Aircraft icing forecasts with the ICE-T microphysics scheme

Photo: Greg Thompson

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Recap

Implemented parts of the Thompson microphysics scheme into ICE3

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Validated against observations of ice loads at transmission lines

Next step: Up into the air!

Up into the air!

What? Check the effects higher up in the atmosphere

Goal: Check if ICE-T can be used for forecasts of aircraft icing

How? Validate the model simulations against pilot reports (aireps) and satellite retrieved profiles of Liquid and Ice Water Content (LWC and IWC) over a 3 month winter season

3 month winter simulation

Dec 1 2016 - Feb 28 2017

CTRL and ICE-T

No data assimilation, input forecast ECMWF, Cold start, 00+36h (use 12-36)

2.5km grid spacing, 65 vertical levels, 949x739 grid points covering Norway, Sweden and parts of Finland

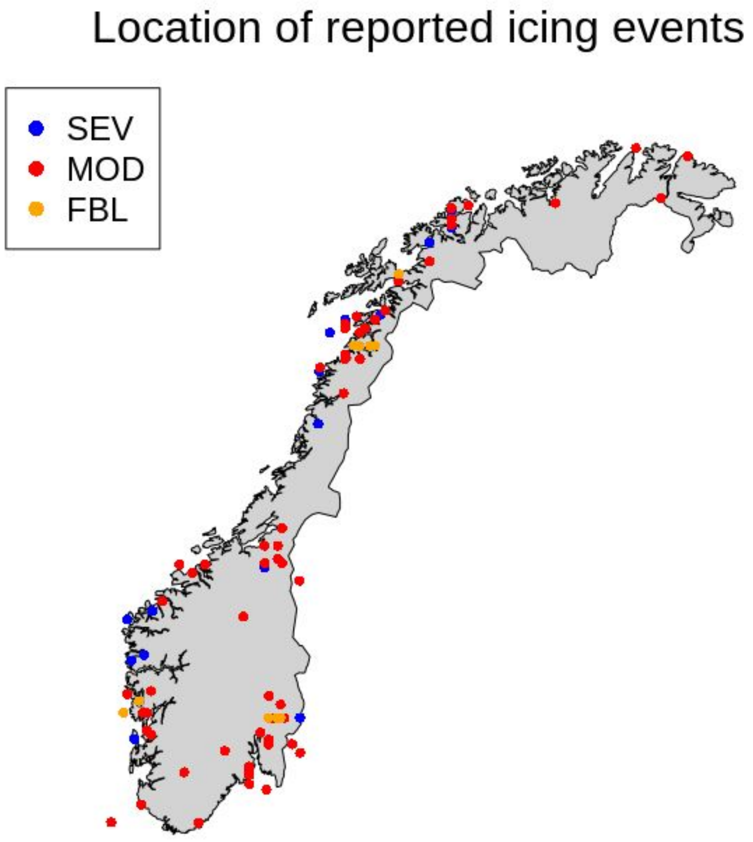
Aireps

111 reported icing events in total

12 FBL (light), 78 MOD (moderate), 21 SEV (severe)

Time, location, height interval, severity

Problem: Biased and subjective



Icing algorithm

Currently at MET-Norway: Based on the ice accretion model described by Makkonen (2000)

Input from NWP:

Cloud water
Rain
(Snow, graupel, cloud ice)
Specific humidity
Pressure
Temperature

