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Collapse of an Arctic Power Line due to strong Wind Gusts during Wet Snow Accumulation

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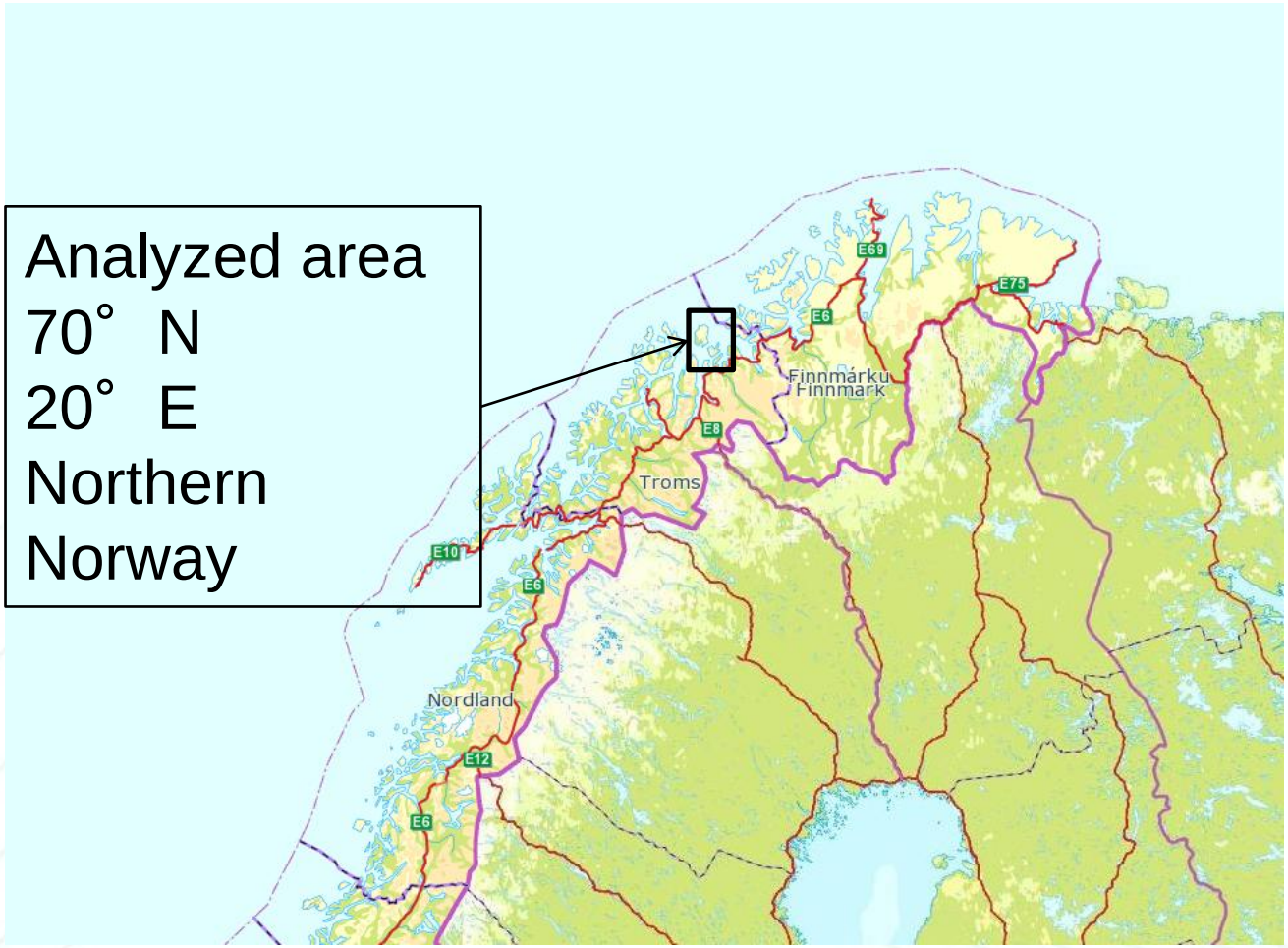
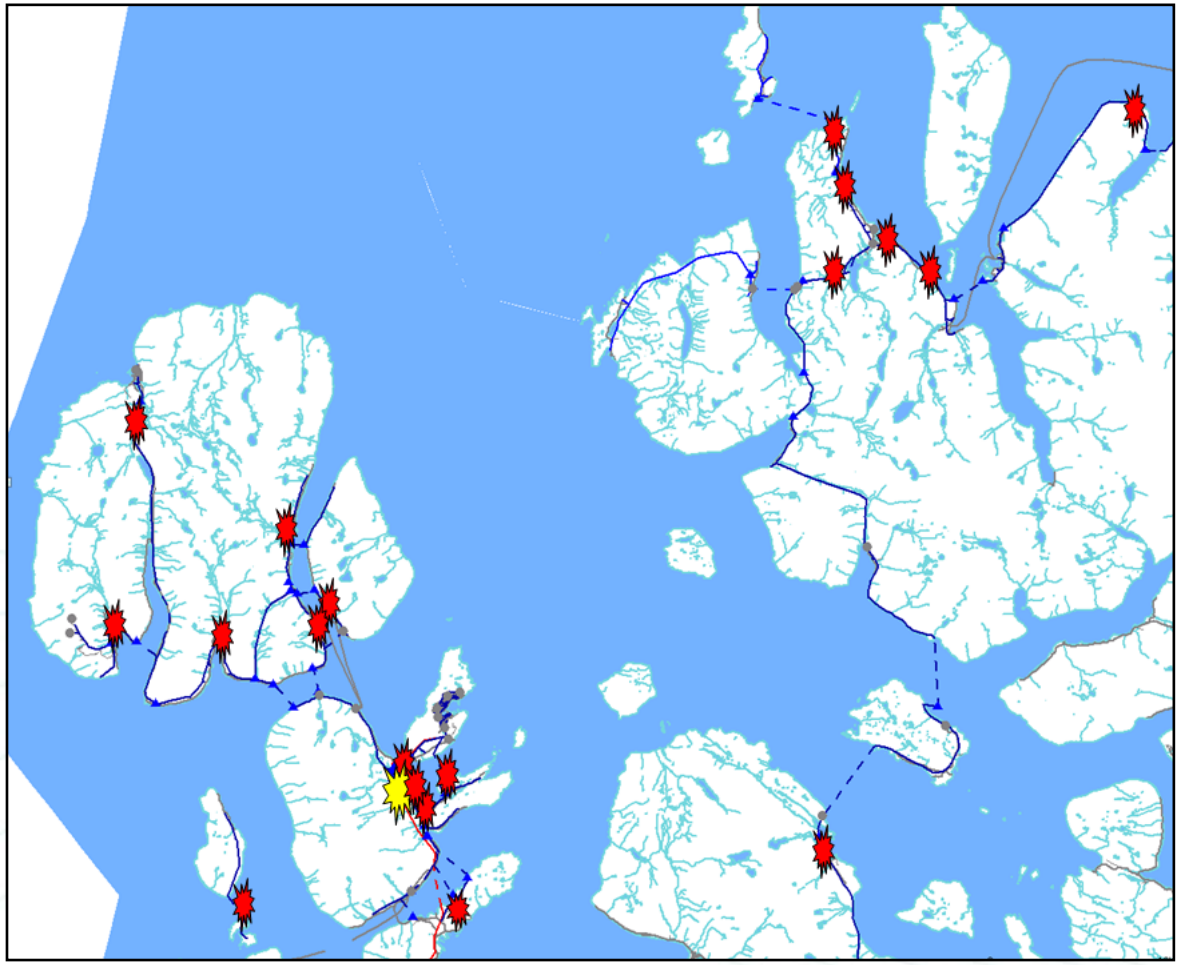


