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Operational applications of dual-polarized Weather Radar in Finland

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  - What are we working on right now?
  - What is planned for the near future?

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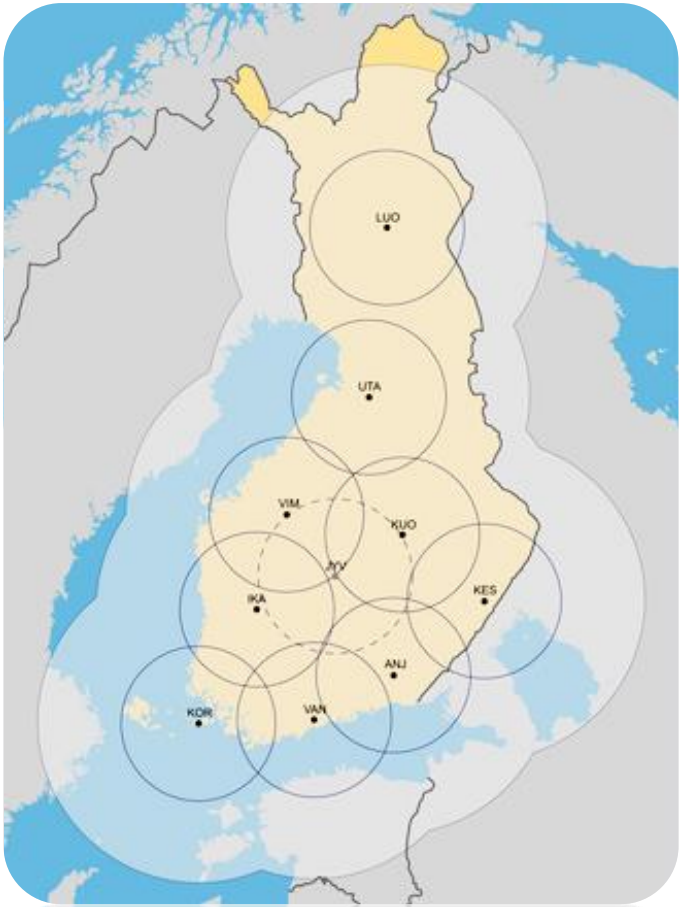
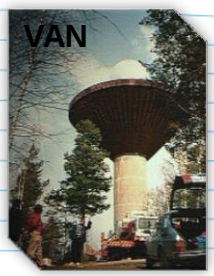
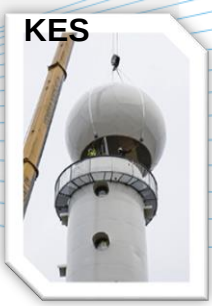
FMI Weather Radar Network

- FMI weather radar network consists of nine C-Band Doppler radars
- Eight Dual-polarization Vaisala WRM200 C-Band Doppler radars
- One single-polarization Selex-Gematronik HW & Vaisala-Sigmet SW C-Band Doppler radar
- The new tenth dual-polarization radar will be installed in October 2015







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FMI Weather Radar Network

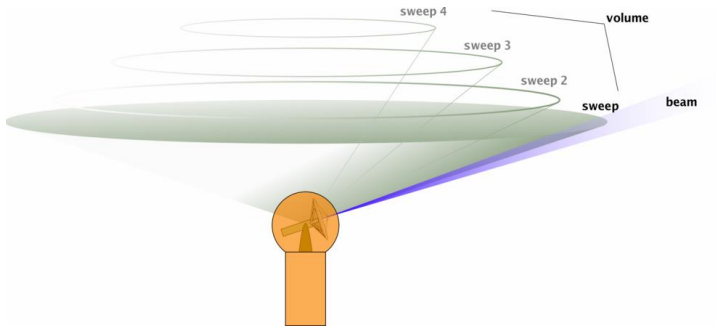
Vaisala Dual-pol C-band Weather Radar WRM200

Characteristics of FMI radars (range from…to)

tower height	from 19.0 m to 37.0 m
beamwidth	0.94°…. 0.98°
wavelength	5.310 cm …. 5.340 cm
peak power	195 kW …. 260 kW
H/V	-0.94 dB …. 0.30 dB
radar constant (H/H+V)	61.99/64.99 dB …. 63.30/66.60 dB
antenna gain	45.10 dB …. 45.80 dB
ZDR bias	0.38 dB …. 1.19 dB
LDR bias	-2.00 dB …. 0.76 dB

Technical Specifications:

- Antenna diameters: 4.5 m
- Radome: 6.7 m
- Antenna beam width: 0.98 deg
- Transmitter: magnetron
- Frequency: 5.6 GHz
- Wave length: 5.3 cm
- Pulse Width : 0,85µs/ 2,0 µs
- Pulse peak power: 250 kW
- Signal Processor : RVP900
- Software : IRIS

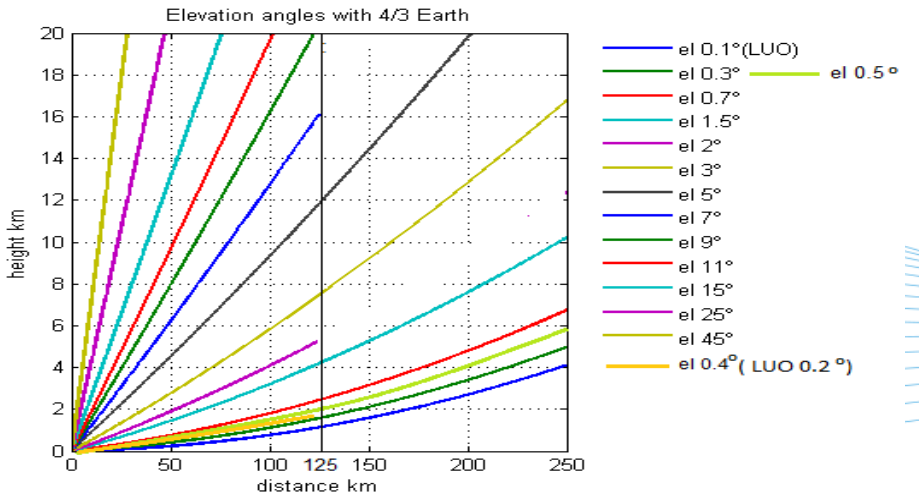


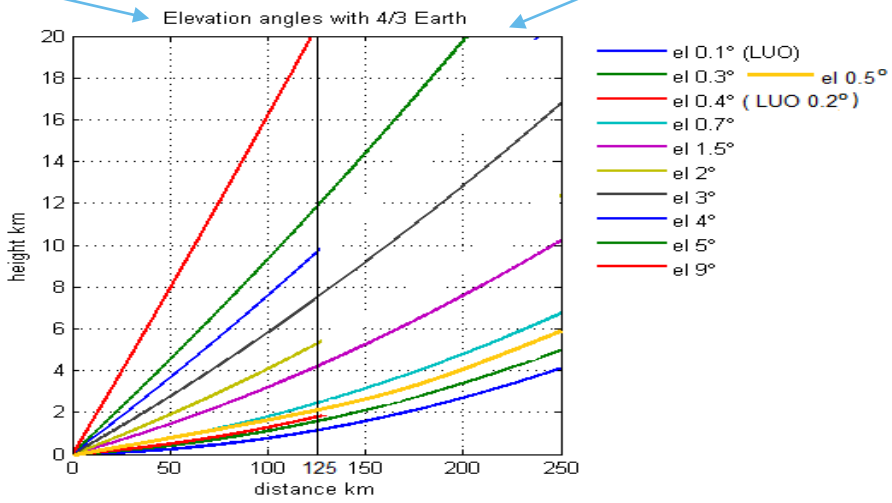
FMI Weather Radar Network

Scanning strategy

- **PPI_Plan Position Indicator scans: the antenna passes through 14 different elevation angles from 0.3º (0.1º, 0.5º) to 45.0 º.**
- **RHI_Range-Height Indicator scans: two azimuth angles, elevation from 0 º to 60 º.**
- **Scanning to be repeated at least every 15 minutes .**

