RG 2000 – the New Gravity Reference Frame for Sweden

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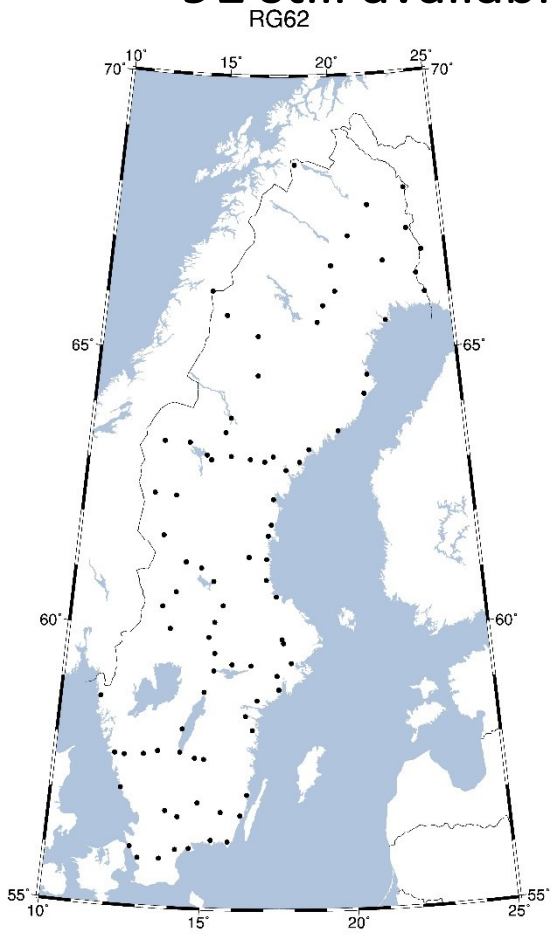
Why a new gravity reference frame?

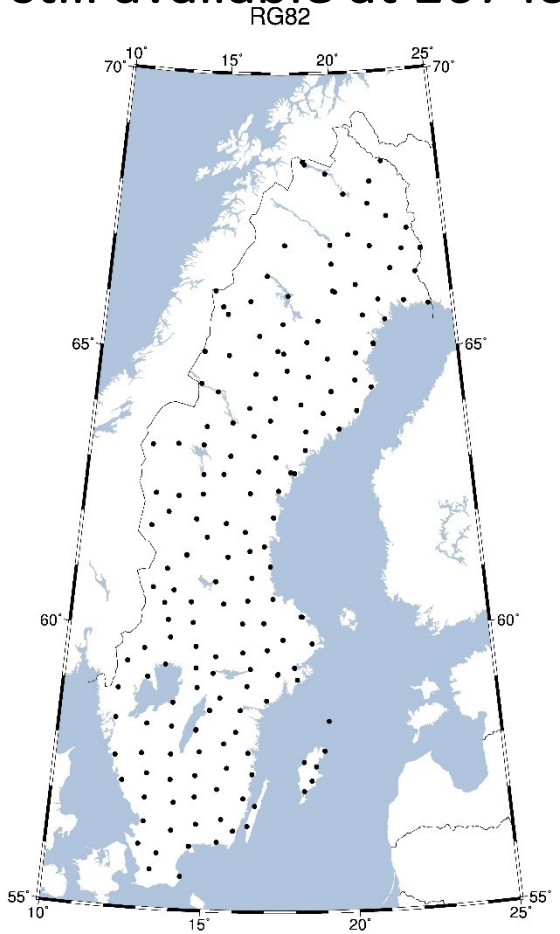
- Today we can see an increased **need for improved geoid models** for GNSS height determination,
- This calls for **additional gravity observations and quality assurance** of existing gravity data.
- In this perspective, a new modern gravity system and the renovation of the high order gravity network is considered as **a moderate strategic investment**, which will provide a firm foundation for further activities.

