



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Enhancing Finland's ceilometer network

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Ceilometer

Solid-state laser

Resolution:

<30 m vertical

<30 s time

Provide:

Cloud base

Cloud coverage

Ceilometer: <30 k€



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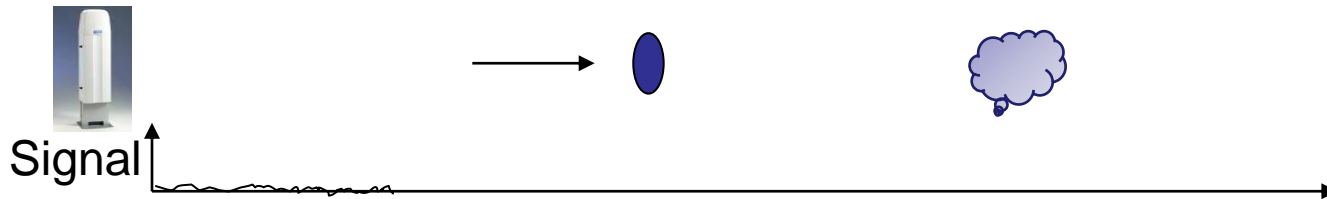
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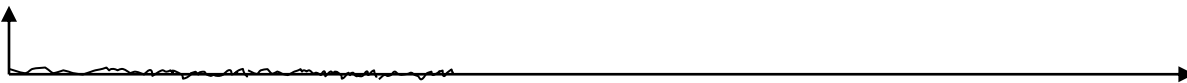
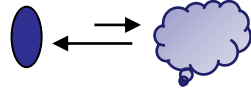
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Signal



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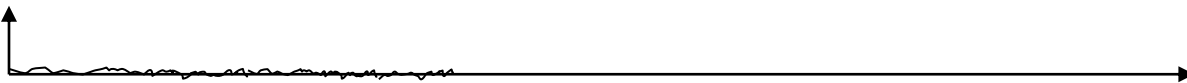
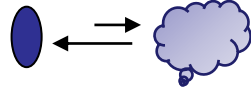
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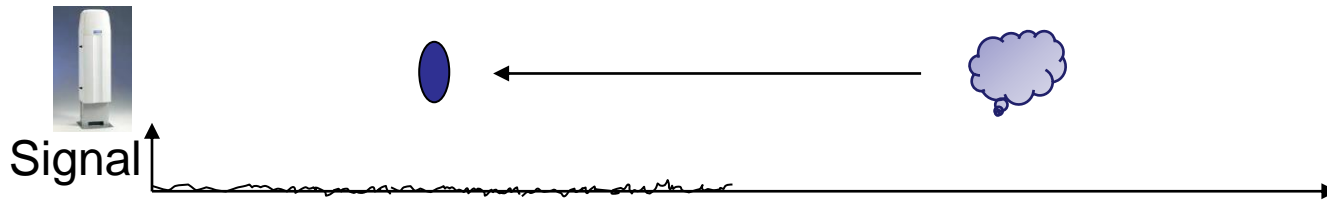
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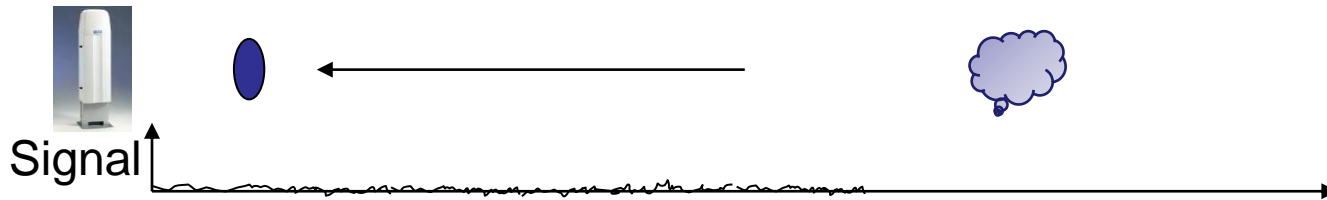
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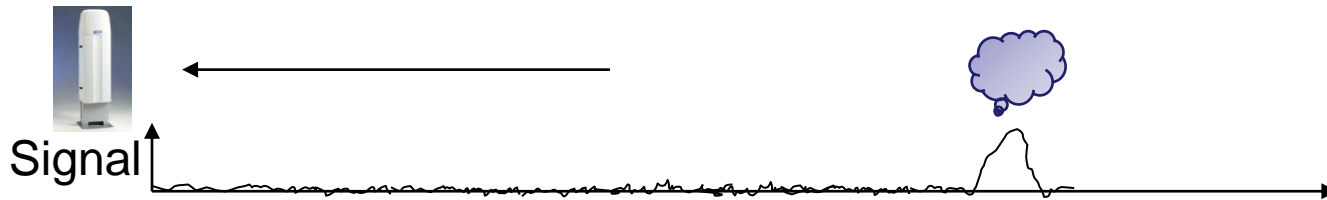
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Ceilometer: <30 k€



Ceilometer

Solid-state laser

Resolution:

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<30 s time

Provide:

Cloud base

Cloud coverage

Very robust!

Ceilometer: <30 k€



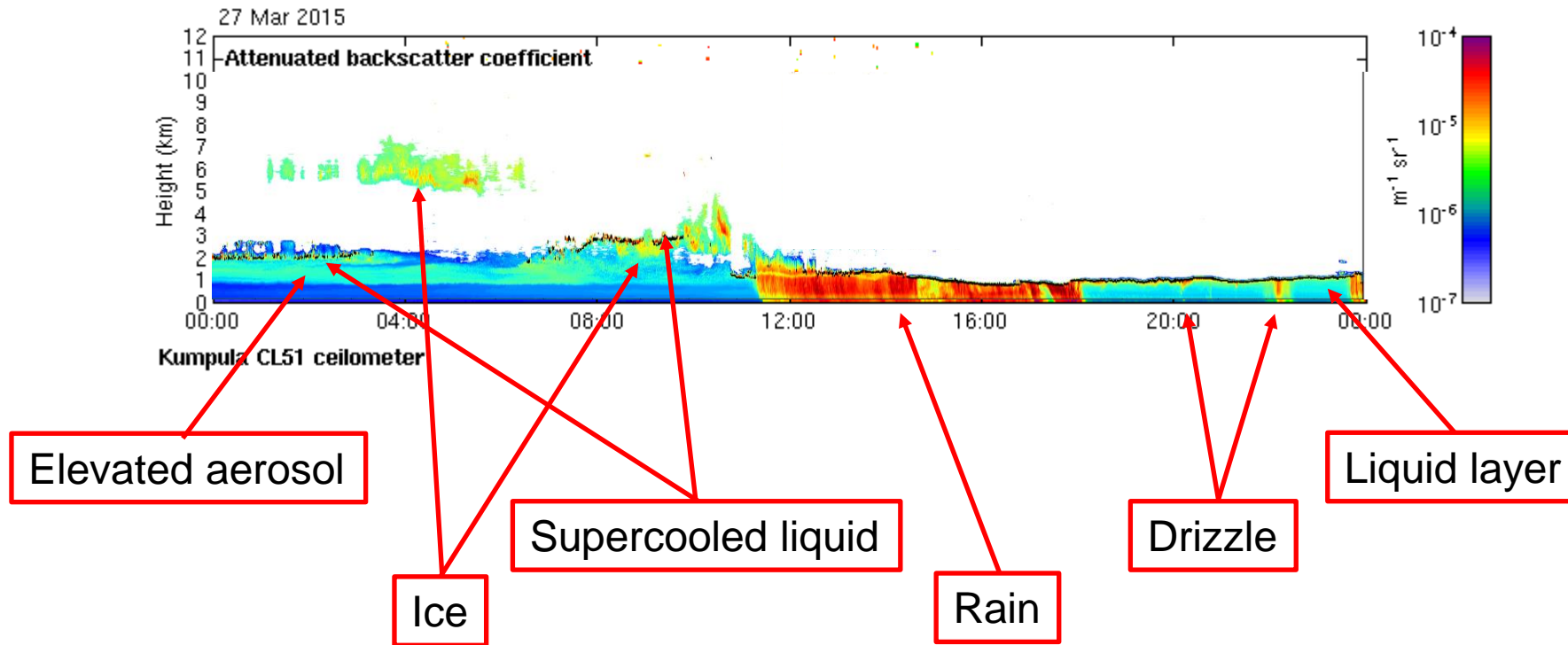
Ceilometer

Marambio

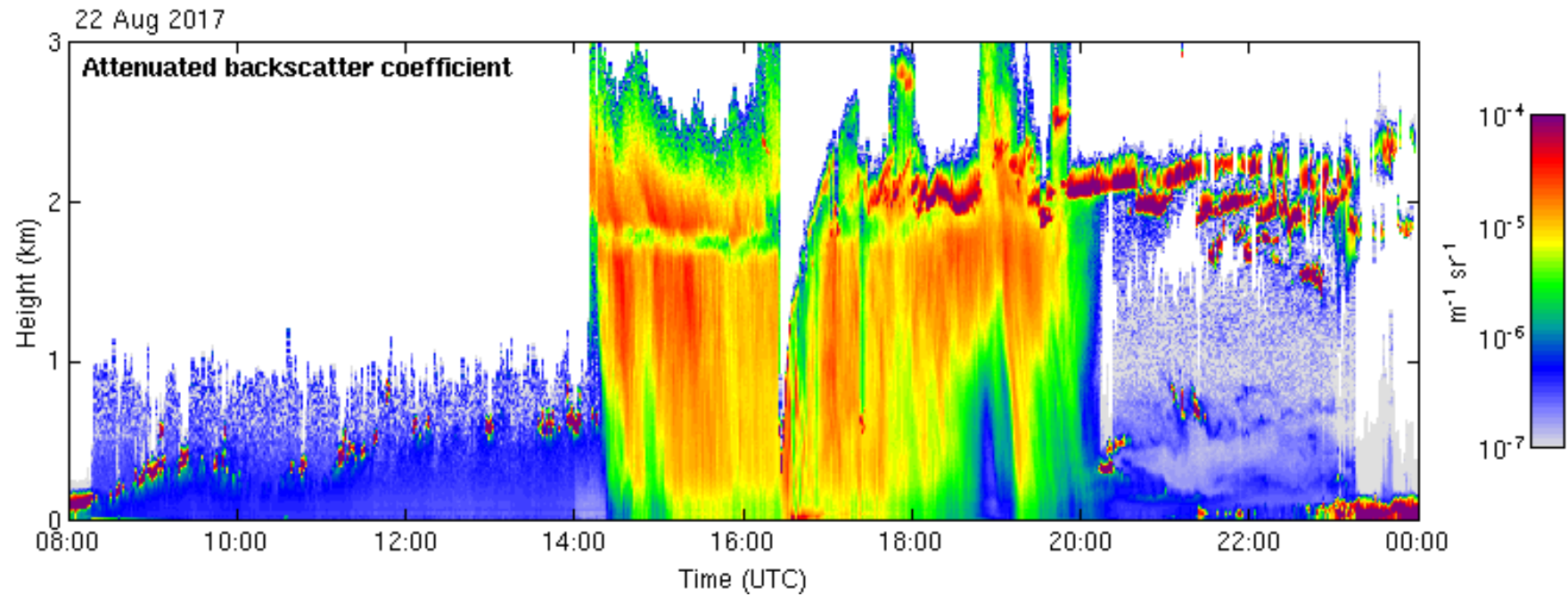


Ceilometer

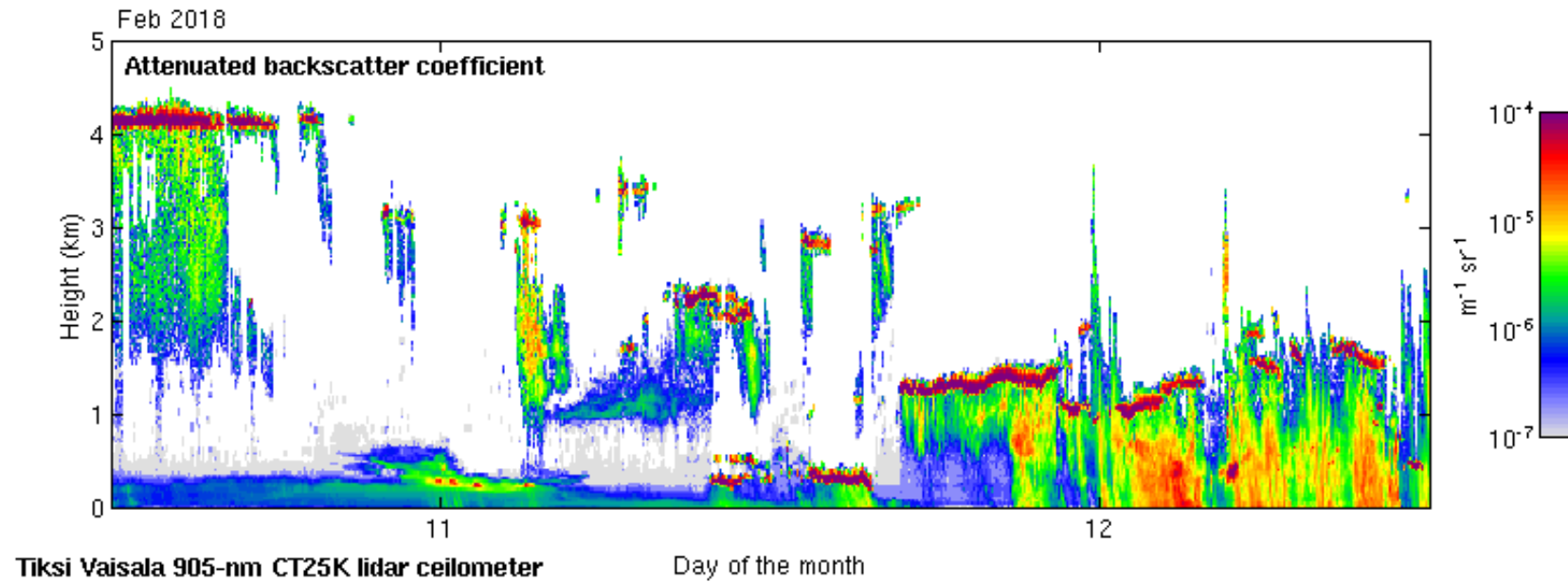
Originally designed to measure cloud base
Can do so much more!



