# A comparison of Airborne Vector Gravimeter Measurements with the Geoid Slope Validation Survey 2014

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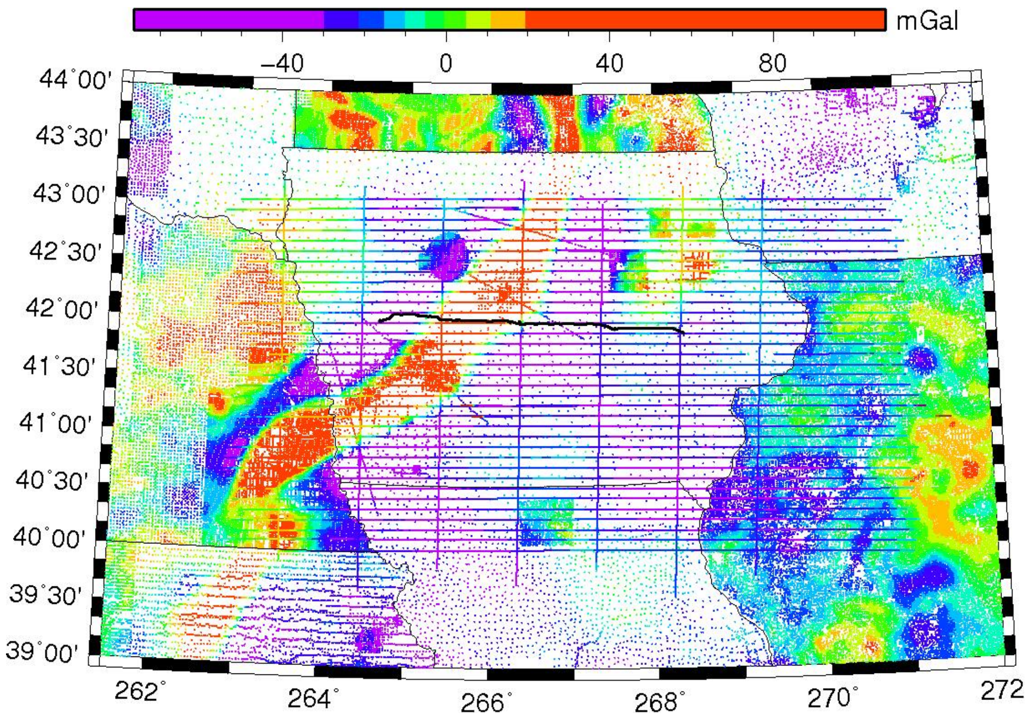
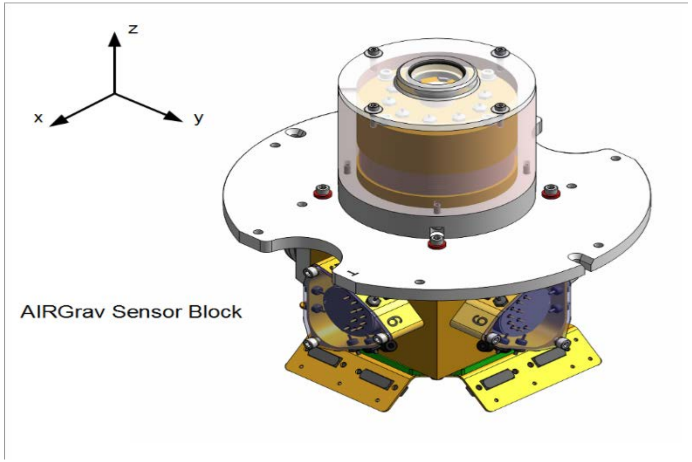
# Geoid Slope Validation Survey 2014

- GSVS14 is the second survey conducted by the NGS to test differential accuracy of the gravimetric geoid model.
- It was conducted in Iowa, predominantly along Highway 30, from Denison to Cedar Rapids
- ~ 200 miles (325 km) long, 204 survey benchmarks
- Medium-high, relatively flat area ranging from 740 feet to 1,440 feet above sea level
- gravimetrically complex (Midcontinent Rift)



