

# Wind conditions at Sisimiut and Sarfannguaq

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SUSTAINABLE ENERGY SUPPLY IN THE ARTIC  
Sisimiut, 1-3 March 2008



# Outline

- Introduction
- Requirements
- Tools
- Data analysis
- Turbulence
- Extreme winds
- Conclusion
- Acknowledgement

# Introduction

Wind conditions are parameters, describing input for:

ultimate loads

- extreme wind speed (50YR),
- extreme flow angles

fatigue loads

- wind speed distribution
- turbulence intensities,
- wind shear.

The local wind conditions are required to

- Select a suitable wind turbine
- Obtain building permits

# Requirements

IEC Standard 61400-2 is valid for  
small wind turbines  
( $A < 200 \text{ m}^2 \approx D = 16 \text{ m}$ ;  $P < 20 \text{ kW}$ )

## Wind turbine classification

WT classes	I	II	III	IV	S
$V_{\text{ref}}$	50	42.5	37.5	30	Values to be specified by the designer
$V_{\text{ave}}$	10	8.5	7.5	6	
$I_{15}$	0.18				
a	2				

# Tools to determine the local wind conditions

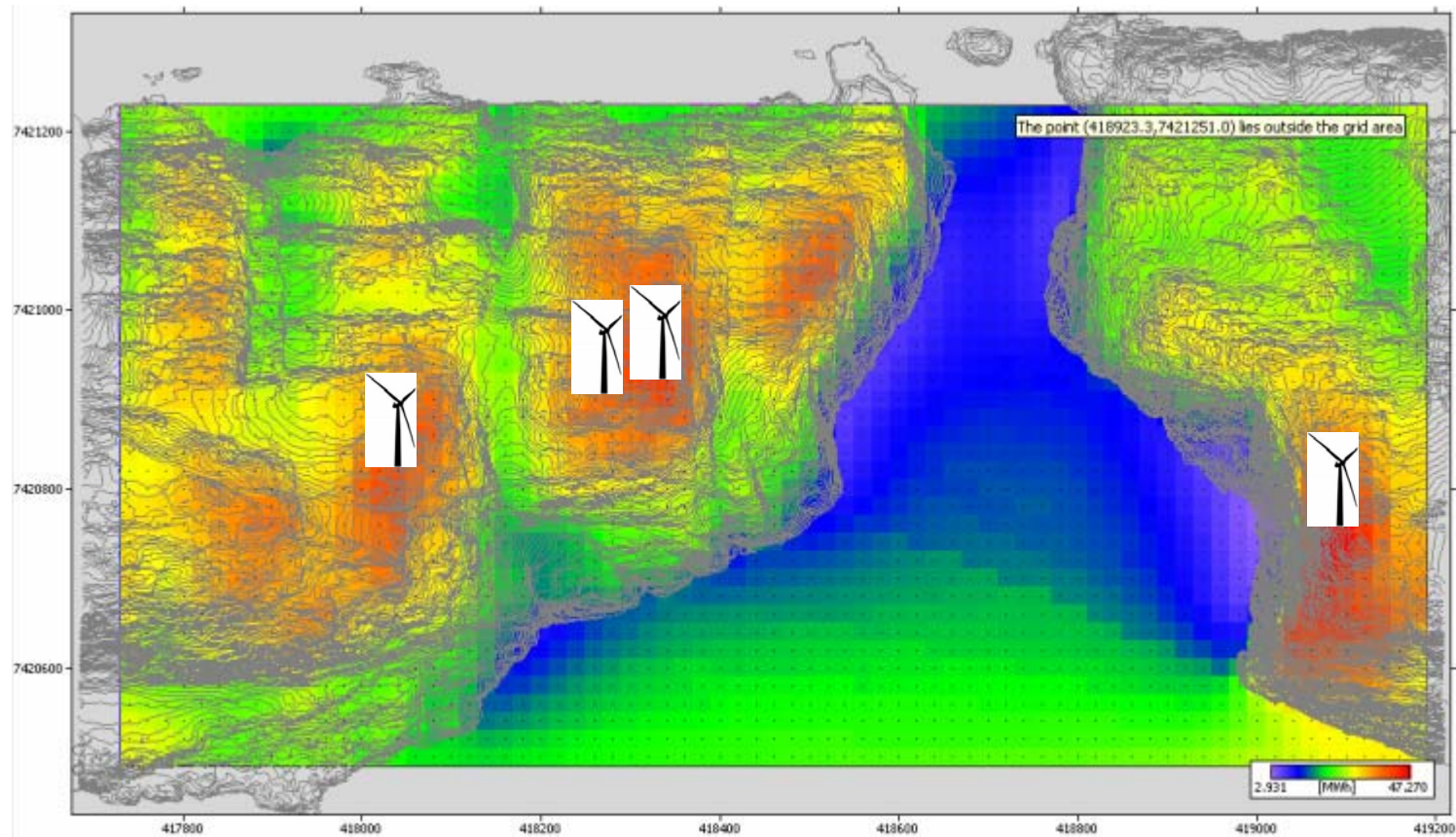
- Long term measurements (>2 YR) in representative heights ( $HUB \pm D/2$ )
- Short term measurements + WAsP Engineering

