

ENERGY

Understanding Icing in the Nordics and North America

Till Beckford

Winterwind 2018

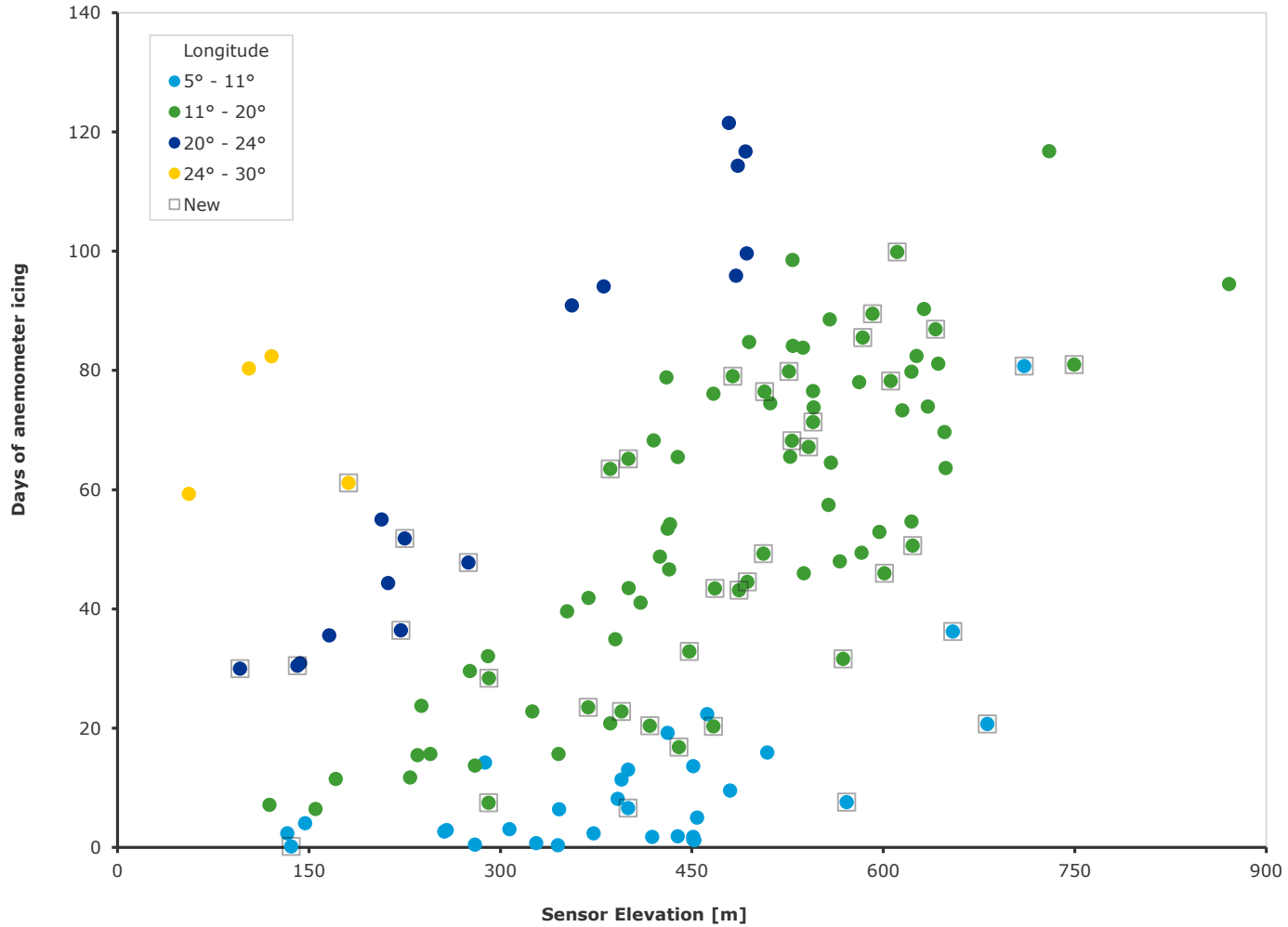
06 February 2018

Contents

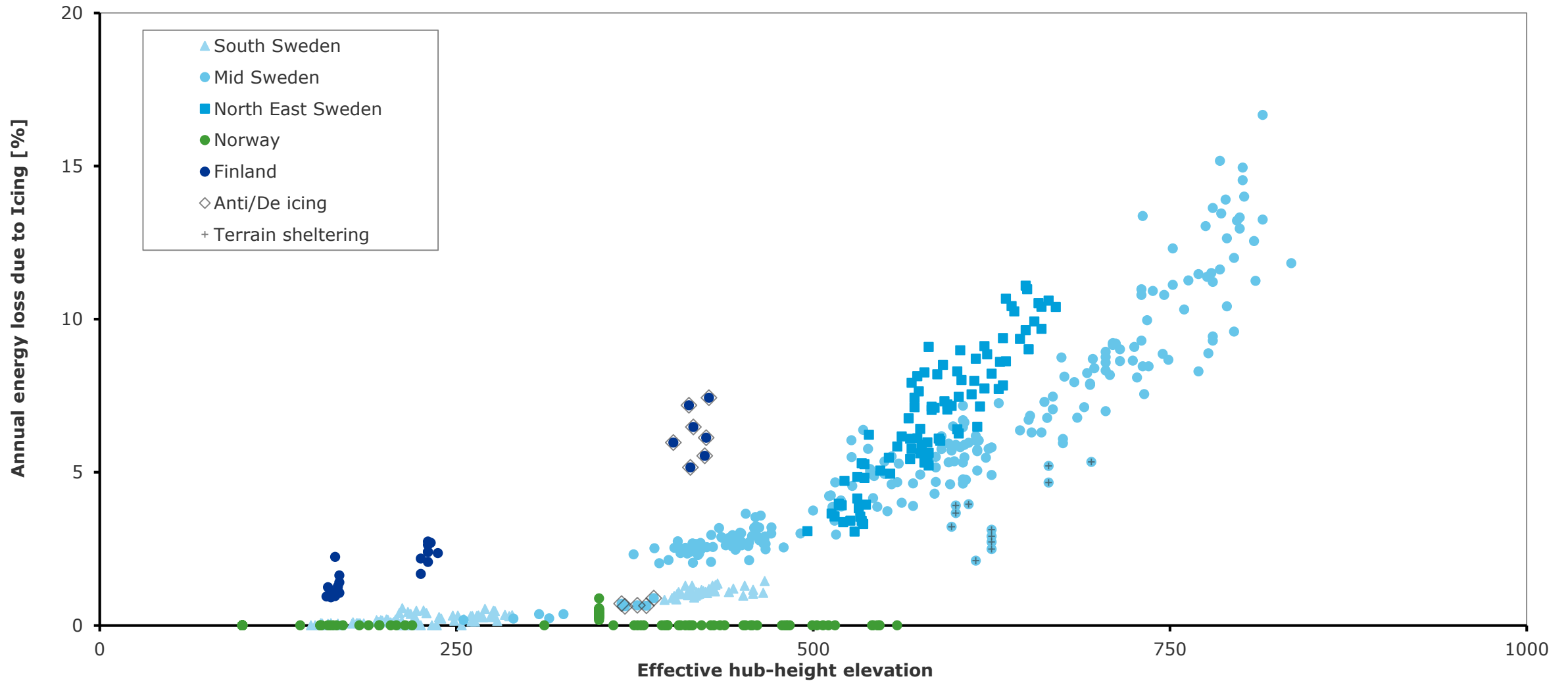
- Part 1: Extension of Nordic data
- Part 2: Preliminary global trends
 - 2.1 Temperature
 - 2.2 Direction
- Part 3: Operational data in North America

