



Modeling Power Loss Due to Wind Turbine Icing

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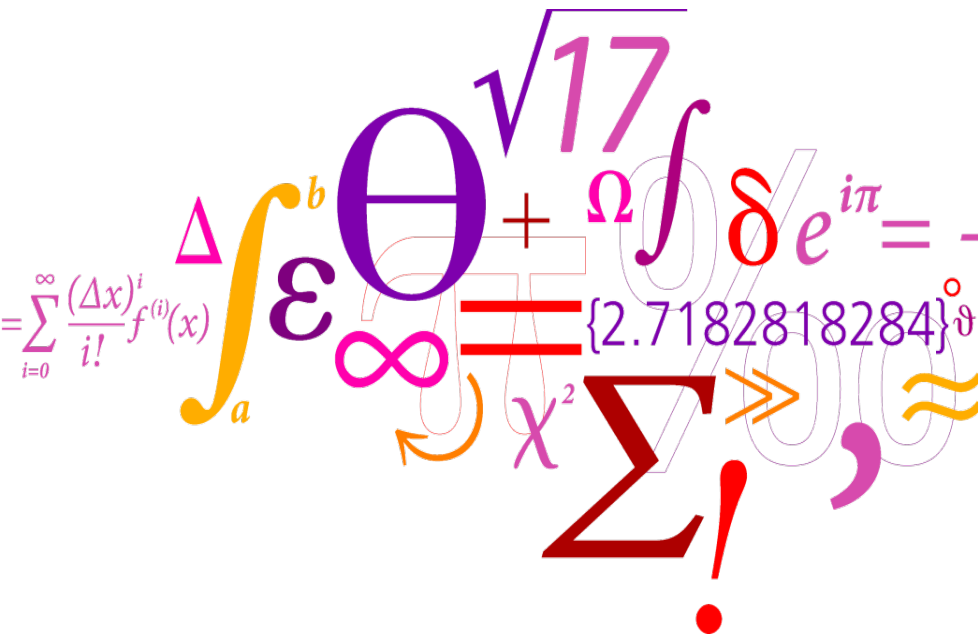
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Modeling Power Loss Due To Wind Turbine Icing

