



Production Loss estimation for wind power forecasting

Winterwind 2014

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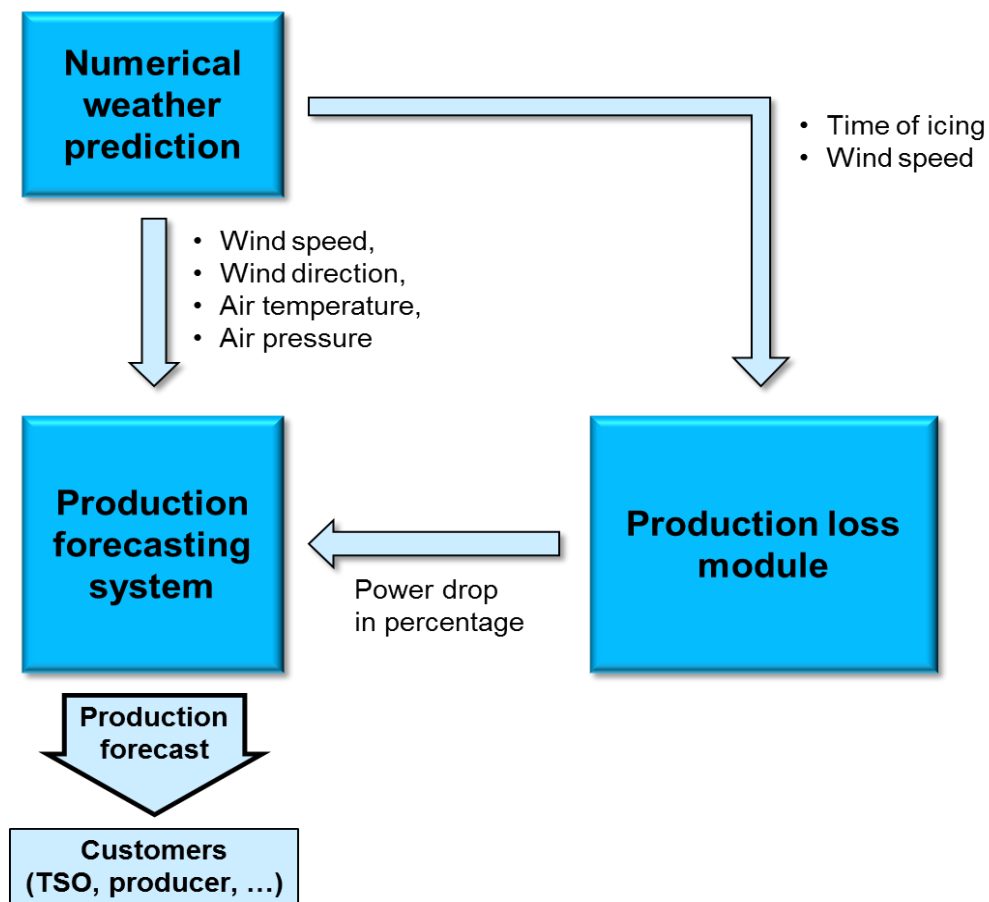
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Motivation

- Icing induced production losses are a known source error for production forecasting
- Need a method to correct the forecasts to include icing events
- Forecasting systems differ
 - Need something that can work in more than one
- Simple solution preferred

