Nordic Geodetic Commission
Joint Meeting of
Working Group for Geodynamics
Working Group for Satellite Geodesy
Working group for Geoid Determination
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National Report for Finland

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This report covers activities by the Finnish Geodetic Institute (FGI) roughly since the previous WG meeting in November 2000 in Onsala.

1. Gravity surveys

The densification of the national gravity network was continued near the city of Tampere. Altogether 496 new stations were measured at the density of 2 points/km^2. GPS-positioning in combination with adjusted geoid models was used.

2. Geoid modelling

The FIN2000 geoid (or height reference surface) is an adjusted version of the Nordic geoid NKG96 in Finland. Its epoch is 2000.0 and it refers to orthometric heights in the N60 height system. It is based on 193 GPS/levelling points; 25 percent of them are points of precision levelling. Residual fitting error is 29 mm (root-mean-square).

3. Land uplift gravity lines

The Finnish part of the land uplift gravity line 65ºN has been observed in 1975, 1980, 1981, 1999 and 2000. The relation between gravity change and apparent land uplift is -0.20 ± 0.06 µgal/mm (one-sigma), determined from relative rates between the four stations.

4. Absolute gravimetry

Regular absolute measurements in Metsähovi with the JILAg-5 have been continued, typically once or twice per month when the meter has not been travelling.

In January 2001 absolute gravity was re-observed at the Finnish Antarctic base Aboa (φ = 73º03' S, λ = 13º24' W). The change in gravity relative to the first measurement in January 1994 is +9 ± 7 µgal (one-sigma). In March absolute measurements were made in South Africa at the stations Paarl and Sutherland. The station in Sutherland is co-located with the superconducting gravimeter of GeoForschungsZentrum Potsdam.

The FGI participated in the Sixth International Comparison of absolute gravimeters (ICAG 2001) at the BIPM (Bureau International des Poids et Mesures) in Sèvres, July 2001.

Two sites (B1, B) were occupied with the JILAg-5 and two stations (A, A2) with a hybrid instrument (JILAg-5 with the JILAg-1 interferometer).

5. Superconducting gravimetry

The superconducting gravimeter GWR T020 is recording in Metsähovi since August 1994, sampling gravity once per second. It participates in the Global Geodynamic Project, with data exchange and co-operation with 18 other stations.

The gravimeter functions as an ultra-long-period seismometer, too. In June 2001 the Institute of Seismology (University of Helsinki) installed an STS-2 seismometer next to it. The combination of two instruments improves possibilities to study the free oscillations of the Earth.

Research into the influence of environmental parameters continues. To get a better hold on the local hydrology, the thickness of soil layers around the station has been mapped by the Geological Survey of Finland. Water level in two wells, precipitation, and snow cover around the station and on the roof of the building are monitored. Hydrology-related variation in gravity at the station reaches 6 µgal peak-to-peak.

The variation in the level of the Baltic is well visible in gravity residuals (Figure 1). Modelling is under way.

