Enhanced Data Processing for SGL AIRGrav data

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- Introduction to Sander Geophysics
- AIRGrav Quality Control
- Turner Valley Oil Exploration Example
- Enhanced AirGrav Results
- Latest Developments in AirGrav

Sander Geophysics

- founded in 1956 - currently 160 employees, 15 aircraft
- head office at Ottawa International Airport, Canada
- world-wide operations – fixed-wing and helicopter
- high resolution airborne geophysics – petroleum, mineral, environmental
    - magnetic total field
    - gamma ray spectrometer
    - gravimeter
    - LIDAR Laser Scanner
    - EM

SGL Aircraft

15 Survey Aircraft

8 Cessna 208B Grand Caravans
3 Diamond DA42 Twinstars
2 Britten-Norman Islanders
1 Cessna 404 Titan
1 Eurocopter AS350-B3 helicopter


Britten-Norman Islanders


Cessna Grand Caravan


Diamond Twinstar


Cessna 404 Titan


Eurocopter

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AIRGrav Airborne Inertially Referenced Gravity

- AIRGrav was designed and built by Sander Geophysics
- 10 years of R&D followed by 10 years of survey flying
- 12 Gravimeters built at SGL
- Specifically for airborne gravity surveying
- Based on inertial navigation system technology

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AIRGrav System

- Three axis (x y z) gyro stabilized platform
- Three (x y z) accelerometers
- Dual frequency GPS receivers
- Gravity = inertial accelerations – GPS accelerations

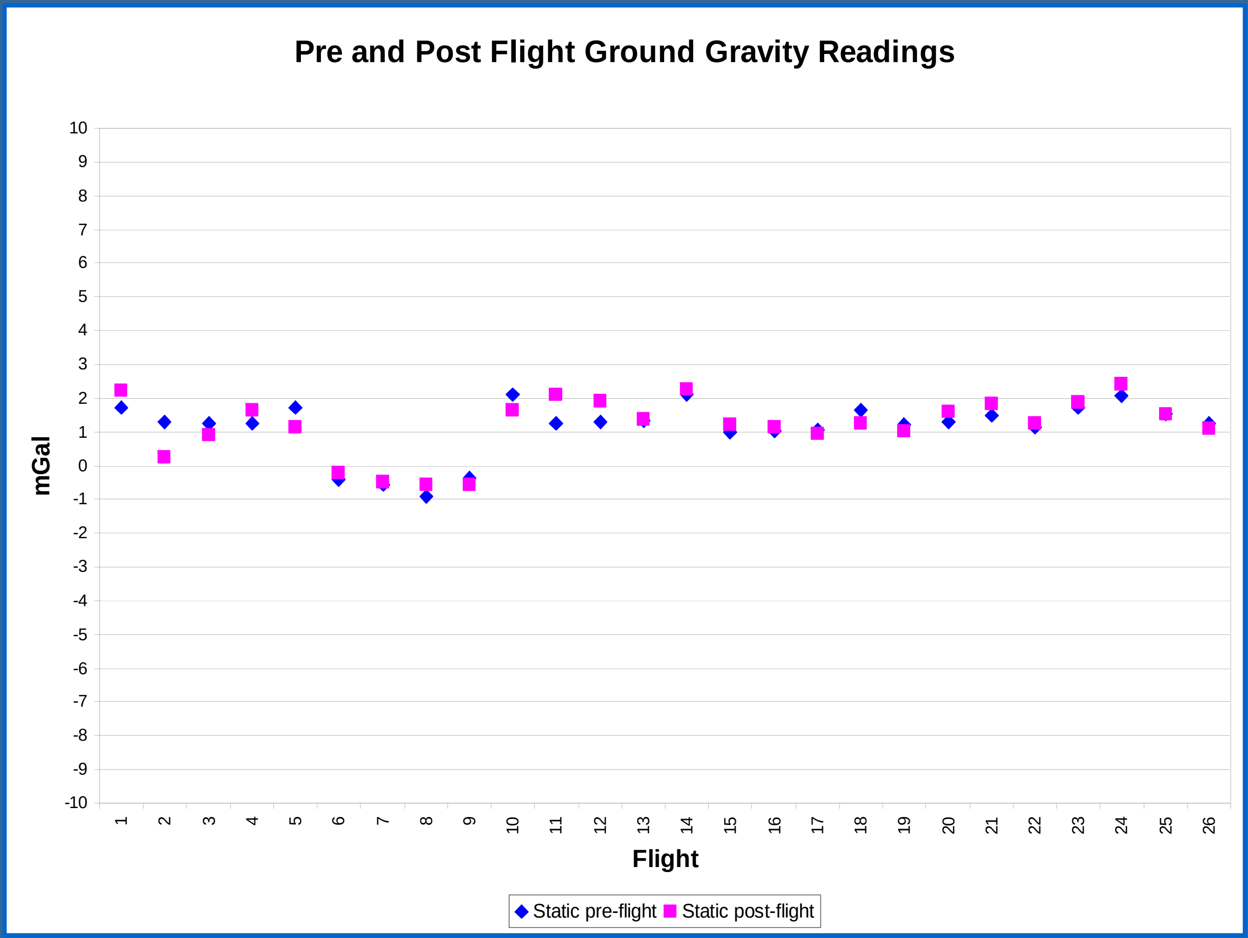
AIRGrav Operations

- < 100 kg - can be used in any of SGL's aircraft
- Height above ground level - 100 to 500 m
- Drape or constant altitude surveys – AIRGrav unaffected by horizontal accelerations, and turbulence
- Line spacing 50 m to three kilometers
- Operate under normal day time conditions

Quality Control

- Static Tests
- Test Lines
- Intersection Statistics
- Odd versus Even Grids
- Comparison to Ground Gravity

Static Tests and Test Lines



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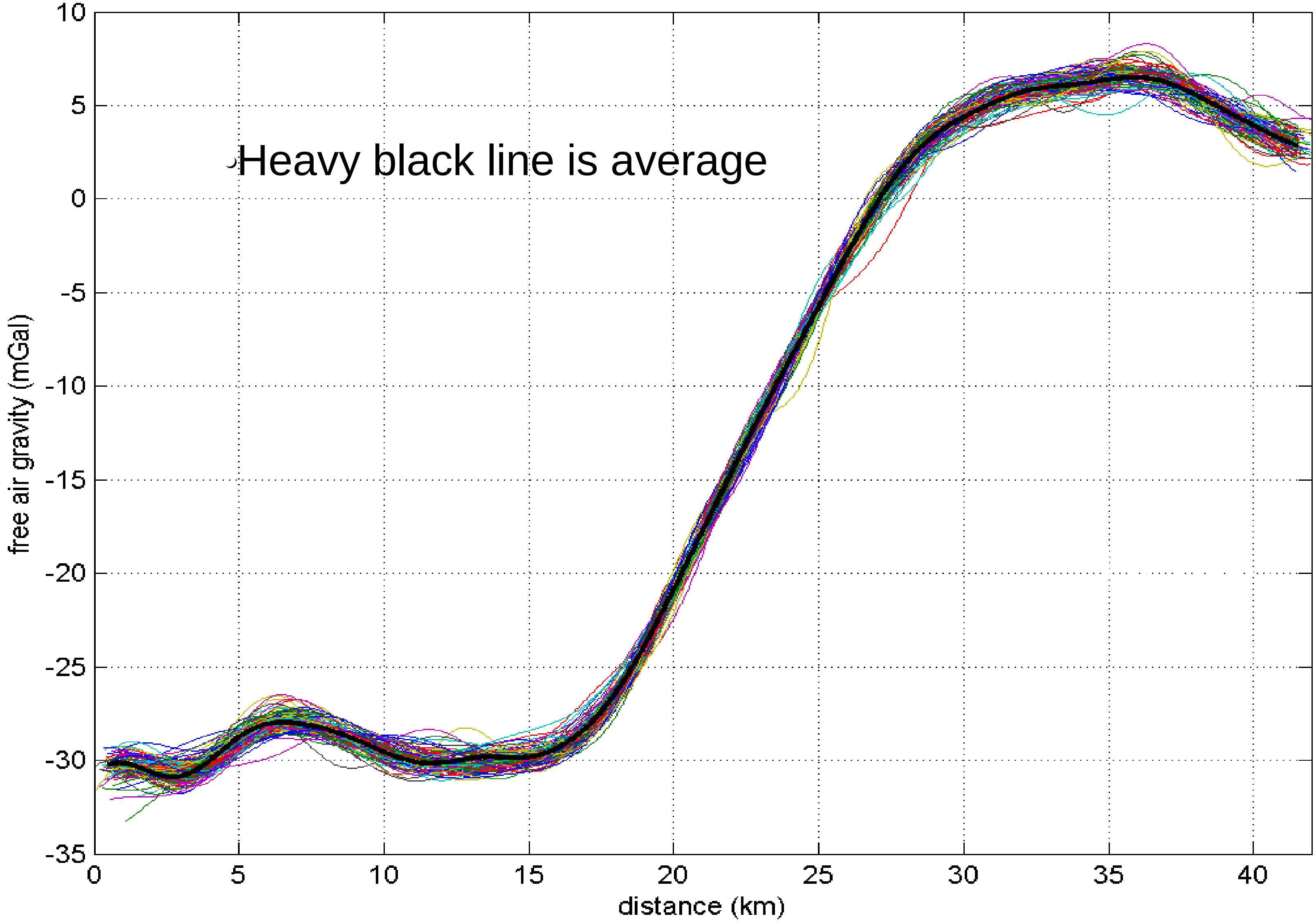
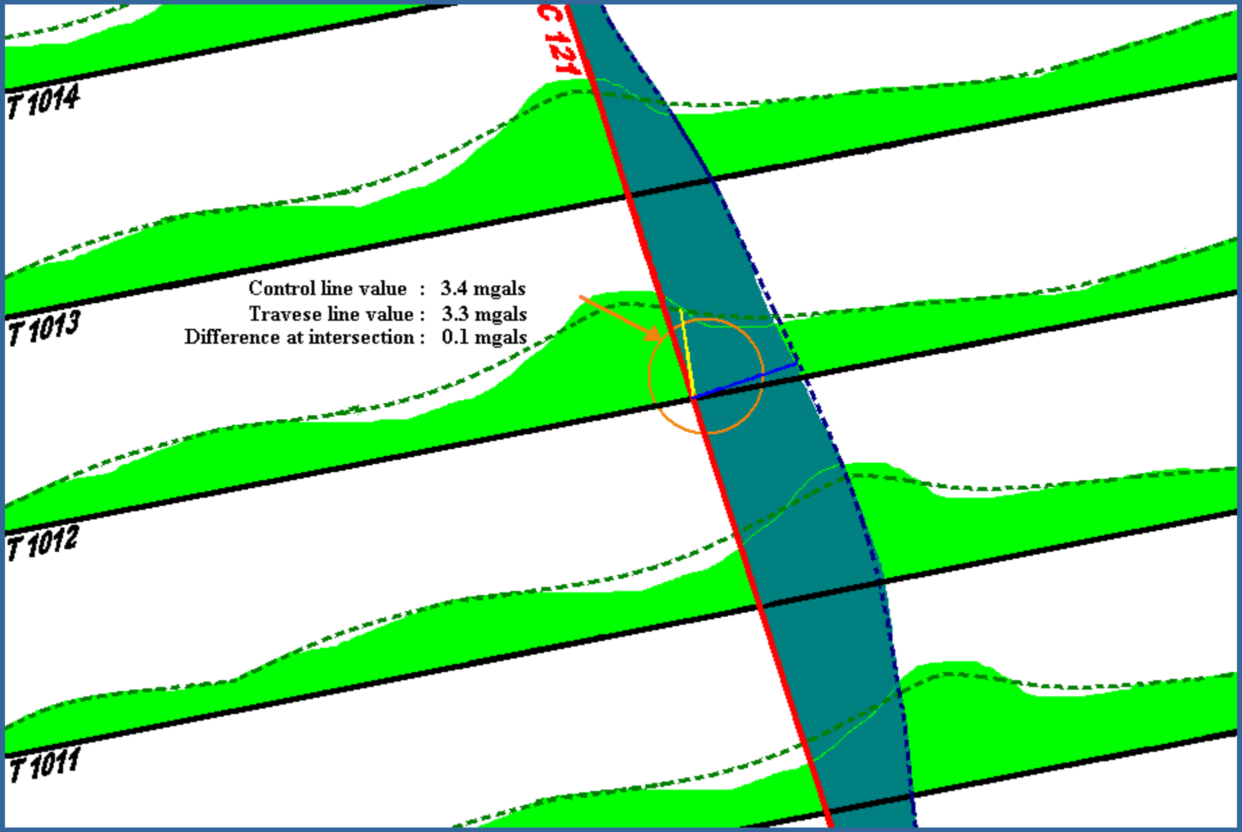
Repeat line profile



