Geophysical surveys using UAV’s

Radai Oy

radai

GEOPHYSICAL SURVEYS AND REMOTE SENSING WITH UAV'S

Radai Oy

- Established in 2013
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Case study 1
UAV magnetic surveys

Radai magnetic UAV system

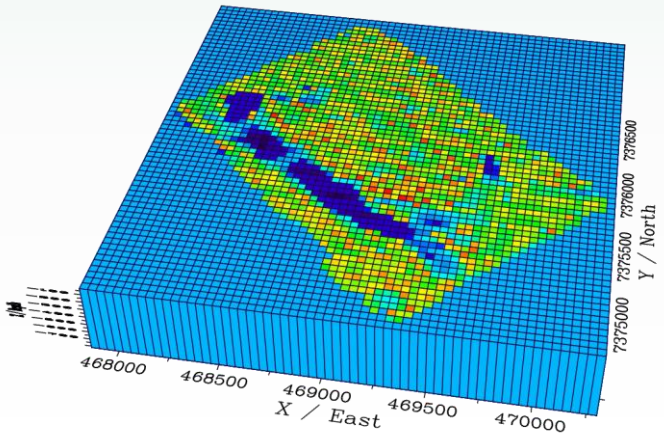
(Photos by M. Pirttijärvi)

Radai magnetic UAV system

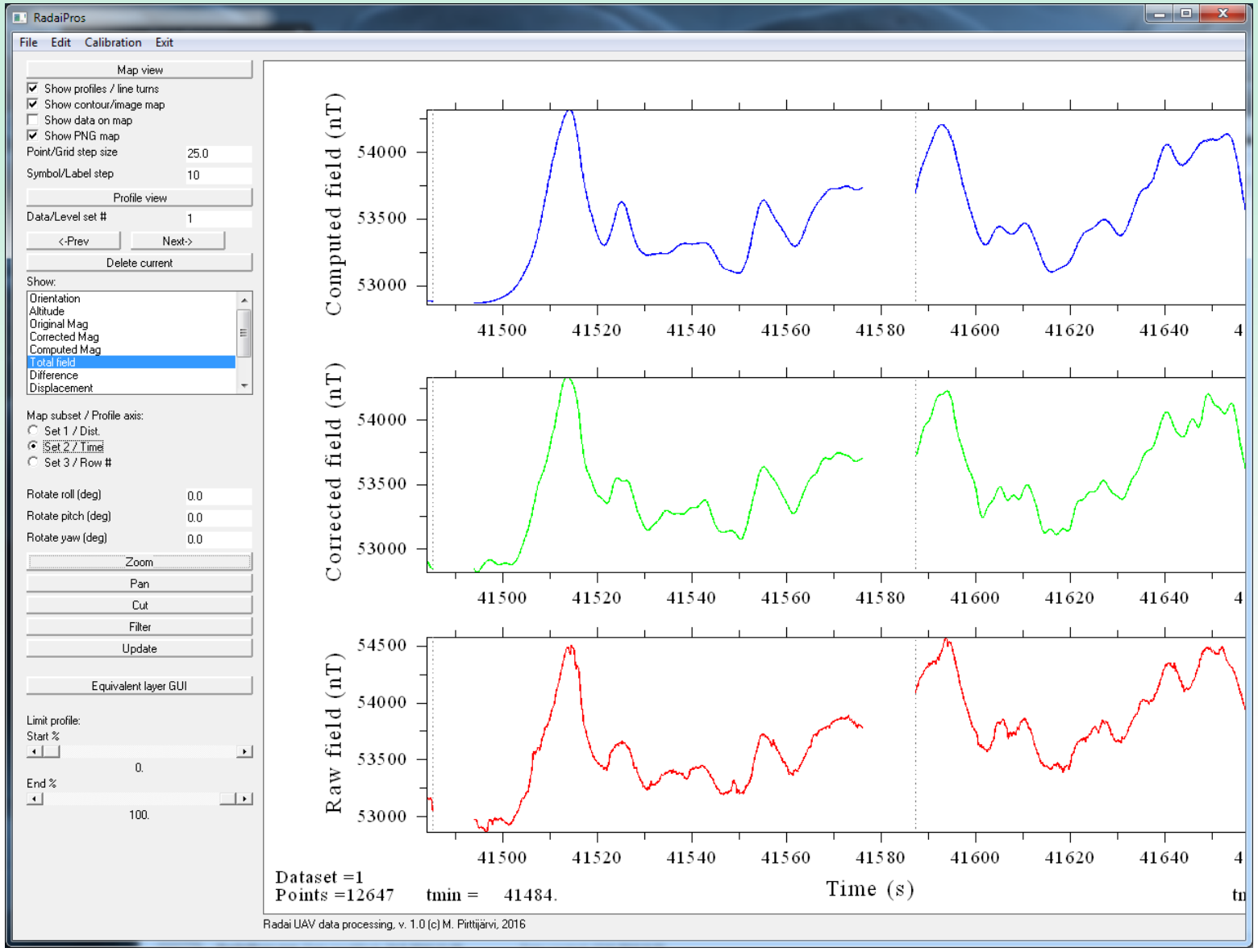
- Custom-made UAV with 780 W electric engine
- Wingspan 2.12 m, mass 3.5kg
- Autopilot follows waypoints designed for the survey
- Real-time telemetry link & control station with a PC surveillance software
- 3-component flux-gate magnetometer
  - ±1 nT resolution, 1 Hz sampling (1-3 samples/m)
- Base station (proton) magnetometer

