

An Icing Index Comparison to Luosto Icing Measurements

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Contents

1. Icing indexes and HIRLAM NWP models
2. Icing measurements in Luosto
3. Forecast and measurement comparisons

Scope of the work

- Test and verify an icing index (Olofsson et al, 2003)
- Investigate the feasibility of an operational NWP model HIRLAM to forecast in-cloud icing events at low altitudes

Icing indexes

- $A = 5 + \ln(cw)$

- $B = A + Cr(T)$

- $C = B + Cr(w)$

Table 1 Correction $Cr(T)$ according to temperature applied to the icing index A to get index B .

$T(^{\circ}C)$	0...	-1...	-2...	-3...	-12...	-15...	-18...	-25...
	-1	-2	-3	-12	-15	18	-25	-40
$Cr(T)$	-2	-1	0	+1	0	-1	-2	-3

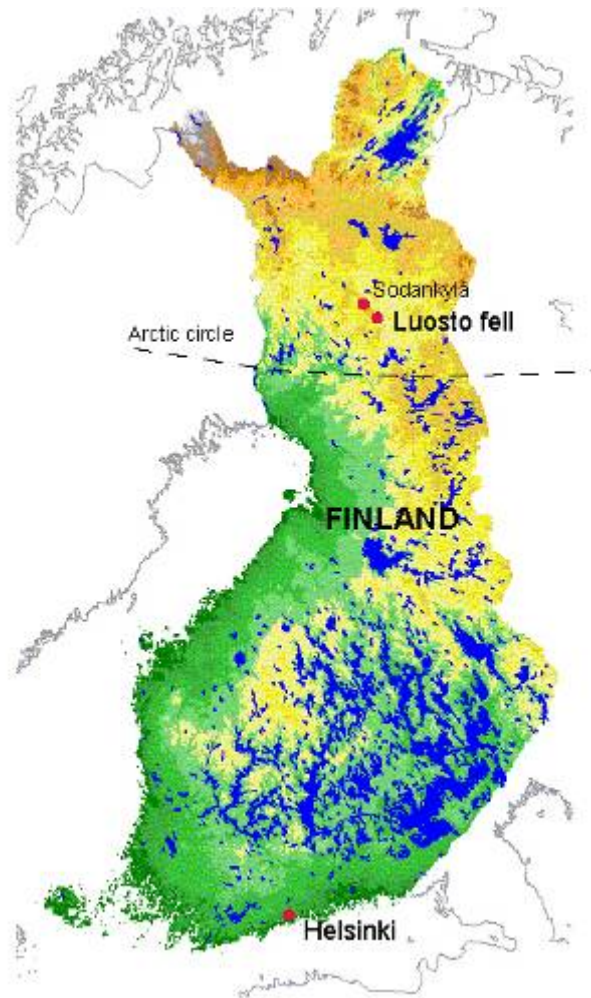
Table 2 Correction $Cr(w)$ according to vertical velocity applied to the icing index B to get index C .

$w(\text{cm/s})$	below 0	0...10	10...20	20...30	over 30
$Cr(w)$	-1	+1	+2	+3	+4

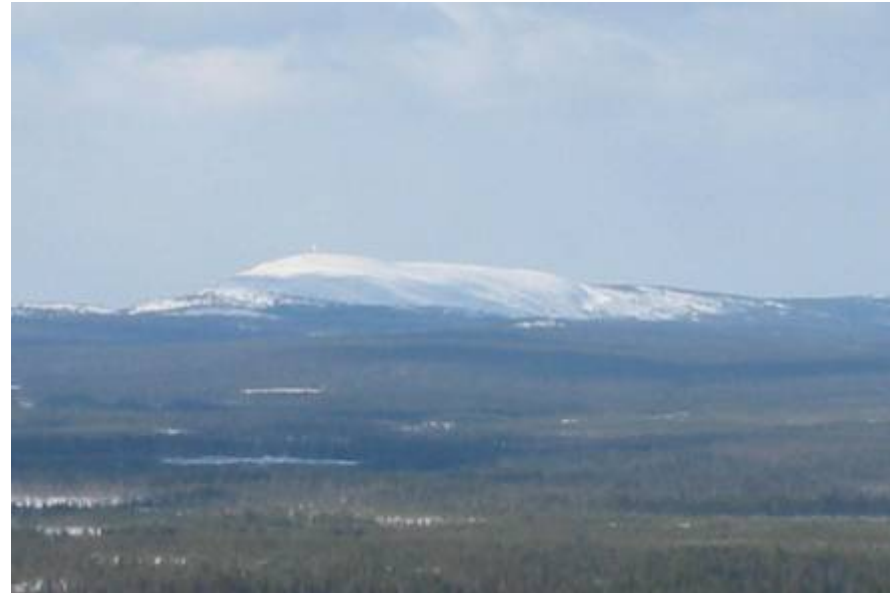
HIRLAM NWP models

- RCR-HIRLAM, 22 km, 40 levels
 - ≡ 7, 8, 9 and 12 h forecast fields
 - ≡ icing index A and C
- MBE-HIRLAM, 9 km, 40 levels
 - ≡ 7, 8, 9, 10, 11 and 12 h forecast fields
 - ≡ icing index A and B
- the closest grid point at level #37, 470 m MSL