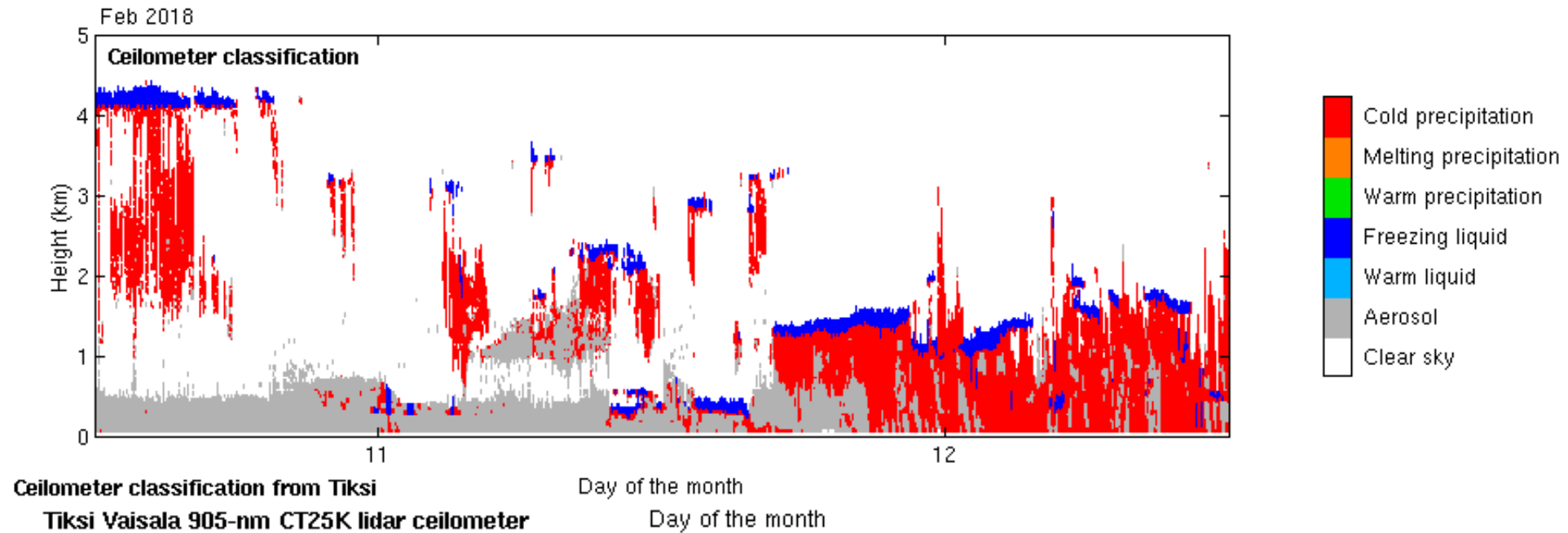
Melting layer detection



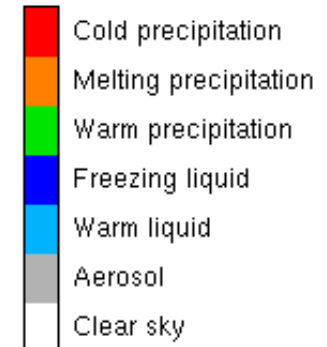
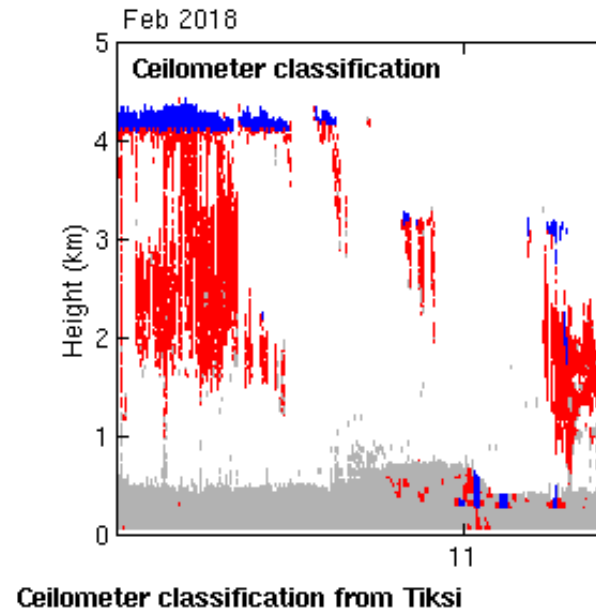
Ceilometer classification



Ceilometer classification



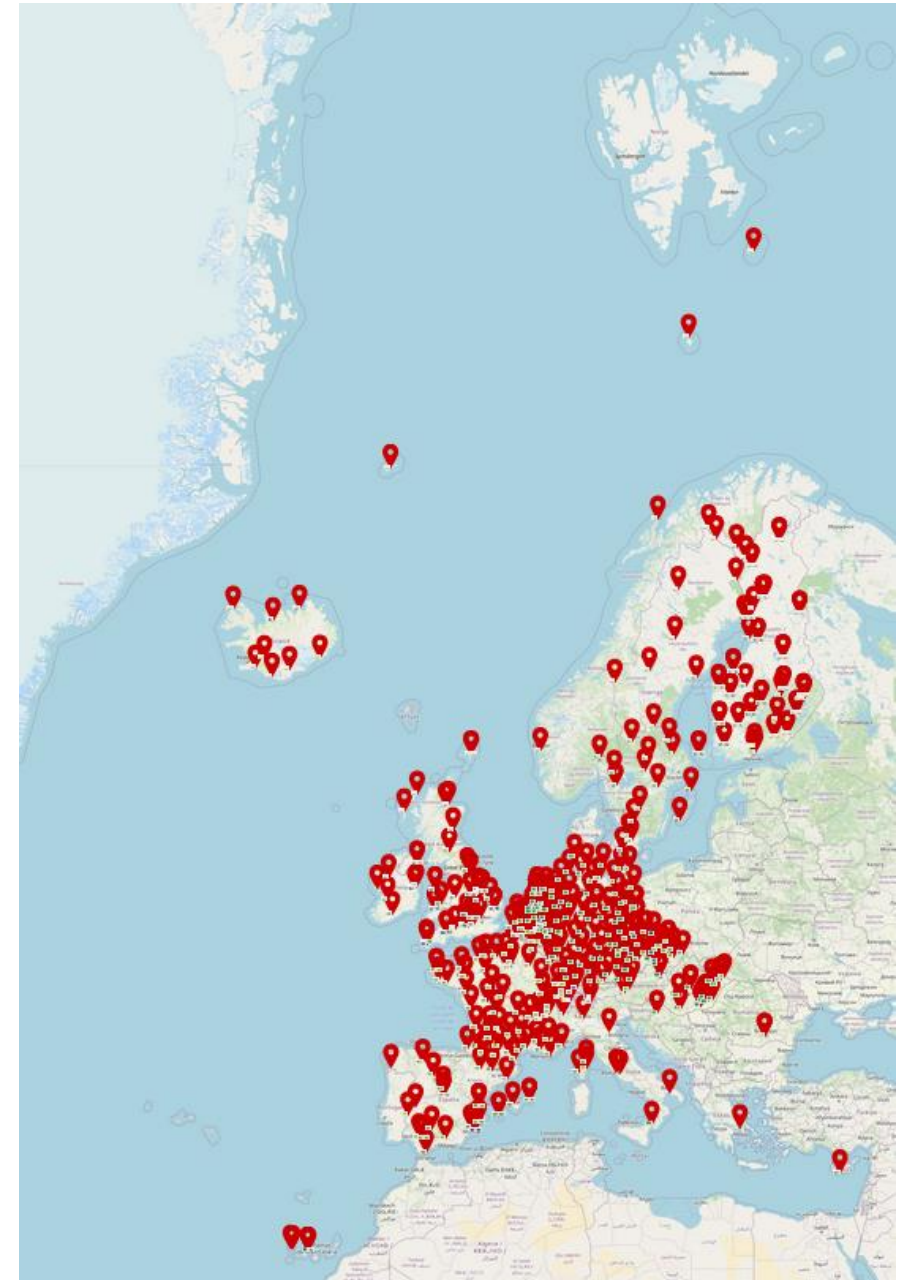
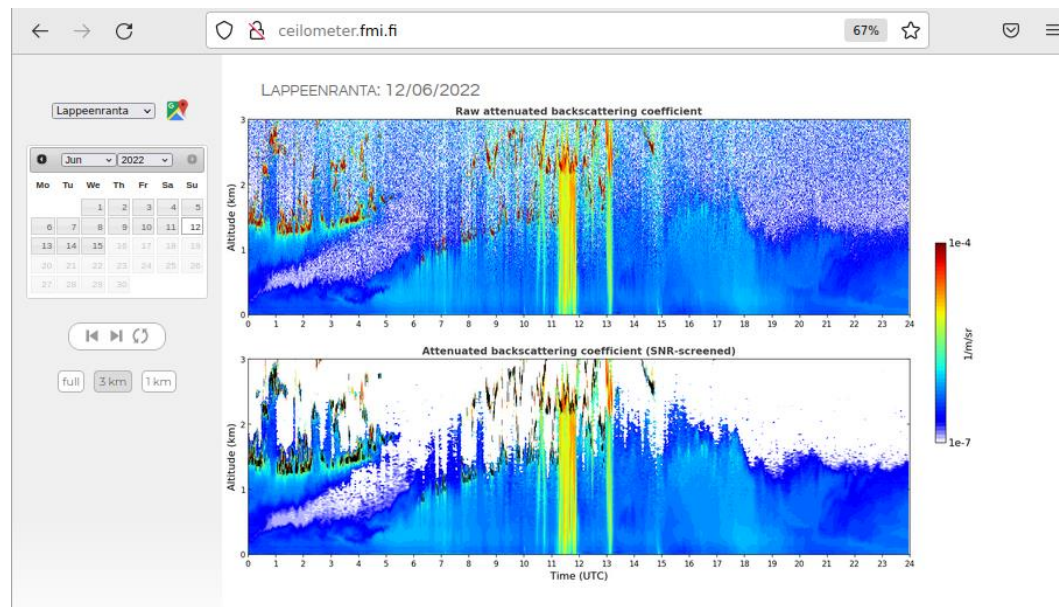
Mixed-phase clouds



Ceilometer Network

- Operational network

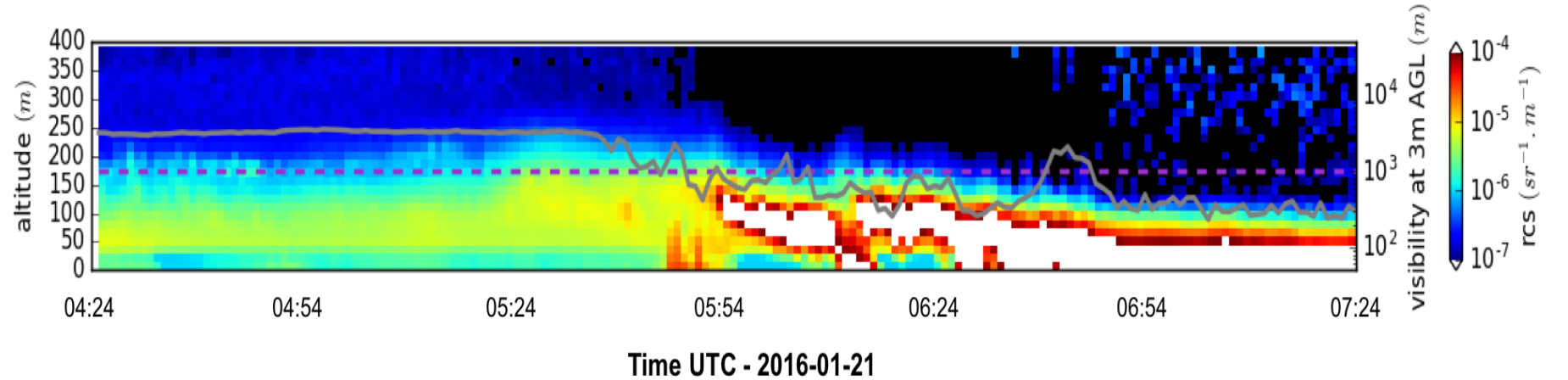
<http://ceilometer.fmi.fi>



Low cloud, fog, low visibility

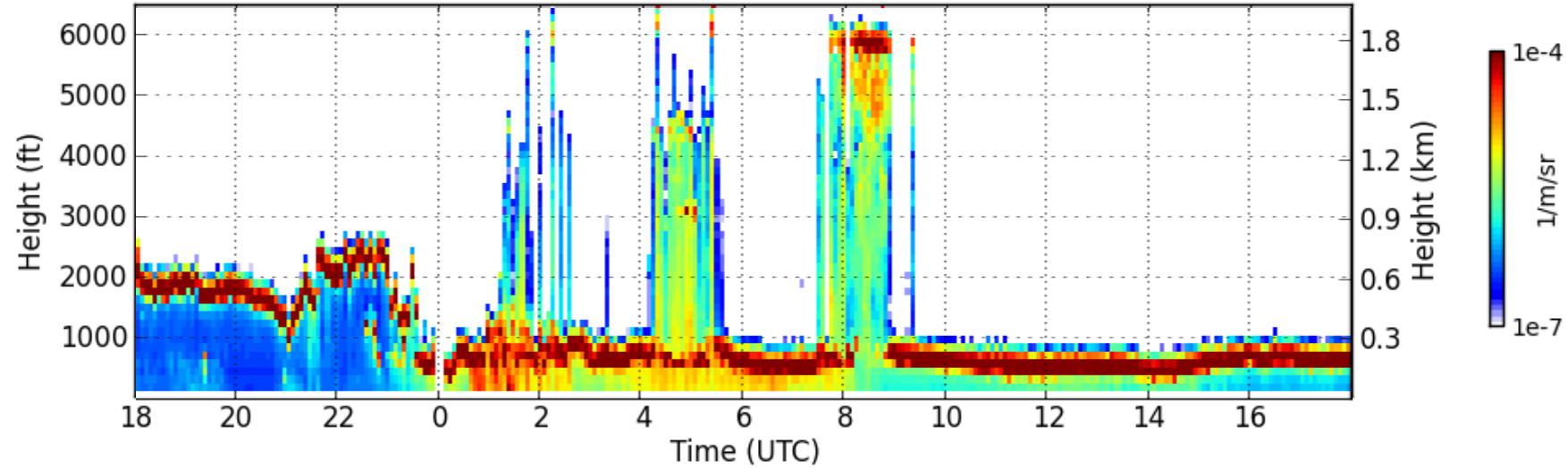
- Very important for airports
 - Need to start LVP (low visibility procedures)
 - VIS \leq 600 m and/or ceiling \leq 200 ft.
 - 1 minute delay costs ~60-70€ for an airline
 - 2014 data
- Forecasting: challenging
 - Nowcasting?