5 minutes **5 minutes** **5 minutes**





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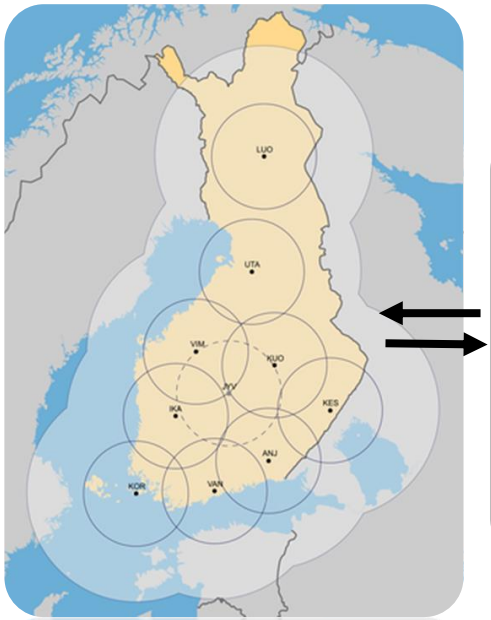
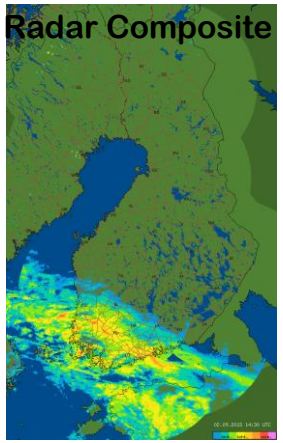
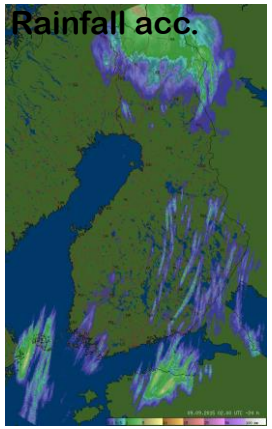
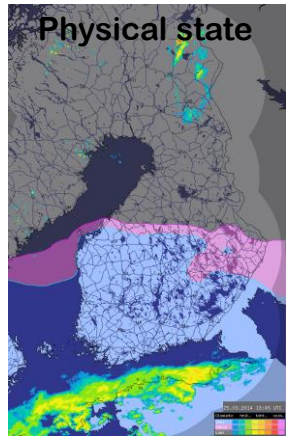
FMI Weather Radar Network

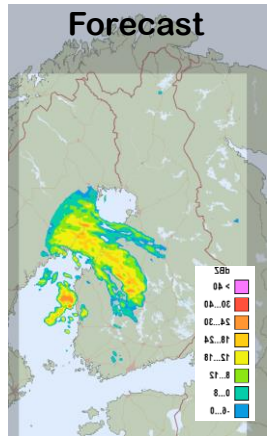
Radar.fmi.fi
http://radar.fmi.fi/

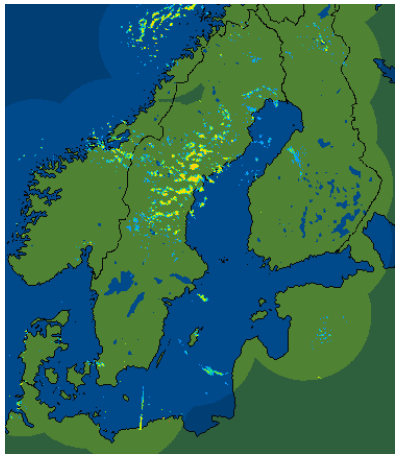




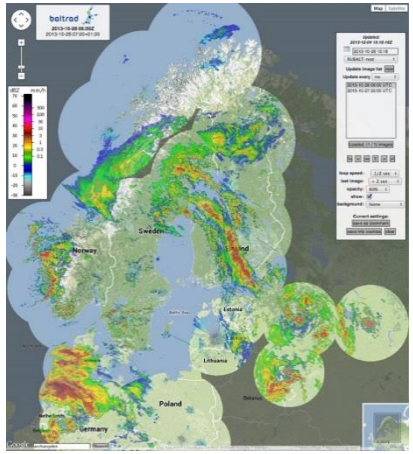






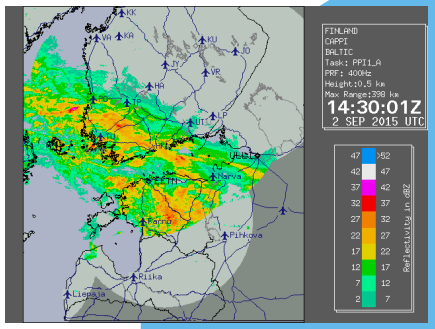


The Nordic countries Radars network

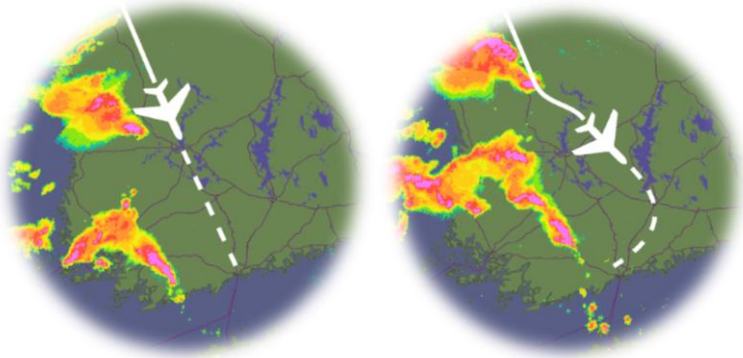


An advanced Weather Radar network for the Baltic Sea Region

The Gulf of Finland

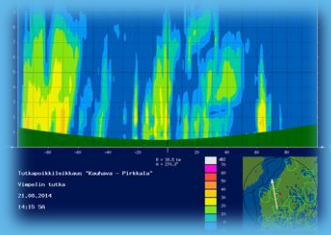


End-users of Radar data and products



Servises for professionals

- Aviation
- Road maintenance
- Forest fire risk
- Flooding
- Hydropower
- Insurances …



