the IFS (Cy31r2) and continues to be updated in real time [source: <http://www.ecmwf.int/en/research/climate-reanalysis/era-interim>]



# Modules of Validatf

- **Temporal check**
  - ✓ reveals outliers
  - ✓ at least three fixed-date values are needed

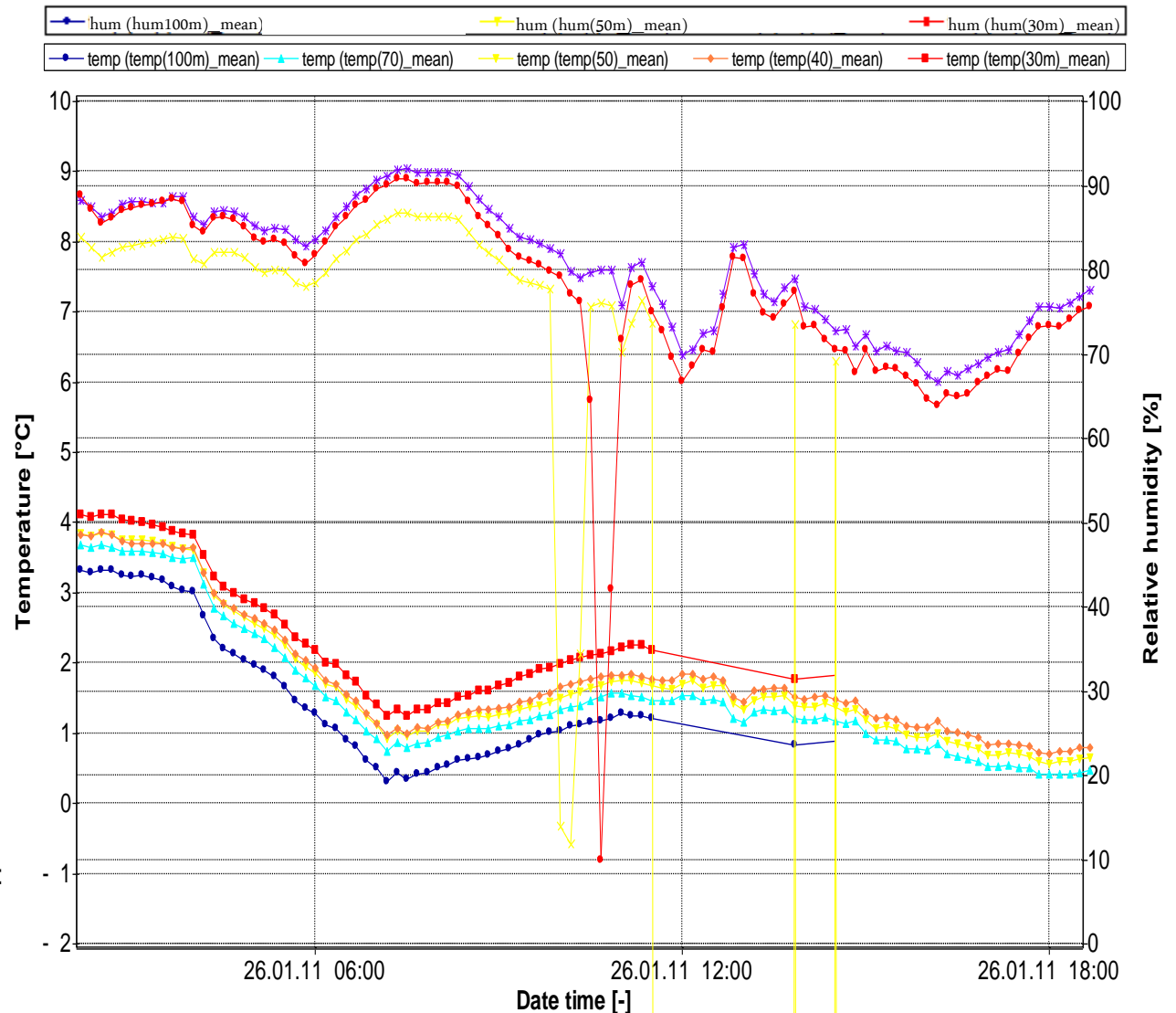


Figure: example of temporal check: relative humidity in heights of 30 m and 50 m show significant outliers.

# Modules of Validatf

- **Repetition check**

- ✓ examine whether a value remains unchanged over an unusual long period of time

- ✓ two limits are defined:

REPEAT1: possible irregularities

REPEAT2: values are flagged as wrong

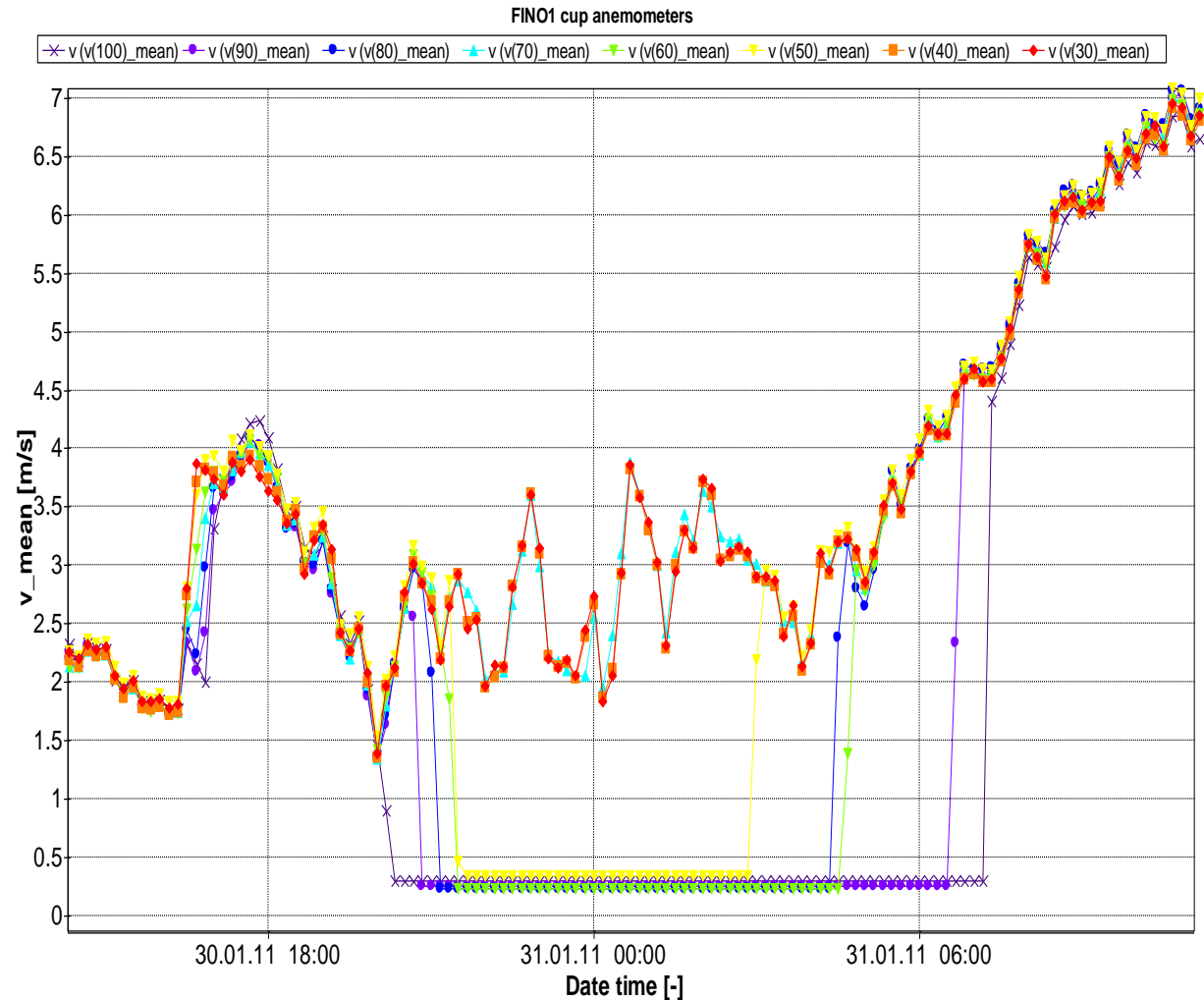


Figure: example of repetition check: Icing of cup anemometers at different heights.

# Modules of Validatf



- **Consistency check**

- ✓ a number of sub-checks is performed to verify the different elements against each other in various combinations and for different criteria
- ✓ based on general principles of physics
- ✓ for example: dew point is not allowed to be higher than the air temperature

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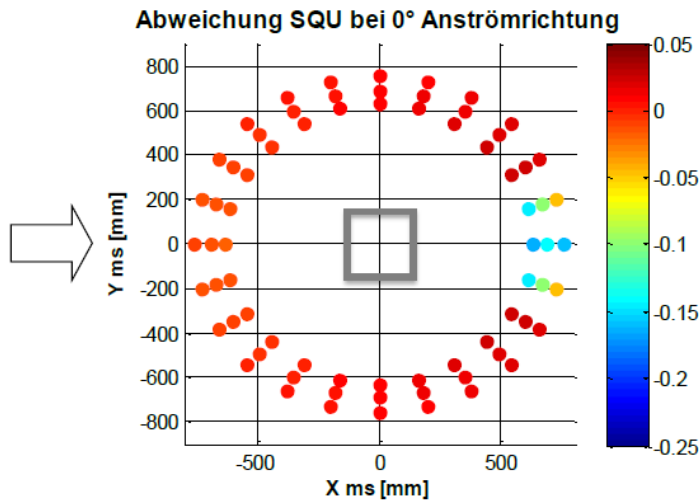
### 3) Better data – Wind speed correction for FINO1, 2 and 3 mast effects



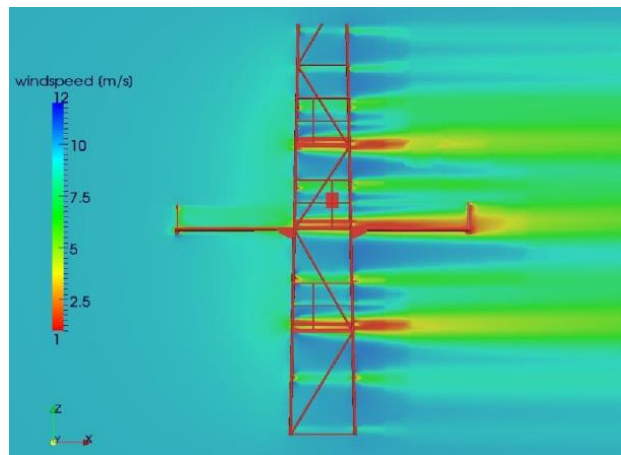
Development of a wind speed correction matrix

