National Report of Finland

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1. The Finnish permanent GPS network FinnRef®

The Finnish permanent GPS network FinnRef® (Fig. 1 and Fig. 3) at present consists of 12 stations. Station no. 13 at Degerby tide gauge (N=60º02', 8=20º23') in the Aland Islands will start later this year. All stations have two-frequency receivers, choke ring antennas, and meteorological sensors. Both the GPS and the meteorological data are collected into receiver memory, and downloaded to the Finnish Geodetic Institute (FGI) once every 24 hours. METSähovi is a station of the International GPS Service (IGS) network. JOENsuu, METSähovi, SODAnkylä, and VAASa belong to the EUREF Permanent Network (EPN). METSähovi, VAASa and Degerby are TIGA stations. All FinnRef® stations are used in the computation of the joint Nordic GPS network. FinnRef® forms the backbone for Finnish GPS point densifications and enables the study of the crustal motions of the Earth.

By the end of 2002 all stations except three (OLKIluoto, KIVEtty and ROMUvaara) will be attached to the precision levelling network.

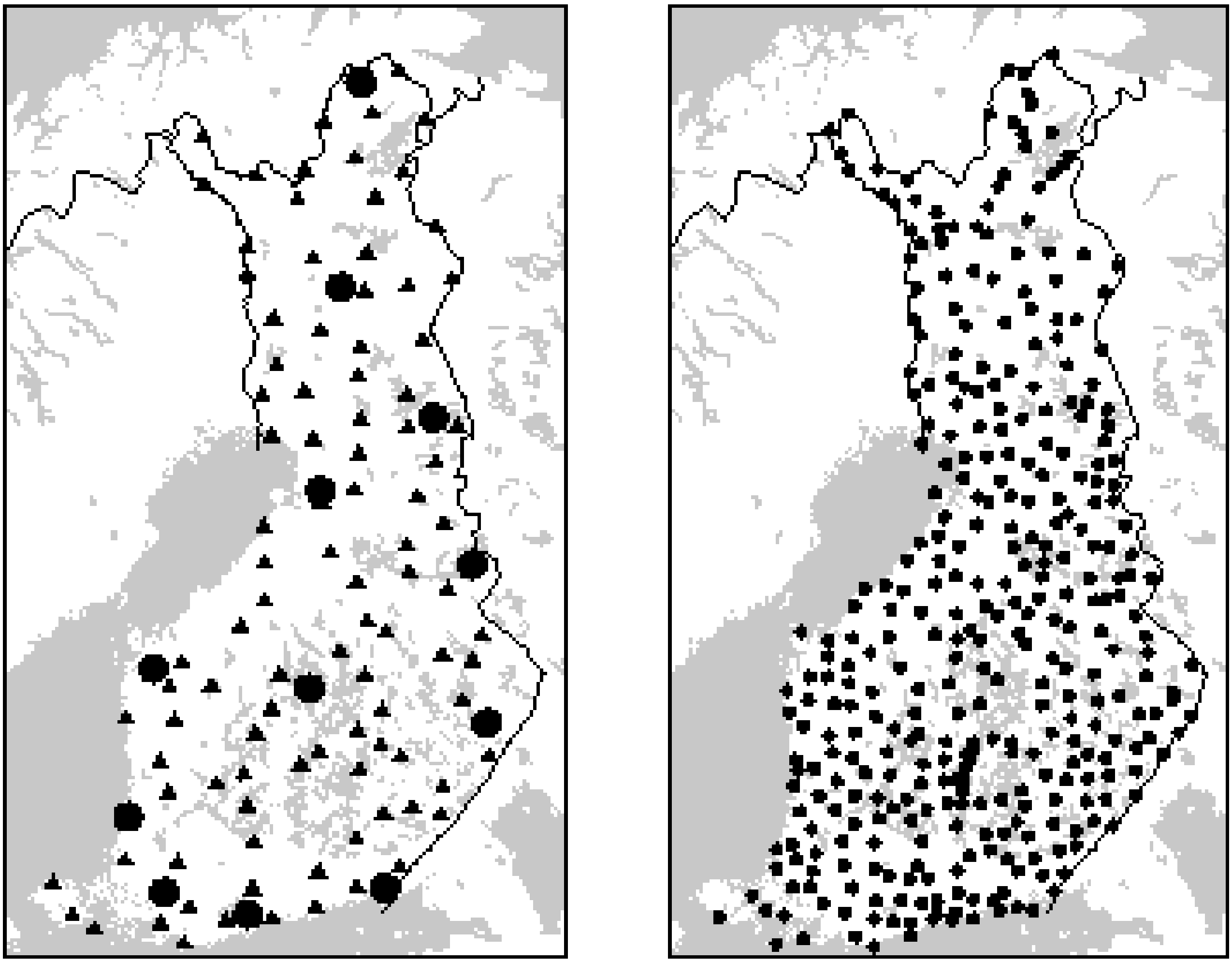

Fig. 1. Left: The 12 stations of Finnish permanent GPS network FinnRef® (solid circles), and the 100 points of the first EUREF-FIN densification phase (triangles). Right: The 350 points of the second phase.