Overview of the area



Damage on power – lines in Troms, 31.12.2004

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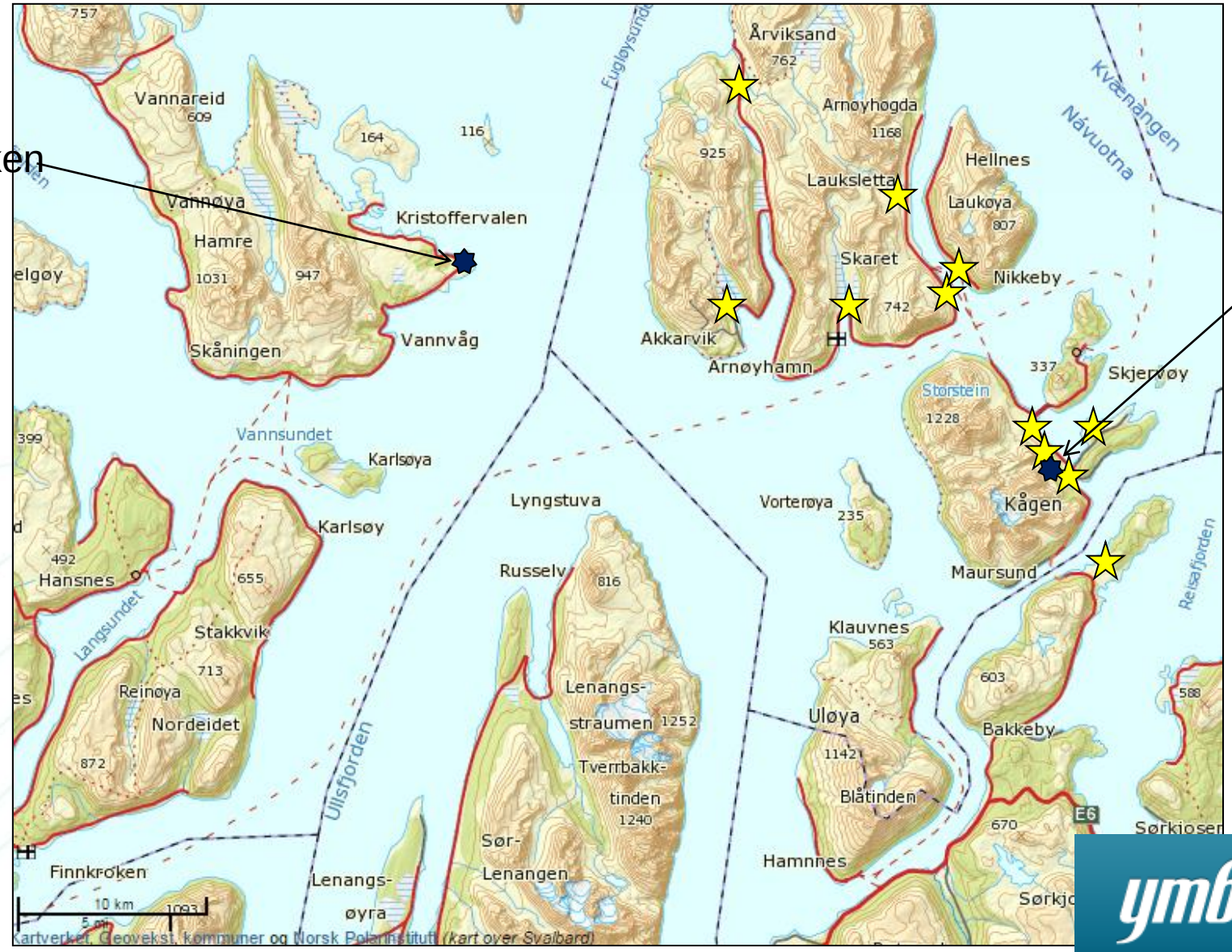