Module for forecasting

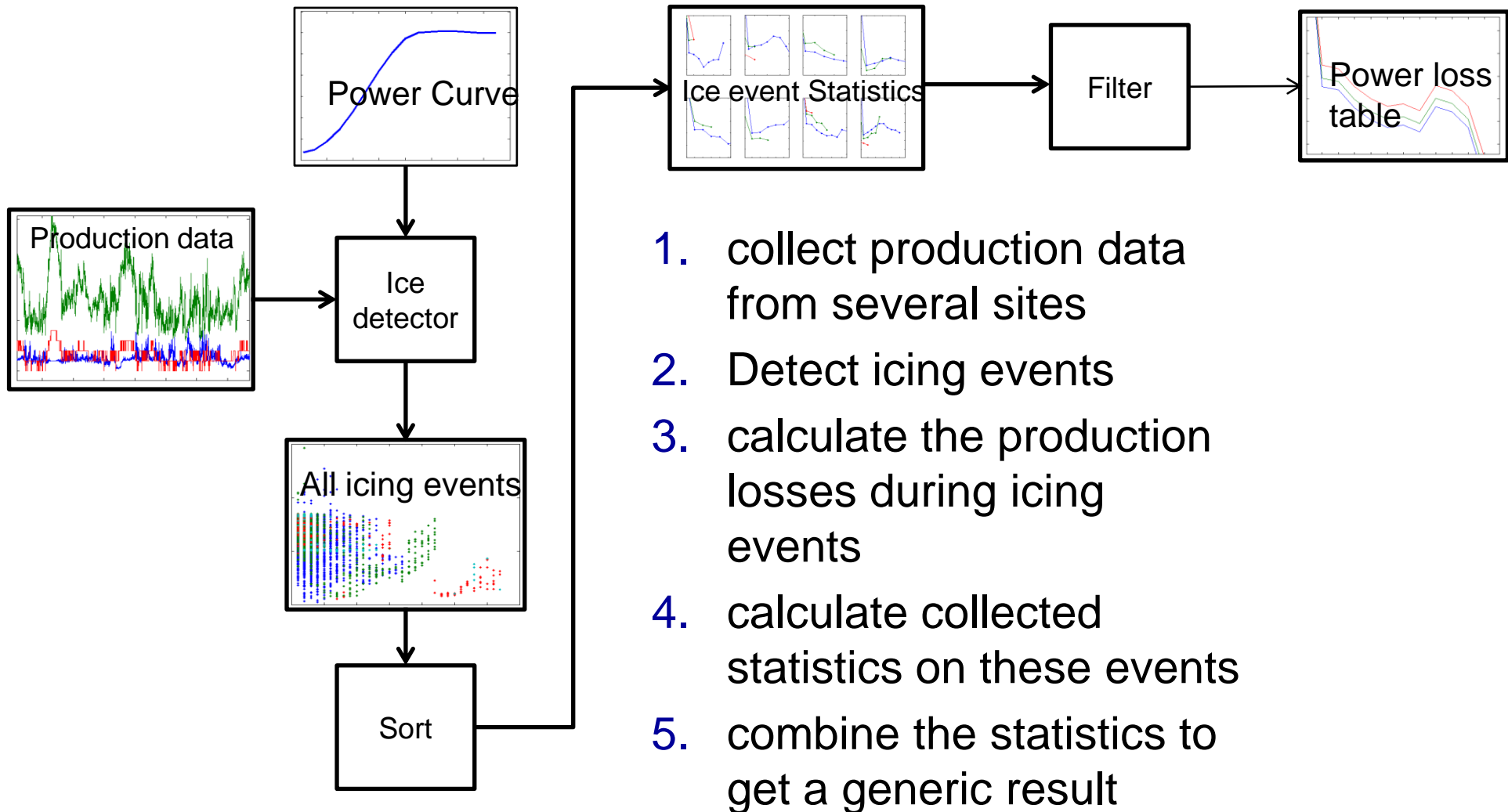
- estimate production losses caused by icing
- use real production data
- Look at effects of rotor icing
- Quantify the actual production losses



Design Goals – KISS principle

- Portability
 - not dependent on a certain forecasting system
- Generality
 - results not case/site dependent
- Simplicity
 - minimize the amount of needed inputs

