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Application of GNSS length metrology to CERN geodetic network

Length determination in the open field is routinely done with electronic distance meters (EDMs) that are limited in accuracy by the imperfect knowledge of the index of refraction of the light path through the atmosphere so that obtaining distances of several kilometers within an accuracy of 10-7 is a major challenge. Refractivity compensated EDMs, from the initial designs of the early 1970s (e.g. the two-color Terrameter) until the last prototypes (e.g. the Arpent and the TeleYAG by CNAM and PTB, respectively) are exclusive solutions to overcome this problem which are not commercially available. By contrast, Global Navigation Satellite System (GNSS) technologies are relatively inexpensive positioning solutions that have experienced a wide adoption in the last decades. The use of scientific or commercial software for GNSS processing meets well the requirements of geodetic, surveying, and engineering applications but fails to do so in the field of length metrology, where the accurate uncertainty budget for all contributing error sources must be provided along with the resulting distance. We present our approach to GNSS-based length metrology, where all relevant error sources are characterized along with their uncertainties at the zero differences level in a relatively straightforward way and then rigorously propagated through the particular double-differenced equations used to obtain the distance. The method is applied to the CERN geodetic network using data from a GNSS campaign in July 2022 and the results are compared with those obtained for the same epoch by means of the Kern Mekometer ME5000 EDM as well as with other data available from previous campaigns.

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