

ICETHROWER

Risk Area Reduction for Ice Throw ?

Workshop, Winterwind, Åre
6 February 2018

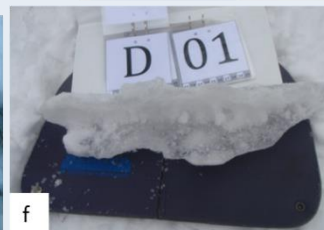
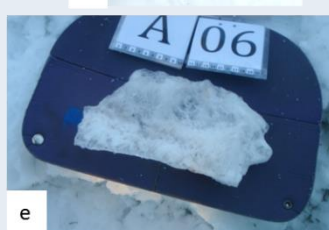
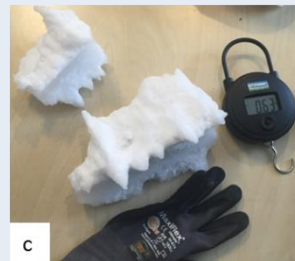
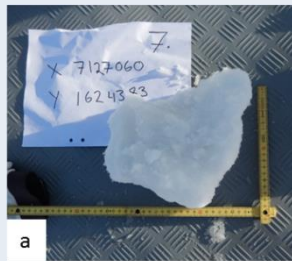
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THE FIELD STUDY - METHOD

Three wind farms in Sweden
Data collection during winter 2013-2016

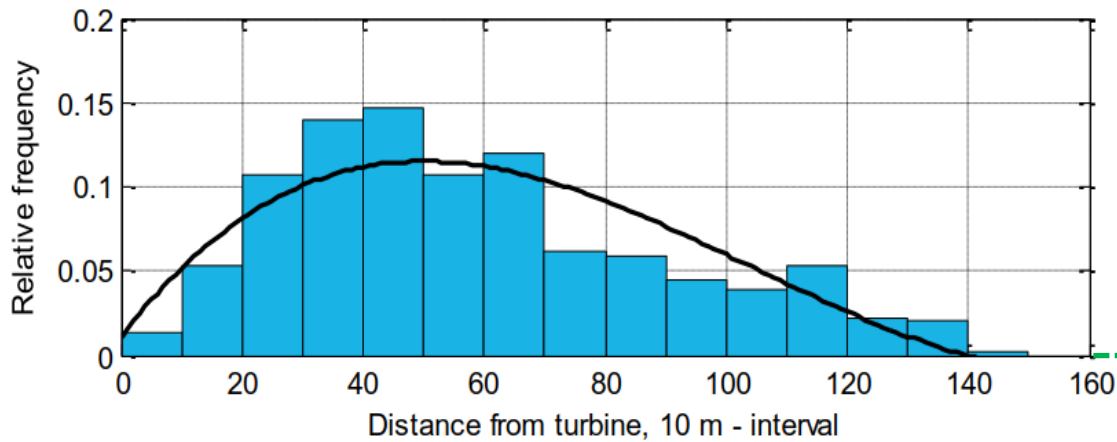
Collecting information:

- Physical properties of ice lumps
- Throwing distance
- Meteorological data at the time of ice throw



**Data from 530 ice lumps
was collected**

THE FIELD STUDY – RESULTS (ALL DATA)



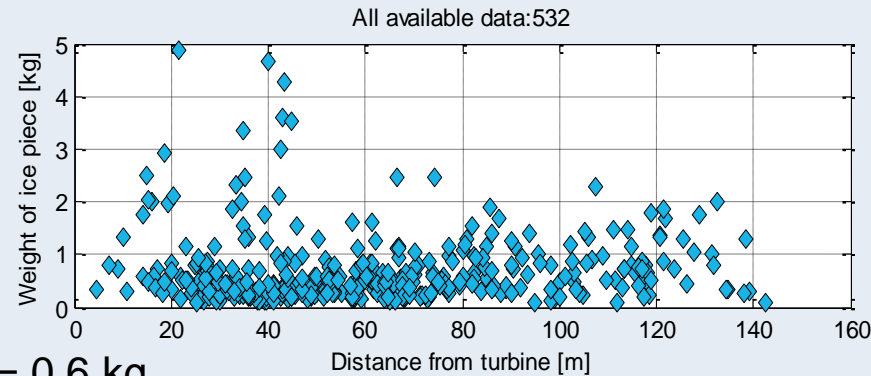
The established safety distance, $s = 1.5 \times (D + H)$,
 $s = 277$ m.