Part 1: Extension of Nordic data

Nordic anemometer data – Icing vs Elevation



Nordic operational data – Icing vs Elevation



Part 2: Preliminary global trends

2.1 Temperature

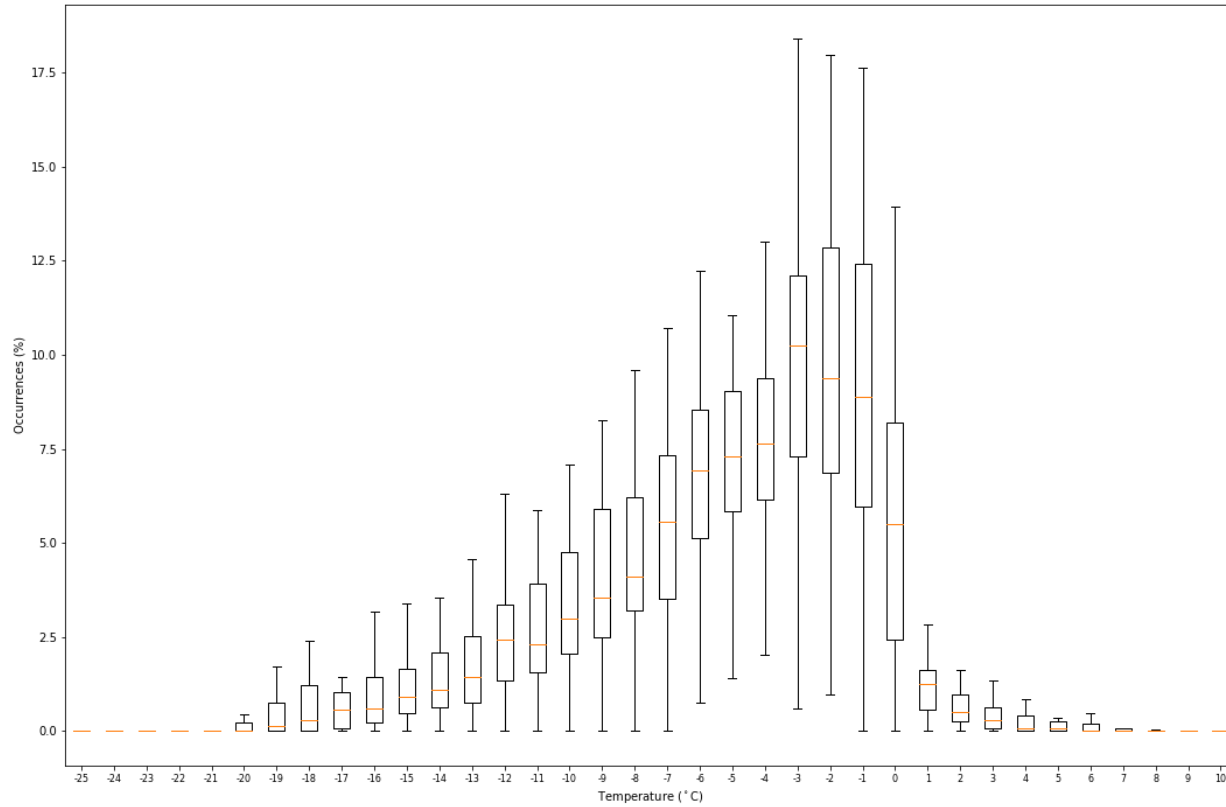
The dataset



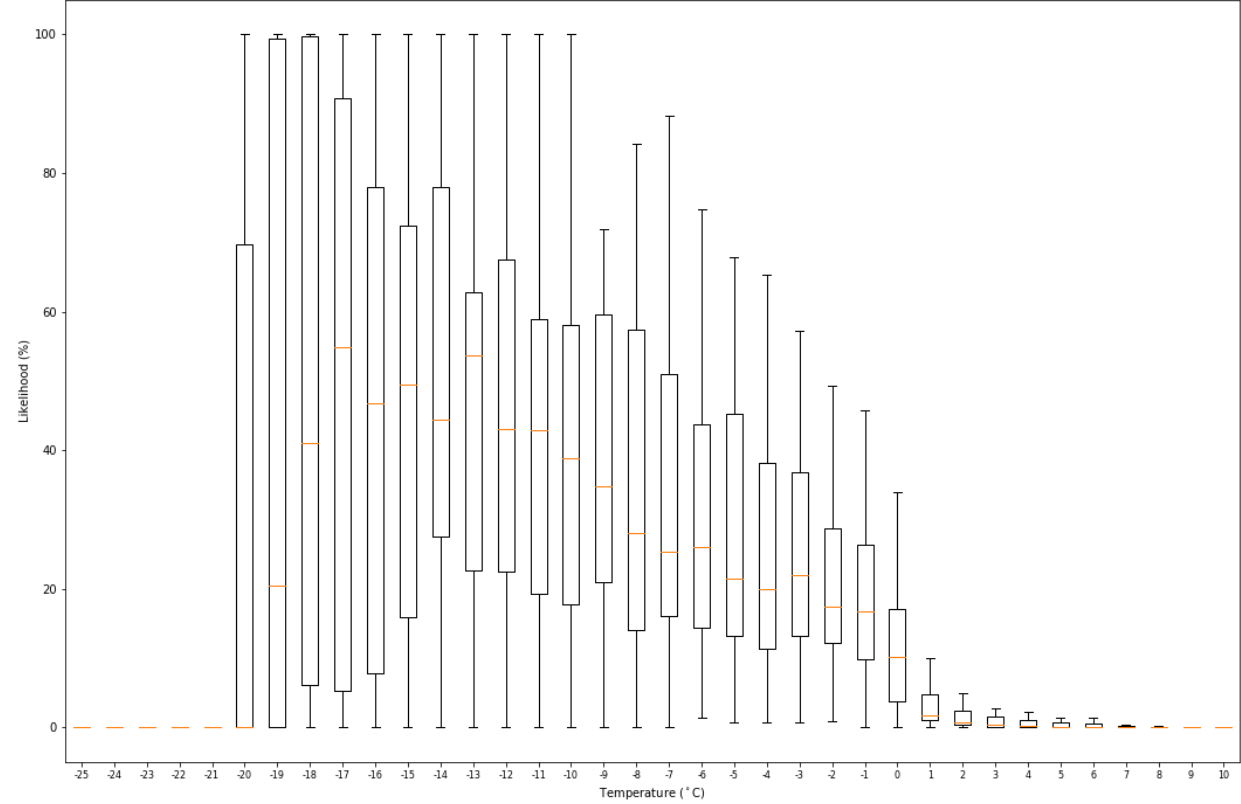
- 38 masts in the Nordics
- 8 masts Eastern Europe and Turkey
- 3 masts Great Lakes USA