The situation at the start of the RG 2000 work

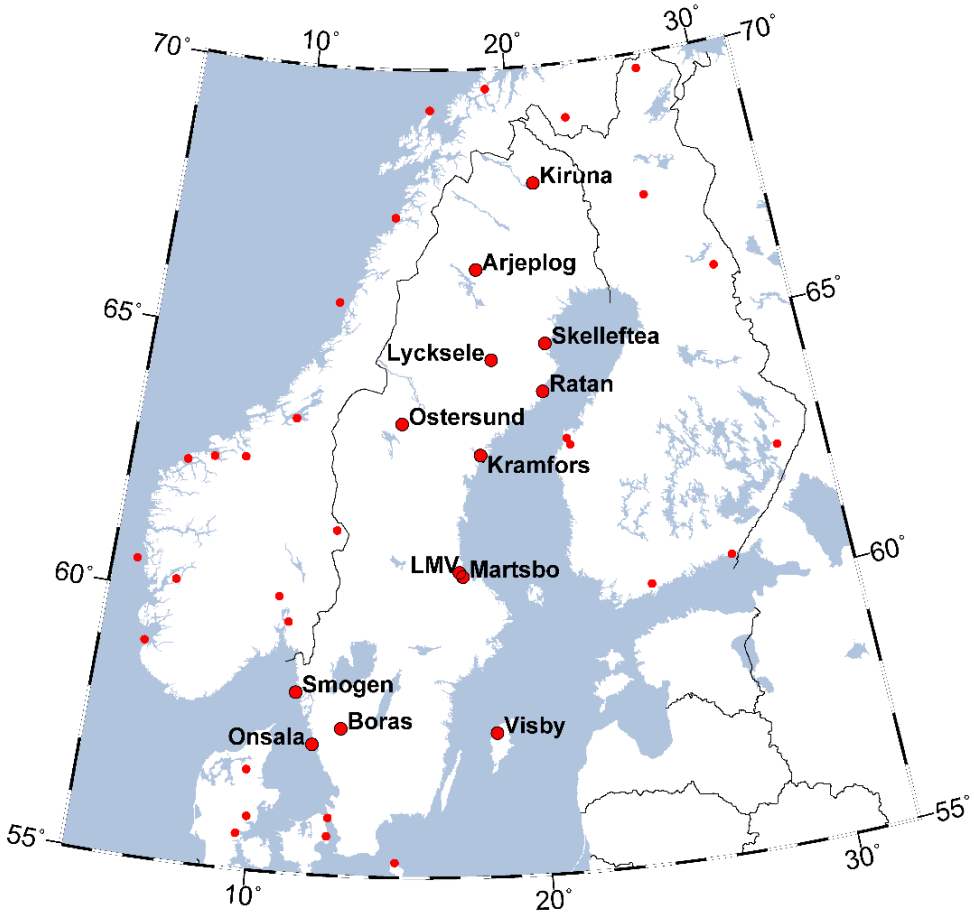
RG 62 – not marked points, 91 still available



RG 82 – points on benchmark, 190 still available at 167 locations

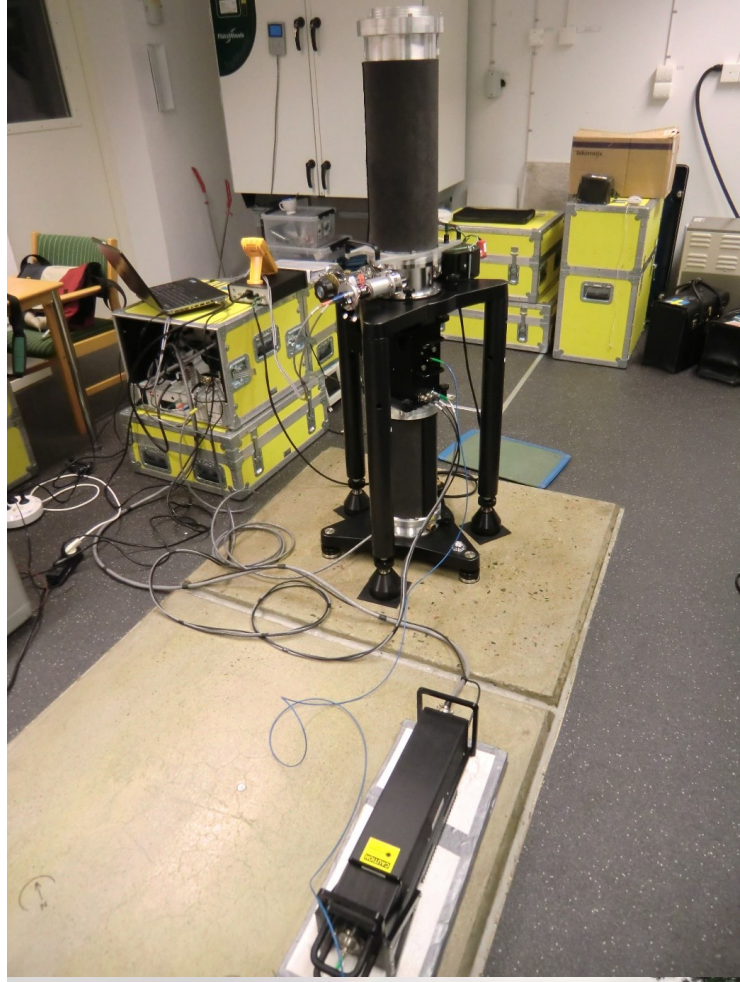


FG5 points – 17 at 13 locations (4 in Onsala and 2 in Mårtsbo)