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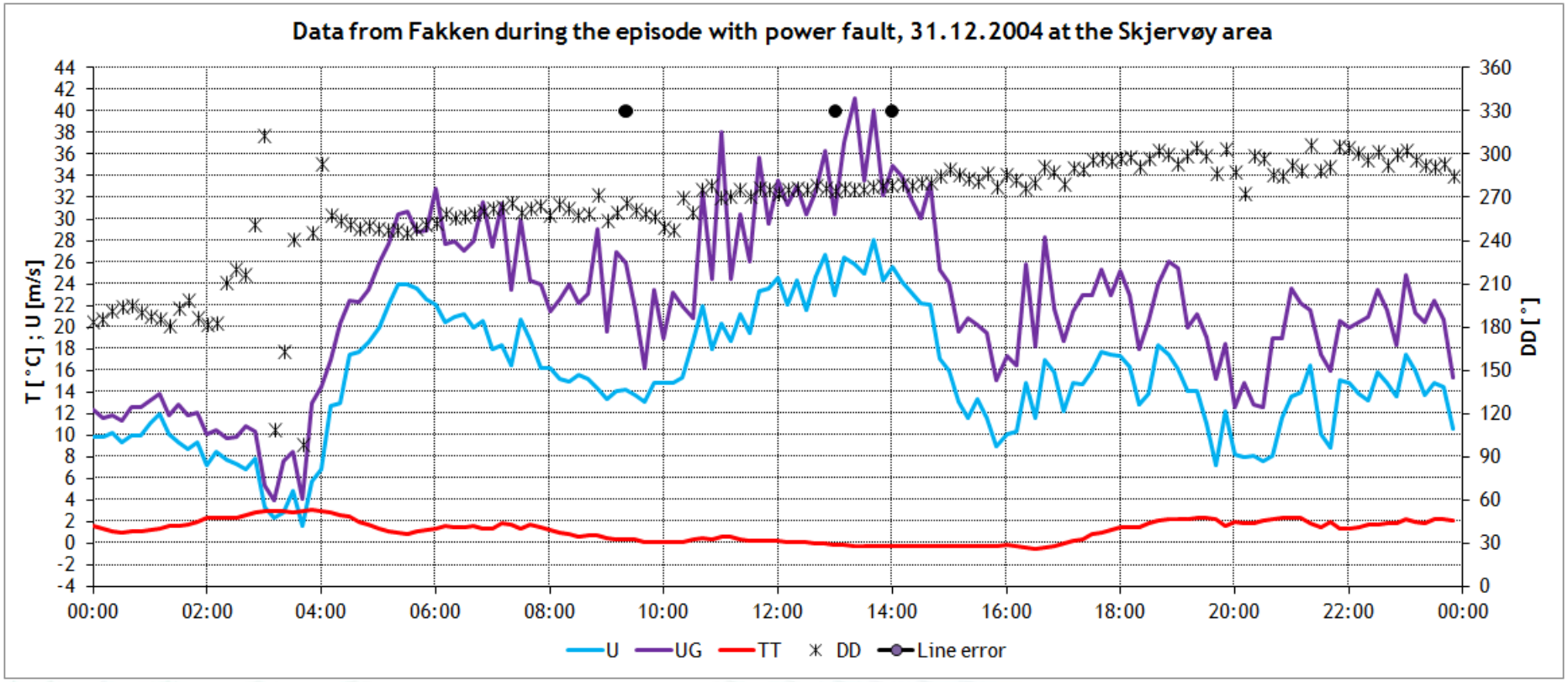

