ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

An estimation of the dual-polarization C-band radar products in the hail events cases.

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❑ Objectives:

This research will focus on finding new operational capabilities from dual-polarization radars as well as on the operational assessment of dual-polarization radar products in connection with hail events. These products will greatly contribute to an enhanced capability for the identification of severe weather threats, precipitation types, and precipitation accumulation. These products are rather complex and thus their proper interpretation will require deeper investigations and some broader experience. The final aim of this research is to development new ways to extract relevant information for understanding in-cloud processes, especially hail formation and cycling, to development of the new methodology for hail detection and using these new results for dual-polarization radar products into the operational forecast and warning process.

❑ Methods:

In this study, I use a dataset collected in the framework of the Helsinki Testbed project in 2010. From May to October 2010, WXT 510 weather transmitters reported 17 hail hits. This dataset not only provide records of hail occurrences, but also provides exact location and times of those events. I was compared and analyzed the Helsinki Testbed dataset with to Probability-Of- Hail (POH) calculation result from FMI and Reports (photos) published in Media. Through the FMI Radar Data Repository Browsers Tools, which was developed 2015-2017 in FMI (developer Markus Peura), I studied radar observations data from the Vantaa C-band dual-polarization radar in those days, times and places when the hail was detected. The browser is developed in the last 2-3 years. Unfortunately, at the present time in the FMI are no WXT sensors, therefore I use the Testbed data. I conducted studies for the hail events based on such variables as Base reflectivity (Z), Hydrometeor classification (HCL), Differential Reflectivity (ZDR), Correlation Coefficient (RhoHV) and Specific Differential Phase (KDP).

VAISALA WXT510

The WXT510 precipitation sensor is an impact based sensor, which can perform precipitation intensity measurements, and especially discriminate between rain and hail. The measured hail parameters are cumulative amount of hails, current and peak hail intensity and the duration of a hail shower. Hail intensity is given in hit/cm²h. Hail cumulative calculated as amount of hits against collecting surface. Hail duration counting each 10 second increment whenever hailstone detected. Hail intensity one minute running average in 10 second steps.

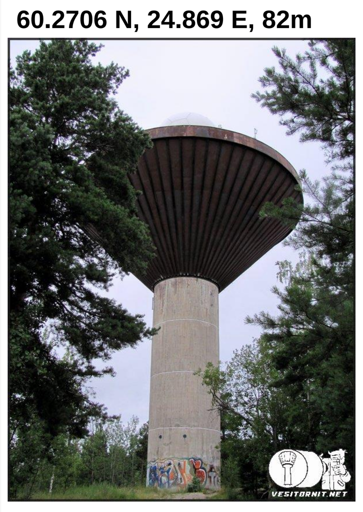
Results of data analysis, HClass:

hail, graupel, snow, wet snow, rain, no met, undetect, no data, ???

No.	Date (2010)	Time (UTC)	Latitude (N)	Longitude (E)	Altitude (m)	WXT510 hits/cm²h	POH %
1.	17-May	14:30:00	60,6612	25,7235	77	6	50
2.	22-May	13:05:00	60,3821	25,6575	61	6	50
3.	22-May	16:25:00	60,1442	25,0328	25	6	10
4.	06-July	16:00:00	60,6891	24,353	134	6	60
5.	15-July	13:55:00	60,2094	25,0504	50	1	30
6.	15-July	14:25:00	60,2909	25,5965	119	1	50
7.	18-Aug	03:00:00	60,9087	24,5442	117	1	20
8.	23-Aug	09:40:00	60,3631	24,8016	59	2	40
9.	25-Aug	03:00:00	60,2094	25,0504	50	1	40
10.	25-Aug	13:50:00	60,1702	25,435	15	1	0
11.	29-Aug	02:50:00	60,3631	24,8016	59	1	10
12.	29-Aug	03:20:00	60,2366	24,958	48	1	10
13.	01-Sep ??	10:09:00	60,2814	24,88	21,5	530,5 ?	10
14.	01-Sep	14:05:00	60,6176	26,0342	37	6	50
15.	11-Sep	17:35:00	60,6612	25,7235	77	6	0
16.	15-Sep	17:20:00	60,6612	25,7235	77	6	20
17.	15-Sep ??	19:15:00	60,0081	24,5078	26	1	10

