



Ice Detection Methods and Measurement of Atmospheric Icing

Matthew Wadham-Gagnon, eng. M.Eng.

Nigel Swytink-Binnema, Dominic Bolduc, Cédric Arbez

2015-06-30

Presentation Outline

- Introduction
- Site and Ice Detection Methods
- Annual and Monthly Statistics
- Icing Events of Interest
- Conclusions and Future Work

Background



Vindteknikk.com



www.aere.iastate.edu

Image: TCE/SENVION



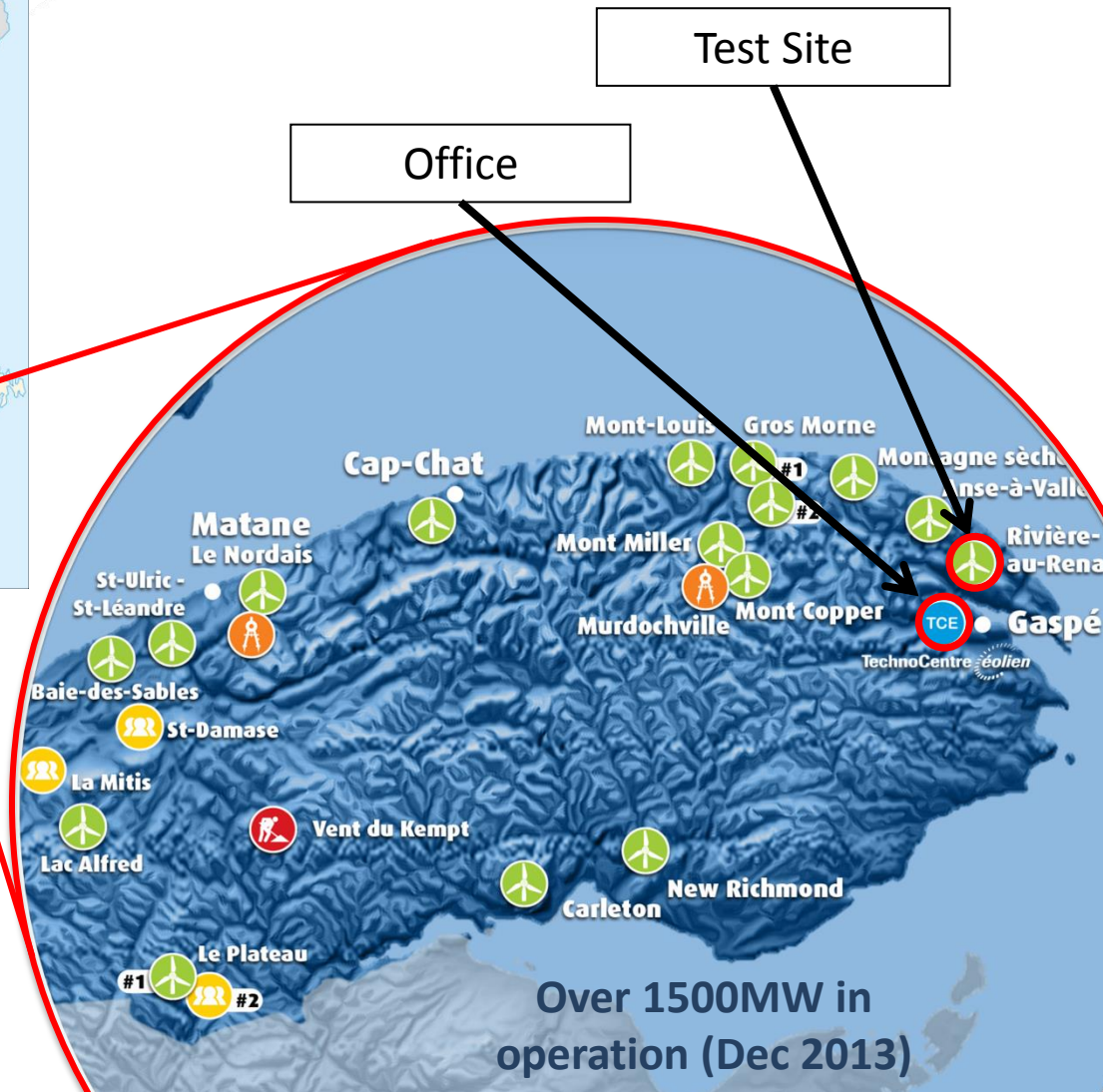
TCE met mast,
Mt Needle, QC



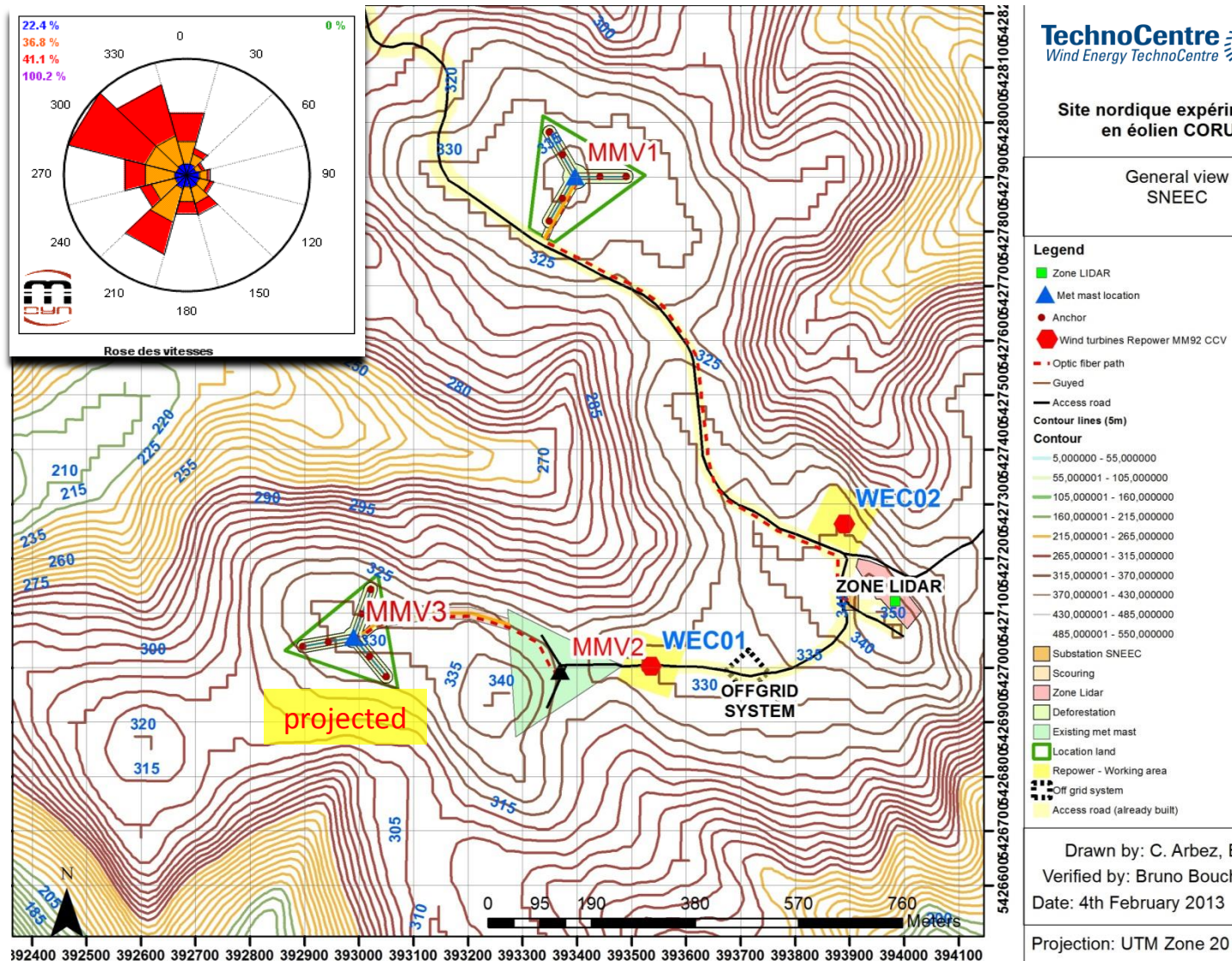
TCE



TechnoCentre éolien (TCE)



Topographical layout



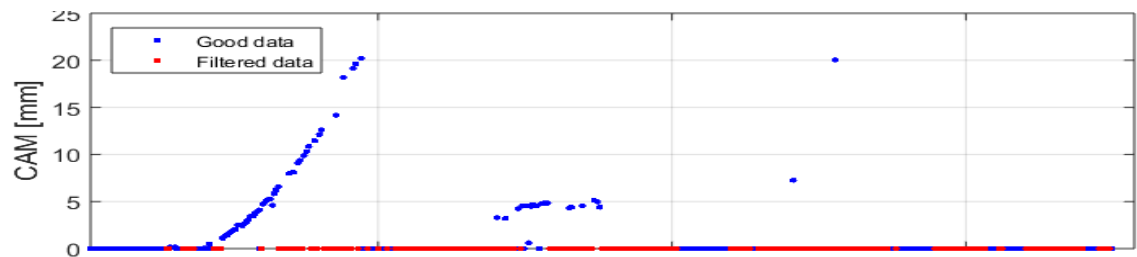
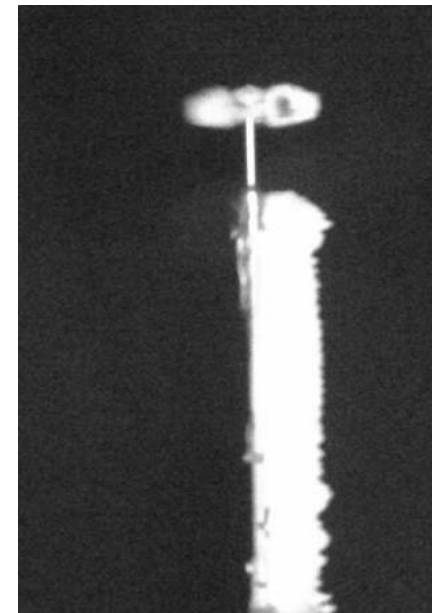
Met Mast