Kobbepollen: Observed Precipitation 31.12.04 (ca 00 – 15 UTC): 42.7 mm

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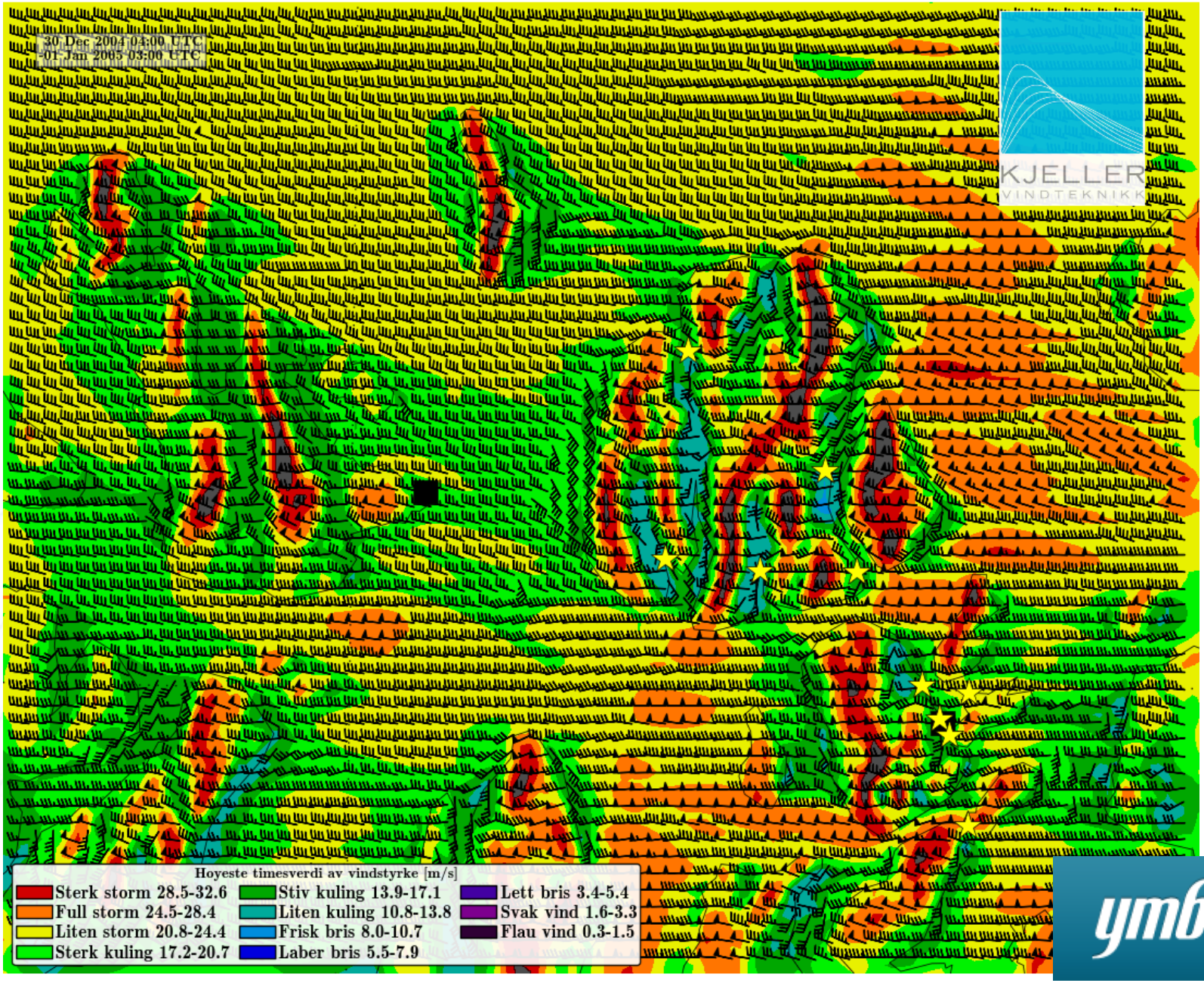

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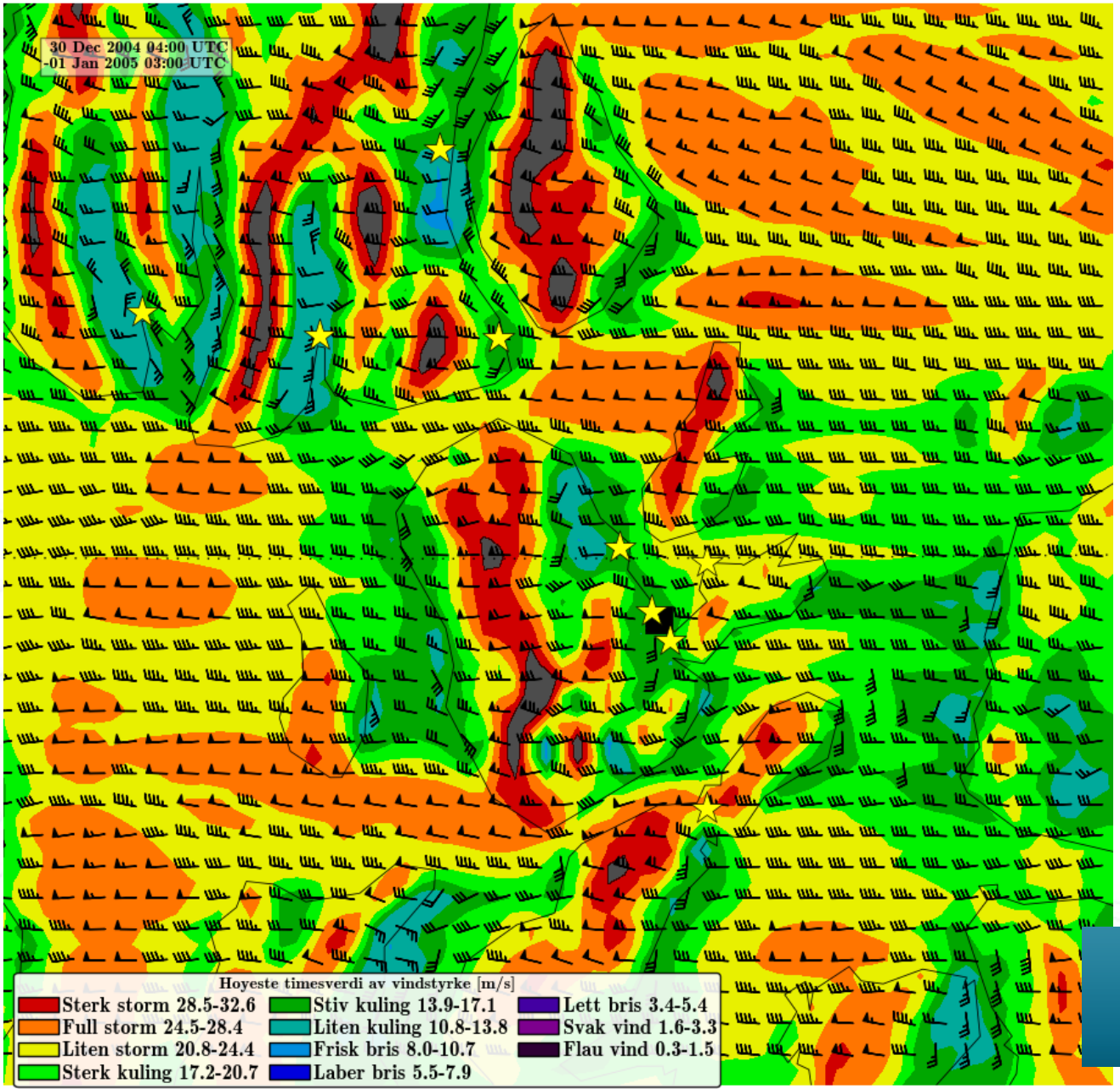