VANTAA RADAR

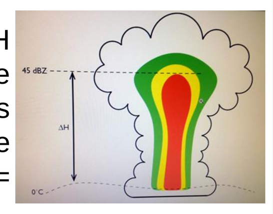
60.2706 N, 24.869 E, 82m

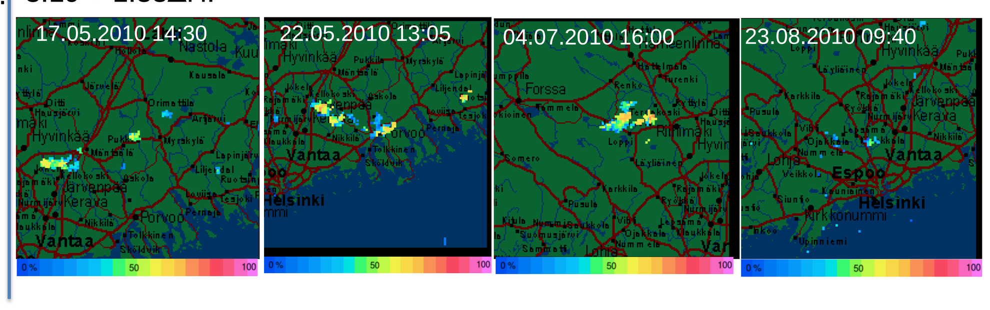


- **Building :** Water tower, 2009;
- **Hardware :** Vaisala WRM200C, Dual-pol, C-Band;
- **Digital IF Receiver and Signal Processor :** Vaisala-Sigmet RVP900;
- **Software :** Vaisala-Sigmet IRIS.

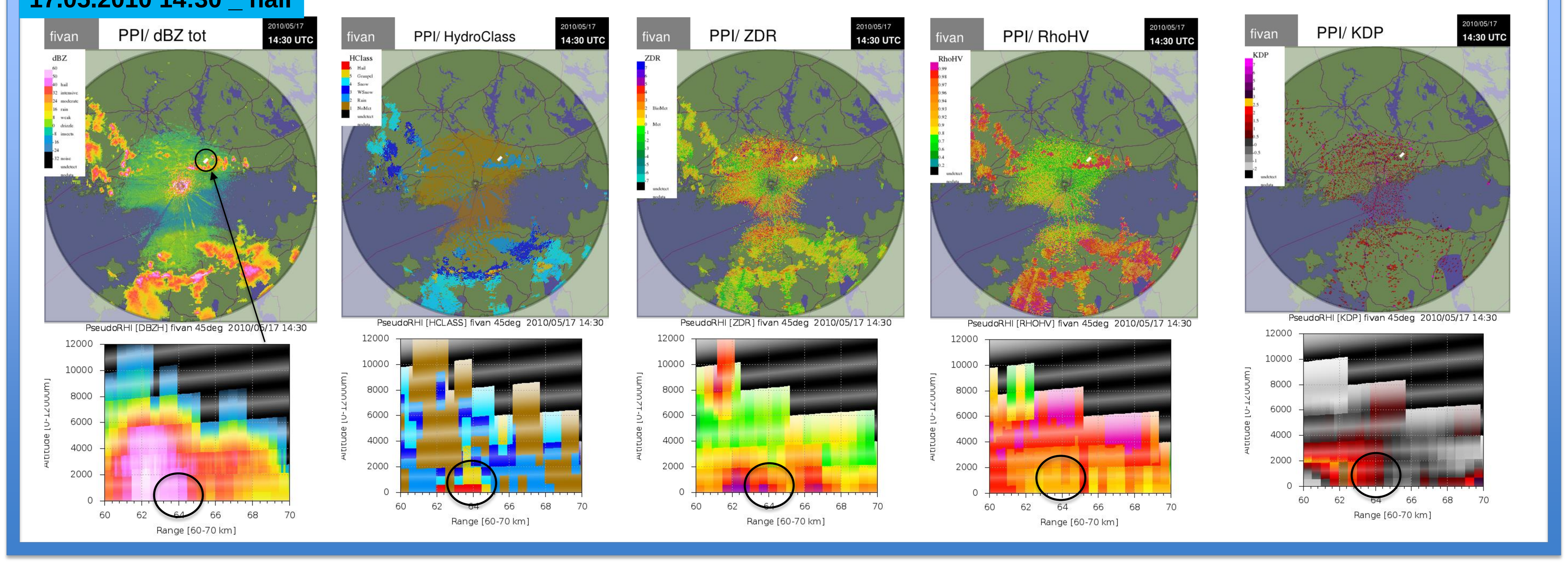
Probability-Of- Hail (POH)