Temperature trends in icing – Sweden

Occurrences

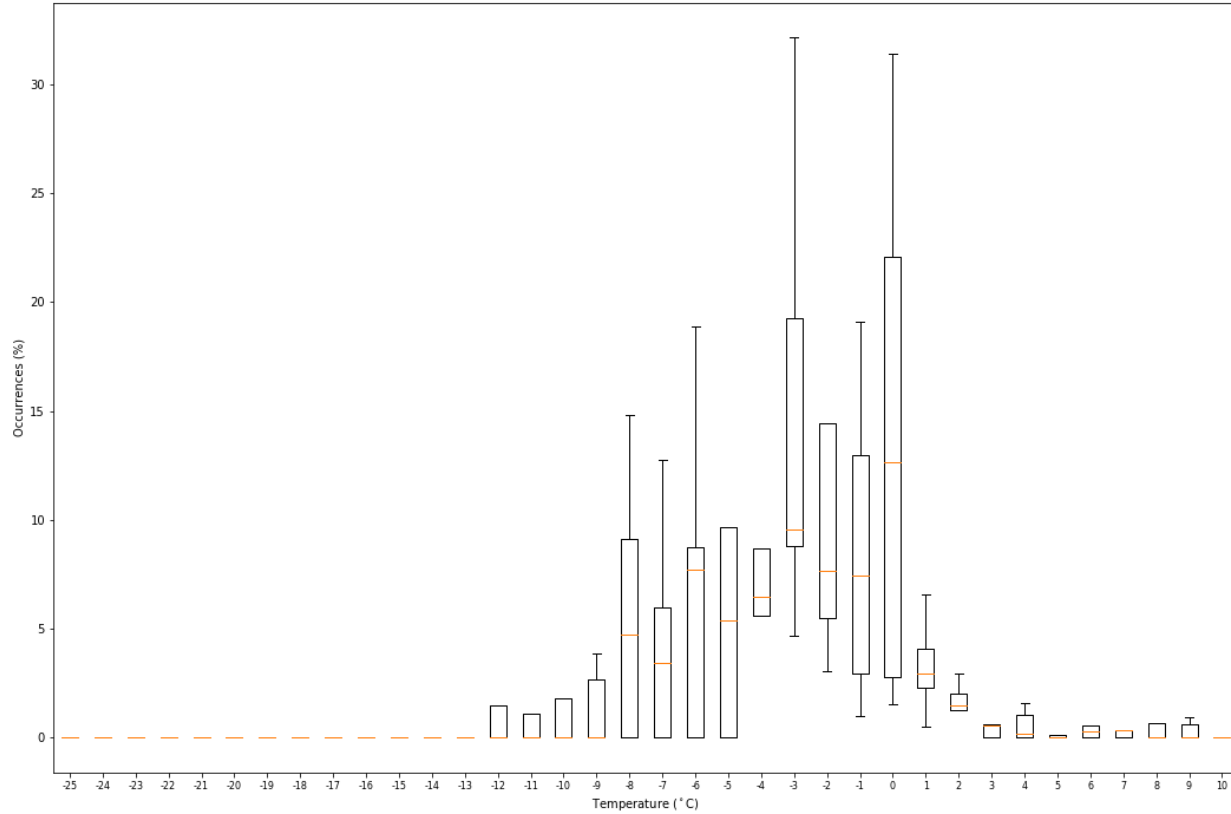


Likelihood

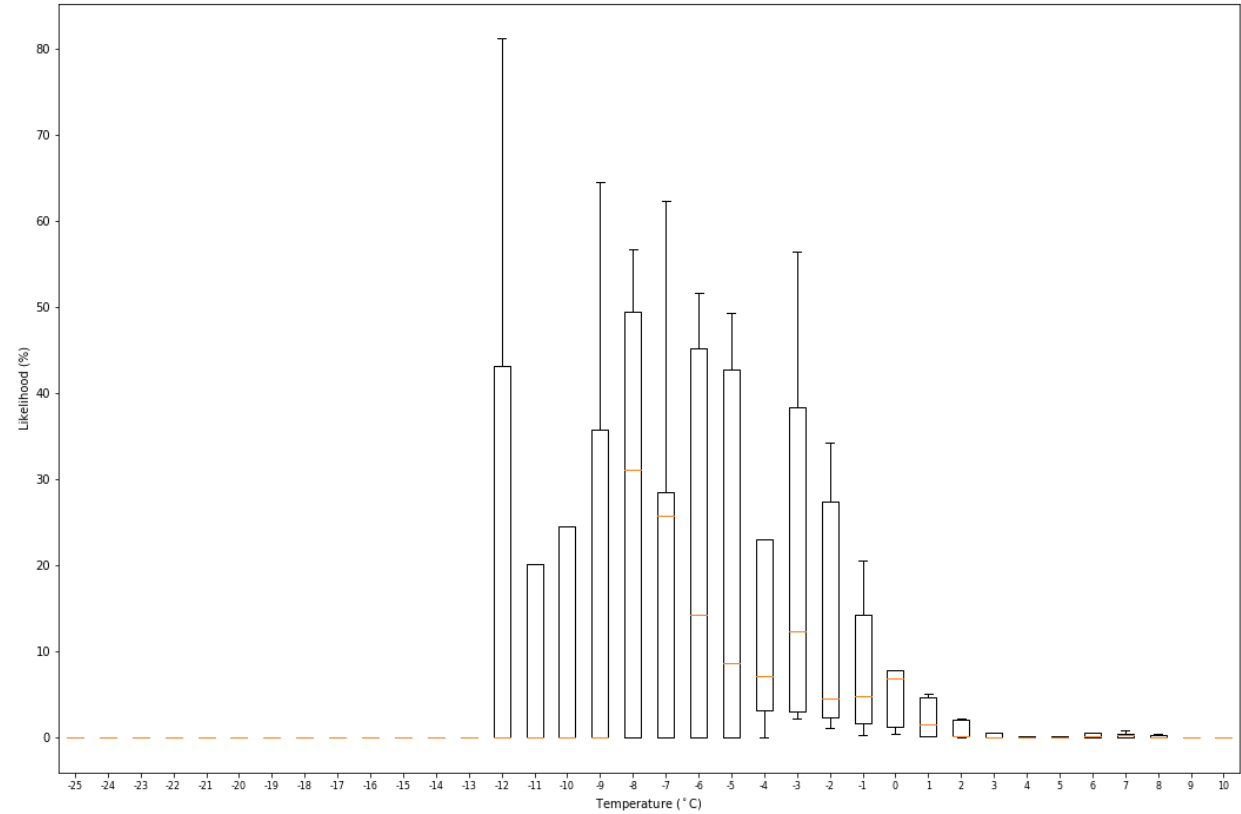


Temperature trends in icing – Eastern Europe and Turkey