## WAsP Engineering, Risø DTU



WAsP Engineering is a computer program for the estimation of extreme wind speeds, wind shears, wind profiles, and turbulence in complex terrain.

# Potential sites: 4 x 11 kW Gaia turbines

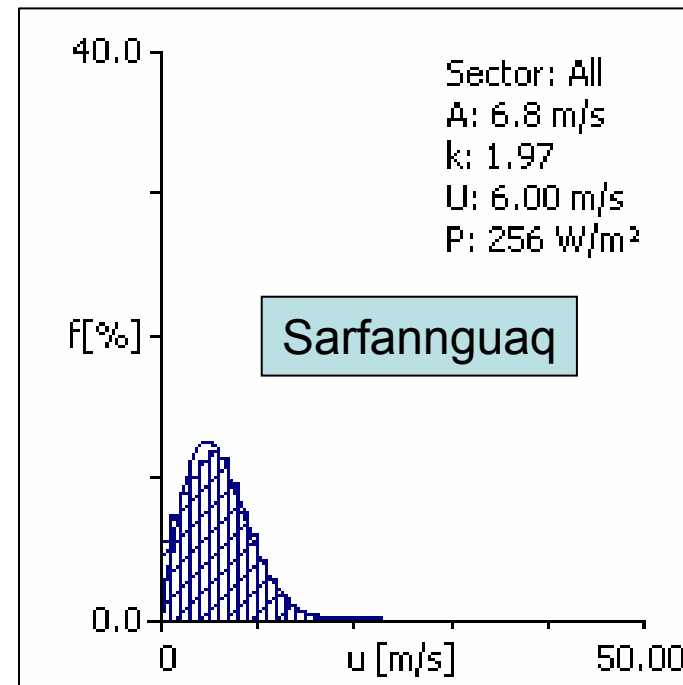
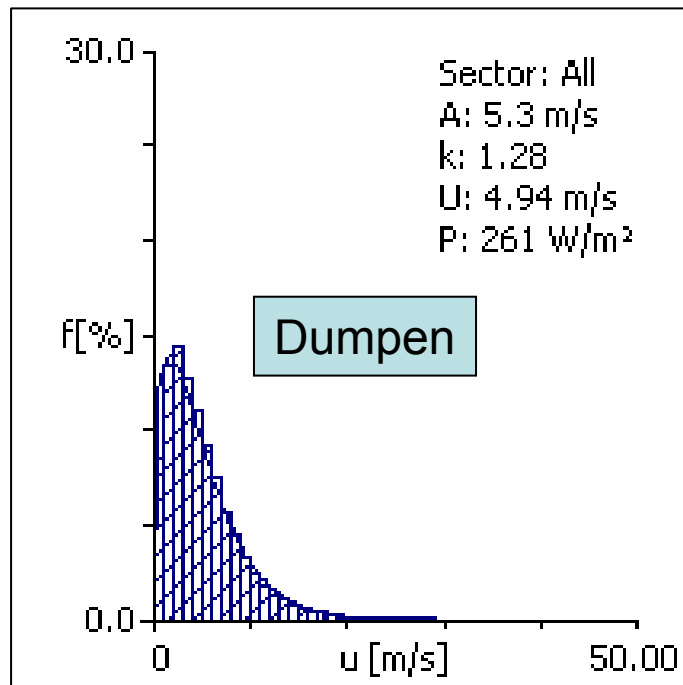