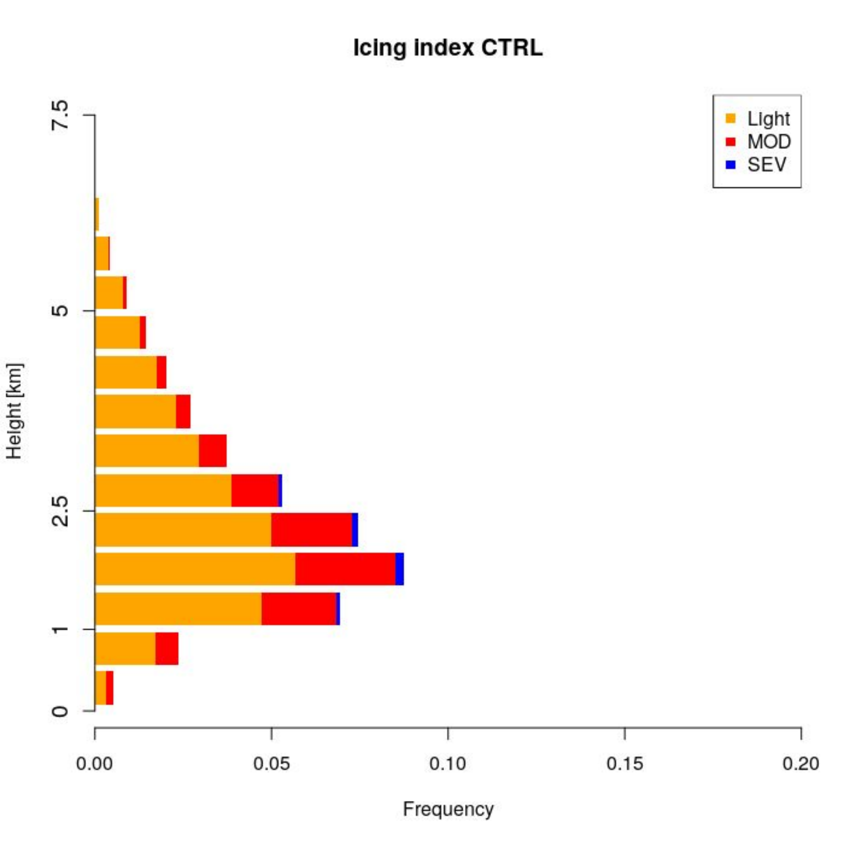
→ **Icing model** →

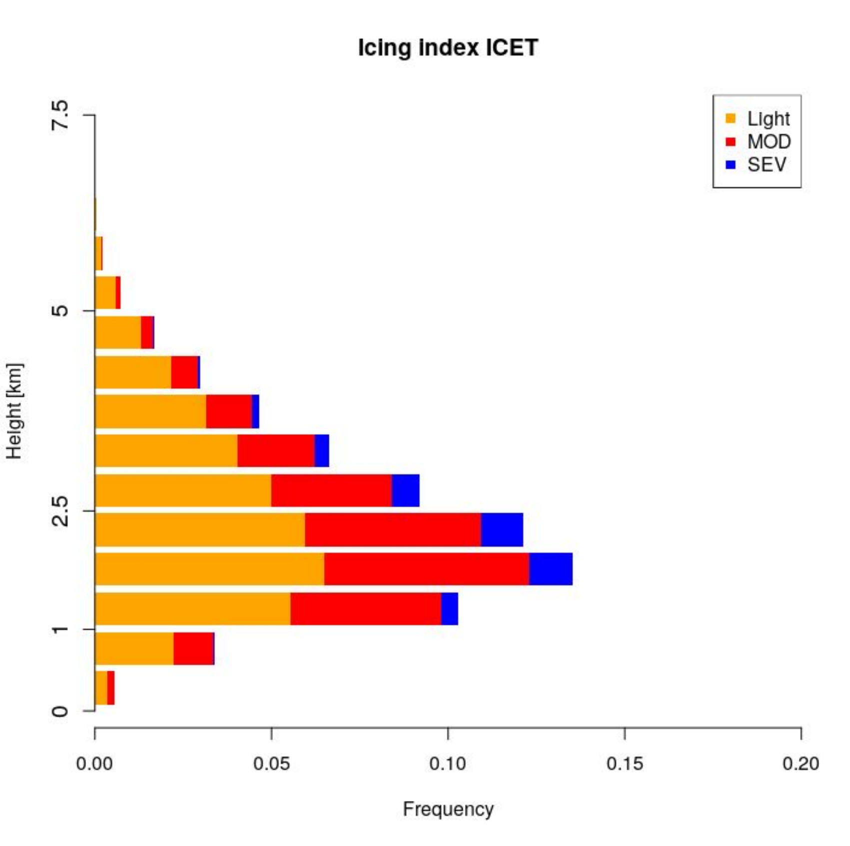
Icing indices:

1: Trace (not used)
2: FBL (light)
3: MOD (moderate)
4: SEV (severe)

Thresholds appear somewhat arbitrary. Could easily be adjusted to fit model output.

Icing frequency





Neighbourhood

Locations given in aireps may be inaccurate, moreover icing often occur in a larger area

Define a set of neighbourhoods of different sizes around the aireps
0, 1, 3, 5, 10, and 15 grid boxes in each direction from the closest point (largest area cover 31 x 31 grid boxes, or ~6000 km^2)

Find hit rate for all neighbourhood sizes (Icing/no-icing), thresholds:

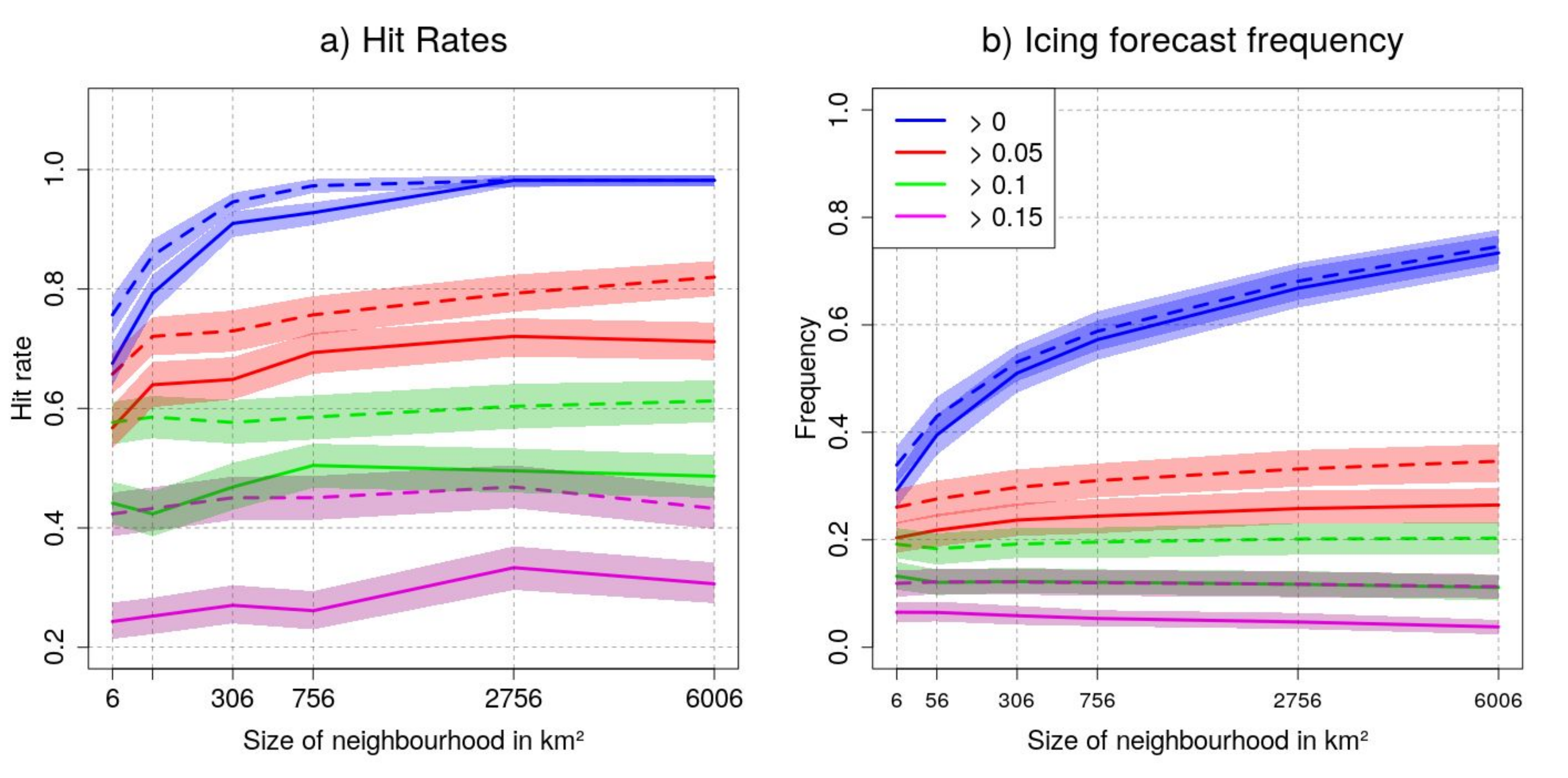
< 0 % (any grid points with icing inside area)

