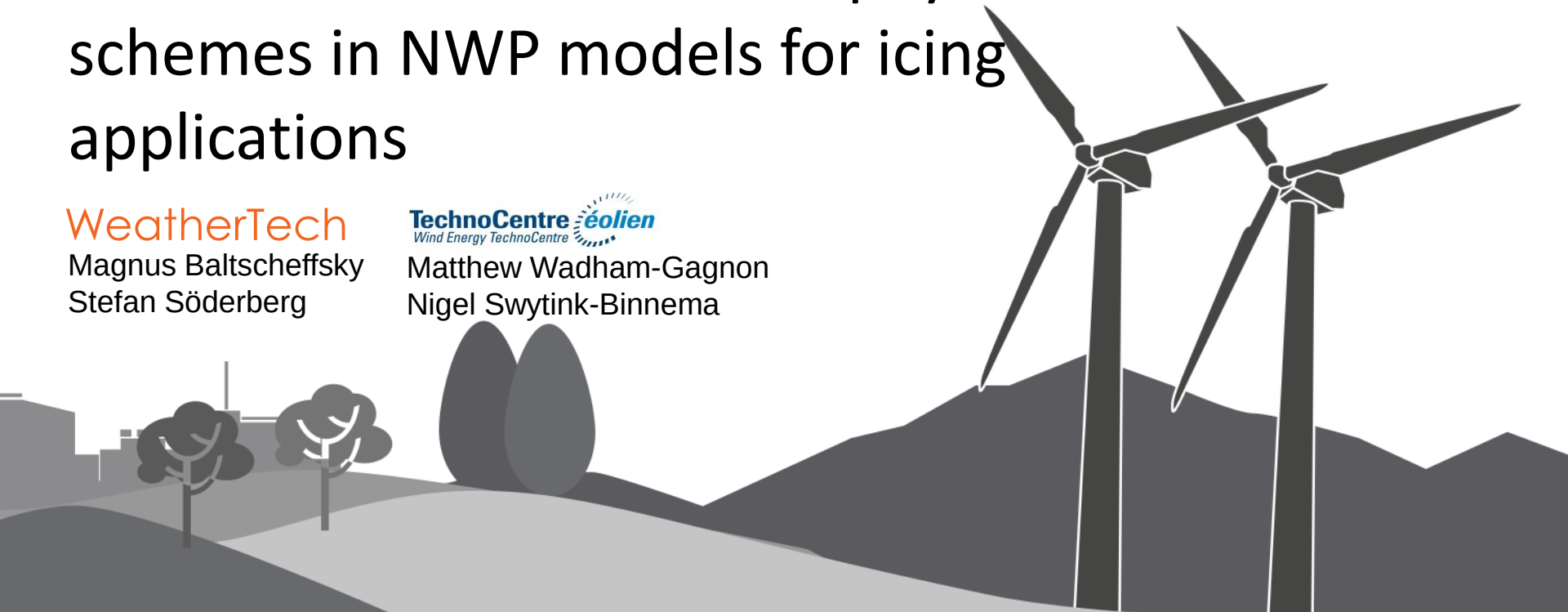
WinterWind
Åre, 2016-02-09

WeatherTech

Towards validation of microphysics schemes in NWP models for icing applications



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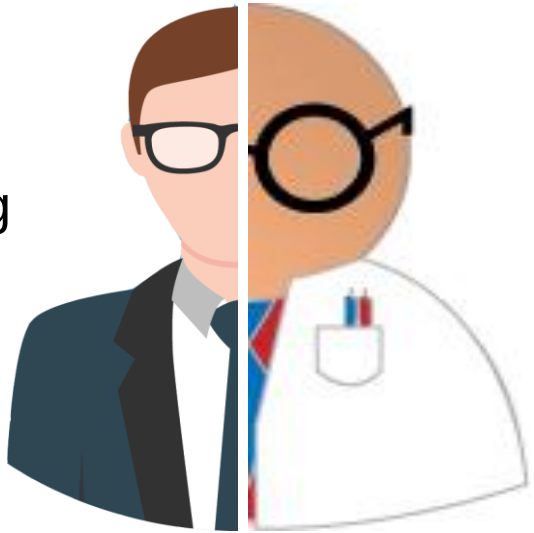
Magnus Baltscheffsky
Stefan Söderberg

TechnoCentre éolien
Wind Energy TechnoCentre
Matthew Wadham-Gagnon
Nigel Swytink-Binnema