and the greater public

- Smartphones
- Internet
- Television
- Newspapers

and FMI forecast, warning process and research

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End-users of Radar data and products

The radars are important forecasting tools for meteorologists. The weather forecaster have always open:

- **SmartMet** (It is a software tool for visualizing and editing meteorological data)
- **Gr2Level (Gr analyst)** (It is a commercial, independent IRIS software extension that allow look at the radar data through a Website)
  http://www.grlevelx.com/grlevel2/
  - **Deer Browser**
    http://radar.fmi.fi/products/fmi/radar/iris/deerbrowser.html
  - **AnimBrowser**
    http://weather.weatherproof.fi/animbrowser
  - **Radar.fmi.fi**
    http://radar.fmi.fi/

Weather forecaster Paavo Korpela, photo by E.Saltikoff

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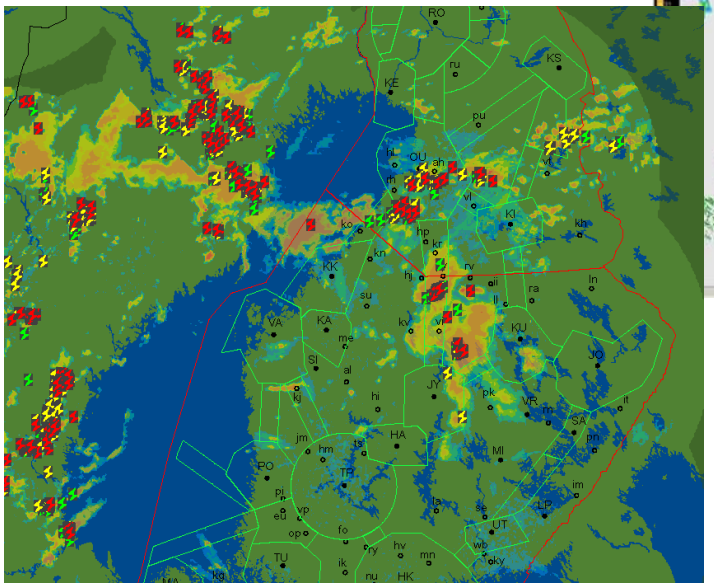
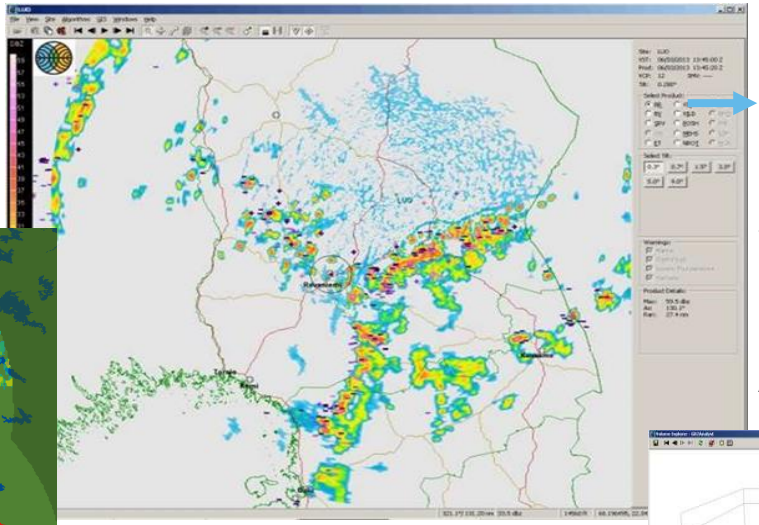
AnimBrowser

dbz
detectability
flash
rdbz
rdbzd
rdbzdweather
rdbzflash
rdbzweather
rflash
rr
rr12h
rr1h
rr24h
rr3h
rr6h
rrform
rs1h
rs24h