- for **every degree wind direction**
  - and **every measurement height**
  - for **every FINO platform**
  - with 5 different methods
  - intensive validation of results for every FINO platform
- ⇒ **Determination of the correction method to be applied at each platform individually**

### 3) Better data – Wind speed correction for FINO1, 2 and 3 mast effects



**Wind tunnel measurements.**  
Wind speeds around the square model, normalized with the undisturbed flow.



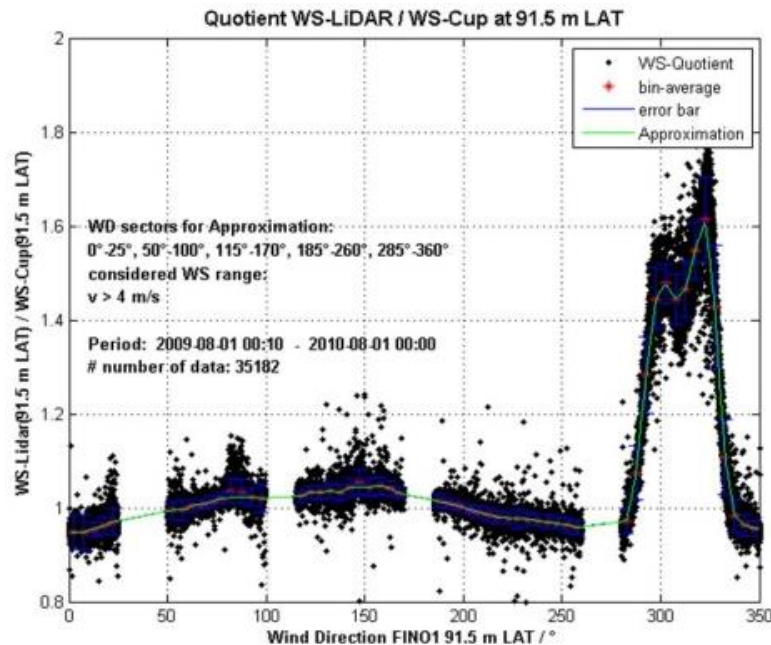
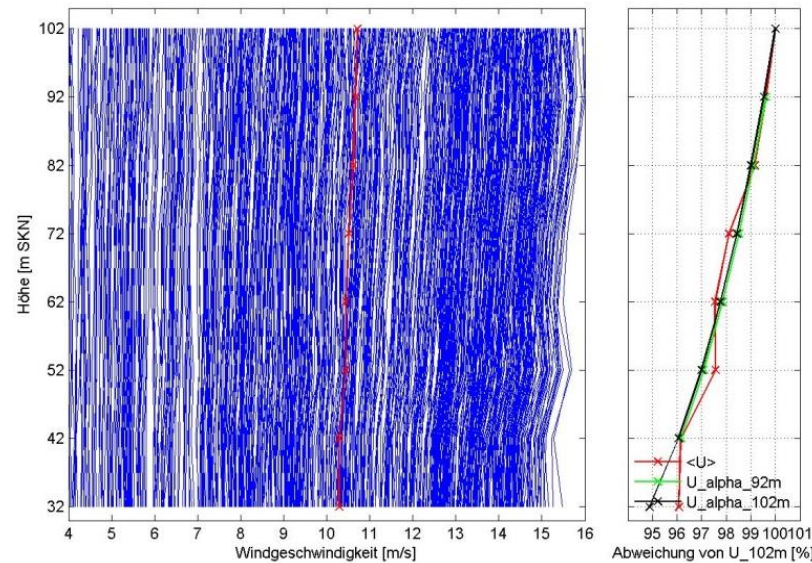
**Computational Fluid Dynamics (CFD)<sup>1</sup>.**

Calculation of wind speed reduction

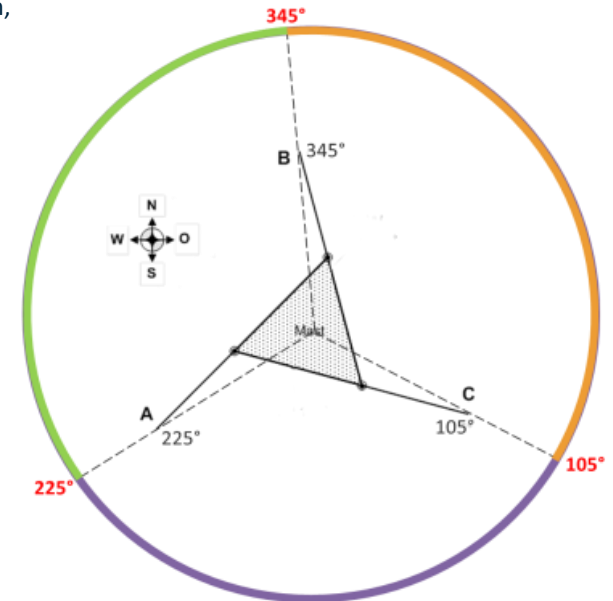
[1] F. Wilts, B. Canadillas, F. Kinder, T. Neumann, CFD calculations of FINO1 mast effects, CEWE 2014, Hamburg.