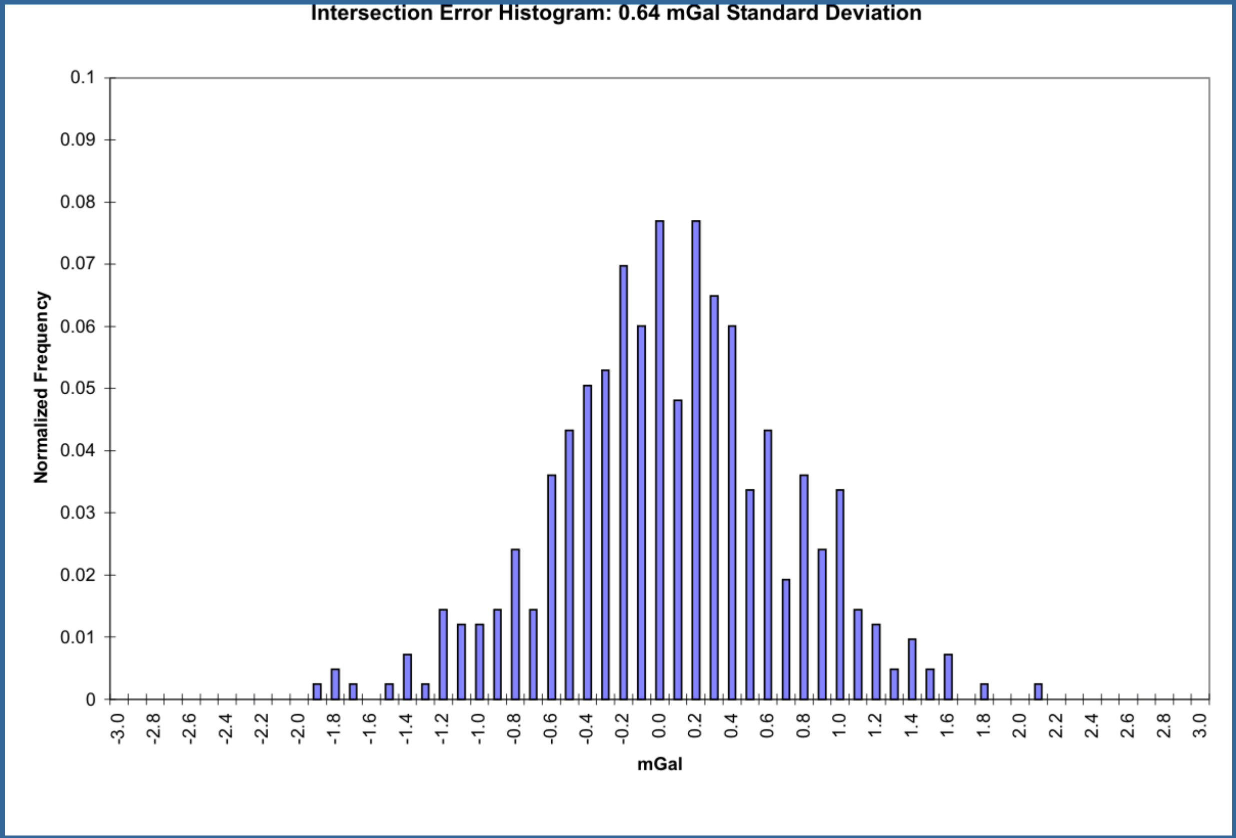
Intersection Errors



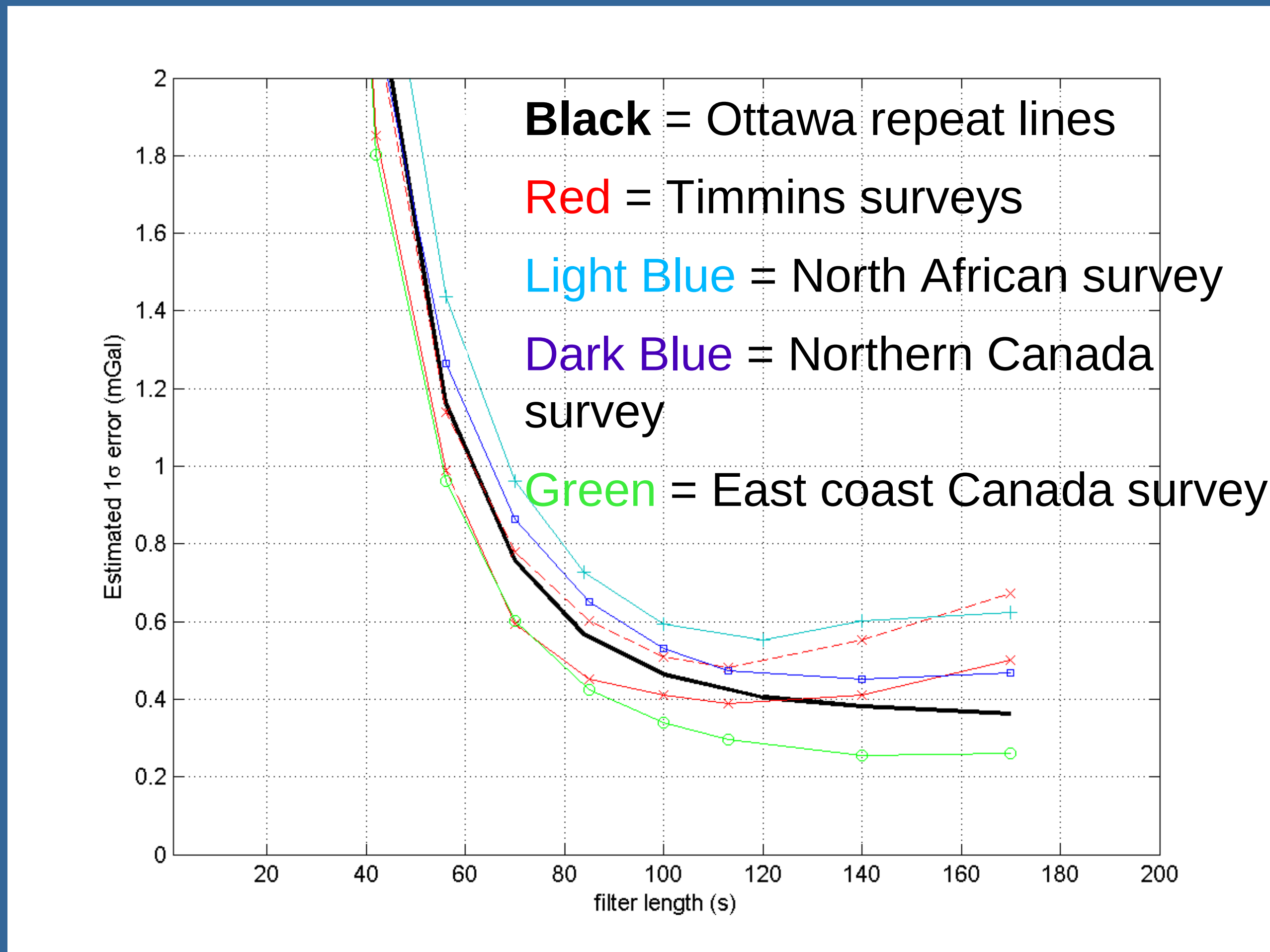
Line filtering will affect anomalies differently depending on line orientation.