Method



Data

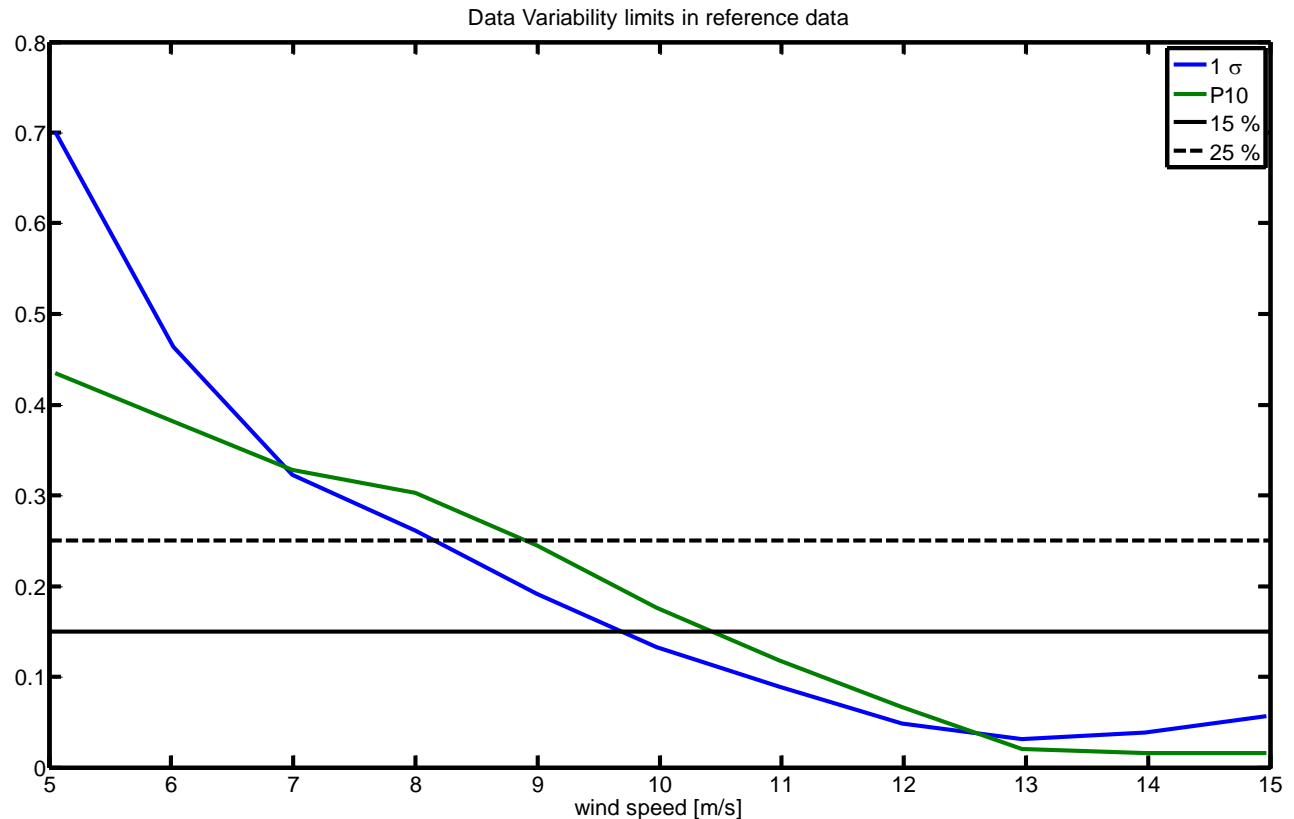
- Two sites in Finland
 - One in North (site A, two turbines)
 - One in South (site B, one turbine)
- different types of turbines
- combine different sites to each other
- Two years of data on both sites
- Production data, no external ice detection

Icing event definition

- Rotor icing detected from production data
- Often used metric is a constant power drop
 - -15..-25% from reference
- Data variability is larger on lower wind speeds
 - Limit should be wind speed dependant
- Lots of outliers
 - Time dependence
 - Robust statistics
 - P10 rather standard deviation