Business

- Atmospheric modelling
- Cold climate studies
- Weather Forecasts



Research

- Wind Power in Forests
- Farm-Farm Interaction
- NEWA
- Cold Climate

ICING

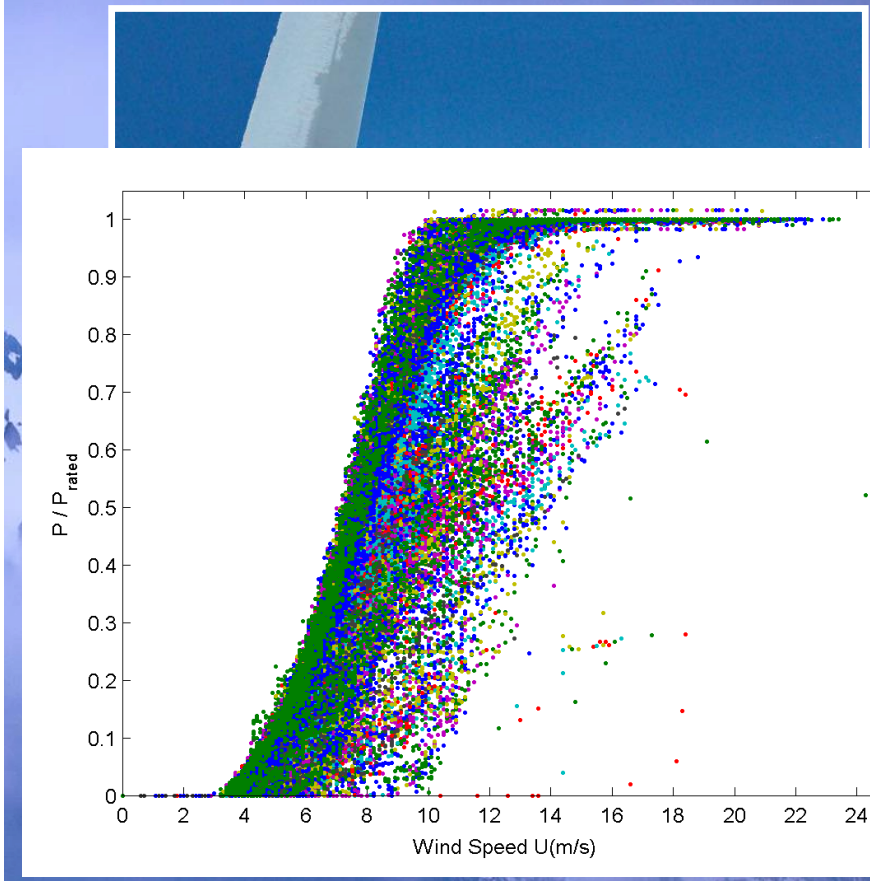
Cloud water droplets & T< 0

↓

Accretion of ice on turbine blade

↓

Reduced efficiency of turbine



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Model chain

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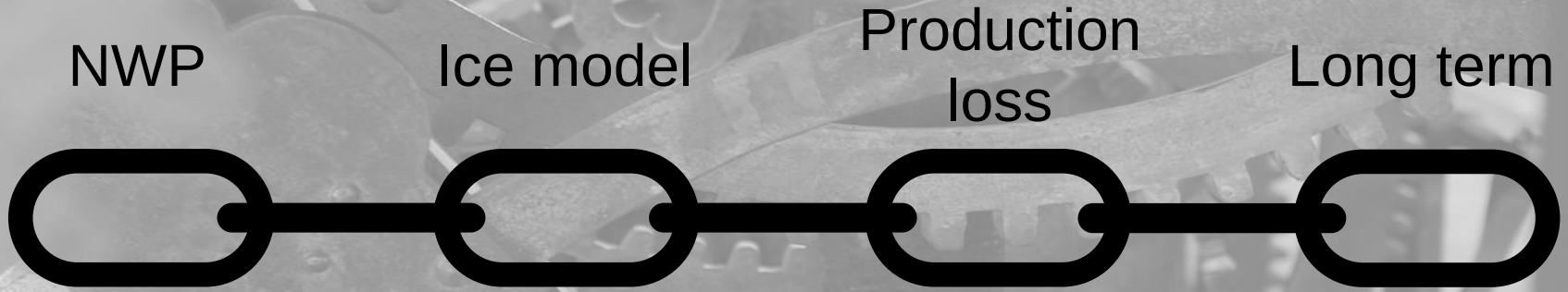

- WRF model
- High resolution
- Microphysics

2013
2016

- Makkonen
- Turbine blade
- De-icing

2013
2014

- WICE
- SCADA

2013

- 30yrs
- Condensates

2012
2015

TechnoCentre éolien
Wind Energy TechnoCentre

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)

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Collaboration between WeatherTech and TechnoCentre éolien

- WRF mesoscale model data
- Icing measurements

Ice detection methods and measurements

Matthew Wadham-Gagnon
TechnoCentre éolien

Ice detection methods

Method	Sensor	Description
CAM	Camera	Ice thickness measured from images of vertical anemometer support
CIM	Combitech Ice Monitor	Freely rotating ISO cylinder with load sensor [5]
GID	Goodrich 0872F1	Specialised ice detection sensor based on ultrasonic frequency change [6]
CBHT	CBH, T	Cloud Base Height and Temperature criteria
LID	Labkotek LID-3300IP	Specialised ice detection sensor based on ultrasonic frequency change [7]
LWCT	MRR & T	Atmospheric icing based on LWC measured from MRR and T
RHT	RH, T	Based on relative humidity and temperature criteria
WDD	WV	Detects ice from the variation in standard deviation of WD
WSD	HUA, UCA	WS difference between HUA and UCA

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Well equipped tower
More the 40 sensors

- Multiple ice detection sensors
- Possibility to evaluate modelled cloud condensates!

Micro Rain Radar (MRR)

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Wind Energy TechnoCentre

NWP Microphysics

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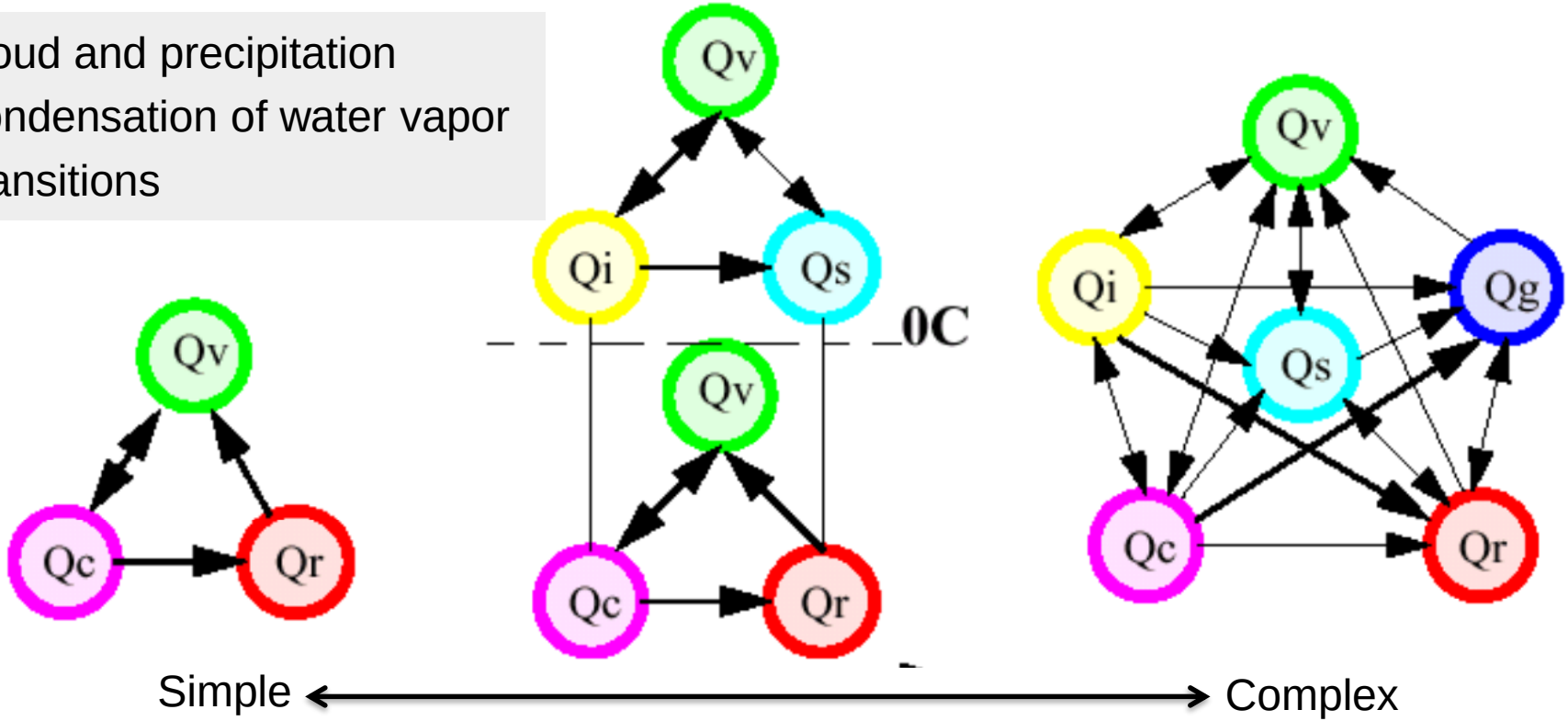
- Cloud and precipitation
- Condensation of water vapor
- Transitions