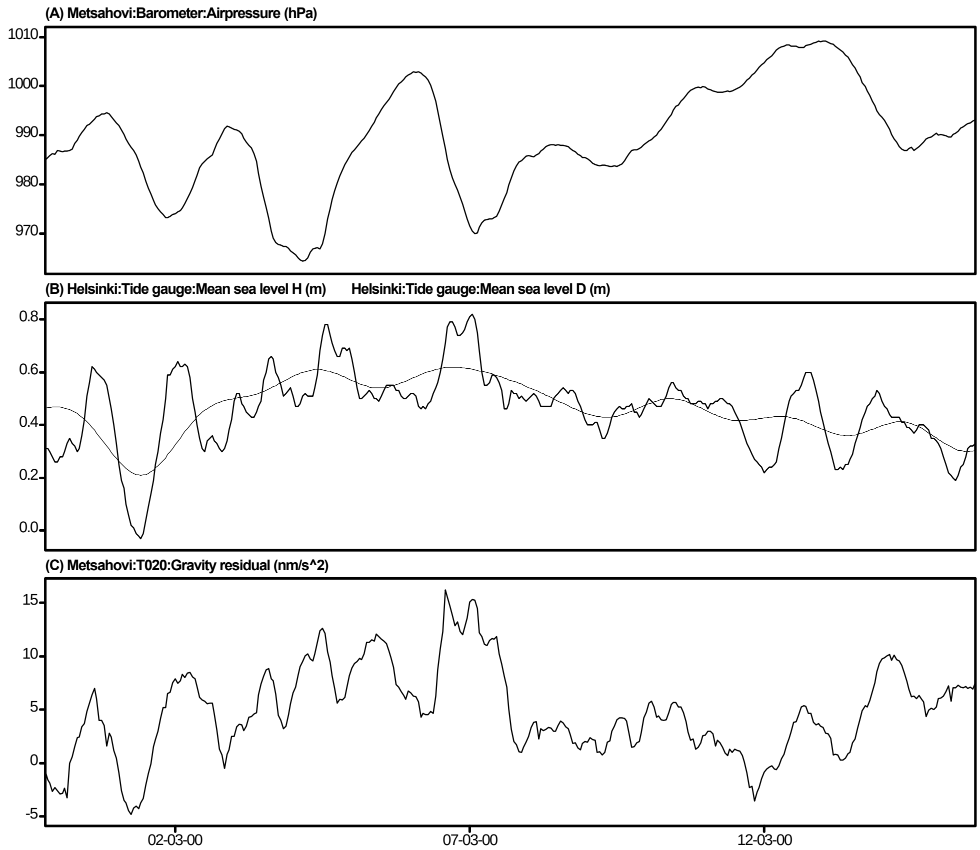

Figure 1. Top: Air pressure at Metsähovi (unit hPa). Center: Sea level in Helsinki, hourly values (metres). The thin line is a spline fitted to diurnal means and is clearly inadequate to describe gravity. Bottom: Gravity residuals from the superconducting gravimeter at Metsähovi (unit nm s^{-2}). Horizontal scale is 5 days per division.

7. Local deformation studies

In co-operation with the Finnish POSIVA company, the Finnish Geodetic Institute established three highly precise GPS monitoring networks in 1994–1995. The networks are Olkiluoto (observed 10 times 1995–2000), Kivetty (8 times 1996–2000) and Romuvaara (8 times 1996–2000), around permanent GPS stations carrying the same name. The networks have a diameter of 2…3 km.

The largest baseline change rates are 0.4…0.6 mm/yr (in absolute value), barely exceeding the accuracy of the GPS observations. The strain parameters solved are smaller than their standard errors. In order to get more reliable results, the measurements will be repeated this year and in coming years.

Studies on the complex fracture zone in Kolari, North Finland were continued. The GPS network (at approximately $\varphi = 67°03'$ N, $\lambda = 24°04'$ W) over Nuottavaara fault was re-observed in June 2000. Previous measurements had been performed in 1991, 1992 and 1995. No significant movements have been detected.

The two micro-networks ($\varphi = 67°10'$ N, $\lambda = 24°24'$ W) over the postglacial fault at Pasmajärvi, last observed in June 2000, were re-levelled in September 2001. This work was prompted by an $M = 2.9$ earthquake (epicentre $\varphi = 67°10.8'$ N, $\lambda = 24°36.4'$ W, depth 4.0 km) in the same fracture zone on May 2, 2001.

8. Renovation of the water-tube tiltmeters

The combined effect of the thermal expansion of the tube, end vessels, liquid fill, and interferometer has been modelled for different materials and constructions. Various interferometer setups, and the automatic interpretation of fringes have been studied (Figure 2).