Name	MMV1
Height (AGL)	126 m
Base Altitude (ASL)	343 m
Tower type	Tripod permanent guyed wire CSA S37-01
Location	Rivière-au-Renard (QC)



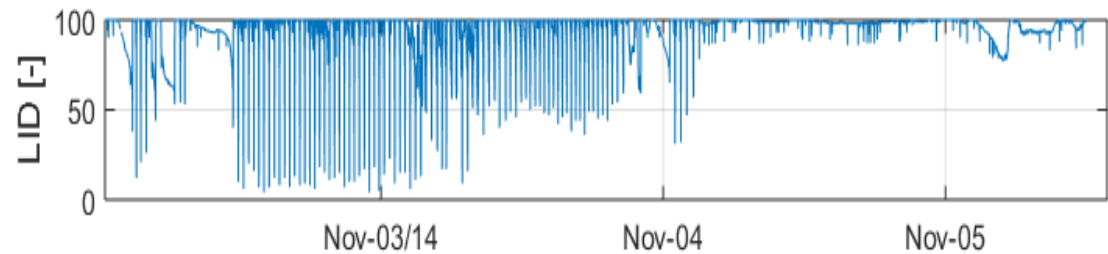
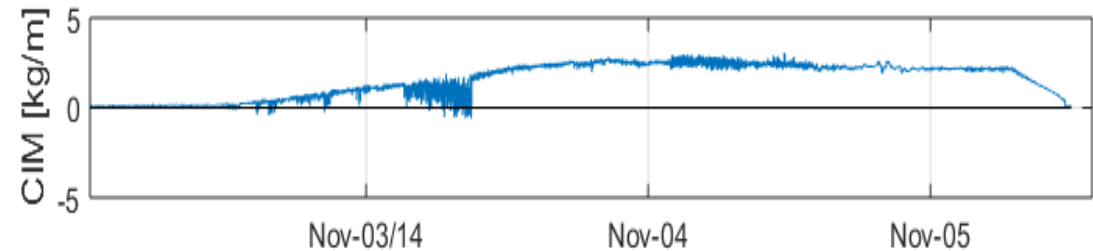
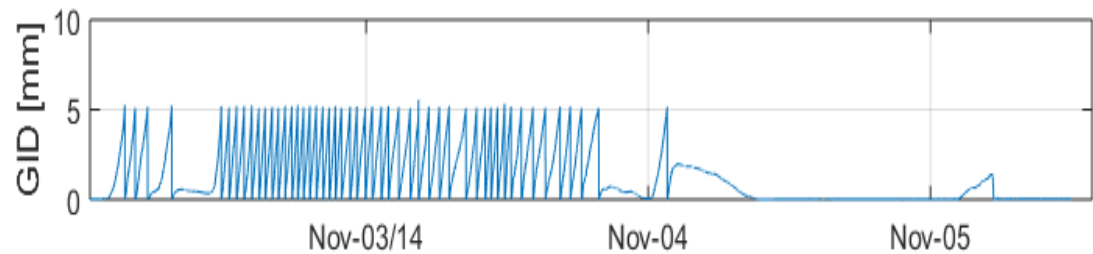
Ice detection methods

Method	CAM	CIM	GID	LID	LWCT	HVT	RHT	WDD	WSD
Sensor	Camera	Combitech Ice Monitor	Goodrich 0872F1	Labkotek LID-3300IP	MRR & T	HV, T	RH, T	WV	HUA, UCA



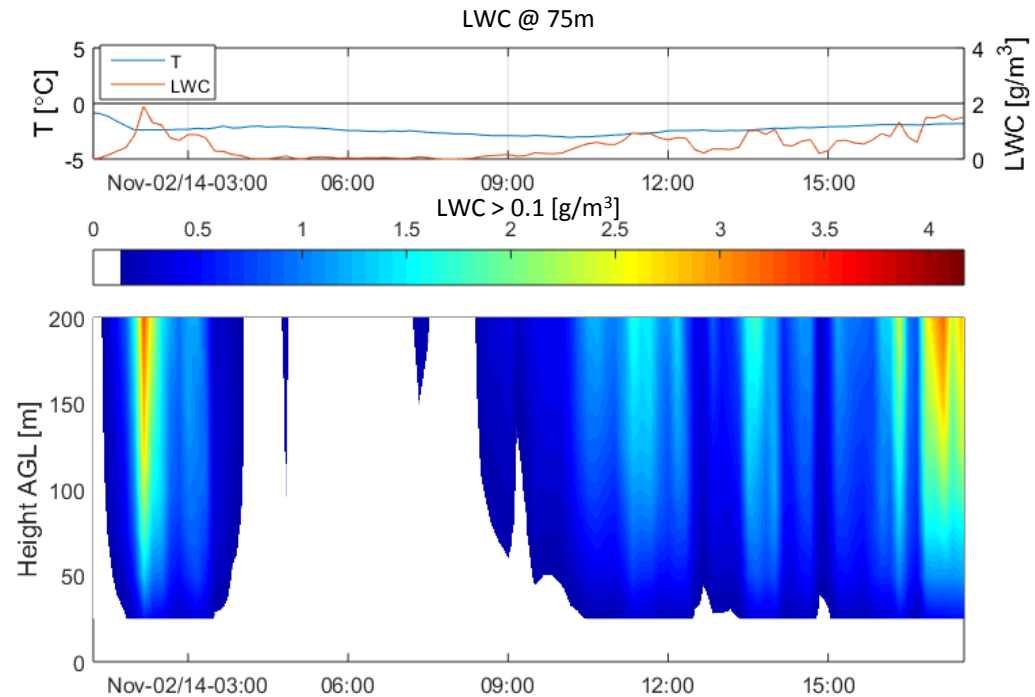
Ice detection methods

Method	CAM	CIM	GID	LID	LWCT	HVT	RHT	WDD	WSD
Sensor	Camera	Combitech Ice Monitor	Goodrich 0872F1	Labkotec LID-3300IP	MRR & T	HV, T	RH, T	WV	HUA, UCA



Ice detection methods

Method	CAM	CIM	GID	LID	LWCT	HVT	RHT	WDD	WSD
Sensor	Camera	Combitech Ice Monitor	Goodrich 0872F1	Labkotec LID-3300IP	MRR & T	HV, T	RH, T	WV	HUA, UCA



Ice detection methods

Method	CAM	CIM	GID	LID	LWCT	HVT	RHT	WDD	WSD
Sensor	Camera	Combitech Ice Monitor	Goodrich 0872F1	Labkotek LID-3300IP	MRR & T	HV, T	RH, T	WV	HUA, UCA