Case study

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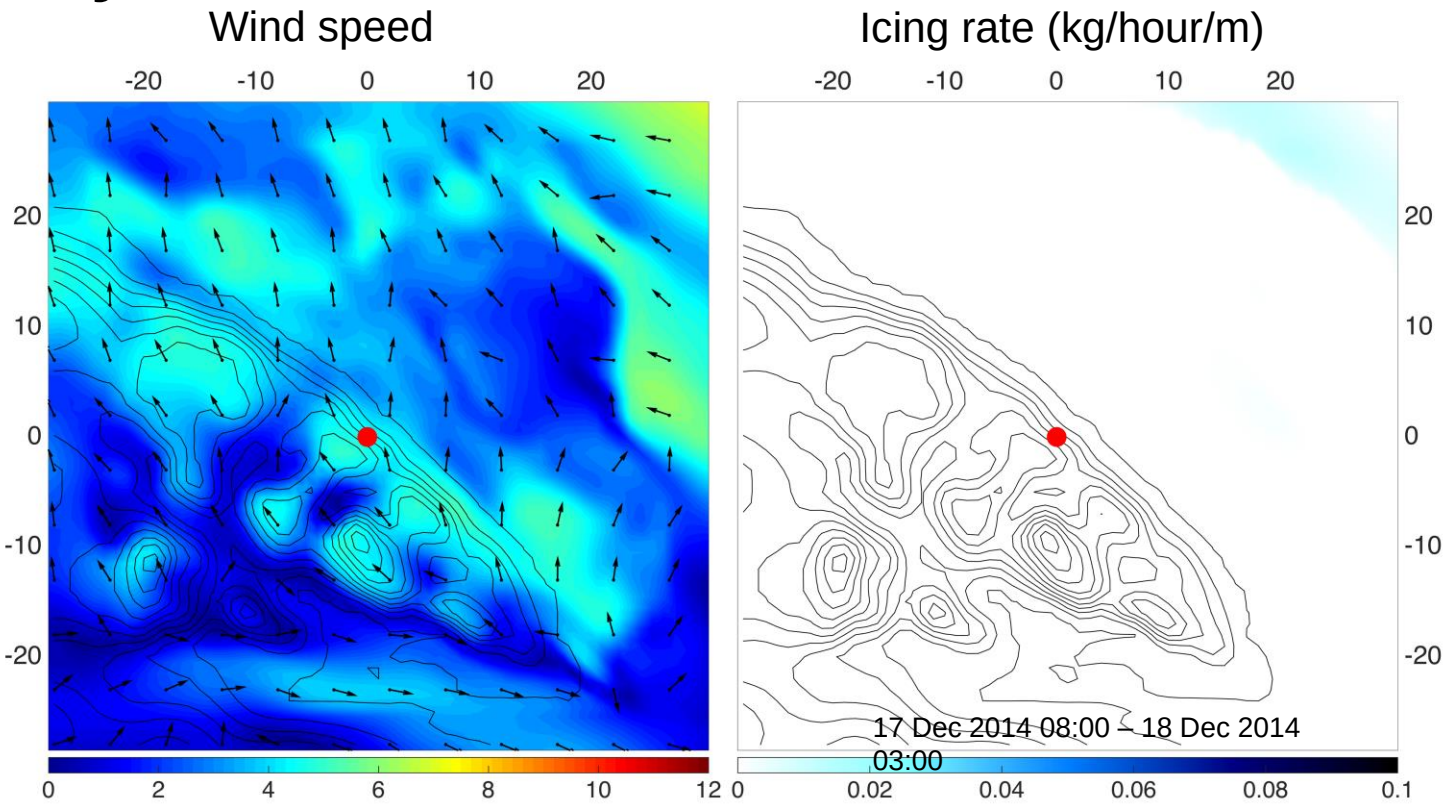
WRF model data 80m above ground