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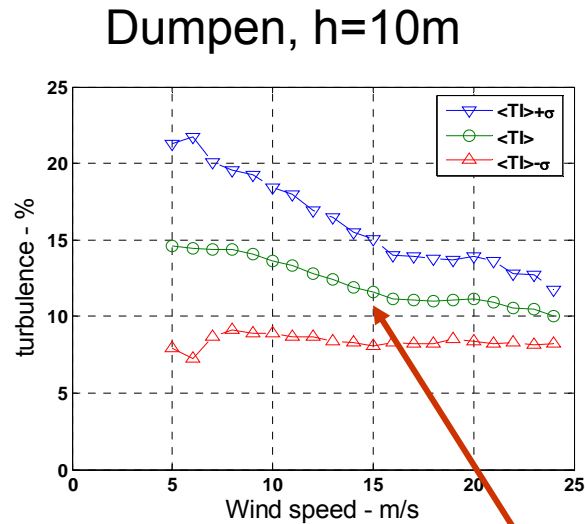


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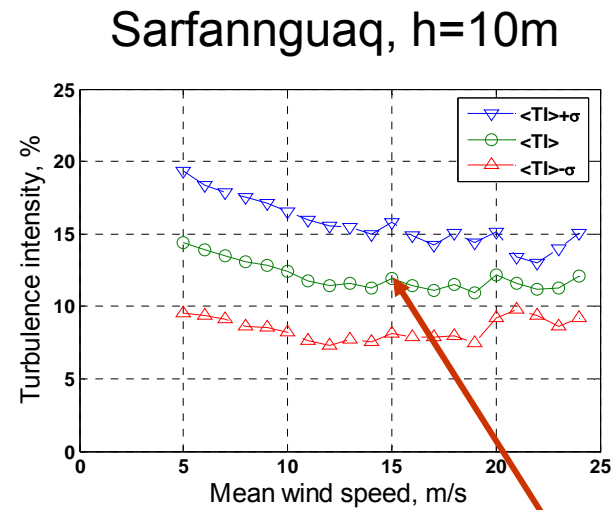
# Measured wind speed distributions