Intersection Difference Plot

Line noise level – 0.45 mGal with an 42 sec (2 km) half wave length filter



Intersections ↔ Repeat Lines



Intersection statistics are independent of line spacing – good for comparing different surveys

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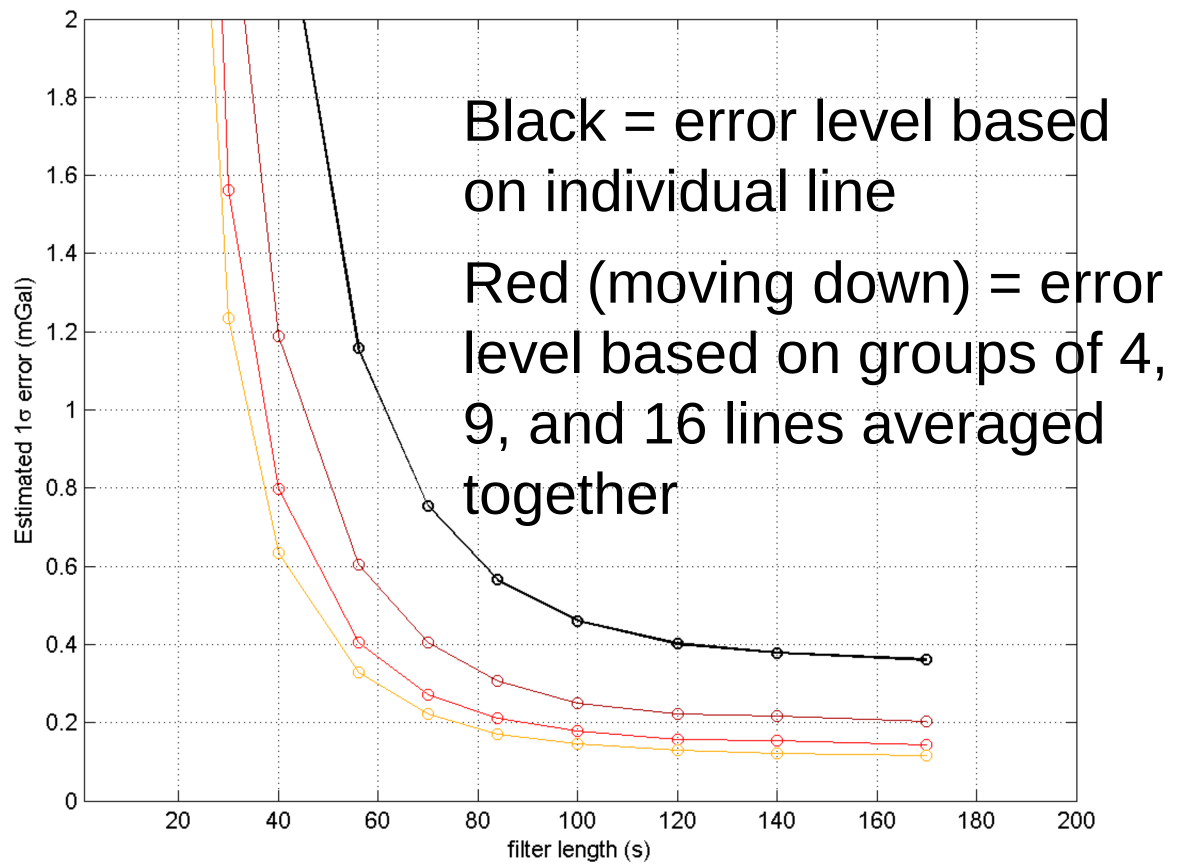
Benefit of close line spacing



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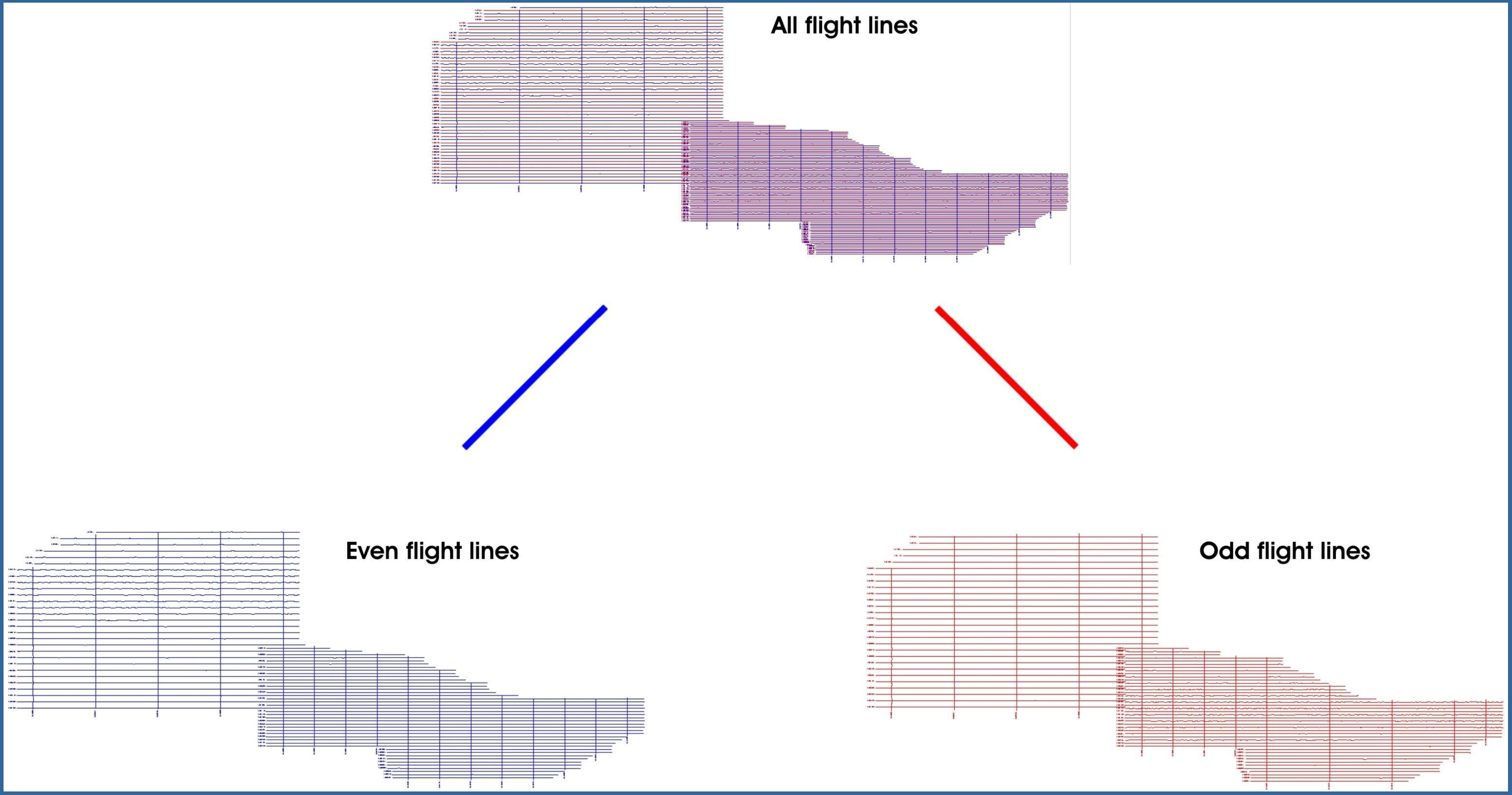
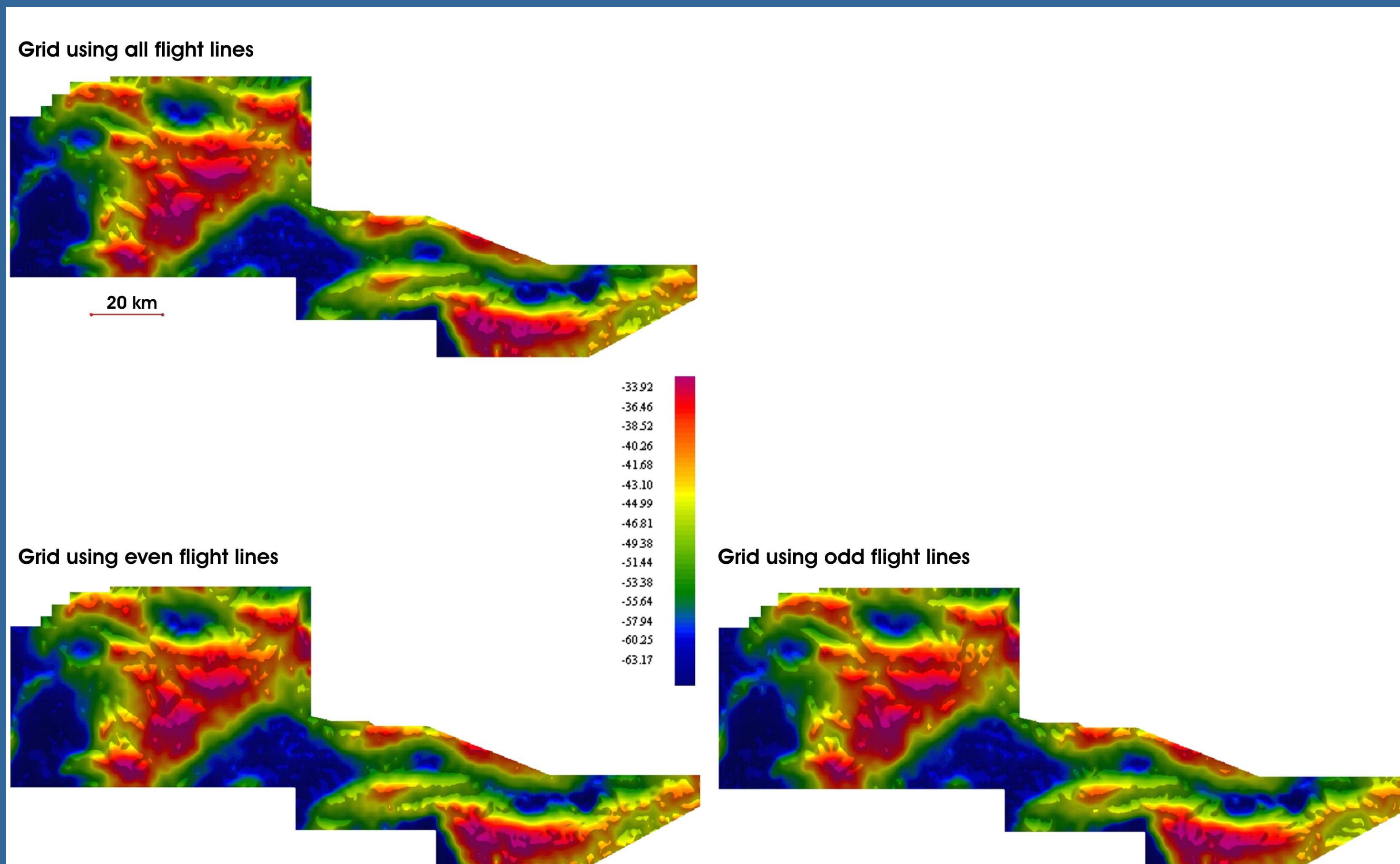
"Stacking" reduces random noise