1km model grid resolution



Case study

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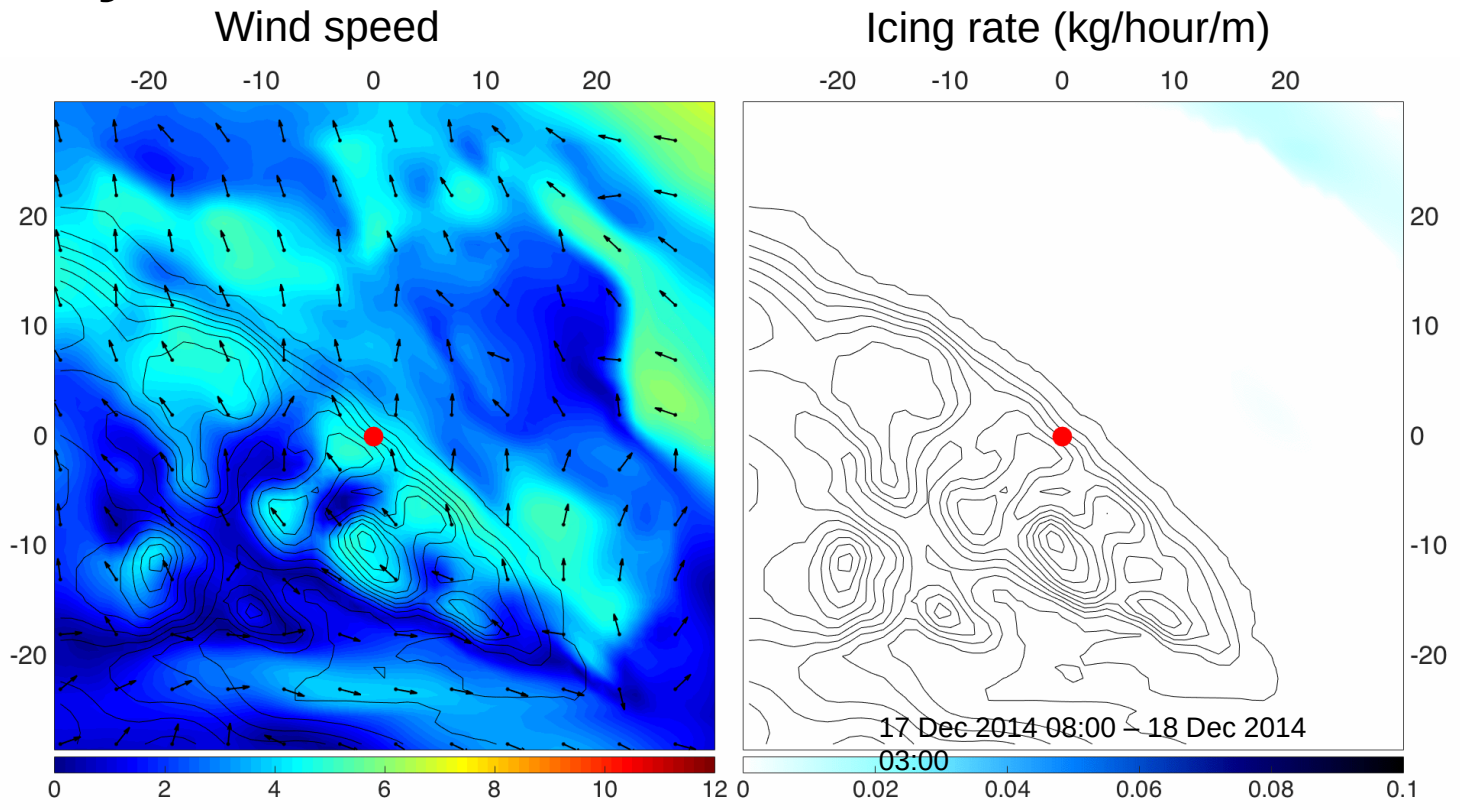

Case study

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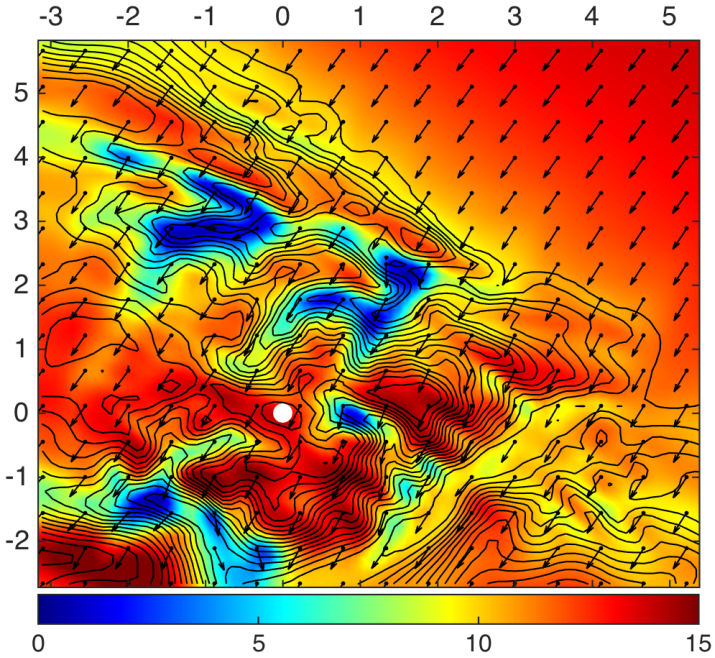
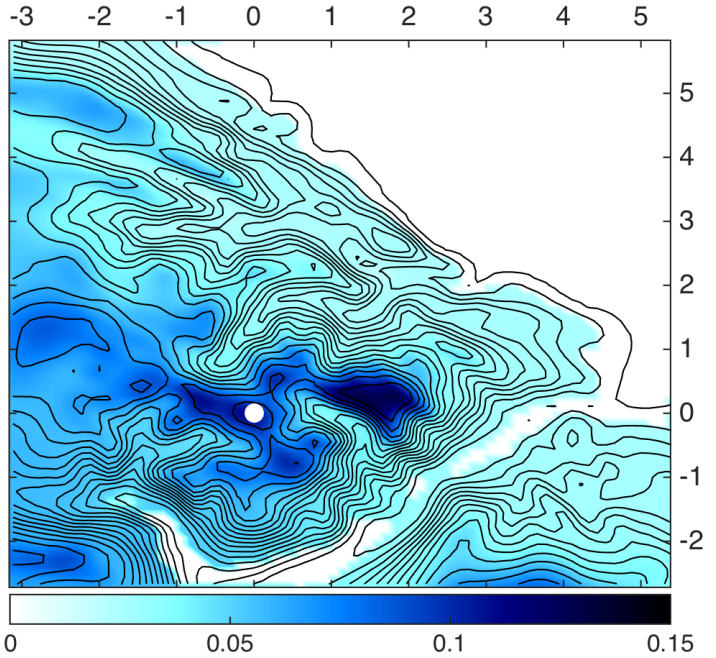
WRF model data 80m above ground