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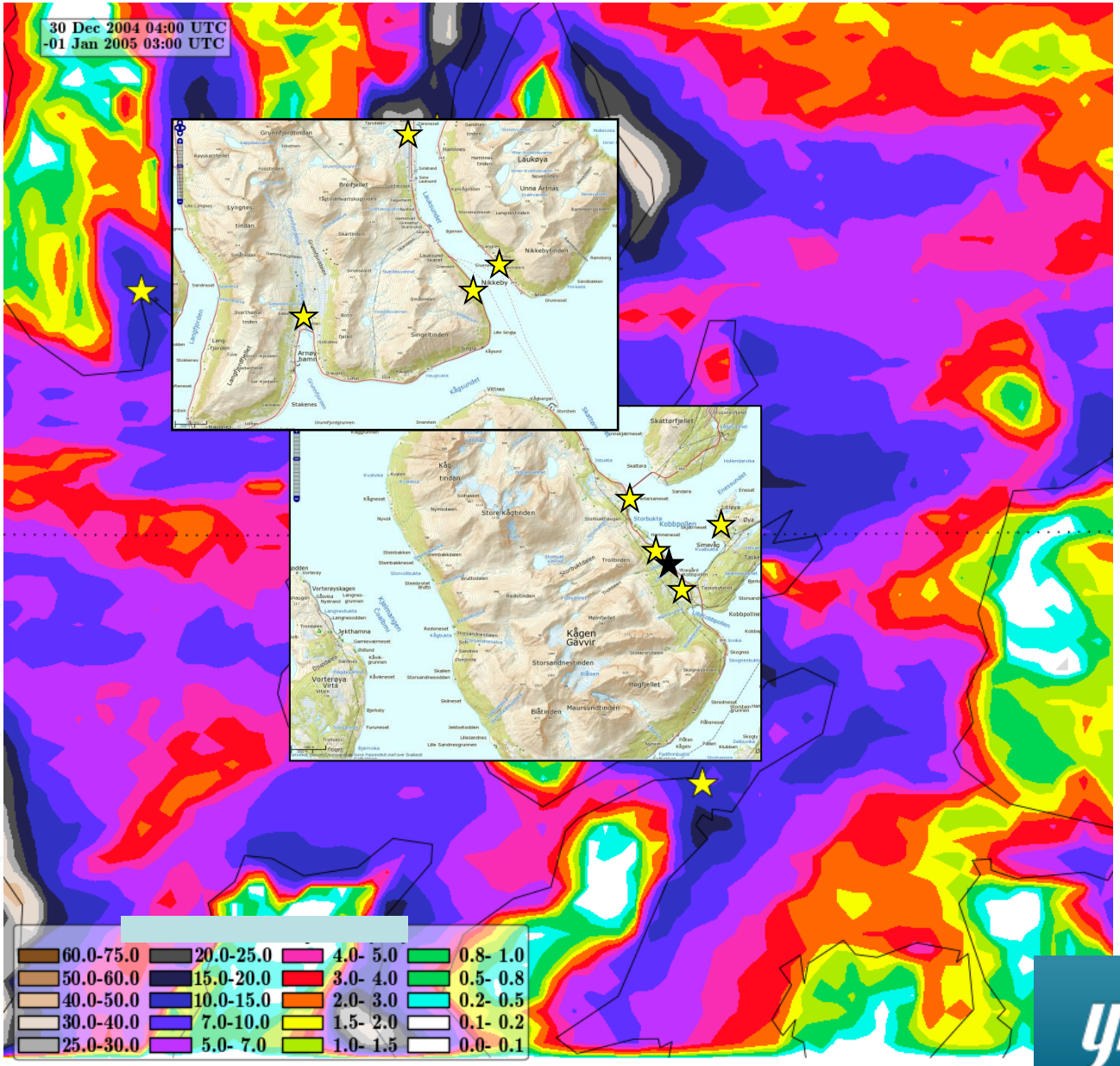

48 h precipitation [mm]

