

Ice throw studies

Gütsch and St. Brais

February 8, 2012

René Cattin

Icing in wind energy



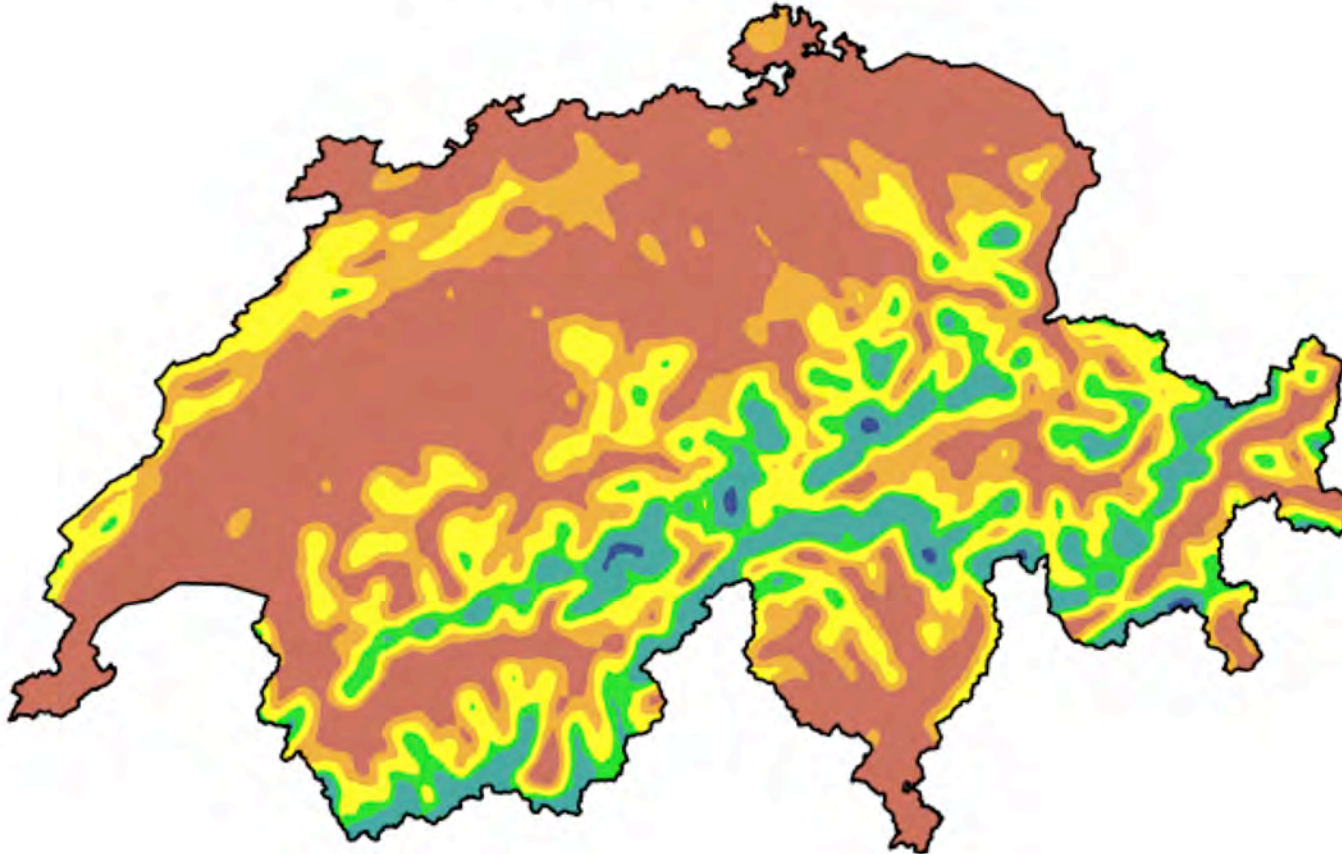
Icing in Switzerland

Wind map of Switzerland

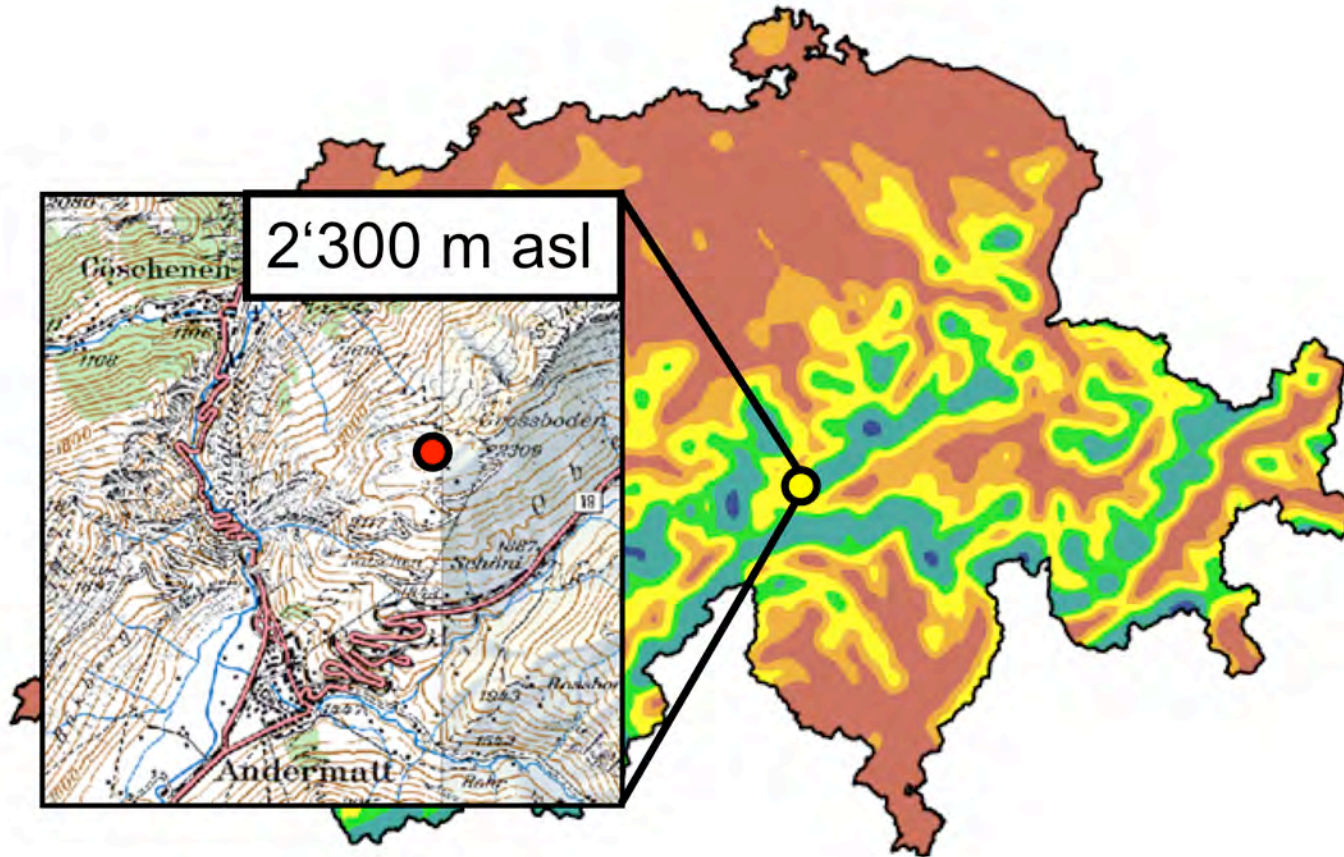


Icing in Switzerland

Icing map of Switzerland



Gütsch



Ene

Does ice throw occur?