Absolute gravimeter FG5

- Standard uncertainty for one observation: about 2 µGal
- Time series from 2007-2016 (FG5-233) and 2004-2008 (FG5-220)
- At 13 locations in Sweden
- Only indoors, at very stable surfaces and at almost constant temperatures (between 17 and 27 degrees)



Absolute gravimeter A10

- A-10 is a smaller and more portable absolute gravimeter than FG5
- A-10 can measure outdoors, but does not work well in **direct sunlight, rain or wind**
- Standard uncertainty for one observation: **5-10 µGal**
- Instrument: A-10-020 of IGiK in Warsaw
- 95 points in 5 campaigns during 2011-2015

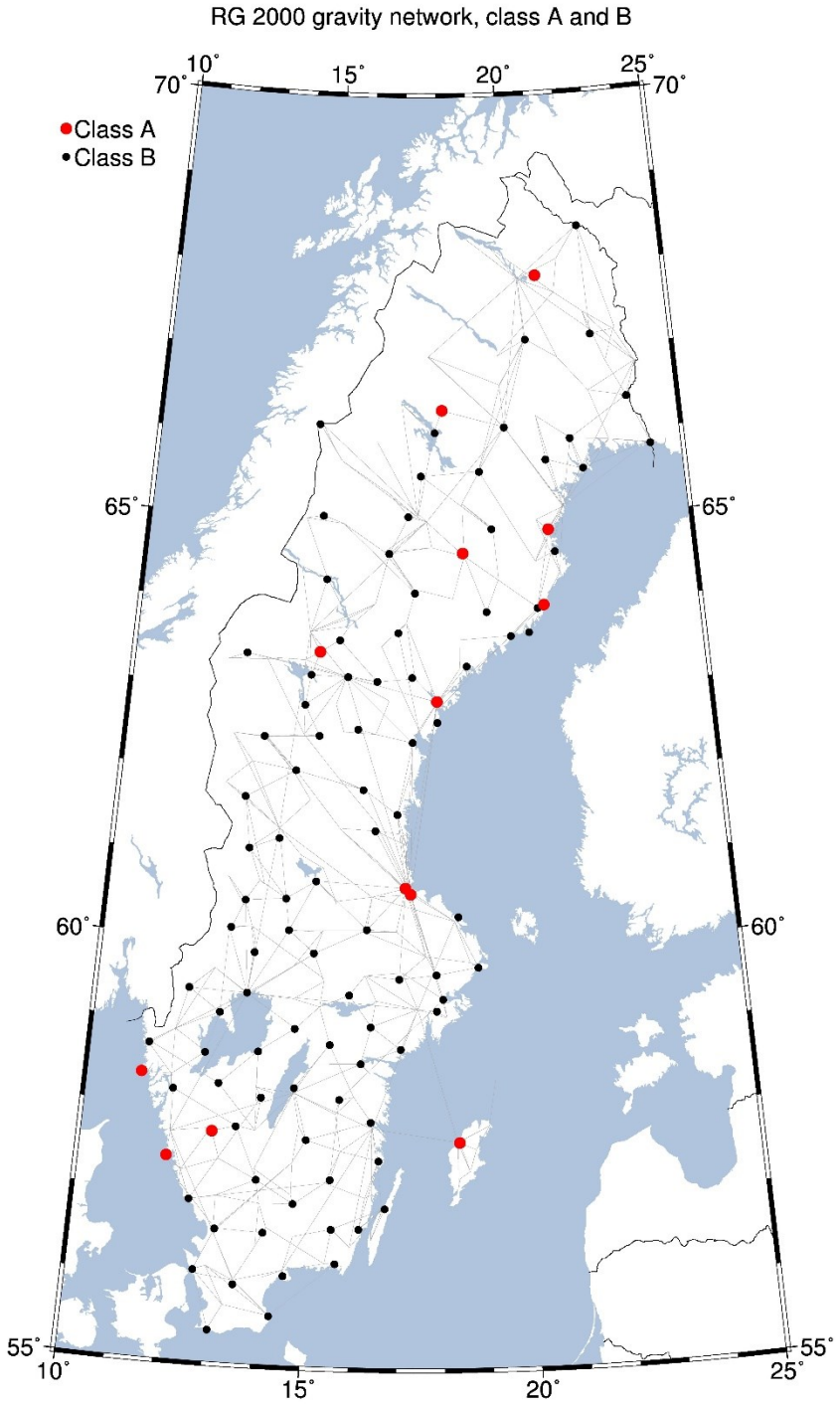



Relative gravity observations

- Existing precise relative gravity observations have been re-used (1975-2002)
  - LaCoste & Romberg G-meter
- RG 2000 campaign (2015-2017):
  - LaCoste & Romberg G54
  - Scintrex CG5
- In total some 3900 observations