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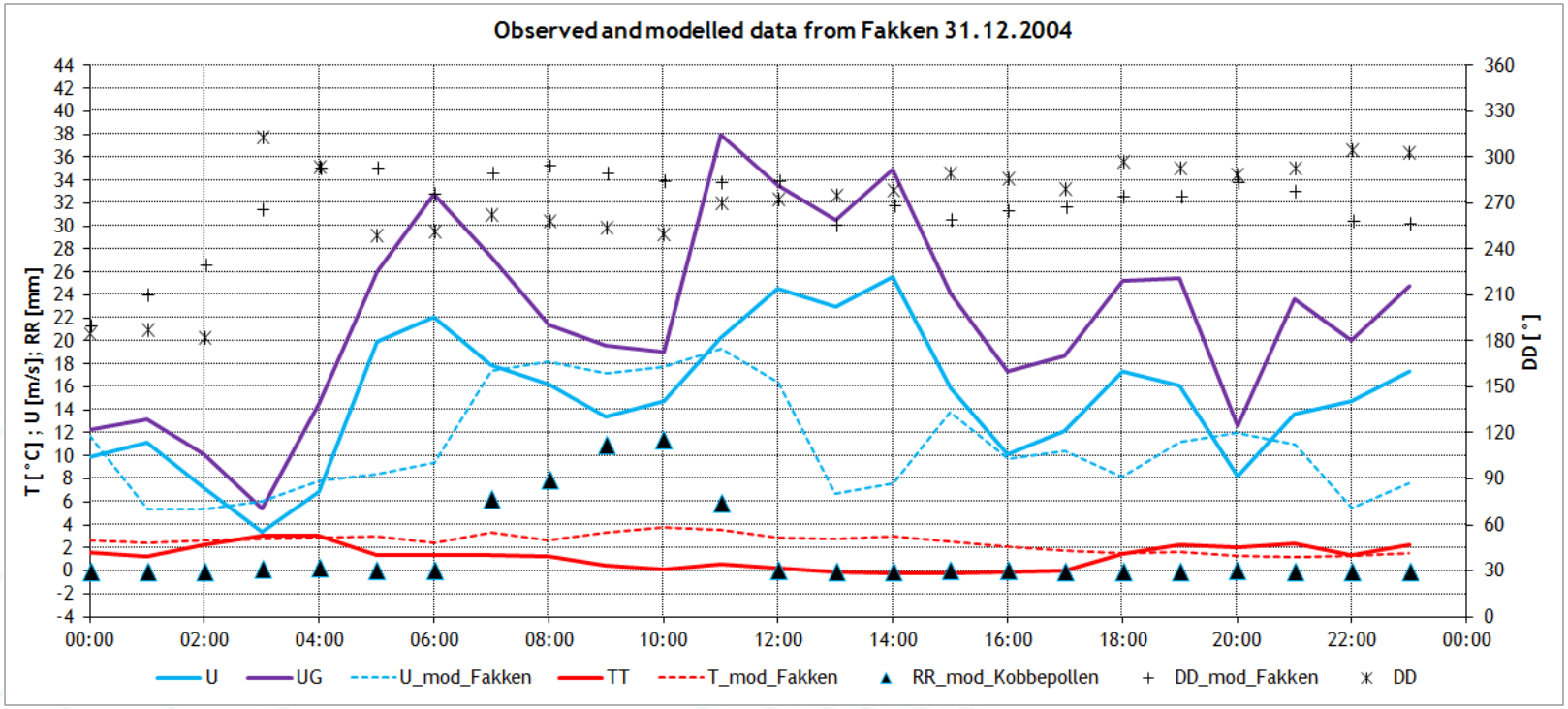

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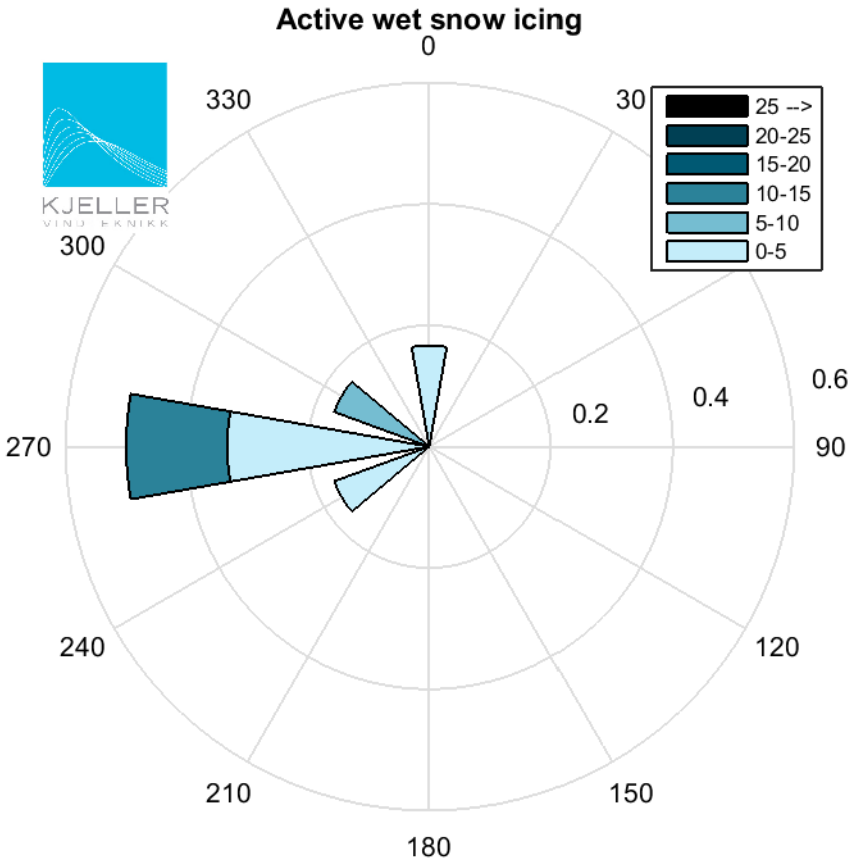