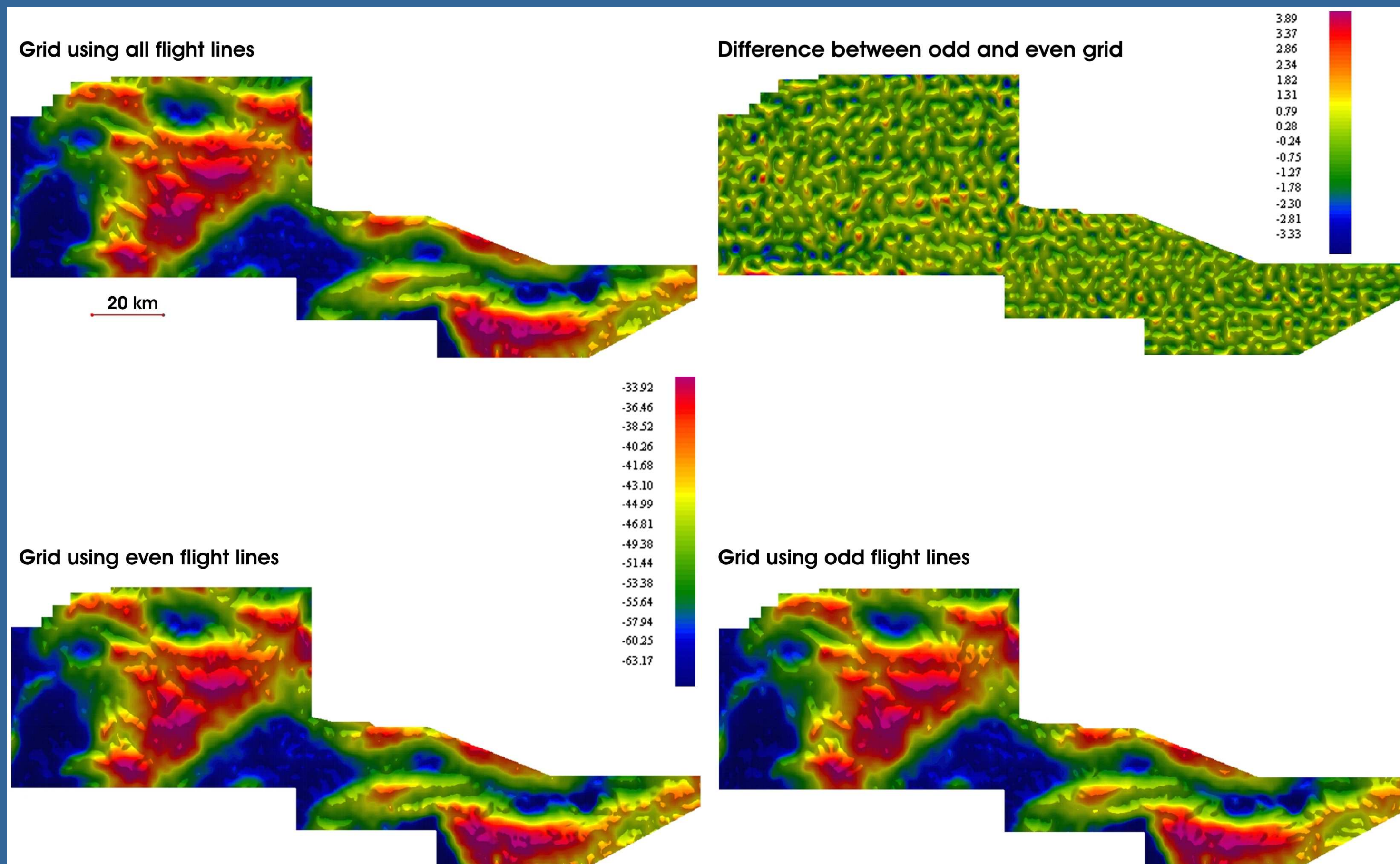
Even-Odd Grid Comparison



Even-Odd Grid Comparison



Even-Odd Grid Comparison



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Noise estimate of 0.15 mGal

Even-Odd Grid Comparison

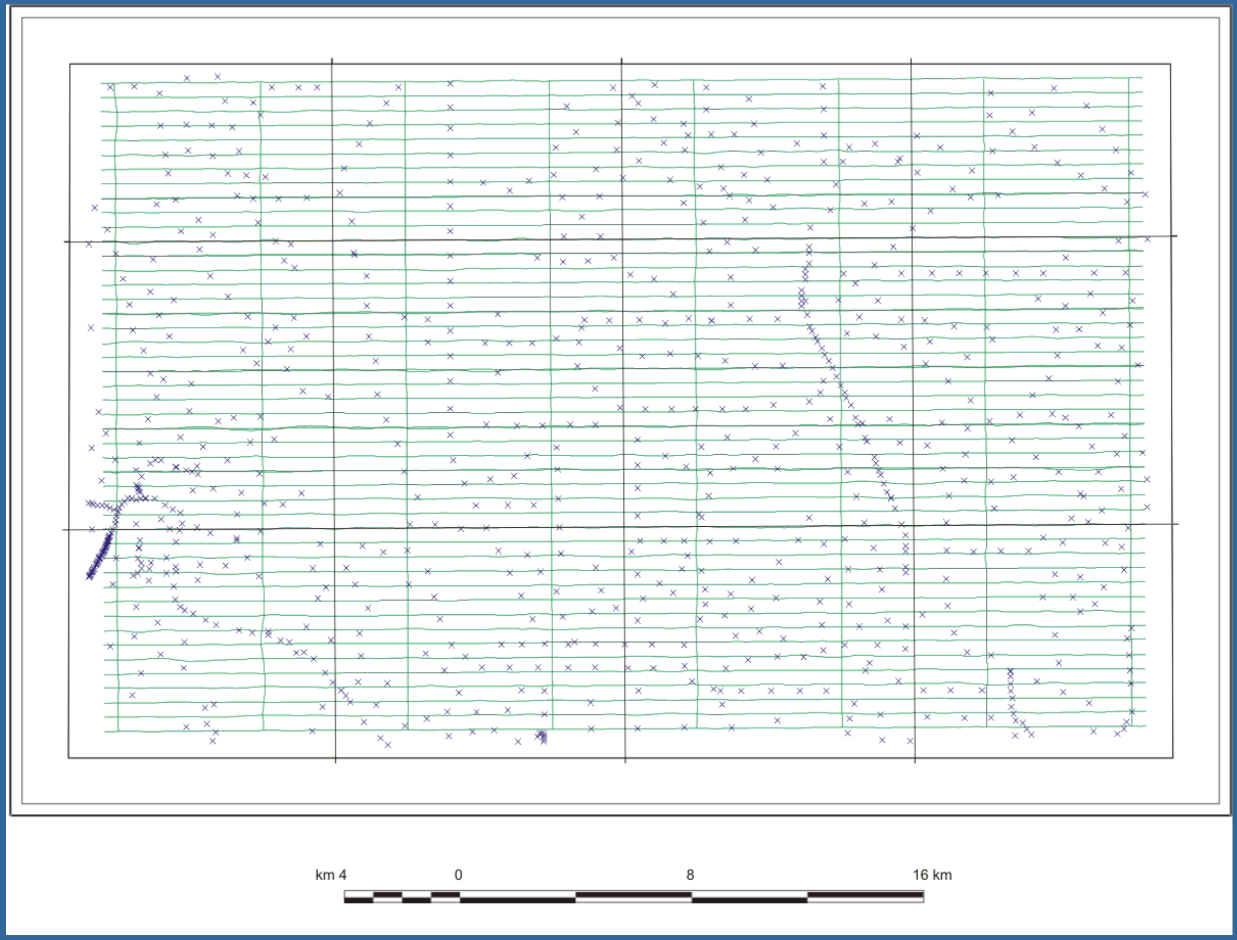
$N_{difference}$ = RMS value of $n_{difference}$

$N_{combined} = N_{difference} /2$

The noise on the combined grid
equals
½ the noise on the difference grid

Measurement of Noise in Airborne Gravity Data Using Even and Odd Grids, Stephan Sander, Stephen Ferguson, Luise Sander and Veronique Lavoie, Sander Geophysics, Ottawa, Canada & R.A. (Bob) Charters, GEDCO, Calgary, Canada, First Break 2002

Comparison with Ground Survey



Airborne and ground gravity acquisition

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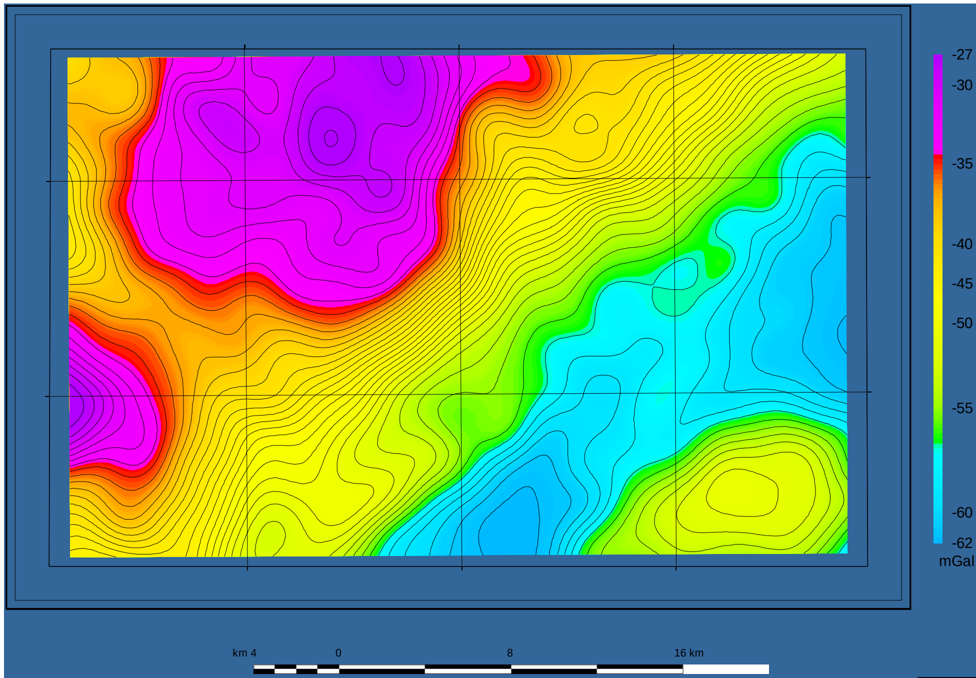
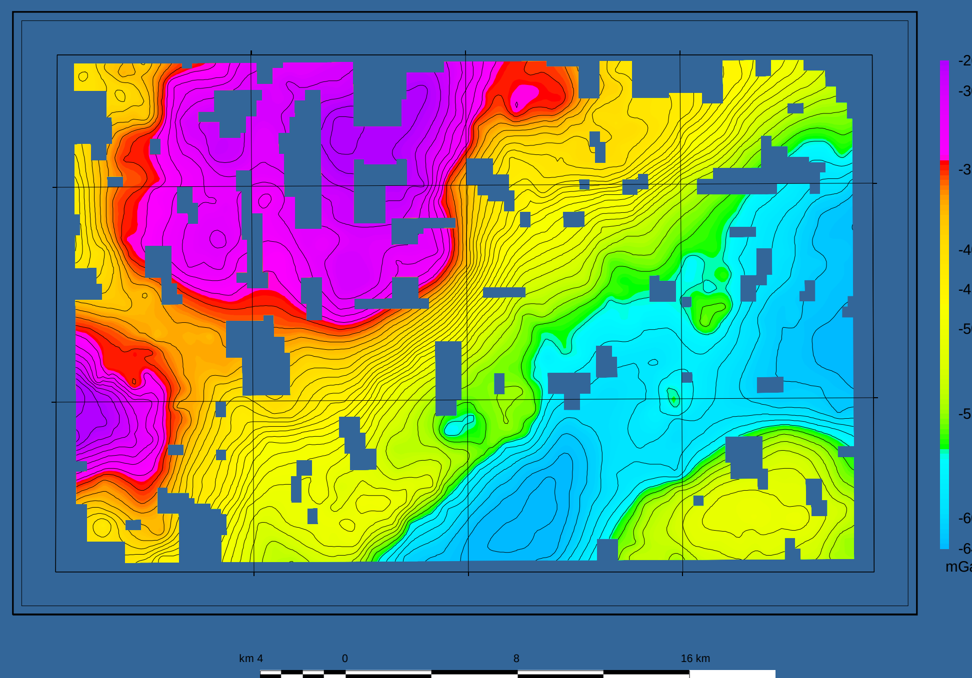