The probability of hail is based on the difference ΔH (km) between the height of the freezing level and the maximum height at which a reflectivity of 45 dBZ is observed (echotop 45 dBZ). (Holleman, 2001).The probability of hail (POH) is calculated as follows: POH = 3.19 + 1.33ΔH.

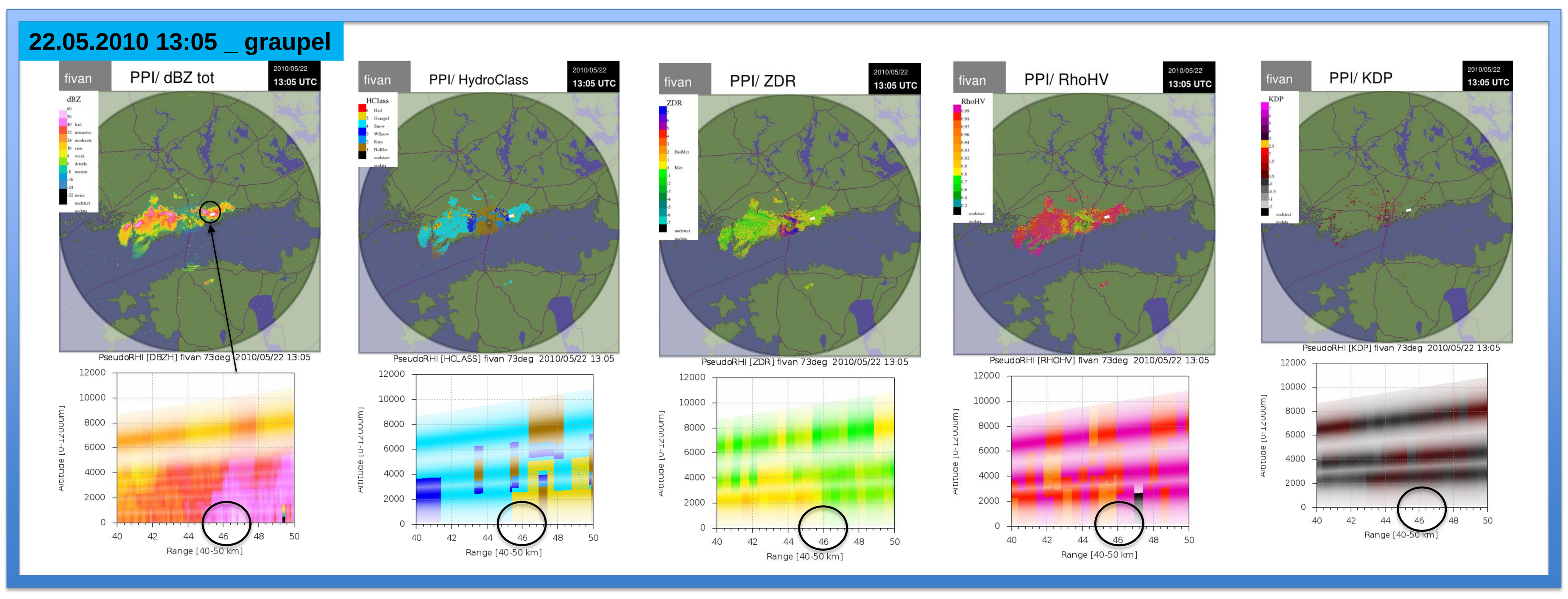




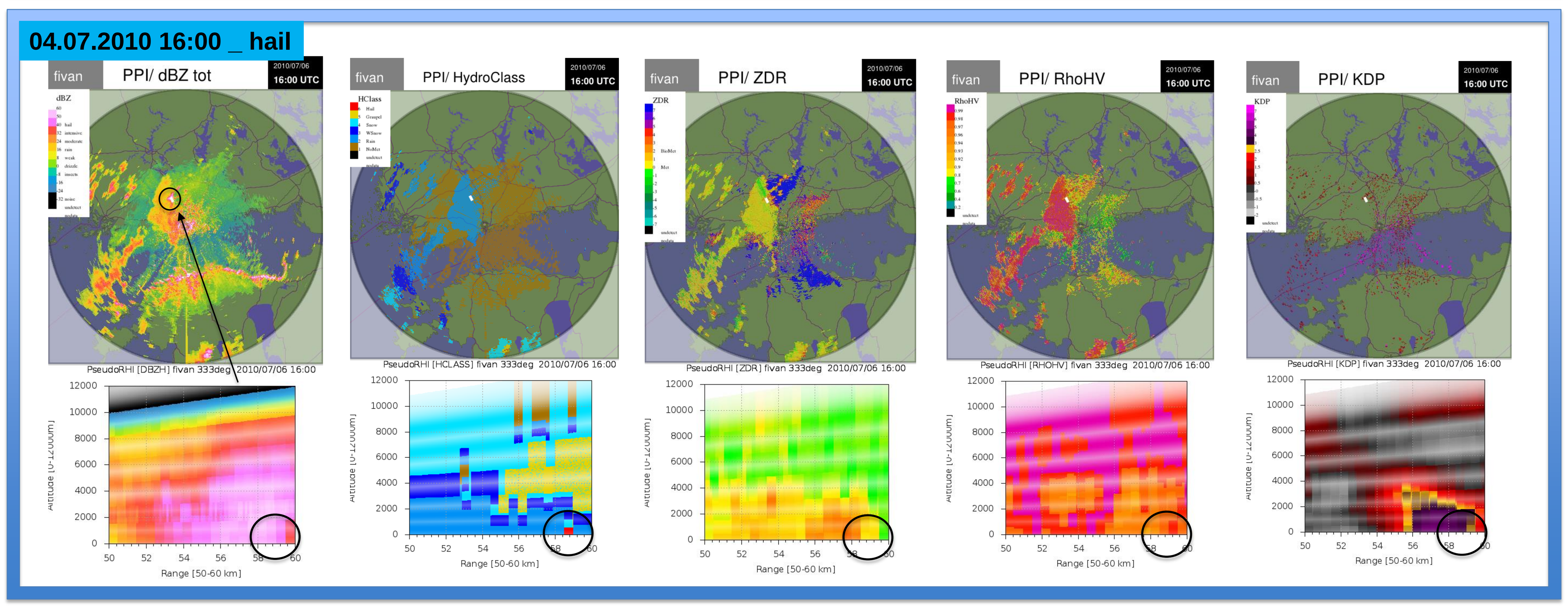
17.05.2010 14:30 _ hail



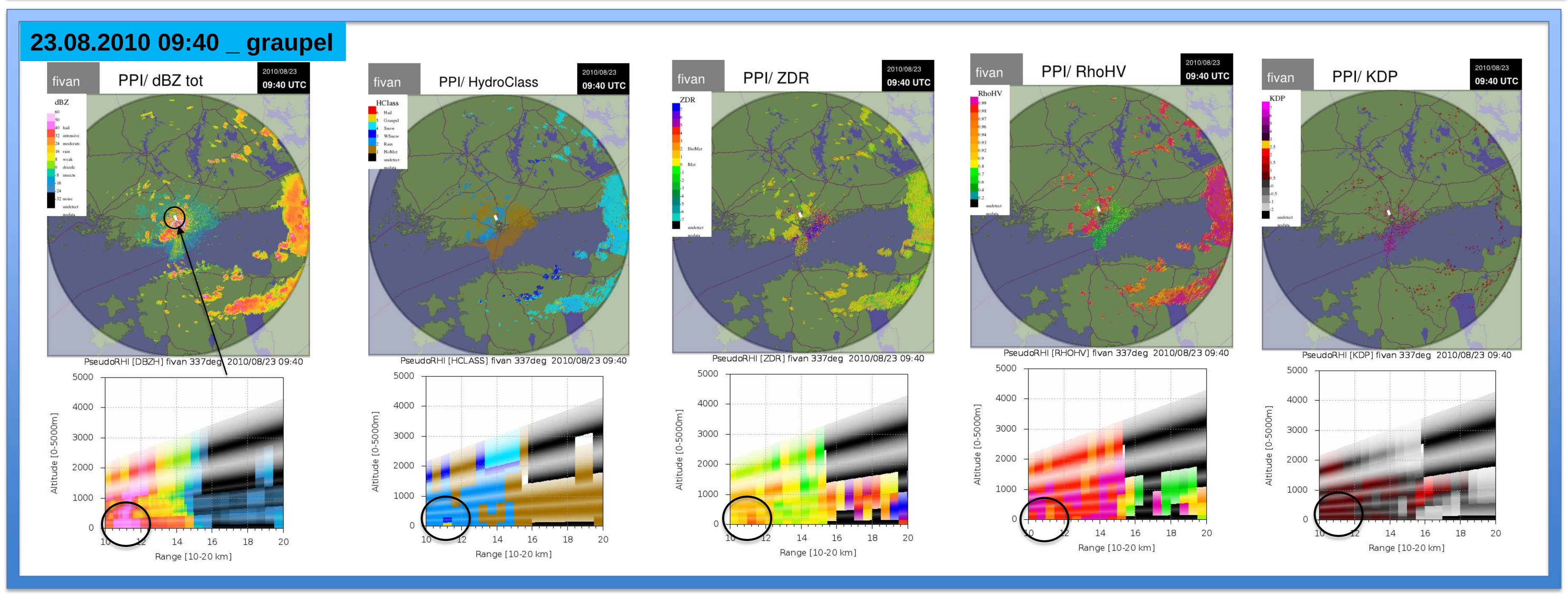
22.05.2010 13:05 _ graupel



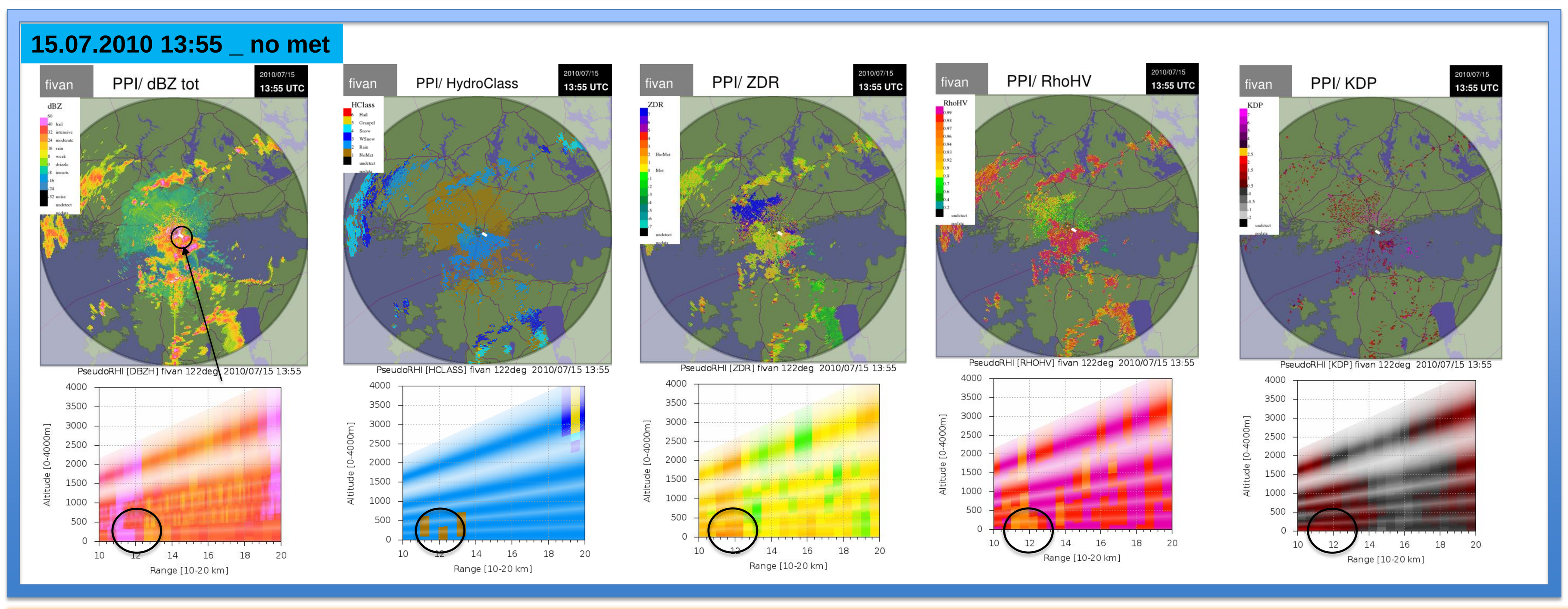
04.07.2010 16:00 _ hail



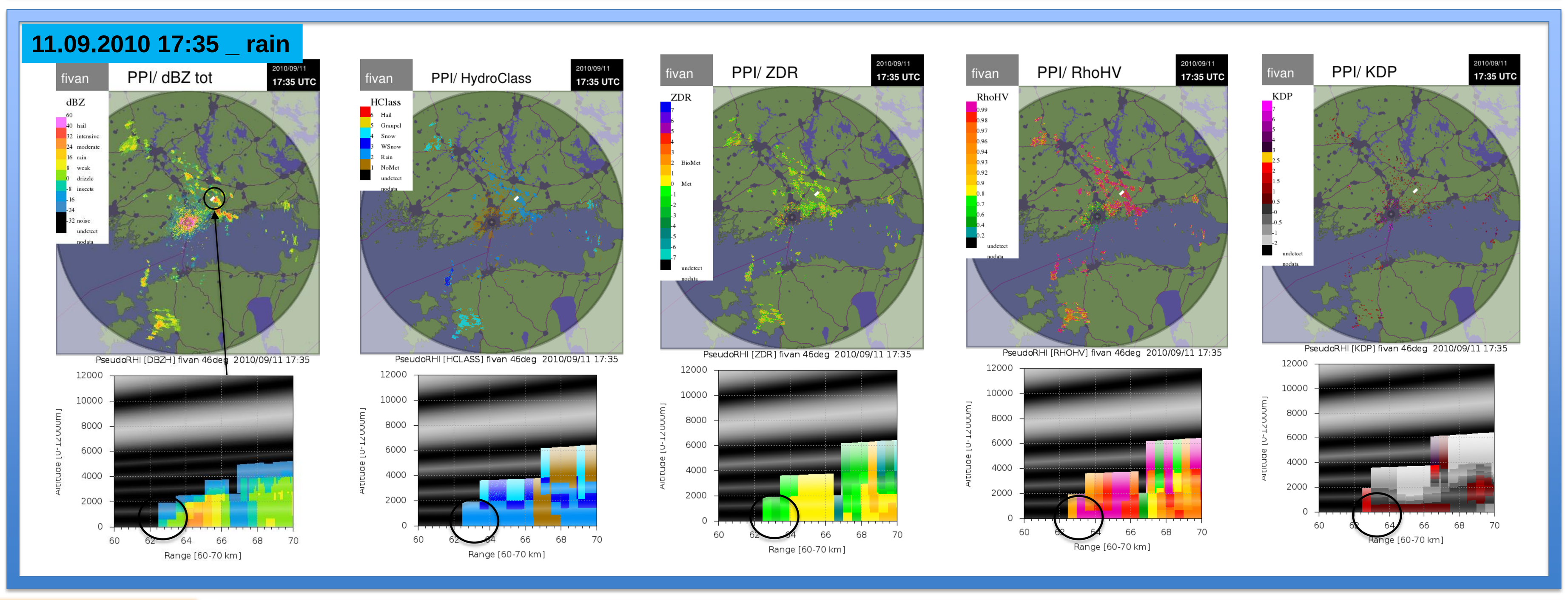
23.08.2010 09:40 _ graupel