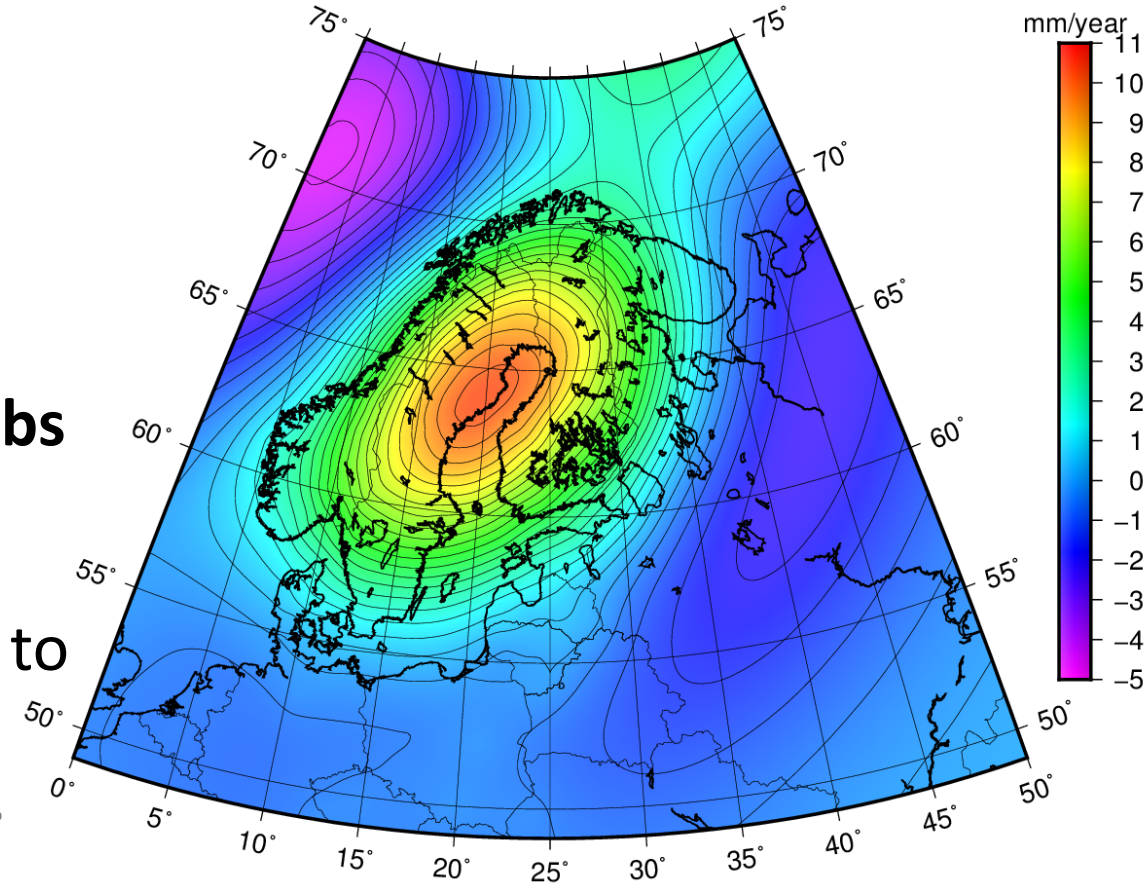
RG 2000 - definition

- The gravity reference level as obtained by **absolute gravity** observations according to international standards and conventions
- The post glacial rebound **epoch 2000.0**
- It is a **zero permanent tide** system



RG 2000 - realization

- The FG5-233 observations are corrected based on results from **international comparisons** (Olsson et.al. (2015b))
- The **land uplift model NKG2016LU_abs** was used to get to the post glacial rebound epoch of **2000.0**
- The value **-0.163 µGal/mm** was used to convert the geometric absolute land uplift to gravity change (Olsson et. al. (2015a) and Olsson et. al. (2018))



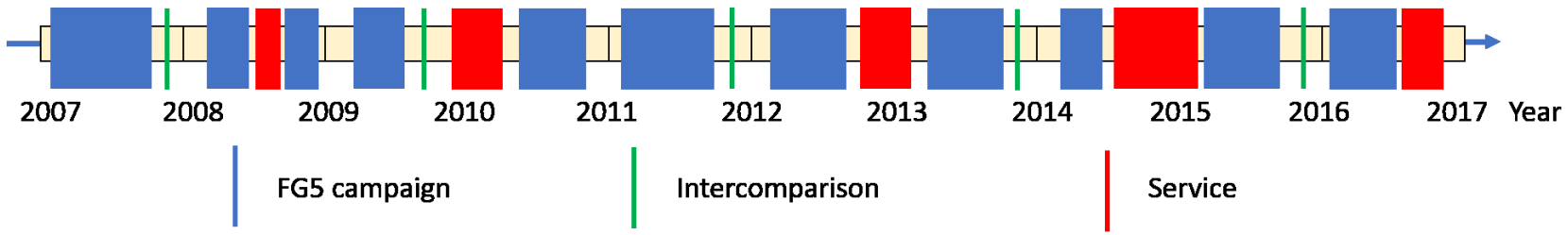
NKG2016LU_abs

Preparations of FG5 data

- The FG5 data for each point and year has been:

  1. transferred to the ground through the measured gravity gradient

  2. been corrected by the offset value from the intercomparison with the most fitting date.

