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The GeoMetre project: a comprehensive study to advance local tie metrology

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Abstract. Local tie vectors are essential to spatially correlate the observations of different space-geodetic techniques at space-geodetic co-location sites. They play an important role for data fusion and the subsequent reference frame computation. Reducing their uncertainty further is hence frequently considered a way to reduce the uncertainty of reference frame coordinates in general. The European GeoMetre project has tackled this problem in a joint effort of 15 institutions from geodesy and metrology from multiple angles. Key studies were performed at the co-location sites of Metsähovi, Finland (METS) and Wettzell, Germany (WTZ).Local reference networks at co-location sites secure traceability of the local tie vector scale to the SI definition of the metre. The surveying networks at METS and WTZ were expanded and updated, e.g., by enabling seamless measurements performed with global navigation satellite system (GNSS) and terrestrial measurements. Furthermore, the project developed several novel instruments capable to measure distances in air with low uncertainty, based on high-frequency amplitude modulation or even absolute interferometry. They were used to measure the longer distances in the METS and WTZ networks. Another issue is the transformation of the local tie vectors measured in a local horizontal system into the geocentric reference frame in which the space-geodetic techniques report their data. Thereby, deviations of the local gravity field from the model geoid can lead to systematic deviations in the height and the deflection of the vertical. Due to the significant orientation error of GNSS-based solutions on short baselines, the high accuracy of terrestrial measurements can also be substantially degraded during the transformation. To assess this problem, the project determined the local gravitational field at METS and WTZ and considered this information in the data analysis.