

# Recent developments at FINO1

Juan-José Trujillo, Richard Frühmann,  
Friederike Bégué and Tom Neumann

OffshoreWind R&D Conference 2018, Bremerhaven

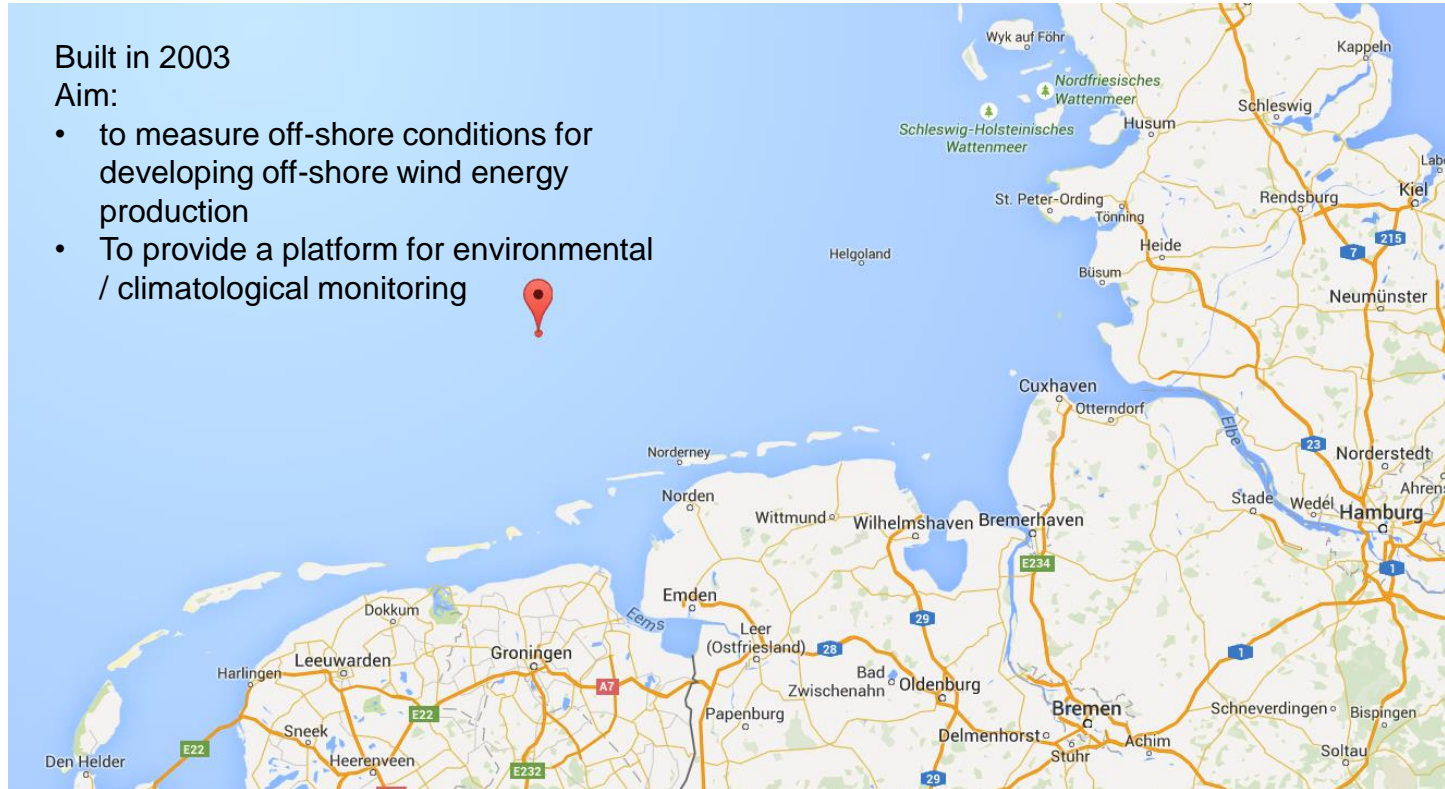


# FINO1 Background

Built in 2003

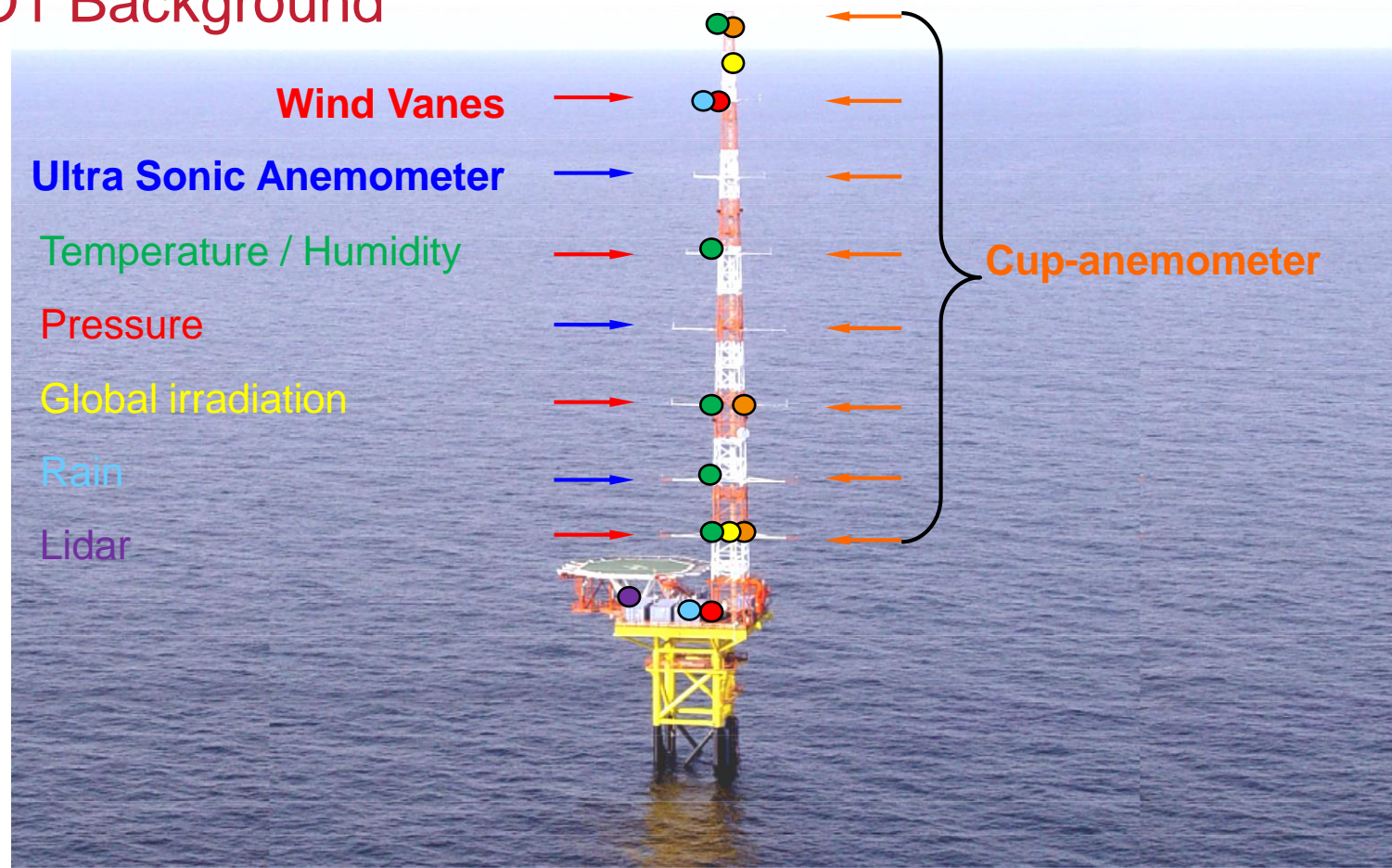
Aim:

- to measure off-shore conditions for developing off-shore wind energy production
- To provide a platform for environmental / climatological monitoring



Google maps

# FINO1 Background



# New sensor: Infrared Sea Surface Temperature (IR SST)

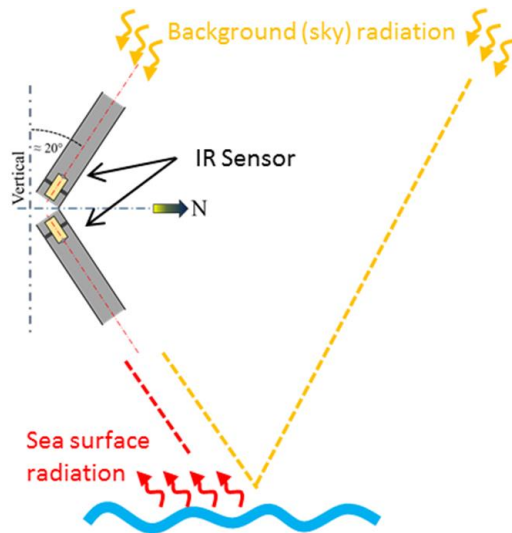
Installation on North corner of FINO1  
since May 2016

## Principle

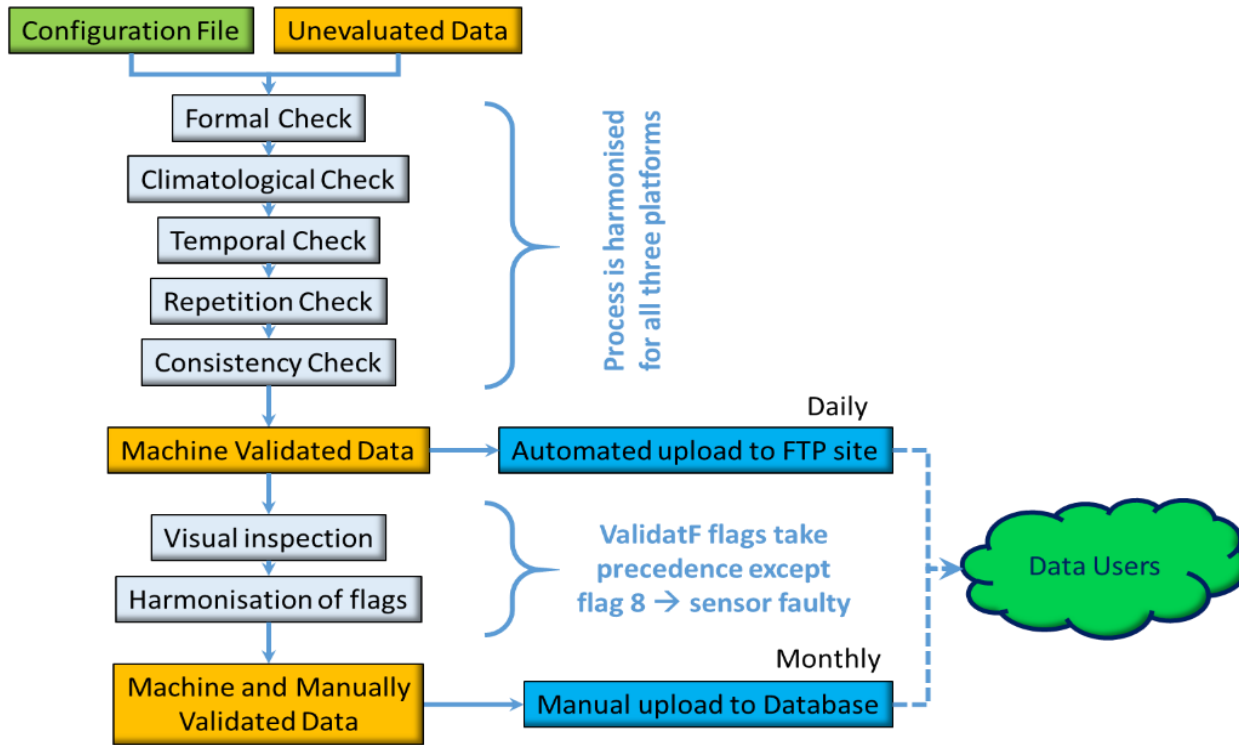