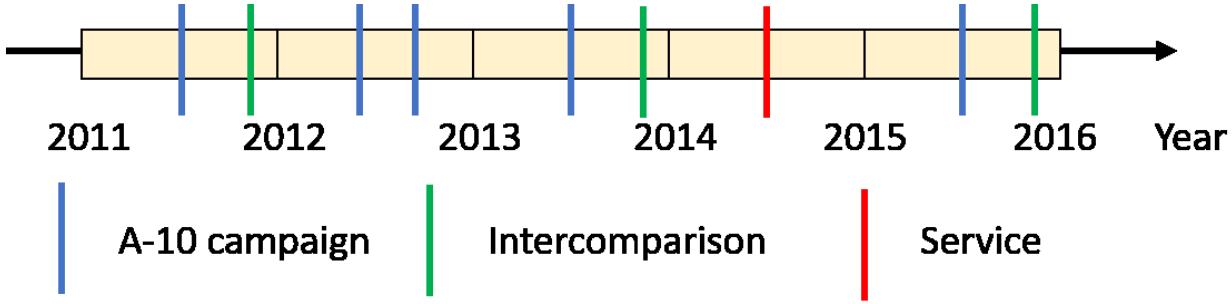


  3. been recalculated to the land uplift epoch 2000.0 using the model RG2000_gdot

- An average gravity value of each point has been used as input data

Preparations of A-10 data

- The A-10 data for each point has been:
  1. transferred to the ground through the measured gravity gradient
  2. corrected by the offset value from the intercomparison with the most fitting date. The offsets were +1.0, -4.7 and -8.9 µGal in the three intercomparisons. The first three campaigns were corrected by -1.0, the fourth campaign was corrected by +4.7 and the fifth campaign was corrected by +8.9 (see Francis et al (2014) and Palinkas et al (2016))



  3. been recalculated to the land uplift epoch 2000.0 using the model RG2000_gdot

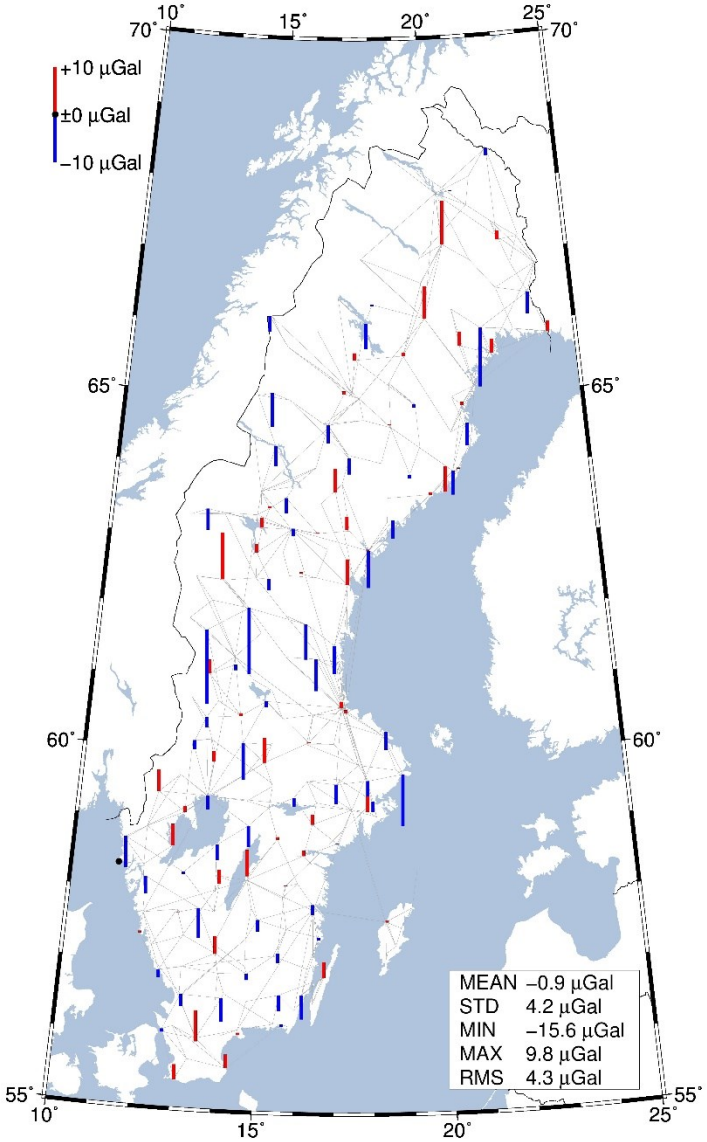
- The recalculated gravity value has been used as input data here. For the points which have been measured twice, the recalculated average value has been used