15.07.2010 13:55 _ no met



11.09.2010 17:35 _ rain



❑ Results:

The preliminary study shows that different climate regimes in Finland produce different hail signatures due to the amount of milting. Of the 17 cases only 7 were confirmed hail/ graupel events. In most cases, hail/ graupel observed on a small area at size is often from 100 to 1000 m and lasts for several minutes. Therefore, the ground stations cannot record all cases of hail. In most observed hail cases in southern Finland, radar hydrometeor classification was reporting graupel or a mixture of hail and graupel, and base reflectivity Z varied between 50 and 60 dBZ. Dual polarization variables in almost all cases have different values. ZDR varied between 0 and 4 dB, RhoHV varied between 0.92 and 0.94 and KDP varied between 0.5 and 5 deg/km.

Date	Time (UTC)	Latitude (N)	Longitude (E)	Altitude (m)	hits/ cm²h	Distance from VAN radar (km)	Azimut (°)	POH (%)	Z (dBZ)	HCL	ZDR (dB)	RohHV	Kdp (deg/km)
17-May-2010	14:30:00	60.6612	25.7235	77	6	64	45	~ 50	50-60	hail	4 dB	0.92	0.5
22-May-2010	13:05:00	60.3821	25.6575	61	6	46	73	~ 50	50-60	graupel	0-1 dB	0.94	0.5
06-July-2010	16:00:00	60.6891	24.3530	134	6	58	329	~ 60	50-60	hail	0 dB	0.94	3.0