AIRGrav Bouguer data grid with 1 mGal contour levels and 2.85 km full wavelength filter

Ground Bouguer data grid with 1 mGal contour levels and 10 km UTM lines



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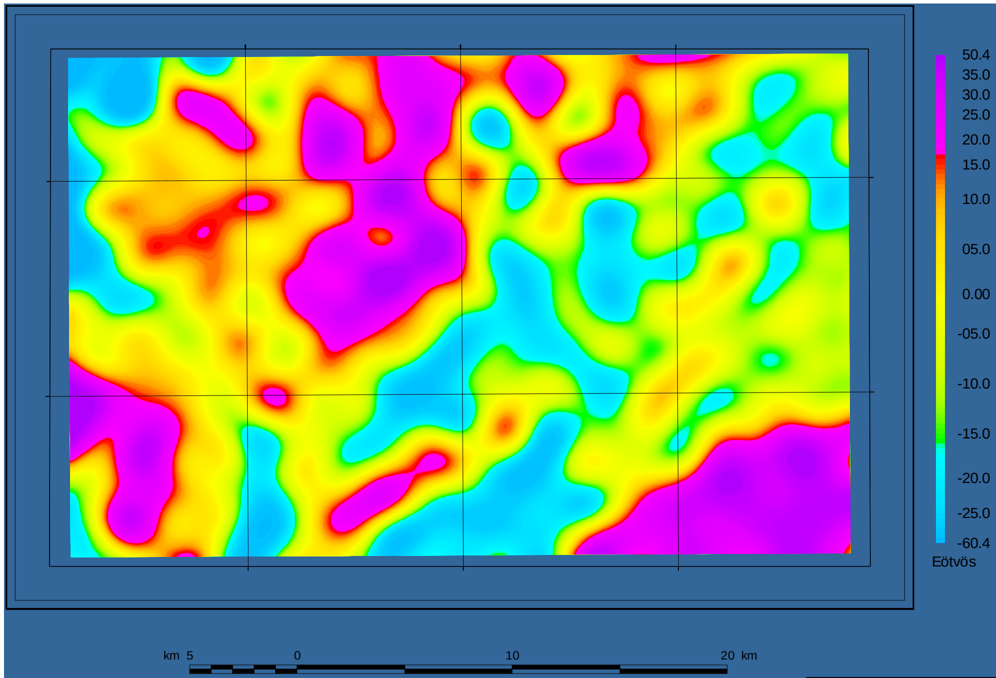
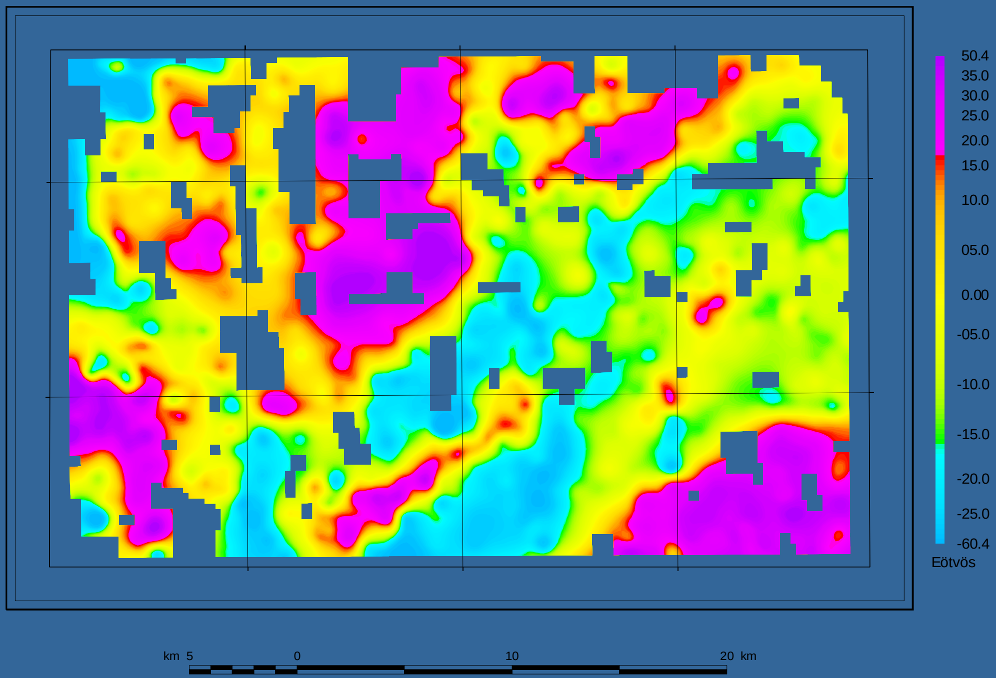


First vertical derivate of the AIRGrav grid with 10 km UTM lines



First vertical derivate of the ground grid after a 200m upward continuation and 10 km UTM lines

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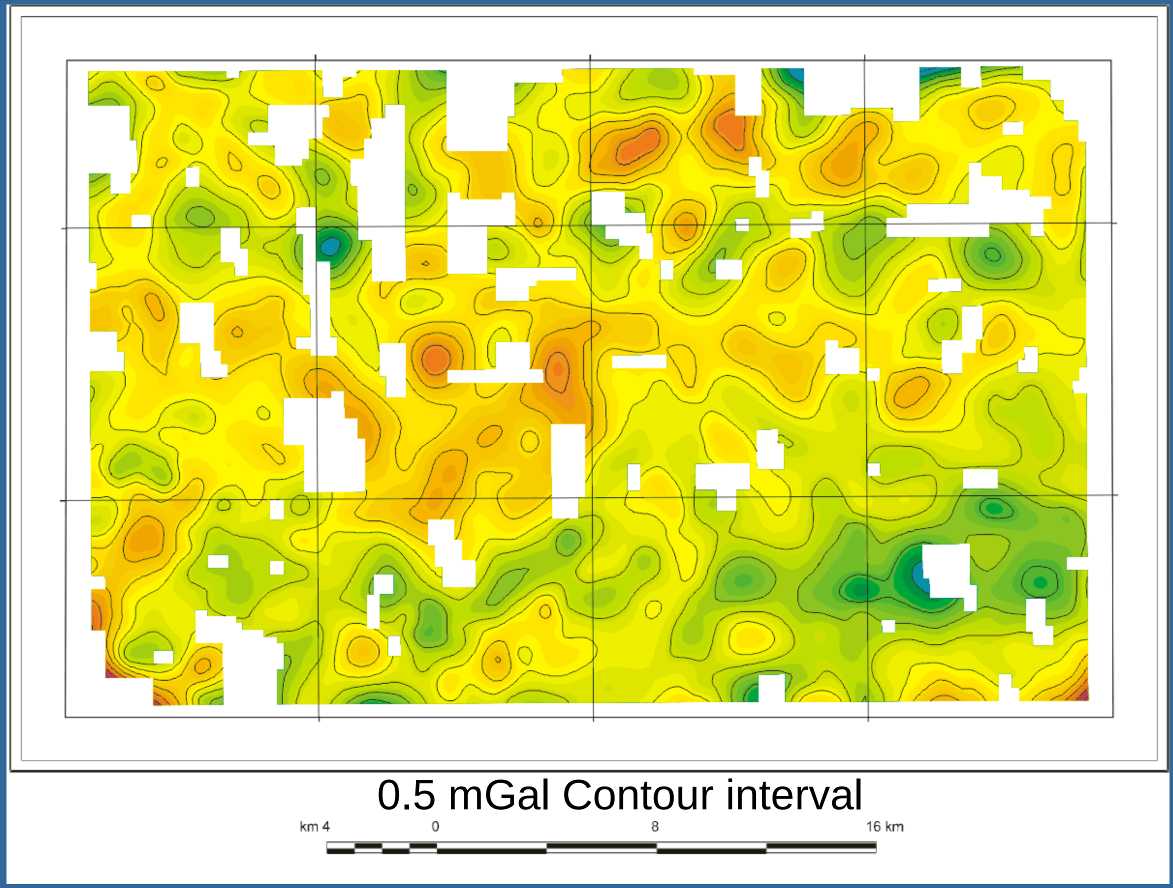
Comparison with Ground Survey



0.5 mGal Contour interval

Later surveys with the same internal noise level – 0.35 mGal

RMS difference calculated on a point by point basis is 0.62 mGal
This includes errors in ground data as well as AIRGrav data