- How often?
- How far?
- How heavy?
- Where?

Enercon E-40

Ca. 7 days/year meteorological icing
Ca. 30 days/year instrumental icing
Ca. 150 days/year temperature below 0°C
Wind turbines equipped with blade heating

Alpine Test Site Güttsch

COST Action 727: Atmospheric Icing on Structures
2005 to 2009



Method

After each icing event, the area around the wind turbine is inspected for ice throw.

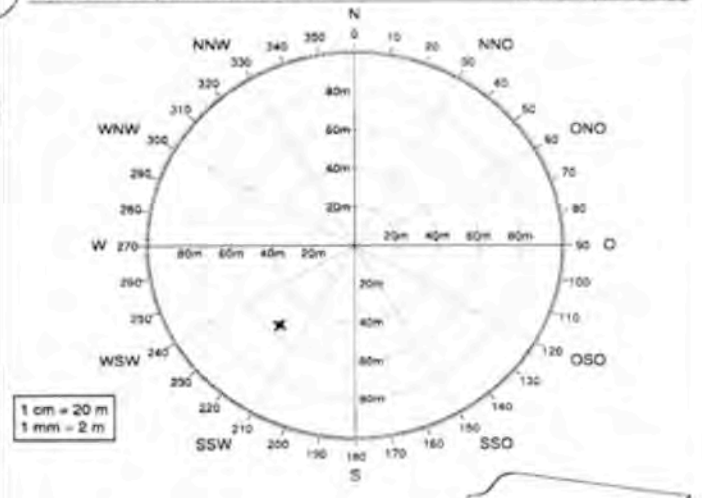
All found ice fragments are recorded

- Distance
- Angle
- Size
- Weight
- Type of ice (rime, glaze, wet snow)
- Photo of ice fragment

Alpine Test Site Gstaad:
Meteorological measurements and wind turbine performance analysis

DOBT 72? Messung und forecasting atmosphärischer long an erdfläche
Météo Suisse, Paysanne / METEOTEST Bern