Measurement site Luosto



- Location $67^{\circ}08' N$, $26^{\circ}54' E$
- Test site located on the top of the fell (hill), 515 m MSL (NWP 470 m)
- Top lies 250 m above the surrounding flat land
- Number of icing hours 1500-1700/y



Measurements



Luosto (GMT) Wed Feb 15 14:11:00 2006 © Ilmatieteen laitos



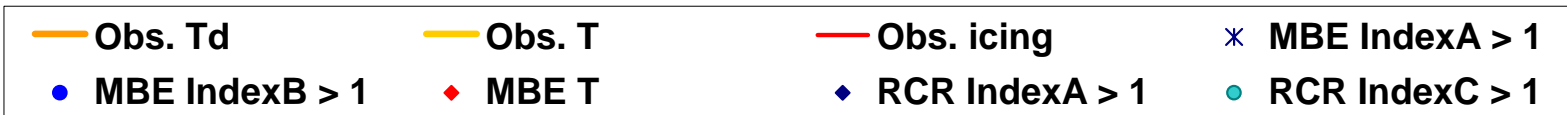
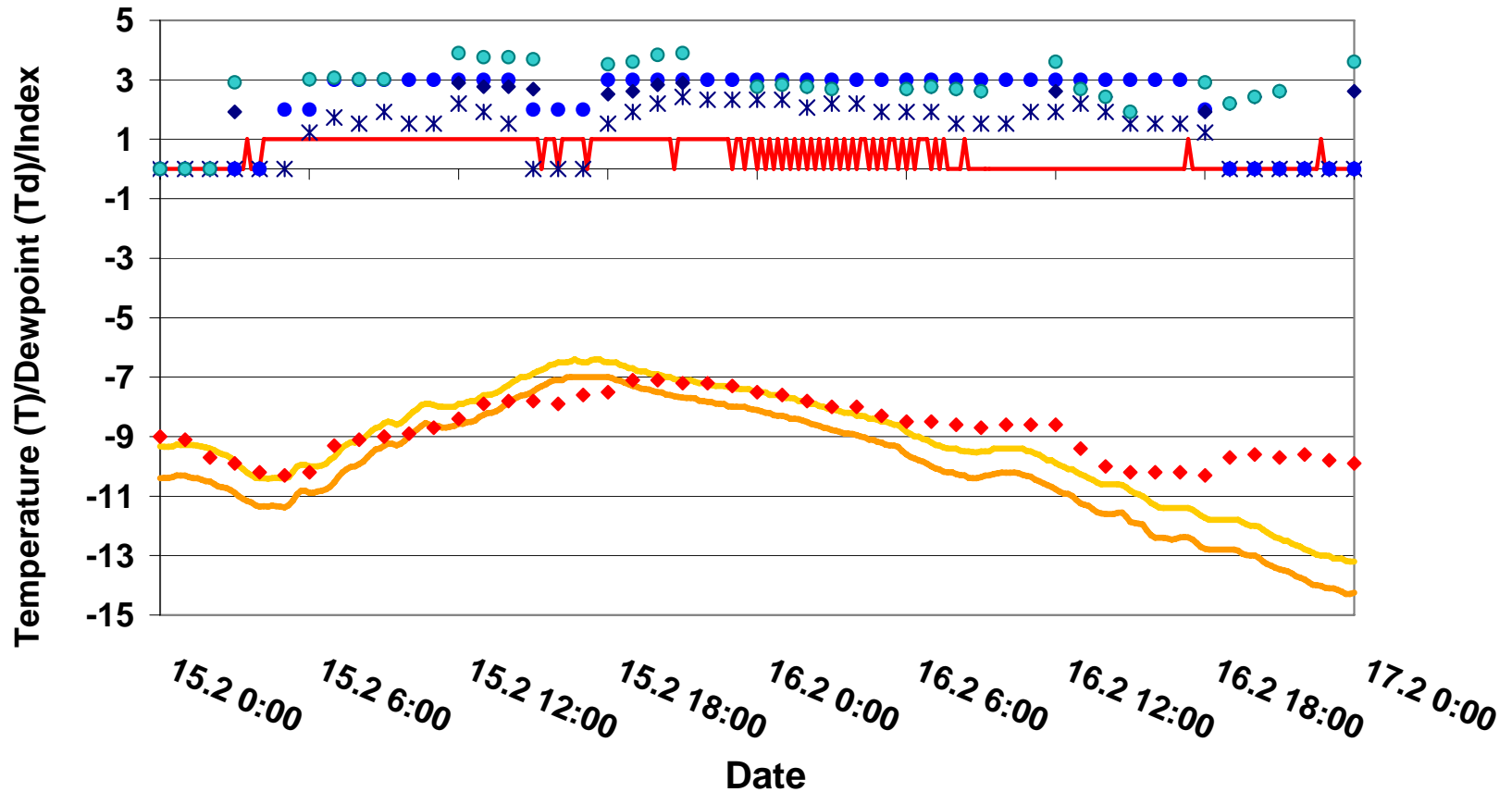
Measuring devices:

- Rosemount ice detector, model 0872J
- FD12P weather sensor (vis, weather)
- Three ice-free wind sensors (Metek, Thies, Vaisala)
- Temperature and humidity sensor (Vaisala HMP243)
- Four video cameras
- Semi-subjective icing classification

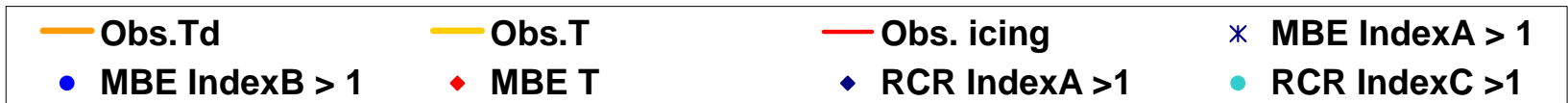
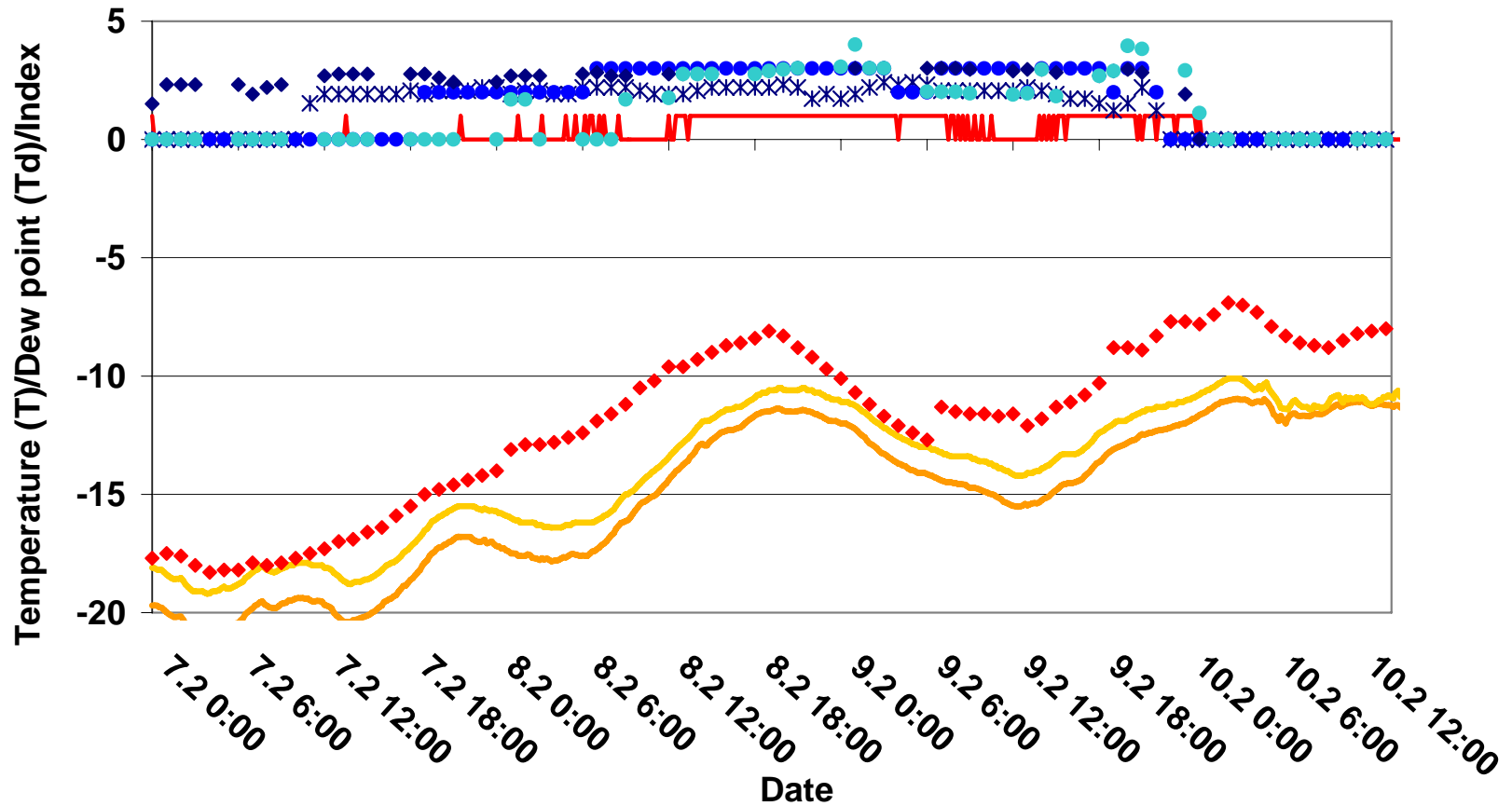
Icing cases