Data processing

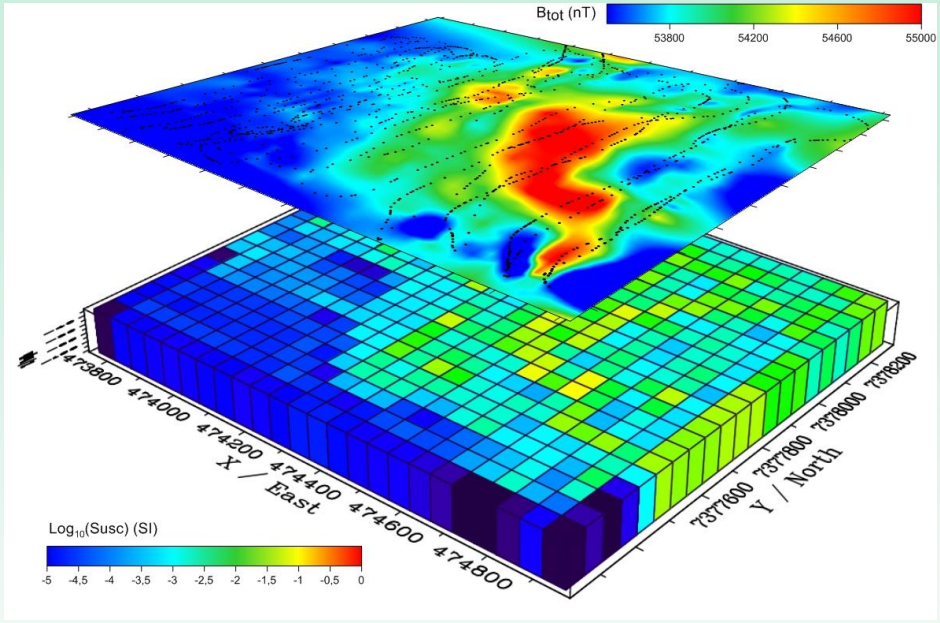
- Visualization as maps and profiles
- Data processing, flux-gate calibration, orientation correction
- Base station and heading correction
- Equivalent layer modelling (ELM)
  - Computation on even grid at constant altitude