- Water and sky radiation

## Application

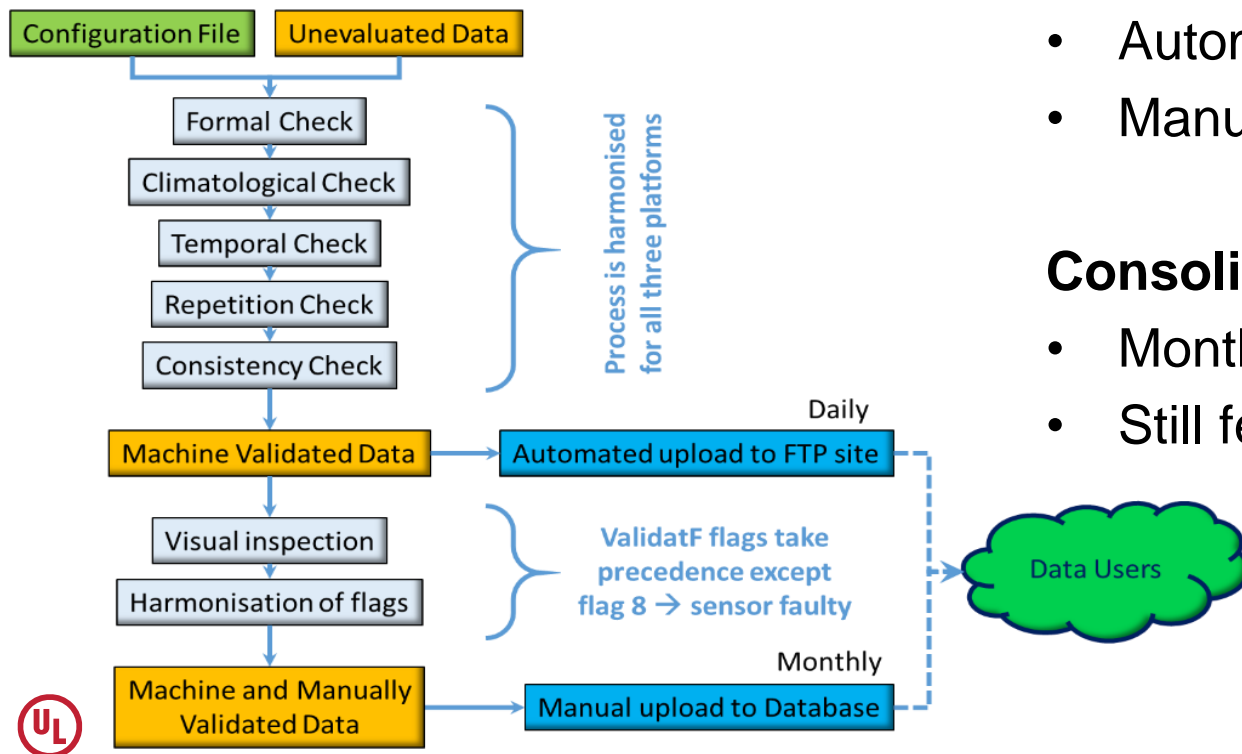
- Micrometeorology
- Atmospheric stability



# Standardisation of quality checks with FINO123



# Standardisation of quality checks with FINO123



## Two quality checks

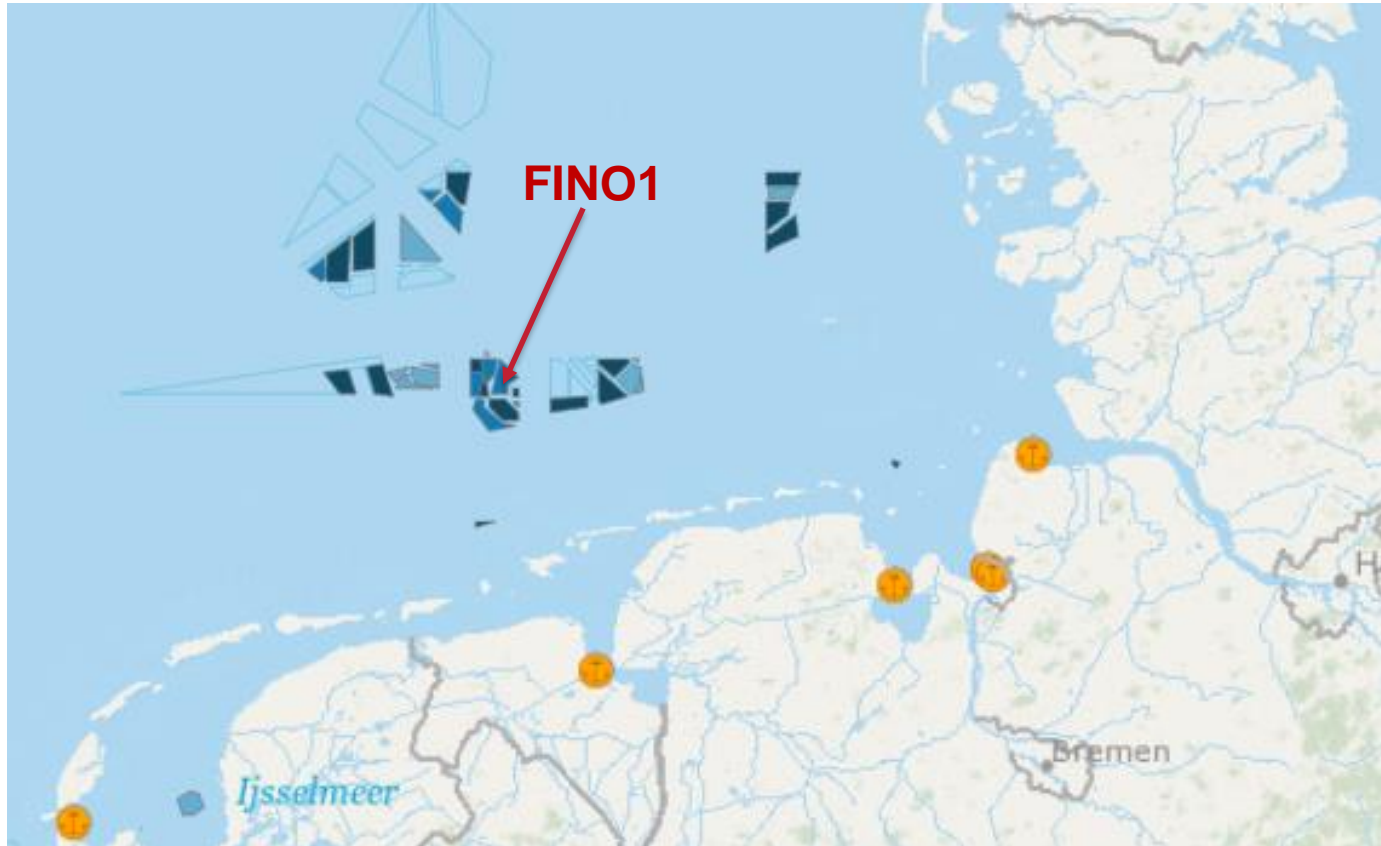
- Automatically by ValidatF
- Manually by operator at FINO1