111m model grid resolution

Wind speed



Icing rate



Case I – Wind Speed

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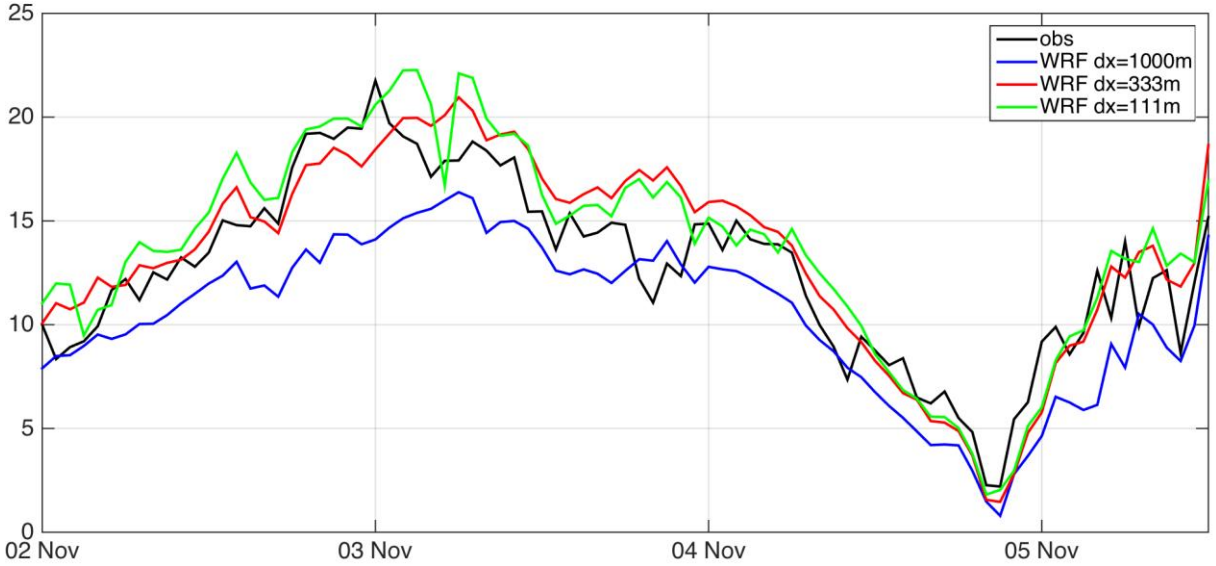
Observations and model data 80m above ground

	dx = 1000m	dx = 333m	dx = 111m
R	0.90	0.92	0.94
BIAS	-2.26	0.74	1.15
MAE	2.39	1.66	1.63
RMSE	2.92	2.04	2.08



Case I – Icing

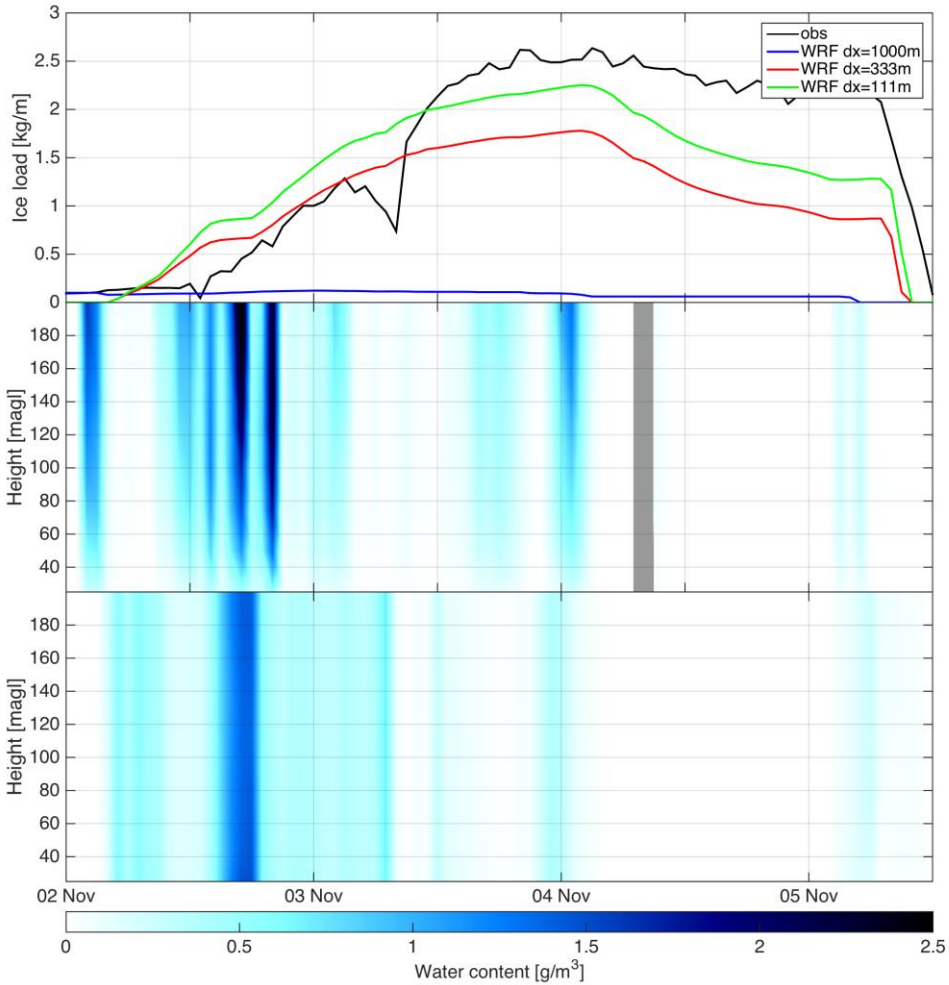
Iceload well modelled, both timing and magnitude

Ice load (kg/m)

MRR water content (g/m^3)

Water content reasonable well modelled (mainly snow in WRF)

WRF water content (g/m^3)