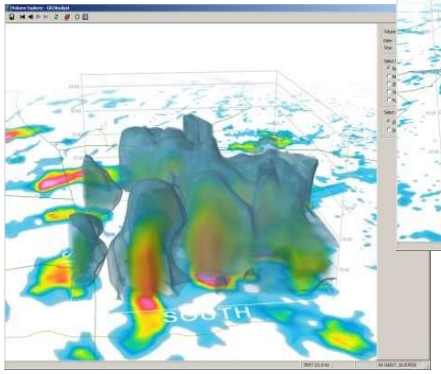
rdbzflash

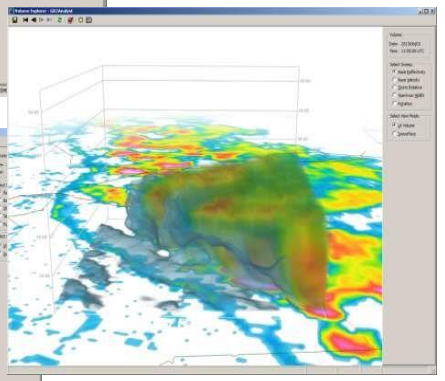


Gr2Level (Gr analyst)



POSH = Probability of Severe Hail
MEHS = Maximum Estimated Hail Size
NROT = Normalized Rotation
ZDR = Differential Reflectivity
RHO = Correlation Coefficient
PHI = Phase Shift
KDP = Specific Differential Phase
HCA = Hydrometeor Classification Algorithm





- composite image
- the radar and rain observations
- the radar and lightning
- …
- 15 minute time step

- a single radar animation
- 5 minute time step
- cross-sections (line or 3D), different height angles
- the radar and lightning

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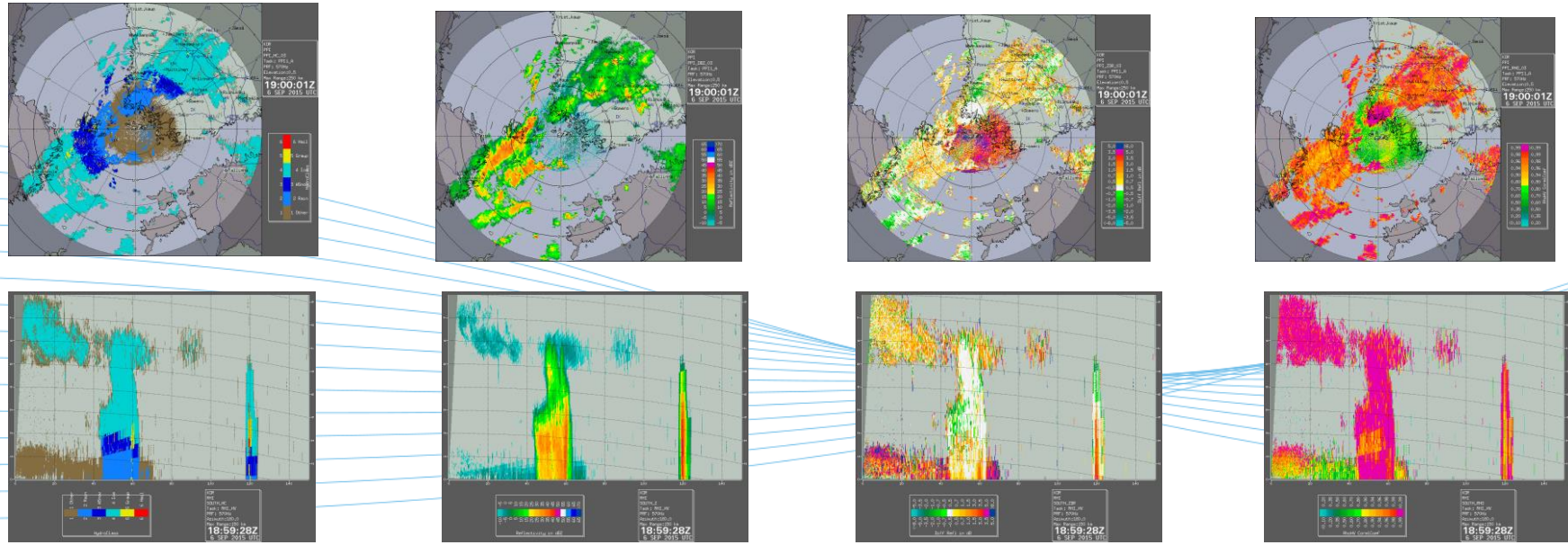
The development based on dual-polarization

What has been improved?