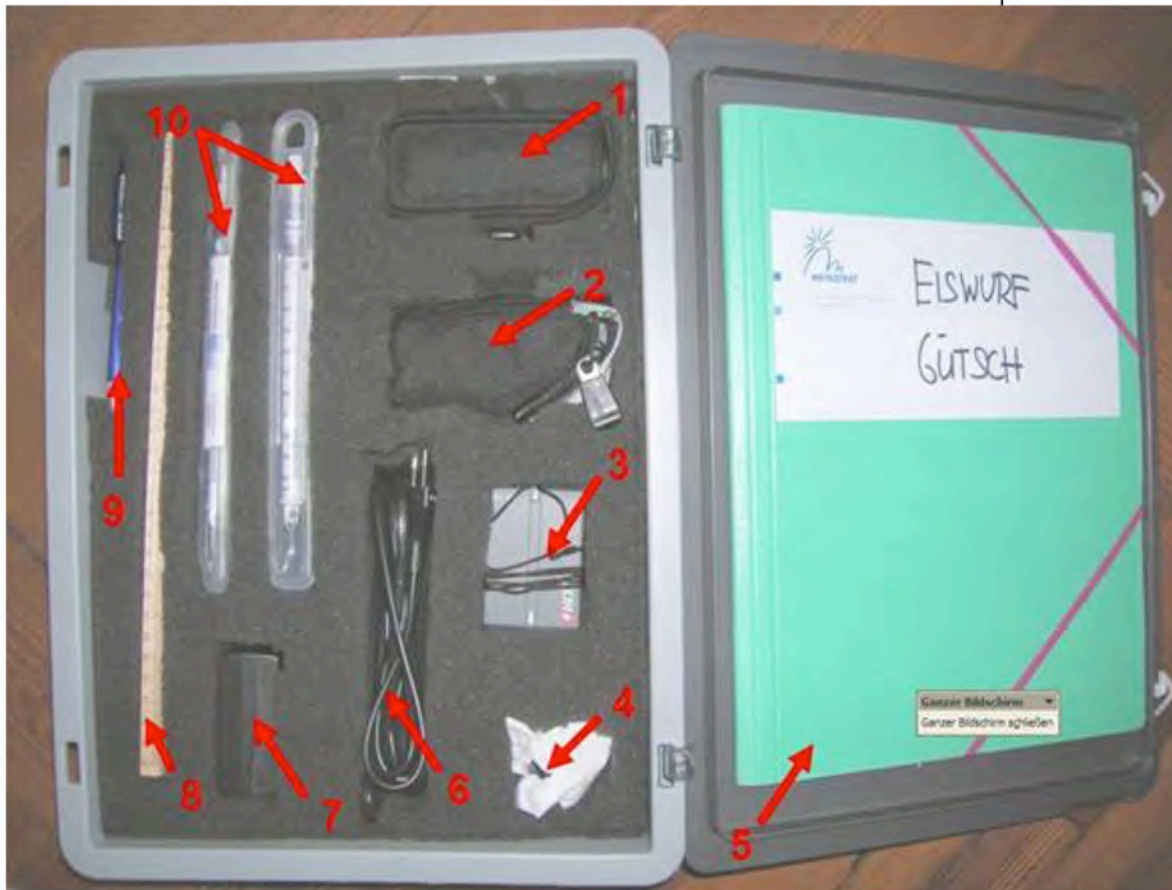
Ice throw Protocol



1 cm = 20 m
1 mm = 2 m

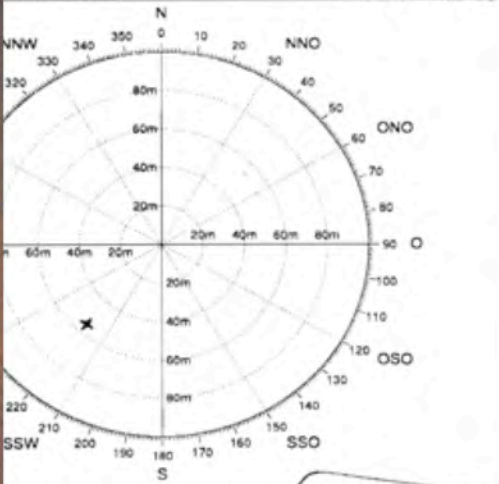
WKA: ENERCON E-40 500 kW Gstaad Anlage in Betrieb? Ja Nein
Datum, Zeit des Fundes: 30.04.06/13.43 Name Beobachter: gR
Filename des Fotos (Foto inkl. Referenz, z.B. Taschenmesser): 0403
Distanz zur WKA [m]: 58 Winkel zu WKA [Grad]: 43 Gewicht [g]: 10
Grösse (LxBxH) [cm]: 8x4x0.5 Art des Eises: Rauheis klares Eis
Wettercharakter: Bewölkung 2/Achtel innerhalb der Wolken
 Schneefall Regen Windrichtung: SO
Sonstige Bemerkungen (andere Vereisungseffekte):

Method



Zweck:
 Measurements and wind turbine performance analysis
 Testing atmospheric icing on structures
 / METEOTEST Bern

Icethrow Protocol



KW Gütsch Anlage in Betrieb? Ja Nein
 30.04.06/13.43 Name Beobachter: gr
 inkl. Referenz, z.B. Taschenmesser: 0402
 58 Winkel zu WKA [Grad]: 43 Gewicht [g]: 10
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 Bewölkung 2/Achtel innerhalb der Wolken
 Schneefall Regen Windrichtung: SO

Sonstige Bemerkungen (andere Vereisungseffekte):

Method



Methodik

- Not all events could be captured
- Inspection partly delayed
- Exact time of ice throw unknown
- No distinction between ice throw and ice fall



Inspections during 4 winters (2005 bis 2009)
→ **32 icing events** recorded
→ **228 ice fragments documented**
→ Also during summer