Case II – Icing

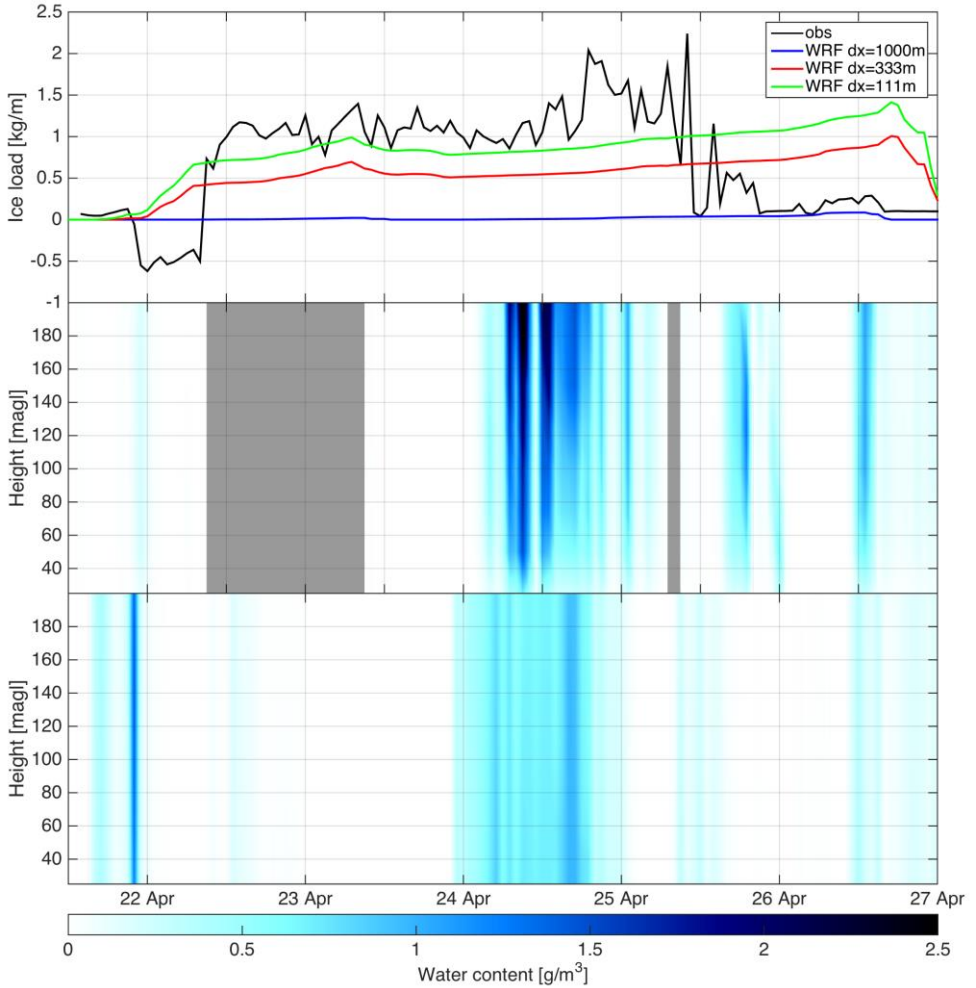
Iceload reasonable well modelled, melting is not captured.

Ice load (kg/m)

MRR water content (g/m^3)

Water content reasonable well modelled (mainly snow in WRF)

WRF water content (g/m^3)



Case III – Icing

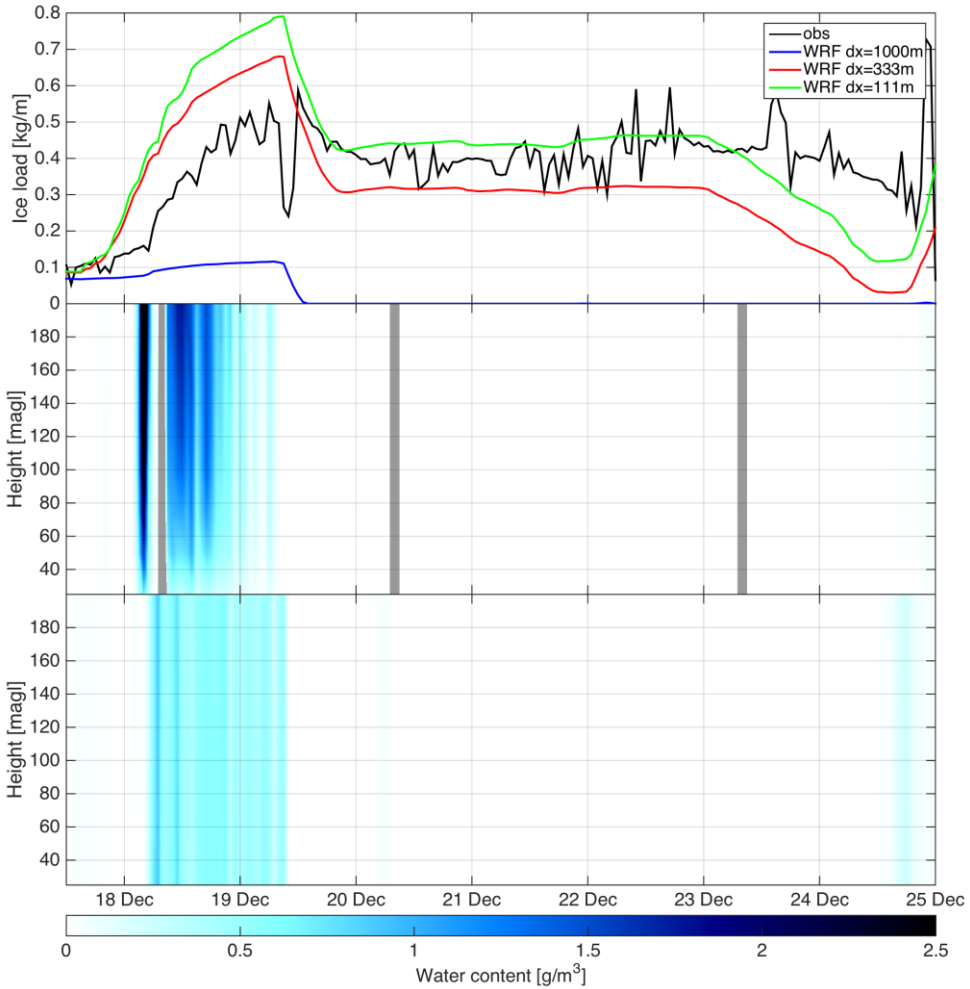
Iceload rather well modelled, both timing and magnitude

Ice load (kg/m)

MRR water content (g/m^3)

Water content quite well modelled (mainly snow in WRF)

WRF water content (g/m^3)