Icing event definition

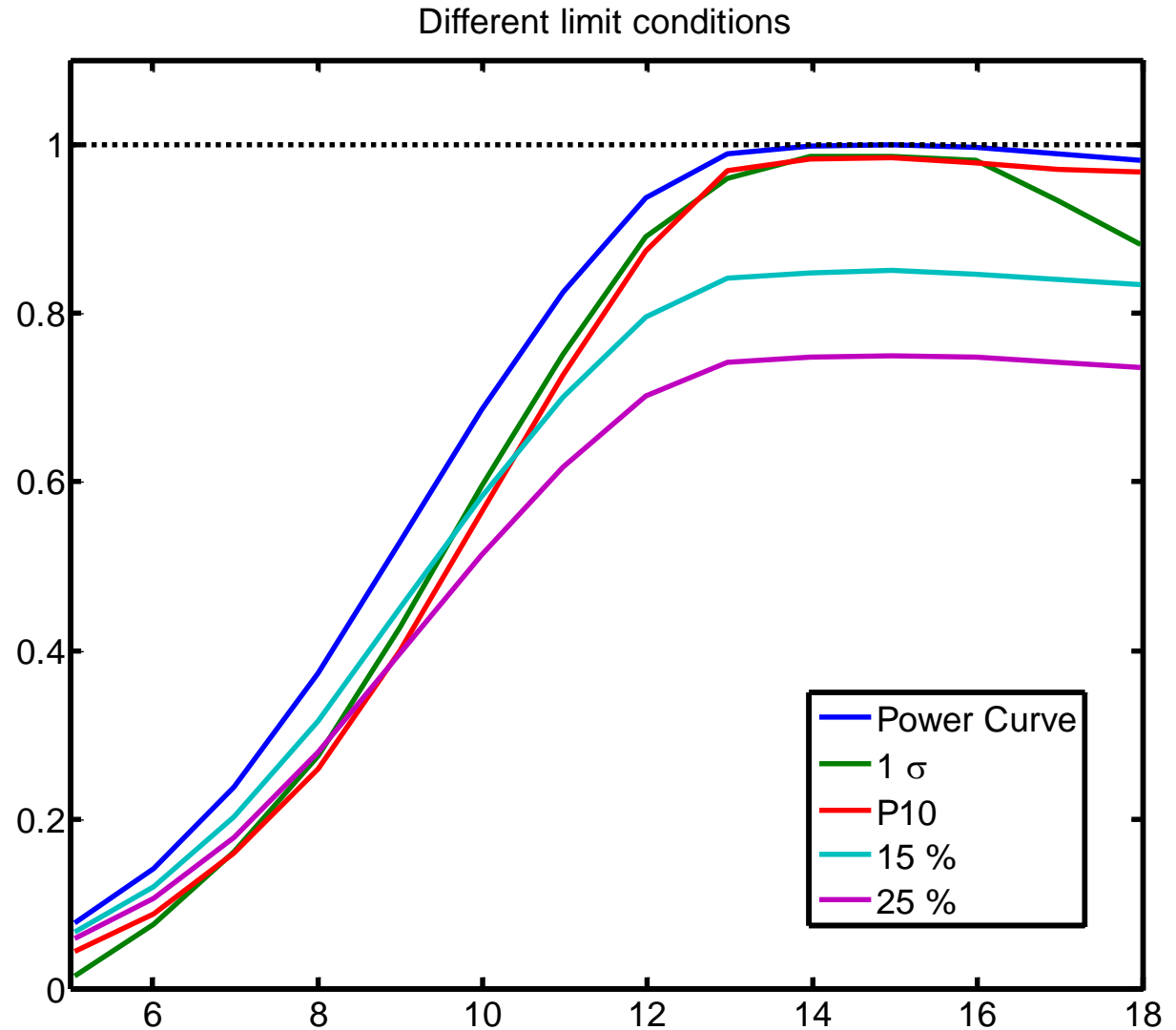
- Data variability:
 - wind speed dependent
 - Large at low wind speeds
- At low wind speed power 25 % below reference is not out of the ordinary