Danish Wind Industry
Annual Event 2014

Neil Davis^{1,2}, Andrea Hahmann¹,
Niels-Erik Clausen¹, and Mark Zagar²

1: DTU Wind Energy; 2: Vestas Wind Systems



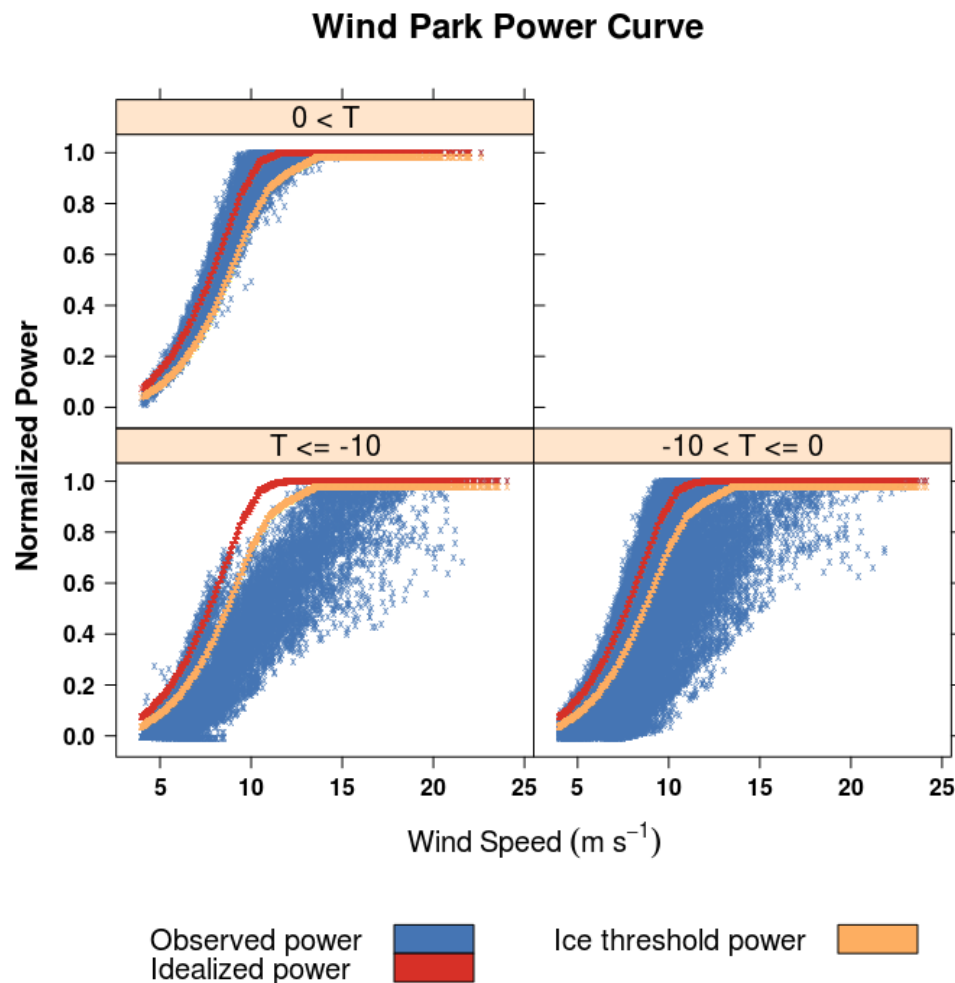
Motivation

- Site location
- Wind park planning
- Energy market pricing