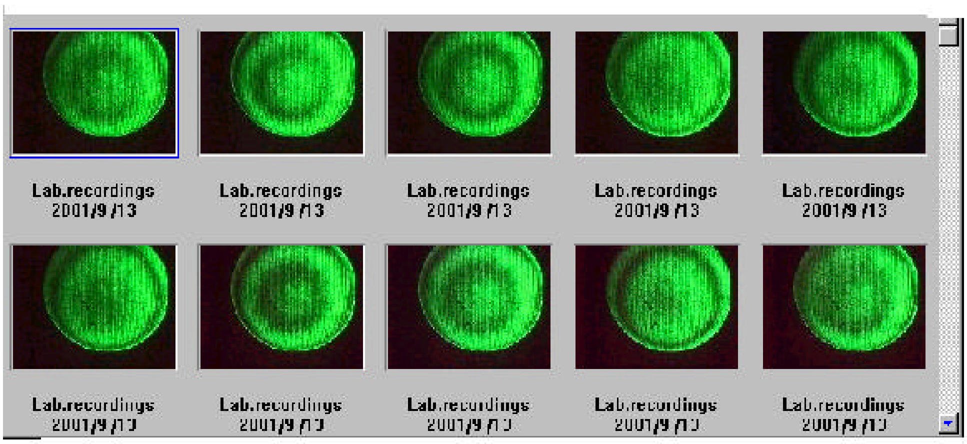

Figure 2. First fringes captured with a web camera in a "quick-and-dirty" setup. A Fizeau interferometer with green HeNe laser and fiber optics are used to detect variation in fluid level.

9. Postglacial rebound from repeated precise levelling

Figure 3a shows vertical velocities determined from three precise levellings in Finland. Third Levelling data up to the field season 2000 are included. In 2001 altogether 405 km has been levelled (not yet used in the map).

10. Finnish Permanent GPS Network FinnRef®

FinnRef® has been fully operational with 12 stations since 1996. Lightning again did damage during the summer, but otherwise the network has functioned well. The data of the four stations (METSähovi, VAASa, JOENsuu and SODAnkylä) that belong to the EPN (EUREF Permanent Network) are processed in the following centers: NKG (The Nordic Geodetic Commission GPS data Analysis Center, Chalmers University of Technology and Onsala Space Observatory, Sweden), COE (The Centre for Orbit Determination in Europe, Astronomical Institute of the University of Bern, Switzerland), and WUT (The Warsaw University of Technology, Warsaw, Poland). METS data is also processed in the IGS analysis centres. In addition, the whole network is processed at OSO (Onsala Space Observatory) for the BIFROST solution, and at FGI (Finnish Geodetic Institute) for a solution relative to METS.

The FGI solution has been used to study periodicities in GPS time series.

Figure 3b shows postglacial rebound determined from weekly FGI solutions. The results agree (Figure 4) with rebound determined from three precise levellings, and with tide gauge solutions.