## Uniform Ambient Mast flow correction (UAM)<sup>2</sup>.

[2] A. Westerhellweg, T. Neumann, V. Riedel, FINO1 Mast Correction, DEWI-Magazin No. 40, February 2012.



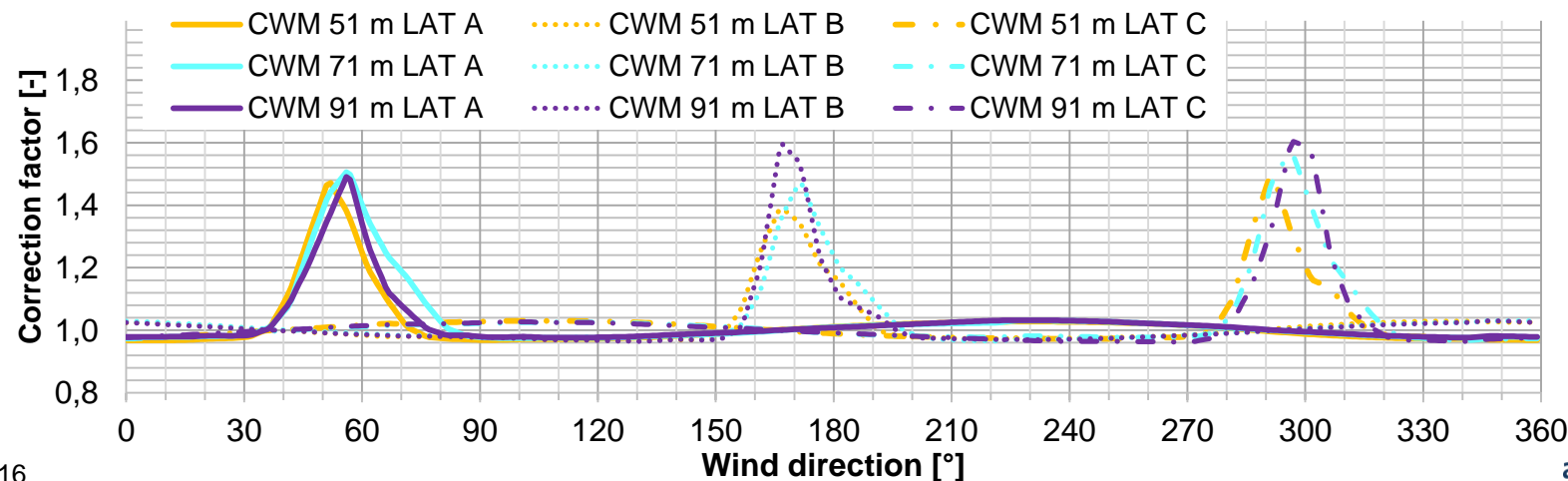
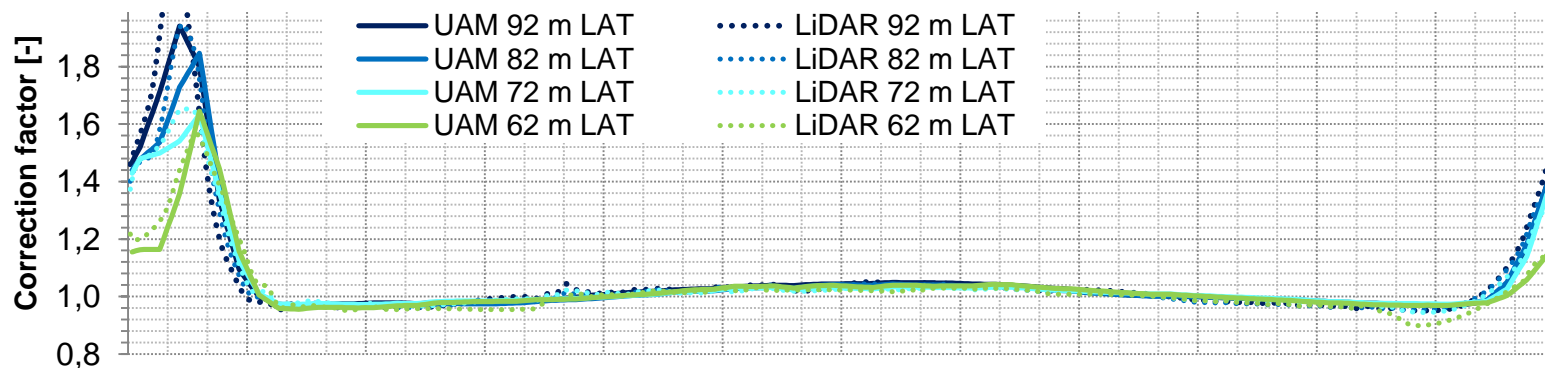
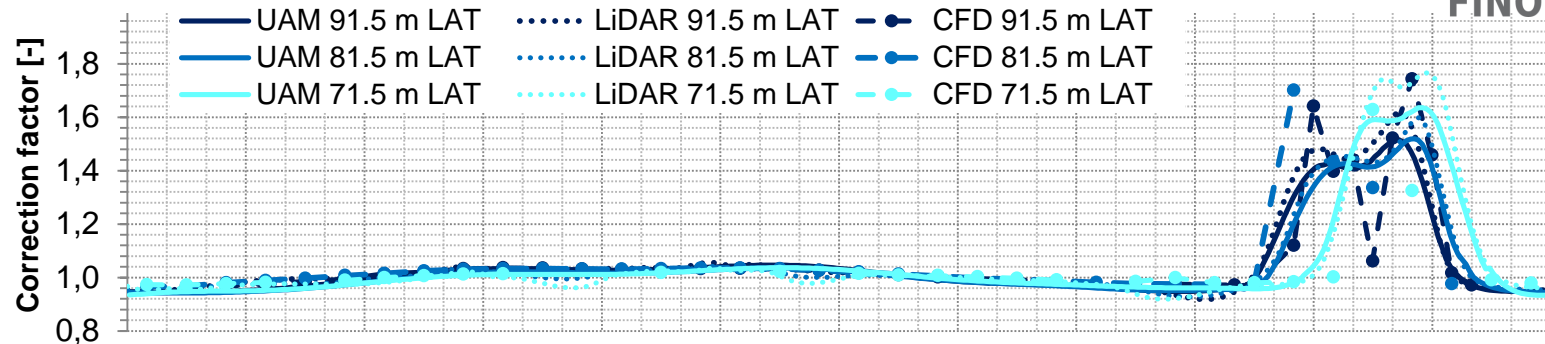
**LiDAR**  
measurements  
(ratio) with cup  
anemometer at  
the same height.