# Measured turbulence intensity



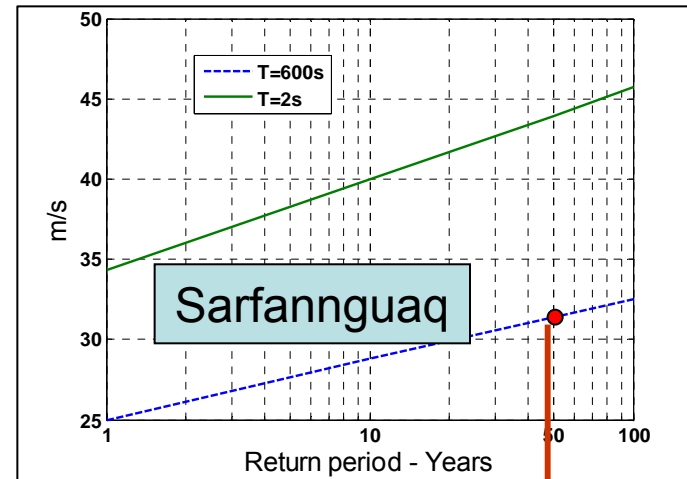
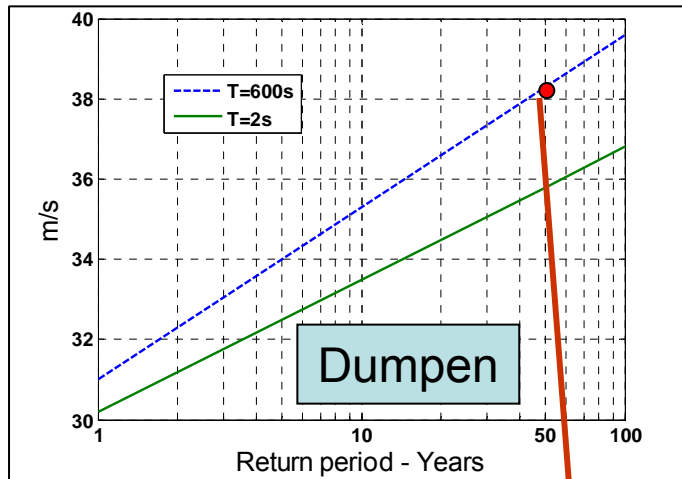
$Ti_{15m/s} \approx 12\%$



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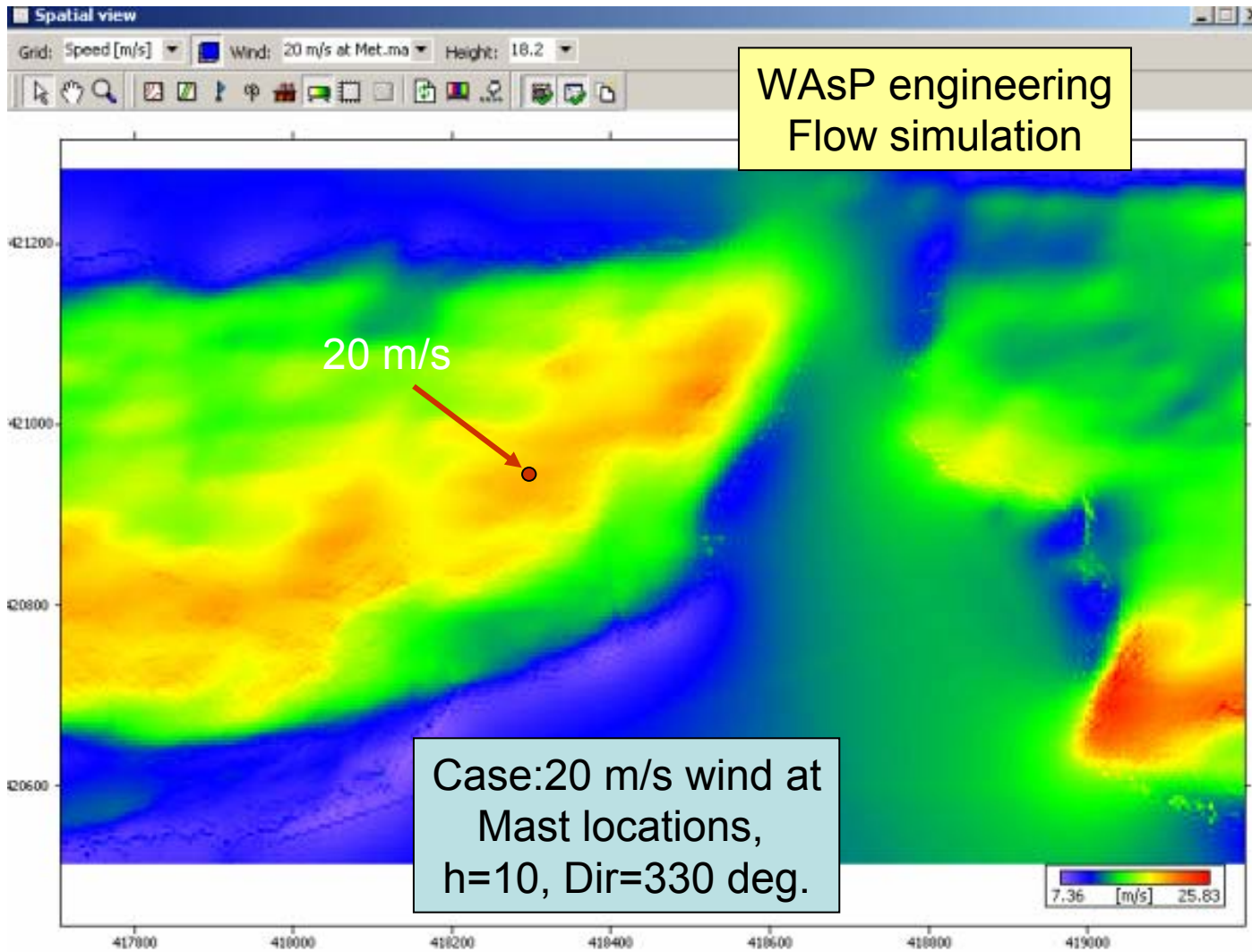
WEng:  $Ti_{h=18m} = \text{max. } 11\%$