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2. The densification of the EUREF

Nineteen EUREF-FIN points by the Finnish Geodetic Institute were accepted as official EUREF-points at the meeting of the EUREF subcommission in Prague, June 5, 1999. They are the 12 FinnRef® stations, 5 GPS-observation pillars close to tide gauges and 2 first-order triangulation points.

Observations in the FinnRef® network are the basis of the densification. The 100 points (Fig. 1) of its first phase define the EUREF-FIN coordinate system (OLLIKAINEN et al., 2000). They are mostly first-order triangulation points, which reliably tie Finland's current system to EUREF.

This choice also helps to preserve the points. In the second phase, about 350 points (Fig. 1) were measured in 1998–1999, and the results published in 2001 (OLLIKAINEN et al., 2001). The points of the second phase are intended as easily used starting points for surveying and mapping. They are mostly lower-order triangulation points measured by the National Land Survey of Finland.

3. Studies in the Finnref® network

The Finnref® stations are used in the BIFROST (Baseline Inferences for Fennoscandian Rebound Observations Sea Level and Tectonics) project where 3-D deformation is estimated using precise point positioning (JOHANSSON et al., 2002; MILNE et al., 2001; SCHERNECK et al., 2002). Relative motions in the Finnref® were studied by MÄKINEN et al. (2001) using Bernese software. The relative uplift rates from four years of data agree with repeated precise levelling and tide gauges to better than 1 mm/yr (Fig 3).

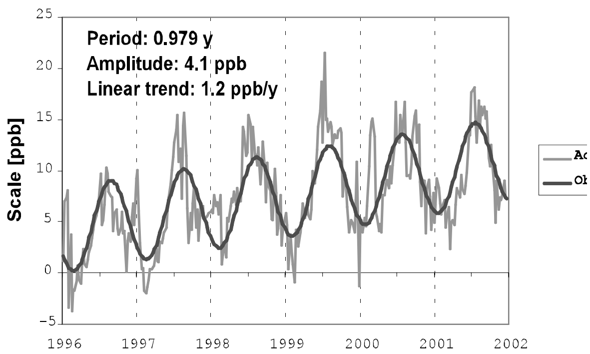

Fig. 2. Scale factor from the 7-parameter Helmert transformation between the first weekly solution and other weekly solutions in the entire Finnref® network (KOIVULA et al., 2002).

Periodic phenomena were investigated by POUTANEN et al. (2001) and KOIVULA et al. (2002). An annual period can be seen in all vector components between all stations, in baseline lengths, and in the scale of the network (Fig. 2). The annual variation in scale has amplitude of about 4×10^{-9}. It could be due to errors in tropospheric modelling, to loading phenomena, etc. E.g., a simultaneous variation in height at all stations with amplitude of 25 mm would produce 4×10^{-9} in scale. The scale changes secularly 1.2×10^{-9}/yr (Fig. 2); this could be due to postglacial rebound.