Occurrences

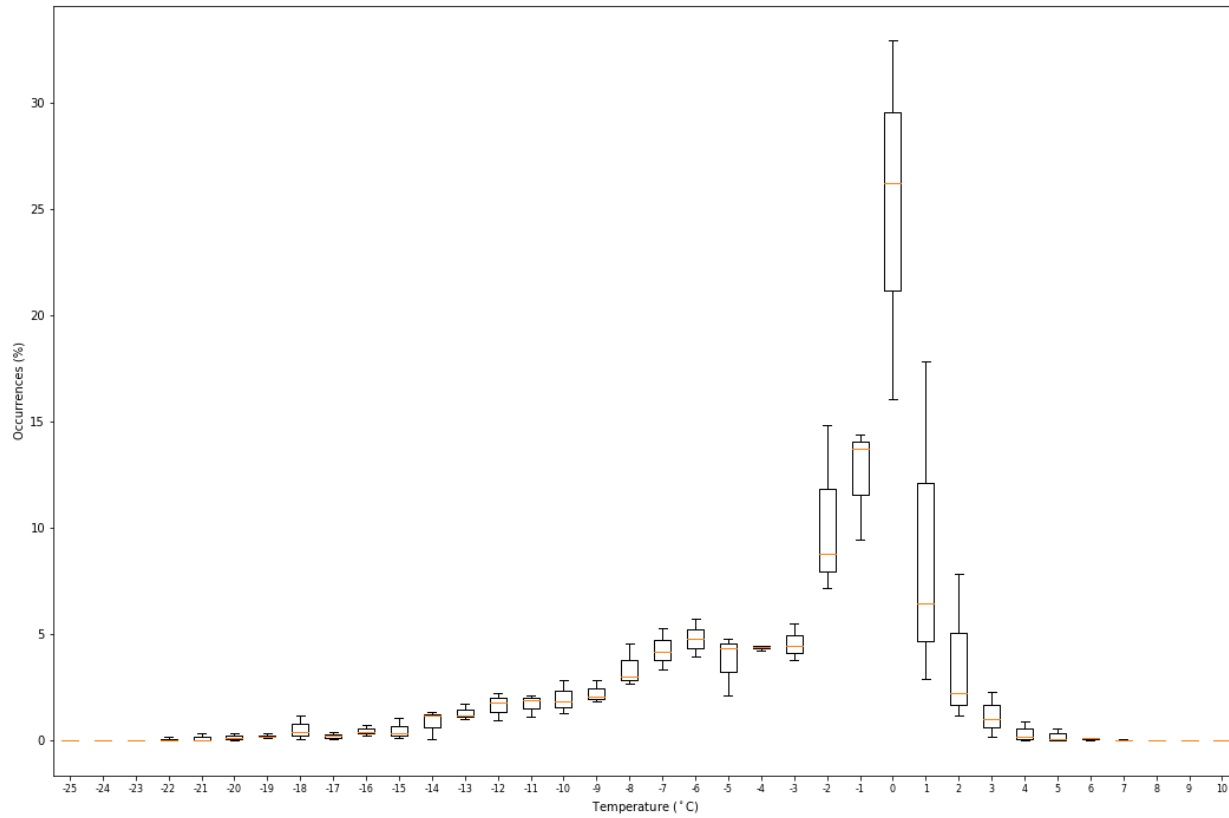


Likelihood

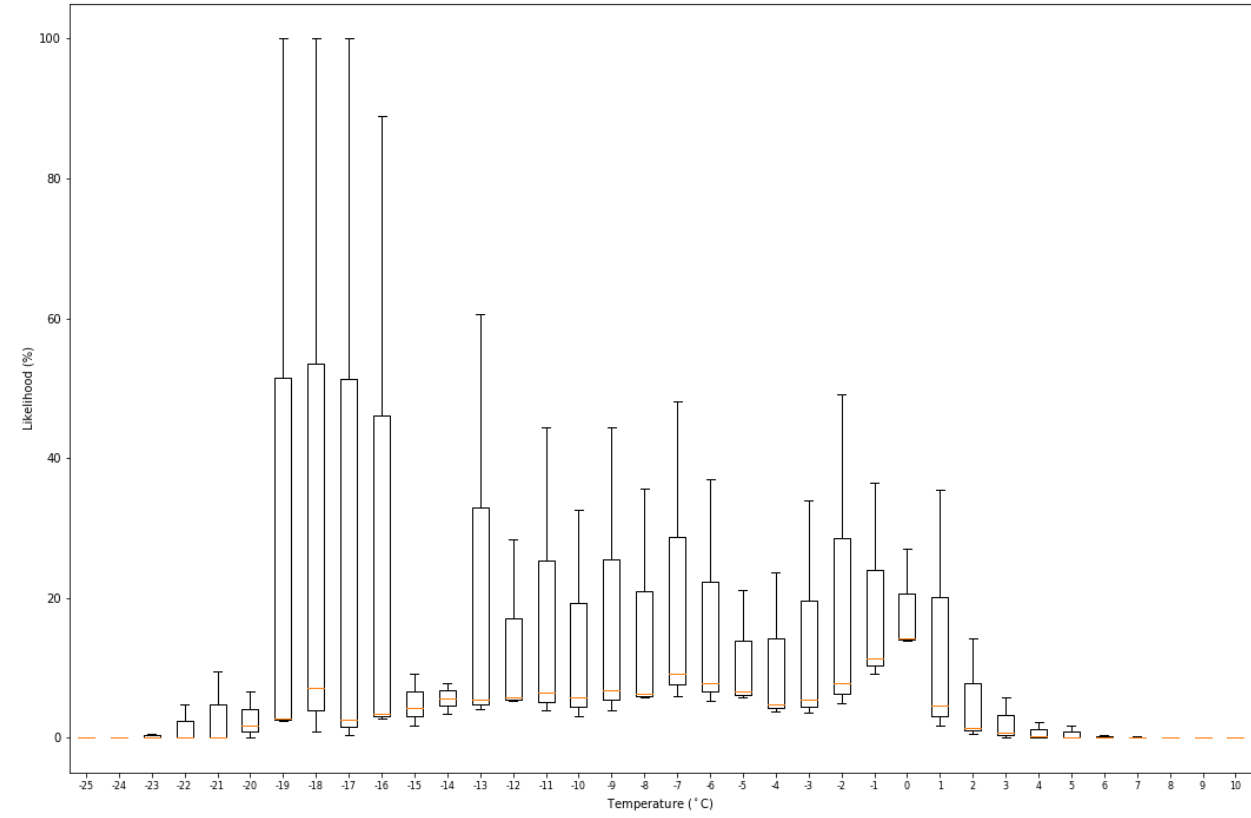


Temperature trends in icing – Great Lakes USA

Occurrences