- Four (4) single icing cases
 - accurate validating measurements are available
- selected on the grounds of observed icing events, not on the grounds of icing forecasts

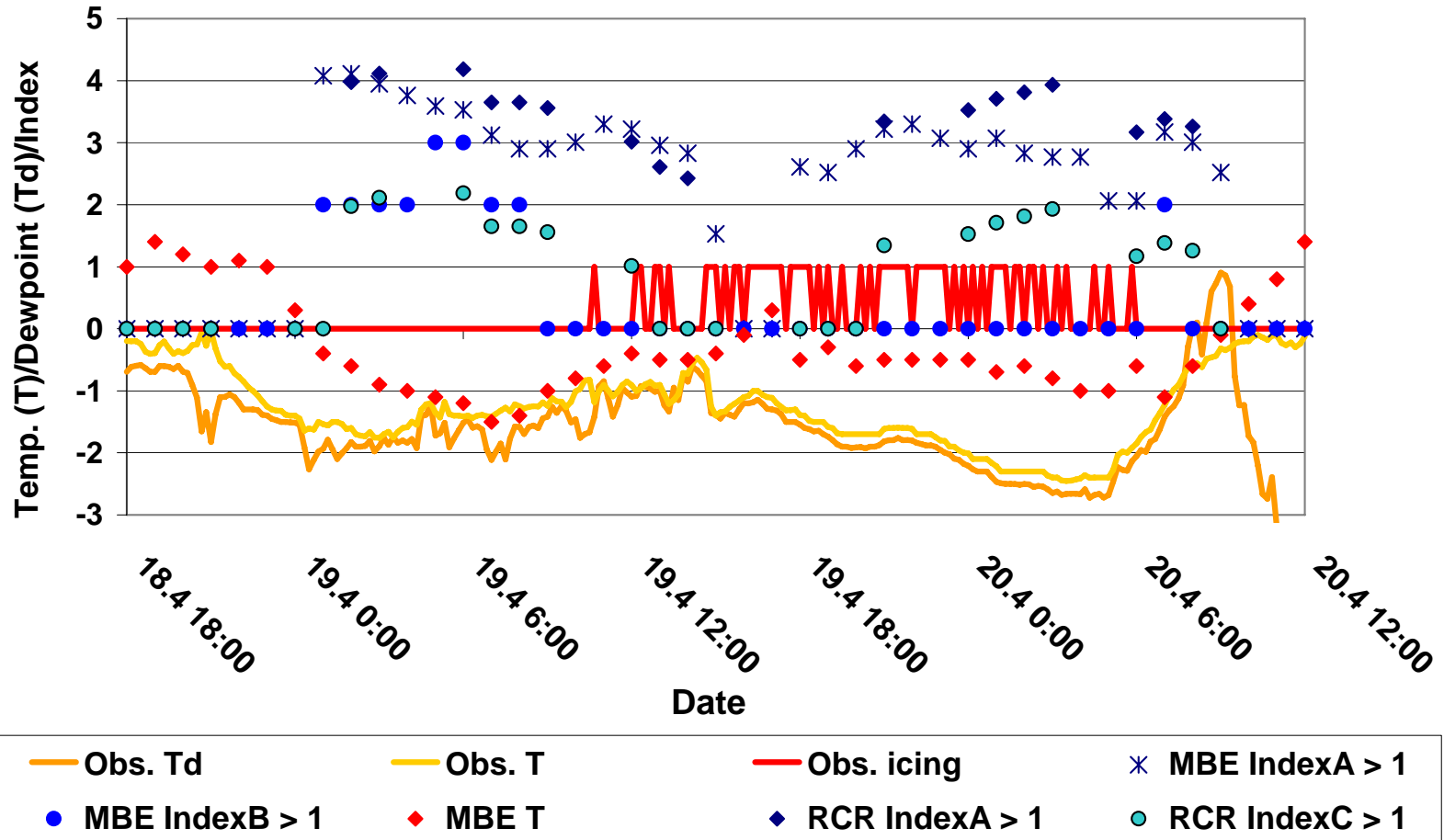
Case 2: continuous, severe



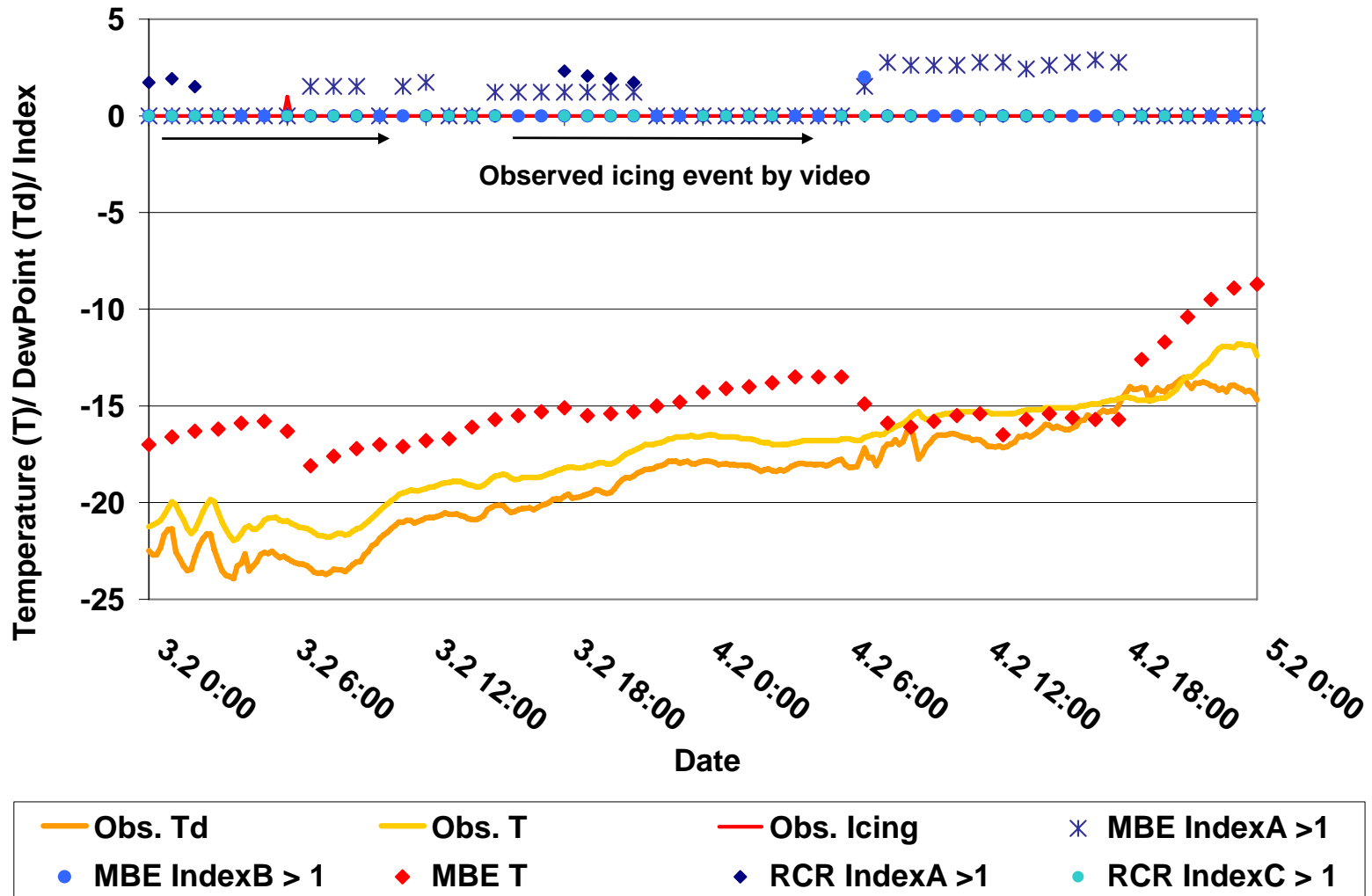
Case 3: continuous, moderate



Case 1: light, temporal variations



Case 4: very light soft rime



Conclusions

- The icing index values clearly show some ability to predict the start and end of the icing event depending on the weather situation
- *B* and *C* improve the timing compared to *A*
- Severity of an icing event cannot be forecasted by the index values
- Differences between NWP models
- Further studies would be necessary