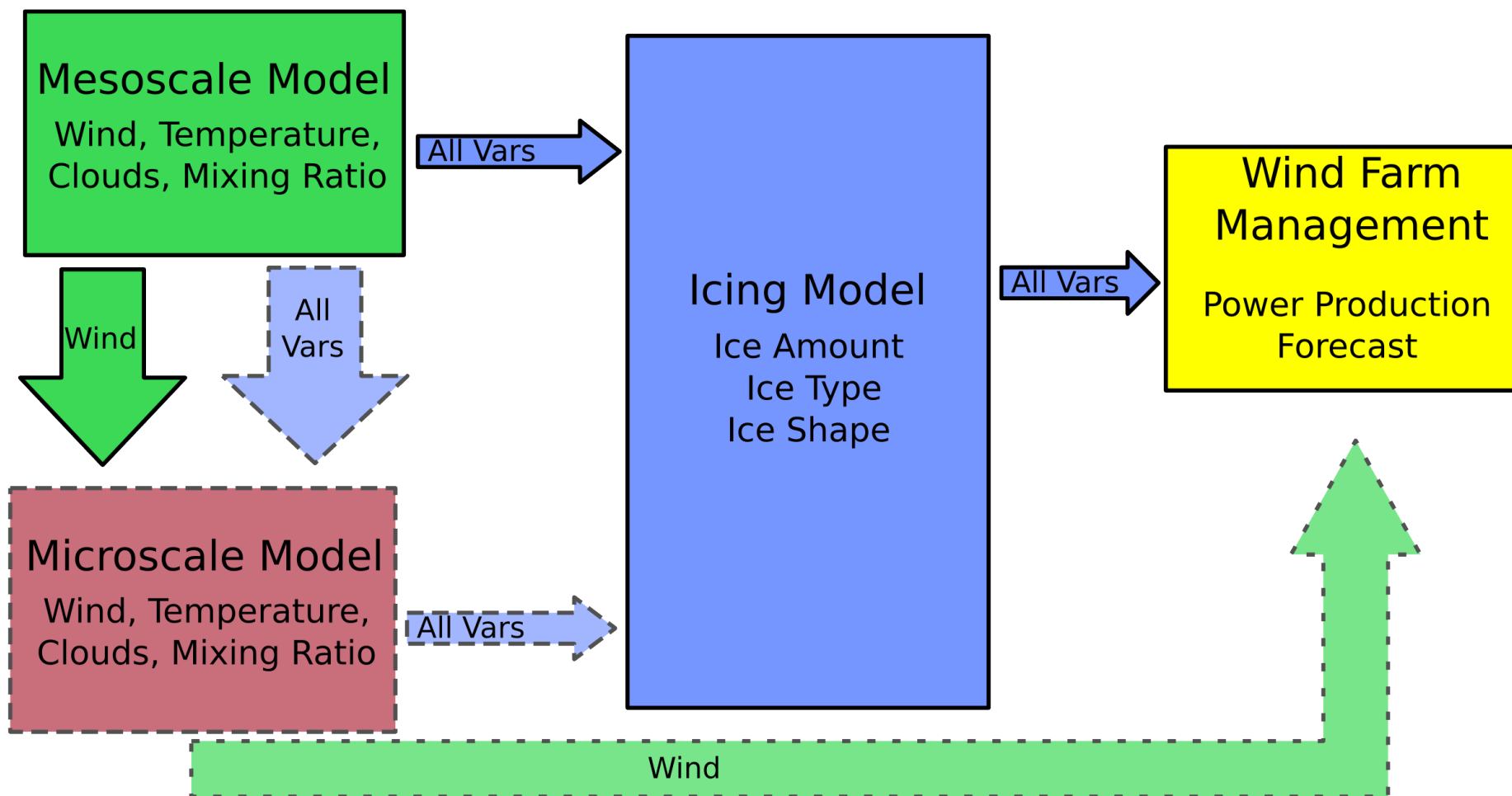


Photo: Andrea Vignaroli

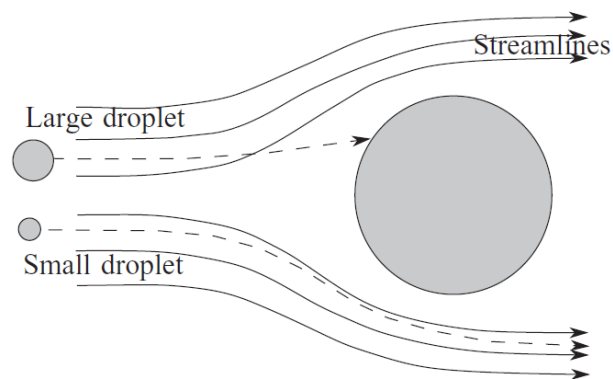
Wallenius, T. and Peltola, E., 2011: Current issues on wind energy production in cold climate. NordVind seminar Vindkraft i kaldt klima, Copenhagen.