Nowcasting of fog formation

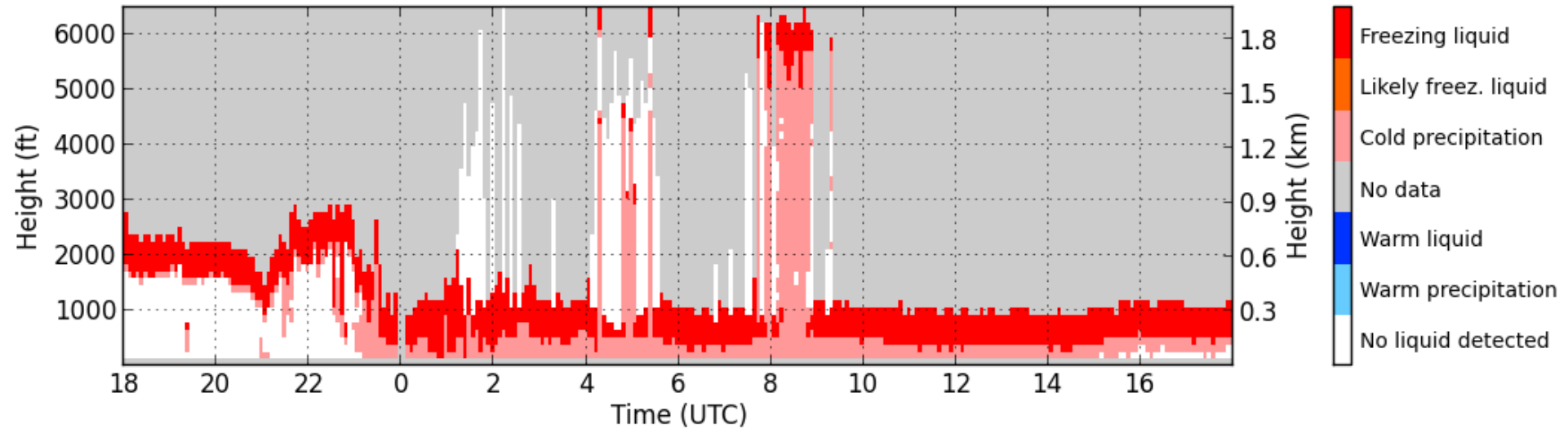


In development at SIRTA, Paris

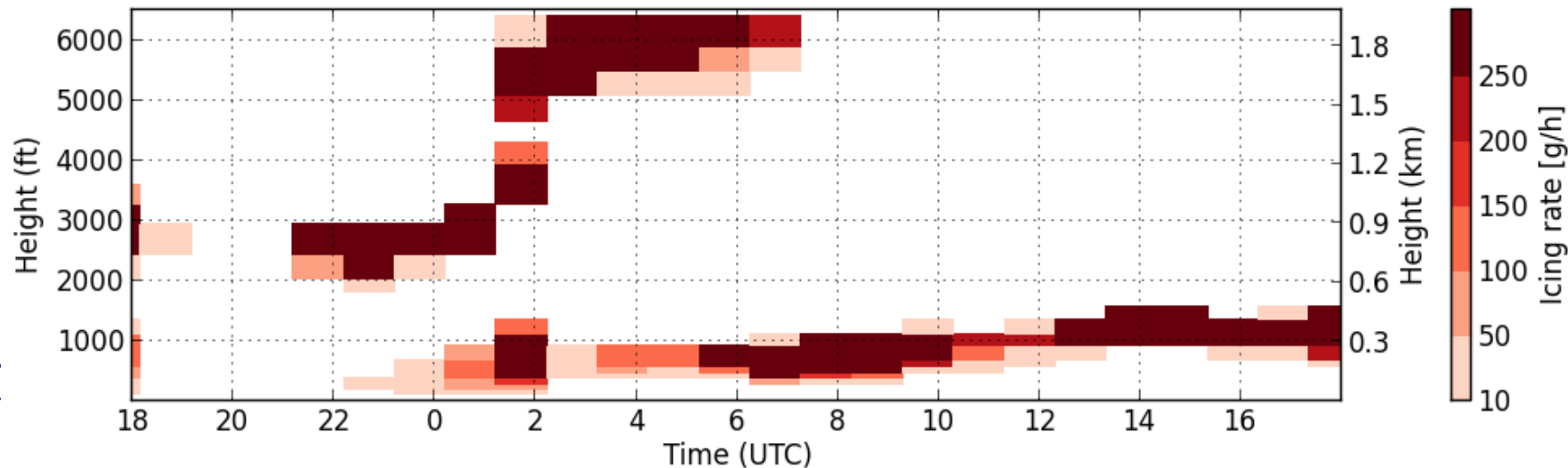
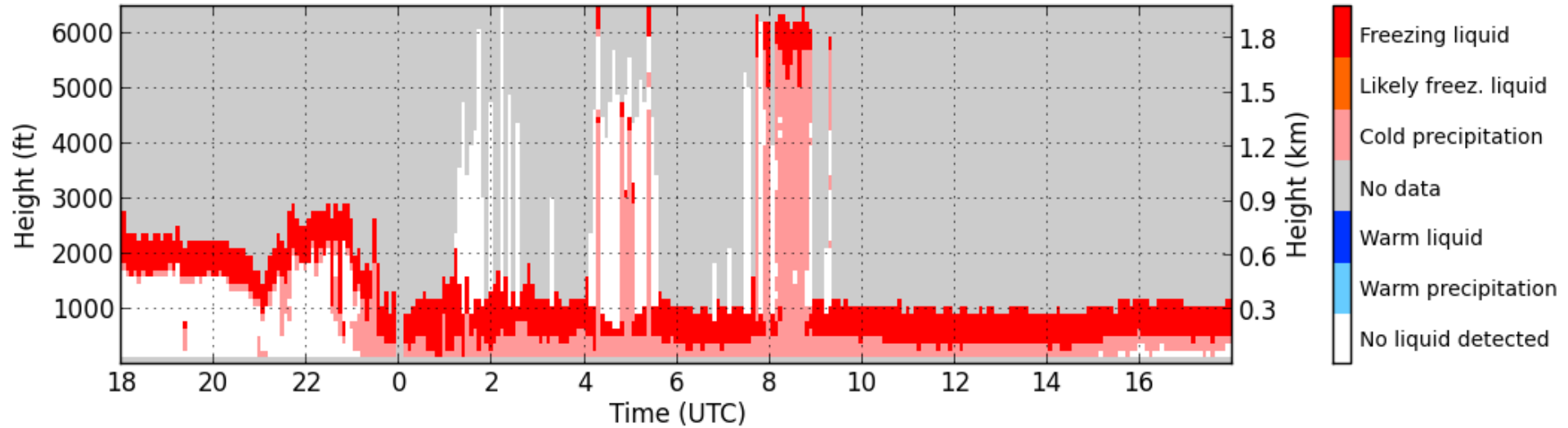
Supercooled liquid layers - icing



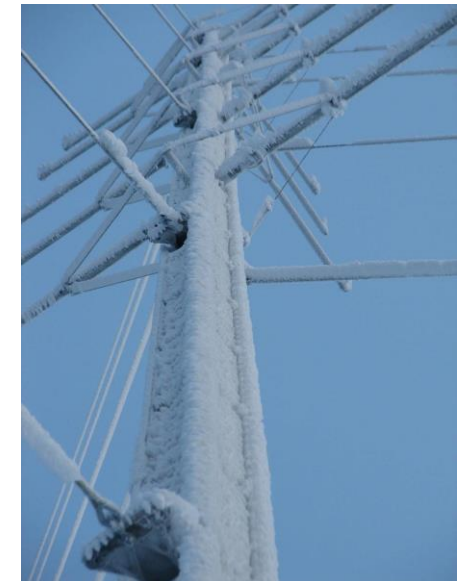
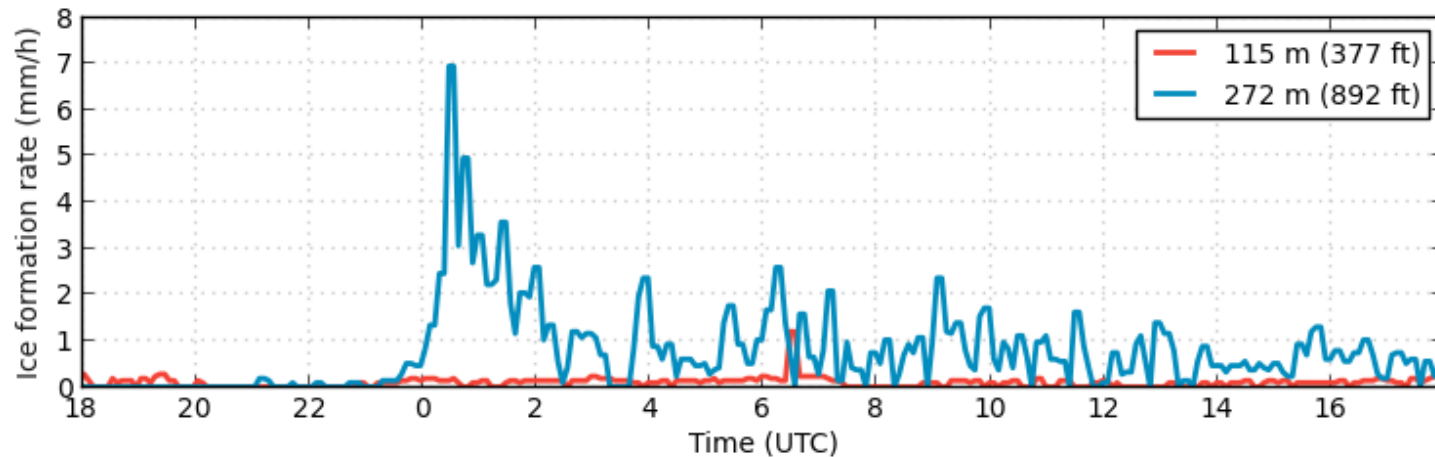
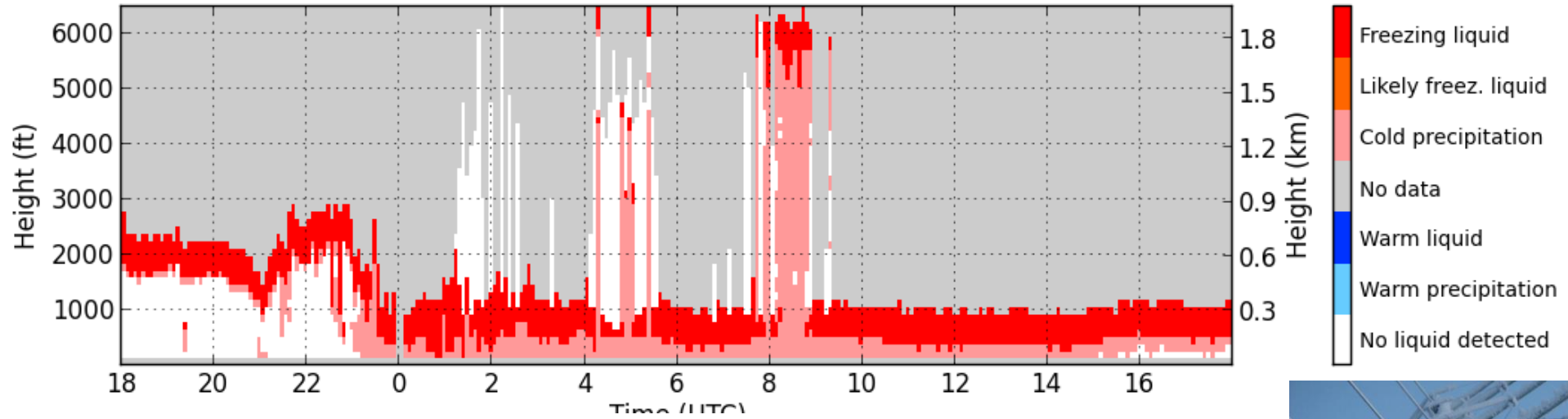
Supercooled liquid layers - icing



Supercooled liquid layers - icing



Supercooled liquid layers - icing



Ceilometer network

- Identify:
 - Liquid cloud base in multi-layer or deep cloud
 - Precipitation below cloud
 - Fog formation and dissipation
 - Supercooled liquid and icing potential
- Nowcasting and forecasting applications
- Most products can be made available in NRT