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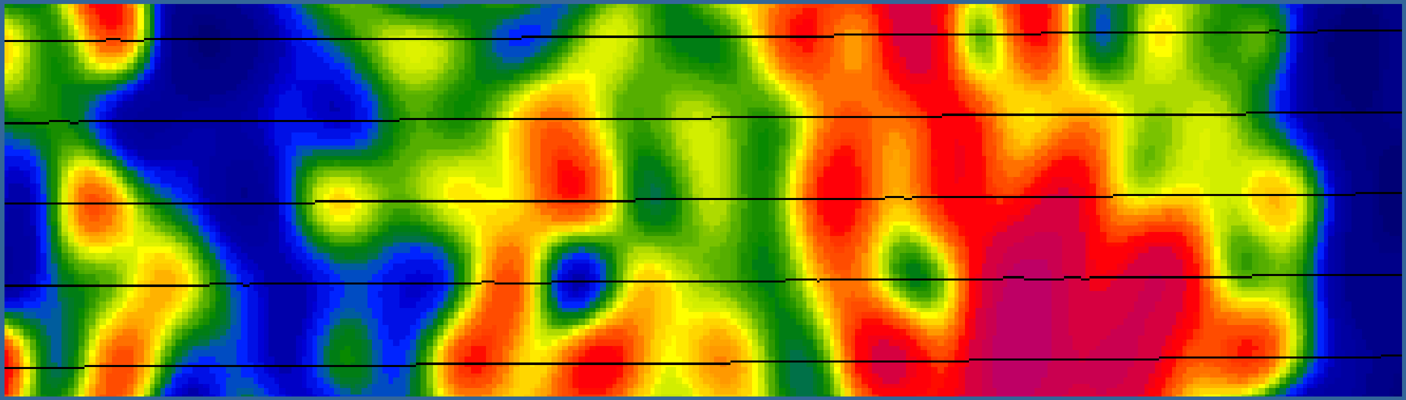
Bouguer Gravity - First Vertical Derivative



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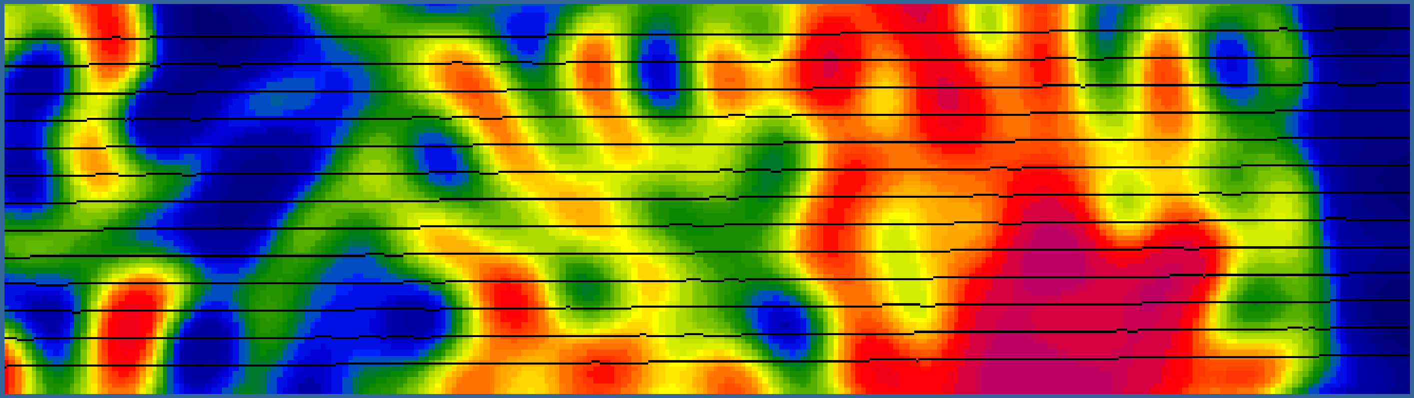
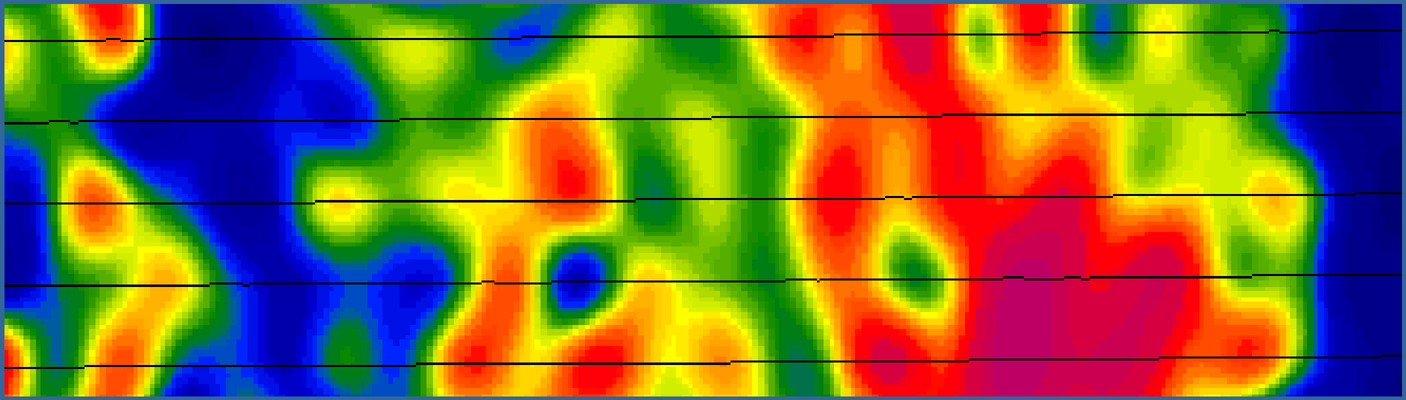
Three km line spacing

Bouguer Gravity - First Vertical Derivative



One km line spacing



Three km line spacing

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Benefits of Closer Line Spacing

- Higher resolution – lower noise levels
- Averaging of noise between lines
- Better sampling for aeromagnetic data
- Better terrain models for terrain corrections using laser and radar altimeters
- Quality control during survey and in data processing

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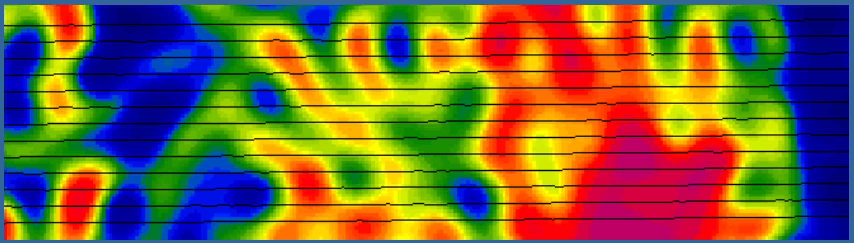
Quality Control Using Close Line Spacing

- Adjacent lines are compared to differentiate noise from real anomalies
- Line data minus profiles extracted from filtered grids gives an estimate of the noise along each line
- Facilitates data processing by identifying problem areas



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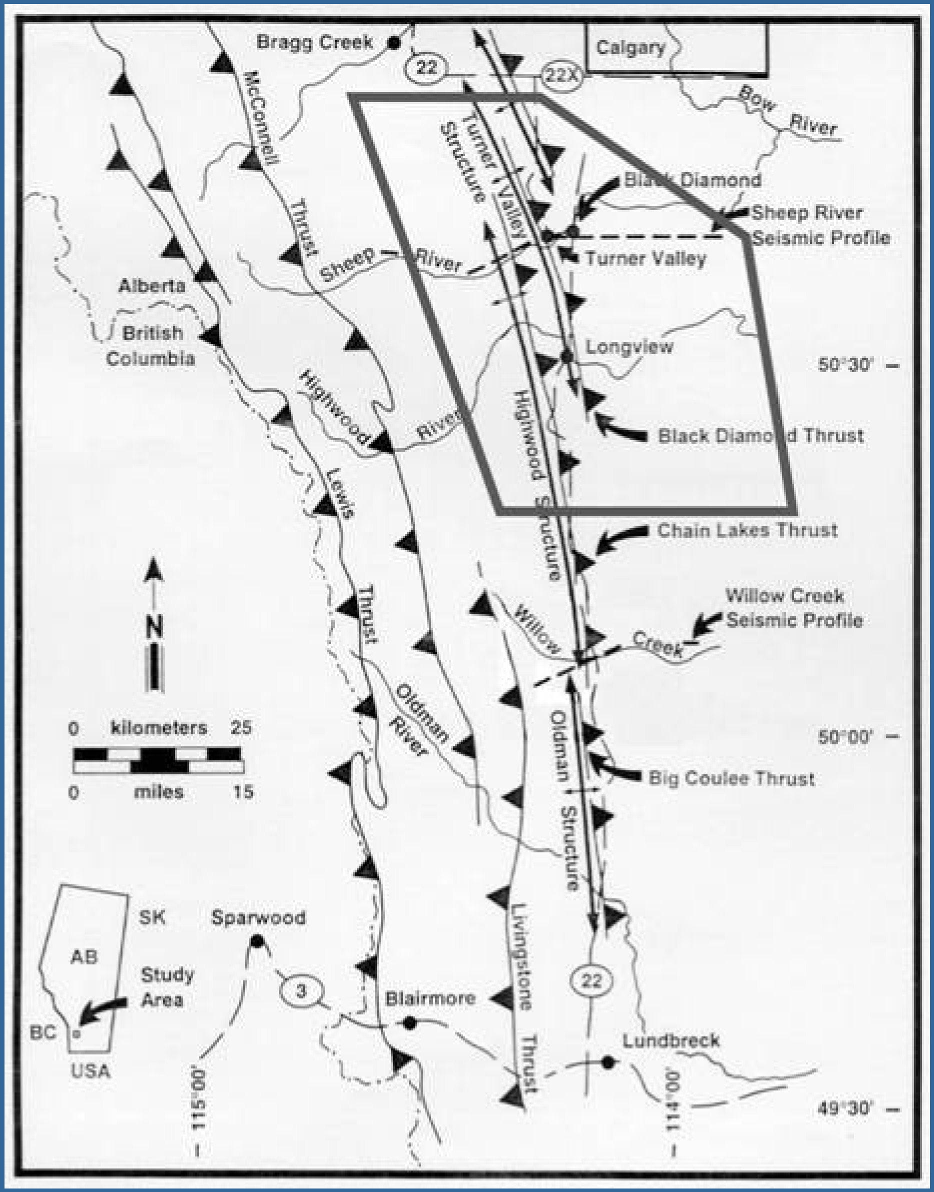
Line Spacing for Gravity – Expected Noise for Fixed Wing @ 51m/s

Line Spacing (m)	Resolution half sine wave (km)	Accuracy (rms mgal)
200	1.6	0.2
500	2	0.2
2000	2	0.4

Line Spacing for Gravity – Expected Noise for Helicopter @ 23m/s

Line Spacing (m)	Resolution half sine wave (m)	Accuracy (rms mgal)
200	800	0.2
500	1,000	0.3
1000	1,000	0.4