75% of ice lumps
between 20 to 90 m

140 m = 1.55 D

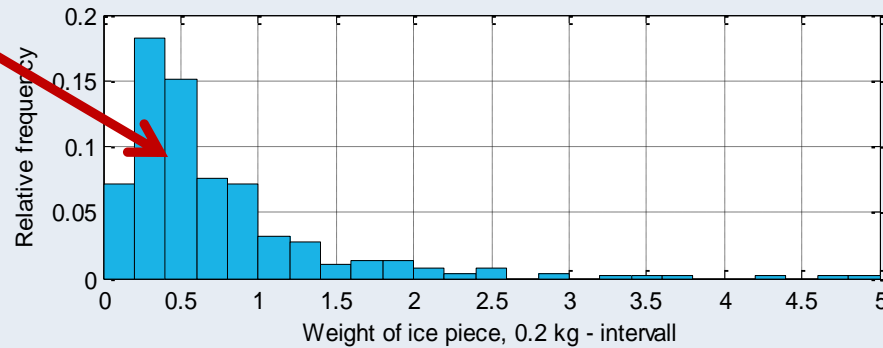
Turbines in the field study had 90 m rotor and 95 m tower (no de-icing system)

THE FIELD STUDY – RESULTS (ALL DATA)



No trend between distance and ice mass

Average ice mass = 0.6 kg



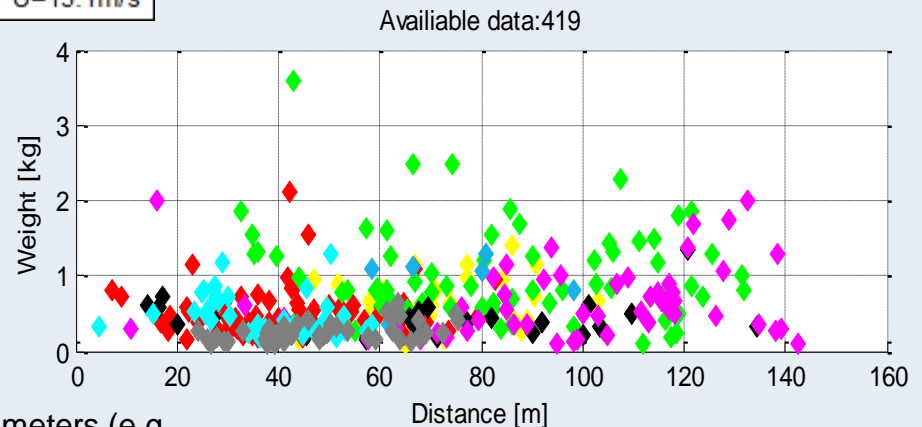
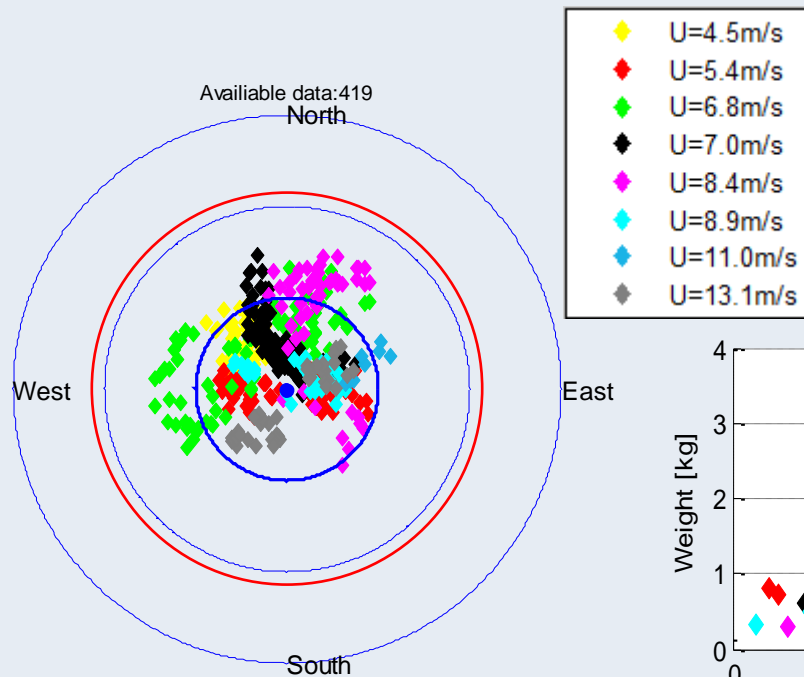
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THE FIELD STUDY - RESULTS (CASE STUDY)

Ice lumps fall in the wind ward direction.
 All ice lumps were found within 2 RD
 Large scatter.