## Consolidation

- Monthly
- Still feeding new DB

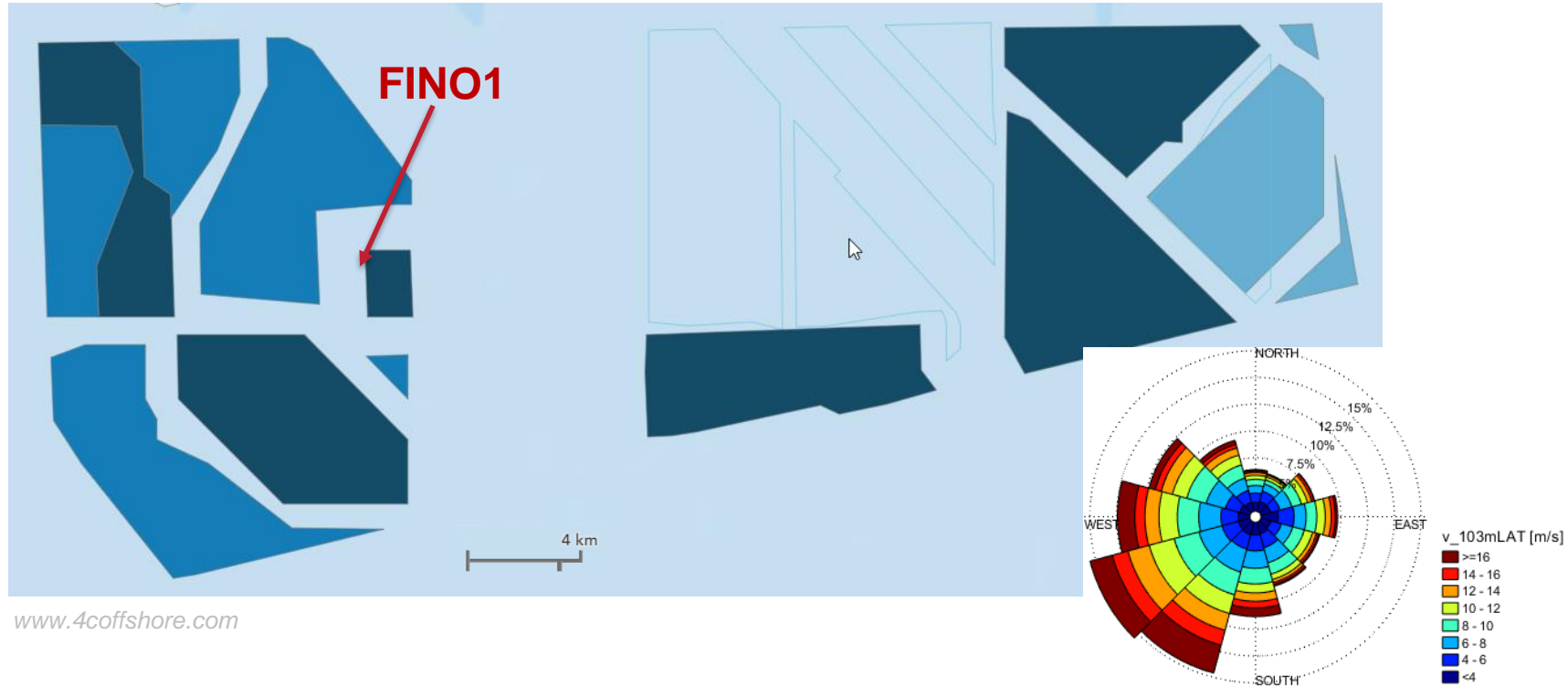


# Wind farm developments near FINO1



# Wind farm developments near FINO1

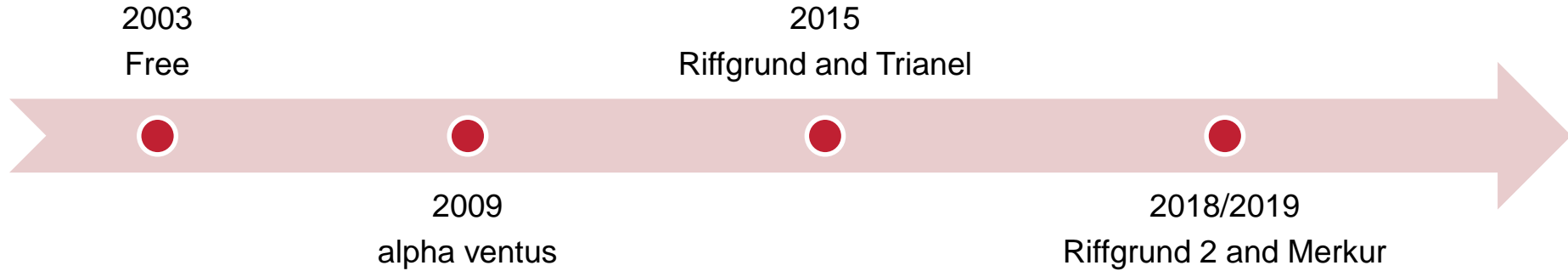
Today FINO1 is fully surrounded by wind farms