# Extreme wind speeds



	10YR	50YR
T=2 sec.	33.5 m/s	35.8 m/s
T=600sec.	35.3 m/s	38.3 m/s

	10YR	50YR
T=2 sec.	40.0 m/s	43.9 m/s
T=600sec.	28.8 m/s	31.4 m/s

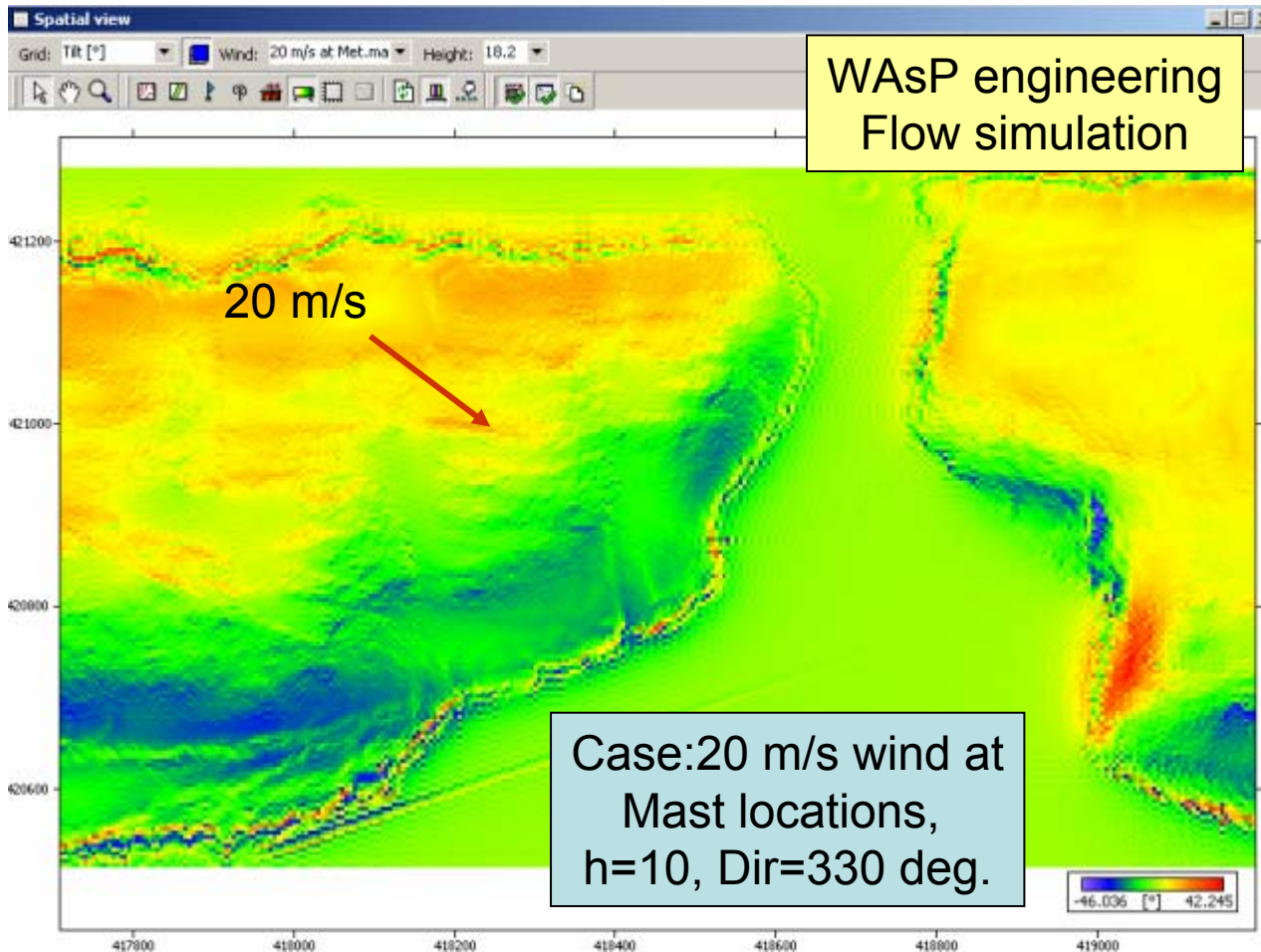


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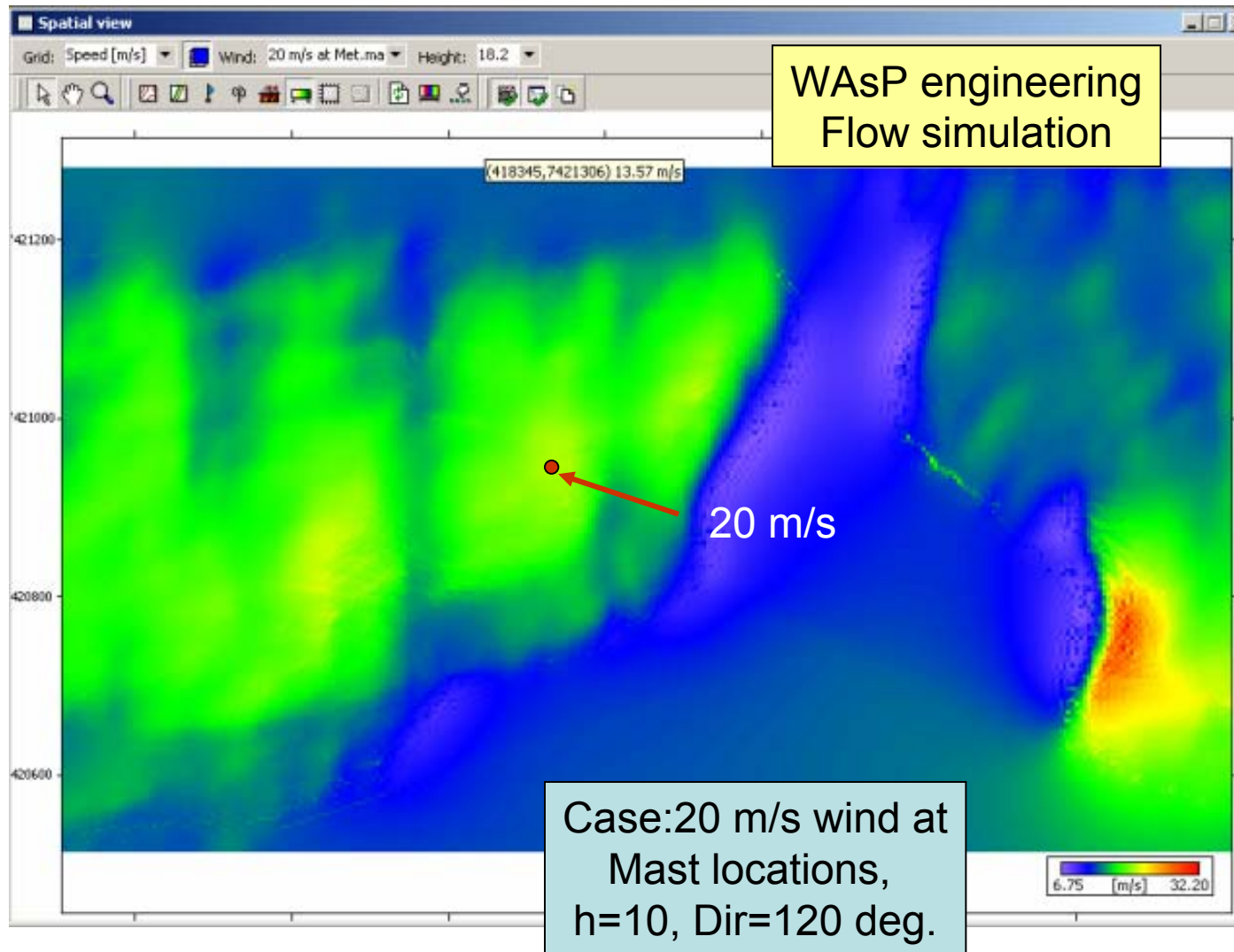
# Flow tilt map