Icing events

- Temperature < 0
- Power < P10
- Duration > 30 min

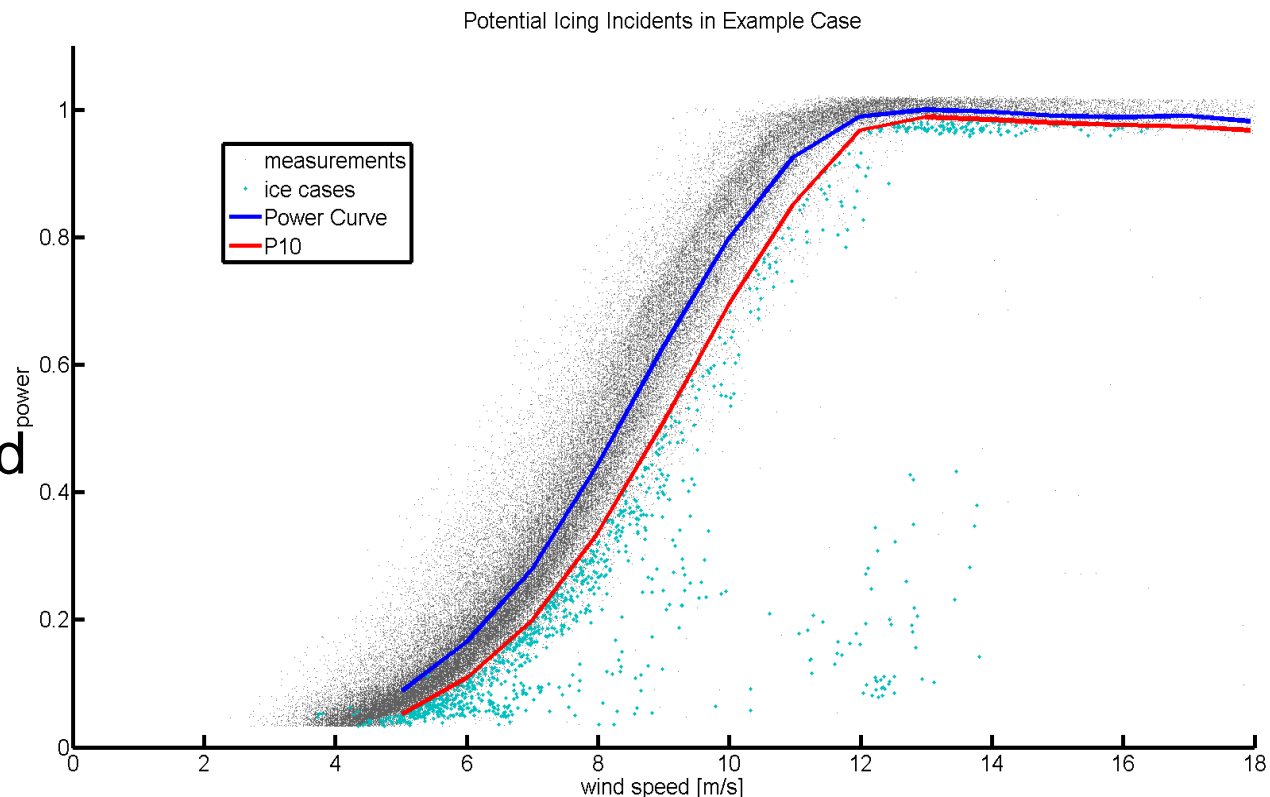
- Power is compared to known "clean" reference dataset