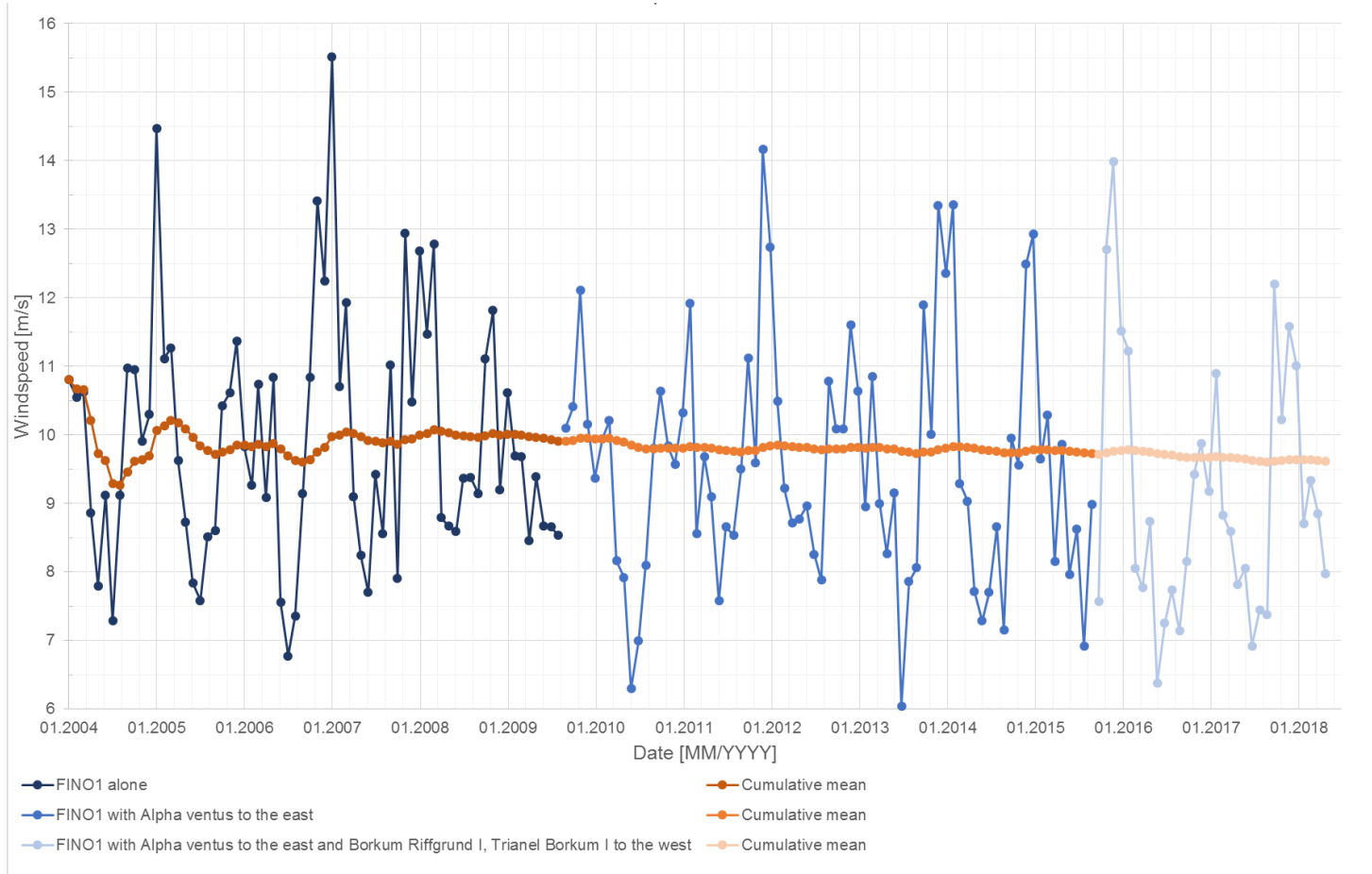
# Wind farm developments near FINO1

Today FINO1 is fully surrounded by wind farms



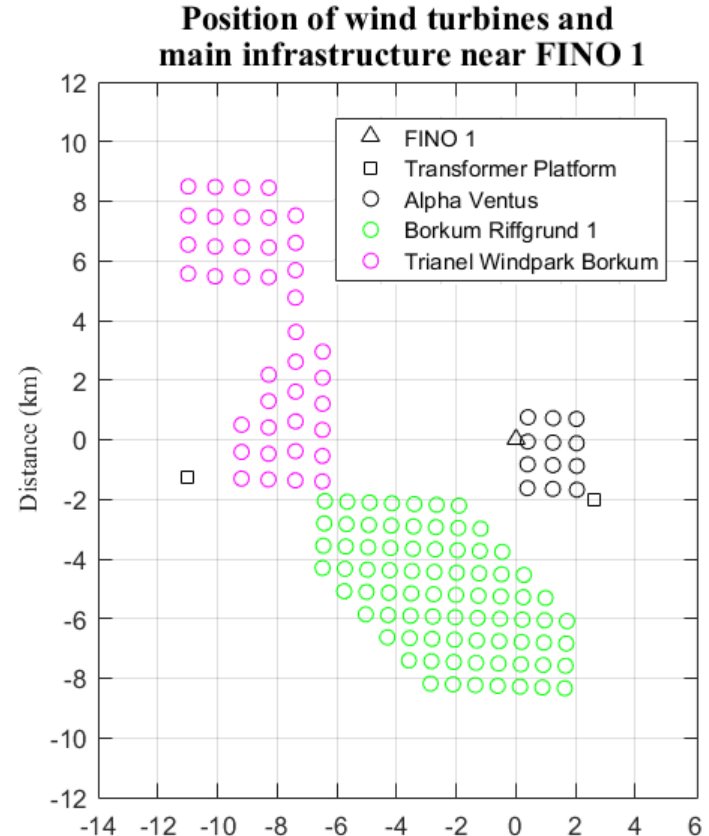
*Photography: View from FINO1 to the south-west*

# Wind farm effects on wind speed at 103 m FINO1



# Effects on turbulence intensity and wind shear

- Wind farms constructed since the summer of 2015 influence the wind at FINO1 from the main wind direction sector
- Using a stability parameter it is possible to filter out conditions during which the influence of the upwind farms is strongest



# Effects on turbulence intensity and wind shear

- Stability from SST and temperature at 20 m
- Wind speed gradient between 40m and 90m reduced by almost 50% under neutral to stable conditions

Percentage change in mean wind speed gradient.

Wind speed range		4 - 8	8 - 12	12 - 16	16 - 20
Stability parameter	> 2 °C	-27.7	-38.1	-28.9	-20.1
	1 : 2 °C	-19.8	-46.5	-28.2	-9.7
	0 : 1 °C	-44.2	<b>-48.5</b>	-27.3	-12.6
	-1 : 0 °C	-40.9	-39.8	-14.9	-9.3
	-2 : -1 °C	<b>-0.9</b>	-10.9	-4.1	-14.9
	< -2 °C	-12.3	-2.2	-7.0	-16.4

*Frühmann et al., Platform based infrared sea surface temperature measurement:*

*(experiences from a one year trial in the North Sea, DEWEK 2017*

# Effects on turbulence intensity and wind shear

- Stability from SST and temperature at 20 m
- Wind speed gradient between 40m and 90m reduced by almost 50% under neutral to stable conditions
- Turbulence intensity increased by almost 78% under stable conditions

*Frühmann et al., Platform based infrared sea surface temperature measurement: experiences from a one year trial in the North Sea, DEWEK 2017*

Percentage change in mean wind speed gradient.

Wind speed range		4 - 8	8 - 12	12 - 16	16 - 20
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Percentage change in mean turbulence intensity

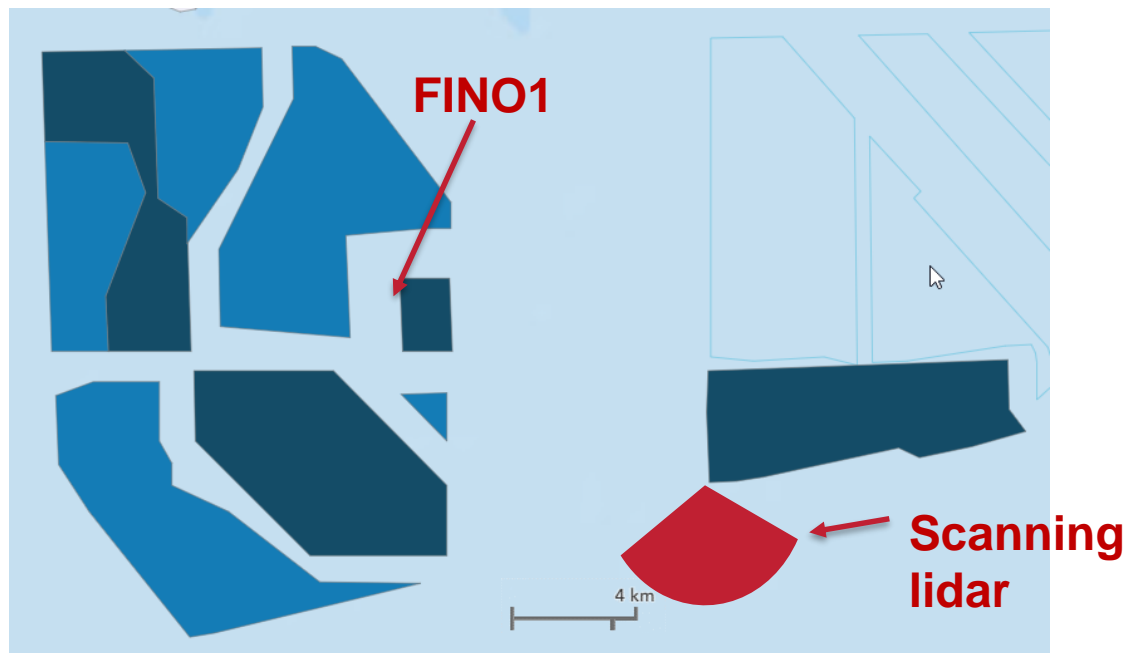
Wind speed range		4 - 8	8 - 12	12 - 16	16 - 20
Stability parameter	> 2 °C	29.4	74.4	62.1	46.0
	1 : 2 °C	25.7	<b>77.8</b>	56.9	18.2
	0 : 1 °C	12.9	61.8	35.1	14.8
	-1 : 0 °C	28.2	39.9	12.3	3.9
	-2 : -1 °C	5.3	15.3	9.7	22.2
	< -2 °C	<b>-7.2</b>	3.4	5.9	12.7