< 5 %

< 10 %

< 15 %

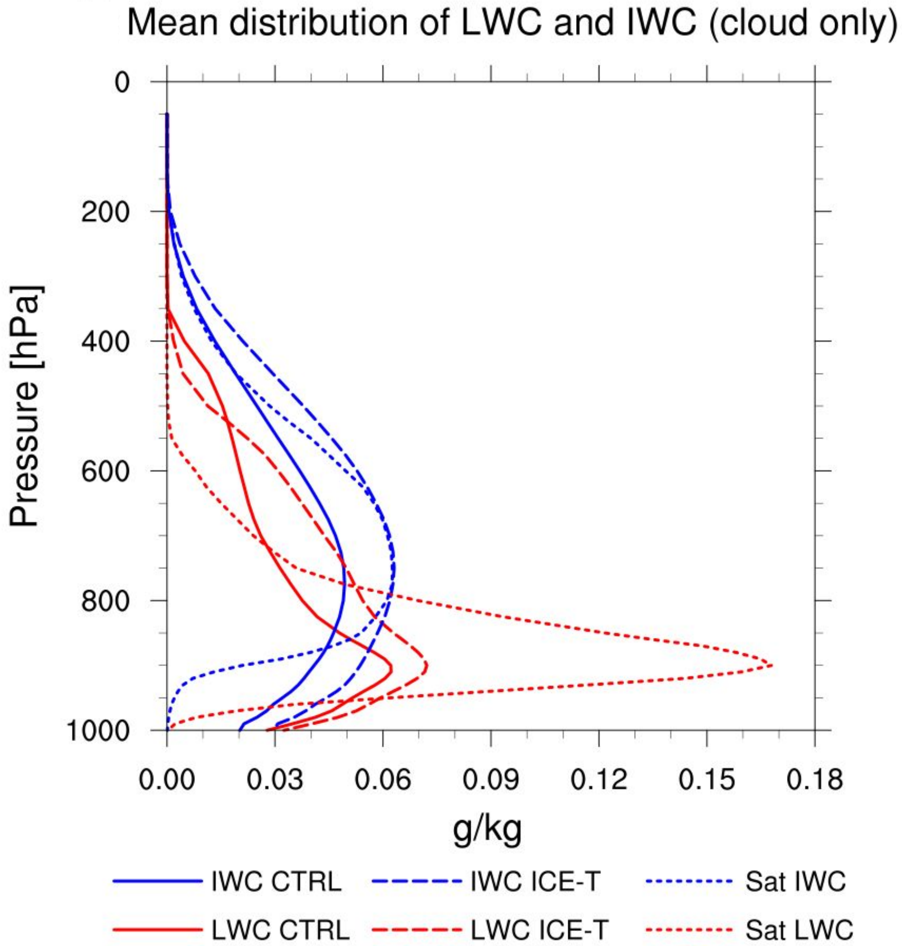
Hit rate and icing frequencies CTRL (solid lines) and ICE-T (dashed lines)



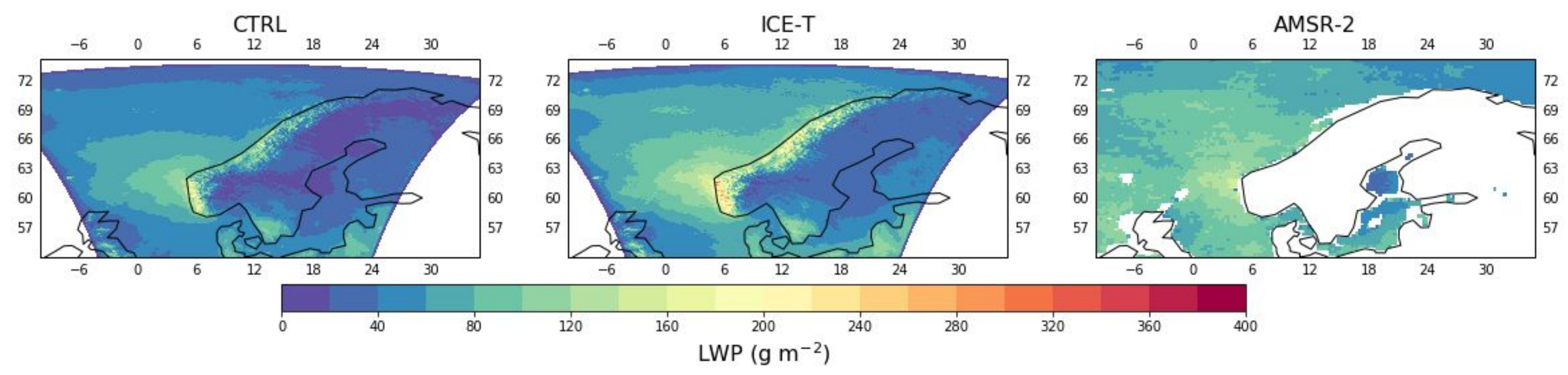
Shaded areas represent 98% confidence intervals

Satellite retrieved observations

Modelled and satellite retrieved (CloudSat-CALIPSO) distribution of LWC and IWC DJF 2016-2017 (cloud only)



Liquid water path



Main conclusions

ICE-T has more supercooled liquid water than CTRL, and subsequently higher icing frequency

ICE-T has a higher hit rate than CTRL, but higher false alarm ratio can not be ruled out for most thresholds and neighbourhoods

ICE-T improves the vertical distribution of IWC, and LWC at lower levels

LWP is improved with ICE-T

Lack of LWC at lower levels should be investigated further

Questions?