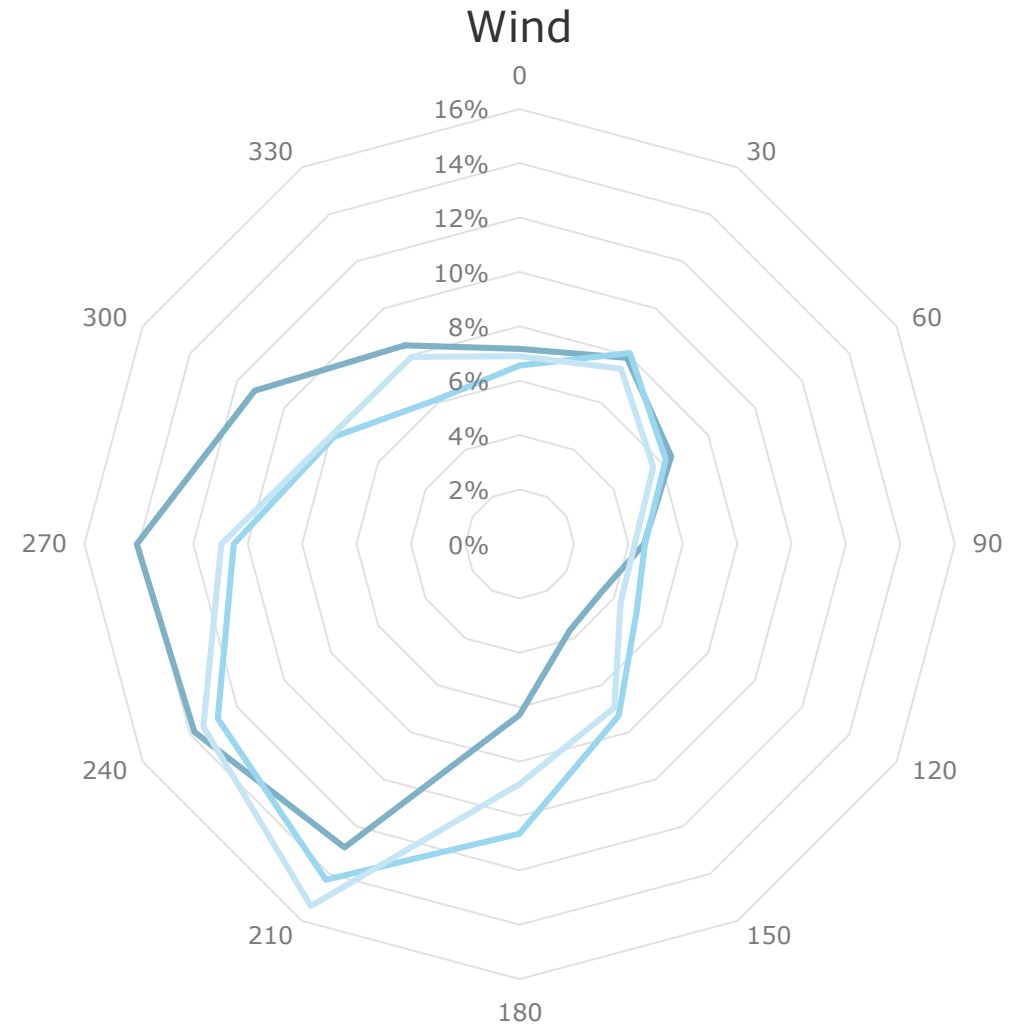
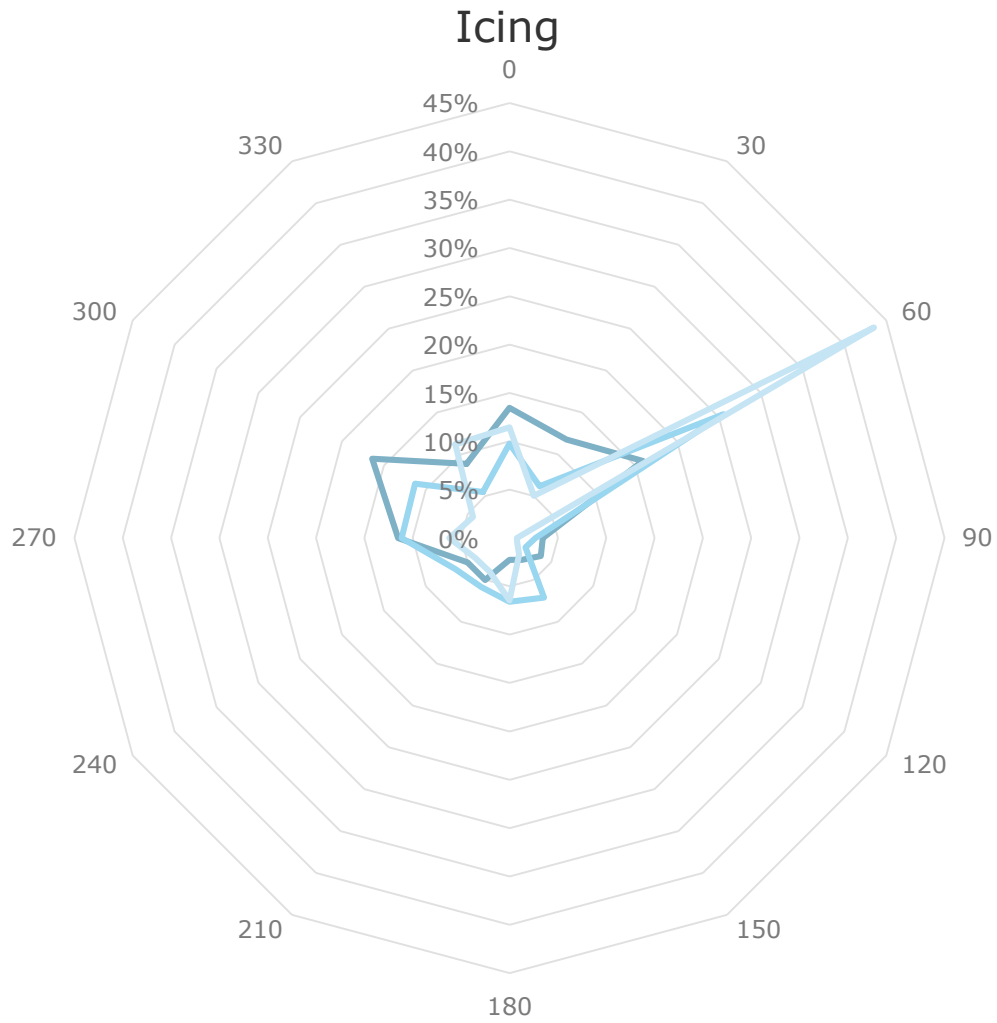
Likelihood



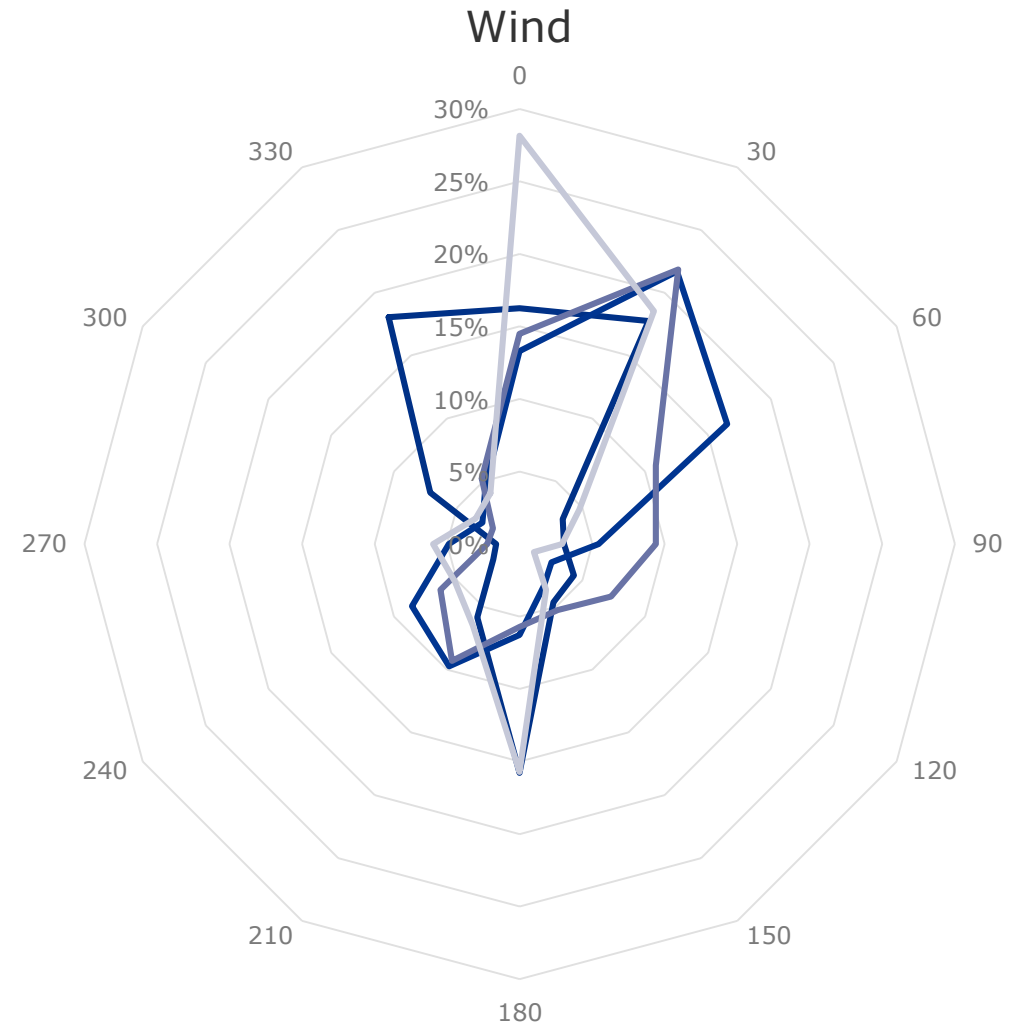
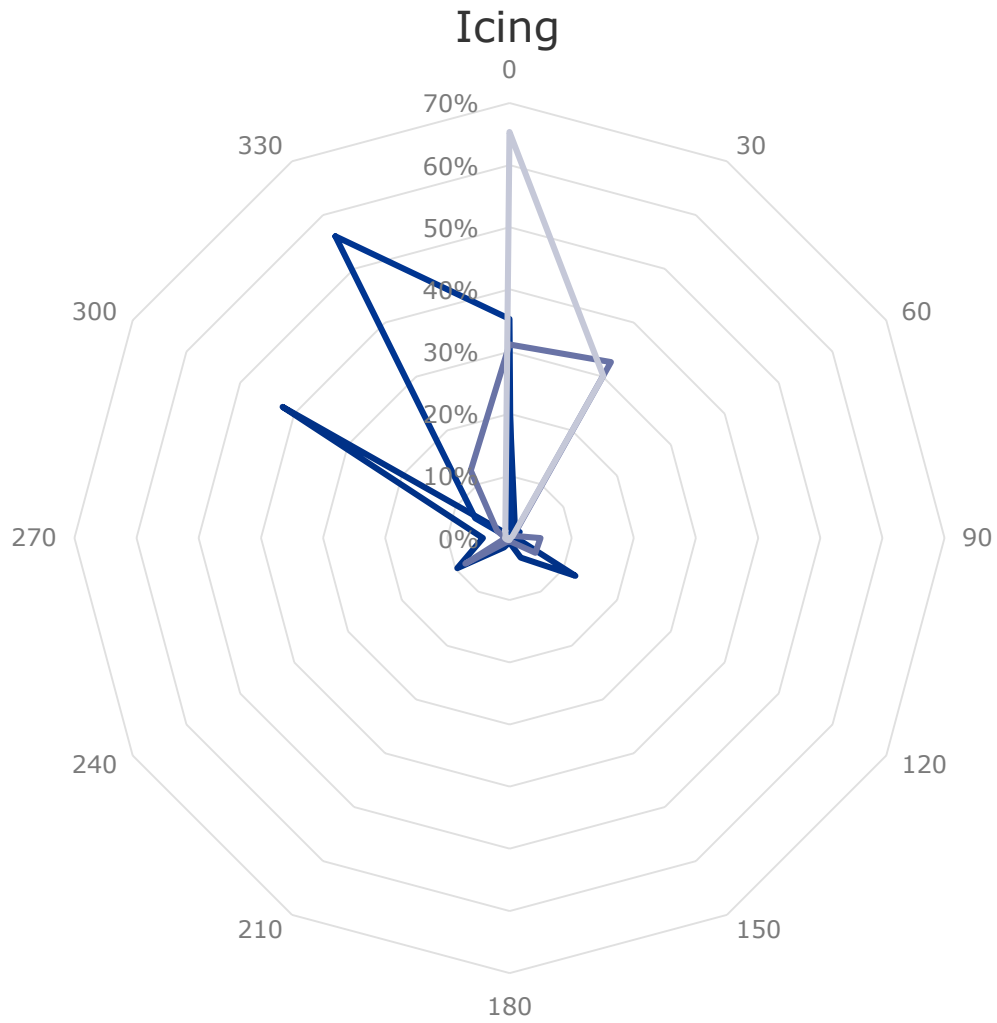
Part 2: Preliminary global trends