Ice throw study Gütsch



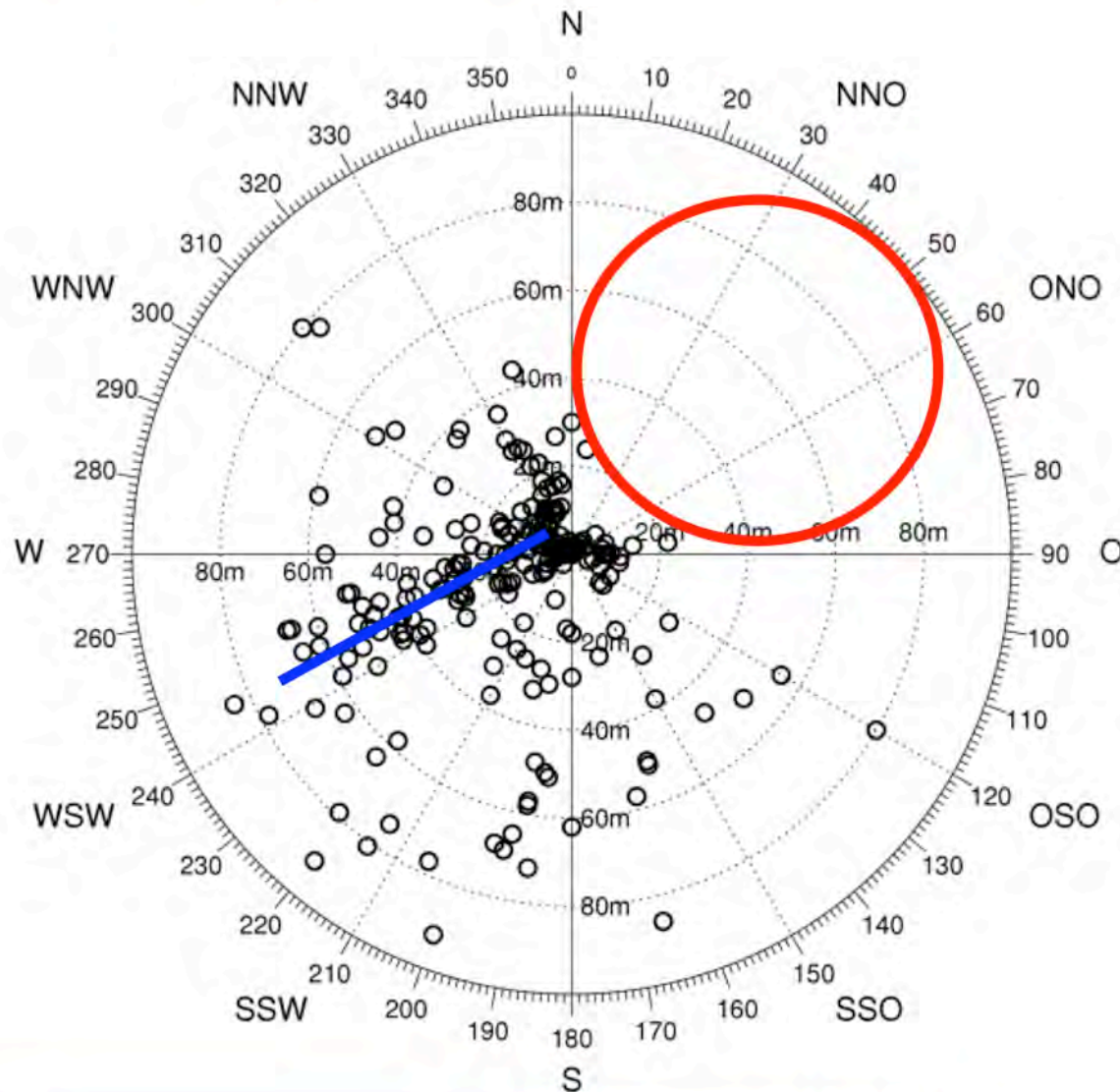
30.04.2006 13:37



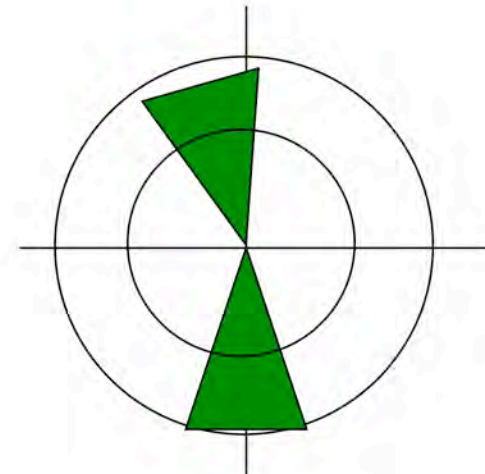
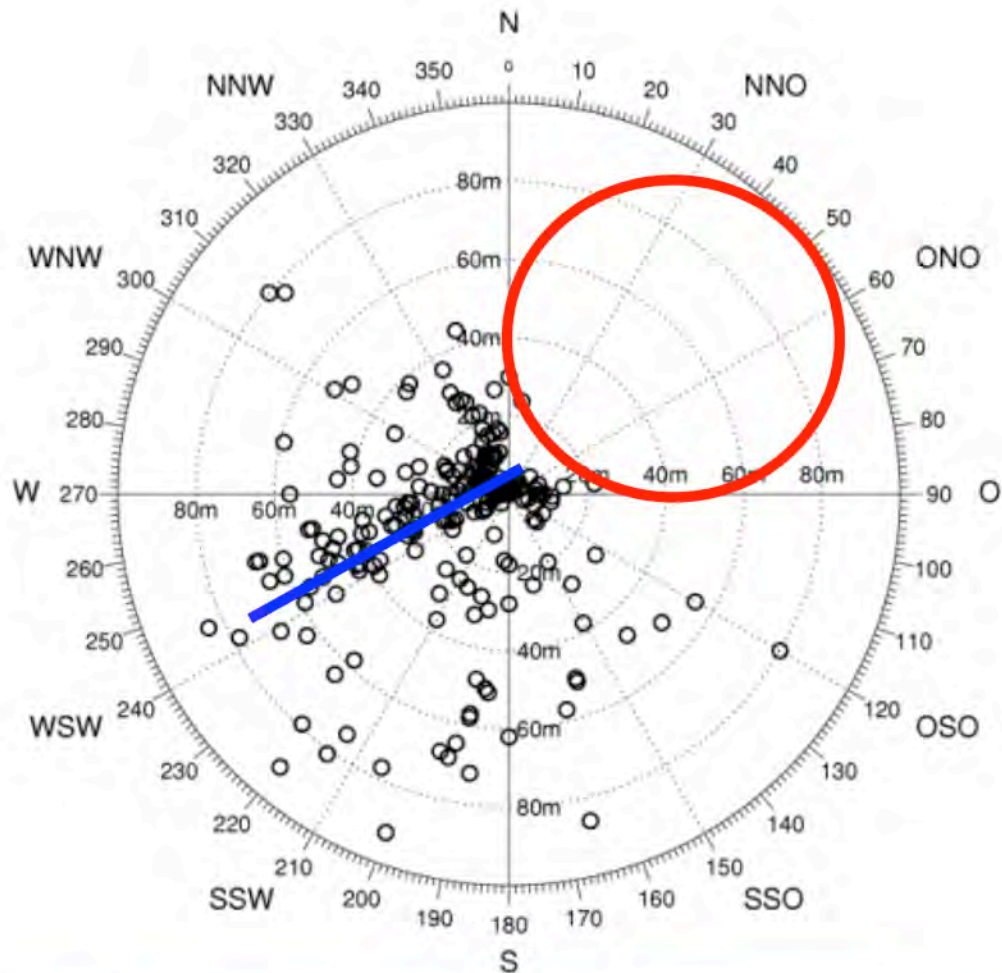
02.03.2007 14:40

Maximum distance: **92m** (2.25 rotor diameter)
Maximum weight: **1.8 kg**

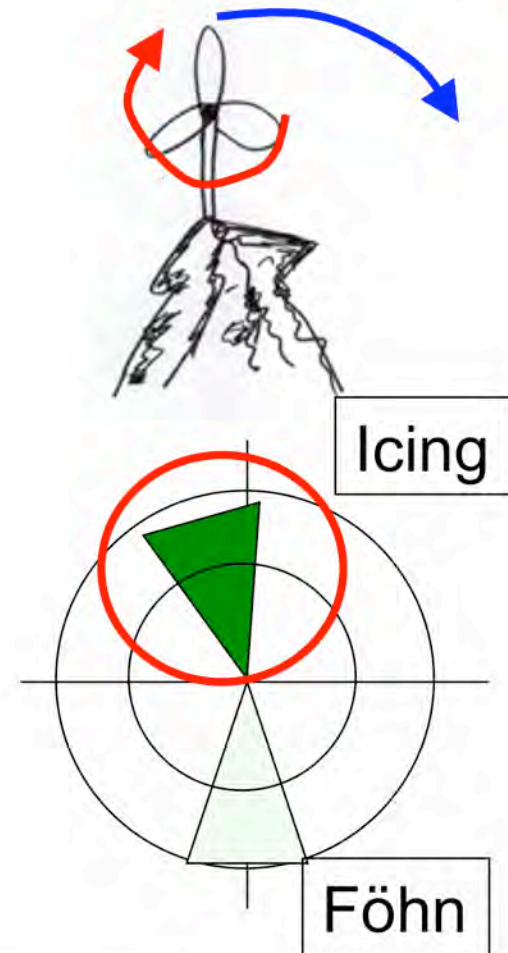
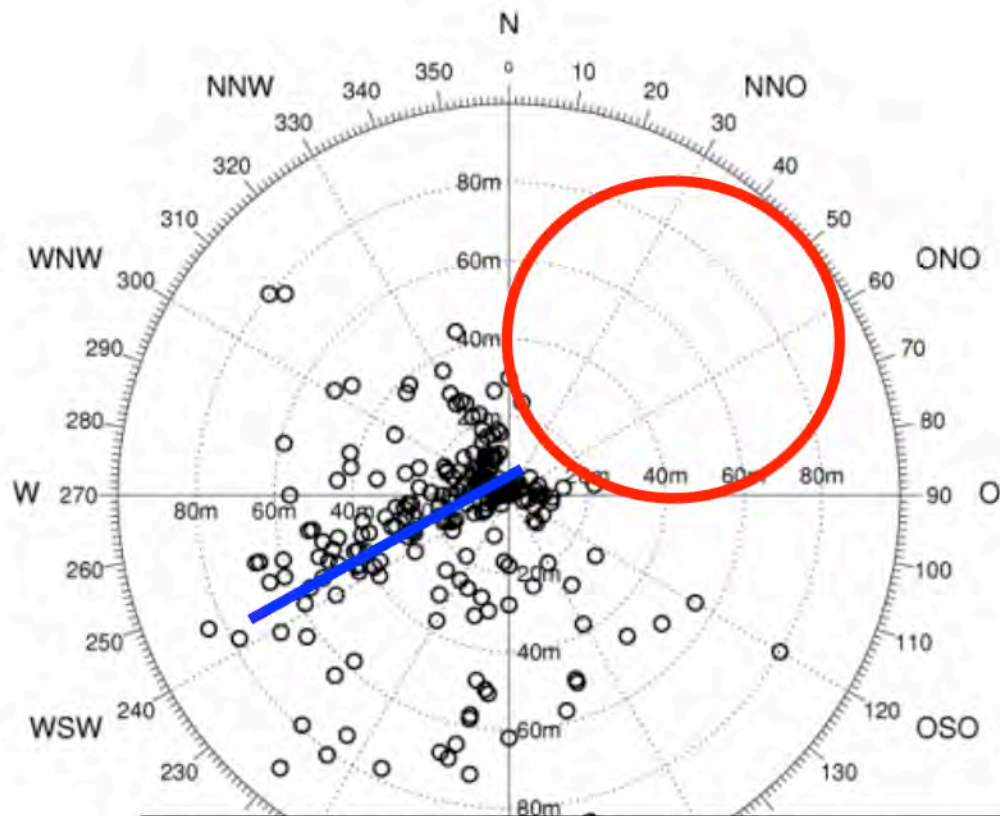
Ice throw study Gütsch



