

Monitoring Icing Events

With remote cameras and image analysis

Presented by: **Matthew Wadham-Gagnon, eng.**

At WinterWind 2014

Dominic Bolduc, TechnoCentre éolien

Moulay Akhloufi, CRVI

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SNEEC

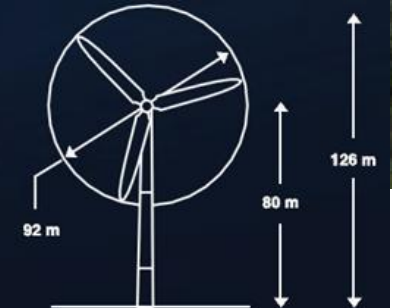
- Two 2.05 MW SENVION MM92 CCV



- Commissioned March 2010
- Icing & complex terrain
- R&D, technological transfer, technological validation, performance assessment.



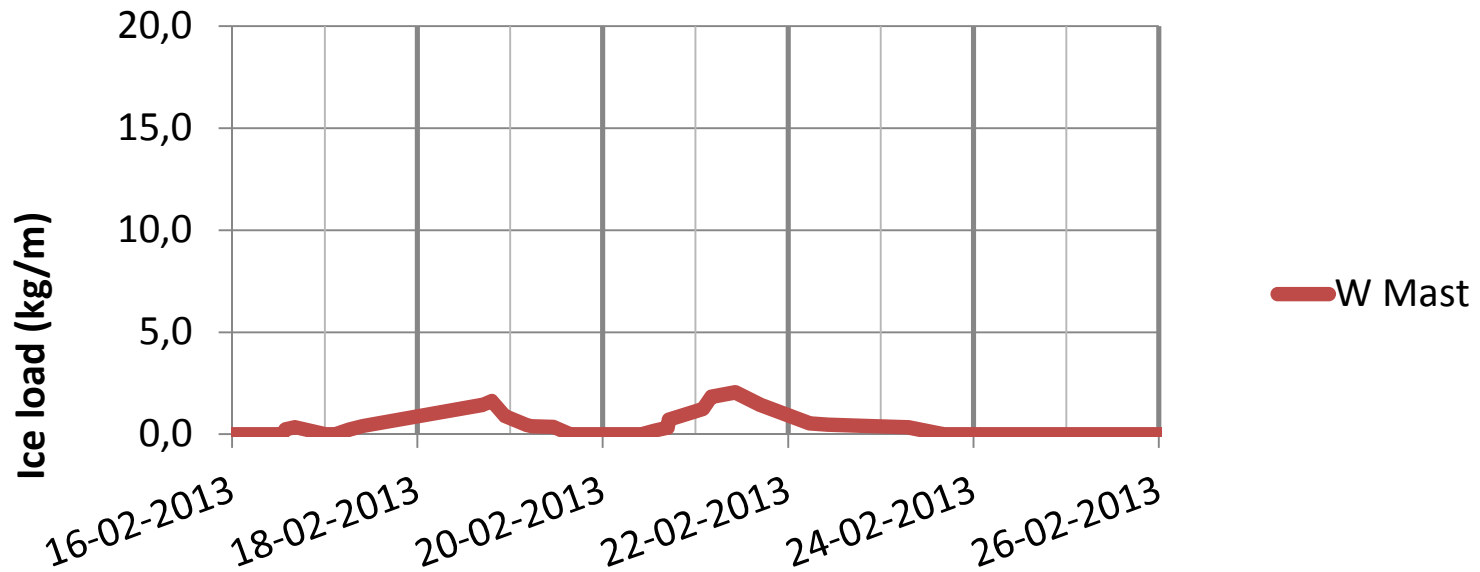
Description	Value
Number of wind turbines	2
Model	REpower MM92 CCV
Rated power / Wind turbine	2.05 MW
Frequency	60 Hz
Rotation speed	7.8 – 15 RPM
Start-up speed	3 m/s (10.8 km/h)
Shut-down speed	24 m/s (86.4 km/h)