CSI CS120



Thies Vane Compact



Thies First Class

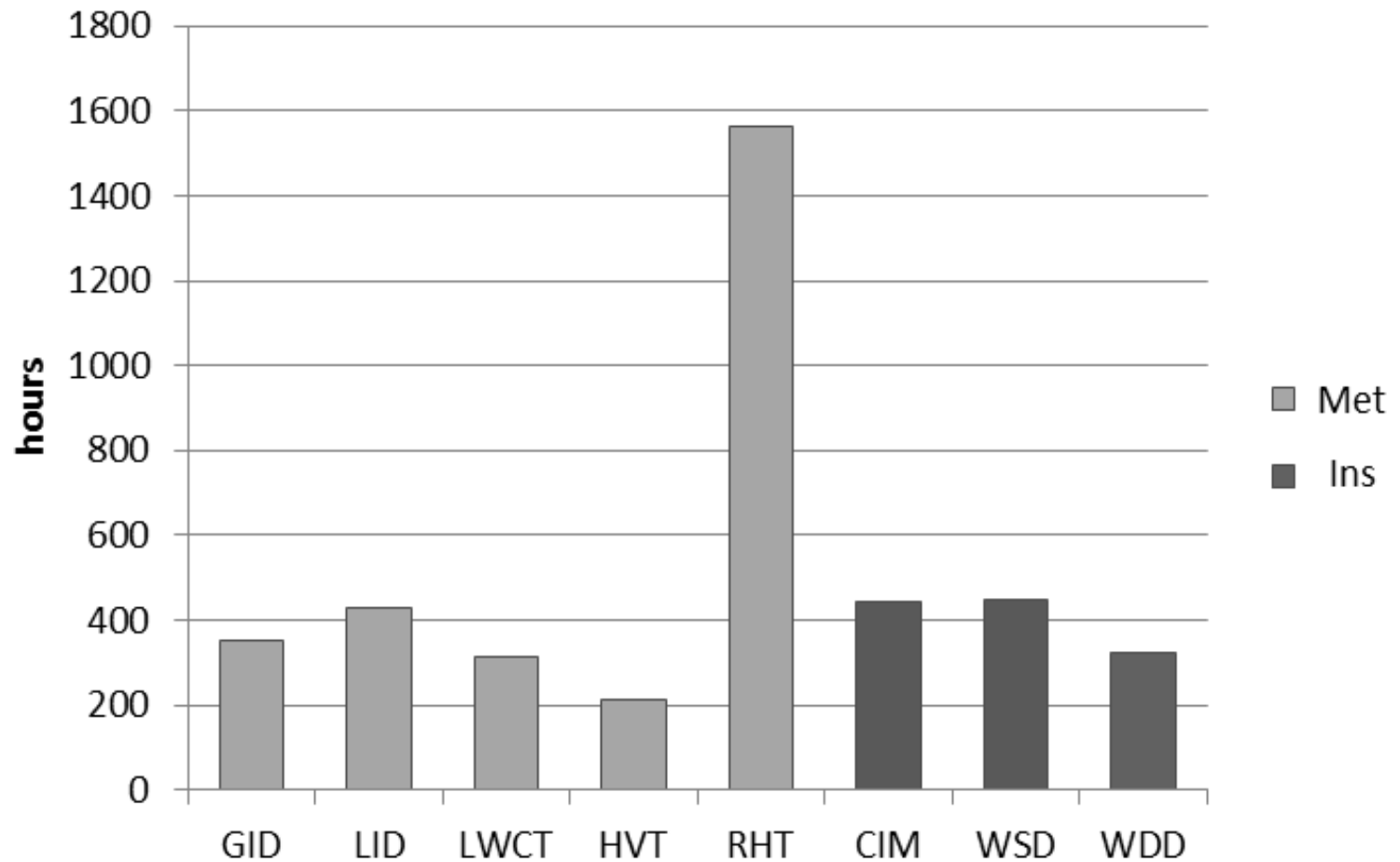


Vaisala HMP60

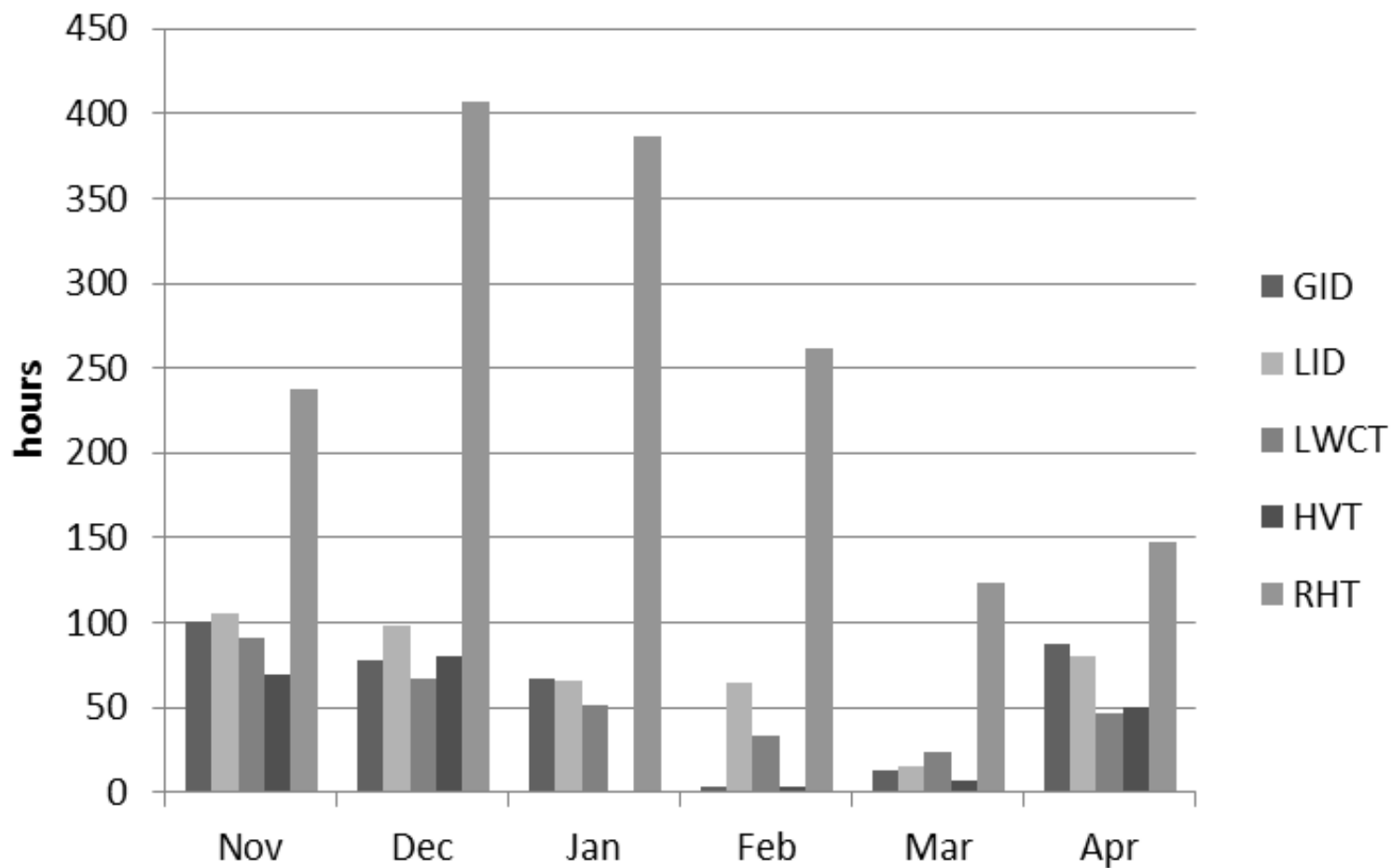


NRG RT240

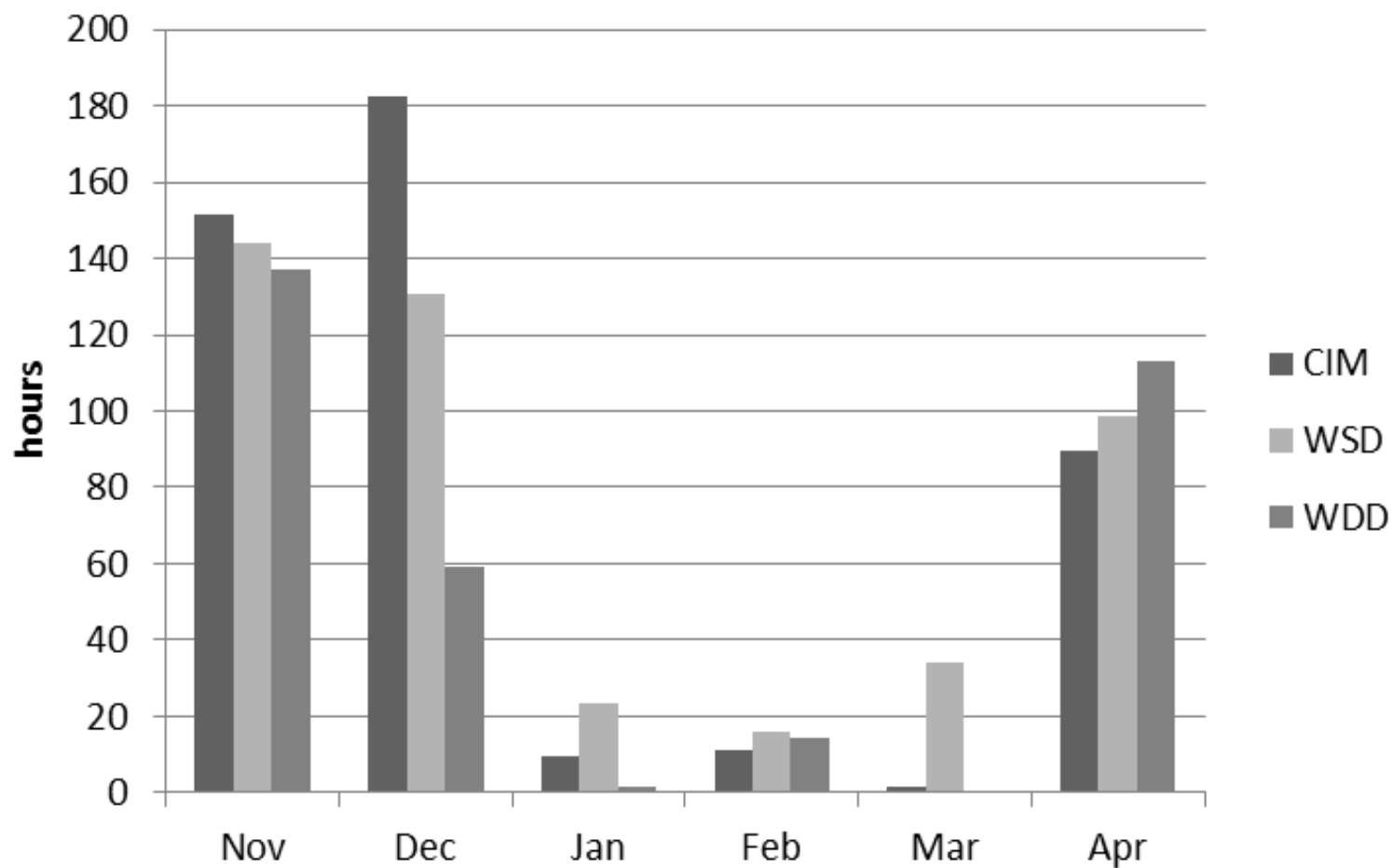