2.1 Direction

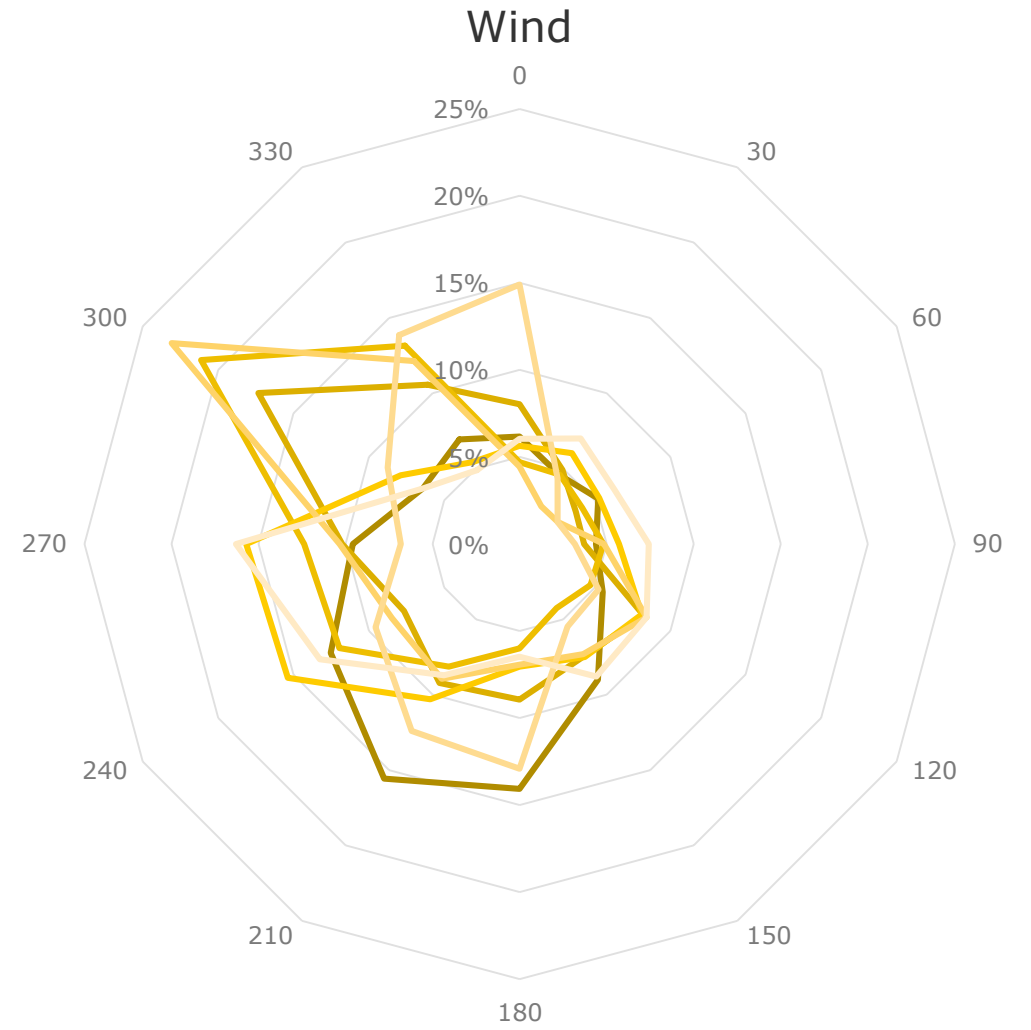
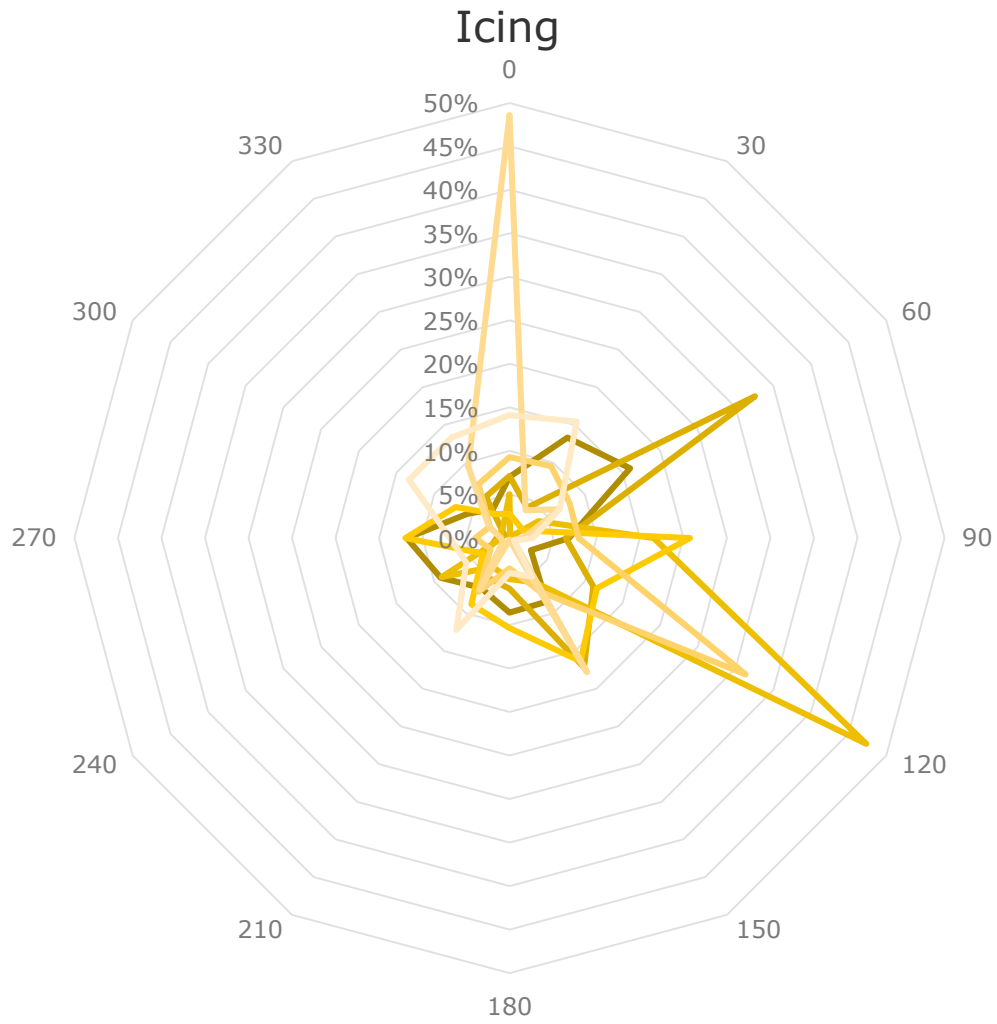
Icing rose – Great Lakes USA