IEC wind class: 2
 Annual average wind speed: 7.9 m/s
 Topography: Complex site with high turbulence, near the sea
 Temperature: -30°C to +30°C
 Ice conditions: Up to 40 mm of ice

Icing severity assessed on nacelle weather mast

Ice load estimated from width measurement on images



Hub camera



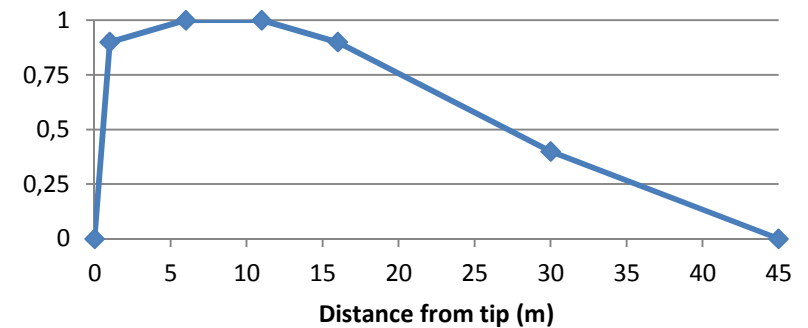
Hub camera – image analysis

Ice load estimated at 5 positions along span

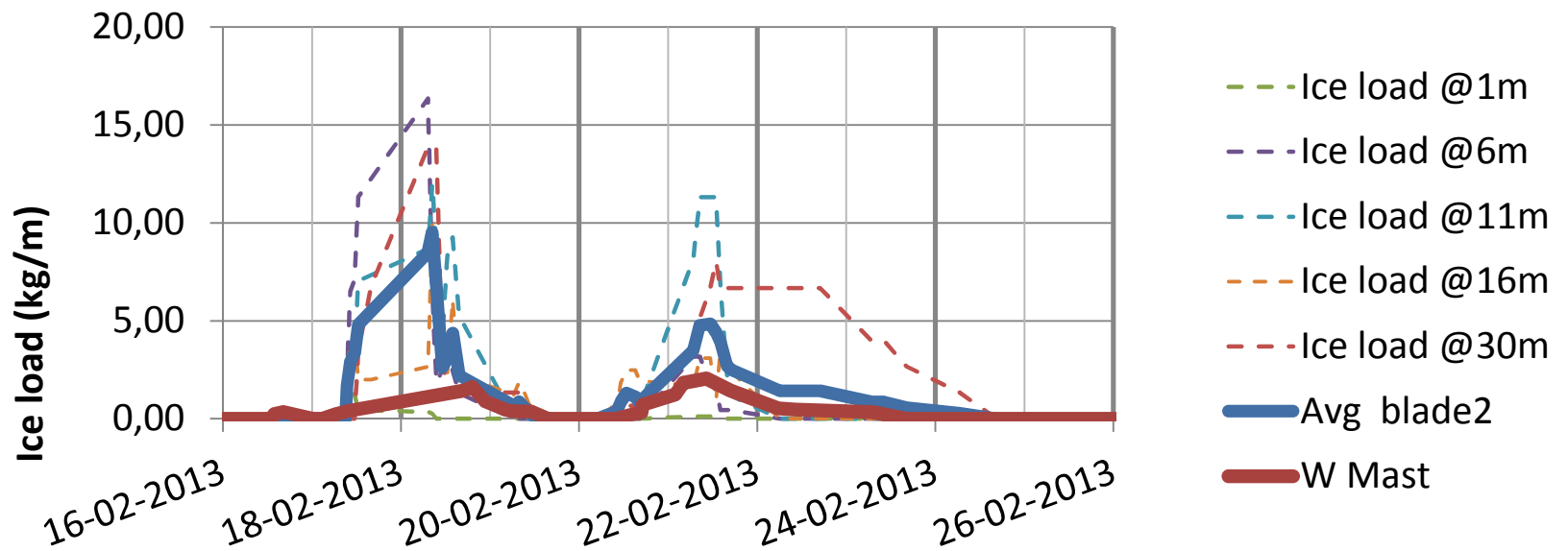
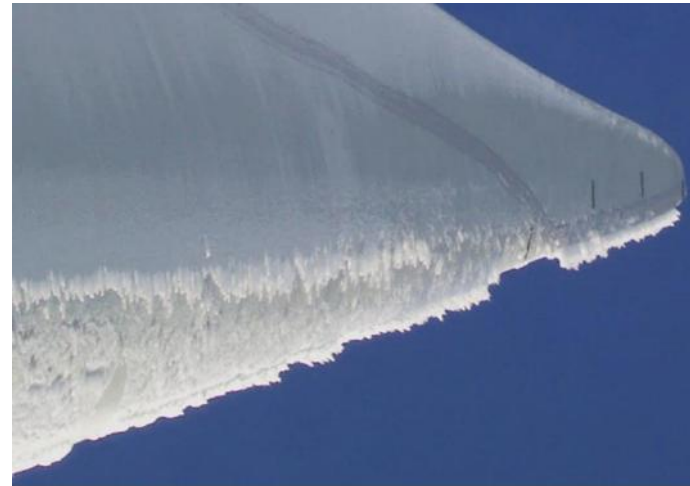
Average ice load determined base on weight function