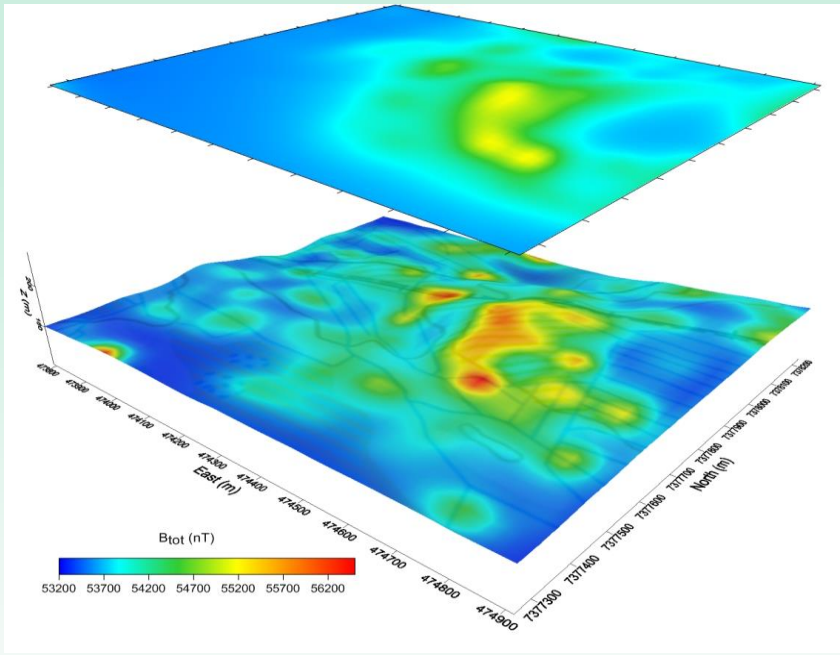


Data processing



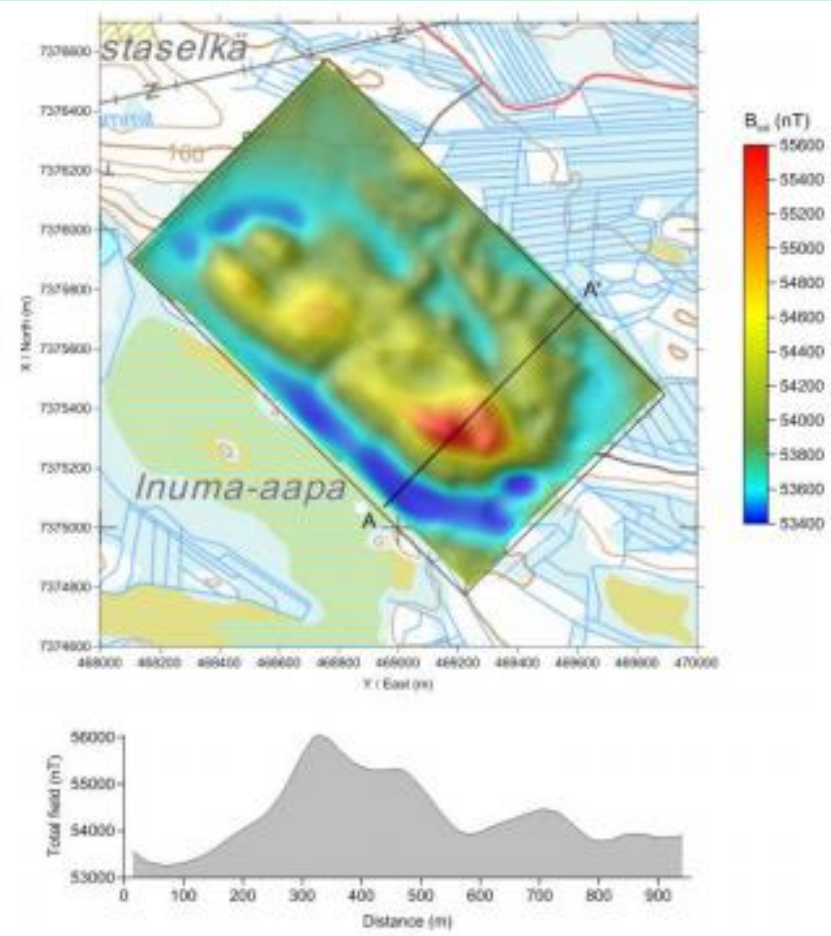
Data processing



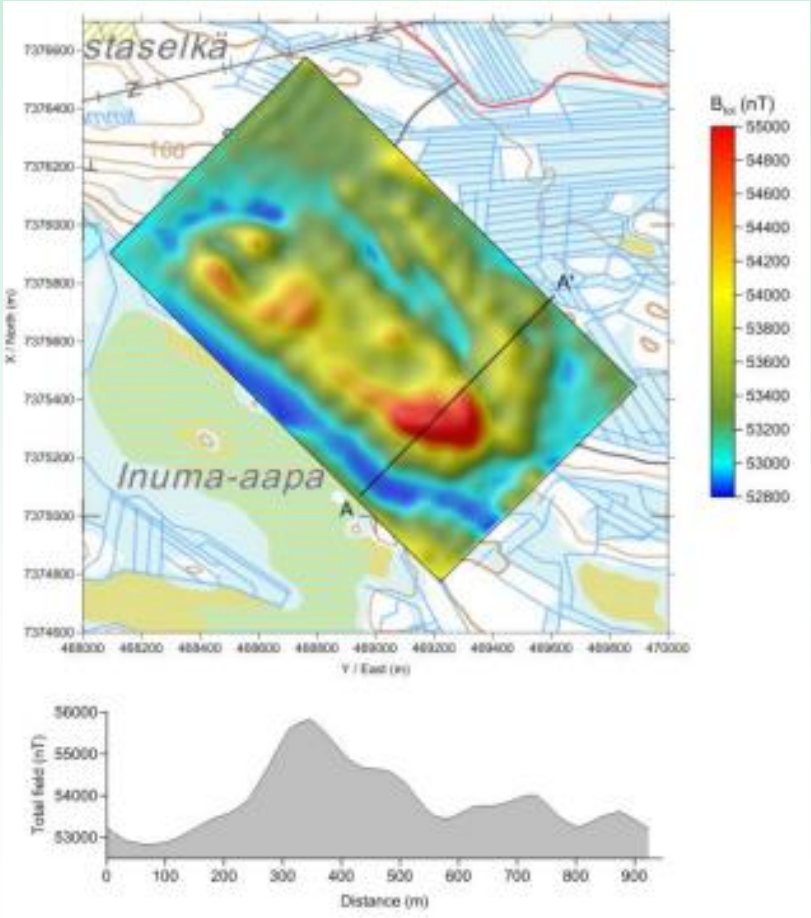


Survey results comparision

GTK's ground data upward-continued by 30 m



Radai's UAV data computed at the height of 30 m using ELM



Conclusions

- UAV based magnetic surveying is feasible
- Finer line spacing gives an advantage
  - More detailed than GTK airborne magnetic data
  - Comparable to ground data at the same height level
- Pros of UAV:
  - Affordable & cost-effective
  - Fast, safe & versatile
- Cons of UAV:
  - Targeted coverage, requires specific data analysis

Case study 2
UAV gamma radiation surveys

Radai gamma radiation system

- Custom-made quadcopter