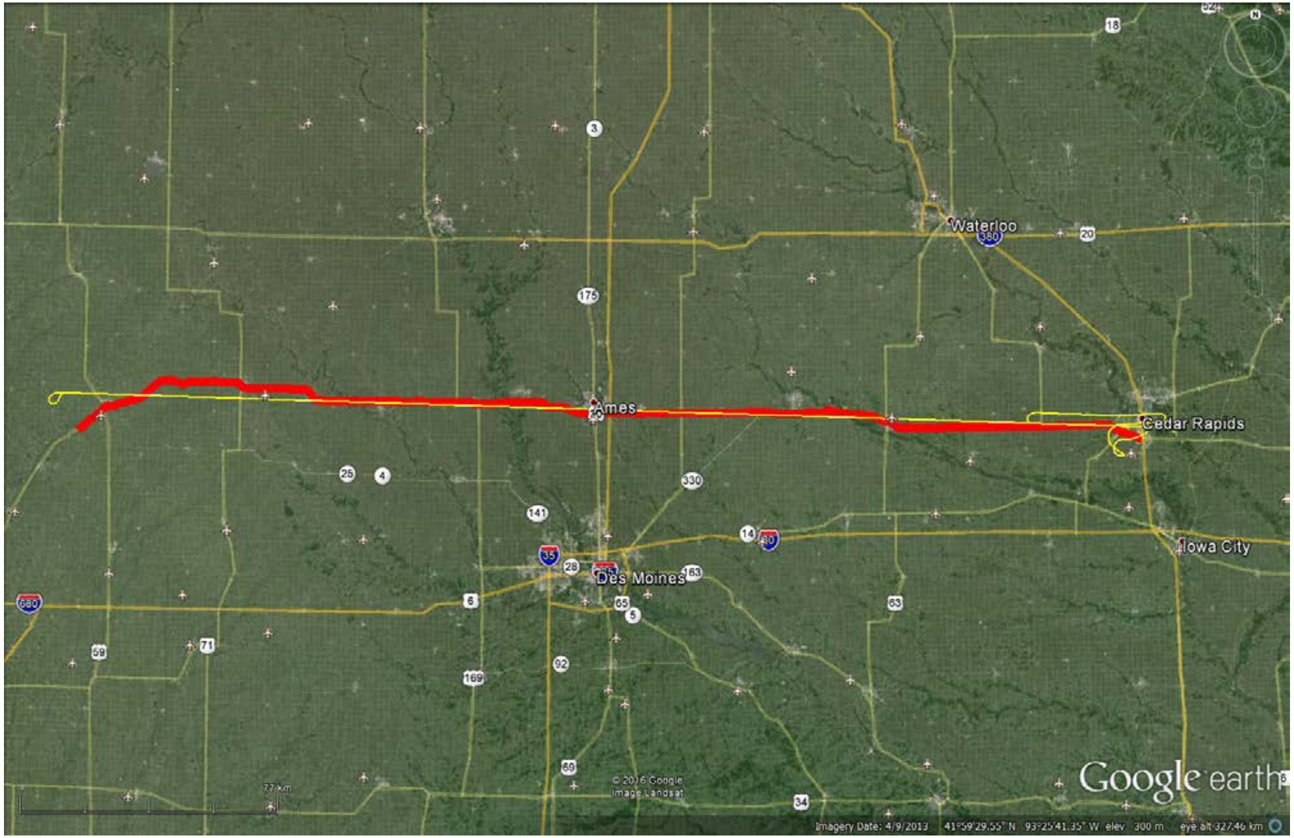
# AIRGrav System
## Airborne Inertially Referenced Gravimetry

- AIRGrav designed and built specifically for airborne gravity surveying by SGL
- 10 years of R&D following by 16 years of survey flying, 12 gravimeters
- Three axis (x y z) gyro stabilized platform, three (x y z) accelerometers
- Dual frequency GPS receivers at 10 Hz
- Gravity = inertial accelerations – GPS accelerations
- Raw gravity data sampled at 128 Hz

# SGL Flight Information

- June 28, 2015
- Repeat line flown West then East
- 600 m ellipsoidal (~ 400 m above ground at East end, ~200 m at West end)
- 320 km long
- ~ 55 m/s (200 km/h)
- Also flown next day at 2185 m ellipsoidal, 58 m/s, West and East (results not presented here)