## Ongoing activity: Free inflow of cluster 2

Long-range scanning lidar measurements from NordseeOne to capture free inflow

Begin : End of April 2018

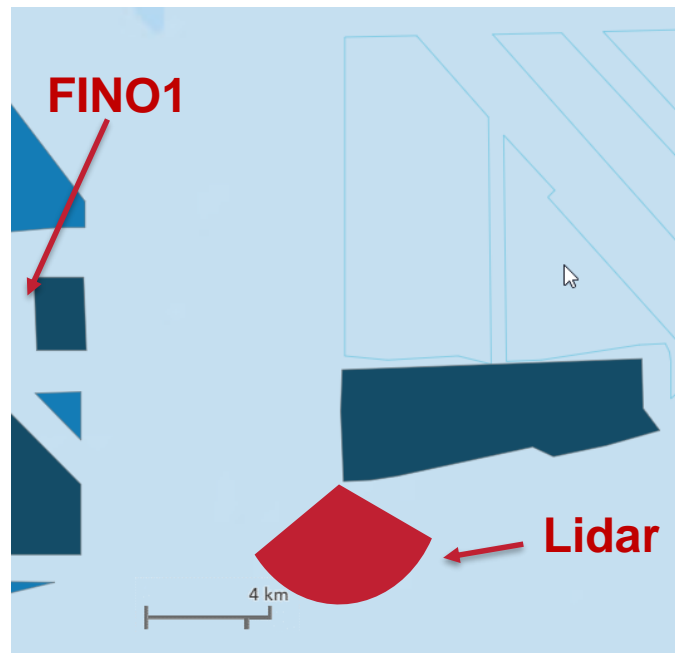
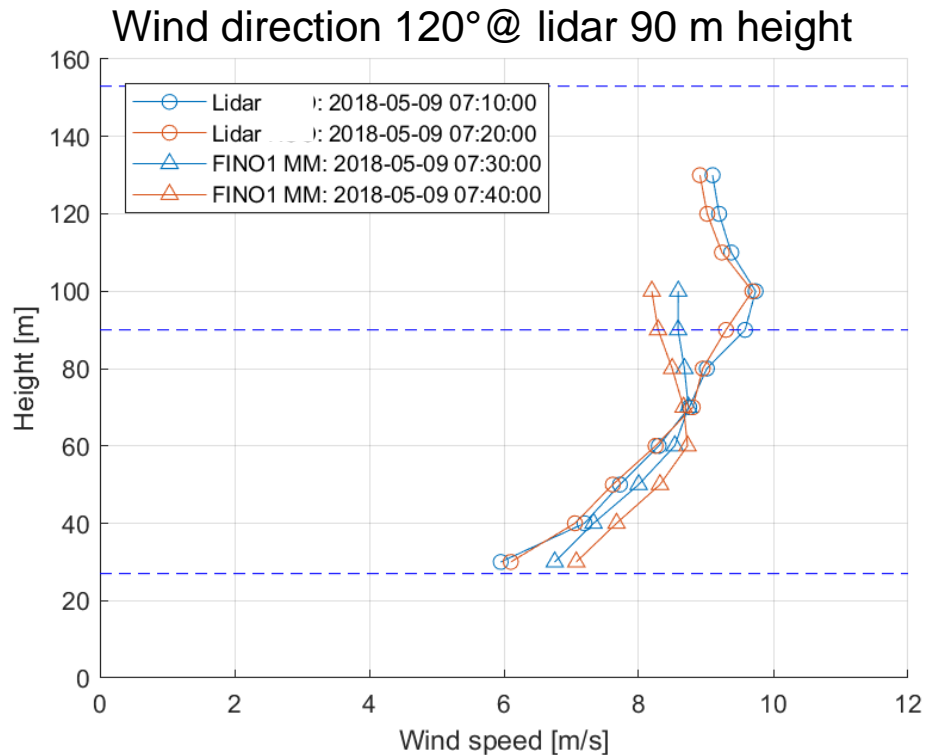
End : October 2018





# Ongoing activity: Free inflow of cluster 2 against FINO1

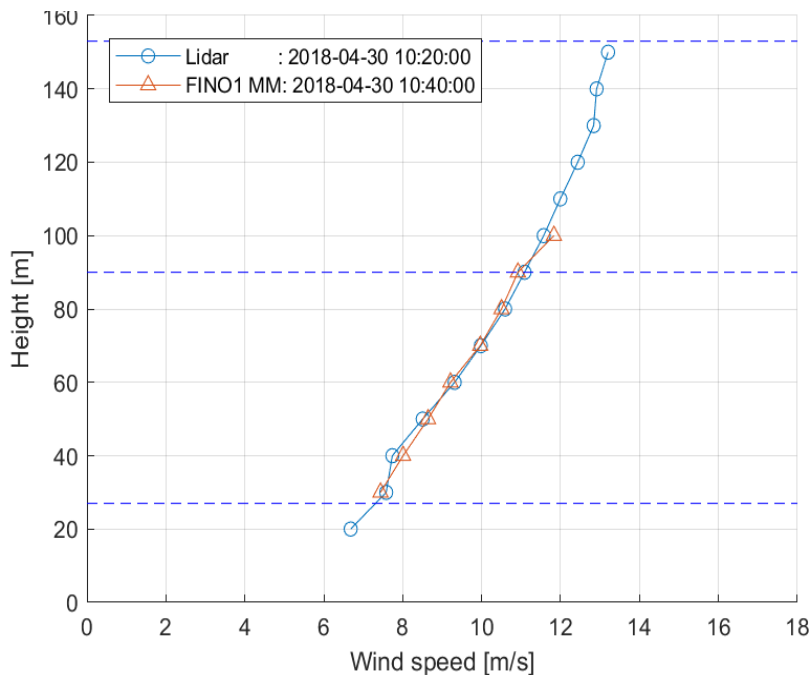
Preliminary result: 10 minute wind speed profile at Lidar and FINO1