- Payload 4kg, flight time 40 min
- Autopilot follows waypoints designed for the survey
- Real-time telemetry link & control station with a PC surveillance software
- Dual Bismuth Germanate (BGO) detector 106 cm3
  - High sensitivity performance
  - Energy response from 25 keV – 3000keV
  - Weight 3.5 kg

Radai gammaradiation UAV system

UAV parameters	Value
Operation mode	Quad-copter
Electric engine	4 x W
Axis span	1.0 m
Propellers	50 cm
Mass	8 kg (10 kg w batteries)
Payload	< 5 kg
Flight speed	0-25 m/s
Flight time	up to 40 m

Fig. 2.1. Radai's Terrain Scout 3.2 UAV.

Gamma radiation survey results

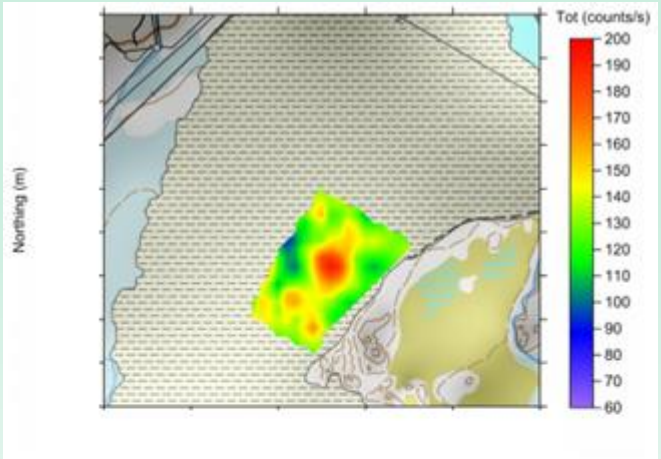


Figure 6.3. Image map of the total intensity at 5 m flight altitude.