Annual Statistics



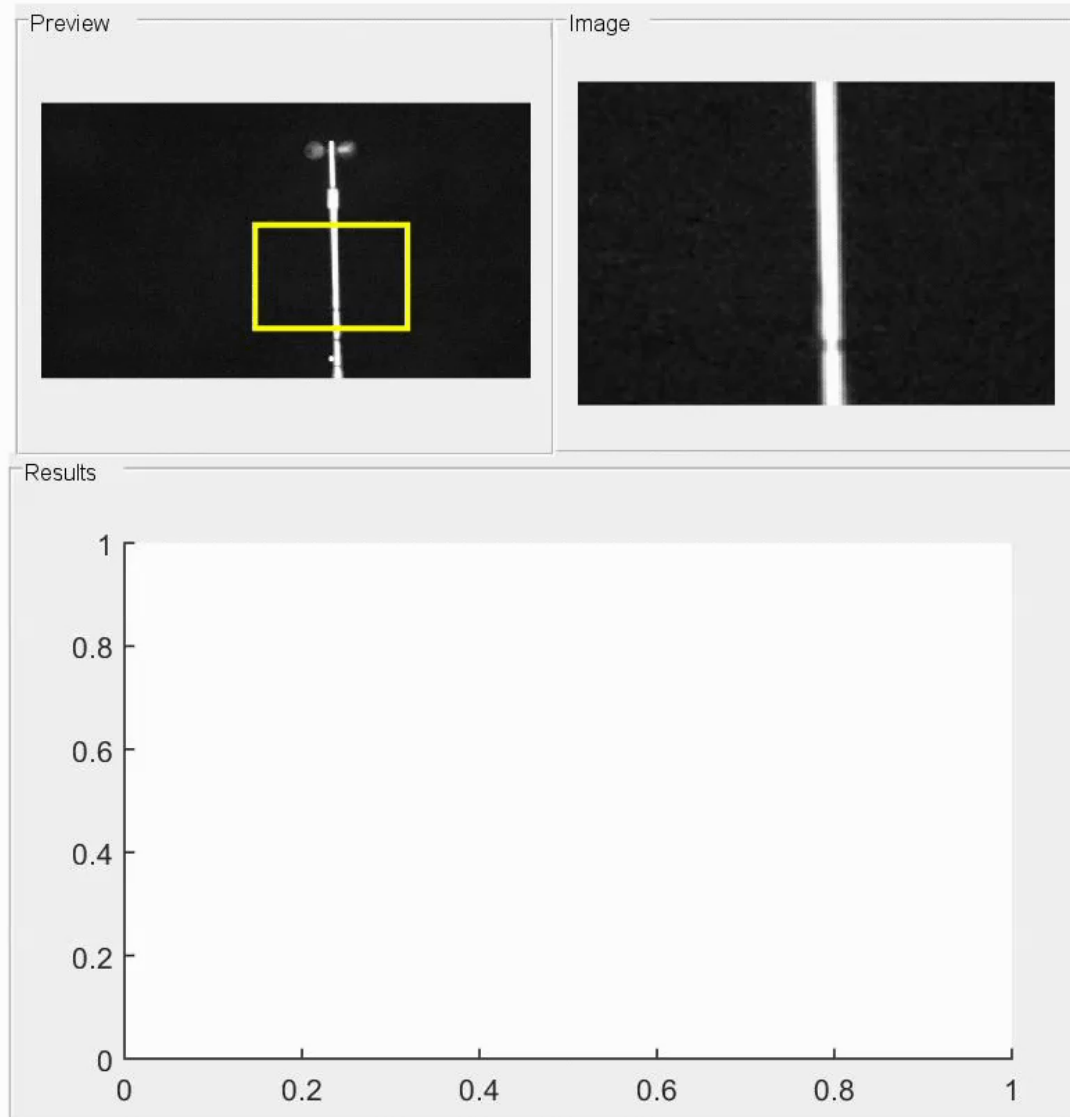
Monthly Statistics – Met Icing



Monthly Statistics – Ins Icing

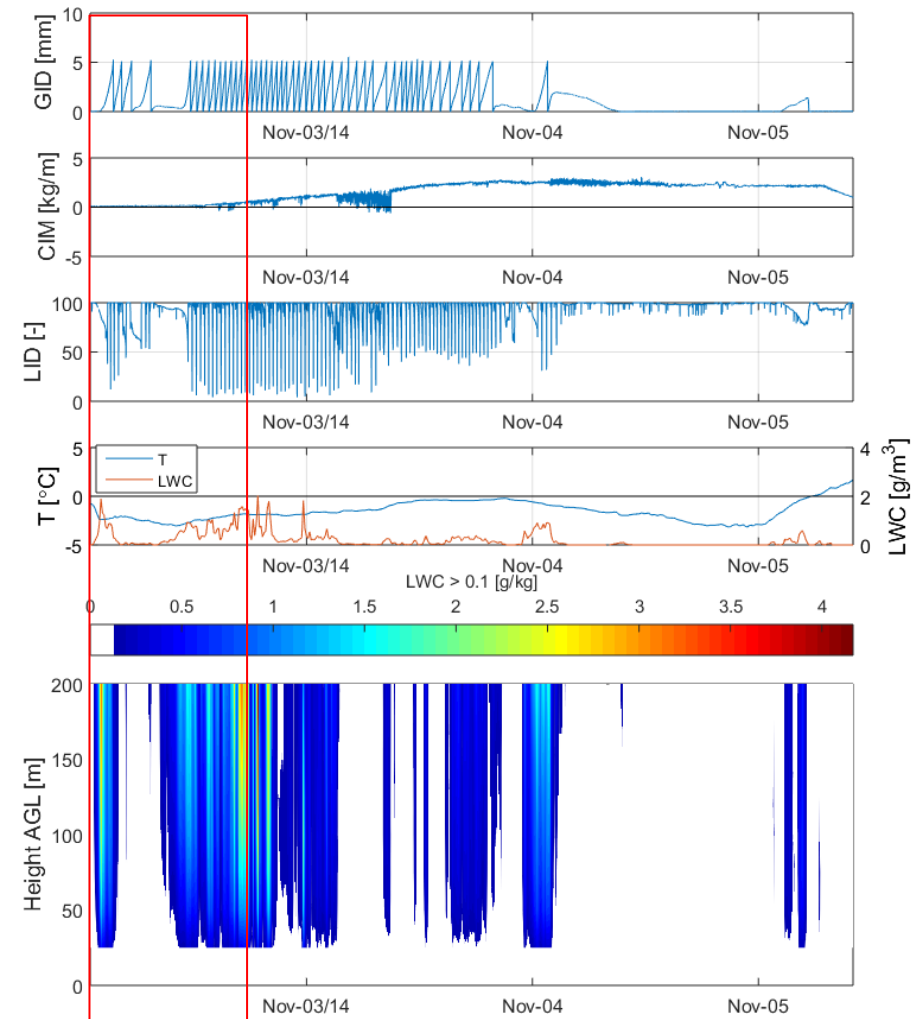
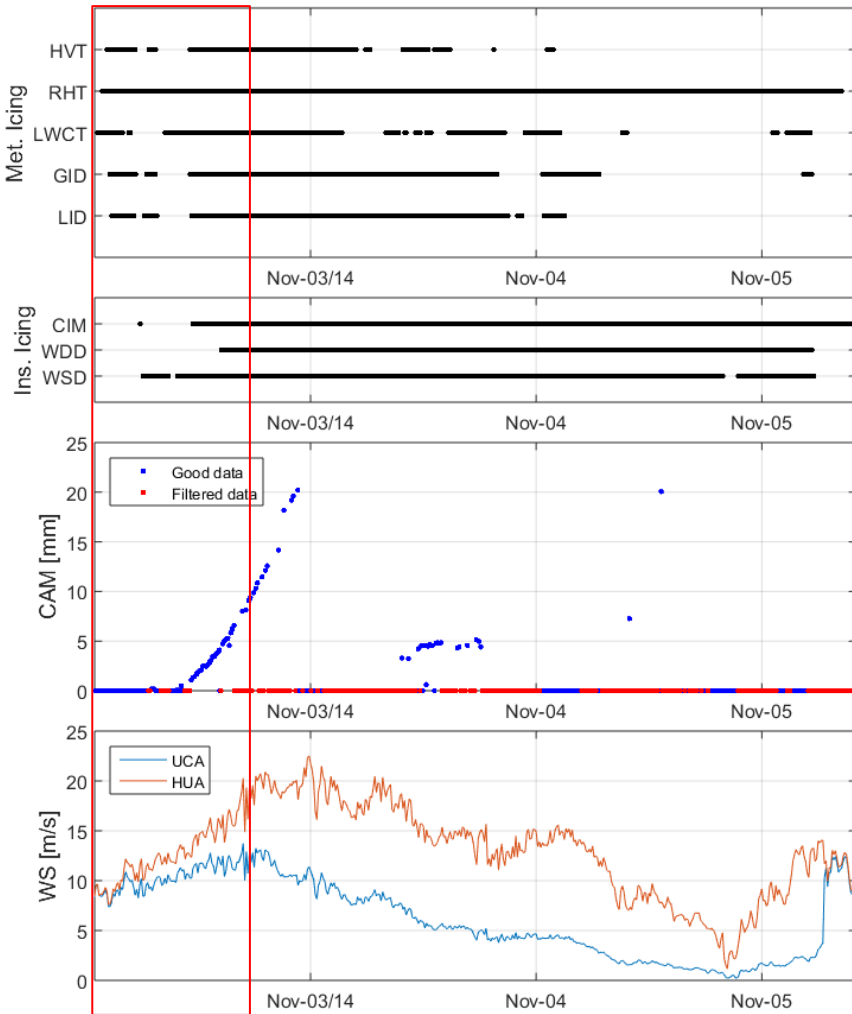