Thank you for your attention

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Summary

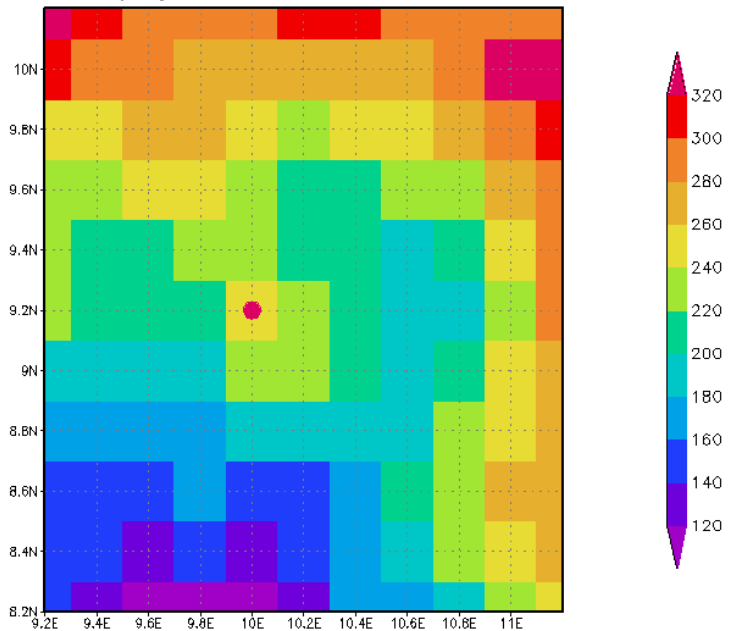
1. Icing indexes values were calculated using the output of two HIRLAM NWP model.
2. Four icing events were selected to compare calculated indexes to measurements made at the top the hill Luosto
3. Index values show some ability to predict start and end of the event but predictions are far from perfect.

Motivation

- Growing need for icing forecasts at low altitudes
 - Low flying small aircrafts
 - Helicopters
- Fact that similar comparisons have not been done in Finland previously
 - Lack of icing forecast verifications