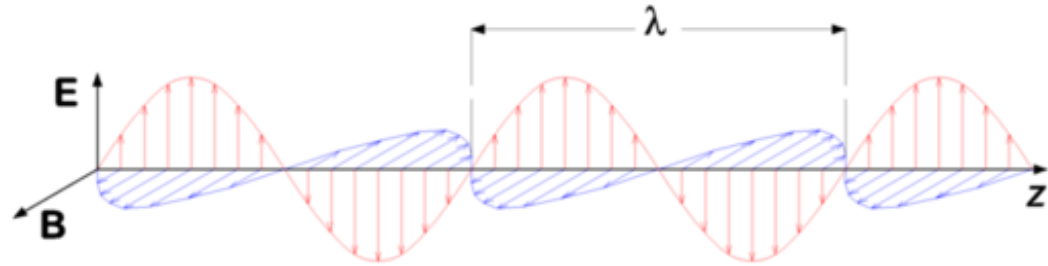
Test campaign - Kent

- Testing prototype – October 2019 to Jan



Depolarisation

Electromagnetic wave

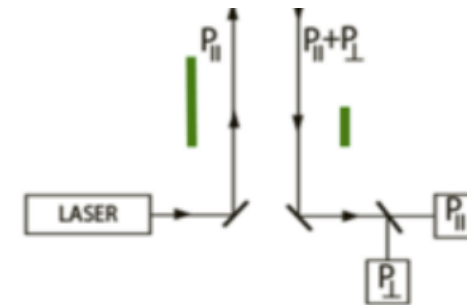


Linear depolarisation

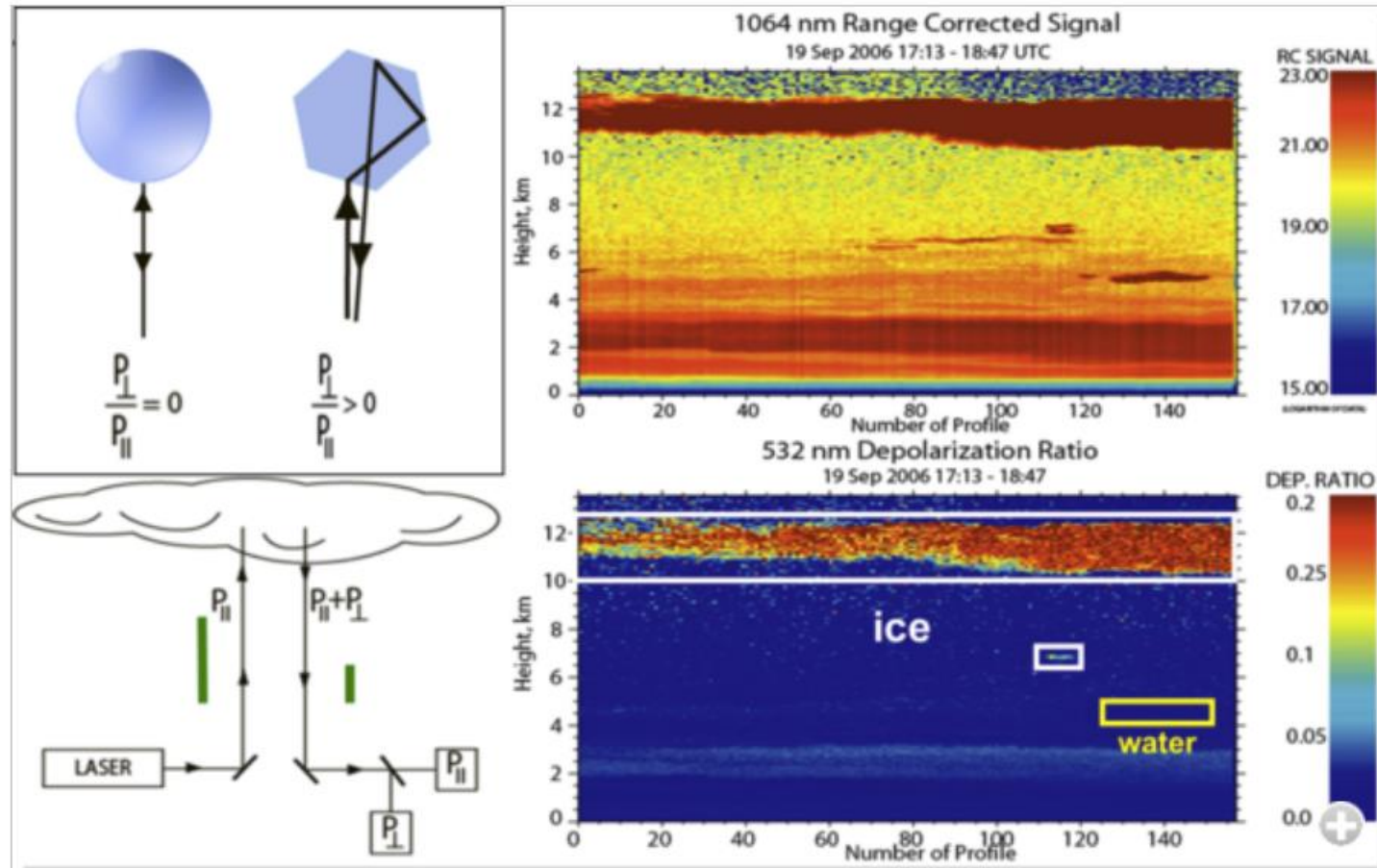
$$\delta_l = \frac{P_{\perp}}{P_{\parallel}} = \frac{\textit{Perpendicular}}{\textit{Parallel}}$$

Transmit

Receive

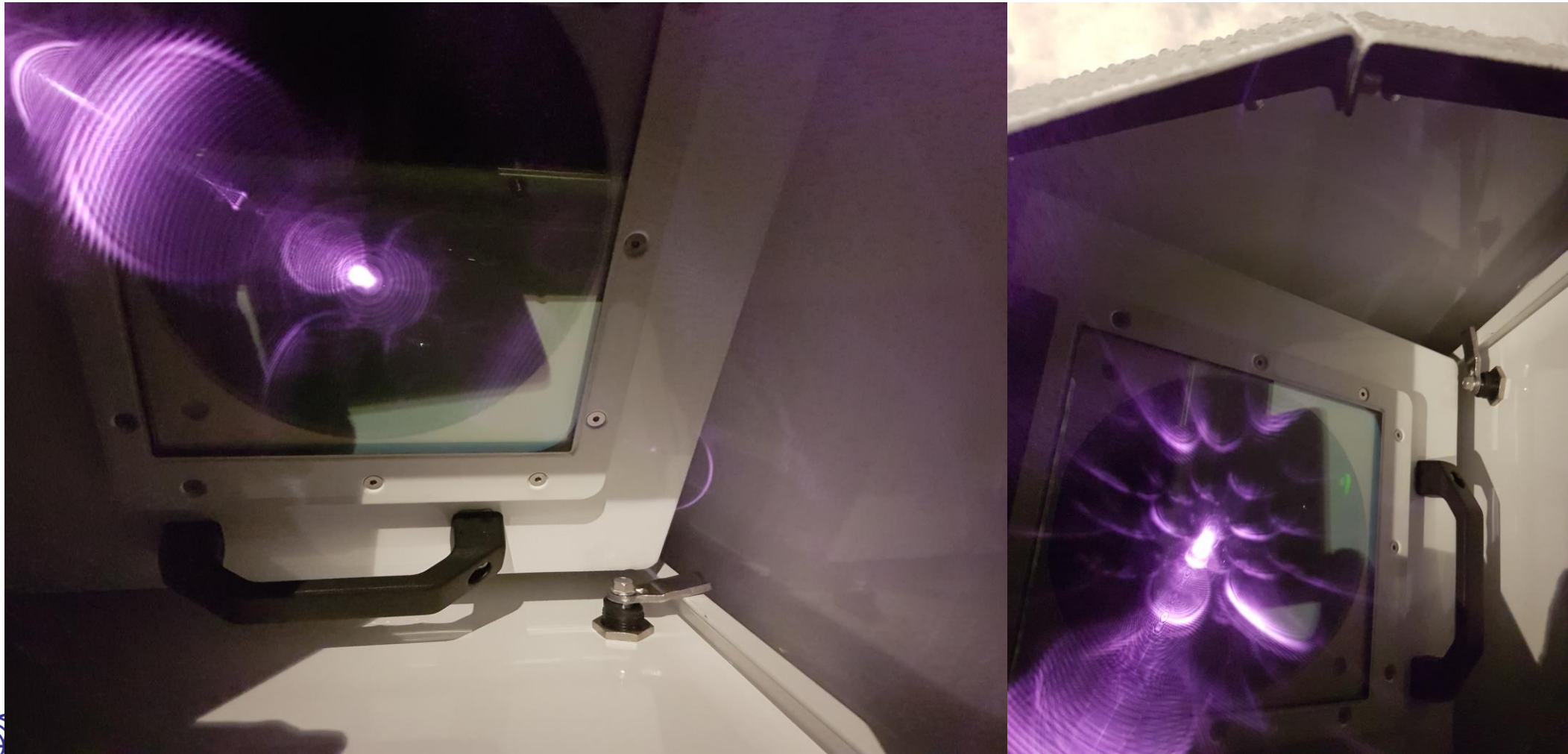


Simple explanation

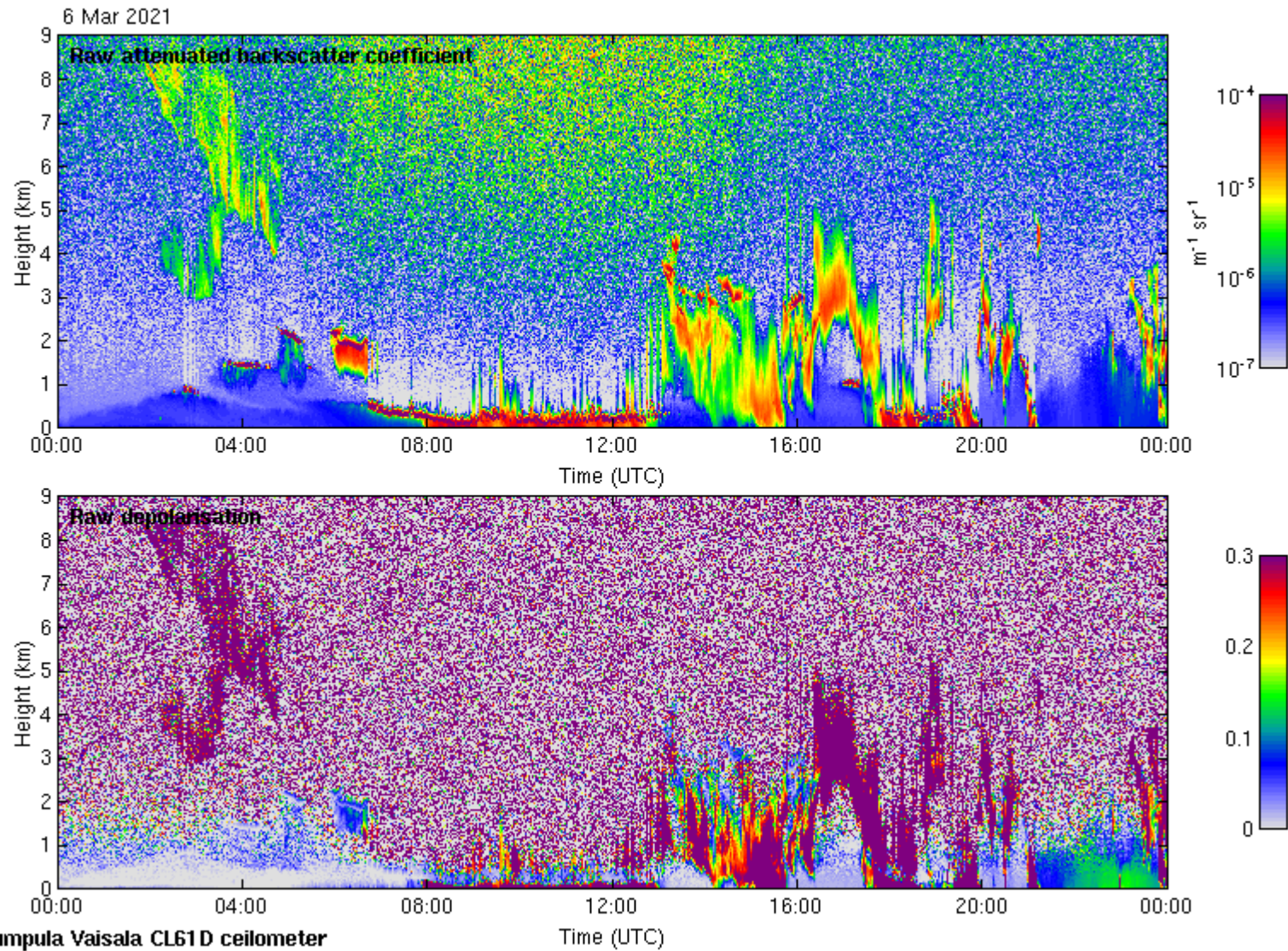


Test campaign - Kenttäröva

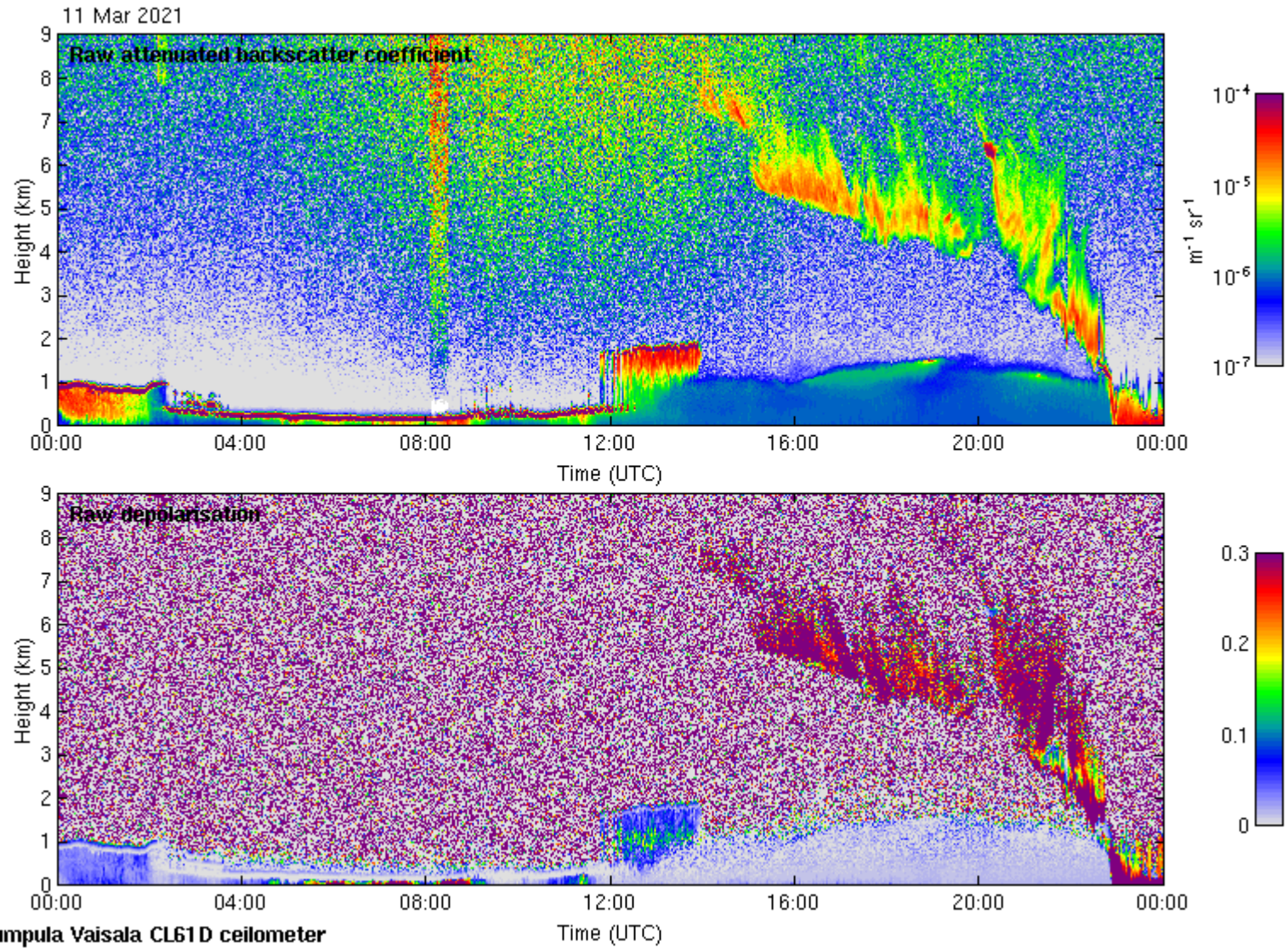
- Testing prototype – October 2019 to January 2020