Icing Event of Interest 1



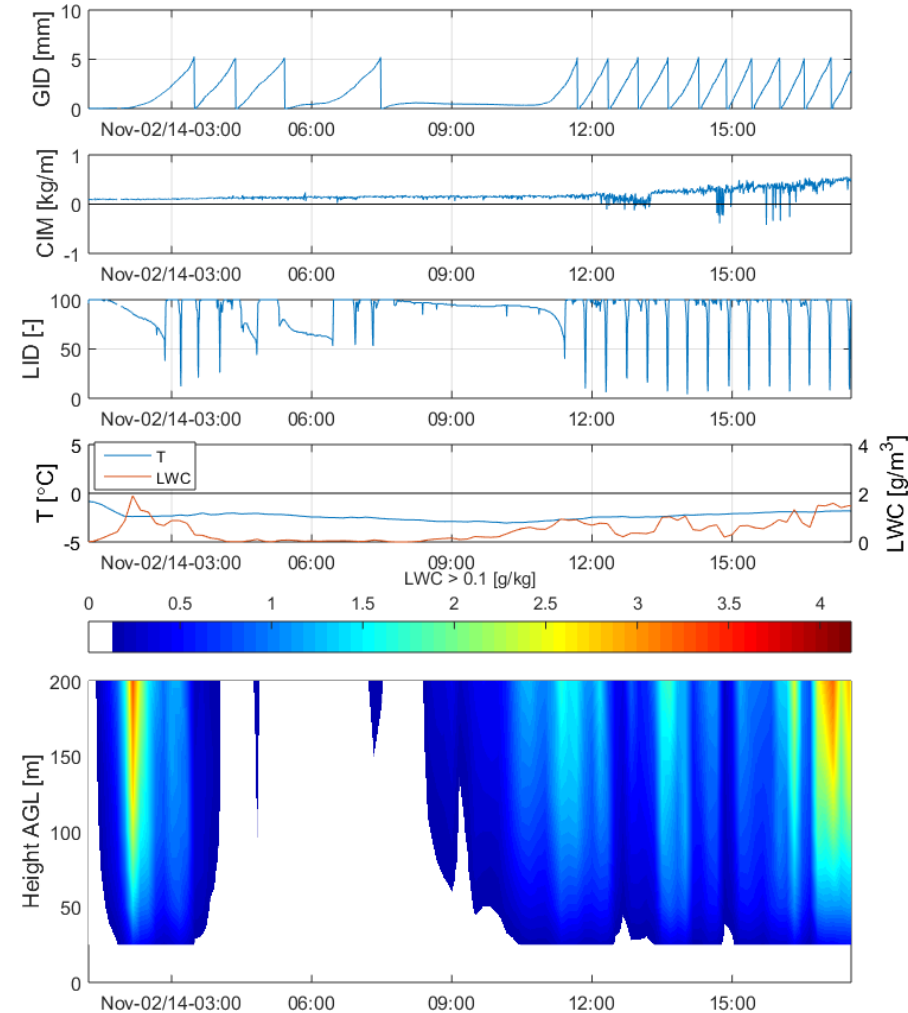
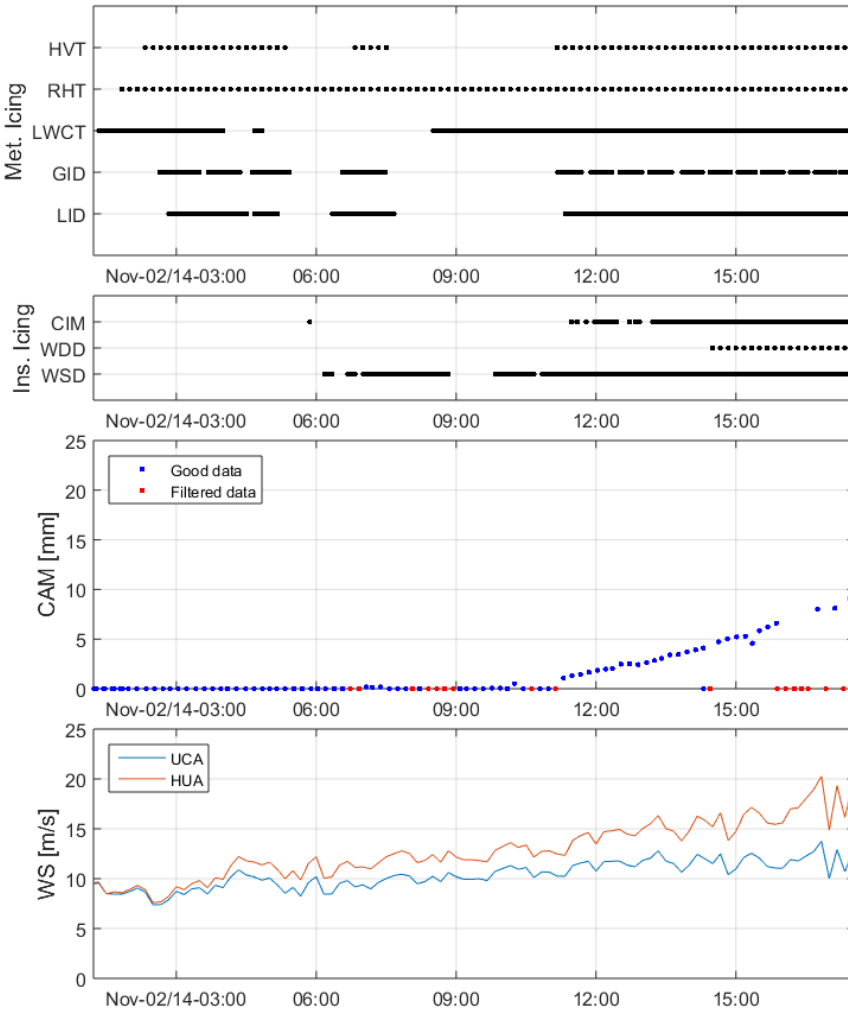
Icing Event of Interest 1