- **HydroClass-products from individual radars to http//radar.fmi.fi.**

PPI HClass dBZ ZDR RhoHV

RHI HClass dBZ ZDR RhoHV



The development based on dual-polarization

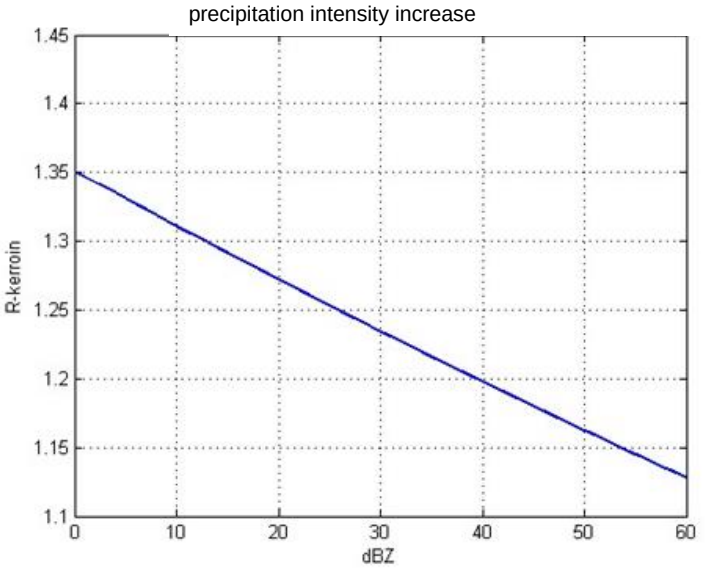
What has been improved?

- Dual-pol data input to SmartMet

- Range Resolution: change in all the radars 500m→ 250m

- Radar calibration : ZDR and LDR calibration
- Rain attenuation correction: dBZc and ZDRc
- Clutter mitigation: PMI thresholding is applied

- Rainfall intensities calculation for Finnish climate $R(Z) = 0.029185035Z^{0,65359477}$ (*Leinonen et. al.: J. Appl. Meteor. Climatol*, 2012.

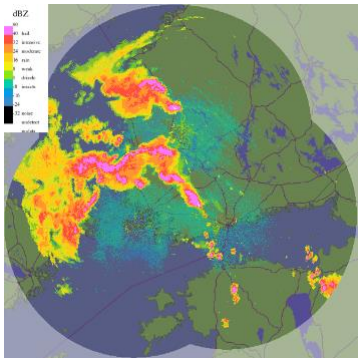
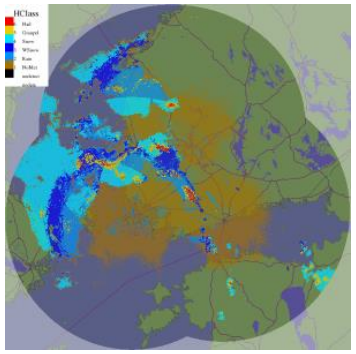
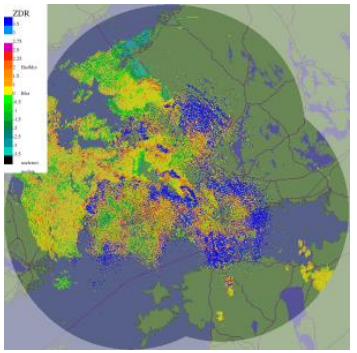
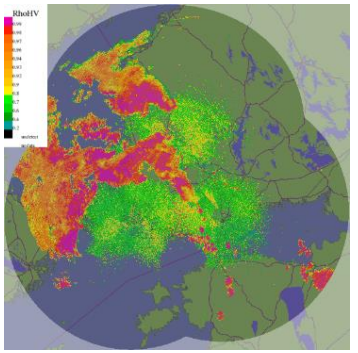


The development based on dual-polarization

What has been improved?

Classification of phenomena

- Birds, insects

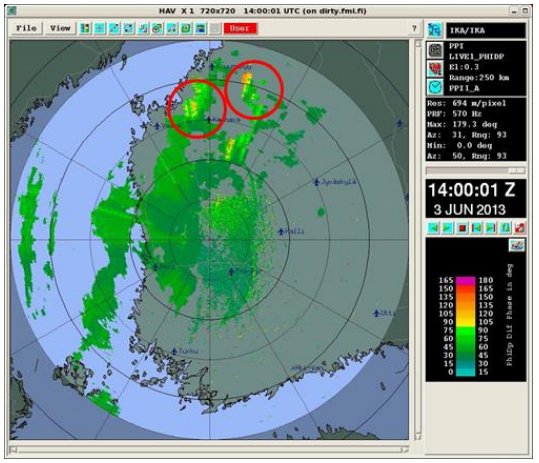





Increase the radar's sensitivity

- Sensitivity increase by dBZE
- In dBZE Z is calculated by comparing the two channels, where the noise level is improved, and thus the sensitivity.
- +2dB for 32 samples pulse

The development based on dual-polarization

What has been improved?

