

#### Modeling Power Loss Due to Wind Turbine Icing

Davis, Neil; Hahmann, Andrea N.; Clausen, Niels-Erik; Zagar, Mark

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### Modeling Power Loss Due To Wind Turbine Icing

Danish Wind Industry Annual Event 2014

Neil Davis<sup>1,2</sup>, Andrea Hahmann<sup>1</sup> $f(x+\Delta x) = \sum_{i=0}^{\infty} \frac{(\Delta x)^{i}}{i!} f$ Niels-Erik Clausen<sup>1</sup>, and Mark Zagar<sup>2</sup>

1: DTU Wind Energy; 2: Vestas Wind Systems

**DTU Wind Energy** Department of Wind Energy

### Vestas.



## Motivation

- Site location
- Wind park planning
- Energy market pricing



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



### Wind Park Power Curve





## **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





**Vestas** 



### Sensitvity 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

Vestas.



### **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