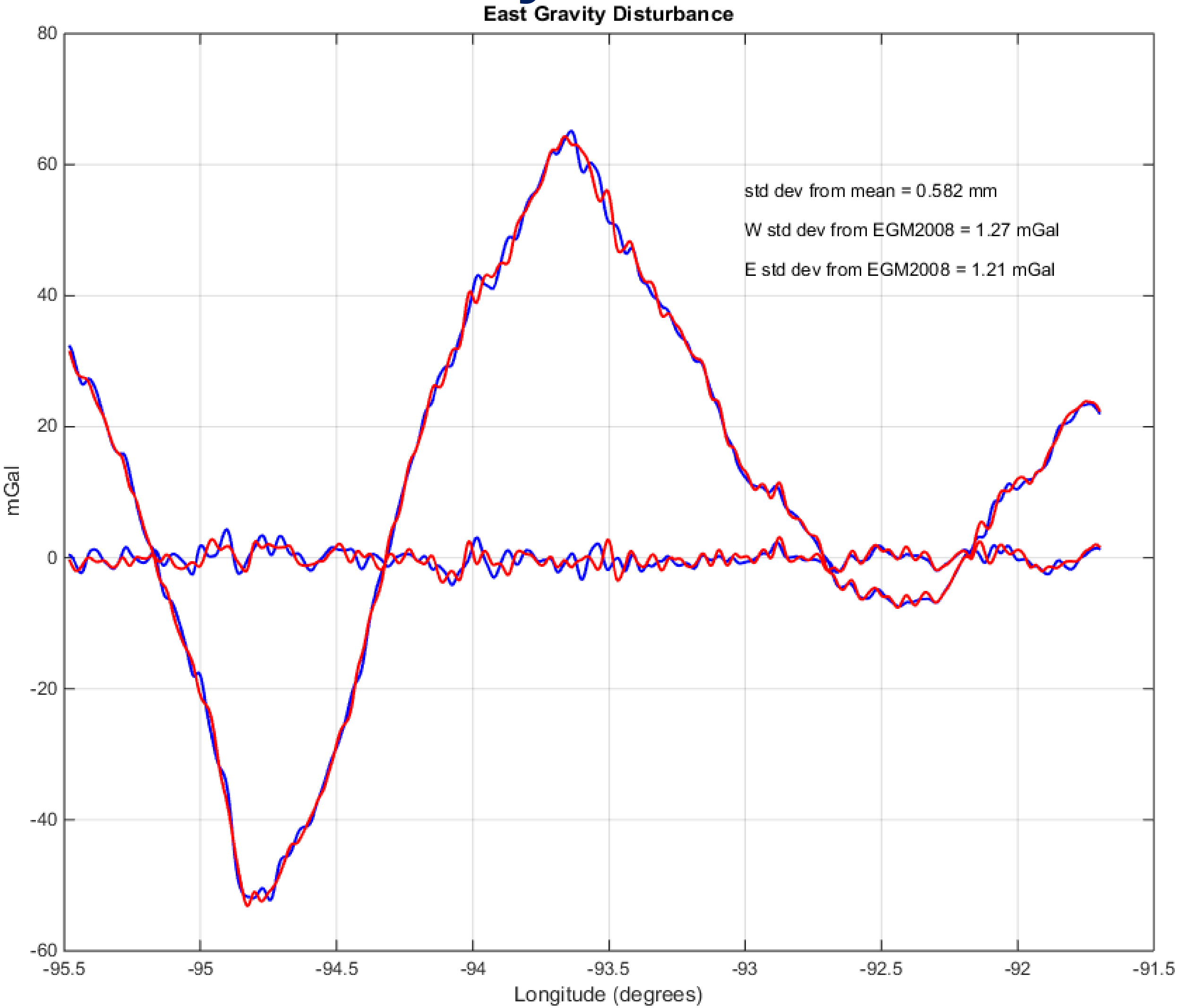


# AIRGrav Data Processing Steps

- Kalman Filter combination of GPS positions and gravimeter accelerations
- Multiple GPS solutions used to minimize acceleration noise: PPP, double and single differencing
- 3 gravity components are estimated states in the filter
- EGM 2008 used during processing to loosely constrain horizontal component estimates, which are corrupted by uncertainty in gyro drift
- 100 s (5.5 km) full wavelength filter applied to gravity components