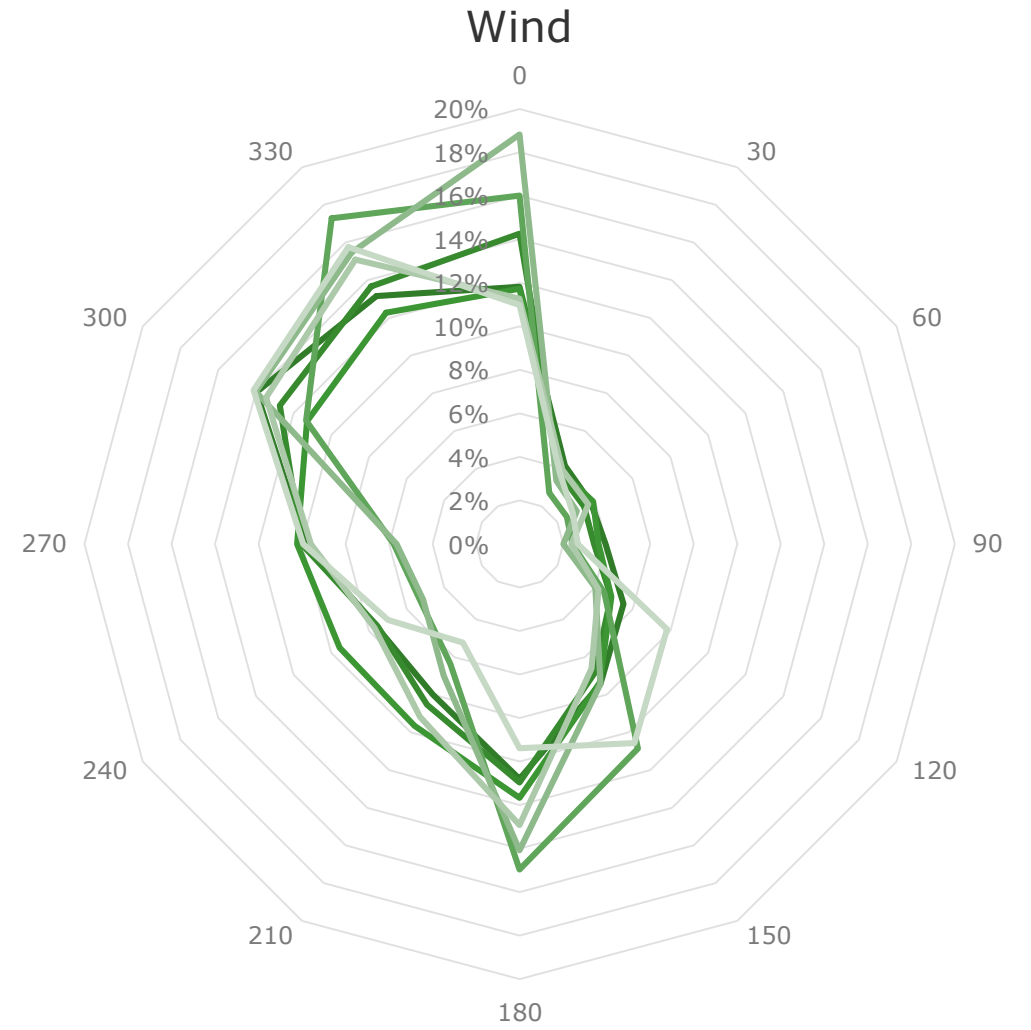
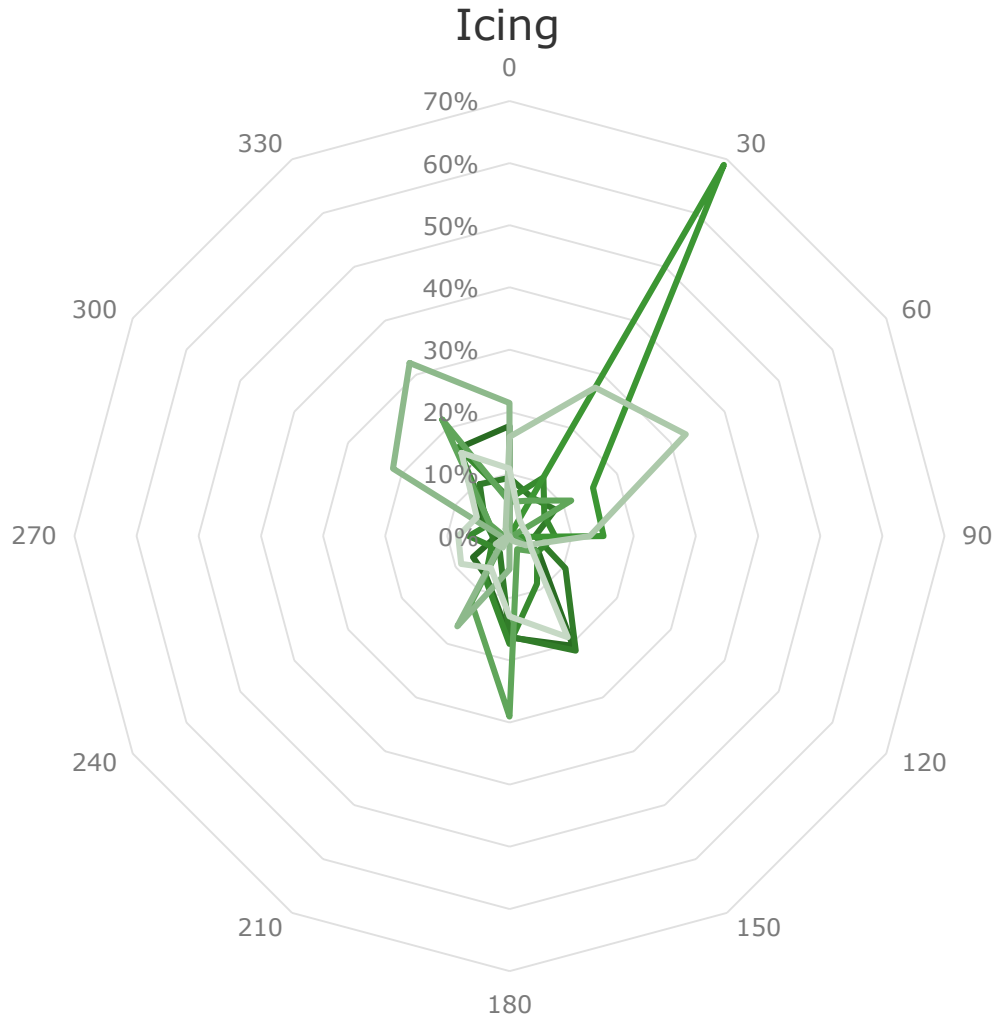
Icing rose – Eastern Europe and Turkey