Ice throw study Gütsch



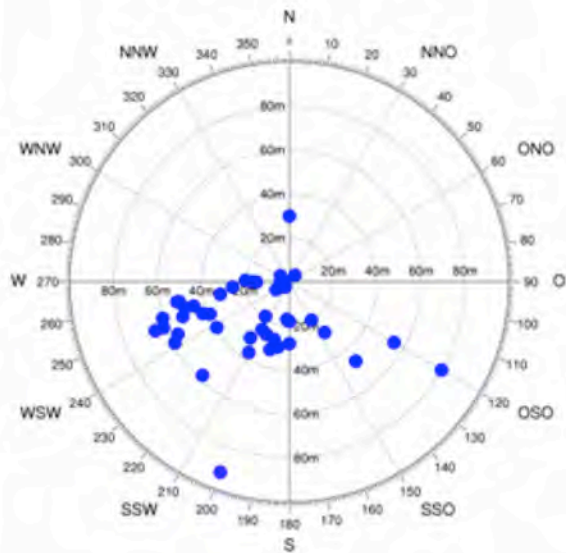
Ice throw study Gütsch



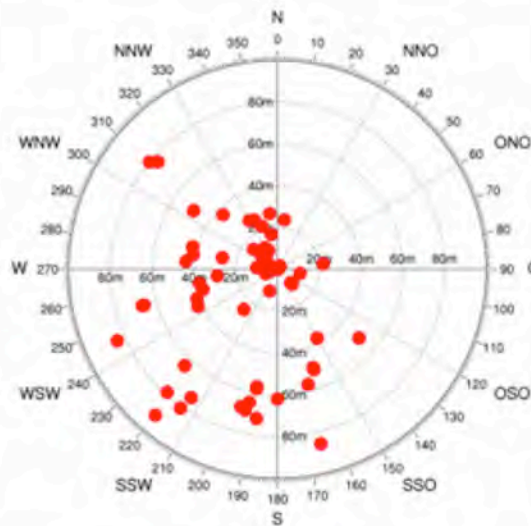
→ Risky areas seem to be dependant on wind statistics under icing consitions