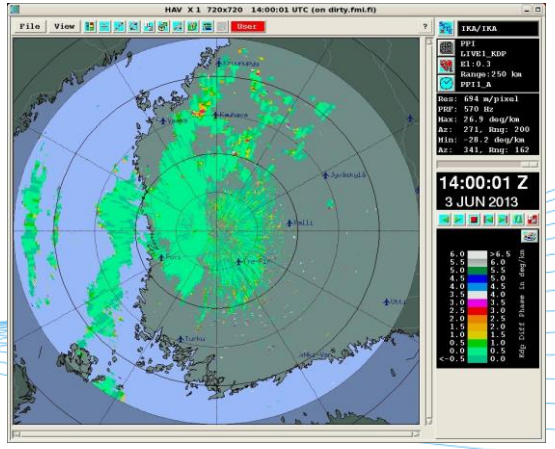


Propagation attenuation correction

- Propagation attenuation based on the PhiDP ratio:
  - raw data improvement
  - in rain attenuation correction is 10 dB
  - an algorithm in operational use

Precipitation intensity

- Precipitation intensity by KDP
  - For Finnish climate $R\,(Kdp) = 21.0 Kdp^{0,720}$ *(Leinonen et. al, 2012.)*
  - Negative issue : requires heavy rain> 5 mm /h
  - Positive issue: KDP solved the radome attenuation problem in heavy rain

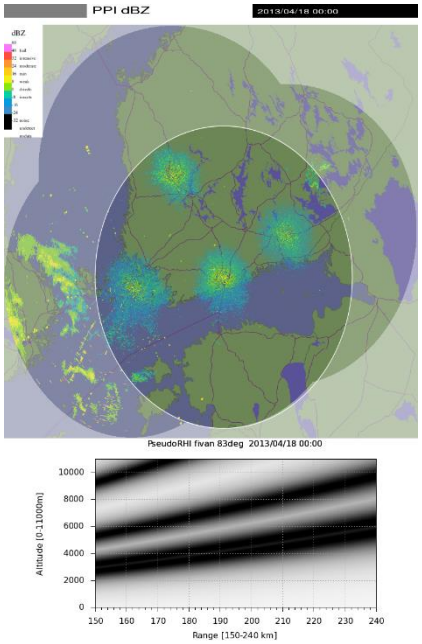


The development based on dual-polarization

What are we working on right now?

- **Birds movements forecasting**

Develop of the radar bird detection product. Based of dual-pol variables.



- **Precipitation intensity**

Polarimetric R(Z) + R(KDP). Combined with the variable Z and KDP ratio-based estimate of the rain as one of the algorithm (*Leinonen et. al.: J. Appl. Meteor. Climatol, 2012.)*

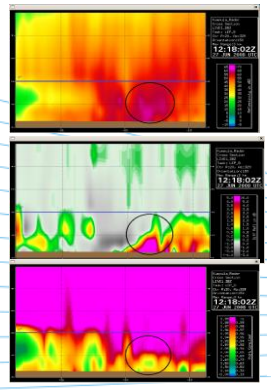
The development based on dual-polarization

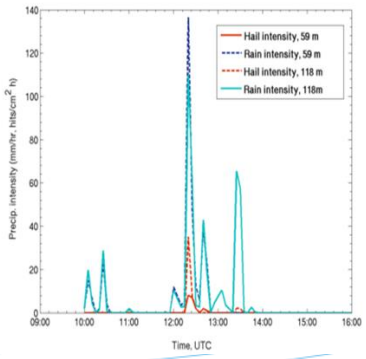
What are we working on right now?

Hail detection

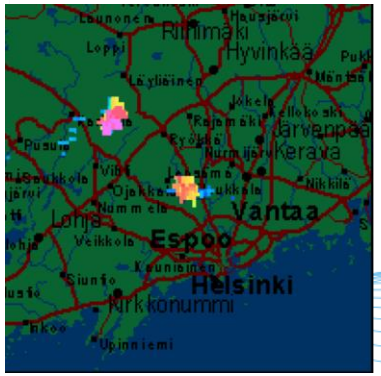
- C-band dual-polarization weather radar hail signatures observed in South Finland.
- Dual-polarization based QPE in presence of hail contamination