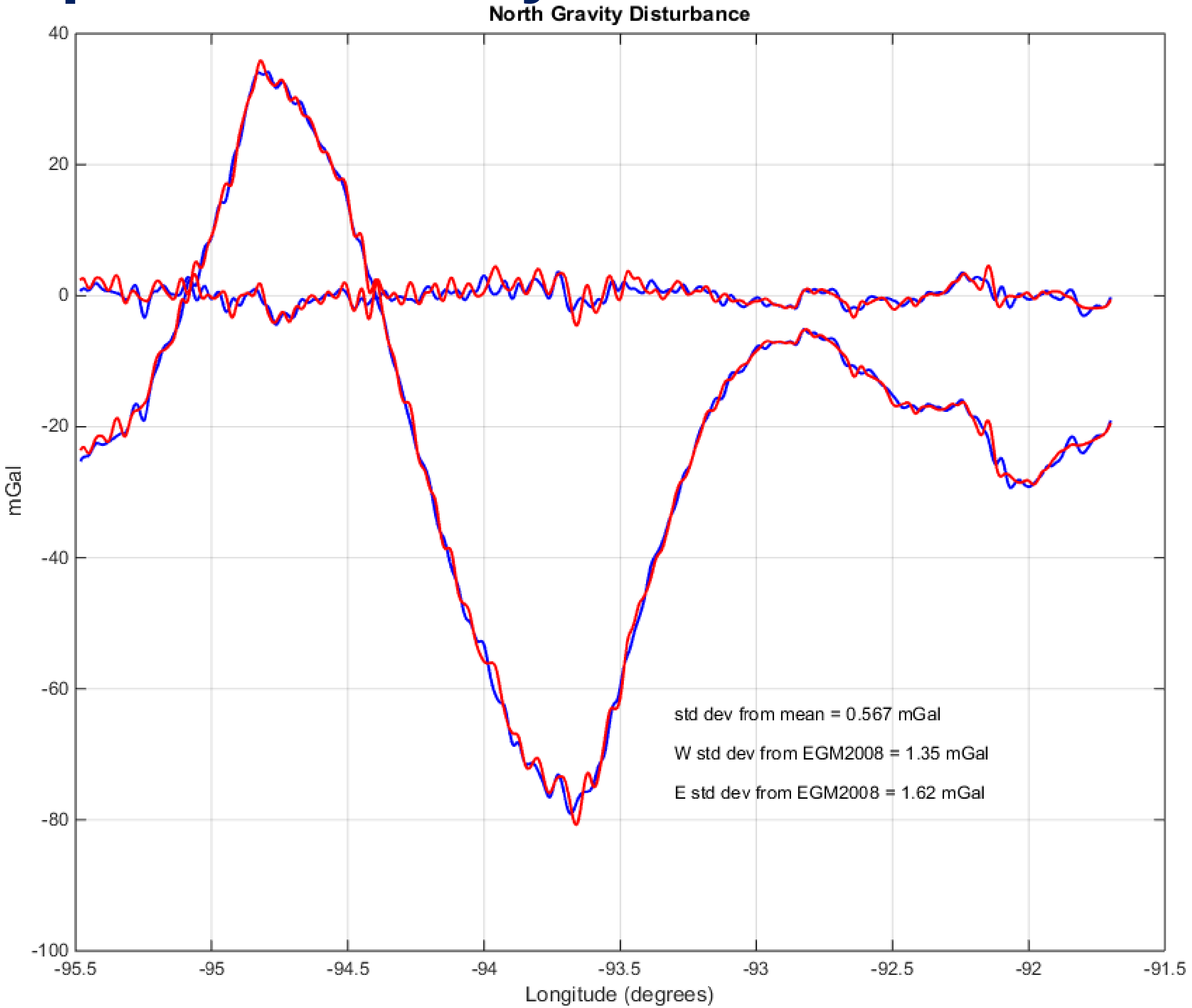
# East-West Component of Gravity Disturbance

- Blue = West
- Red = East
- Std dev from mean = 0.582 mGal