Icing events

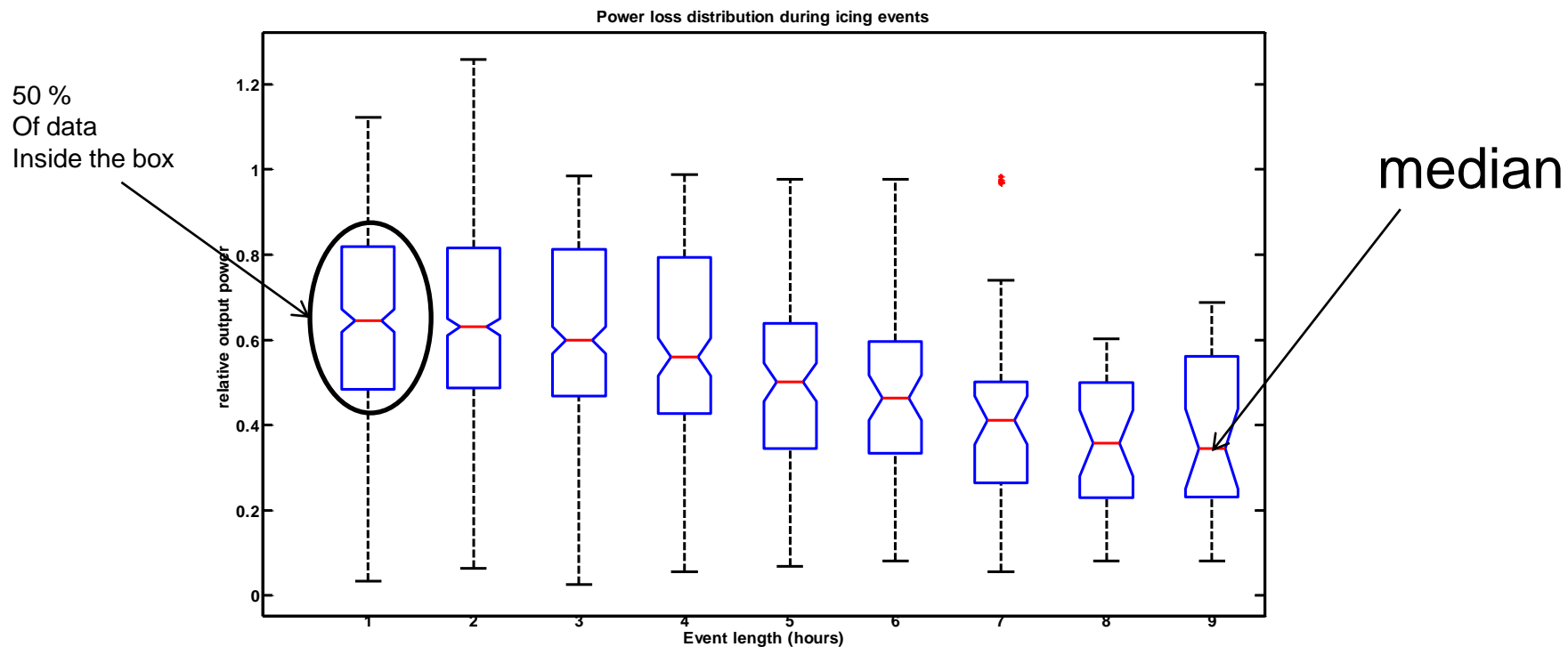
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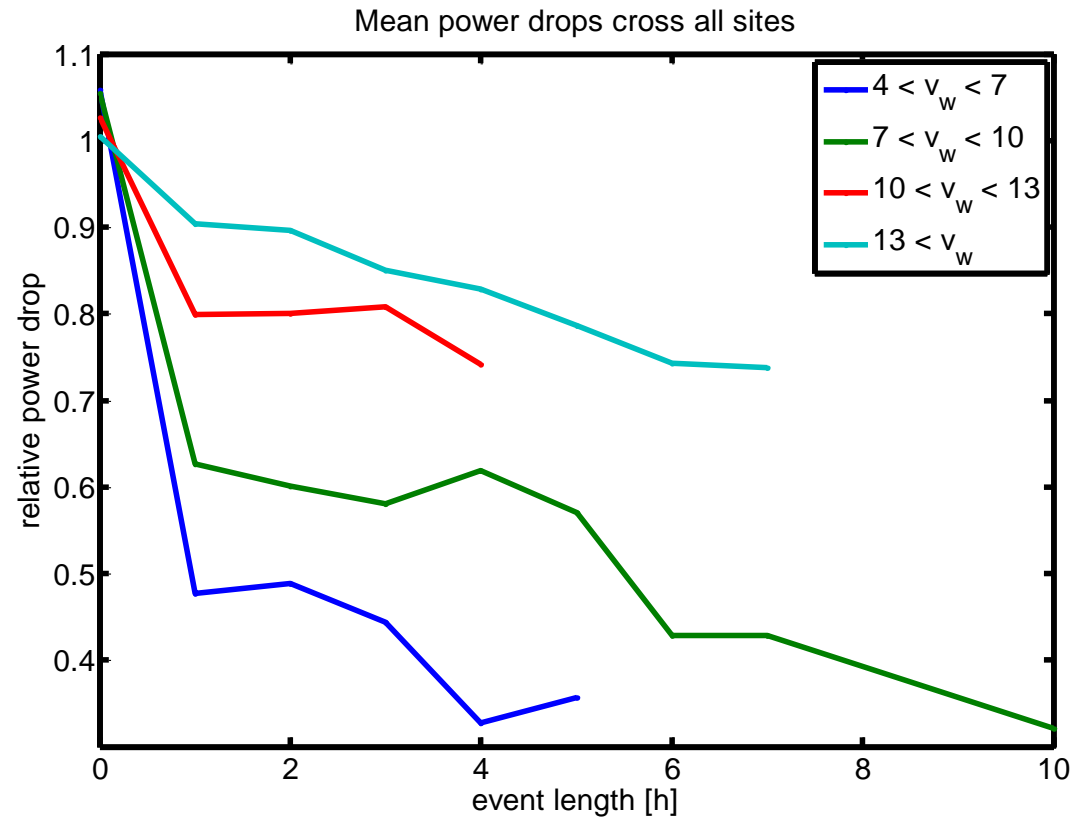
Loss statistics