Turner Valley Alberta Survey Location Map

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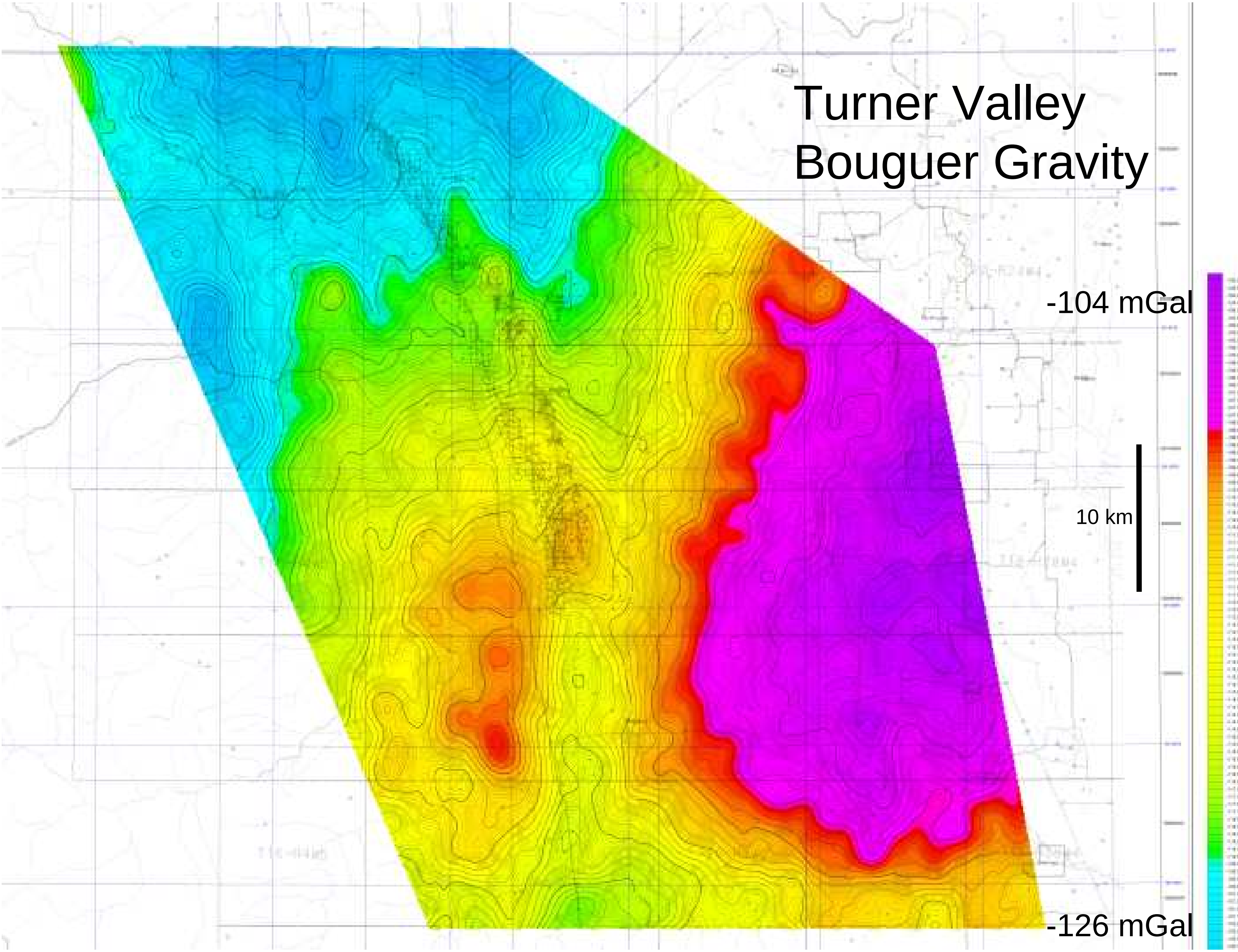
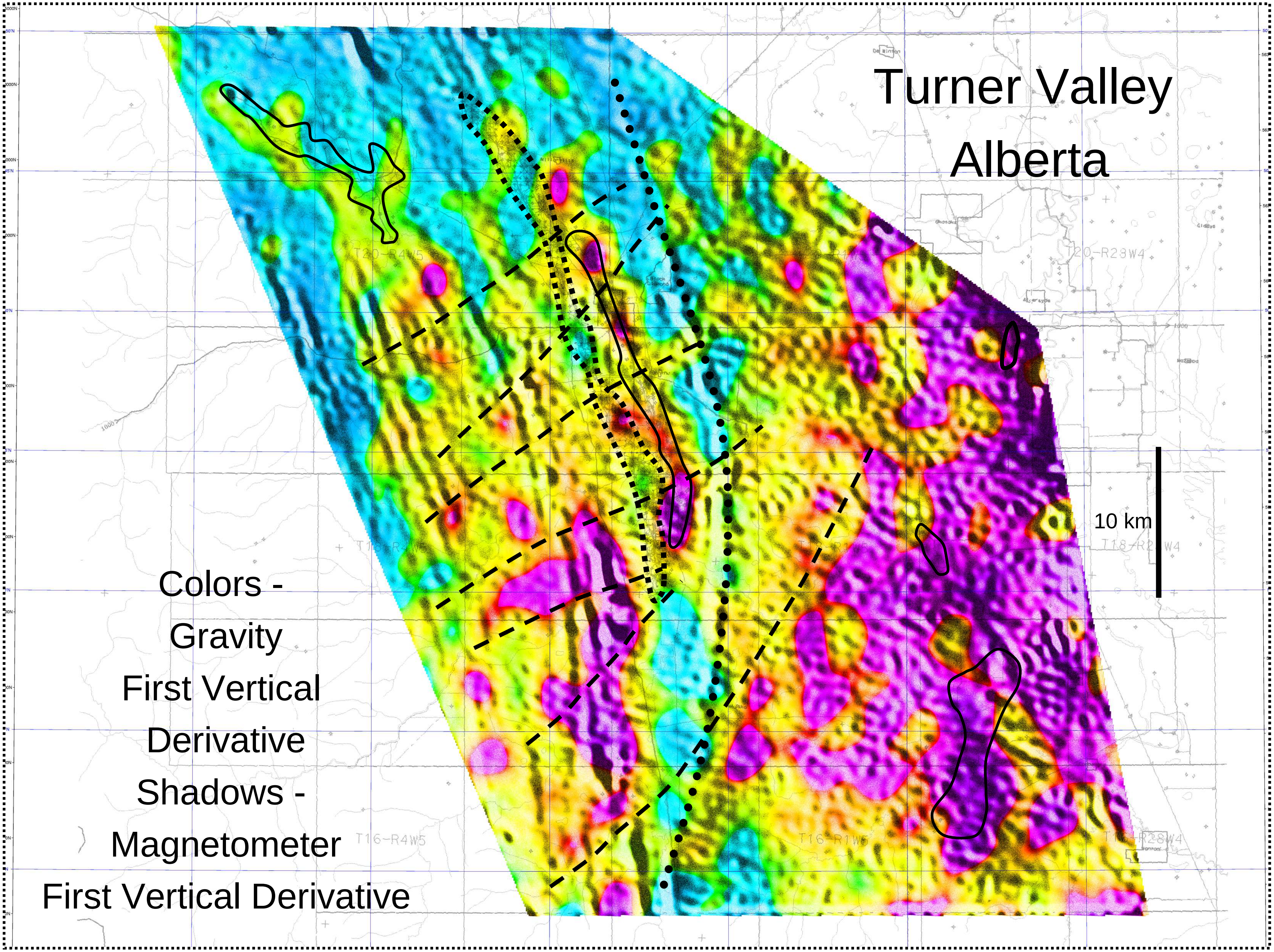

Turner Valley
Bouguer Gravity
-104 mGal
10 km
-126 mGal

Turner Valley Alberta



Colors - Gravity First Vertical Derivative

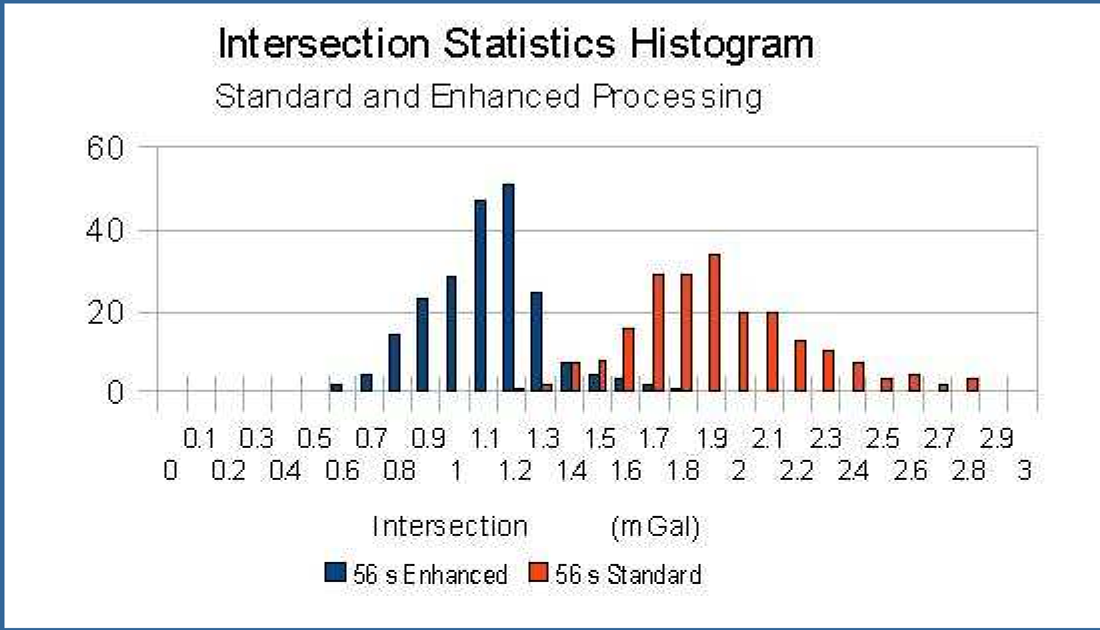
Shadows - Magnetometer First Vertical Derivative

Enhanced Processing

New advances in SGL gravity processing, involving advanced analysis of system states and uncertainties, allow for the generation of enhanced gravity data.

This process reduces system noise and allows for the generation of high quality, low noise raw gravity data through a wider range of survey conditions than was previously possible.