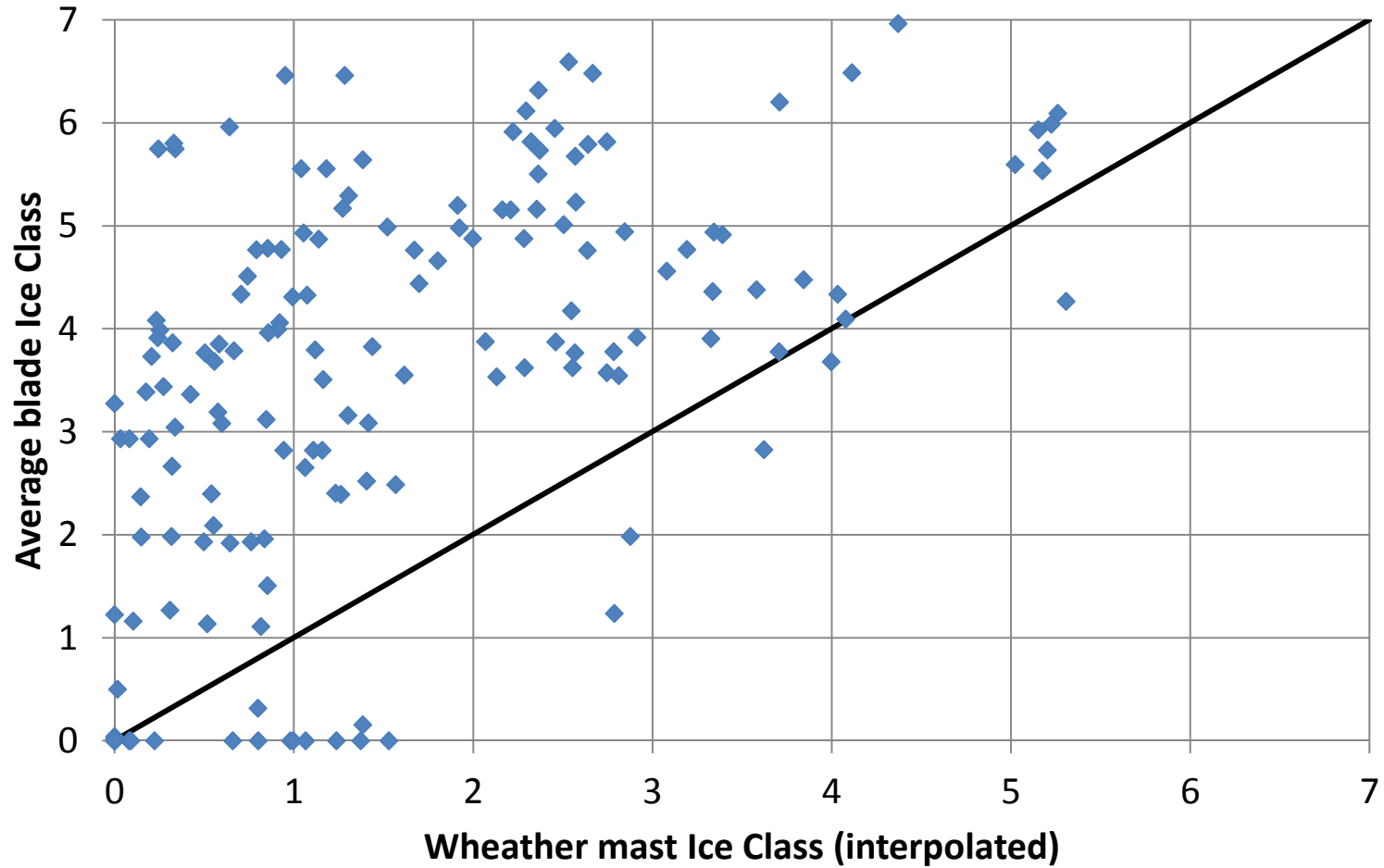
Weight function