Event #1: 02-Nov-2014 to 05-Nov-2014

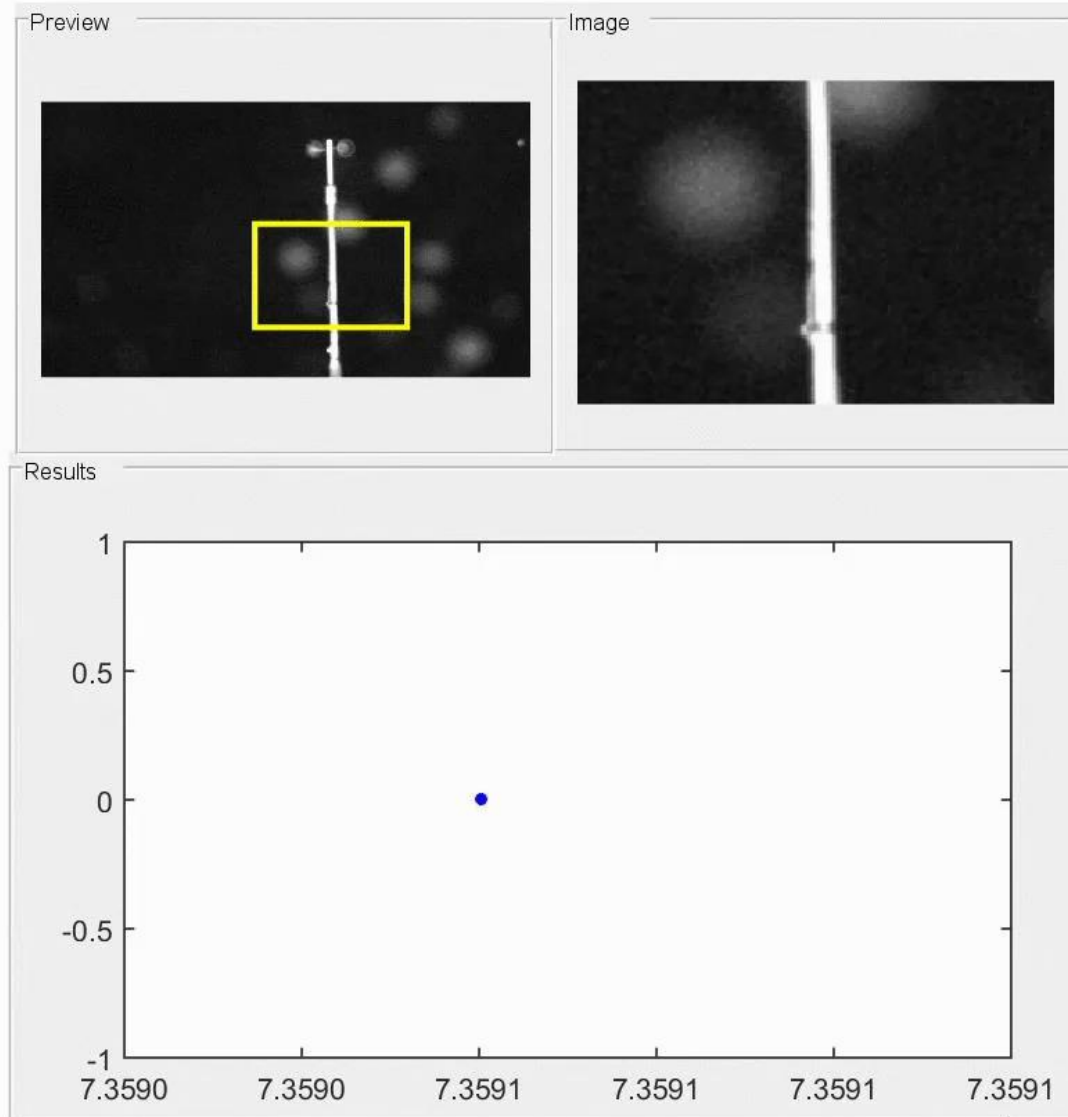


Icing Event of Interest 1

Event #1: 02-Nov-2014 to 05-Nov-2014

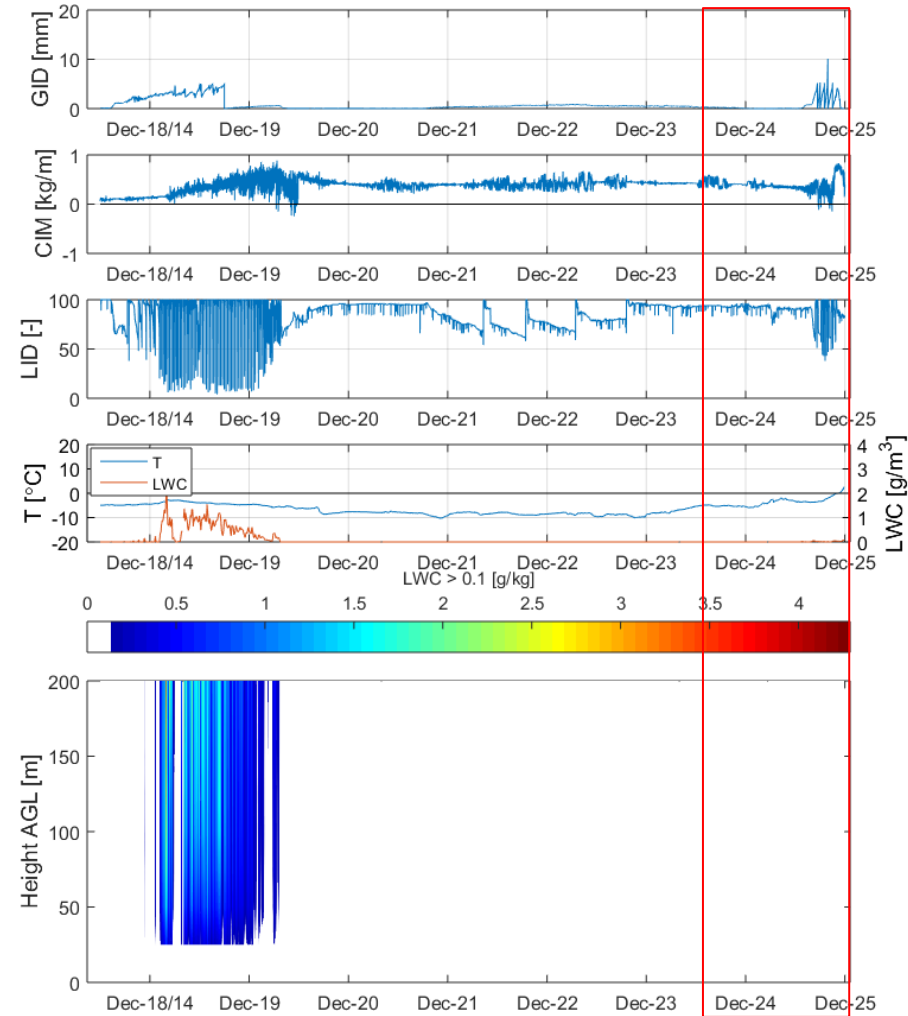
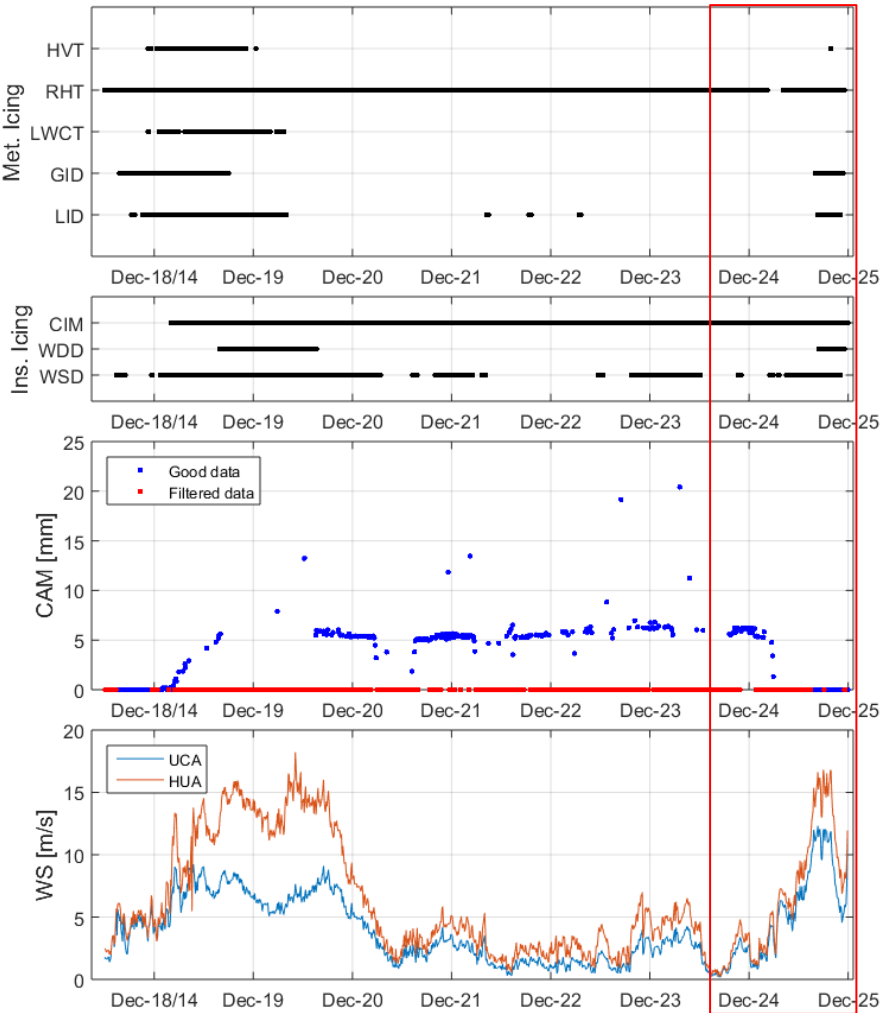


Icing Event of Interest 2



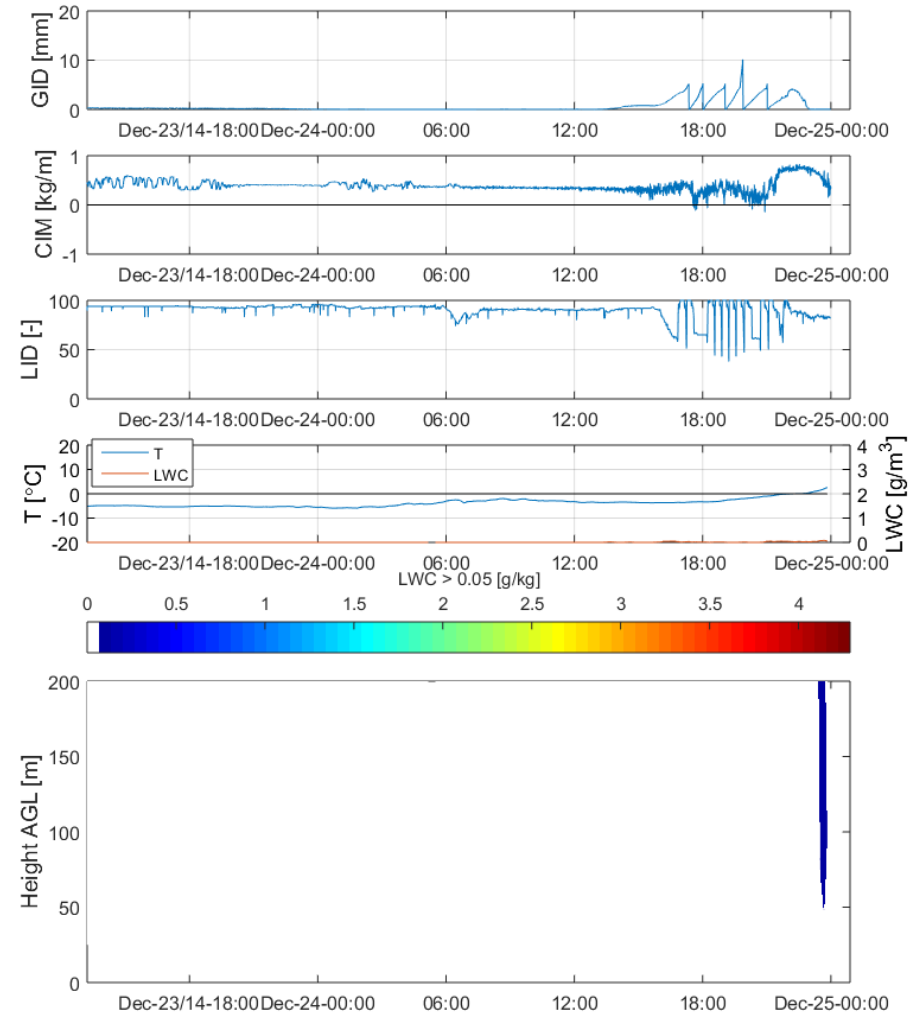
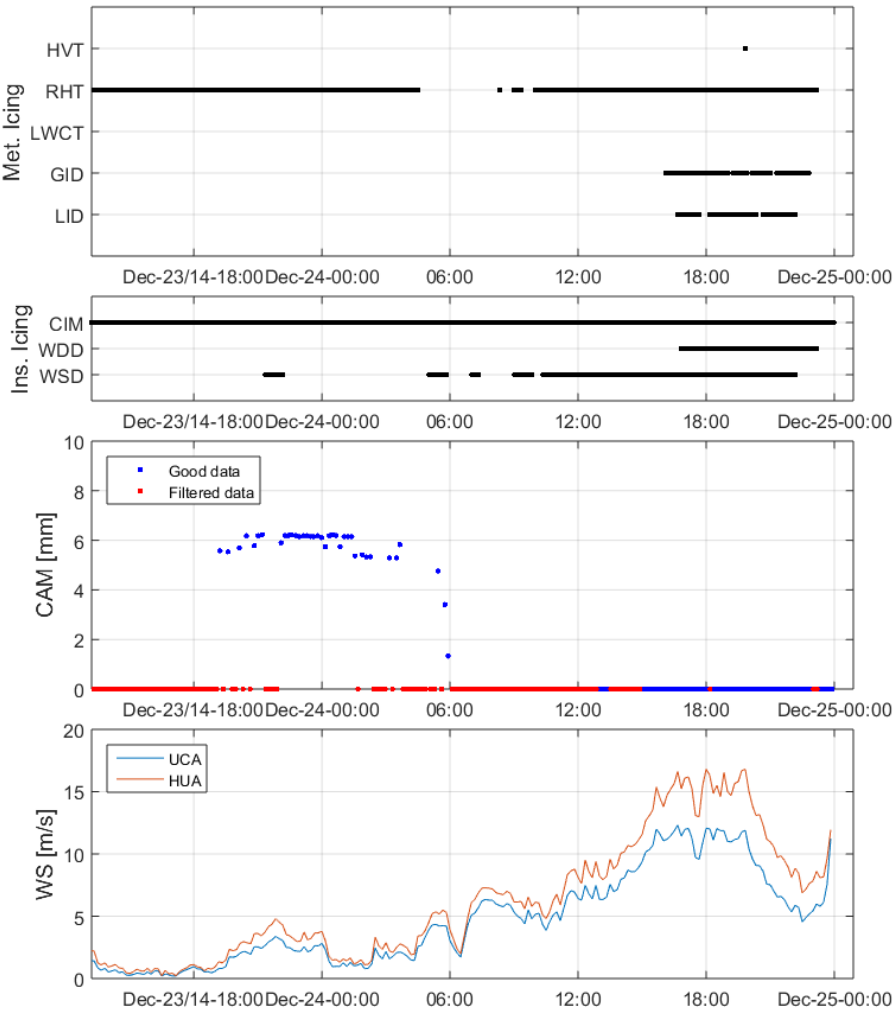
Icing Event of Interest 2