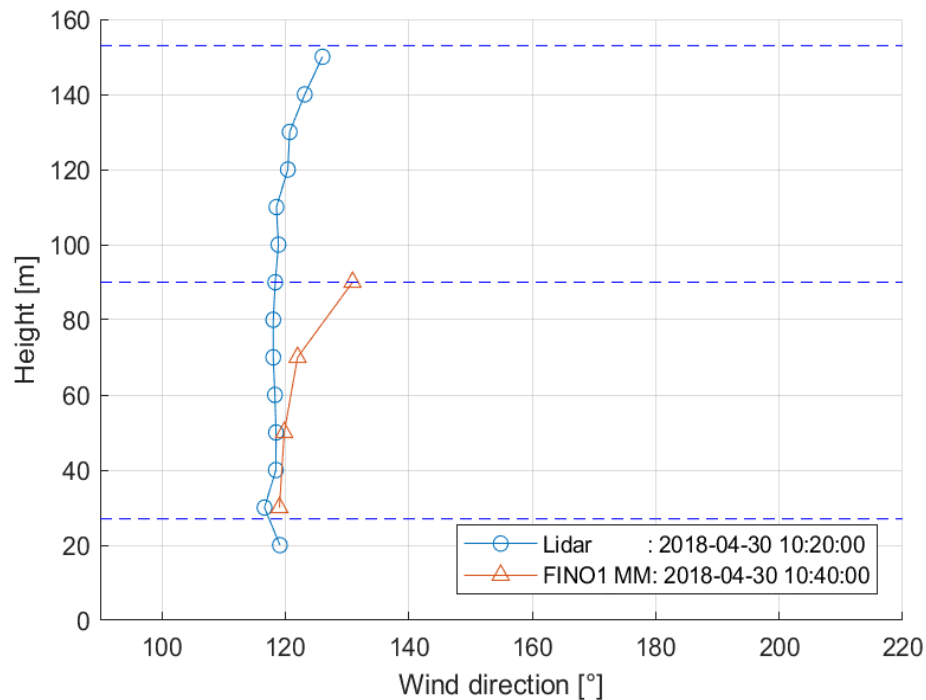
# Ongoing activity: Free inflow of cluster 2 against FINO1

Preliminary result: 10 minute wind speed profile from east-south direction

## Wind speed



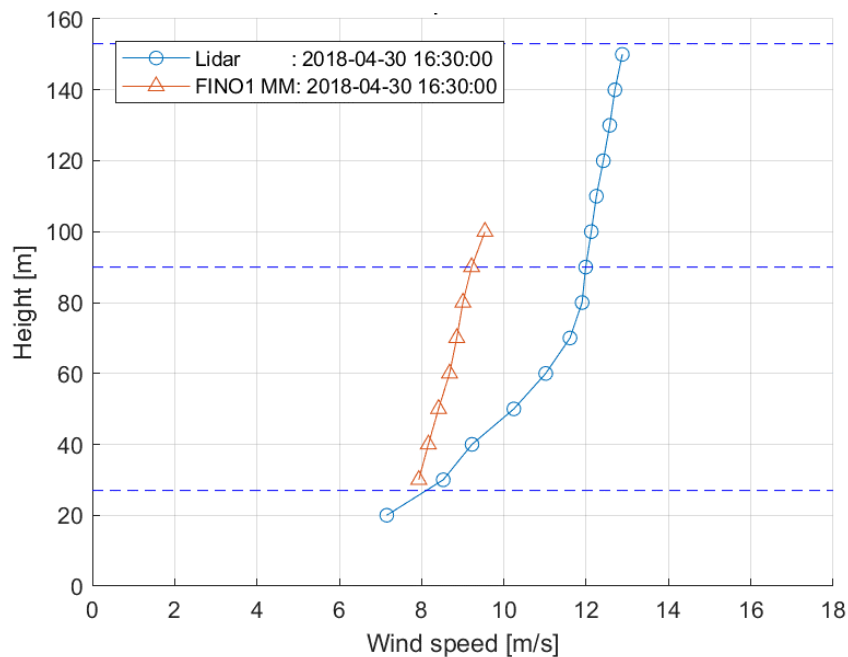
## Wind direction



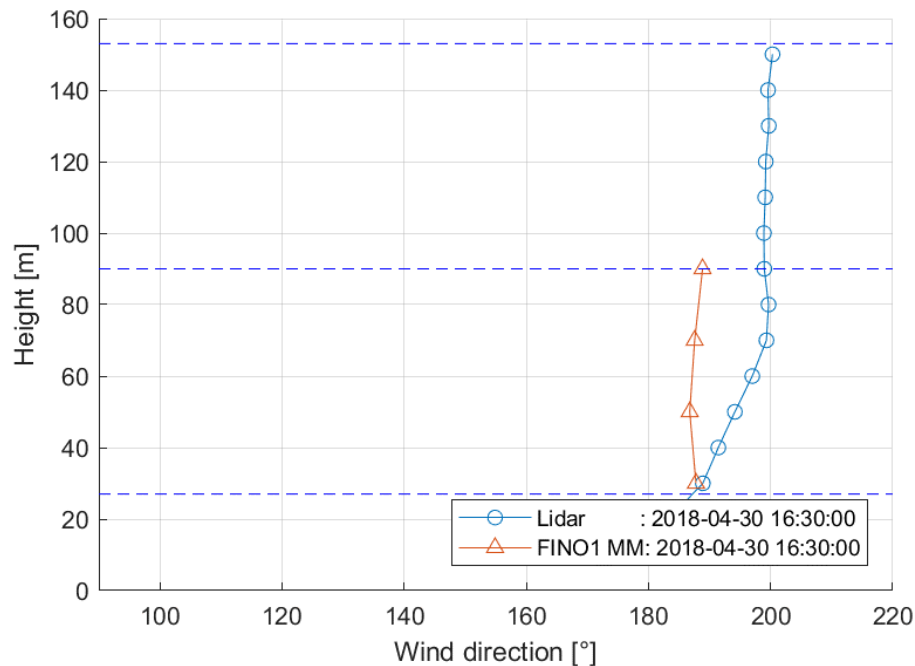
# Ongoing activity: Free inflow of cluster 2 against FINO1