- W std dev from EGM2008 = 1.27 mGal
- E std dev from EGM2008 = 1.21 mGal



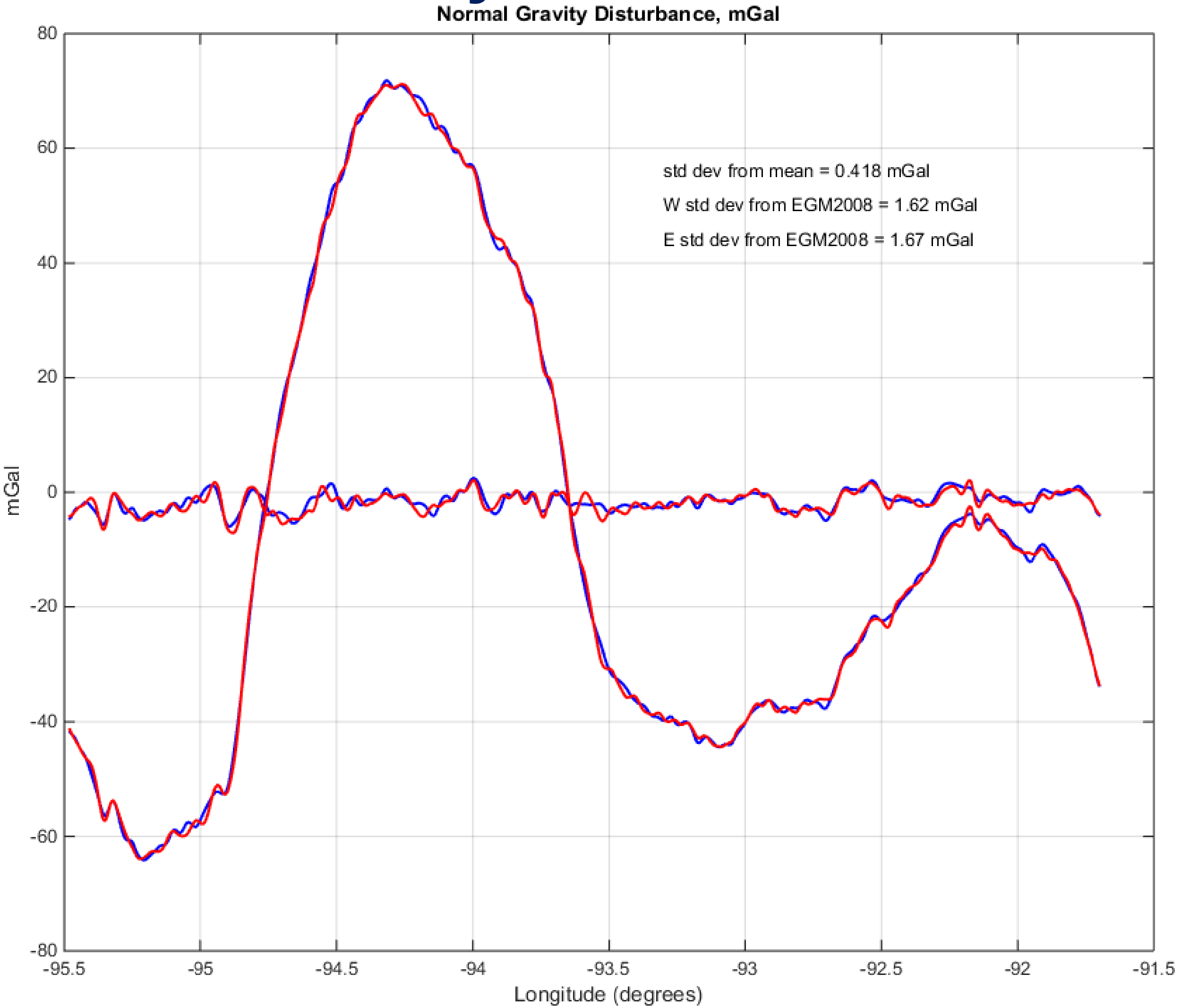
# North-South Component Gravity Disturbance