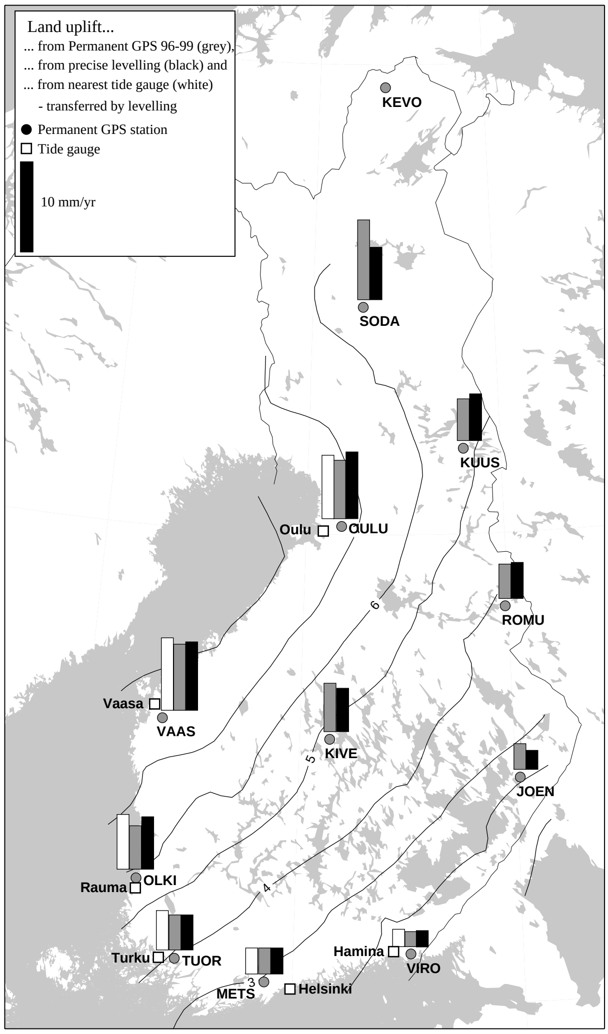

Fig. 3. Uplift rates from permanent GPS, repeated levelling, and tide gauges close to the GPS stations. All are taken relative to METSähovi, which was assigned the value 2.9 mm/yr. Contour lines are from repeated levelling. Field work of 2000 and 2001 is not included. Details in MÄKINEN et al. (2001)

4. The Third Levelling of Finland

In 2001 altogether 411 km of double-run levelling was performed by three field teams. This includes 400 km in the Third Levelling network (Fig. 4), and the control levellings of all tide gauges. The digital levelling system Zeiss DiNi12 was used.

Development of a system calibration facility for digital levels was continued and first results were promising.

Various methods of modelling vertical motion were studied, particularly in view of joint Nordic velocity models.

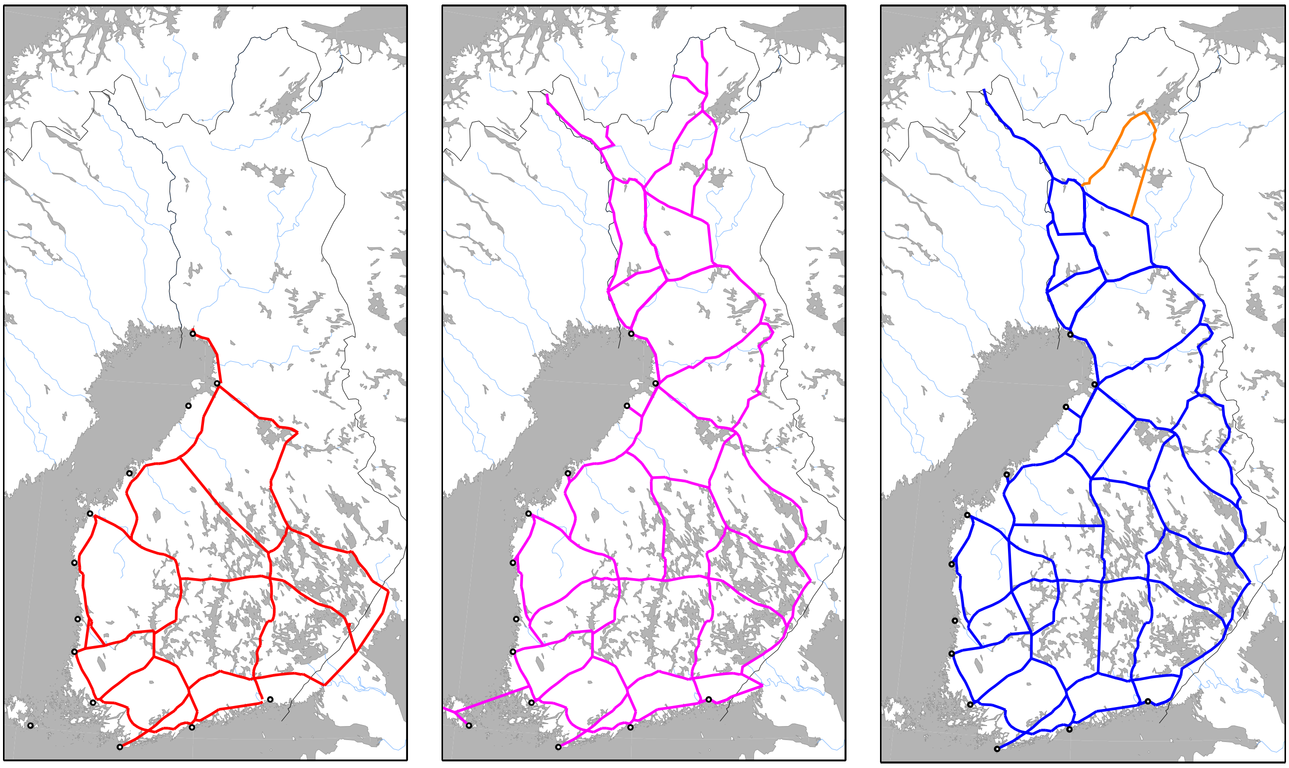

Fig. 4. Networks of the three precise levellings in Finland. The representation is in part schematic, with straight lines connecting nodal points. Tide gauges are shown by circles.

(left) First Levelling (1892–1910). Accuracy estimated from loop misclosures is 1.3 mm/Ökm. Mean epoch is 1902.