Wind rose during wet snow accumulation at Kobbepollen, Skjervøy 31.12.2004

Wet snow load estimation. The Nygaard model

$$\frac{dM}{dt} = \alpha_1 \alpha_2 \alpha_3 VwA = \beta VwA$$

$$\beta \propto \frac{1 - \cos(9SR - 4.5)}{V^{-0.4}} \qquad [0.5 < SR < 0.98]$$

$$SR = \frac{Q_S + Q_G}{Q_S + Q_G + Q_R} \quad (fraction\ of\ frozen\ precipitation)$$

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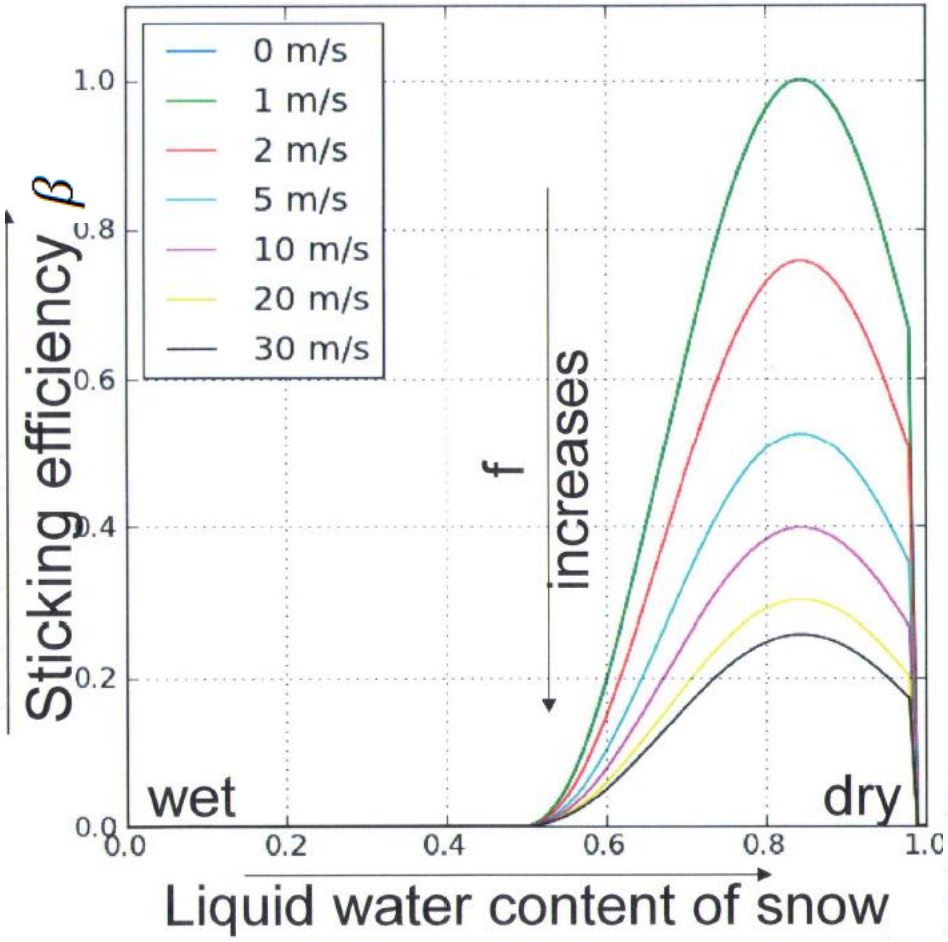
Wet snow load estimation - The Nygaard model