Ice throw study Gütsch

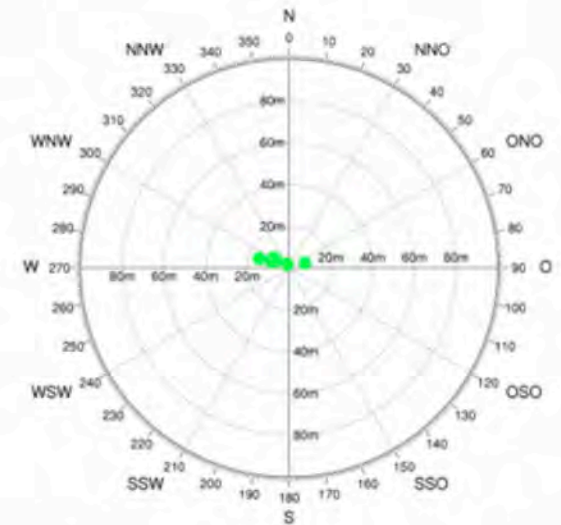
Types of ice



Rime



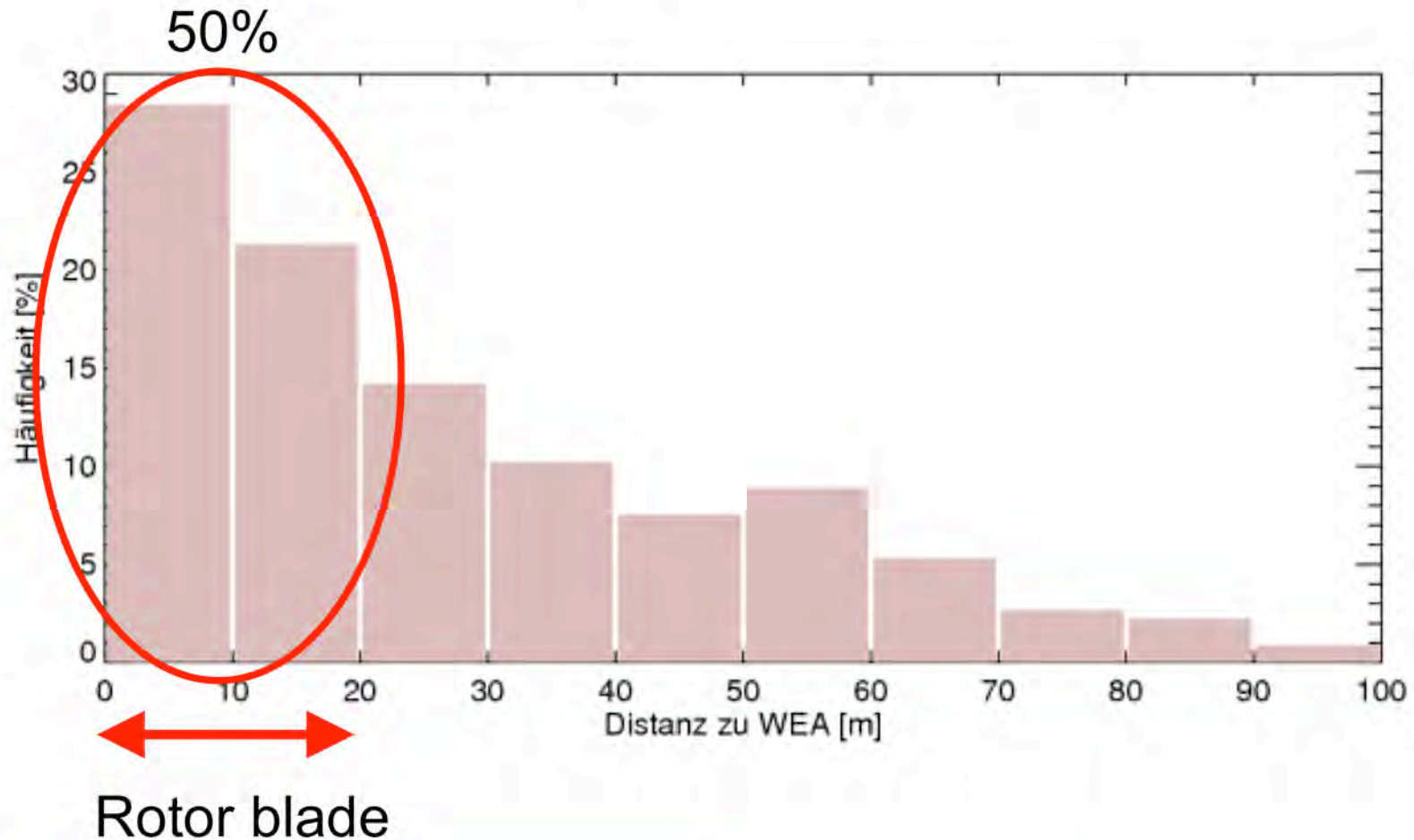
Glaze



Wet snow

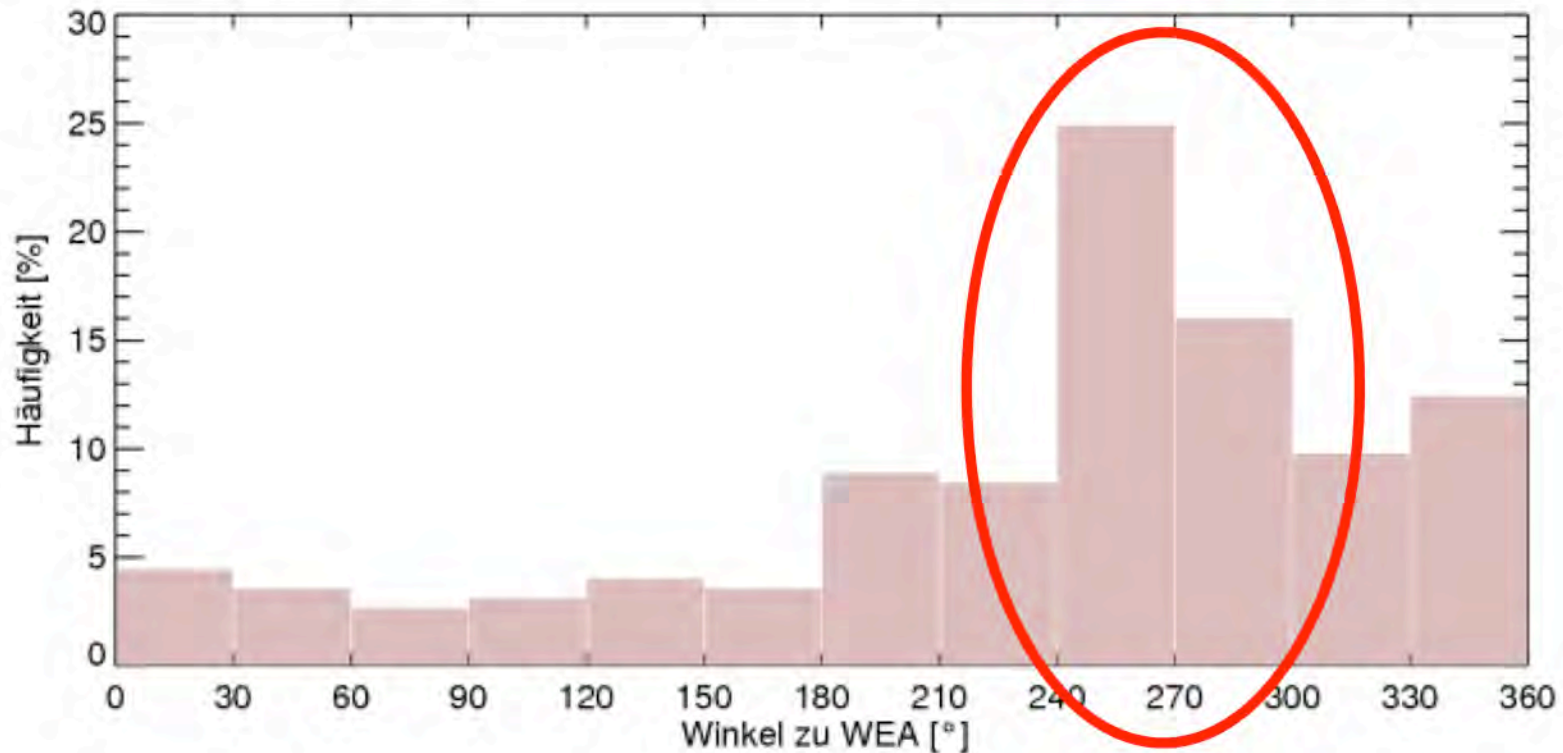
Ice throw study Gütsch

Distance to wind turbine

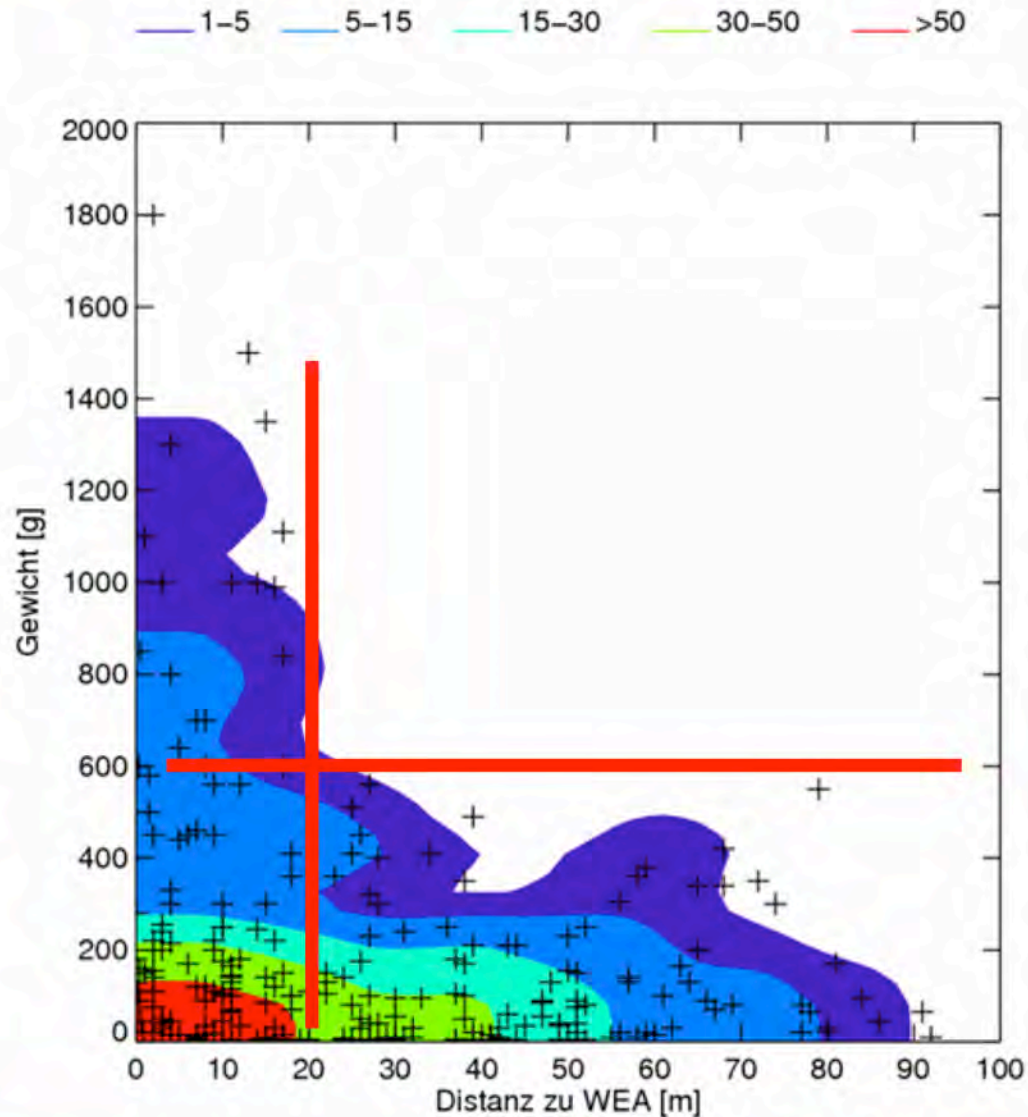


Ice throw study Gütsch

Angle relative to wind turbine



Ice throw study Gütsch



Conclusions

- Ice throw occurs
- Wind conditions during icing event define risk areas
- Ice throw when blade is moving downwards?
- 50% of ice fragments found under rotor blade
- Heavy ice fragments (> 600 g) under rotor blade
- Ice throw also during summer time

→ Übertragbarkeit der Resultate auf grössere WEA??