Production Forecast Model



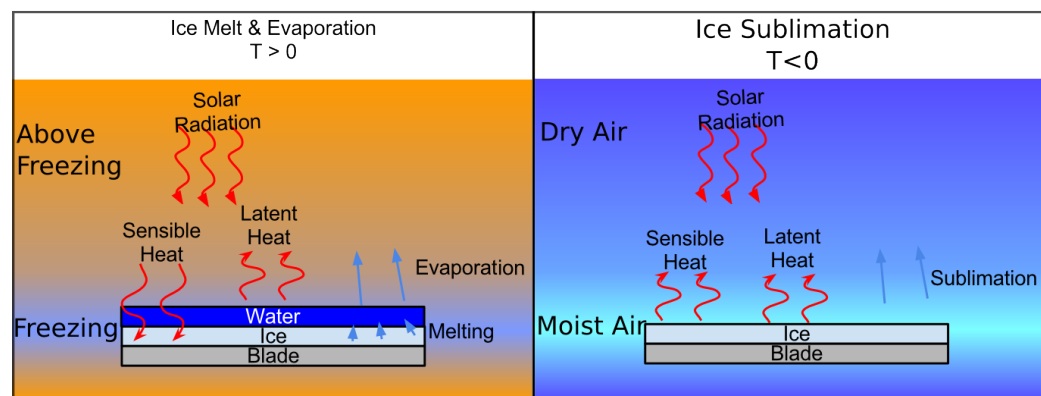
Icing Model



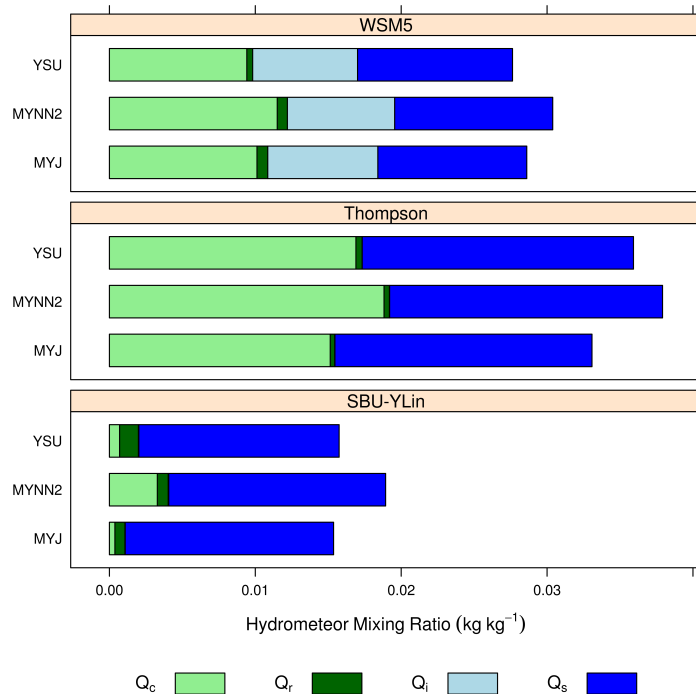
Homola, M.C. et al., 2010. The relationship between chord length and rime icing on wind turbines. *Wind Energy*, 13(7), pp.627–632.

- Accretion
 - Makkonen Model
 - Collision efficiency
 - Freezing Fraction
- Ablation
 - Sublimation
 - Total Shedding
 - Wind Erosion

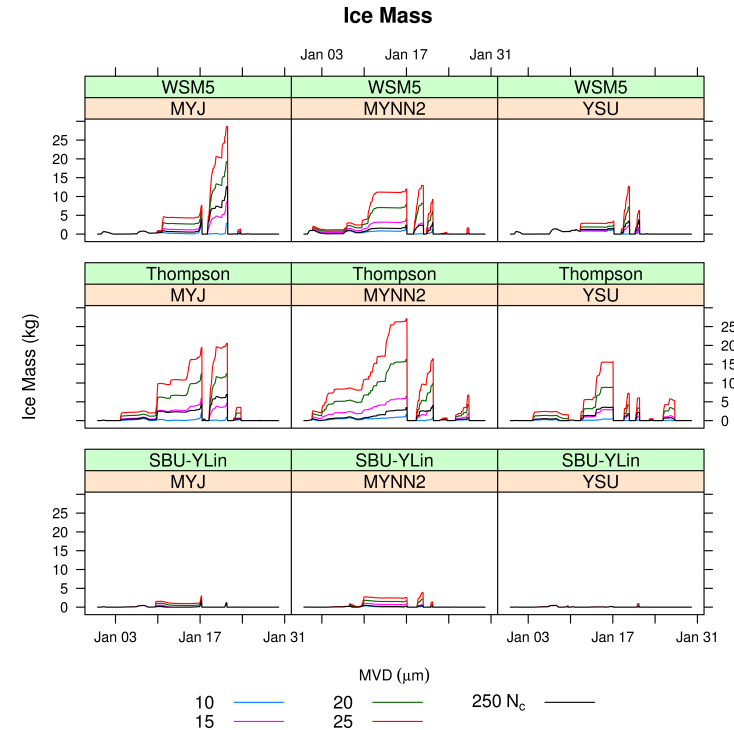
	Very Cold	Cold	Near Freezing
Light cloud	Rime Icing 	Rime Icing 	Glaze Icing
Mild cloud	Rime Icing 	Glaze Icing 	No Icing
Heavy cloud	Glaze Icing 	No Icing 	No Icing