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Site: Sarfannguaq Målestation (418318,7420932) at 18.2m a.g.l.									
Direction	alpha	TI	Sigma-U	Flow angle	Terrain inclination	V-ref (50 yrs)	Frequency	Weibull-A	Weibull-k
[°]	[ ]	[% ]	[m/s]	[°]	[°]	[m/s]	[%]	[m/s]	[ ]
0	0.004	5.1	2.08	-1.1	-3.6	41.12	2.2	5.3	1.56
30	0.014	5.7	2.28	0	-4.5	40.06	2.4	3.8	1.21
60	0.027	7	1.56	1.2	-4.3	22.32	6.5	5.8	1.61
90	-0.009	7.6	1.75	2.3	-2.9	22.84	15.7	7.3	2.38
120	-0.014	4.4	1.48	2.1	-0.7	33.47	15.3	8	2.49
150	-0.032	3.6	0.82	1.8	1.7	22.64	8.2	6	1.66
180	-0.011	4.5	0.81	1.1	3.6	17.82	1.8	2.6	1.03
210	0.016	5.8	1.58	0.1	4.5	27.47	2.4	3.8	1.34
240	0.039	8.3	2.66	-1.2	4.3	31.9	6.4	5.3	1.83
270	0.022	8.9	3.45	-2.1	2.9	38.7	9.9	5.7	1.62
300	0.021	6.2	3.11	-2	0.7	50.31	15.3	6.9	2.03
330	-0.004	4.4	1.86	-1.7	-1.7	42.36	13.9	7.9	2.6
All						37.4			

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# Estimated wind conditions for Sarfannguaq (reference height 18m)

<i>Item</i>	<i>Analysis</i>	<i>WEng</i>
Mean wind speed	6.0 m/s	5.9 m/s
50 YR extreme T=600 seconds	31.4 m/s	37.4 m/s
50 YR extreme T=2 seconds	43.9 m/s	-
Turbulence intensity	12 %	≤9%
Wind shear, alpha	-	0.04
Weibull (A,k)	6.8/1.97	6.65/2.06
Terrain inclination	-	±4.5°
Flow angles	-	-2.1/+2.3°

# Conclusion

- The wind conditions have been determined from measurements for Sarfannguaq.
- Furthermore the wind conditions have been analysed with the dedicated software tool WAsP Engineering.
- Both findings result in the same wind turbine classification, corresponding to a wind turbine class III.