Acceleration of free fall

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Finnish Geospatial Research Institute, FGI

The Finnish Geospatial Research Institute, FGI, of the National Land Survey of Finland maintains measurement standards for geodetic and photogrammetric measurements and is the National Standards Laboratory of acceleration of free fall and length. The FGI takes care of the fundamental measurements in Finnish cartography and of geographical information metrology and carries out scientific research in geodesy, geographic information sciences, positioning, navigation, photogrammetry and remote sensing.

Methods and traceability

The national measurement standard is the absolute gravimeter FG5-221. Its results are directly traceable to length and time standards. We have participated in all international comparisons since the year 1989. At a customer's site the measurements are usually performed with a relative gravimeter, measuring the gravity difference with respect to a point with known gravity.

Acceleration of free fall and gravity

The acceleration of free fall depends on location and time. The time dependence originates from tidal forces (variation in Finland 3 µm s^{-2}) and from mass variations of groundwater and atmosphere (at least an order of magnitude smaller). When the most important time variations are removed from the acceleration of free fall by using agreed methods, the result is the acceleration due to gravity, which can be treated as a time independent quantity..

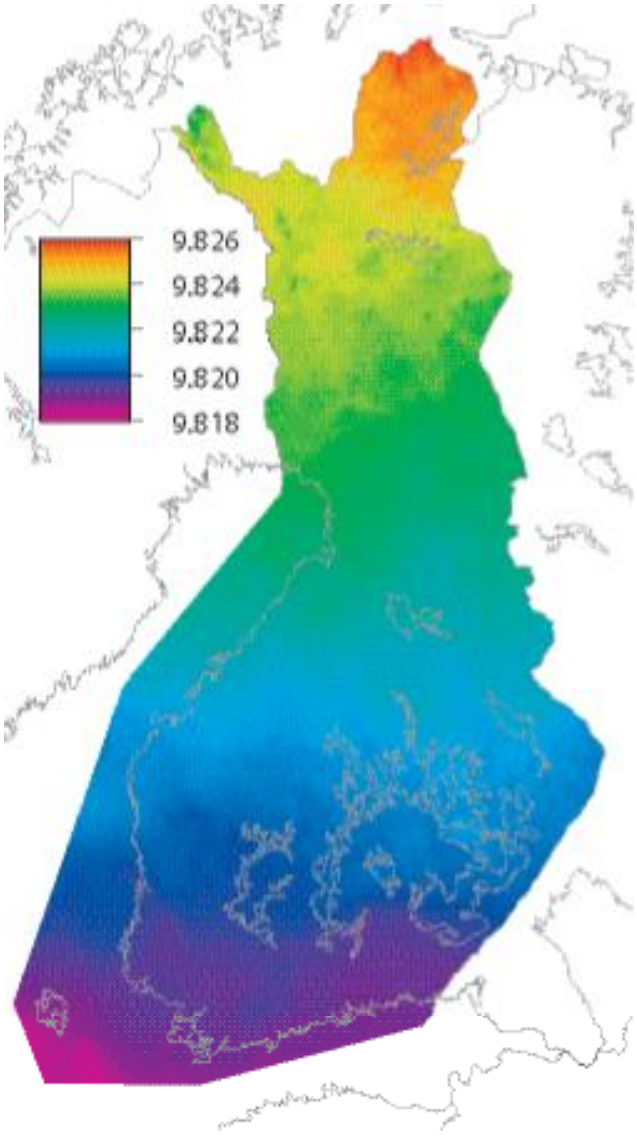

Figure 1. Acceleration of free fall in Finland, unit m s^{-2}.

Calibration services and uncertainty

We measure gravity at requested sites and report the value for the acceleration of free fall. The time variation is included in the uncertainty of 4 µm s^{-2} (k=2). If needed, we supply an accurate value for gravity (the smallest uncertainty is 0.008 µm s^{-2}) and methods to predict the time variation (the smallest uncertainty 0.10 µm s^{-2}). We maintain an open calibration line where customers can verify their gravimeters.

Research, development and reporting

We carry out research and develop national infrastructure for measurements of gravity and acceleration of free fall for all applications (e.g geodesy, geophysics and geology). With the help of the 30 000 points in the national gravity grid, the acceleration of free fall can be estimated with an accuracy of 0.1 mm s^{-2} without any new measurements. We have performed measurements using absolute gravimeters in 20 countries.

Figure 2. A measurement using a relative gravimeter.

Figure 3. The absolute gravimeter FG5X-221 is based on a free fall experiment.

Figure 4. Superconducting gravimeter (Metsähovi, Kirkkonummi) registers even 0.1 nm s^{-2} variations in the acceleration of free fall.