- Blue = West
- Red = East
- Std dev from mean = 0.567 mGal
- W std dev from EGM2008 = 1.35 mGal
- E std dev from EGM2008 = 1.62 mGal



# Vertical component of Gravity Disturbance

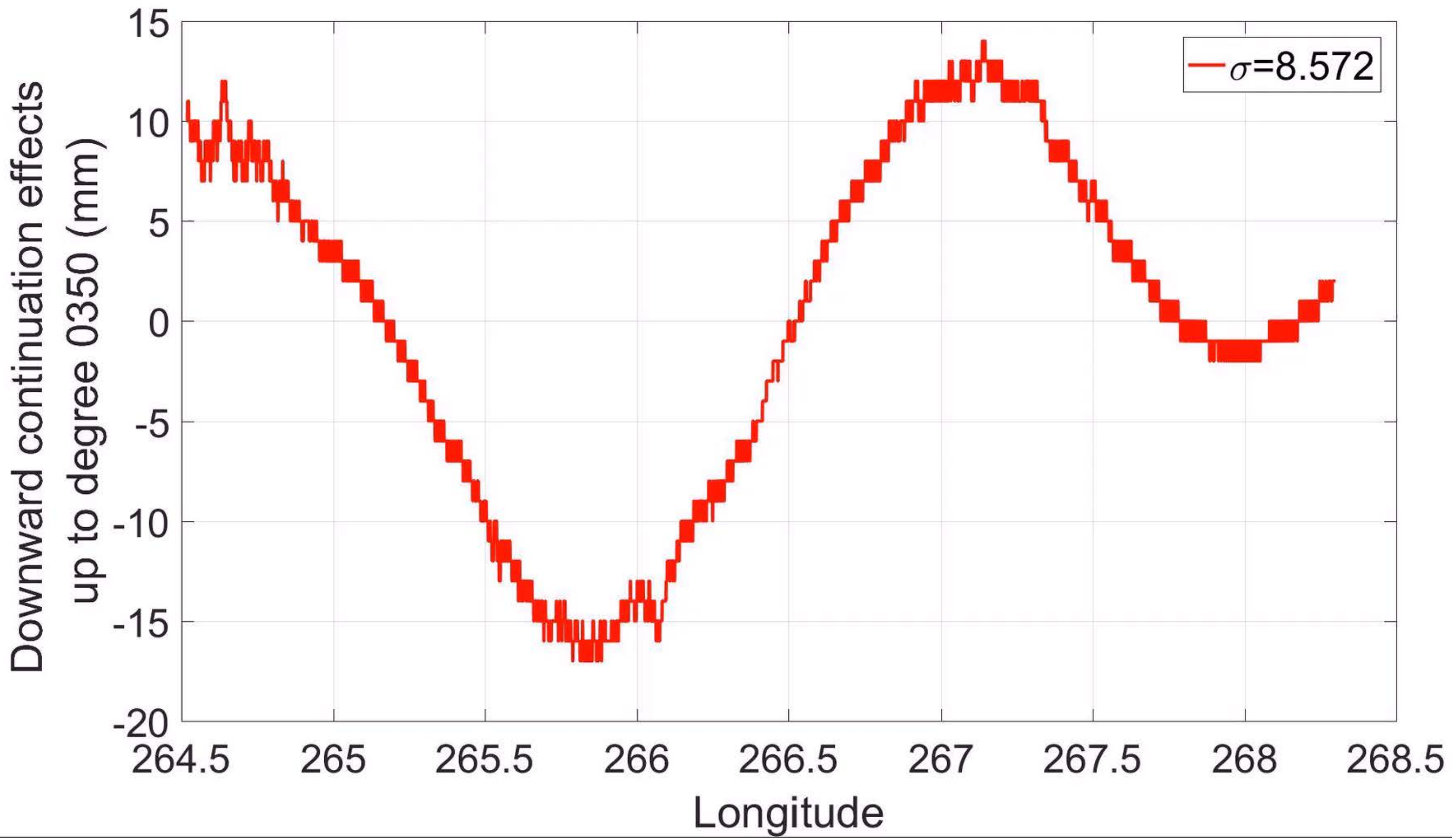
- Red = West
- Blue = East
- Std dev from mean = 0.418 mGal
- W std dev from EGM2008 = 1.62 mGal
- E std dev from EGM2008 = 1.67 mGal