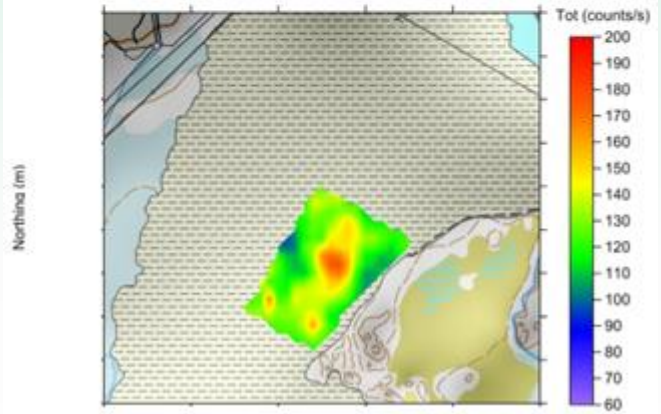


Figure 6.4. Image map of the total intensity at 10 m flight altitude.

Gamma radiation survey
Total intensity

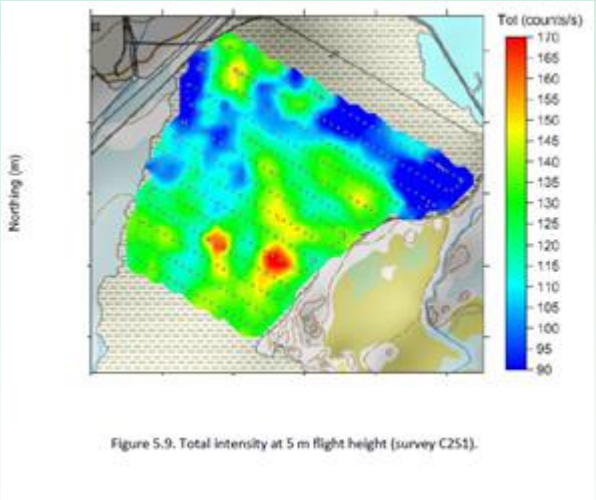


Figure 5.9. Total intensity at 5 m flight height (survey C251).

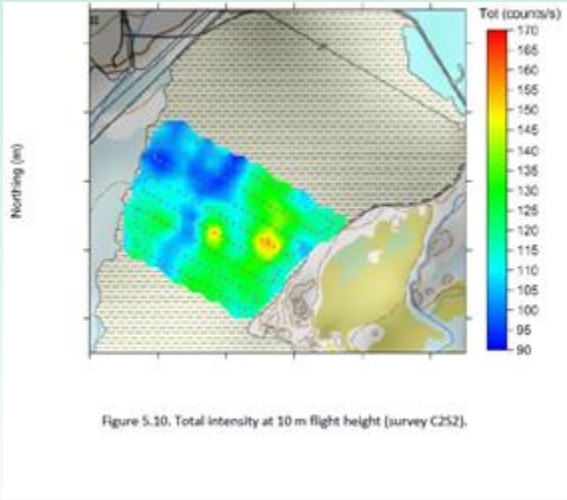


Figure 5.10. Total intensity at 10 m flight height (survey C252).

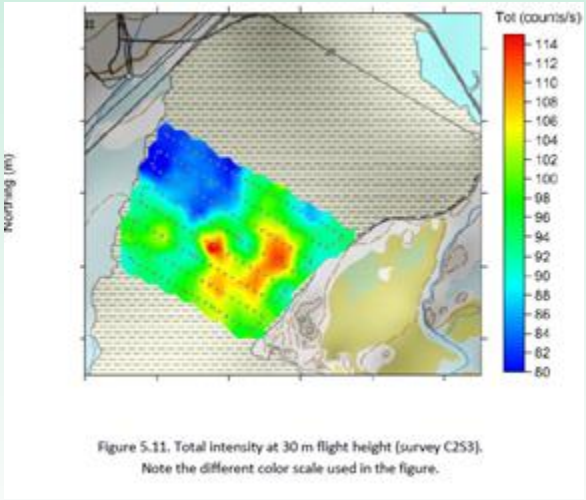


Figure 5.11. Total intensity at 30 m flight height (survey C253).
Note the different color scale used in the figure.