Adjustment of RG 2000 – weighting

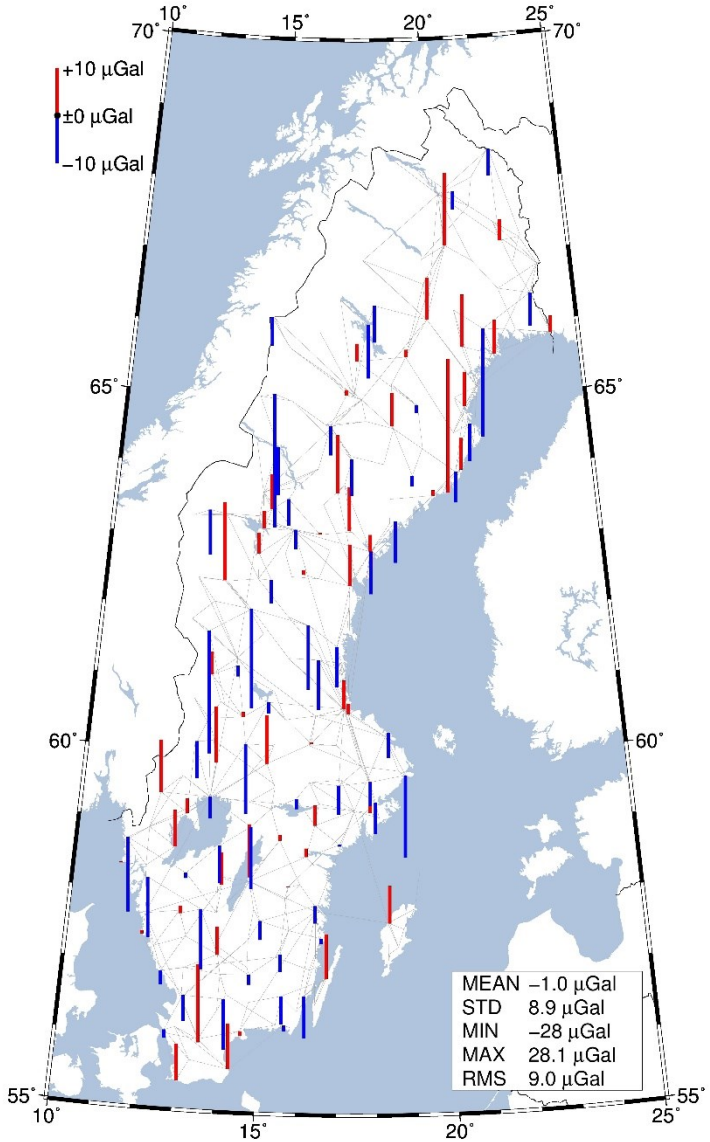
	A priori standard uncertainty (µGal)	A posteriori standard uncertainty of unit weight
FG5	1.0	1.28
A10	5.0	1.32
Rel. grav	Varying, but typical ~10	0.74
All obs		0.76