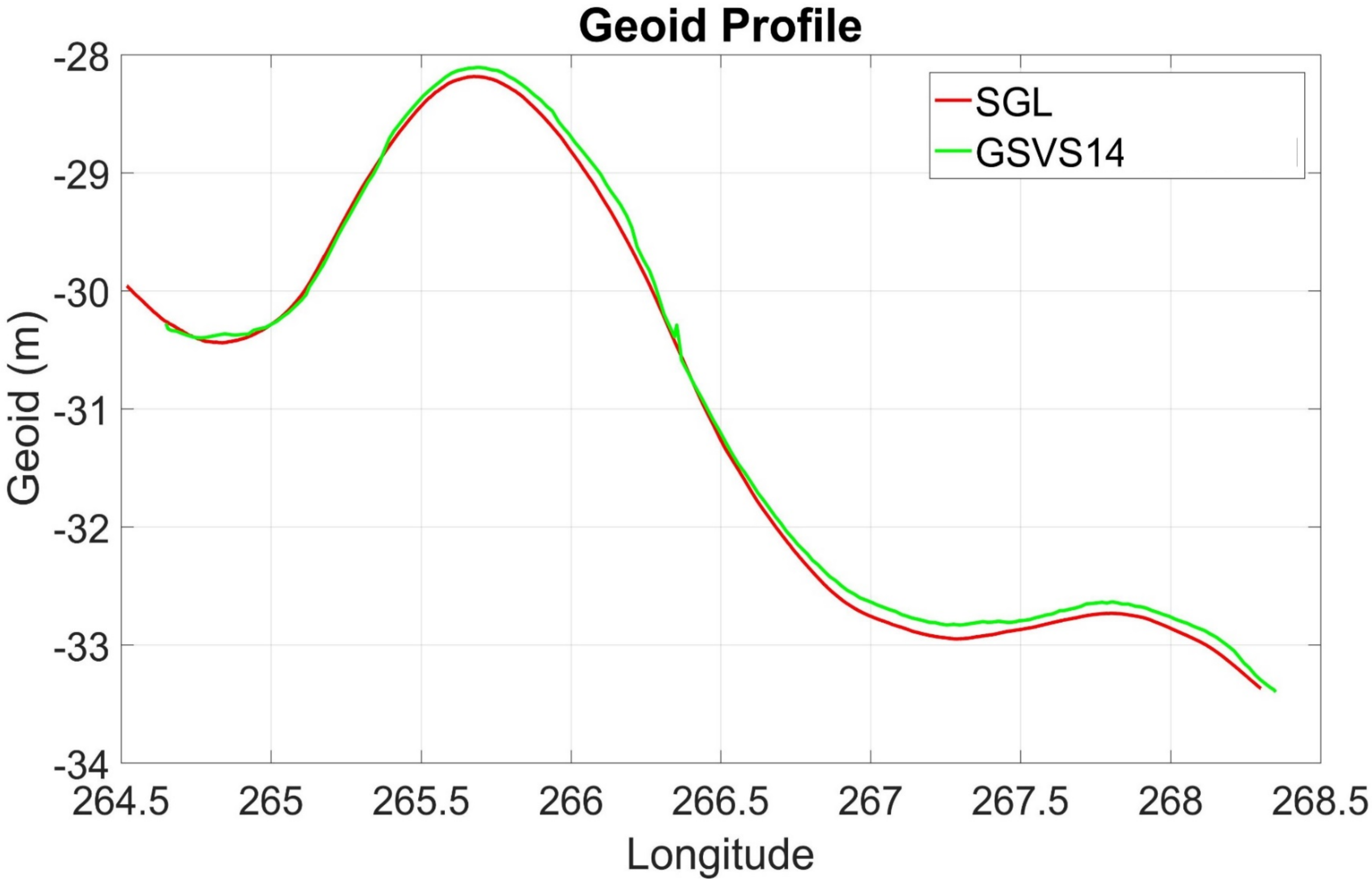


# SGL Geoid Profile Computation

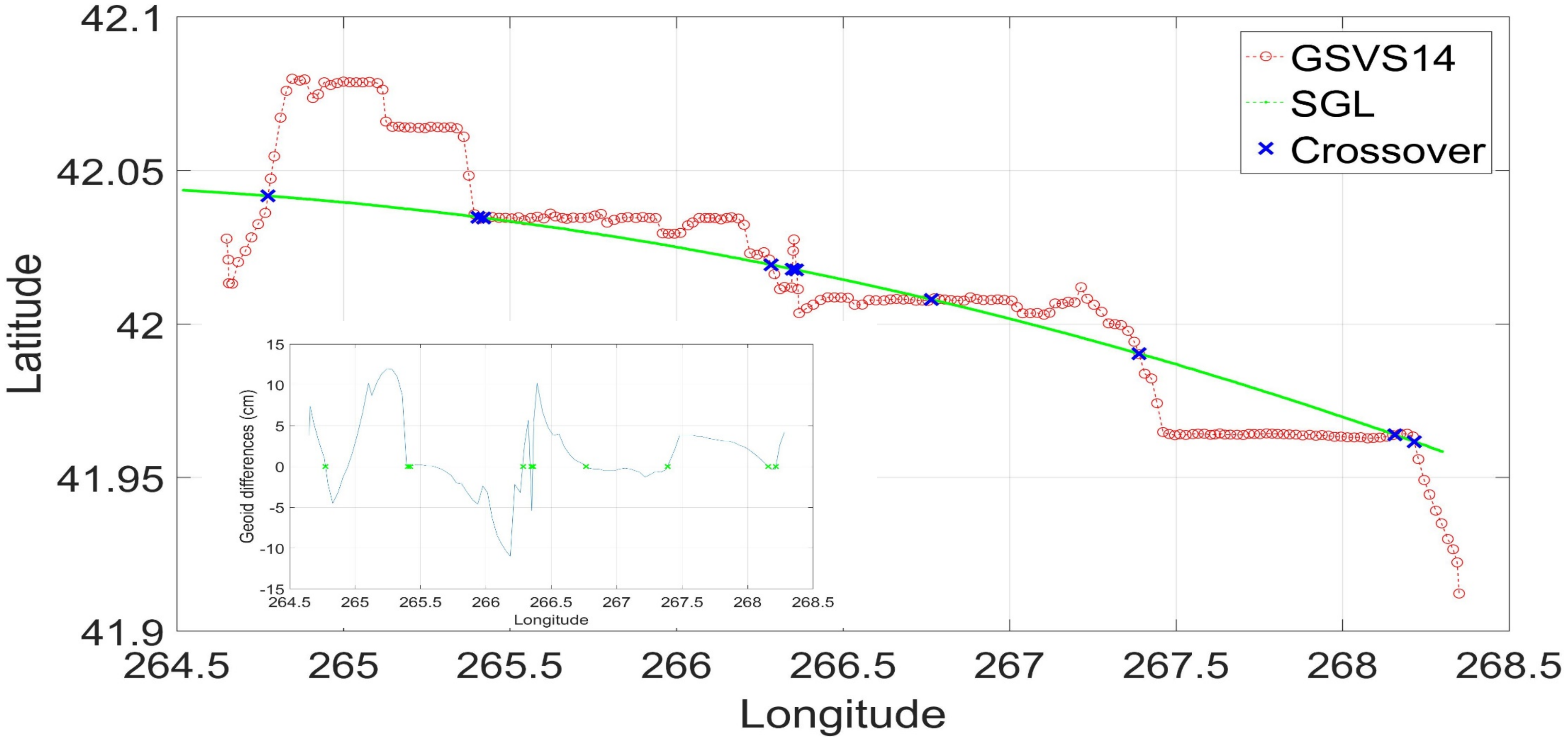
- Method of line-integration (Jekeli and Kwon 2002)
- Horizontal gravity components further filtered to 8.3 km half-wavelength
- High resolution global gravity model EIGEN6c4 was used in the remove-restore fashion
- Downward continuation correction is computed from EIGEN6c4 model