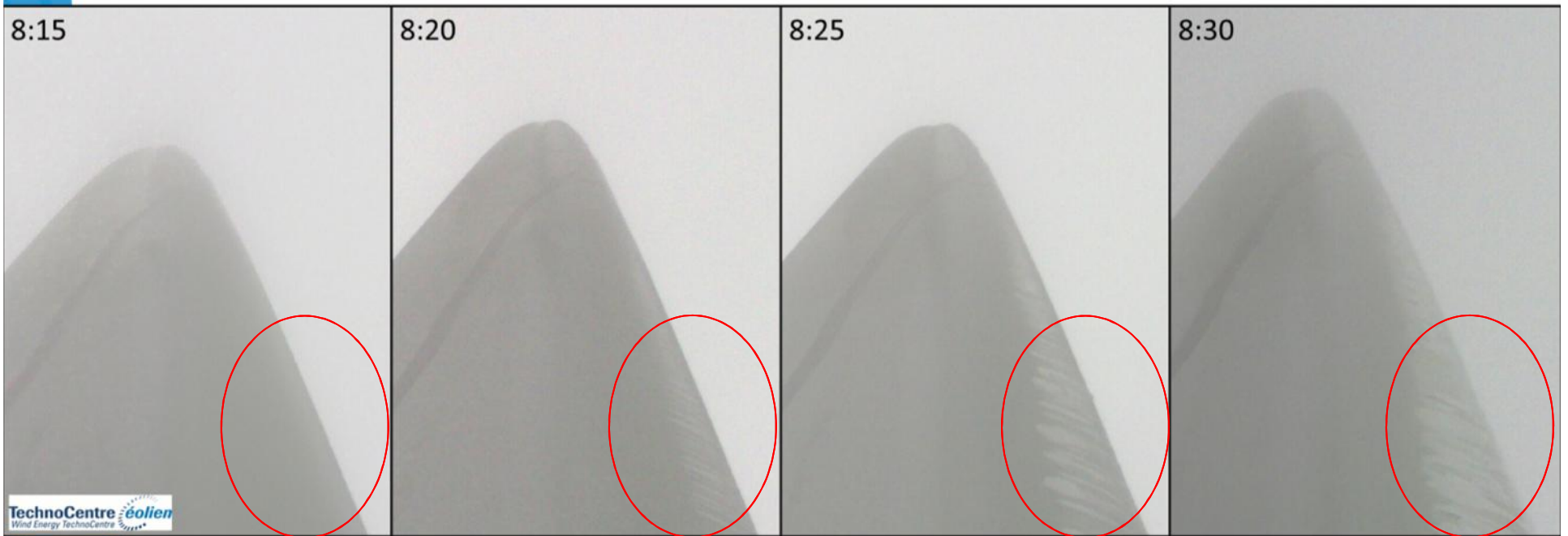
Icing severity assessed blades with hub camera