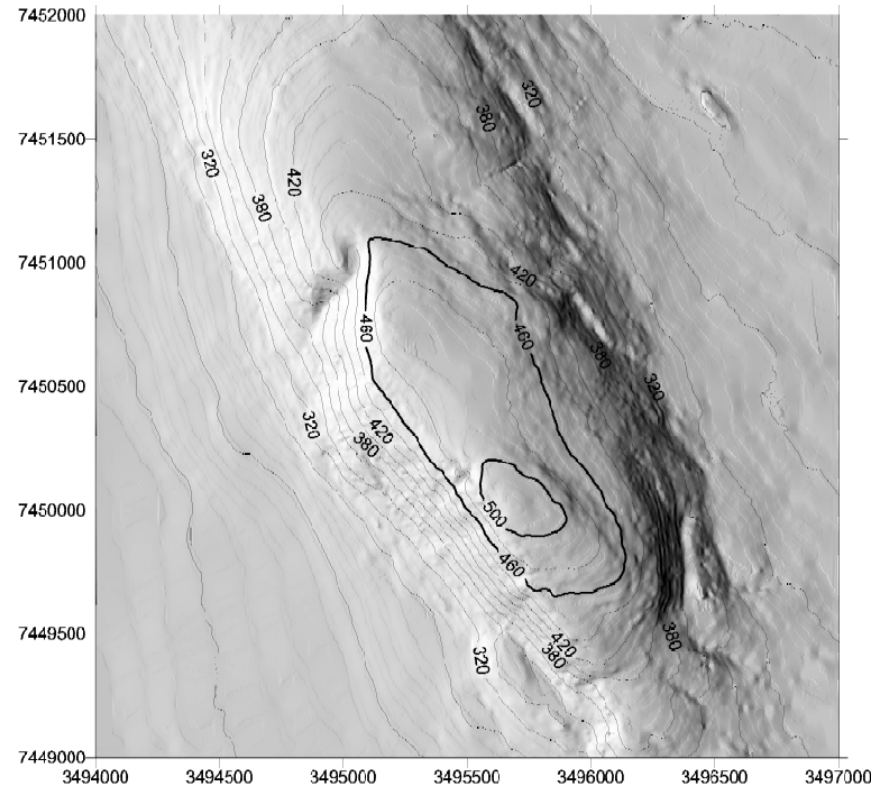
RCR and real topography

RCR-topografian korkein kohta Luostolla



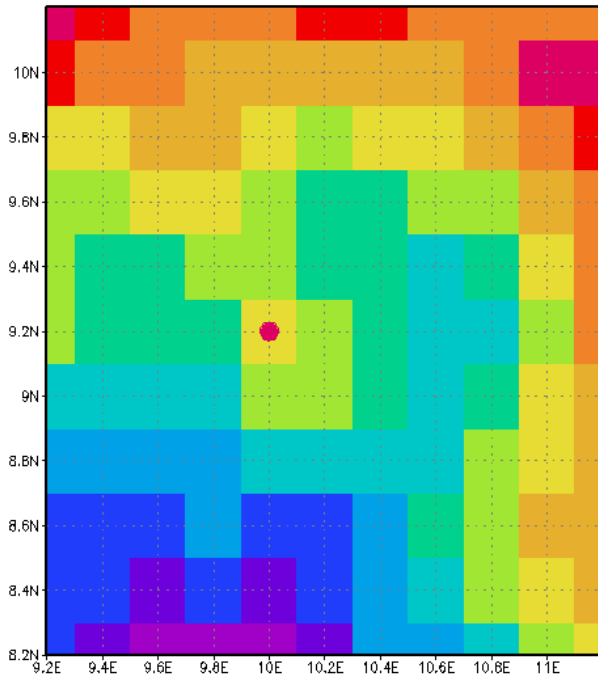
GRADS: COILA/IGES

2006-11-13-08:00

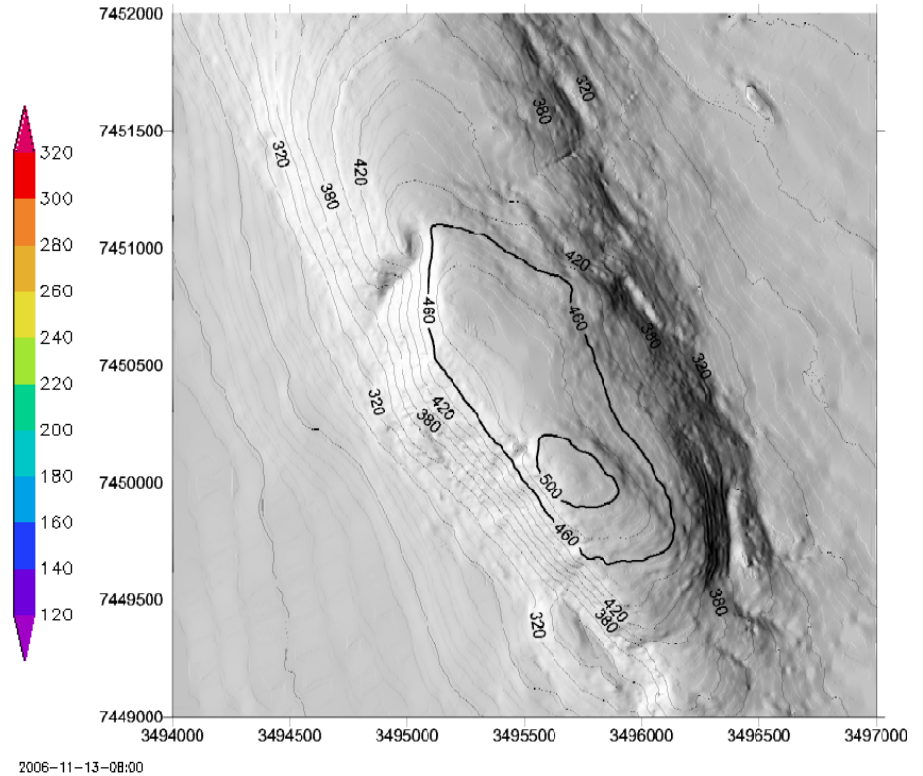


MBE and real topography

RCR-topografian korkein kohta Luostolla



GRADS: COLA/IGES



Correction tables

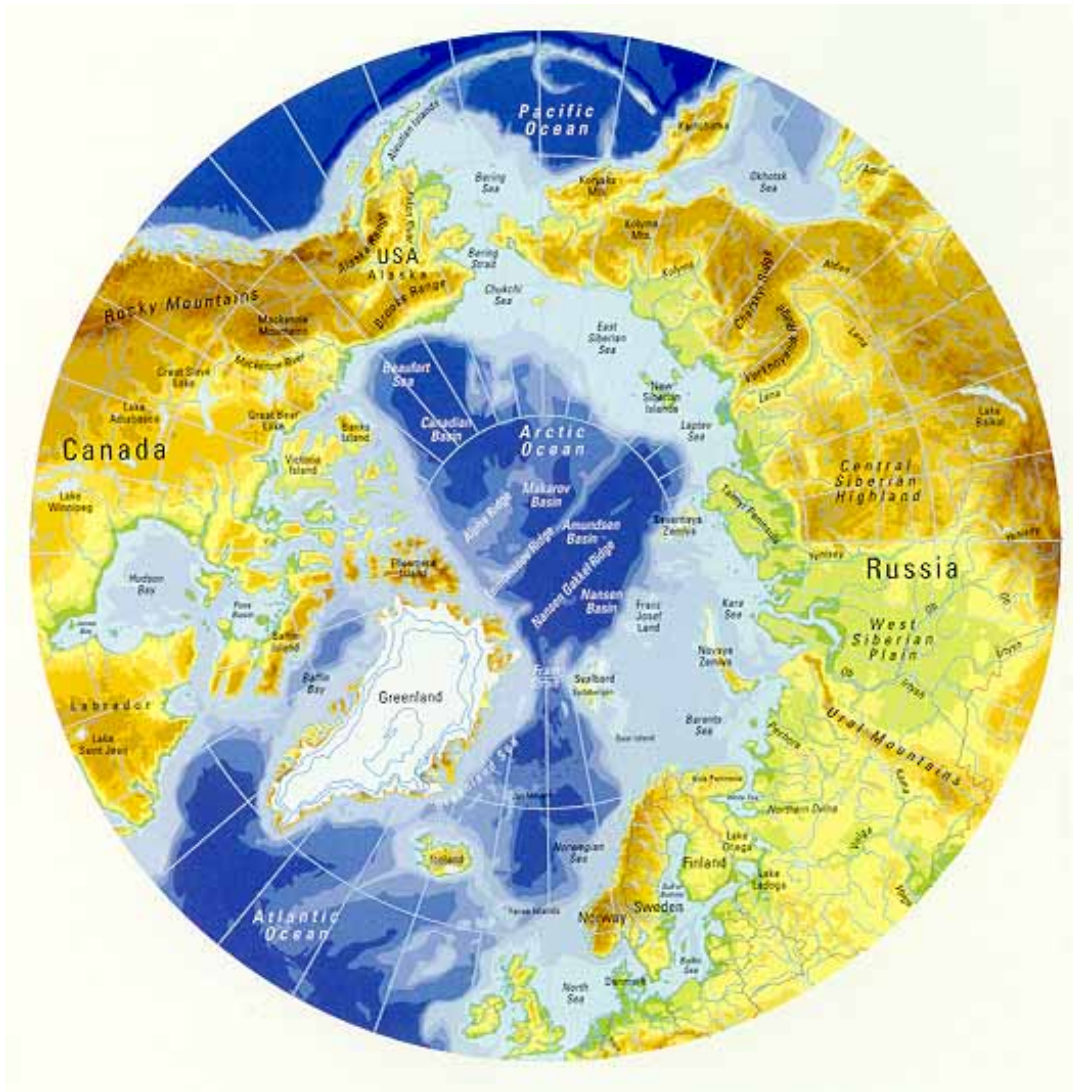
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Location



Subjective icing classification

- Sodankylä soundings
- satellite imagery
- synoptic charts
- cloud height measured at Sodankylä observatory
- kuva!

Case 1

- Apr 19 2006 09:00 UTC - Apr 20 2006 06:00 UTC, duration 21 hours
- Measured temperature: $0^{\circ}\text{C} > T > -3^{\circ}\text{C}$
- Ice accretion detected by Rosemount sensor and video camera:
 - light with temporal variations
- Subjective icing classification: light/moderate icing
- freezing rain possible

Case 2

- Feb 15 2006 04:00 UTC - Feb 16 2006 09:00 UTC, duration 29 hours
- Measured temperature: $-6^{\circ}\text{C} > T > -15^{\circ}\text{C}$
- Ice accretion detected by Rosemount sensor and video camera: continuous with severe accumulation of ice
- Subjective icing classification: severe icing

Case 3

- Feb 8 2006 02:00 UTC - Feb 10 2006 01:00 UTC, duration 47 h
- Measured temperature: $-10^{\circ} \text{C} > T > -18^{\circ} \text{C}$
- Ice accretion detected by Rosemount sensor and video camera: continuous moderate ice accumulation
- Subjective icing classification: moderate/severe icing

Case 4

- Feb 3 2006 16:00 UTC - Feb 4 2006 09:00 UTC, duration: 17 hours
- Measured temperature: $-15^{\circ}\text{C} > T > -22^{\circ}\text{C}$
- Ice accretion detected by video camera: very light soft rime, no ice accumulation by Rosemount
- Subjective icing classification: no icing