## Composed wind speed method (CWM).

Triangular shaped mast at FINO3 with booms for cup-anemometers at three different directions from the mast.

# Mast correction



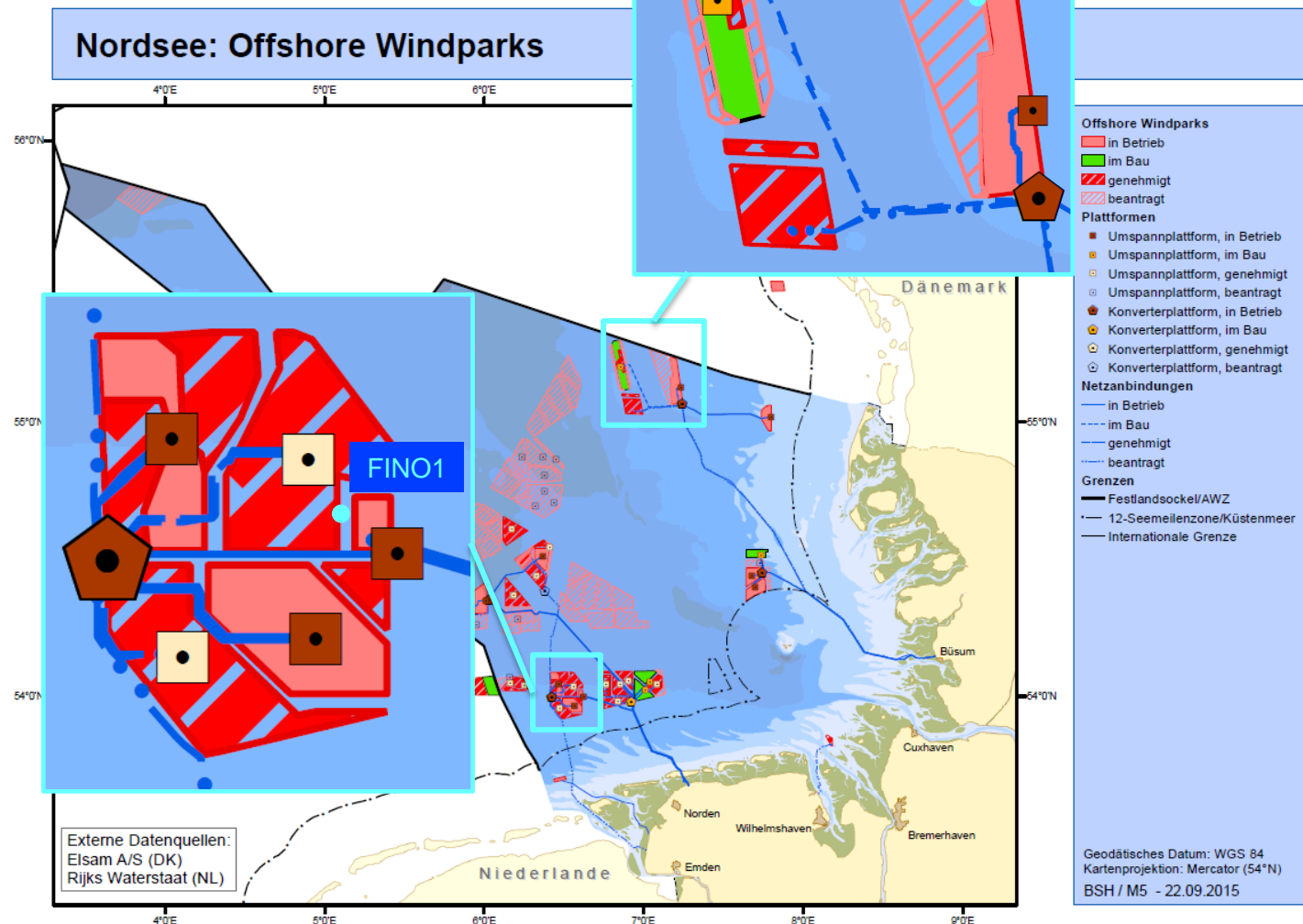


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# 4) New challenge – Wake field situations at FINO1 and 3