Event #2: 17-Dec-2014 to 25-Dec-2014

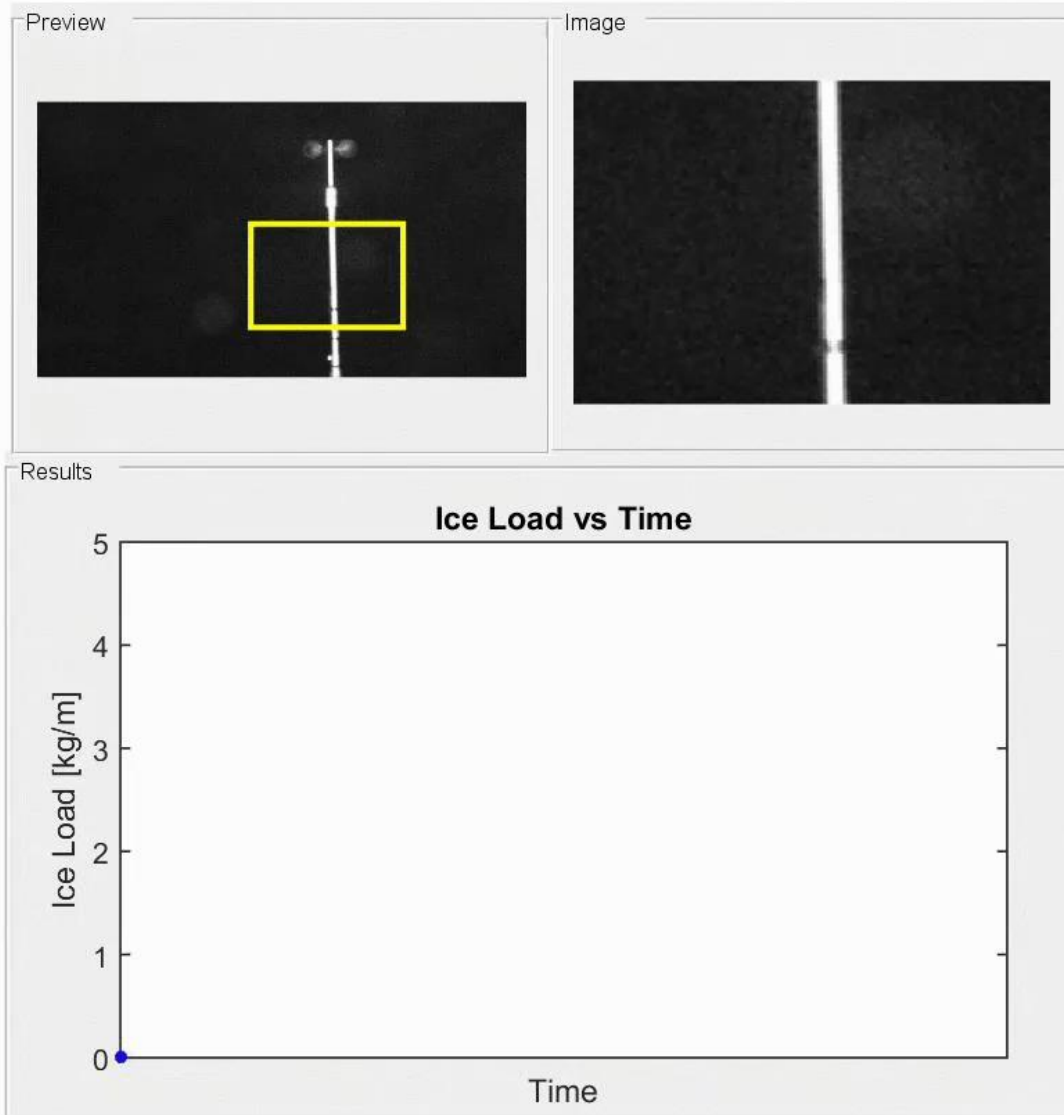


Icing Event of Interest 2

Event #2: 17-Dec-2014 to 25-Dec-2014

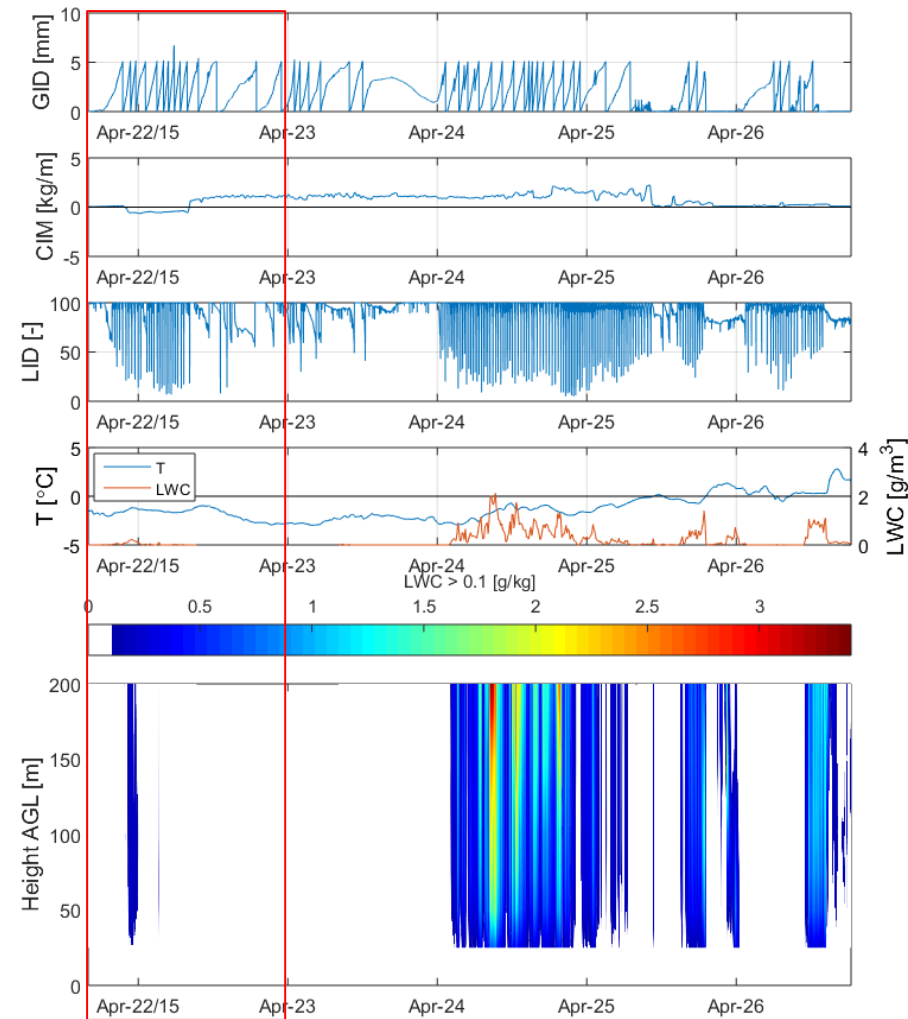
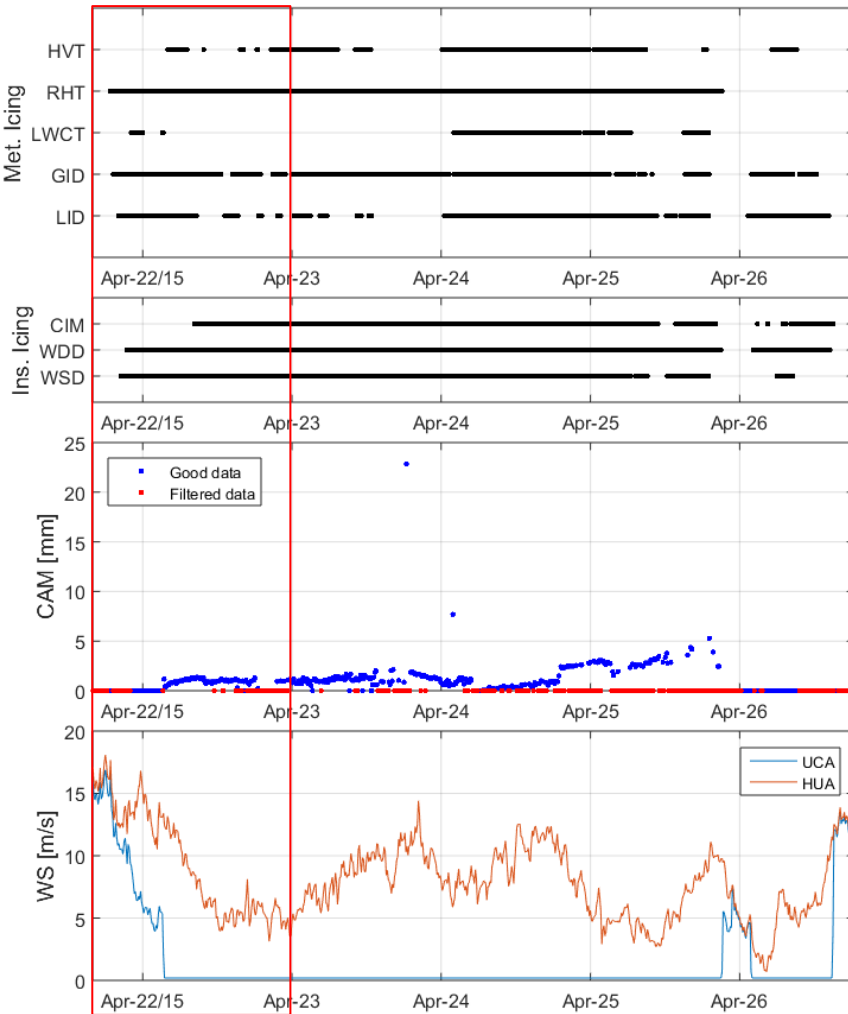