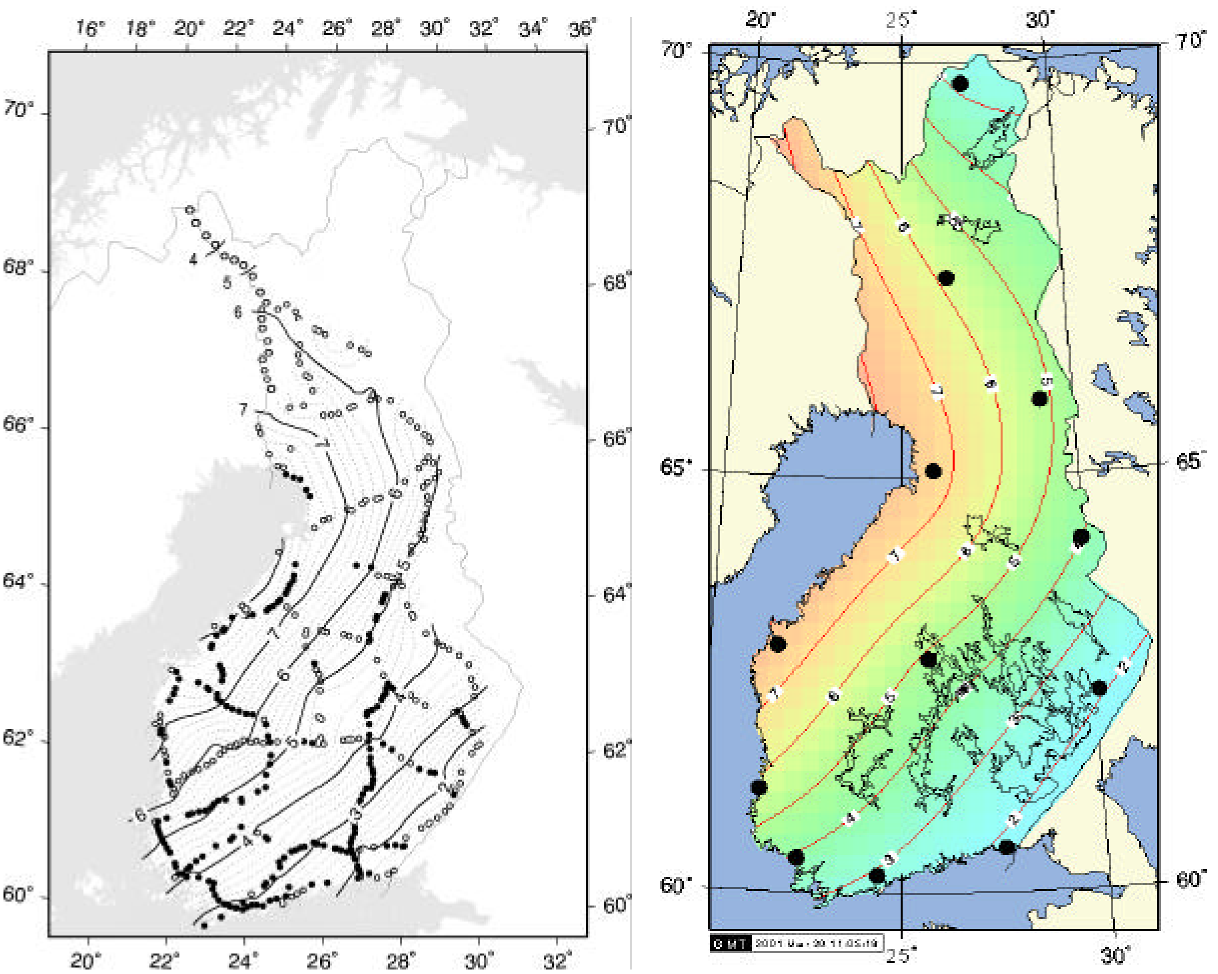

Figure 3. (a) Left: Vertical rebound rates relative to mean sea level, in mm/yr, from three precise levellings and the tide gauge in Hanko. Solid circles are bench marks that belong to three levellings, open circles belong to two levellings: (b) Right: Vertical rebound rates from GPS time series (FGI weekly solutions relative to Metsähovi). Metsähovi was fixed at 2.9 mm/y from map (a).

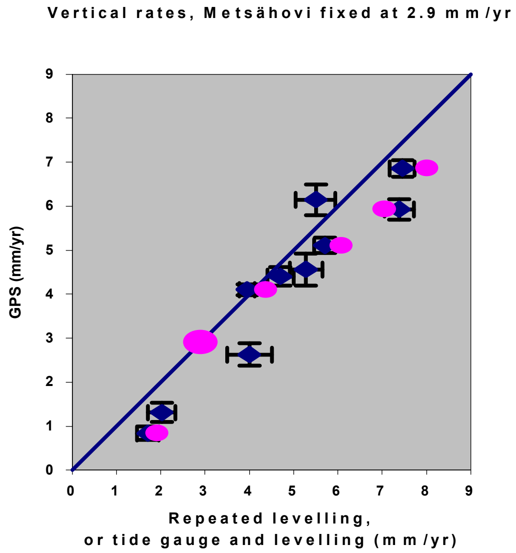

Figure 4. Vertical rates from Figure 3 compared at permanent GPS stations. Diamonds denote GPS rates vs. repeated levelling. Error bars are formal one-sigma. At 6 sites independent results from tide gauges are available. Ellipses denote GPS vs. tide gauges. Metsähovi is fixed at 2.9 mm/yr.

- Slope depicted is 1.00
- Expected slope is about 1.05 (the geoid contribution)
- Slope of estimated linear relationship using "orthogonal regression" (equal variances in x and y) is 1.02
- 95% confidence interval for slope is (0.79,1.32)
- Residual error 0.42 mm/yr in both x and y

11. Space geodesy at Metsähovi

Satellite Laser Ranging (SLR) is operative. Improvement of the new SLR system continues in co-operation with the University of Latvia. Preparations for geodetic VLBI have started in co-operation with the Radio Laboratory of the Helsinki University of Technology (HUT). For the VLBI, FGI has ordered a geodetic S/X-receiver from TTINORTE (Spain). GLONASS reception and the DORIS beacon are operative.

12. Satellite gravimetry

The new satellite missions (CHAMP, GRACE and GOCE) and the possibilities of using their data in Finland and surrounding areas are studied in a FGI project partially funded by the National Technology Agency (TEKES). An FGI/HUT group has been accepted as CHAMP co-investigators, thus gaining access to CHAMP data.

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