
DTU

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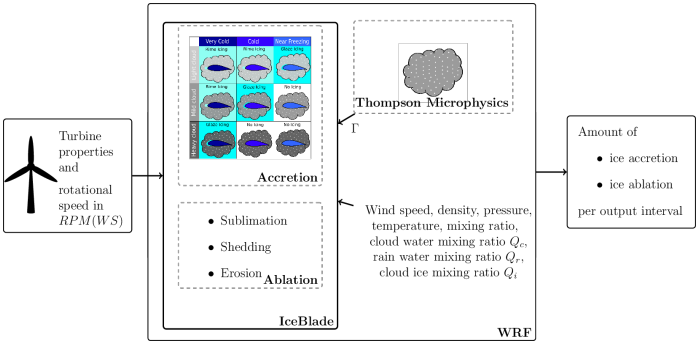
An open source ice model running in WRF

Introducing iceBlade



= Ice model for WRF [Davis et al., 2014, 2016, + updates] for forecasting or resource assessment

- Ice accretion: $\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 \omega v A$ [Makkonen, 2000]
- Ice ablation: sublimation, wind erosion, and total ice shedding

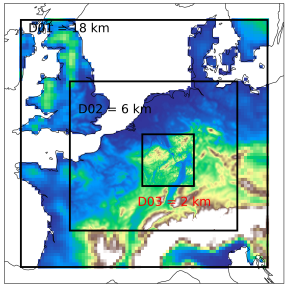
Available soon from `https://gitlab.windenergy.dtu.dk/WRF/wrf-ice`

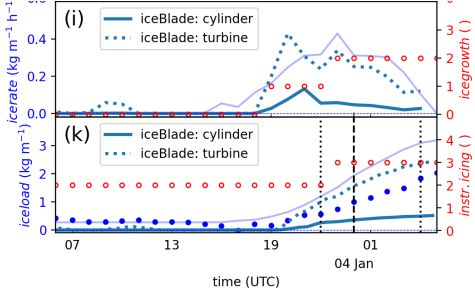
Applying iceBlade

1. Case study validation against measurements
2. Icing maps from New European Wind Atlas (NEWA)
3. Comparison of NEWA-iceBlade with IEC 61400-1 standard

Case study validation against measurements

- WRF-iceBlade simulations for: 3.– 4. Jan 2017 in Ellern, Germany following Strauss et al. [2020]
- Narcelle-mounted measurements collected in project ICE CONTROL (2016-2019)[1]



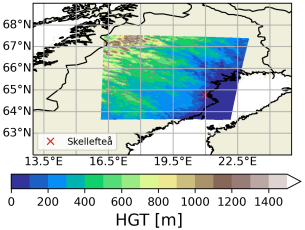


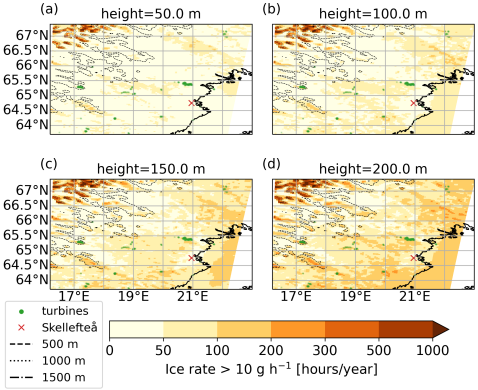
Dots: Measurements
iceBlade Validation: Thick, dark lines
Reproduced from Strauss et al. [2020]: thin, bright lines

[a] provided by Zentralanstalt fuer Meteorologie und Geodynamik (ZAMG), University of Vienna, VERBUND Green Power GmbH, Meteotest AB

Icing maps from New European Wind Atlas (NEWA[1])

NEWA: European wind atlas using WRF for Europe with 3 km resolution [Hahmann et al., 2020, Dörenkämper et al., 2020]





- ice rate: $\frac{dM}{dt}$
- icing episode [Byrkjedal, 2012]: $\frac{dM}{dt} > 10\text{g h}^{-1}$
- Average over 2014-2018 (4 winters)

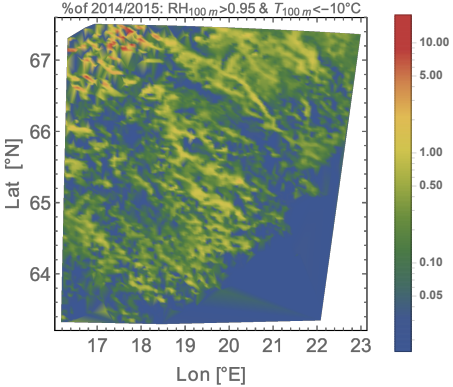
[1] `map.neweuropeanwindatlas.eu`

NEWA-iceBlade vs. IEC 61400-1: Comparison

% of time, for 2014–15

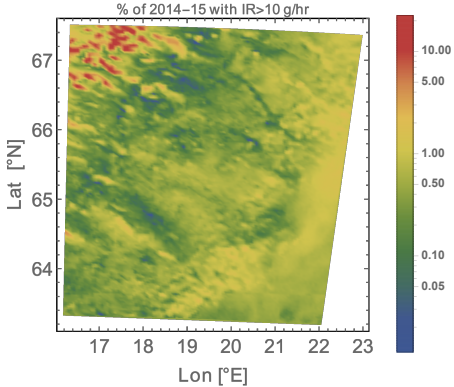
IEC 61400-1 [ed.4]

$T_{air} < -10°C$ and $RH > 95\%$



iceBlade

ice rate>10 g/hr



Conclusions: iceBlade

= ice model running in WRF for ice forecasting or resource assessment[1]
- \+ Ice accretion $\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 \omega v A$ [Makkonen, 2000]
- \+ Ice ablation: sublimation, wind erosion, total ice shedding [Davis et al., 2014, 2016]
- $\rightarrow$ for standard cylinder and blade cylinder
- Case study evaluation against measurements [Strauss et al., 2020]

... results for standard cylinder are available from the New European Wind Atlas (NEWA[2], 30 years)
- Preliminary icing maps for ice rate and total ice load for 4 winters
- Total ice load is more variable than ice rate from winter to winter

... comparison against IEC61400-1 (LTC: $T_{air} < -10°C$ and $RH > 95\%$)

[1] Available soon from `https://gitlab.windenergy.dtu.dk/WRF/wrf-ice`

[2] Available from `map.neweuropeanwindatlas.eu`

References & Acknowledgements I

The Ellern measurements were made in the project ICE CONTROL (2016-2019) conducted by the Zentralanstalt fuer Meteorologie und Geodynamik (ZAMG), the University of Vienna, VERBUND Green Power GmbH, and Meteotest AB, whom kindly provided the data. The measurements have been published graphically in Strauss et al. (2020).

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