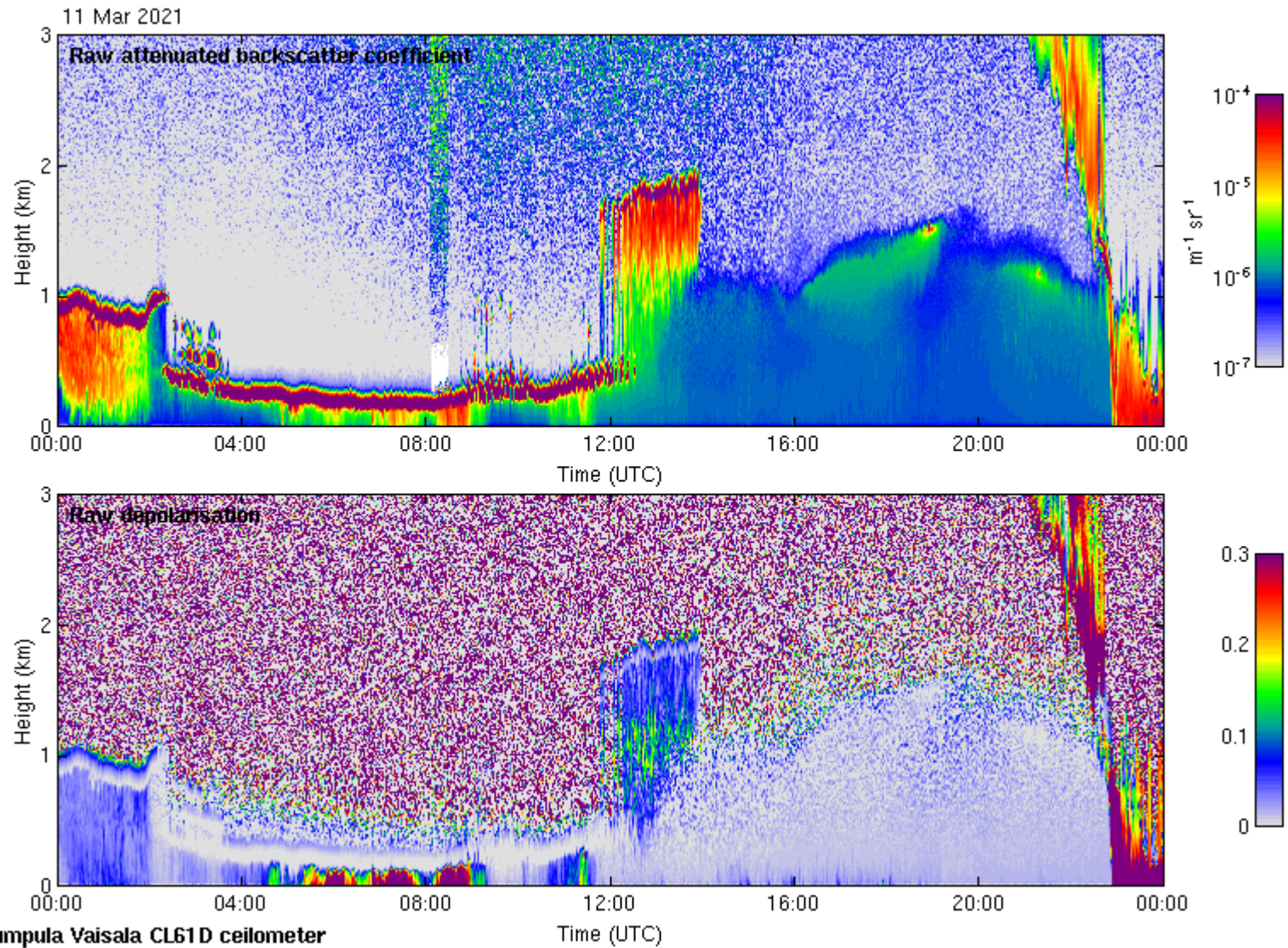
Examples



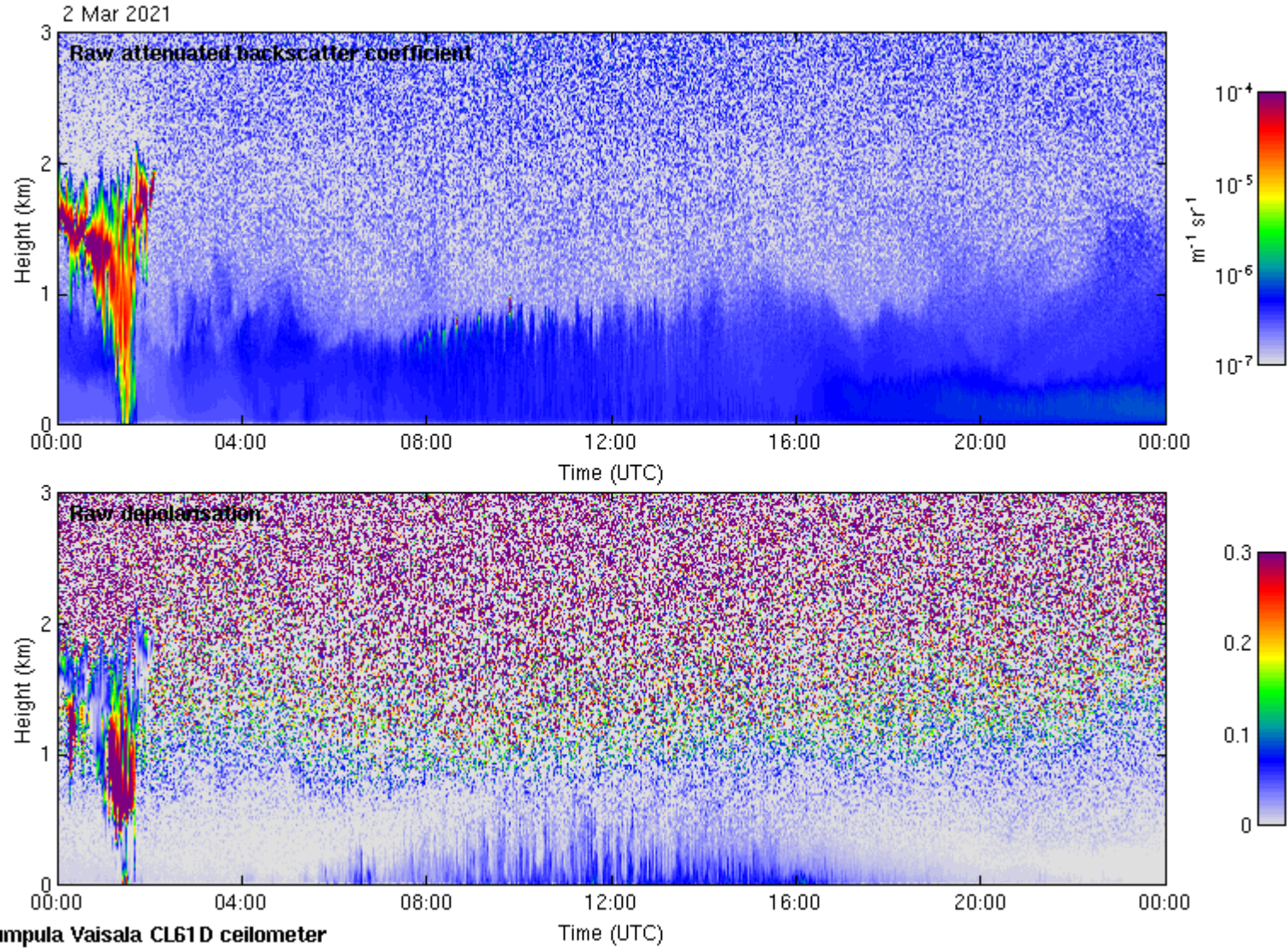
Liquid vs Ice



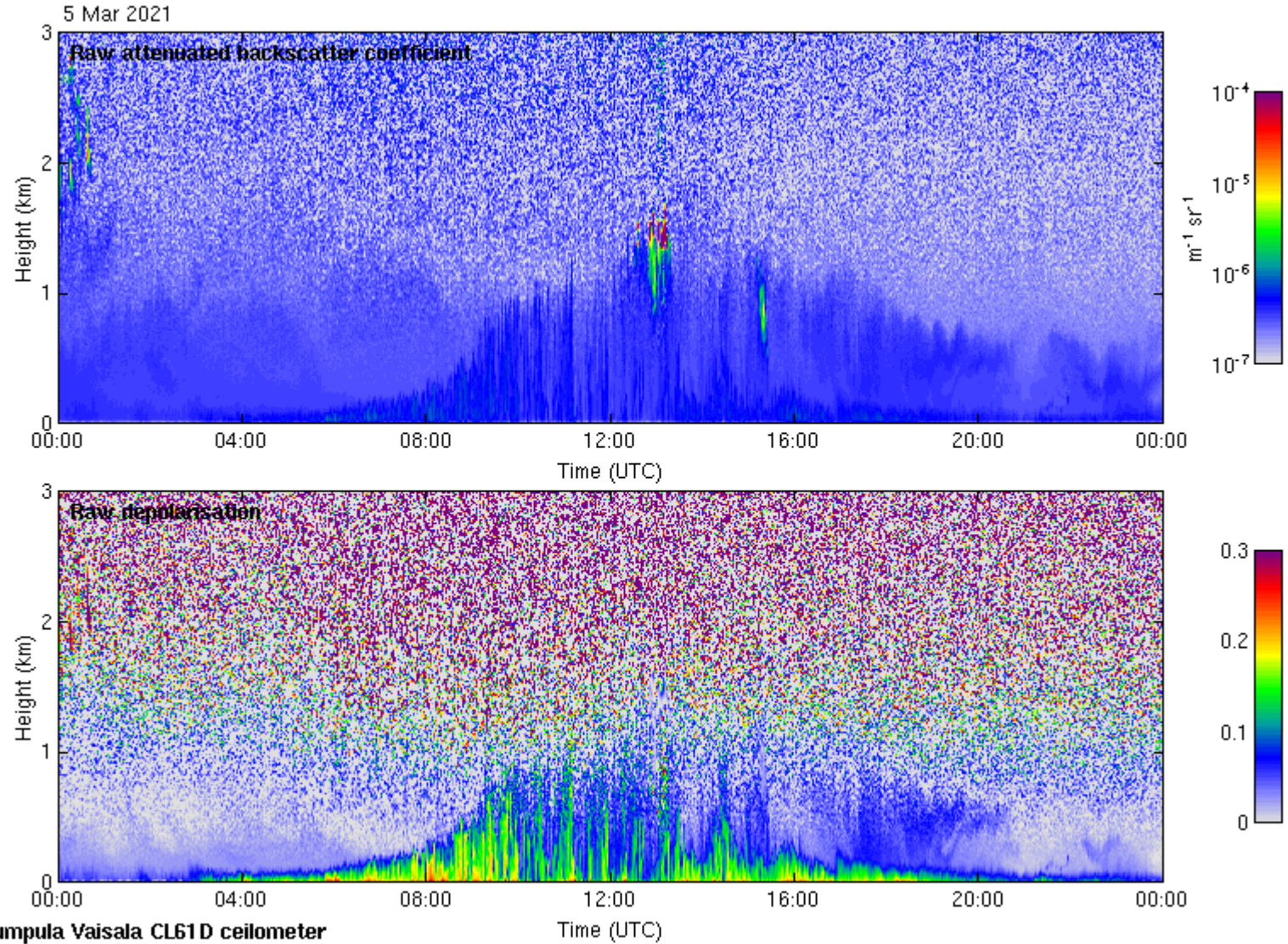
Liquid



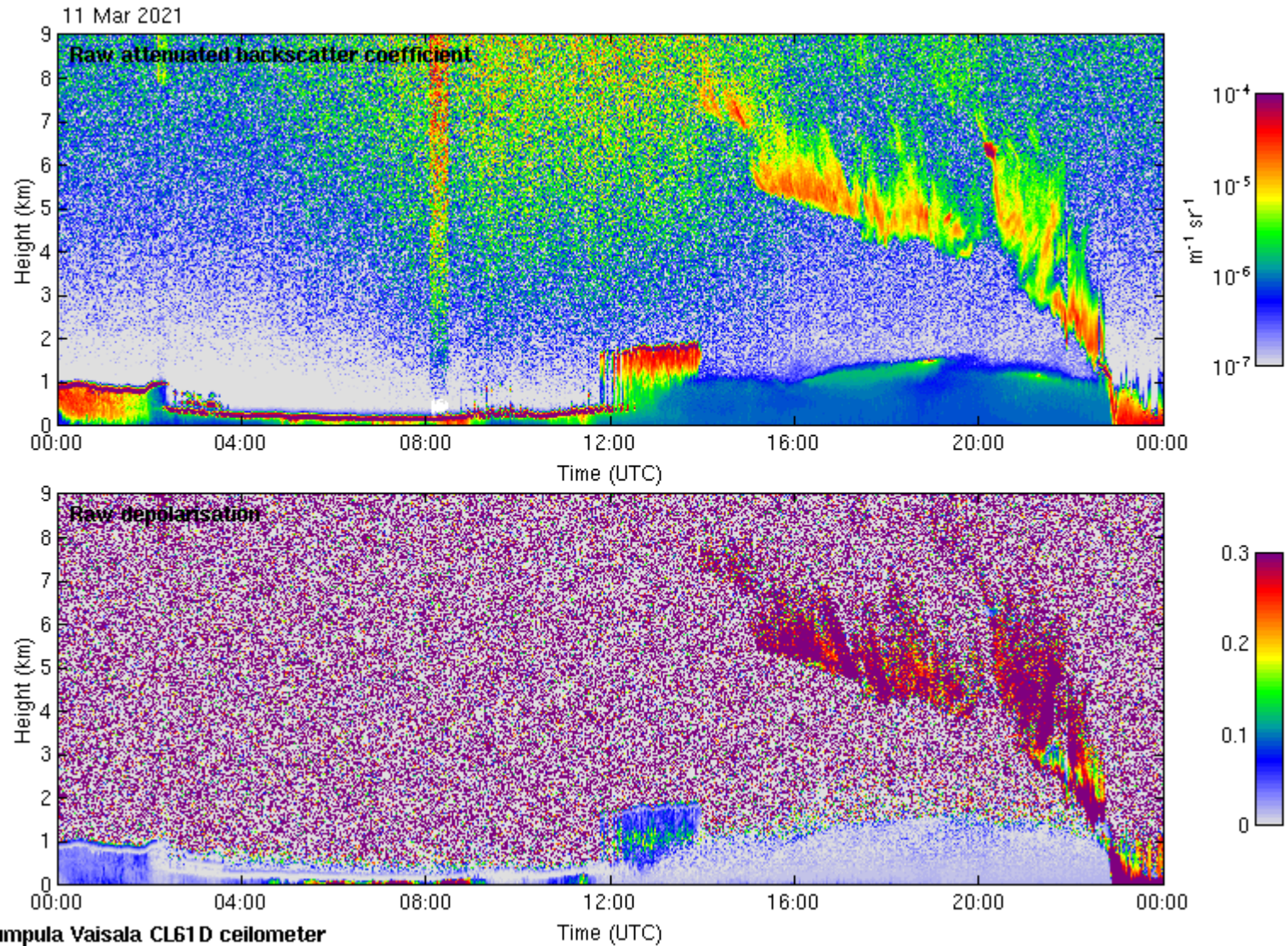
Pollution



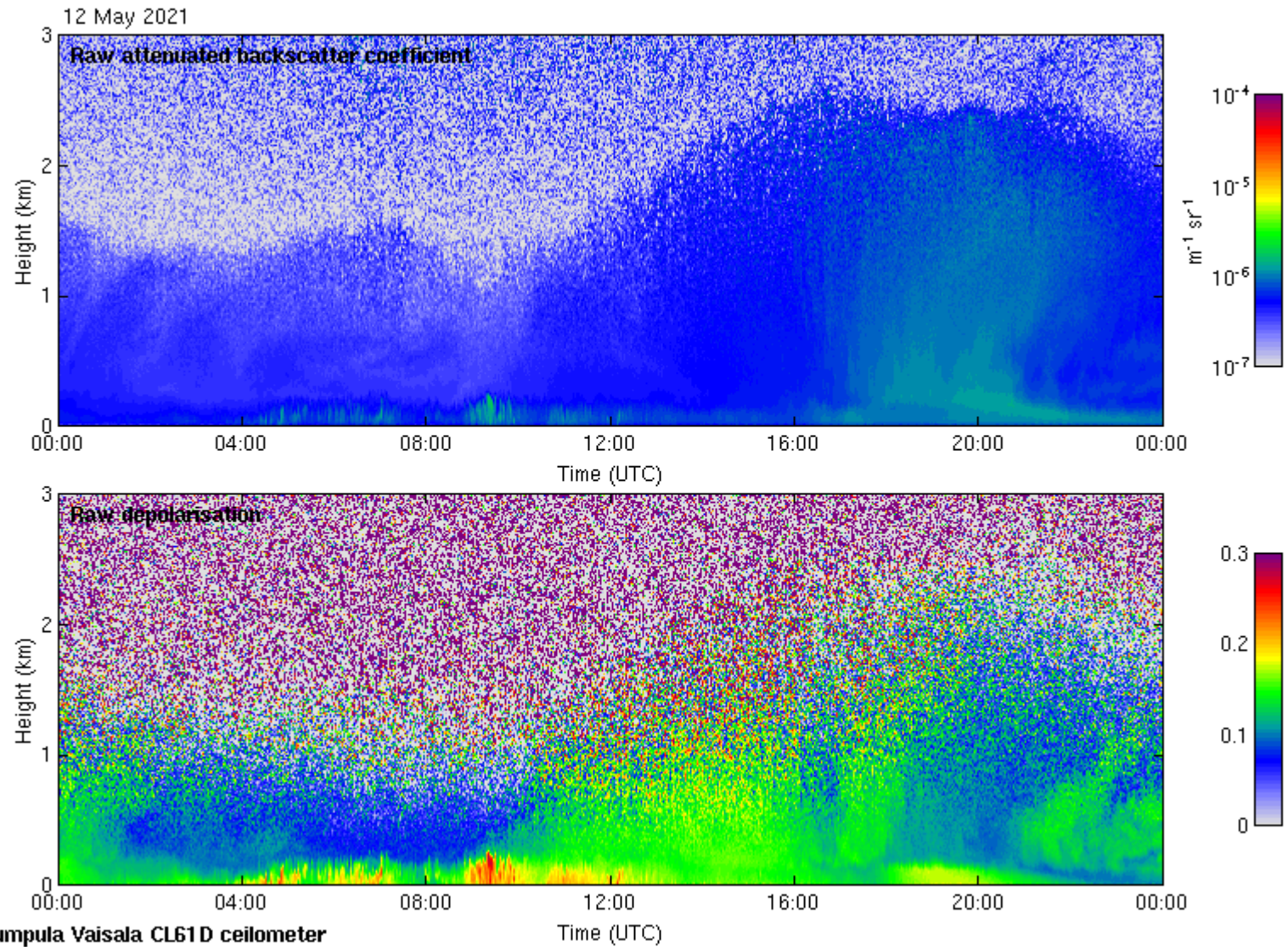