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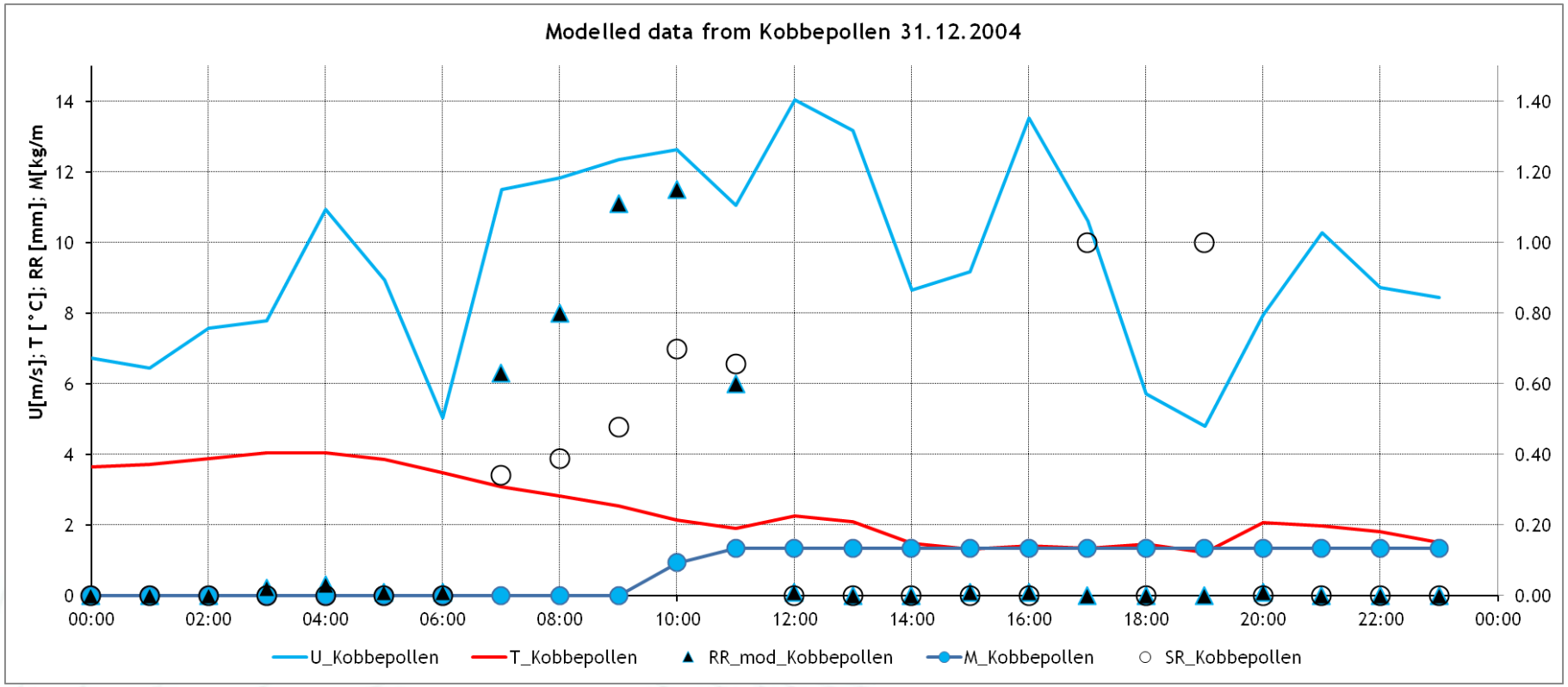

Sum RR_WRF 500m: 44.0 mm
Sum RR observed: 42.7 mm

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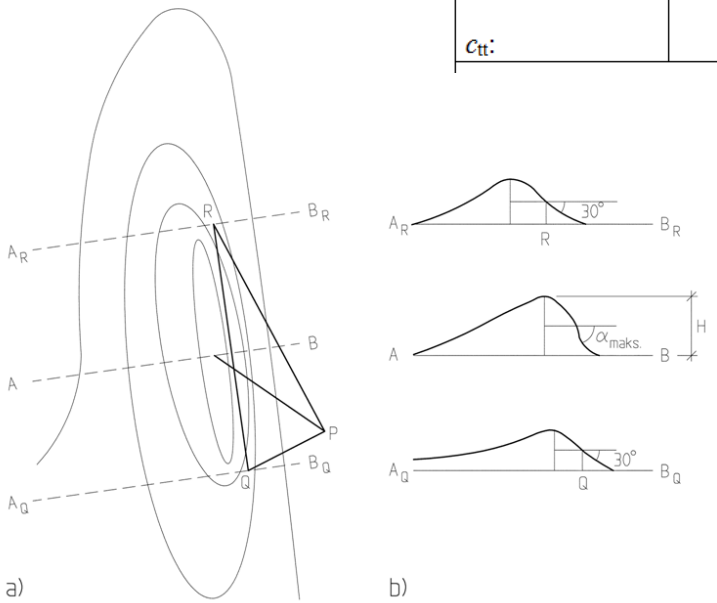
Wind gusts close to steep terrain

Krav til α_{maks}:	$30° < \alpha_{maks}(\theta) \leq 40°$		$\alpha_{maks}(\theta) > 40°$		
Krav til $L(\theta)$:	$L(\theta) \leq 8H$		$L(\theta) \leq 10H$		$10H < L(\theta) \leq 15H$
Områdetall [1)]	I og V	II	I, II og III	V	IV
c_t:	1,0	0,9	1,0	0,9	0,9
c_{tt}:	1,0	1,75	1,75	1,75	1,75



$$I_v(z) = \begin{cases} \dfrac{\sigma_v(z)}{v_s(z)} = \dfrac{c_{tt}}{c_t(z)} \cdot \dfrac{1}{\ln(z/z_0)} = \dfrac{c_{tt} \cdot k_T}{c_r(z) \cdot c_t(z)}; & for\ z \geq z_{min} \\ I_v(z_{min}); & for\ z < z_{min} \end{cases}$$

Consequence: Strongest gust is increased with 20 % referred to plain terrain in the most exposed areas

Modeled wind speed at open sea (WRF 500 m): 25 m/s

Typical wind gust: 25*1.35= 33.8 m/s

Estimated gust at exposed lee-side sites: 33.8*1.2= 40.5 m/s

Observed at Fakken: 41 m/s

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Conclusions:

The combination of heavy precipitation and strong wind may occur on the lee side of steep rock formations.

At temperatures just above 0° C this may cause large combination loads on overhead lines.

WRF 500 m x 500 m model is a good tool to describe this phenomenon. It's like the model provides good information about spillover effect, but will underestimate the wind speed.

In a single weather situation, however, it will always be difficult to model the wet snow loads at a specific site, especially because the temperature range for collecting such load is narrow.

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