Blade vs WM icing



Hub camera – ice accretion

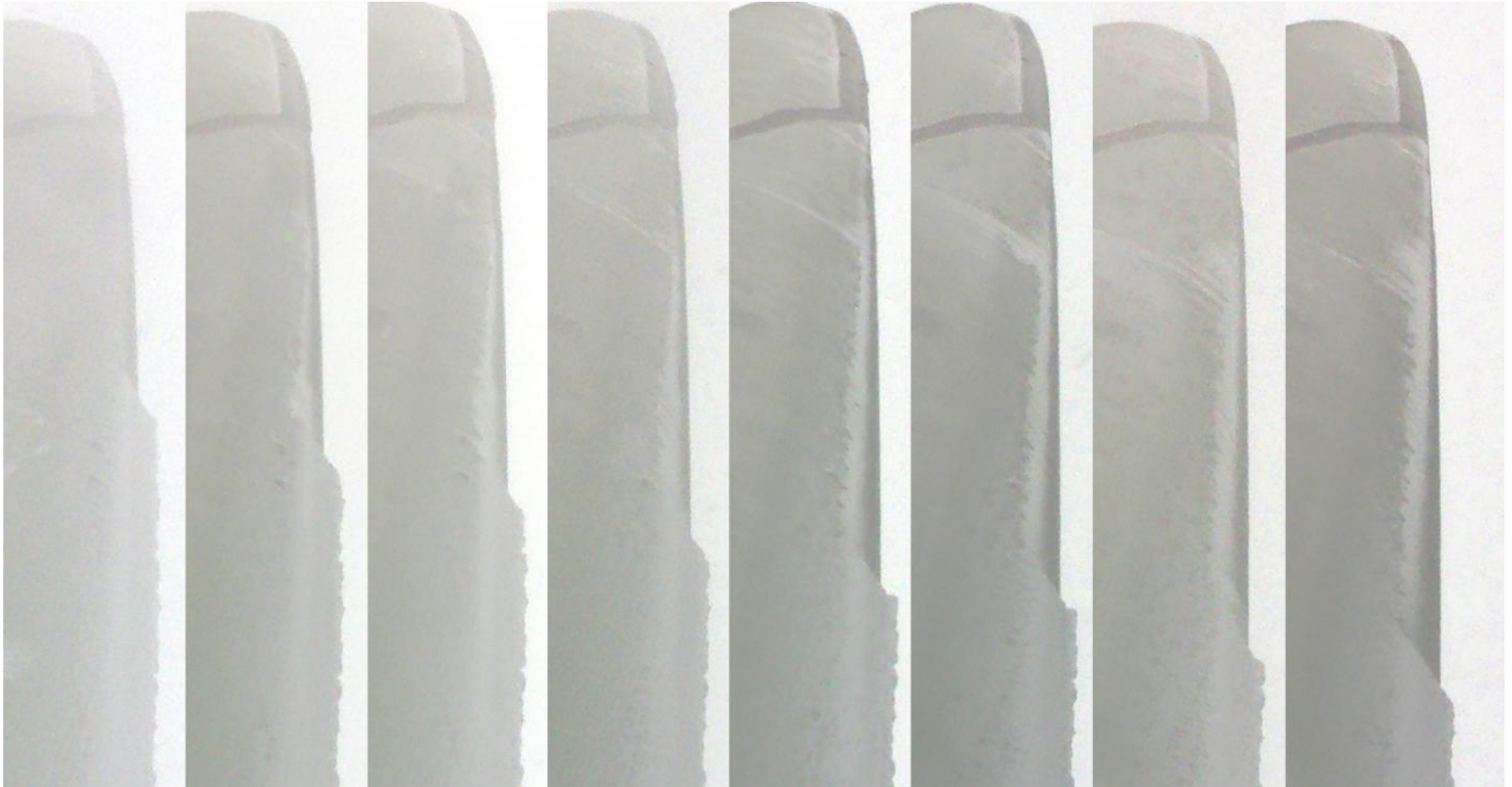


Hub camera – ice shed

10 min. later



Hub camera – ice shed over 1 hour



Conclusions

- Presence of ice on weather mast indicates presence of ice on blades
- Ice load on weather mast underestimates ice load on blades
- Hub camera provides insight on ice accretion and ice shed

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