Road dust



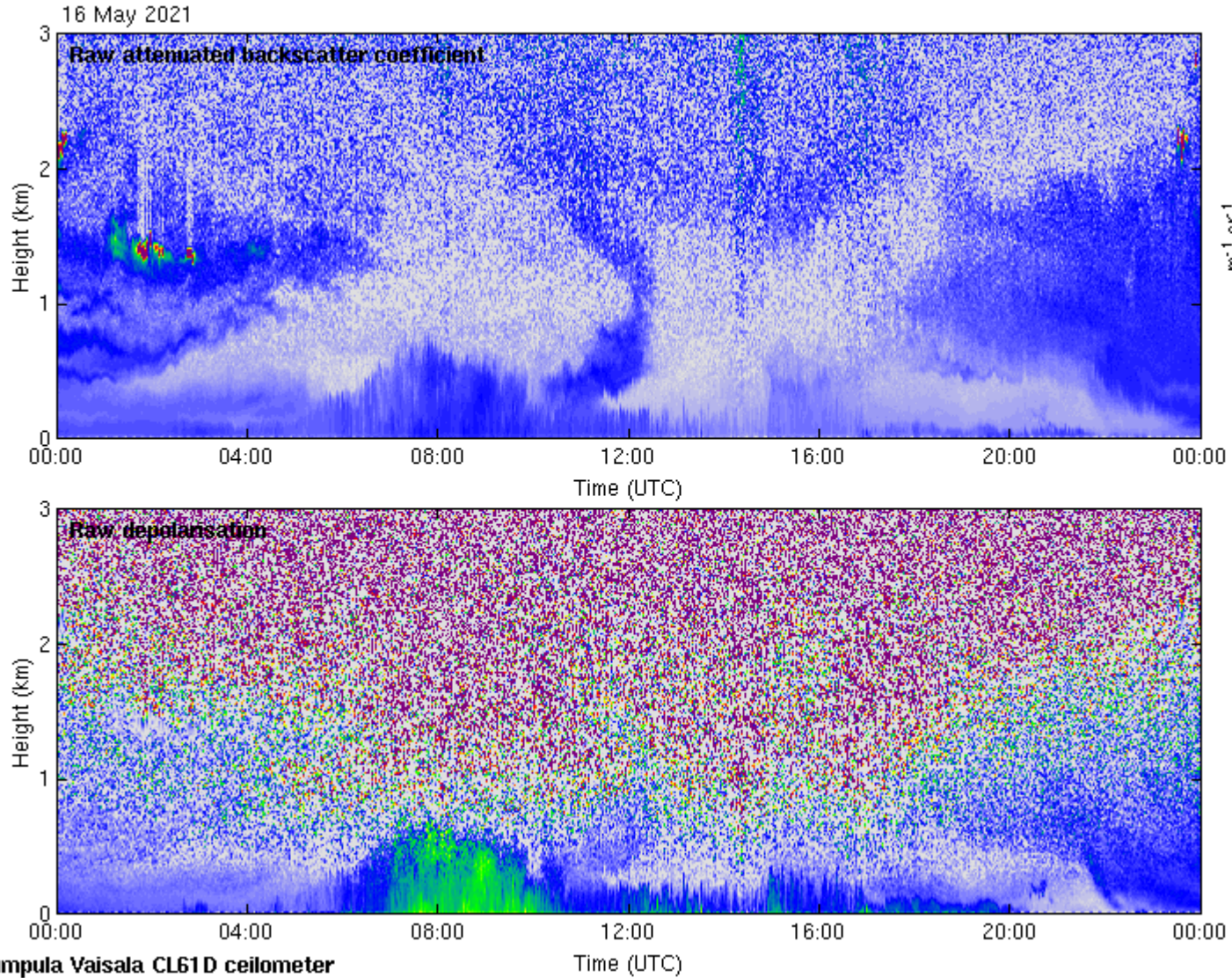
Marine aerosol



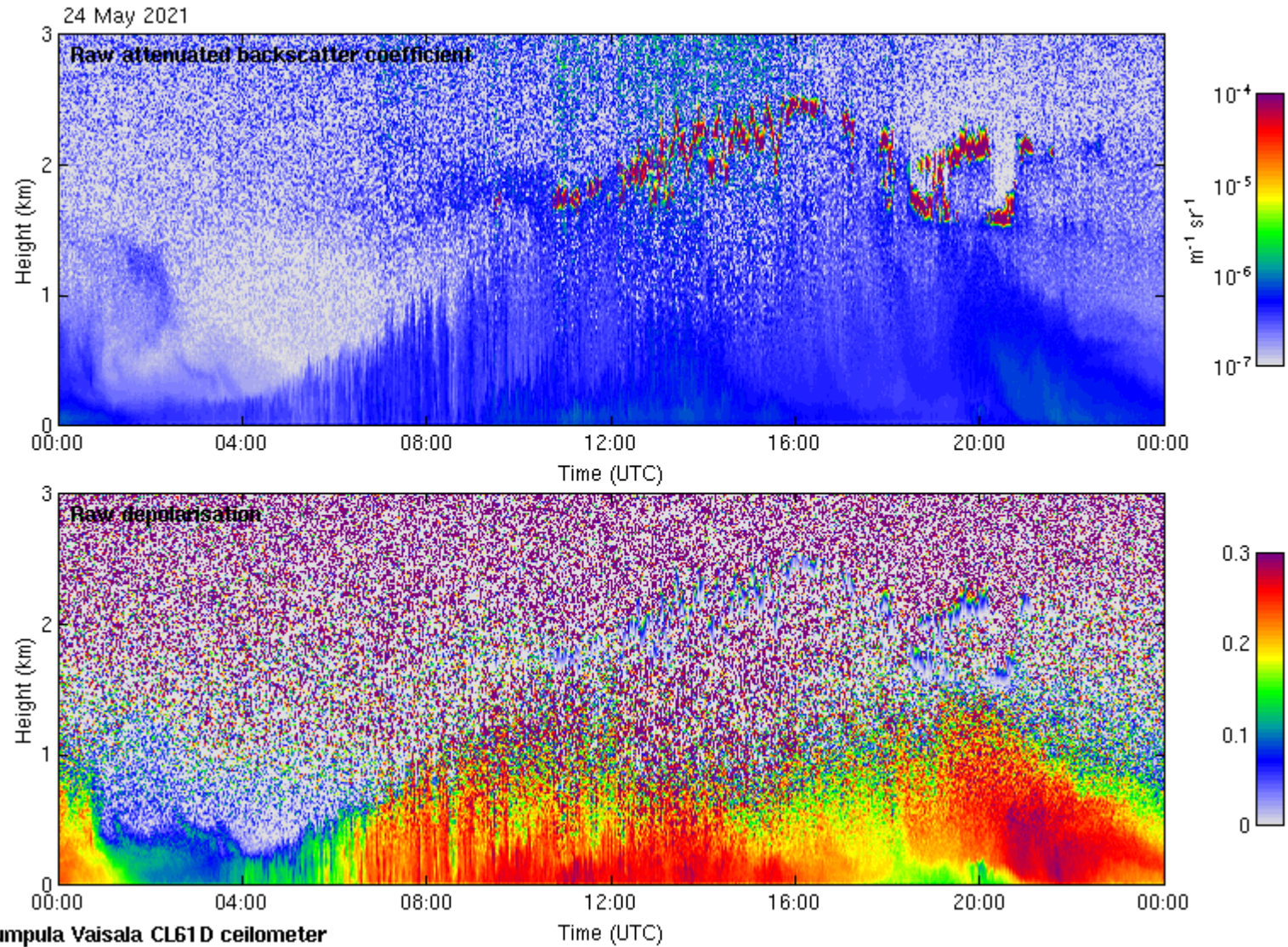
Pollen



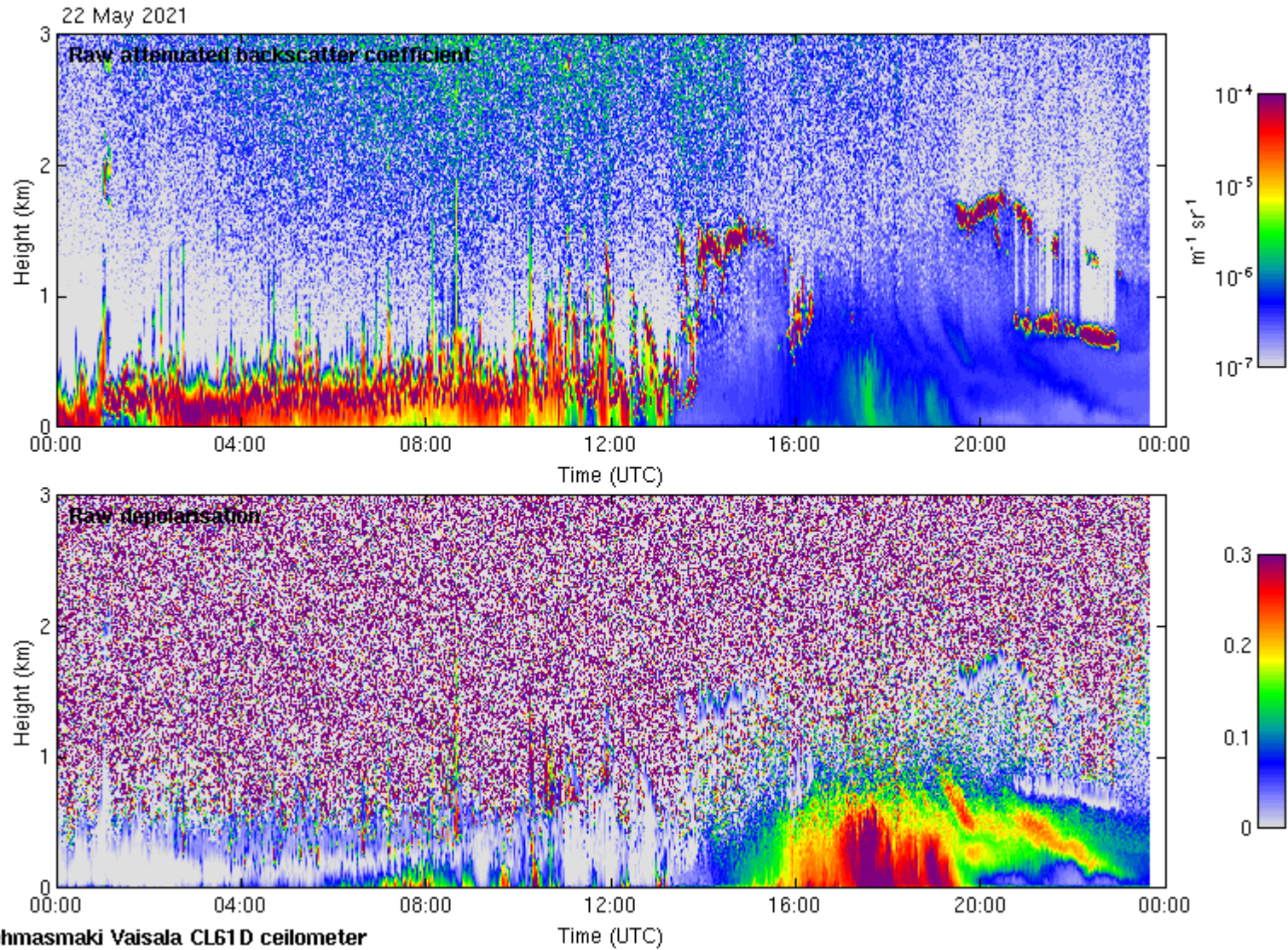
Pollen – sea breeze



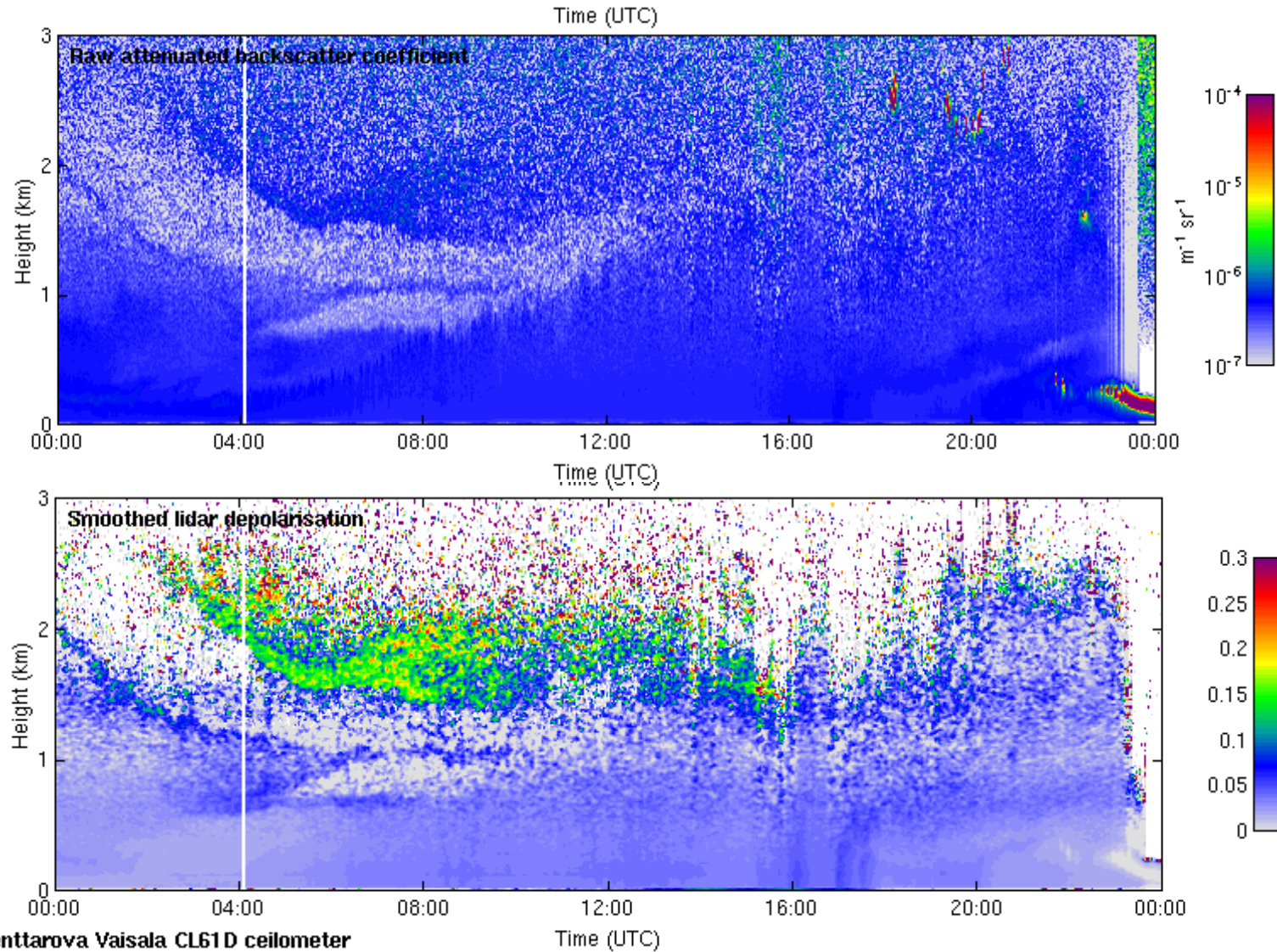
Pollen - bad