15-July-2010	14:25:00	60.2909	25.5965	119	1	39	88	~ 50	~50	hail	4 dB	0.93	1.0
23-Aug-2010	09:40:00	60.3631	24.8016	59	2	11	337	~ 40	~50	graupel	3 dB	0.94	0.5
25-Aug-2010	03:00:00	60.2094	25.0504	50	1	13	122	~ 40	50-60	hail	3 dB	0.93	5.0
01-Sep-2010	14:05:00	60.6176	26.0342	37	6	75	59	~ 50	50-60	graupel	1 dB	0.93	1.0

Saturday 2010-05-22 at 1.04 P.M. Road 110, Kiikala, Southern Finland.

❑ Conclusion:

The detection and forecasting of hail is a key issue for hail mitigation. The results obtained in the study of 17 cases of hail caused many questions and needs further careful study. Using a Radar Data Repository Browser Tools showed good results in the study of hail cases. This browser created for users and researchers and it is easy to use, but some errors must be considered:

- The geographical precision: it is not verified;
- Hydro Class PseudoRHI product: is not a "finished" product, because it Classification codes are interpolated in the same way as physical Intensities;
- The Vantaa Radar settings were not completely effective at the beginning of the use of the dual-pol radar.

In the future, research will be continued for the remaining more than 100 measured cases of hail.