Sensitivity to Mesoscale Model



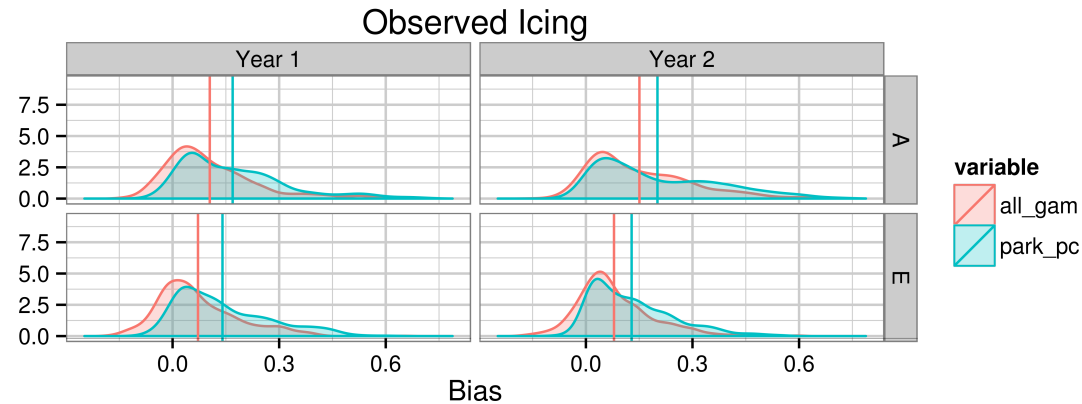
Davis, N. et al., 2014. Forecast of Icing Events at a Wind Farm in Sweden. Journal of Applied Meteorology and Climatology, 53(2), pp.262–281.



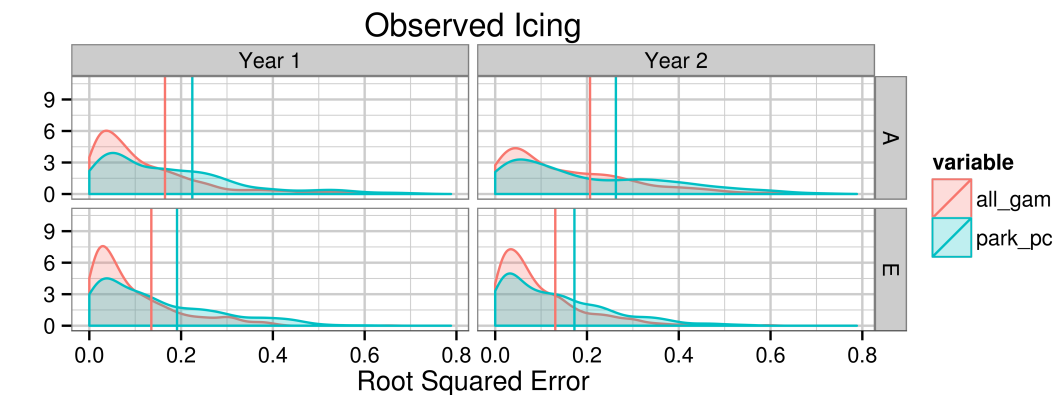
Davis, N. et al., 2014. Forecast of Icing Events at a Wind Farm in Sweden. Journal of Applied Meteorology and Climatology, 53(2), pp.262–281.

- Large impact on clouds from physics options
- Feeds to a large difference in projected ice mass

Power Loss Model



- Fit on ice model results reduces estimated power bias and error
- Park_pc is unadjusted power curve



- all_gam is the statistical model fit
- Better results are near 0.0