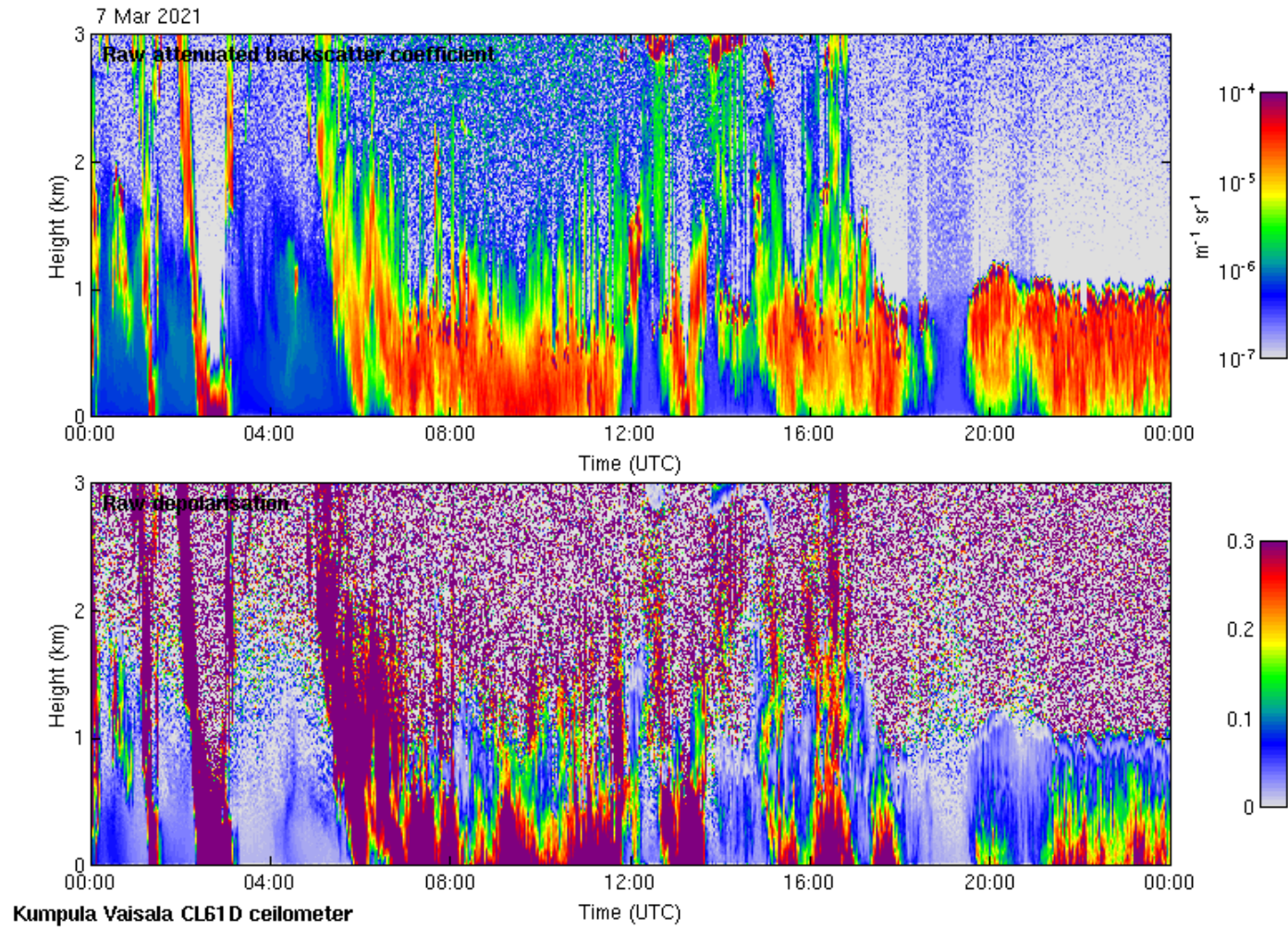
Pollen - Vehmäsmaeki



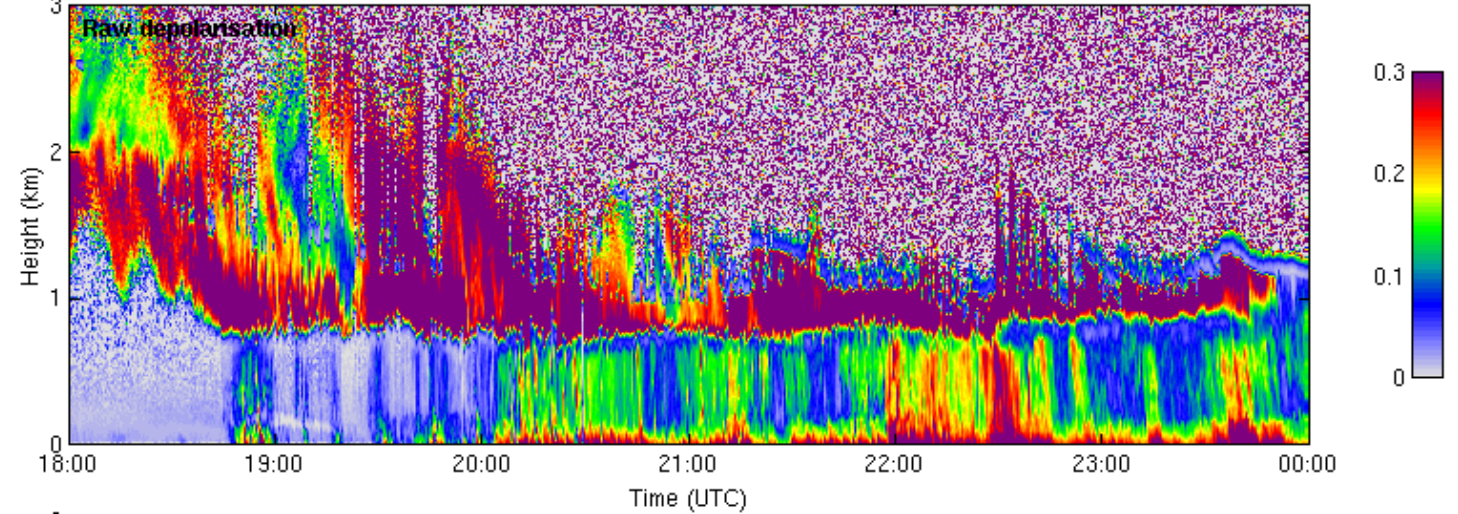
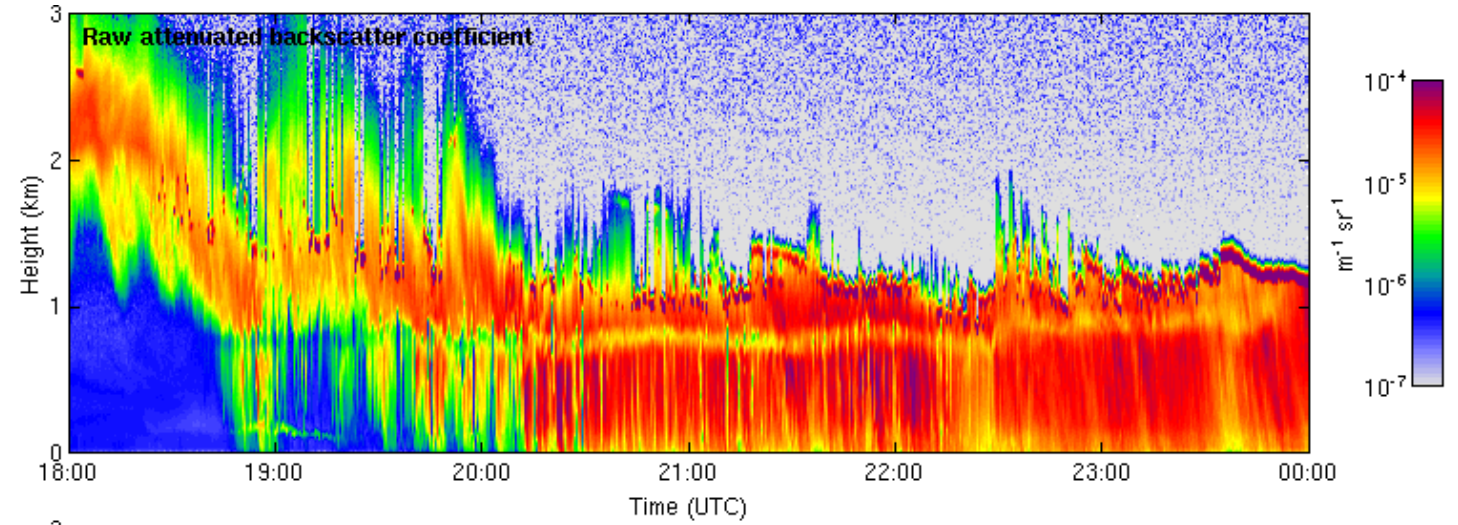
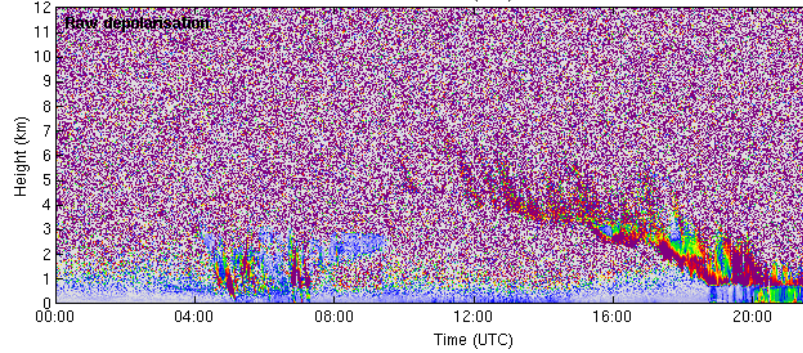
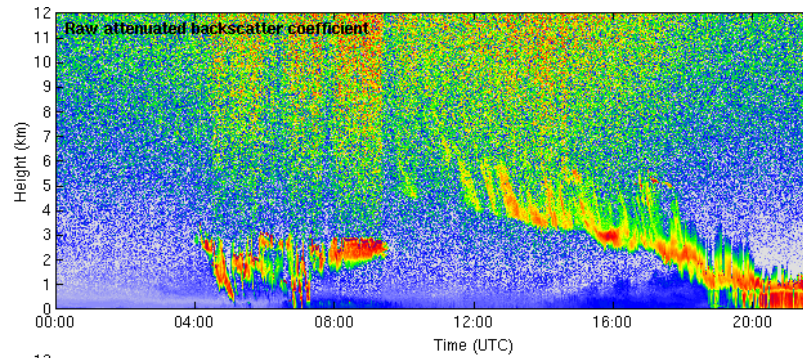
Smoke - Kenttäröva