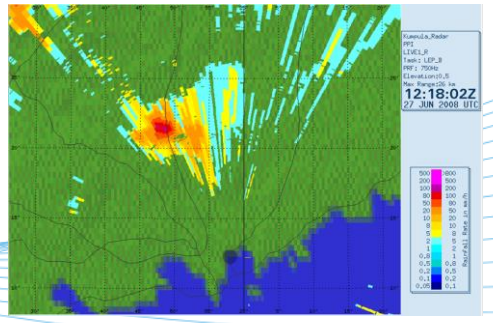
Radar vs. WXT510 vs. POH





R(Kdp)





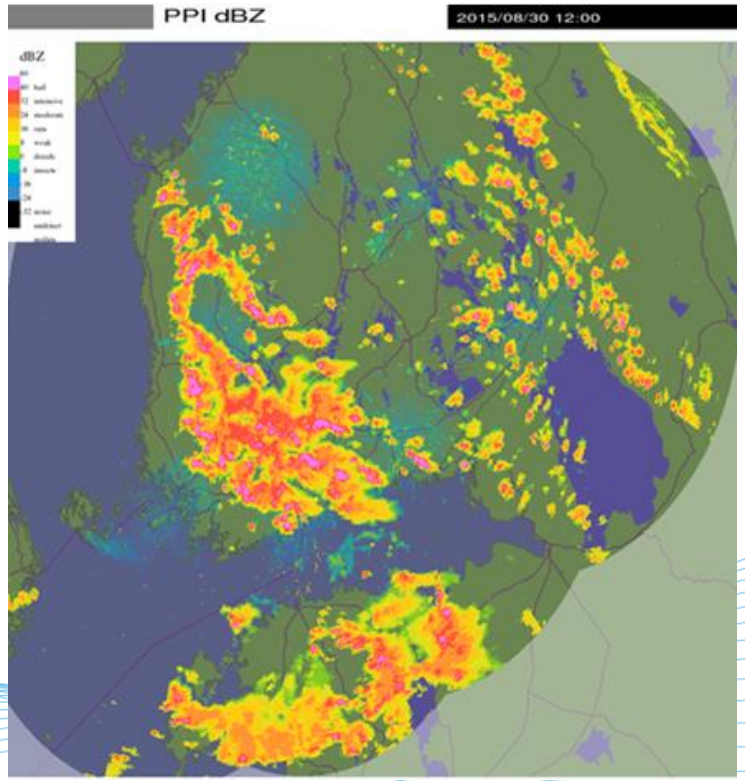
The development based on dual-polarization

What are we working on right now?

- **Heavy rain evaluation of polarization**

The Radar quantitative precipitation estimation(*QPE*) development . The starting point for Brandon Hickman algorithm.

- **Removal of residual ground clutter and echoes by non-meteorological targets**
- **Hail correction algorithm**
- **The optimal rainfall intensity-reflection conversion to Finnish conditions**

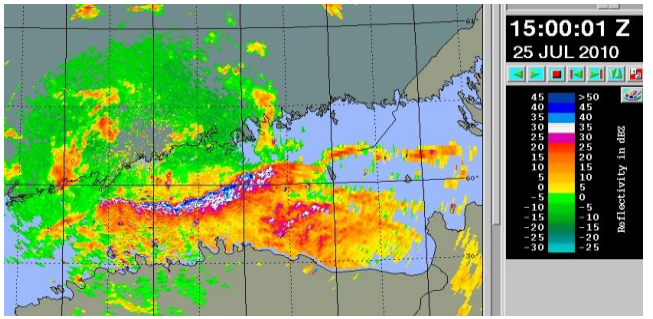


The development based on dual-polarization

What is planned for the near future?

- **SmartMet**

HydroClass- especially hail and graupfel product

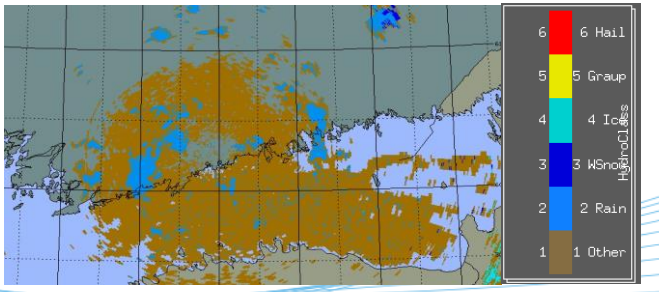


- **AnimBrowser**

HydroClass composite

- **Snowfall intensity**

R(ZE) +R(KDP) - relation



- **Clutter mitigation**
  - Sea clutter

PMI-thresholding affect to all non-meteorological echoes. Finding the right threshold level requires verification.


Thank You

Any questions?

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