<http://www.bsh.de/de/Meeresnutzung/Wirtschaft/CONTIS-Informationssystem/index.jsp>

## FINO1:

Wind parks to

- east (alpha ventus, since 2010)
- south west (Borkum Riffgrund, since 2015)
- west (Trianel Borkum, since 2015)

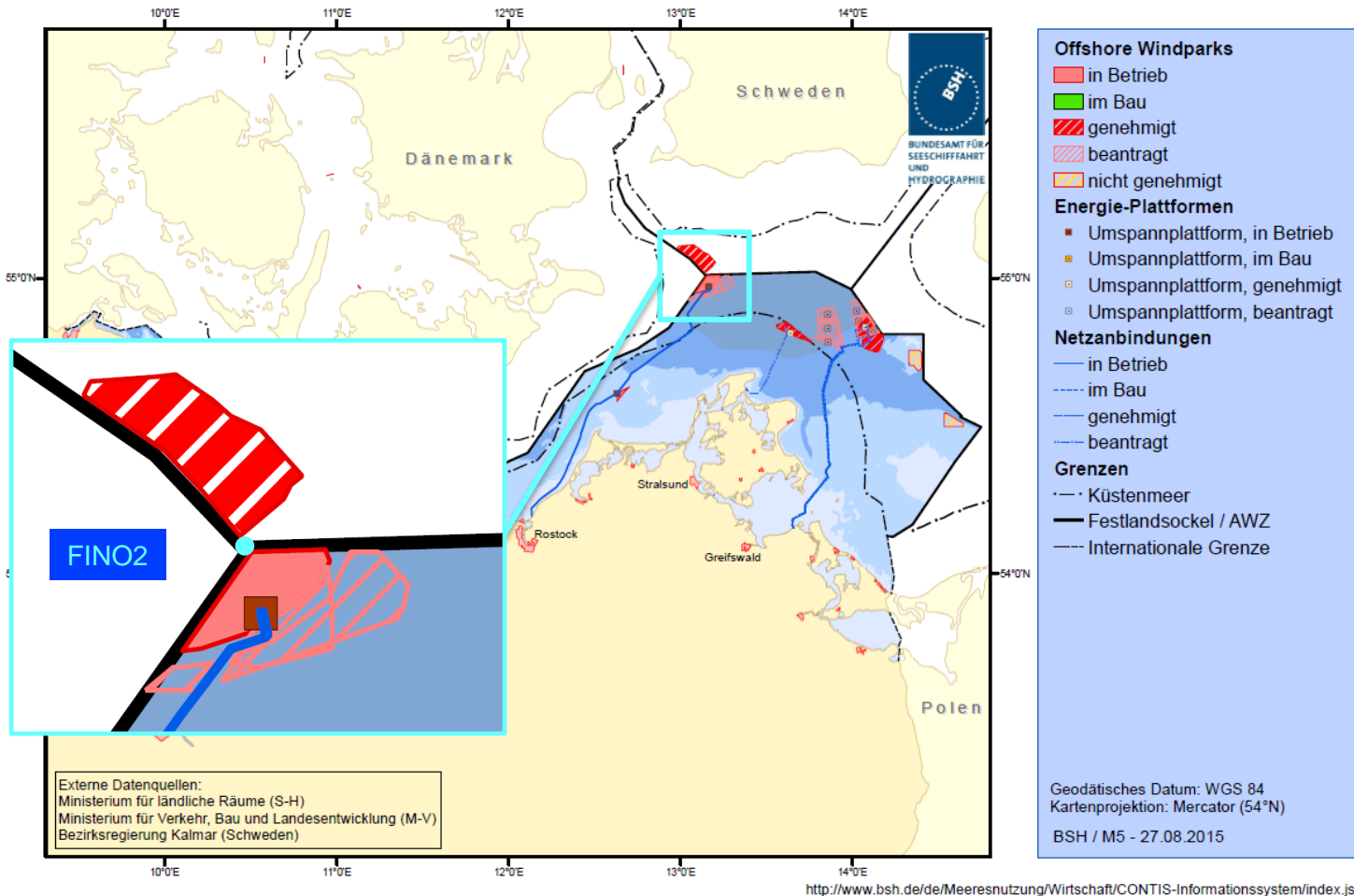
## FINO3:

Wind parks to

- east/south east (DanTysk, since 2014)
- west (Sandbank, under construction)