Enhanced Gravity Intersection Statistics



Enhanced data RMS of 1.07 mGals

Standard data RMS of 1.8 mGals

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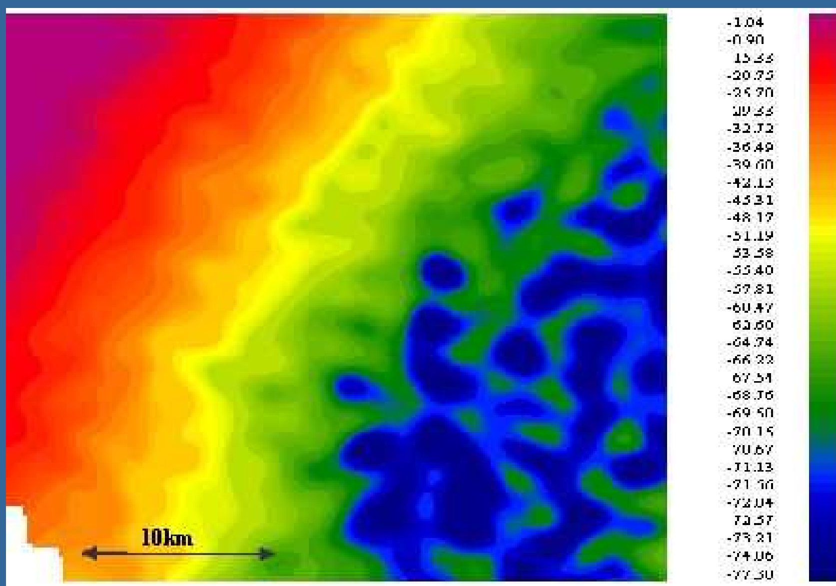
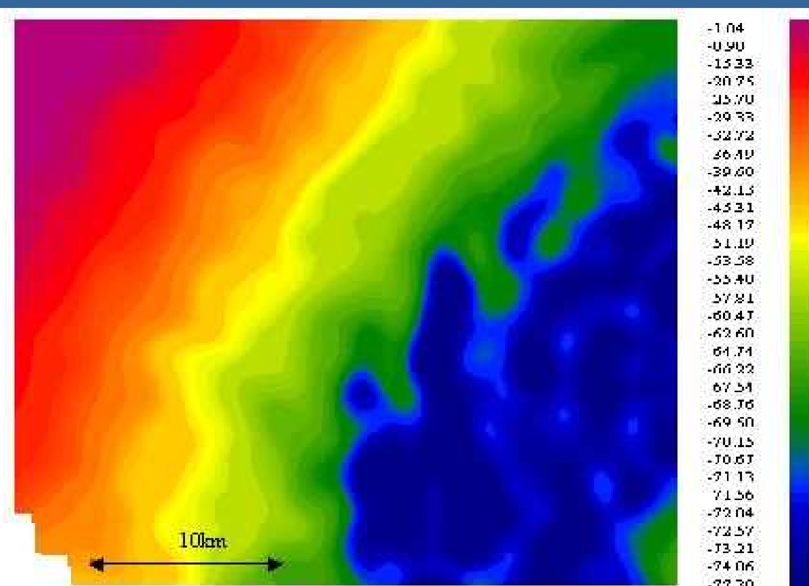
Enhanced Bouguer Gravity

500m line spacing, 1250m half wavelength resolution

Standard: 0.85 mGal RMS, Enhanced: 0.4 mGal RMS





Standard Bouguer Gravity

Enhanced Bouguer Gravity

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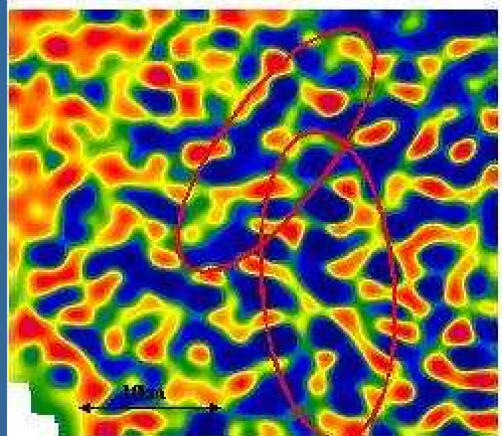
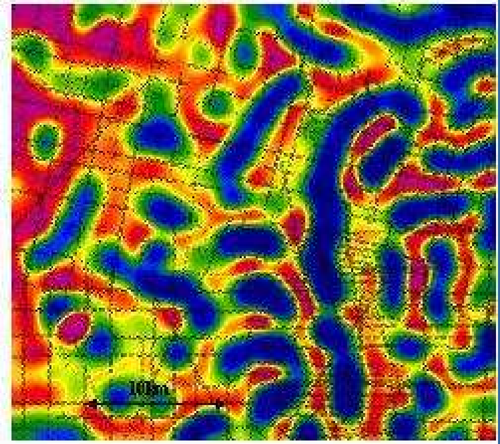
Enhanced Gravity Compared to Ground Gravity

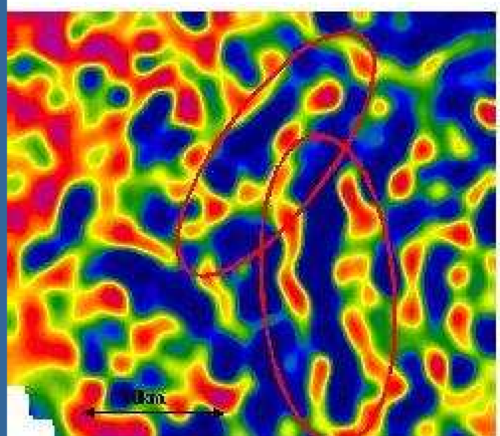
1st vertical derivative, standard Bouguer Gravity



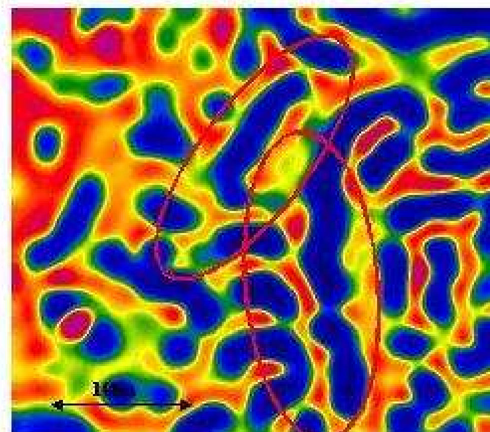
1st vertical derivative, ground Bouguer Gravity with sample lines



1st vertical derivative, enhanced Bouguer Gravity



1st vertical derivative, ground Bouguer Gravity

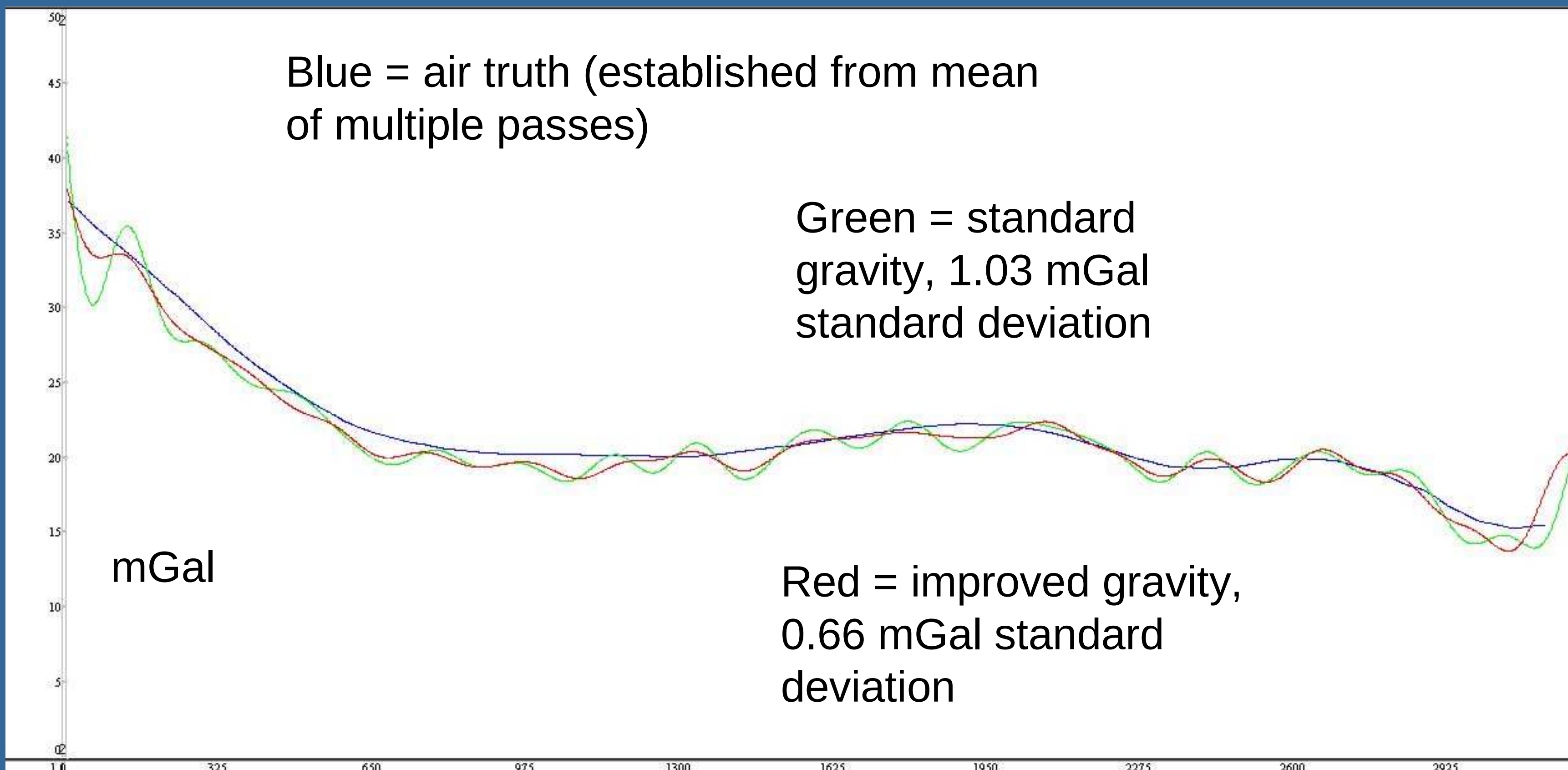


Latest Developments at SGL

A new methodology to reduce ambiguities in the GPS positional data provide improved GPS corrections for aircraft accelerations.

Limited analysis indicate a 30% reduction in noise over standard (non-enhanced) gravity.

Improvement from New GPS Processing



What is Next?

Full potential of improved GPS method stand alone and in combination with Enhanced Gravity is being evaluated.

Further improvements in noise reduction at higher resolutions are anticipated.

What Next for AIRGrav?
SEAGrav

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