- Massive variance in the data
- big median losses even after just one hour
- median loss trending down along with event length



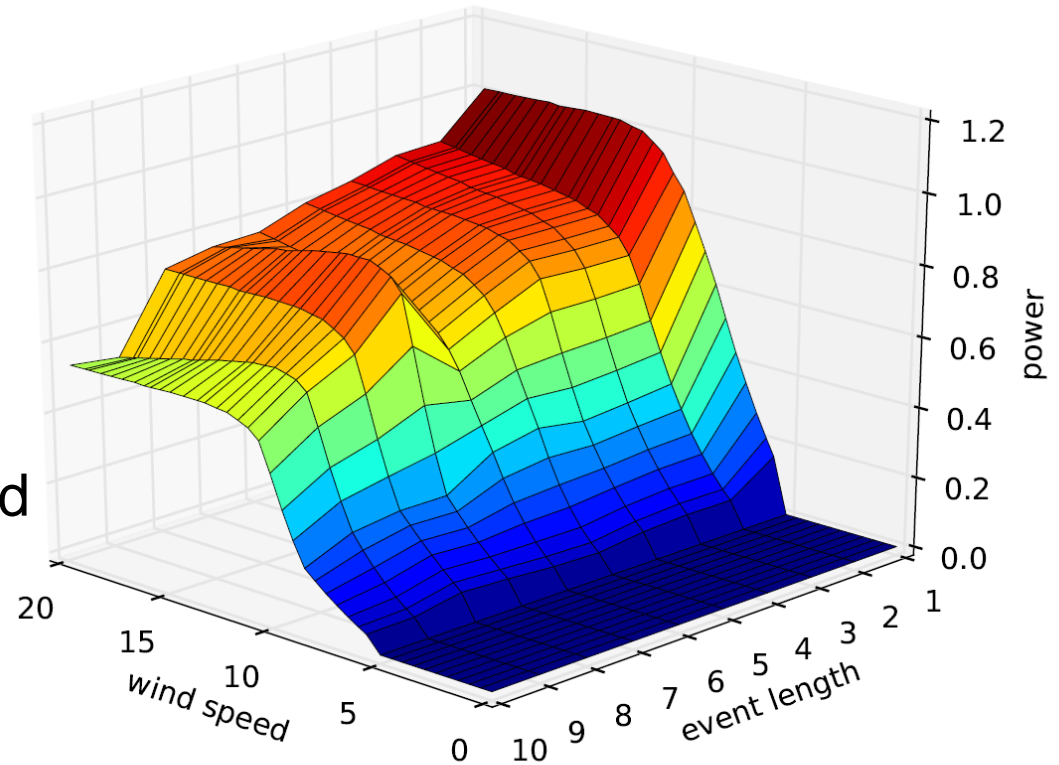
Loss Statistics

- Differences between sites are visible
 - Caused by differences in data variability
- Icing effect a lot more dramatic on smaller wind speeds