# 4) New challenge – Wake field situations at FINO2

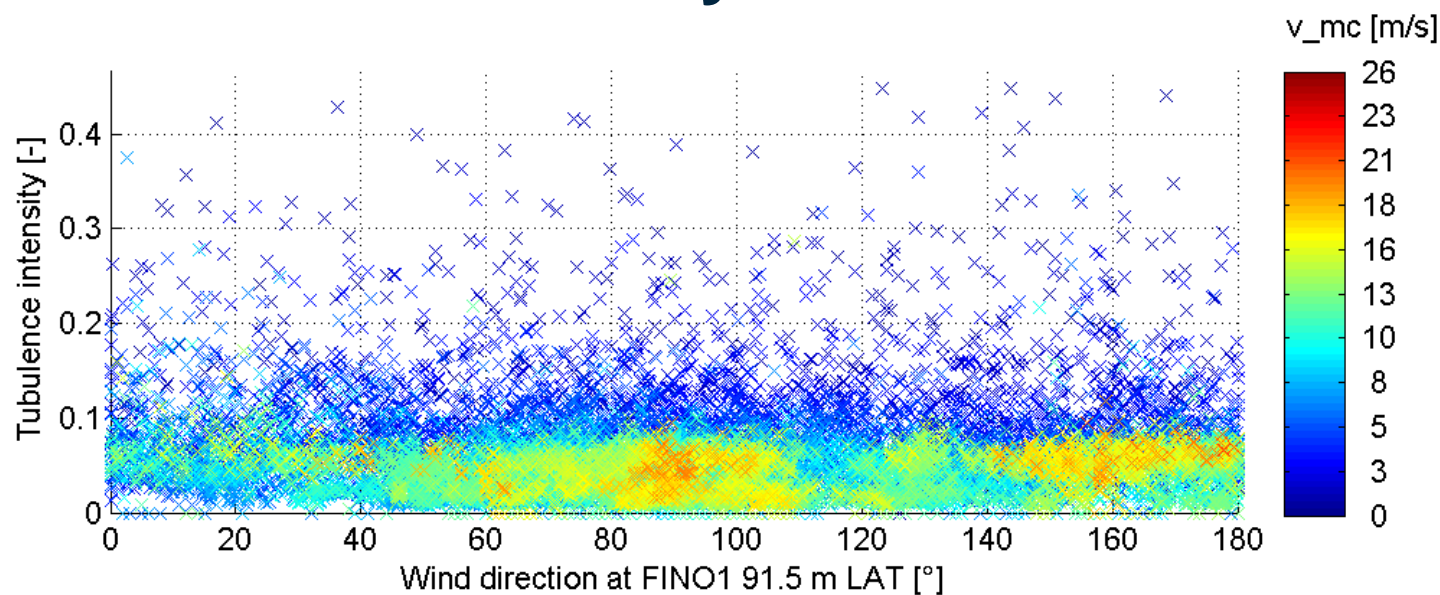
## Ostsee: Offshore Windparks



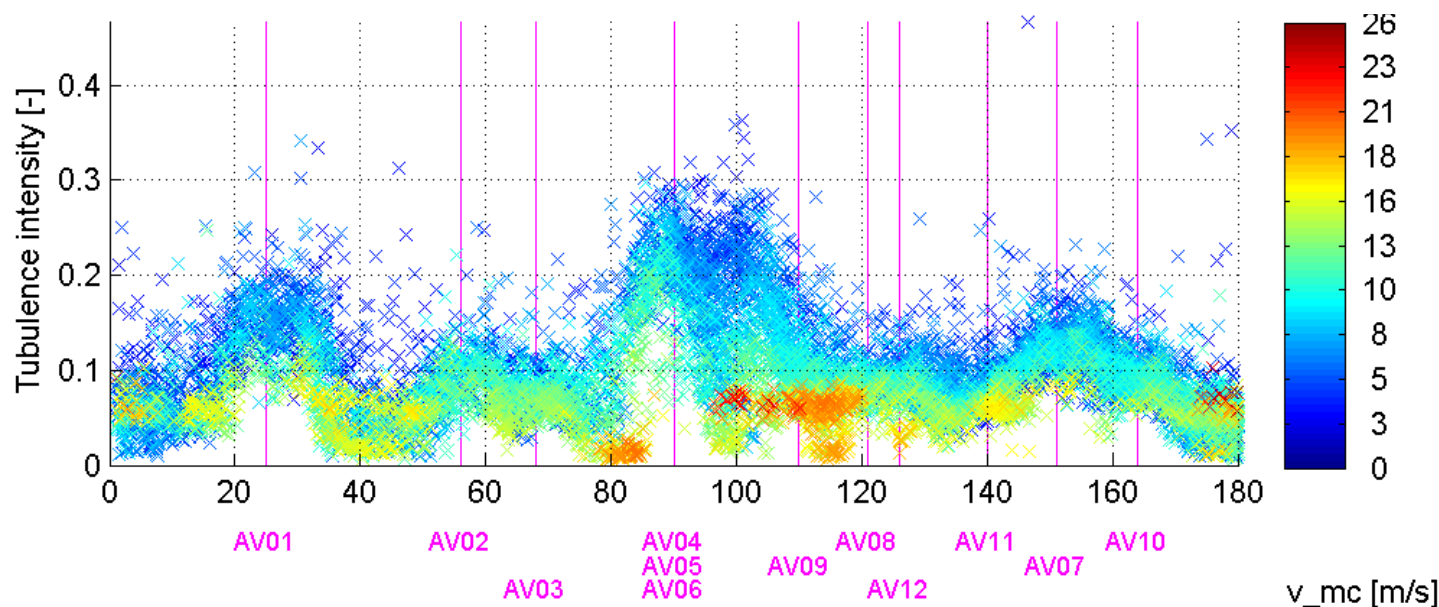
Wind park to

- south east (EnBW Baltic 2, since 2015)