Icing rose – Sweden subset

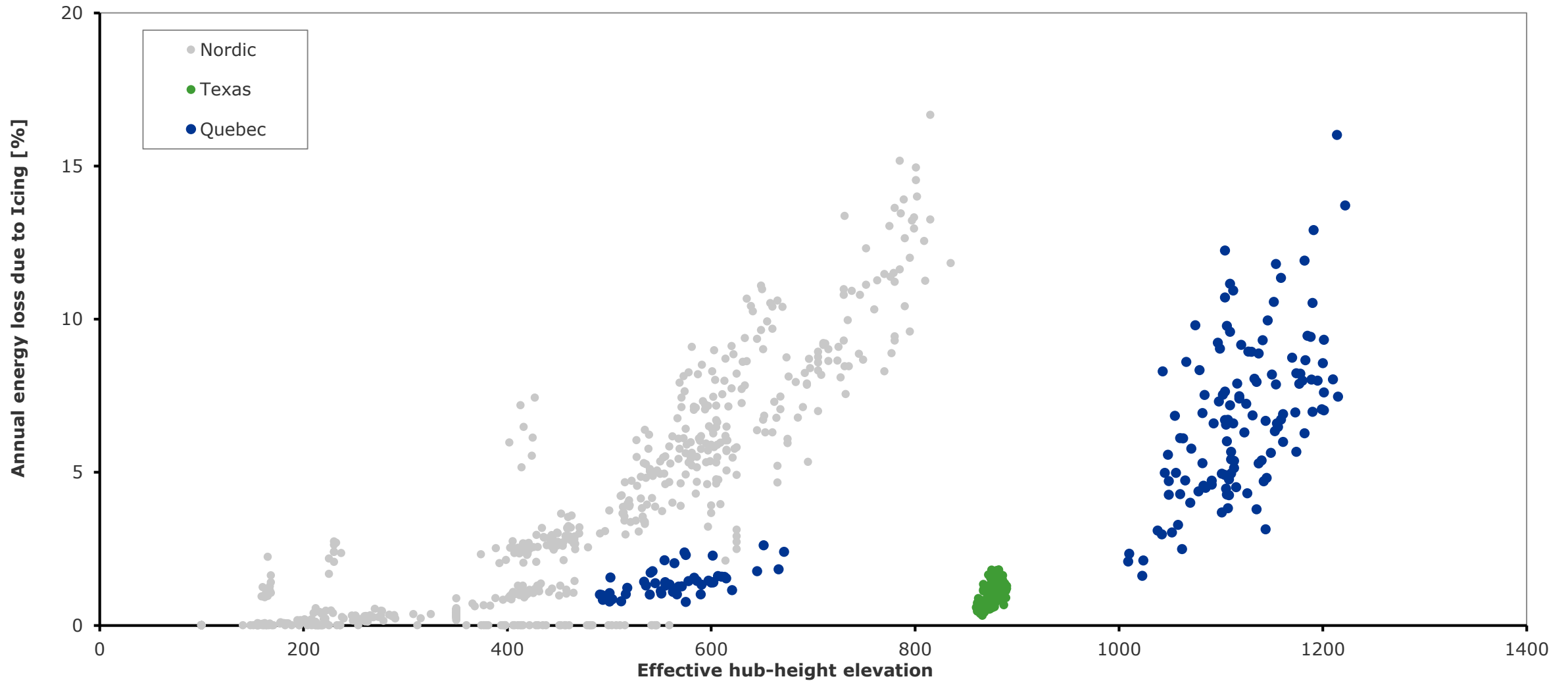


Icing rose – Single site, Sweden

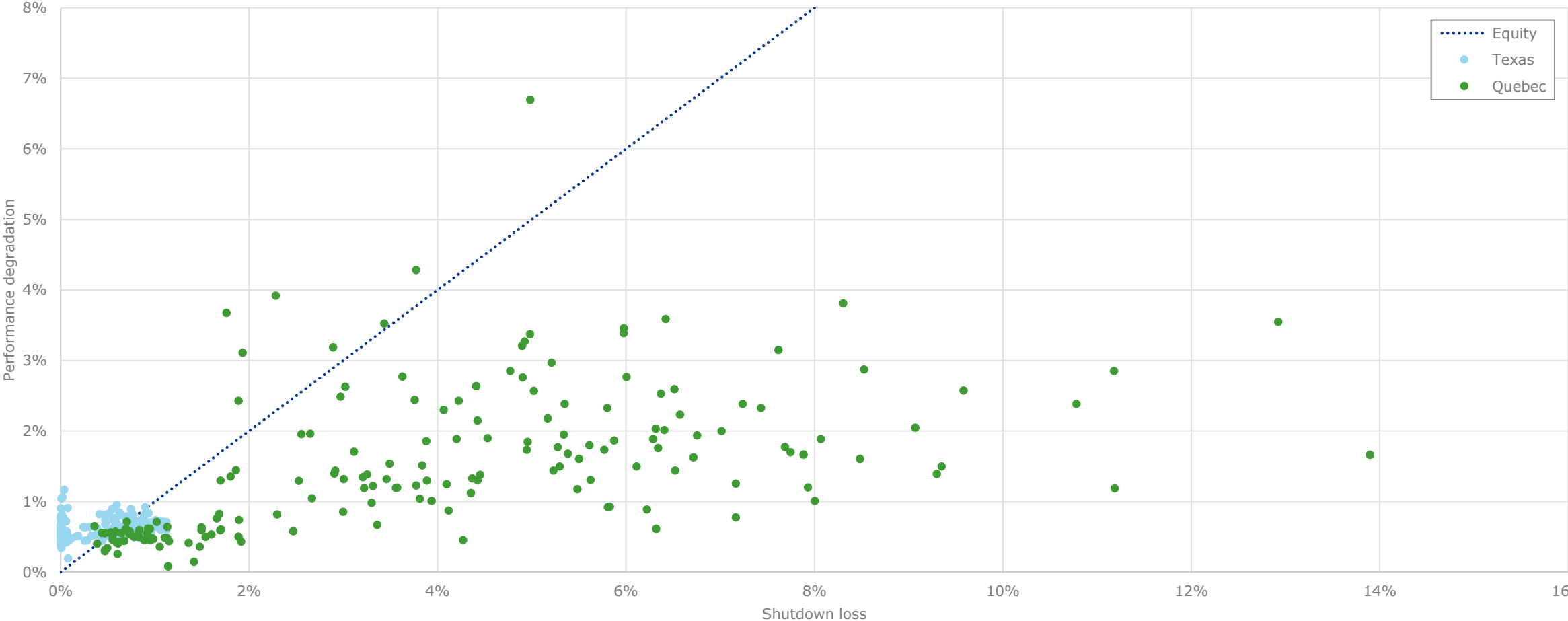


Part 3: Operational data in North America

North American operational data – Icing vs Elevation



North American operational data – Performance degradation vs shutdown



Conclusions

Conclusions

- Extension of data in the Nordics refines previously observed trends
- Preliminary look at a global met mast dataset suggests:
 - Different temperature characteristics in different regions
 - Icing often not in the predominant wind direction
 - Direction of icing events can be variable within a single site
- North American operational data:
 - Shows similar elevation trend to the Nordic countries
 - Icing losses driven by high levels of shutdown

Thank you!

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Till.Beckford@dnvgl.com

www.dnvgl.com

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