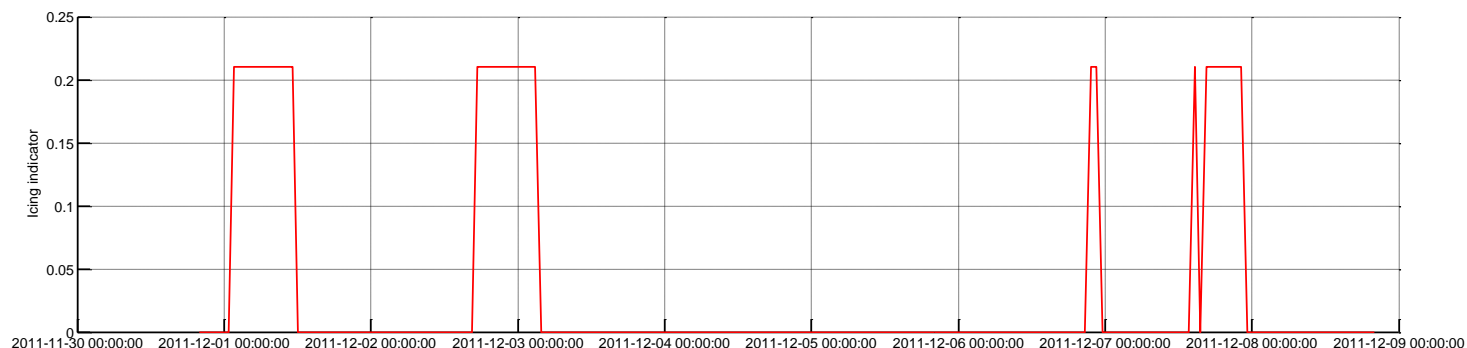
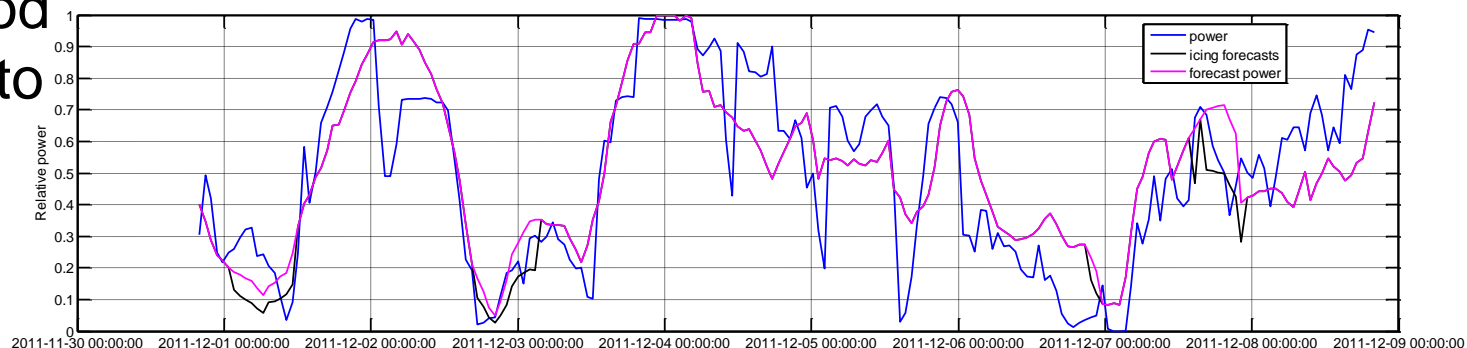
Conclusions from statistics

- Event length matters
 - Longer icing event -> bigger losses
- Wind speed has an effect
 - Relative losses significantly bigger at small wind speeds
- Site by site differences caused by data variability



Preliminary look at forecasting

- Resulting method really sensitive to icing forecast accuracy
- Timing another source of errors
- Meteorological vs. rotor icing



Sources for forecast errors

- Site-specific differences
 - Large data variability -> larger predicted power drops
- Stops
 - Losses caused by unscheduled, unpredicted stops can be larger than losses caused by decreased production
 - Model needs to be able to predict stops
 - Ice mass, if available
- Timing

Conclusions

- Production losses
 - Can be estimated from past production data
 - Wind speed
 - Icing event definition
 - Stops
- Some similarity accross sites
- Forecasting:
- Error sources
 - Timing
 - Rotor vs. meteorological icing
 - Production loss accuracy

Future work

- More work on forecasting
 - Different time windows
 - Different kinds of icin forecasts
 - More sites
- Later this year



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