Case III – Icing

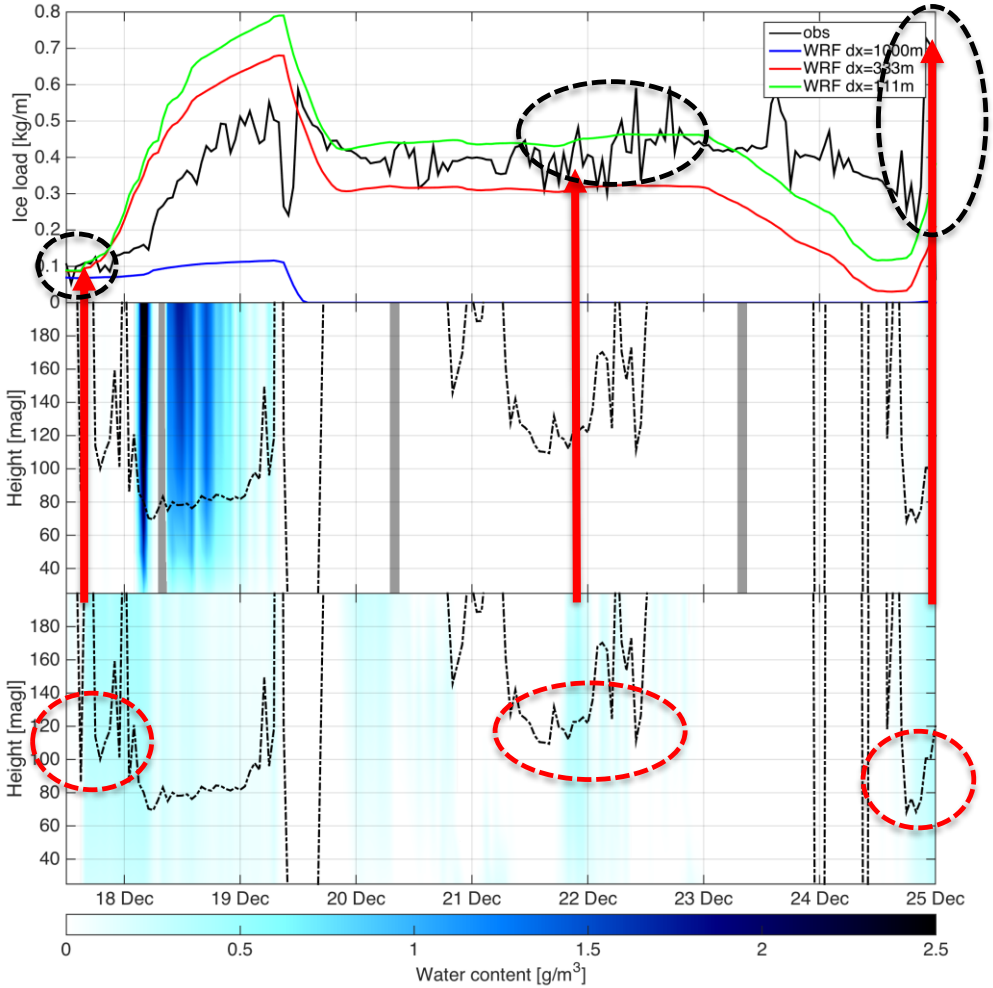
Observed increase in iceload but no MRR detection.

Ice load (kg/m)

In-cloud icing. Agrees with timing of modelled cloud water and observed low clouds.

MRR water content (g/m^3)

WRF cloud water (g/m^3) and cloud base



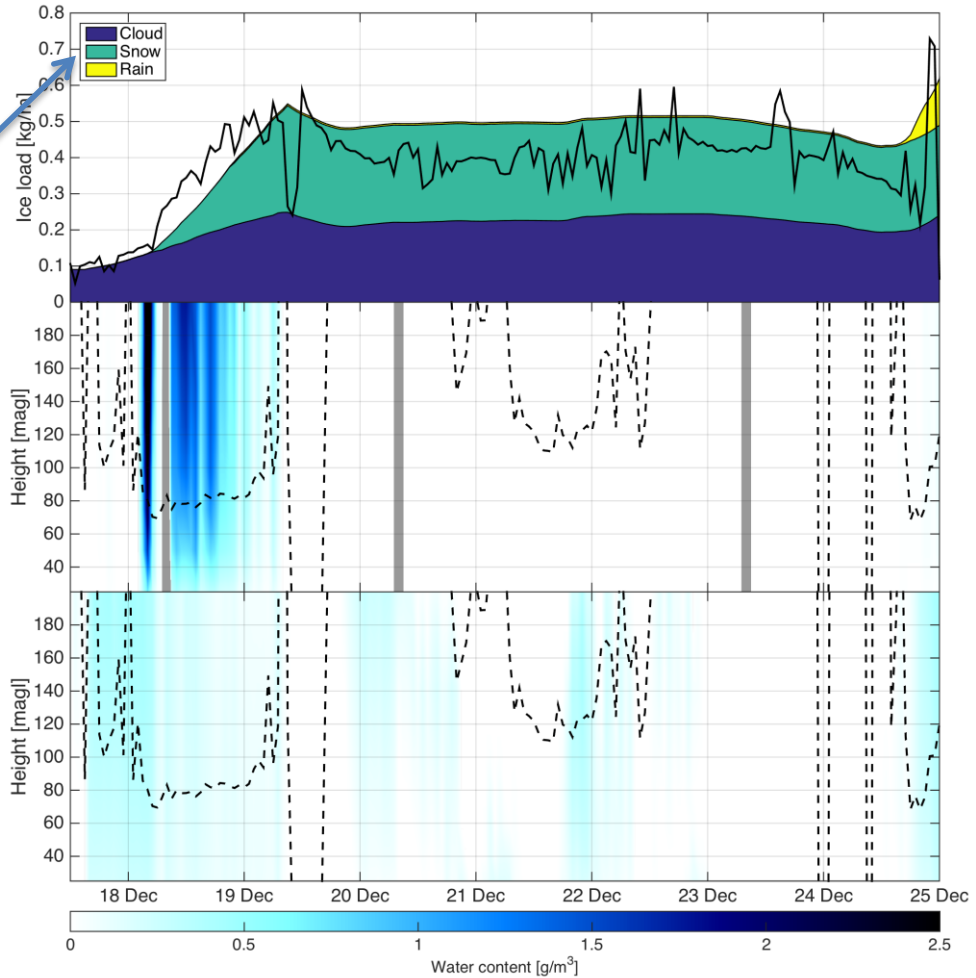
Case III – Icing

Scaled contributions to ice load

- Aim is to improve the wet snow contribution to modelled ice load

MRR water content (g/m^3)