# Turbulence intensity at FINO1

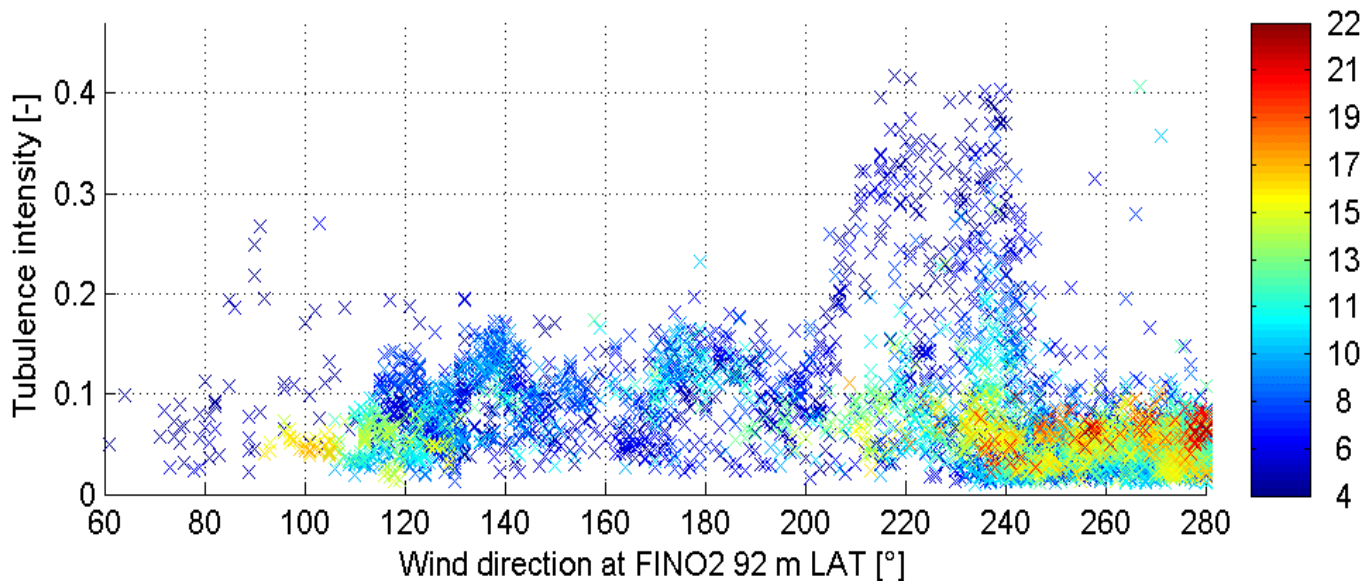
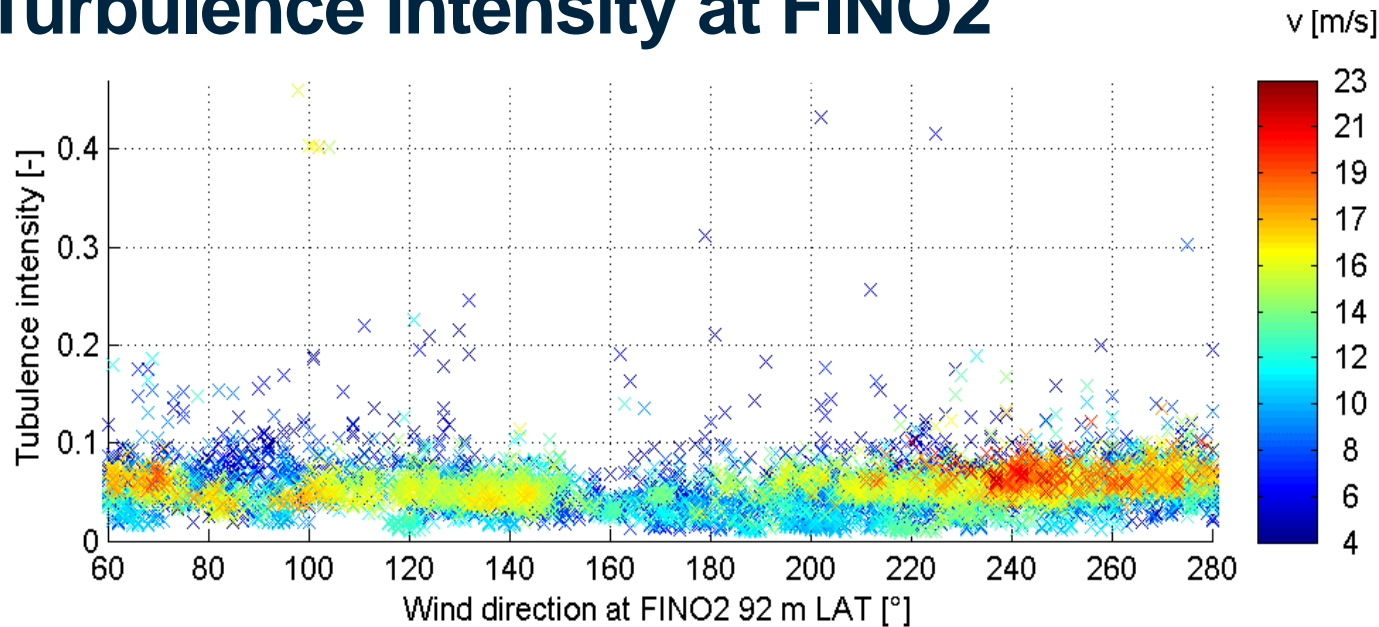


01/2008 – 12/2008



05/2011 – 09/2012

# Turbulence intensity at FINO2



## 5) Conclusions

Project FINO-Wind provides:

- quality validation tool Validatf
- consistently checked data provided in the FINO database of BSH
- thoroughly derived mast corrections for each of the FINO masts
- initial analysis of wind park situations for each platform
- meteorological investigations based on improved data sets





# THANK YOU!