Preliminary result: 10 minute wind speed profile from south-west direction

## Wind speed

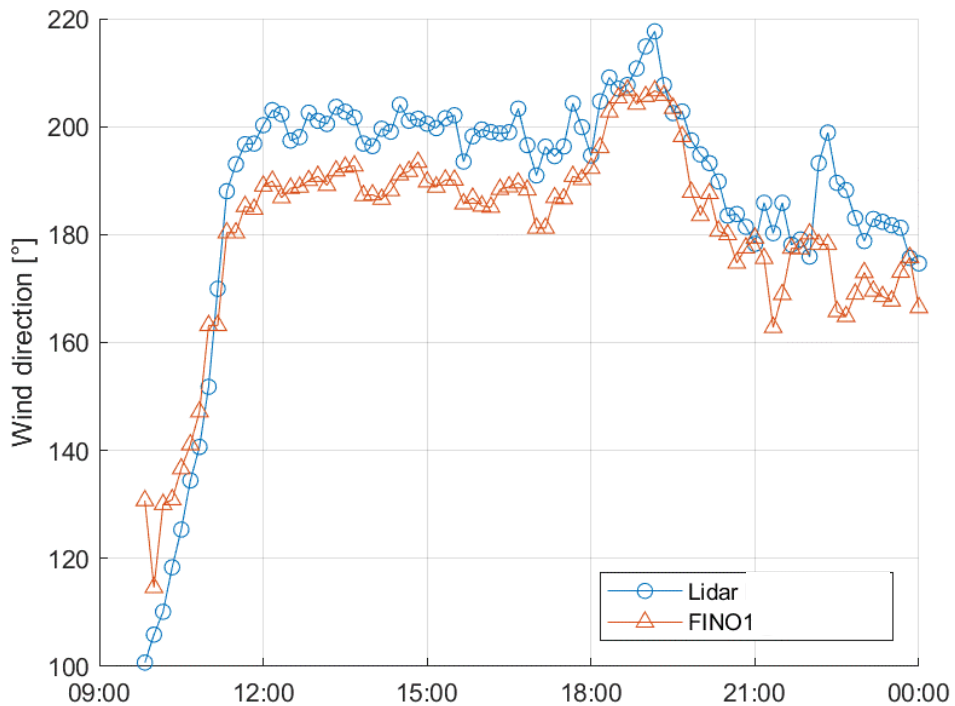
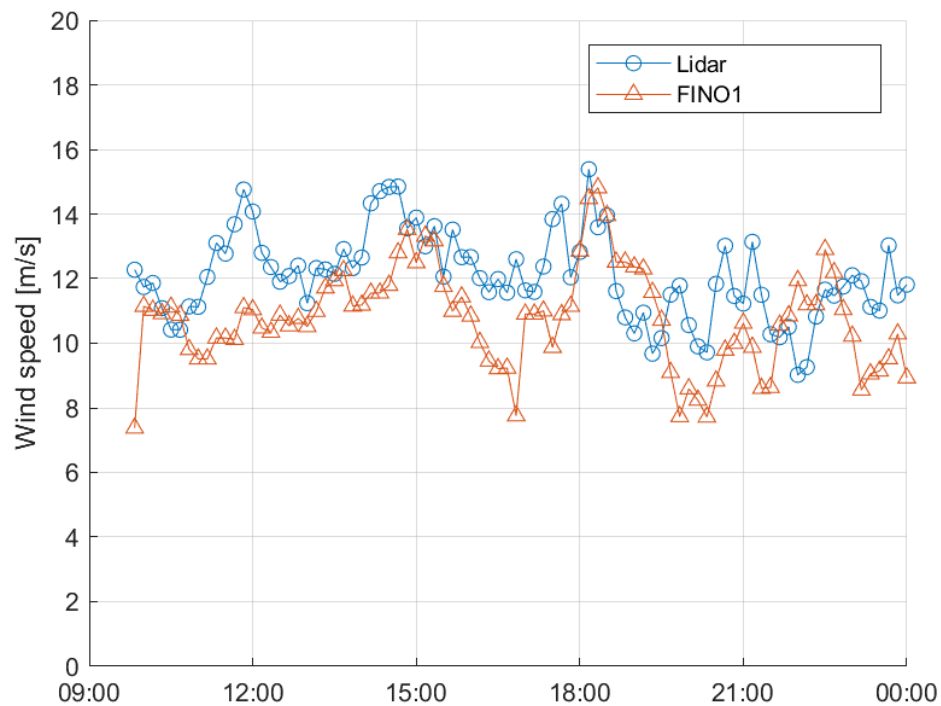


## Wind direction



# Ongoing activity: Free inflow of cluster 2 against FINO1

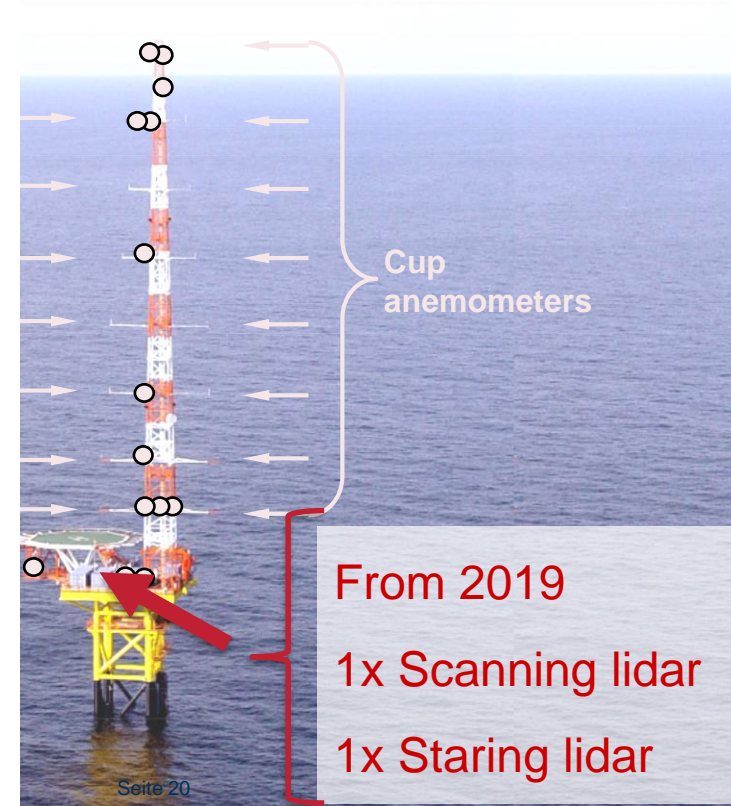
Preliminary result: Time series of 10 minute averages  
@90 m from south-west direction



# Outlook FINO1 : Additional activities until 2021

By means of new long-range and staring lidar :

- Assess the **effect of nearby wind farms** on the new ,offshore' conditions:
- Changes in wind characteristics, i.e. **turbulent properties in wake**



# Acknowledgements

The data originated partly from the FINO and RAVE databases. Both projects are funded by the German Federal Ministry for Economic affairs and Energy through Projektträger Jülich.