Counter measures

- Routing of winter walkway was changes
- Warning signs were installed



Conclusions

Further study during

2 Enercon E-82

Hub height 78 m

Enercon blade heating



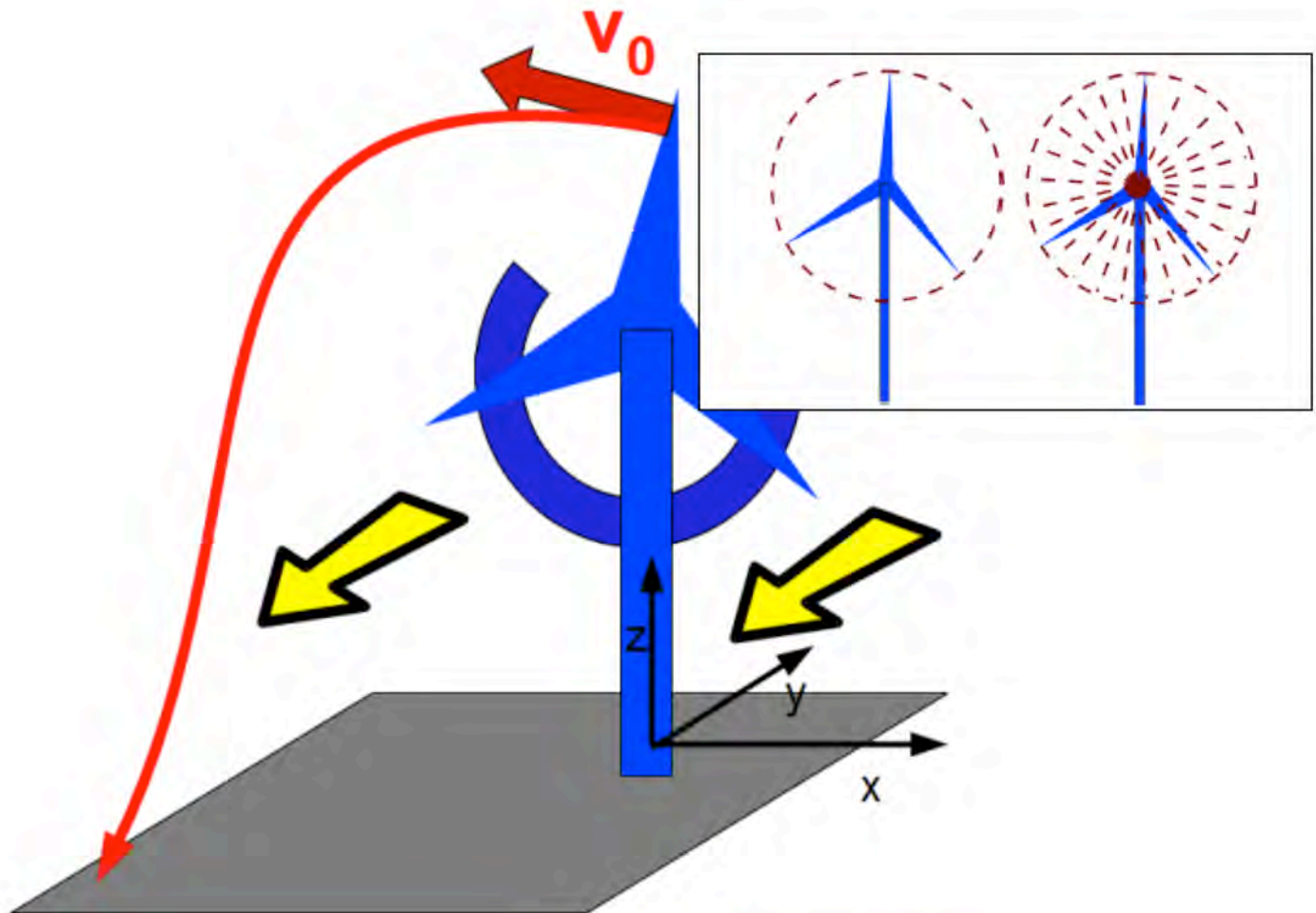
St. Brais
1'100 m asl



No real icing events so far

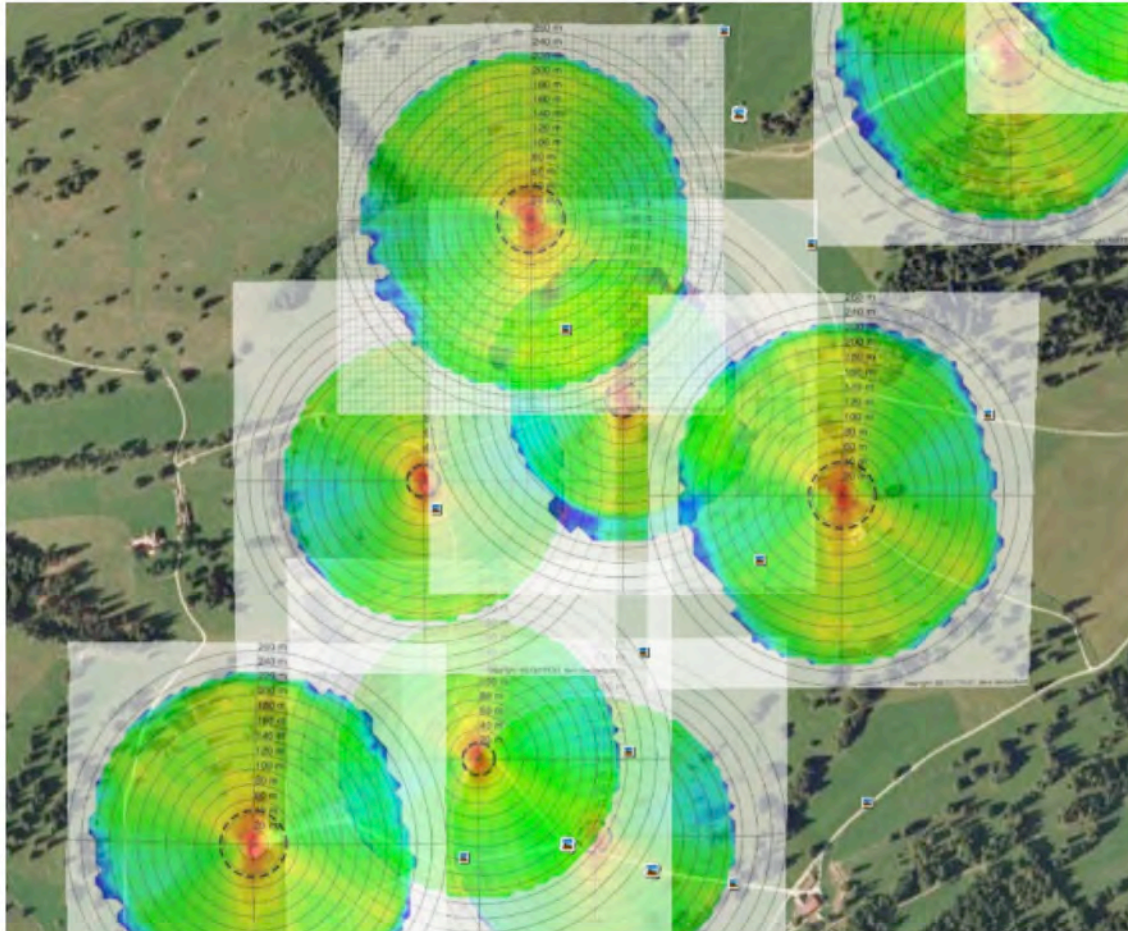
Ice throw model SWIM

- Simple **W**ind turbine **I**cethrow **M**odel



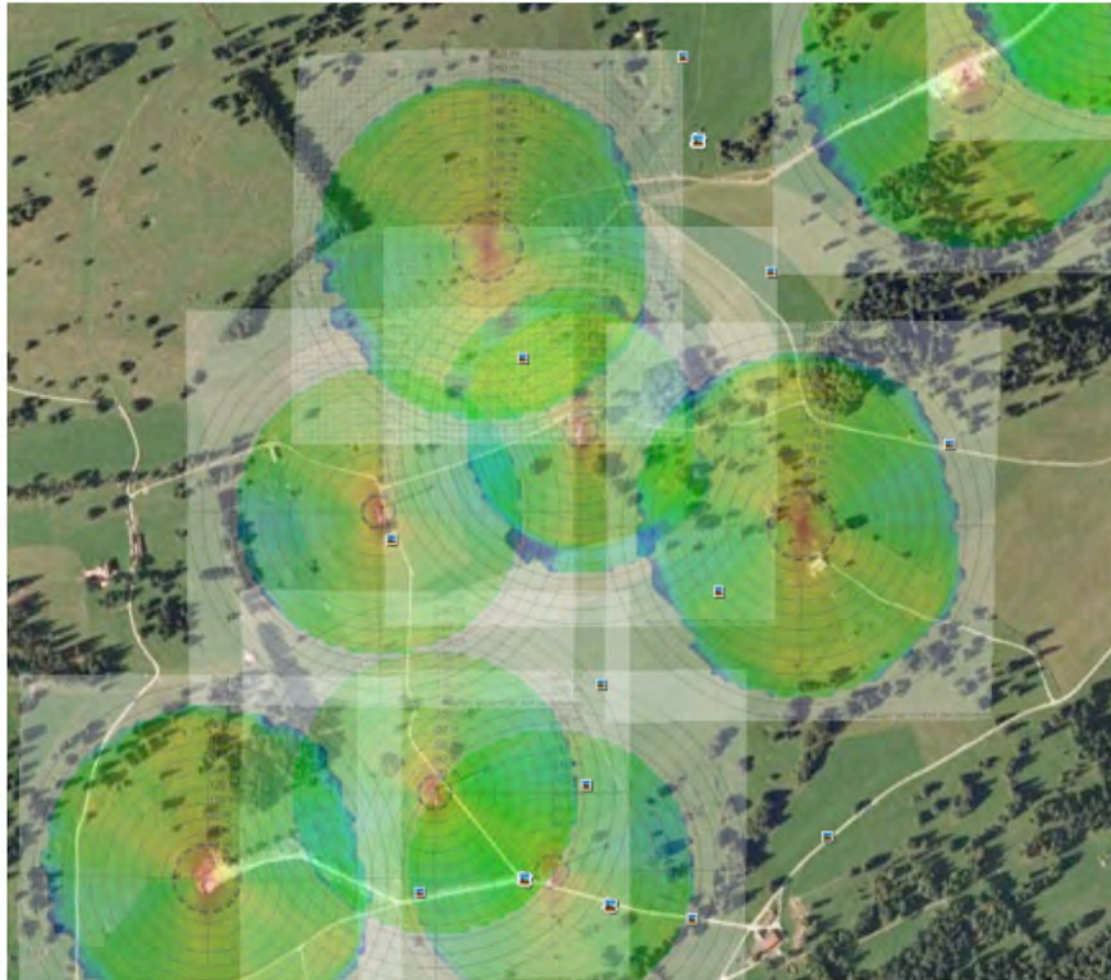
Ice throw model SWIM

- Simple Wind turbine Icethrow Model



Ice throw model SWIM

- Simple Wind turbine Icethrow Model



Thank you...



METEOTEST
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...for your attention