(middle) Second Levelling (1935–1975). Accuracy estimated from loop misclosures is 0.7 mm/Ökm. Mean epoch of the part now covered by Third Levelling is 1948.

(right) Third Levelling (1978–), status after field work of 2001. The lines levelled in 2001 are indicated by a different hue. Accuracy estimated from loop misclosures is 0.8 mm/Ökm. Mean epoch is 1991.

5. Navigation and Positioning

In 2001 a new department, Navigation and Positioning started at the FGI. Its research topics are the new Global Navigation Satellite System (GNSS) technologies, intelligent navigation, multi-sensor positioning and real time mapping systems. During 2001 the focus was on defining the research topics of the department and on planning the research projects.

Preparations were started in cooperation with the European Space Agency (ESA) to establish a Ranging and Integrity Monitoring Station (RIMS) of the European Geostationary Navigation Overlay Service (EGNOS) in Finland. The RIMS will be important when developing the ground segment of EGNOS, which will ensure a better navigation service in Finland once the GALILEO satellite navigation system is in operation.

The development of a system to receive the EGNOS SIS (Signal In Space) using a Pocket PC was started at the end of 2001. The development work is important for the EGNOS users in Nordic countries because it will make it possible to access the EGNOS services on the fly over the wireless network and the Internet, without the limitation of the low elevation angles to the geostationary satellites. The implementation of the system will be completed in 2002 in cooperation with ESA.

6. Geoid models

The FIN2000 tailored geoid model (Fig. 5) was developed by OLLIKAINEN (2000) from the Nordic geoid NKG-96 (FORSBERG et al., 1996). Various geoid models were studied by comparing them with GPS/levelling points.

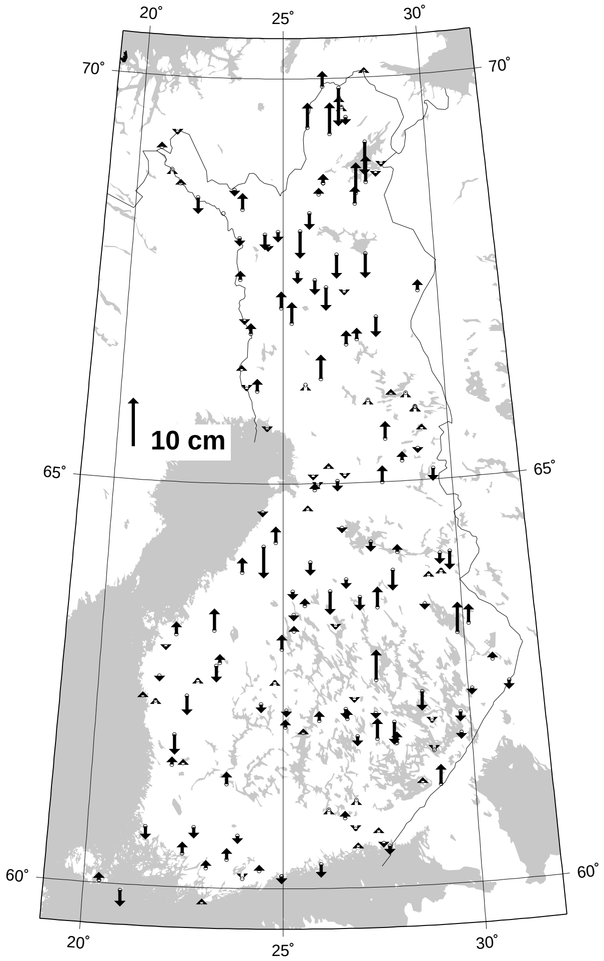

Fig. 5. The FIN2000 tailored geoid model is obtained by a fourth-degree polynomial fit of the Nordic geoid NKG-96 to GPS/levelling points in Finland. These are the residuals from that very fit.

7. Metsähovi research station

The Metsähovi research station was founded in 1978. Its current satellite laser ranging system was acquired in 1994 and it is continually being upgraded. It consists of a 1-m telescope, made by the University of Latvia (Riga), and a mode-locked Nd:YAG laser with 50 ps pulse length. Typical ranging precision is 25 mm. The data are submitted to the International Laser Ranging Service. During 2001 altogether 92577 observations on 544 orbits of 16 satellites were made.

The permanent GPS receiver started operations in 1992 and it is a part of the International GPS Service (IGS) network. A GPS/GLONASS receiver was installed in 1998 and the DORIS beacon in 1991. The superconducting gravimeter GWR T020 is recording in the gravity laboratory since 1994, and the time series of absolute gravity with the JILAg-5 goes back to 1988.

Preparations for geodetic VLBI are in progress, in cooperation with the Metsähovi Radio Observatory of the Helsinki University of Technology. First test observations are expected to take place in 2002.

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