Conclusion

- Survey at 30m altitude corresponds quite well to result measured at lower height levels.
- Radiometric measurements with D320A spectrometer provides useful information from 30m altitude
- Larger sensor would provide more reliable radiometric results

Case study 3
UAV gas surveys

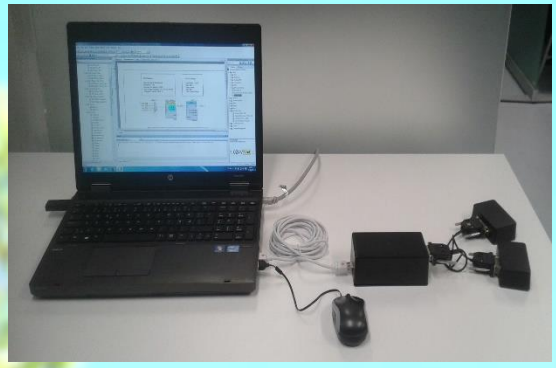
Radai gas survey system

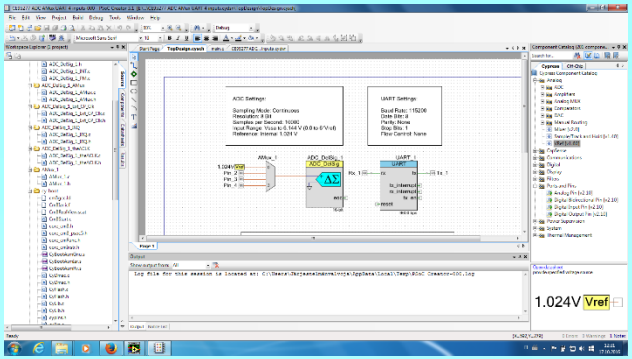
- Custom made gas sensor platform module prototype.
- Multiple sensor platform.
- Autonomous UAV operations.
- UAV can follow terrain model – based on Lidar.
- Possible to integrate other survey devices to UAV.
- Data prosessing system under development

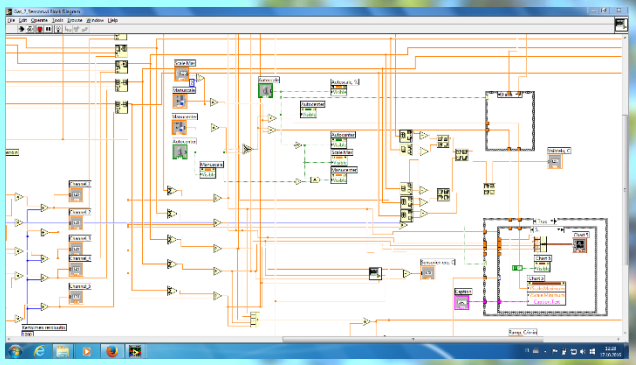
Gas measuring system

System development tools:

- Measurement electronics with sensor data logger and communication with software platform.
- Software platform for schematic drawing, configuration and programming.
- Analysis tools for data processing, modeling and result visualizing.