# Harmonic Downward Continuation Correction to the Geoid (Eigen6c4, Unit in mm)

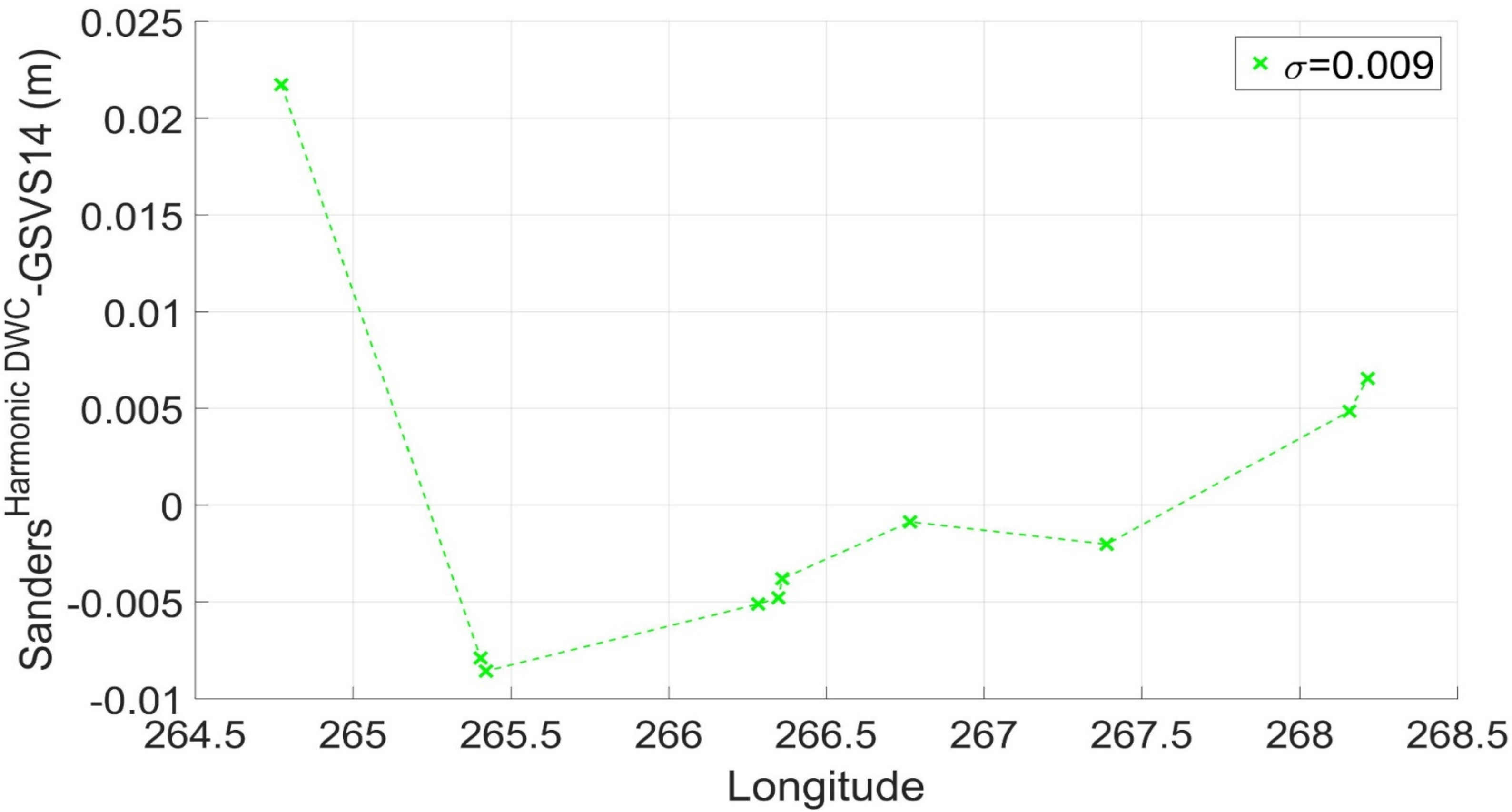



Geoid Profile
-28
-29
-30
-31
-32
-33
-34
Geoid (m)
264.5
265
265.5
266
266.5
267
267.5
268
268.5
Longitude
SGL
GSVS14

# Collocated points between the SGL flight and GSVS14 traverse



# Geoid height differences (SGL flight – GSVS14) at the collocated points



# Conclusions (1)

- 3 components of the gravity disturbance observed by AIRGrav agree with EGM2008 around 1.4 mGal.
- The geoid height differences between the SGL and NGS - GSVS14 geoid profiles is ±0.9 cm at 10 collocated points, one order better than the results of Serpas and Jekeli (2005) due to the high quality AIRGrav data.
- The off-track corrections are critical because of strong gravity field variation in the region.
- The harmonic downward continuation correction is in the order of a few cm and has to be applied.

# Conclusions (2)

- Horizontal gravity components (HGC) are a direct measure of the slope of the equipotential surface at flight level
- HGC can be integrated directly to calculate equipotential surface at the flight altitude see Jekeli and Kwon (2002)
- HGC contain wavelengths down to about 5km full wavelength with sub-cm repeatability
- HGC can be combined with satellite models to encompass full spectrum of gravity field
- HGC can be used to verify geoid models
- Similar to the astrogeodetic leveling, HGC can be used in geoid computation along flight lines.