Icing Event of Interest 3



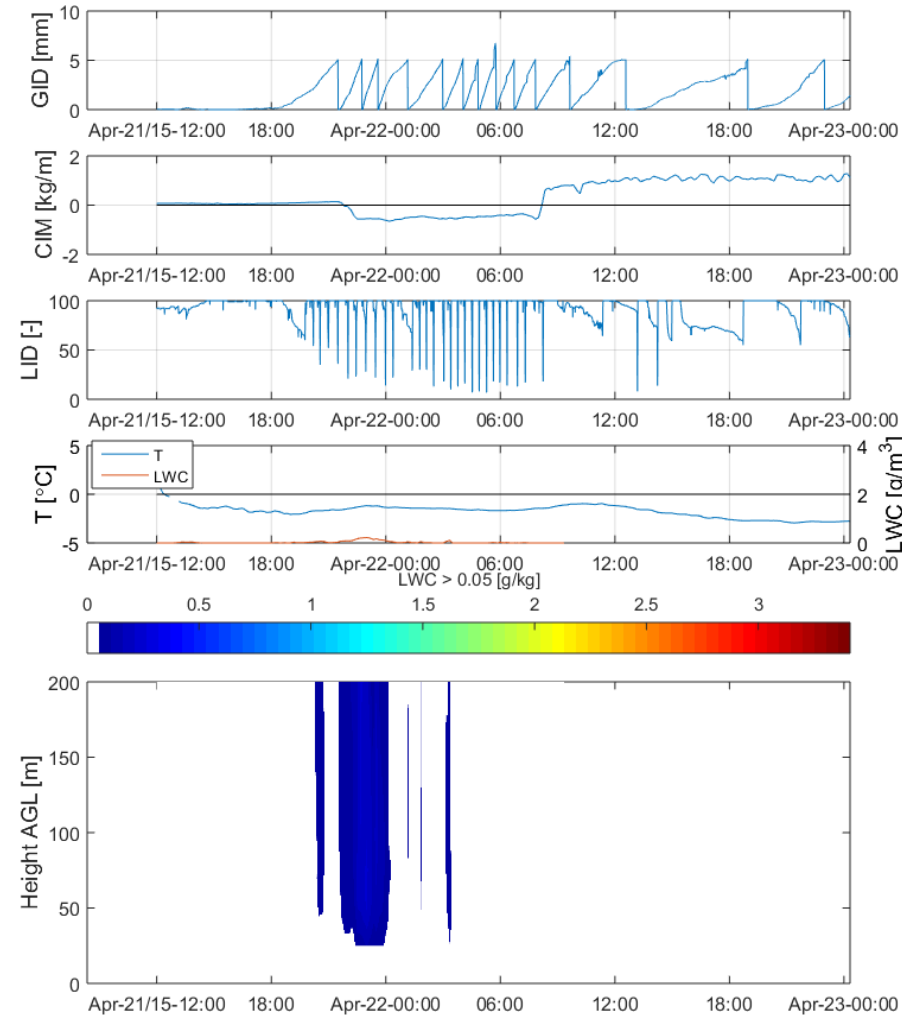
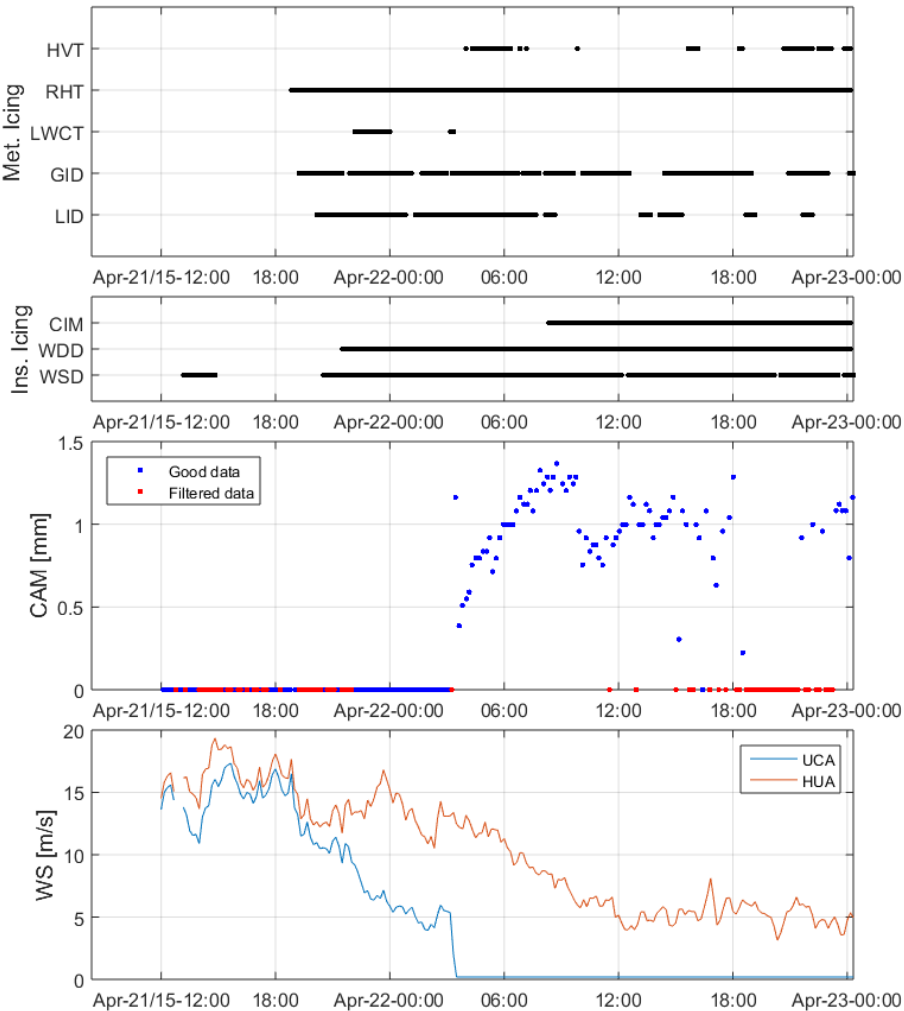
Icing Event of Interest 3

Event #3: 21-Apr-2015 to 27-Apr-2015



Icing Event of Interest 3

Event #3: 21-Apr-2015 to 27-Apr-2015



Conclusion

Method	Pros	Cons
CAM	Most information	Camera icing needs to be managed, visibility affects algorithm
CIM	Direct measurement of ice load	Negative values can appear at the beginning of icing events
GID	Very sensitive to meteorological icing	Ice thickness unverified
LID	Adjustable parameters and thresholds (requires further investigation)	Less sensitive, possibility of false positives during non-icing precipitation
LWCT	Very promising, can provide more information by adding parameters	Does not detect freezing rain
HVT	Similar to cloud base height method	Indirect method
RHT	N/A	Not a useful ice detection method
WDD	Good indication of Instrumental icing	Loss of data at low wind speeds
WSD	Good indication of Instrumental icing	Loss of data at low wind speeds

Future Work

- Include Cloud Base Height method in study
- Develop ice accretion model from LWC, WS and T
- Integrate icing severity and intensity in GID, LID and CIM methods
- Implement real time monitoring with CAM method

Matthew Wadham-Gagnon

Project Lead

mgagnon@eolien.qc.ca

70, rue Bolduc, Gaspé (Qc)

G4X 1G2, Canada

Tél. : +1 418 368 6162

Nos principaux partenaires / Our principal partners



Développement
économique Canada
pour les régions du Québec

Canada Economic
Development
for Quebec Regions

Canada

Québec



Thank you

TCE