Precipitation - snow

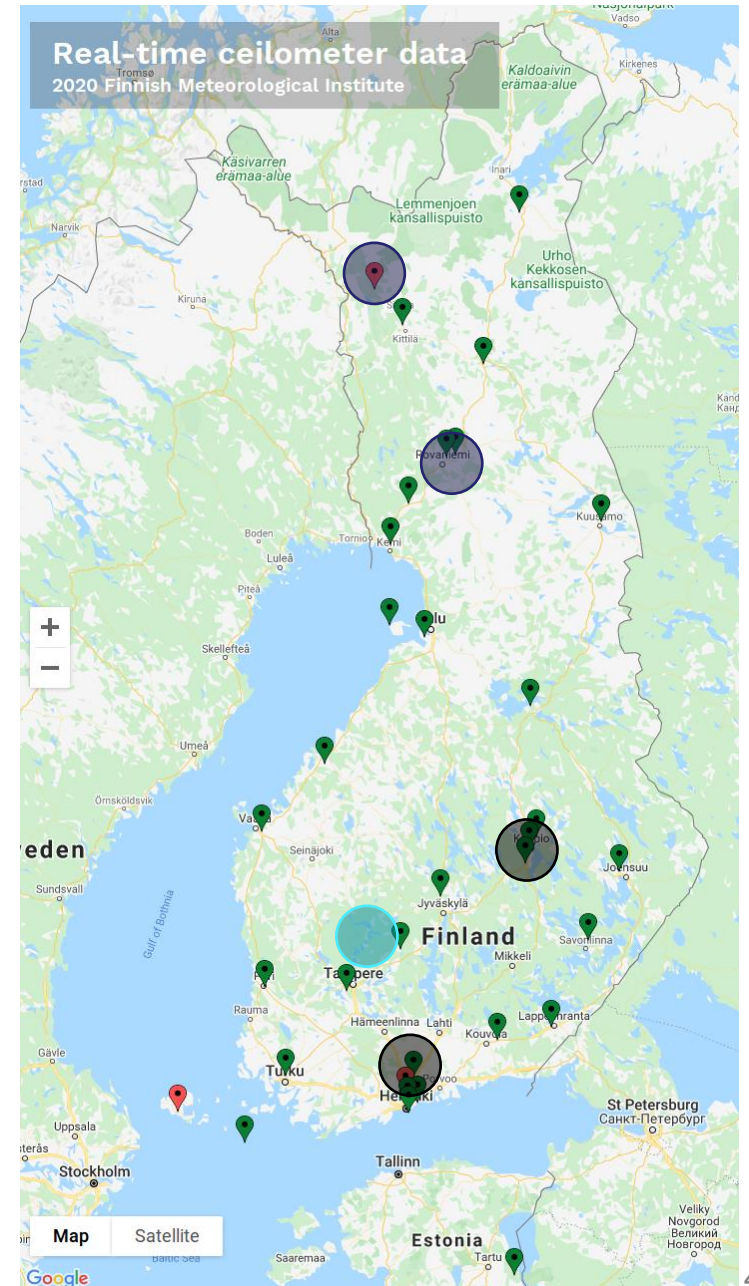


Precipitation - rain



Network

- Operational network
 - Joins ceilometer network
- Locations
 - Vantaa
 - Vehmäsmaeki
 - Rovaniemi
 - Kenttäröva
 - Hyytiälä
- Option to obtain more



Processing chain



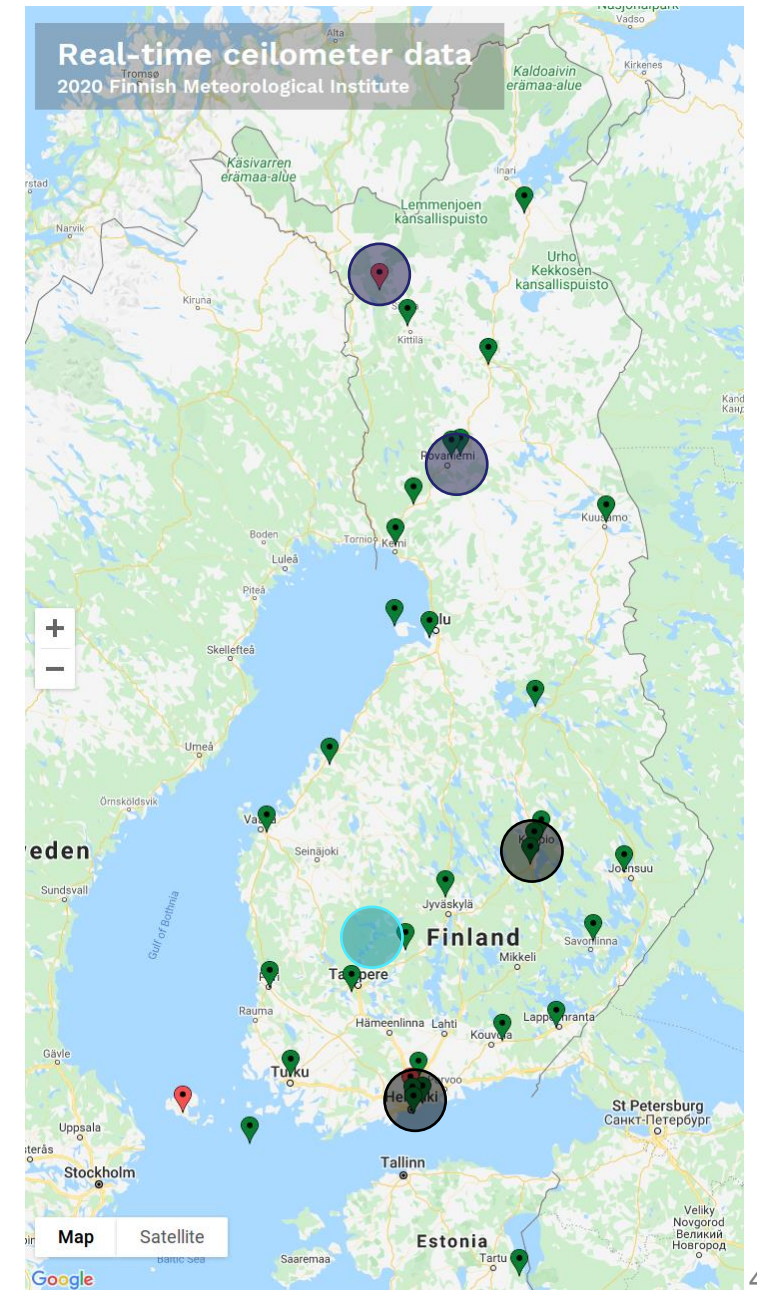
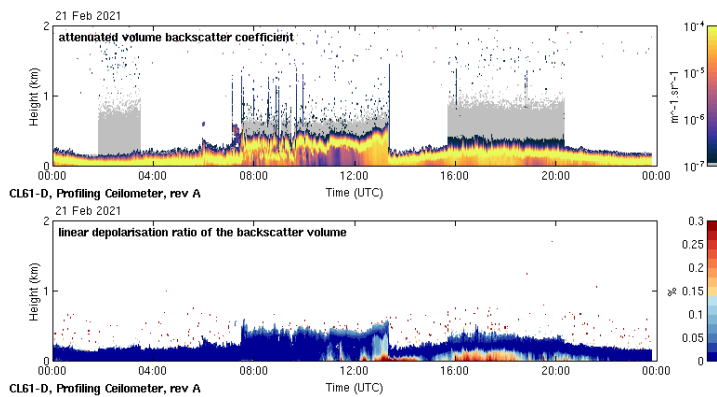
HAVY network

S3 raw archive

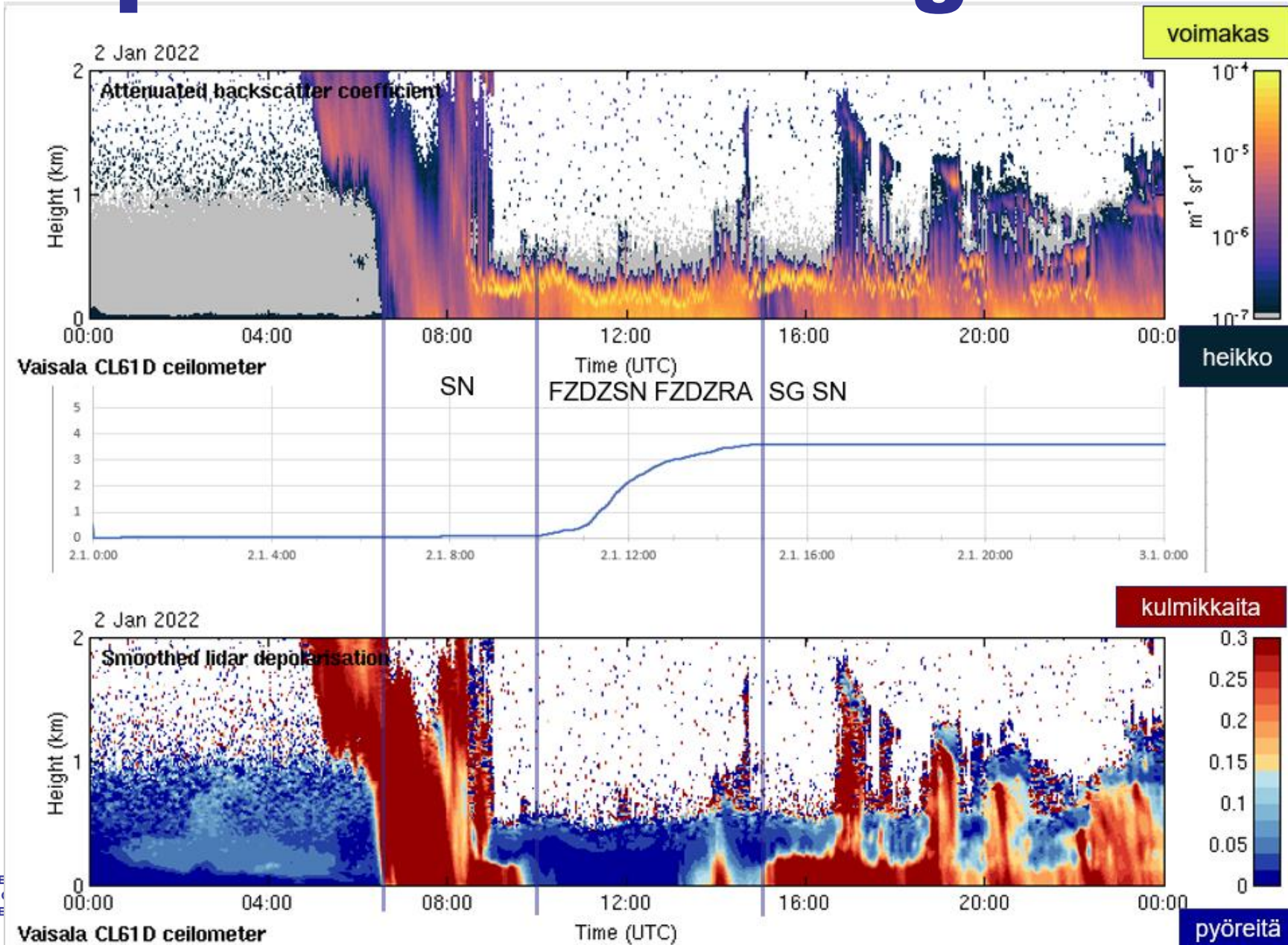
Processing
ceilometer.fmi.fi

Images
SmartNet

Forecasters



Precipitation – freezing rain/drizzle



Depolarisation improves ceilometer products

- Easier to determine:
 - Water phase
 - Supercooled liquid vs ice
 - Snow vs rain (and melting transition)
 - Target diagnosis
 - Aerosol vs ice or precipitation
 - Specular reflection (misdiagnosis of supercooled liquid)
- Products
 - Aerosol, cloud, precipitation classification
 - Identify presence of pollen, dust, smoke, volcanic ash