Results final adjustment of RG 2000

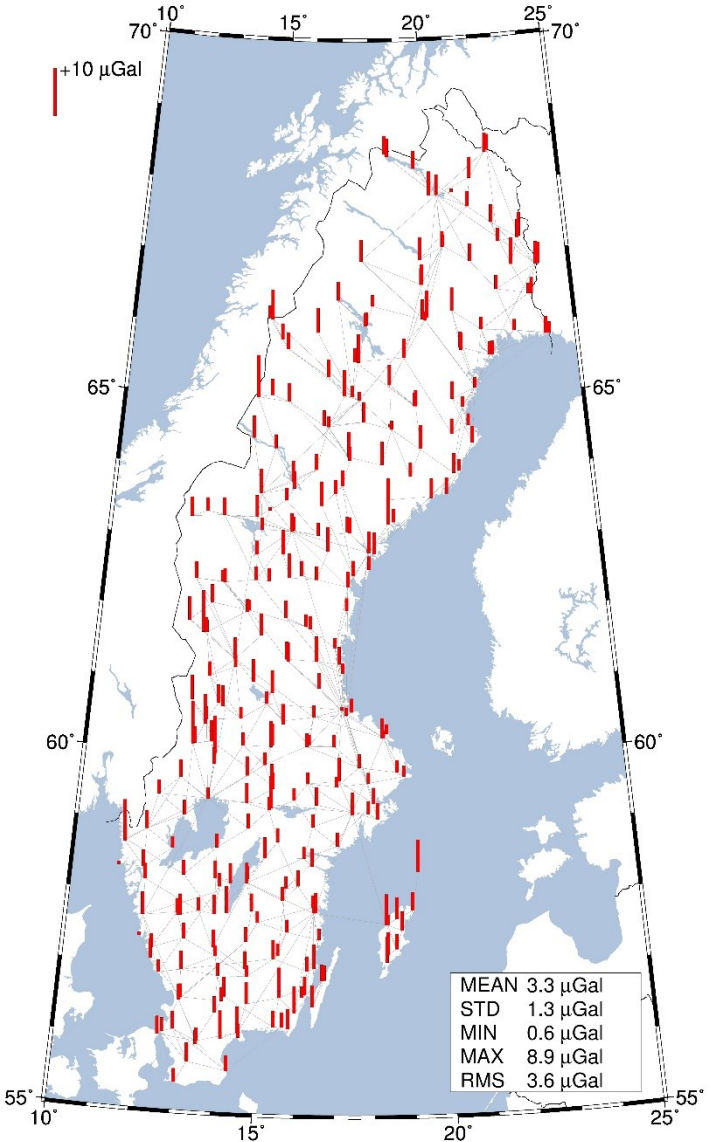
AG residuals
4.3 µGal RMS



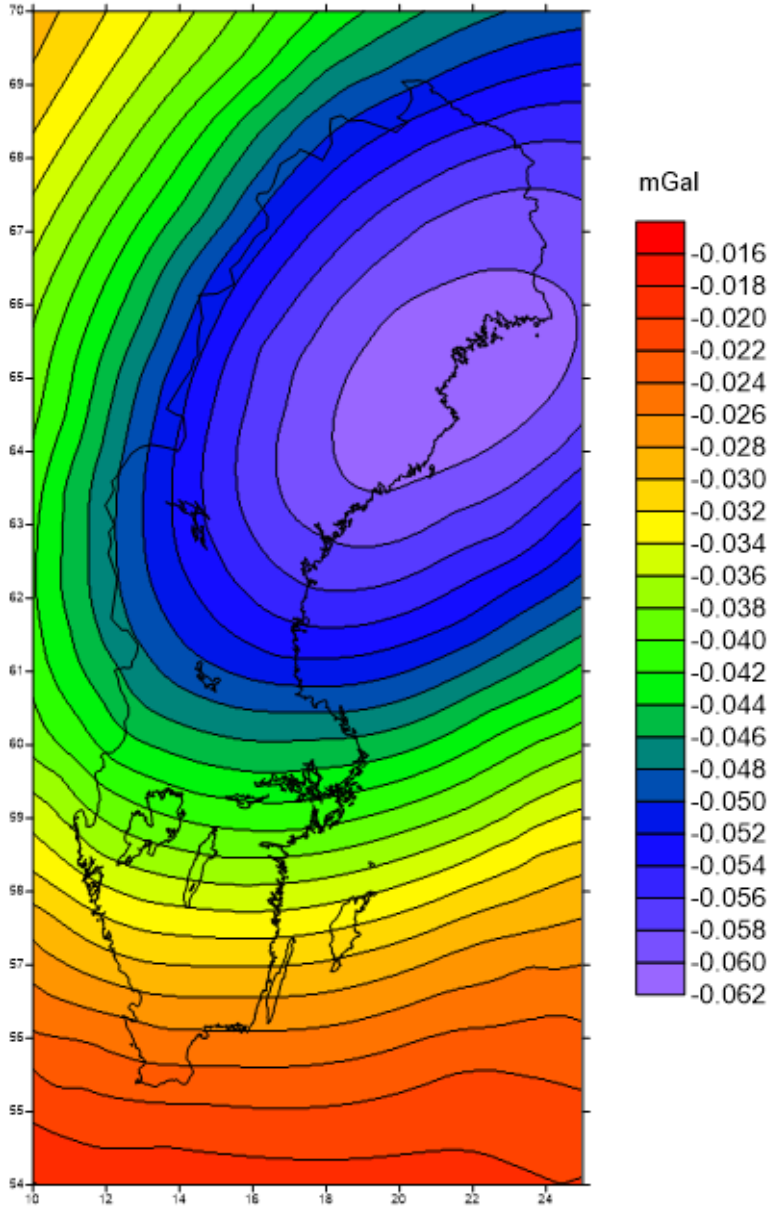
AG cross validation
9.0 µGal RMS



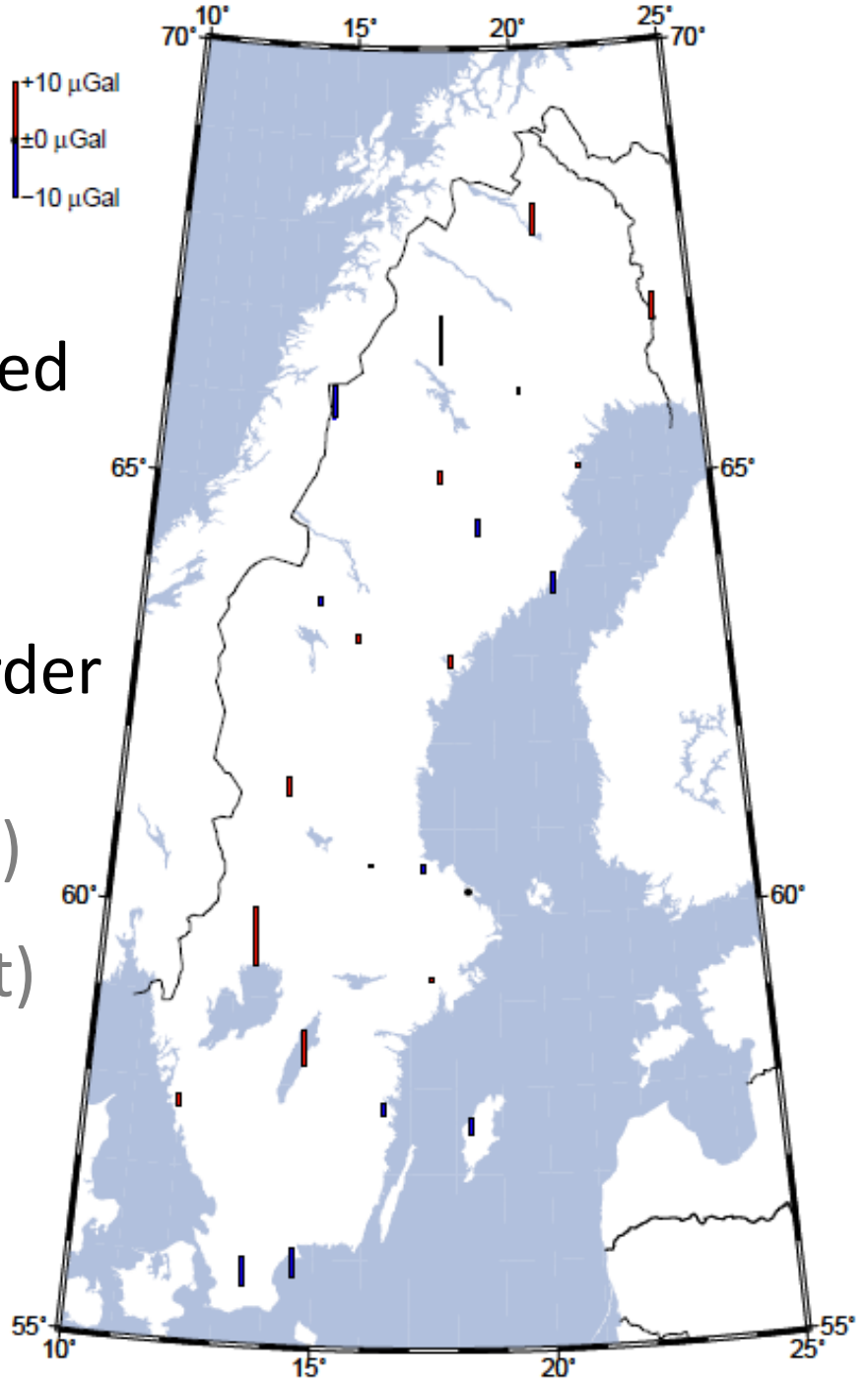
Estimated standard uncertainty
3.6 µGal RMS



RG 2000 - transformations

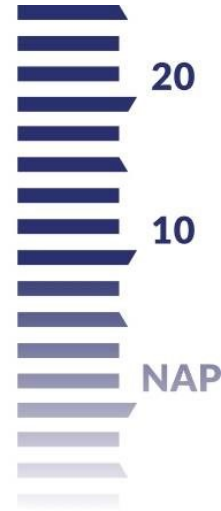


- Transformation from old RG 82 to RG 2000 is needed
- Apply correction for land uplift (2000-1982)
- Make 3 par fit using 1st order points of RG 82
- RMS of fit: 4.5 µGal (right)
- Direct correction grid (left) (-16 to -62 µGal)



Thank you for your attention!

Discussions?



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