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Vertical gradient evaluation and the reduction of absolute gravity results in Estonia

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Since the beginning of the 1990s absolute gravity values have been determined three times in Estonia: In 1995 at three stations by the Finnish Geodetic Institute (FGI), in 2007 at two stations by the Institut für Erdmessung (IfE), University of Hannover, and last year at seven stations again by FGI. During these campaigns two stations, Suurupi and Tõravere, were occupied three times and Kuressaare station twice. The first campaign in 1995 was carried out with the JILAg-5 absolute gravimeter, which measures gravity at about 0.85 m height above the pier. The measurements in 2007 and 2008 were performed with FG5 instruments where the corresponding figure is 1.2 m. These absolute measurements have many scientific and practical applications. Currently the most important outputs in Estonia are the realization of the national gravity system and the constraints for gravity change due to postglacial rebound.

For determining gravity change with time, absolute measurements made at different heights need to be compared. In the realization and subsequent use of the national gravity reference network, relative gravimeters which may have different sensor heights are mounted directly on the pier, or possibly on the various types of tripod. Therefore it is important to know the change of gravity as a function of height above the marker at the absolute stations. However, there are usually local mass anomalies, in particular massive piers constructed for the absolute gravimeters that make gravity a strongly non-linear function of height, i.e. the vertical gradient of gravity is not constant. To deal with this problem in the reduction of the gravity value from the observation height of the absolute meter to other heights we apply three methods: (i) theoretical modelling of the effects of local masses, (ii) observing gravity at different heights with relative gravimeters with subsequent fitting of a polynomial function of height to the data, (iii) combination of the two, where the polynomial function is fitted to the gravity data after removing the theoretical influence of local masses from the data ("remove-restore"). We use absolute gravity results as well as relative gravity observations above the concrete piers of Estonian absolute stations to test these three methods for the vertical gradient evaluation. We present examples how different approaches may affect the accuracy of the national gravity network, or the deduction of gravity change from the comparison of absolute measurements at different heights.