2013: 2 ice days
 2014: 2 ice days
 2015: 1 ice day
 2016: 3 ice days

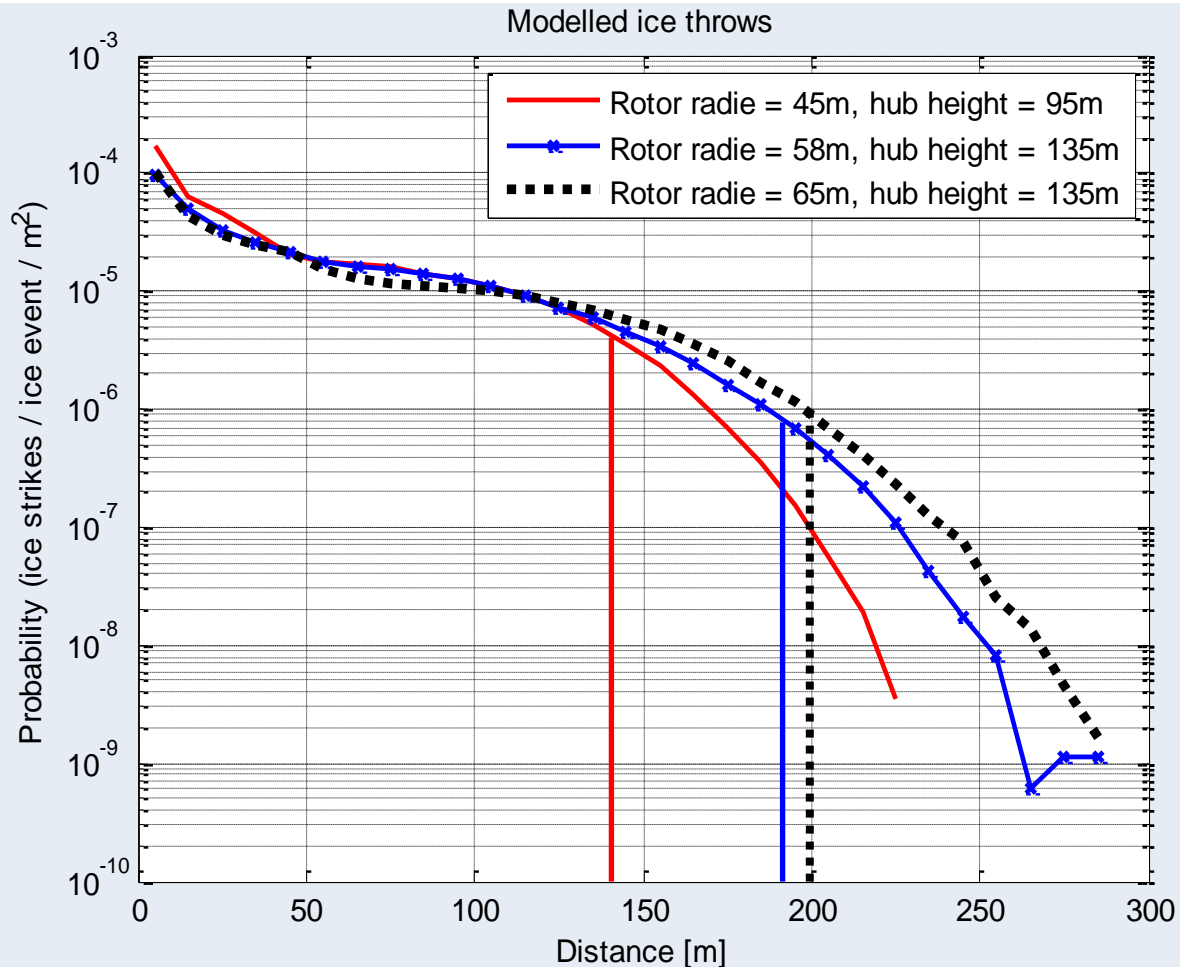
10 – 80 ice lumps / ice event



Blue circles show one, two respective three rotor diameters (e.g. 90, 180 and 270 m)
 Red circle shows D+H

Turbine in the case study had 90 m rotor and 95 m tower (no de-icing system)

THE ICE THROW MODEL - RESULTS



Based on 100 000 simulated ice throws, all wind directions included

EXAMPLE OF RISK ESTIMATE CONT.

High or low risk?

In the example the total risk (one working day)

- 1.5×10^{-4} for 2 service personnel or 1 in 6 900 years.
- In comparison the risk of a fatal car accident is 5×10^{-5}

The estimated risk for service personnel is considerable high and not acceptable without certain safety provisions.

For the public the risk is lower since their site visit is not correlated with an icing event.



RISK AREA REDUCTION

Present risk distance definitions

At operation $S = 1.5 x (D + H)$

At standstill $S = v x \left(\frac{D+H}{1.5}\right)$

S = safety distance

D = rotor diameter

H = hub height

V = wind speed at hub height

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ICETHROWER proposal

At all times $S = (D + H)$

Thank you!



PÖYRY

Engineering balanced sustainability™

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