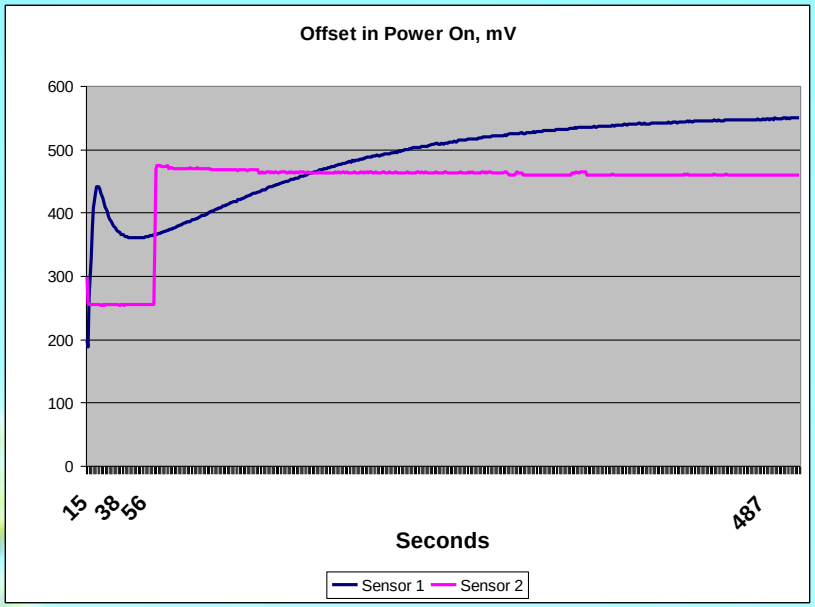


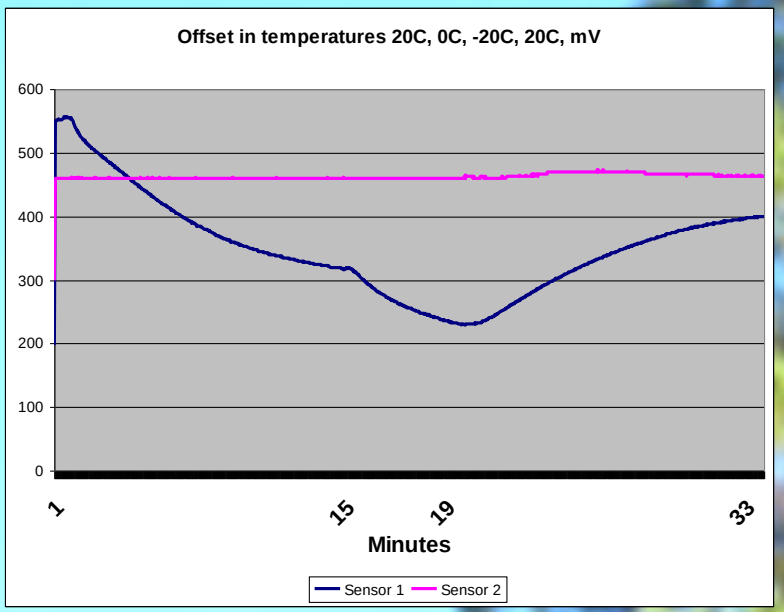
Gas measuring system

Sensor type comparison:

Methane sensors features

	Sensor 1	Sensor 2	Sensor 3	Sensor 4
Range of volume	500 to 10 000 ppm	500 to 10 000 ppm	5% to 100%	0% to 5%
Resolution of volume			0,10 %	0,01 %
Linearity of reading	-	-	20 %	20 %
Accuracy of reading			20 %	20 %
Warm up time	~ 3min	~ 3min	1min @ 98%	1min @ 98%
Response time	~ 2min	~ 1min	30s @ 90% volume	30s @ 90% volume
Long term zero drift			0,1% volume per month	0,1% volume per month
Operation conditions	0C-40C, 30-95% RH	0C-40C, 30-95% RH	-20C-50C, 0-95% RH	-20C-50C, 0-95% RH
Power	~300mW	~300mW	75-80mA	75-80mA





Gas measuring system

Measuring System Analysis, MSA:

- Every measurement systems have variation. With MSA we ensure the suitability of the system for the application.

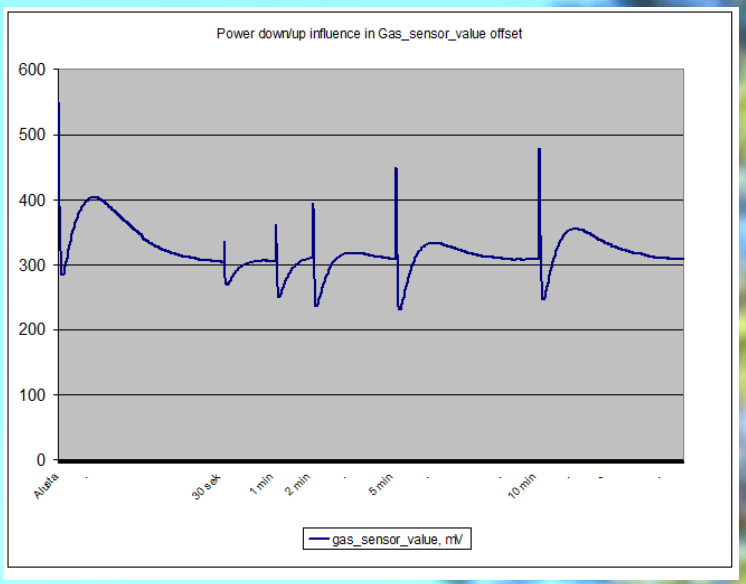
In case Gas Measurement MSA we select factors:

- Sensor type; repeatability, sensitivity, response time
- Gas content; offset, scale, linearity
- Temperature; temperature compensation
- Measuring method; on foot, UAV
- Measurement condition; laboratory, outdoor