WRF cloud water (g/m^3) and cloud base



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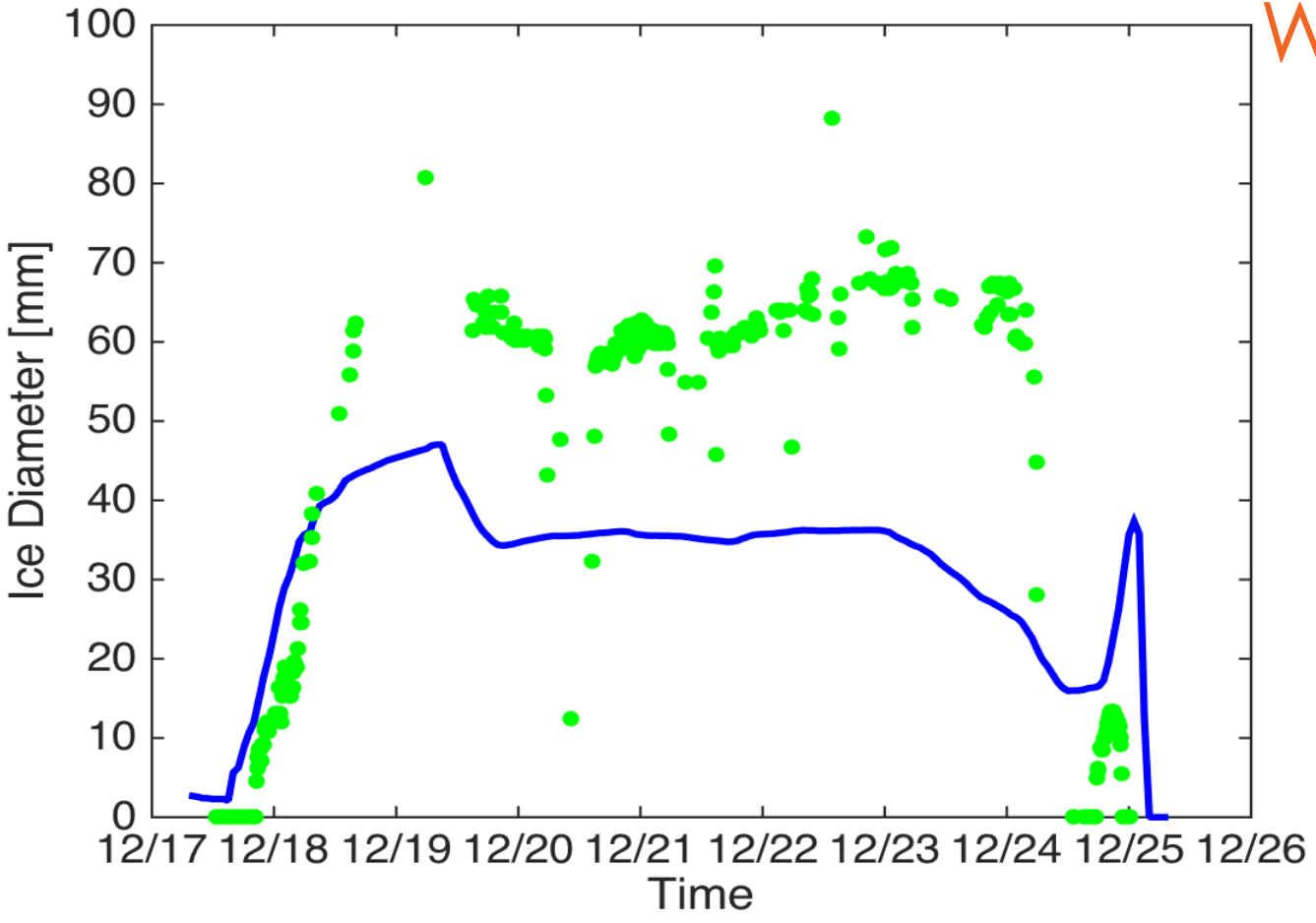
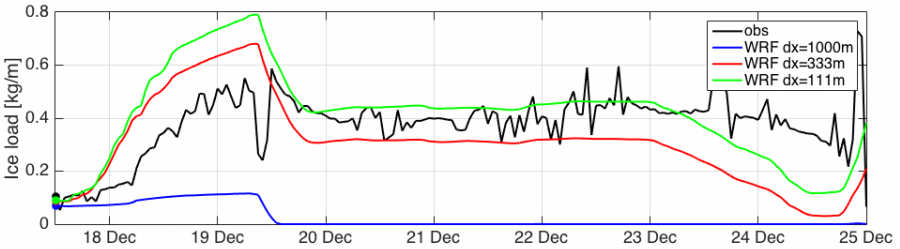


Ice diameter derived from camera

Helpful tool for understanding ice events

Case study

Ice load (kg/m)

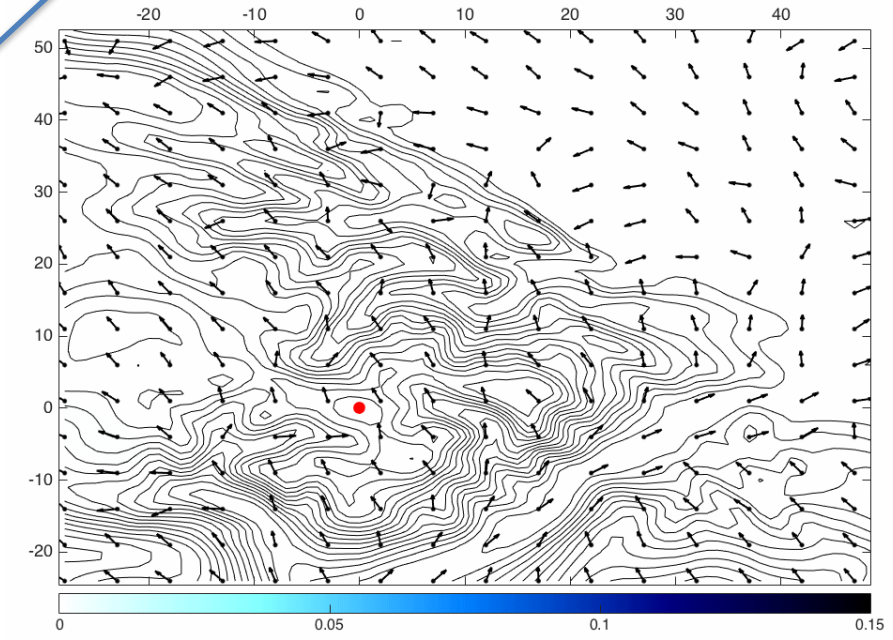


WRF model data 80m above ground

111m model grid resolution

17 Dec 2014 08:00 – 19 Dec 2014 19:00

Validation will help building confidence in detailed model studies of icing climate and production loss estimates



Icing rate (kg/hour/m)

Summary

1. Unique observational data set
2. Model result agree quite well with observed icing events
3. Combining observations and model data – new insights
4. Improve modelling of different types of icing events

WeatherTech

Thank you!

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