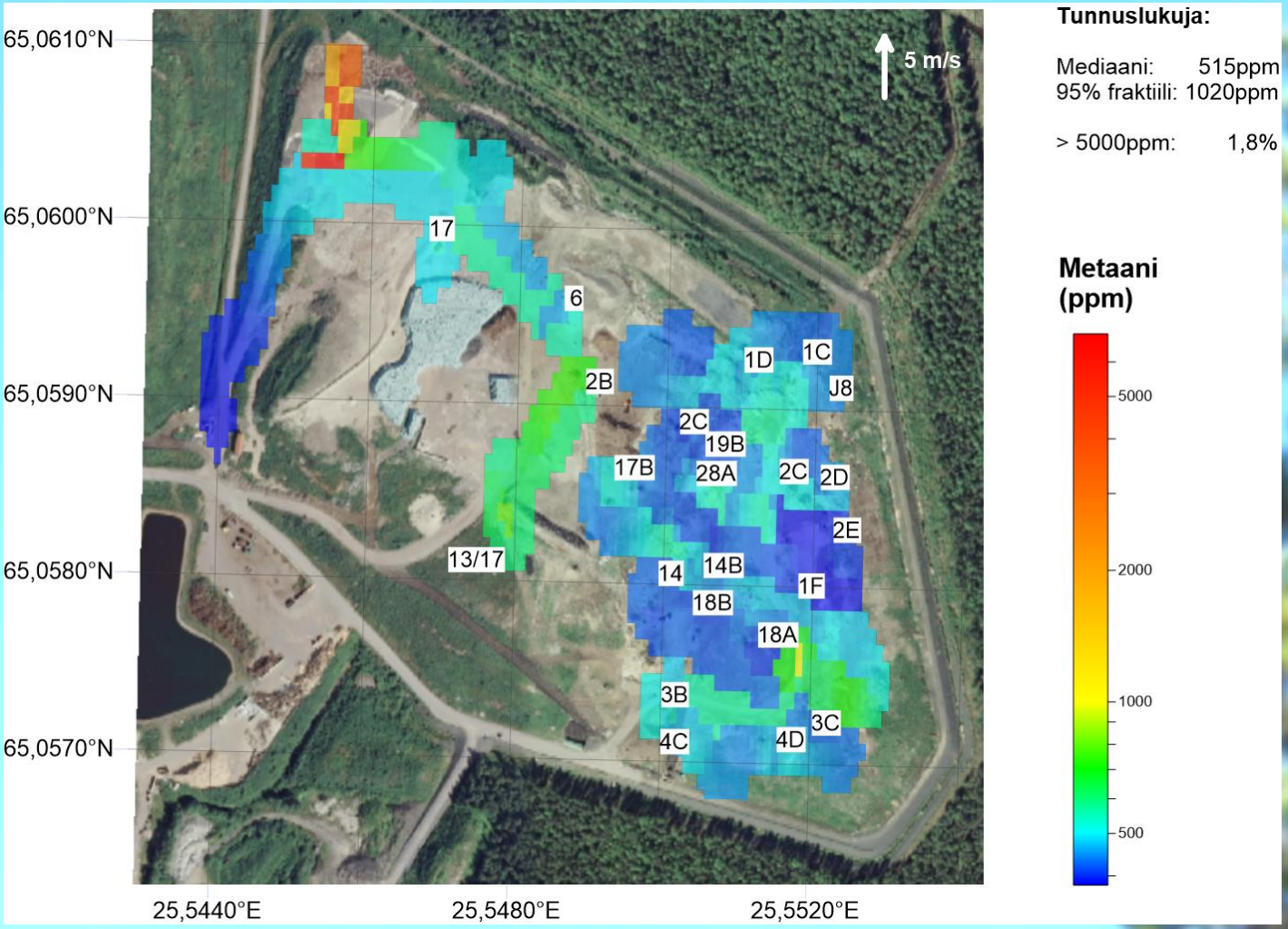
Gas measuring system

Gas Measurement MSA tools:

- Test chamber
- Reference gases
- Sensors and measuring device
- Data analysis software; LabVIEW, RadaiLab, Minitab etc.



Gas survey test in Rusko landfill at Oulu




Thank you !