Doctoral Thesis Title: Development and validation of novel tropospheric models for a GNSS-Based Distance Meter as applied to length metrology

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Abstract:

Absolute determination of distances outdoors with uncertainty of tenths of a millimeter is target of growing interest in fields such as length metrology, unique engineering projects or deformation monitoring. The challenge, located on the limit between Geodesy and Metrology, is complex and requires an international research effort [1,2].

This thesis is focused on the development of tropospheric models applicable to the GBDM technique for the range from 10 to 5000 m with measurement uncertainty better than 1 mm and their corresponding validation in the geodetic network of CERN (Switzerland) compared to other prototypes under development. [1,2,3,4,5]. Once metrologically validated, these tropospheric models will be adapted to optimize the long-range laser scanning technique (1-3 km) also used in deformation monitoring.

Among the specific objectives are:

1. Analyze the residual tropospheric delay error contained in double difference equations (DD) for the target range and its comparison with the obtained results from continuous recording meteorological sensors (temperature, humidity and pressure).
2. Develop a DD tropospheric correction model based on meteorological data automatically measured in field, including optimization of the projection function used.
3. Adapt the tropospheric model developed to the particular case of long-range laser scanning used in deformation monitoring.

4.Implement a software module for the tropospheric correction of DD and point clouds captured by long-range laser scanning.
5.Contrast the goodness of the results obtained in field tests carried out in geodetic and metrological reference infrastructures in Europe in comparison with the prototypes currently under development (project EMPIR-18SIB01- GeoMetre).

Available Means:

The thesis is associated with the European project EMPIR 18SIB01-GeoMetre Large-scale dimensional measurements for geodesy. The geodetic networks of Cortes de Pallás and CERN will be used as test areas. Regarding the equipment, there are available 10 sensors for the automatic measurement of meteorological parameters, 2 GNSS choke-ring 3D antennas with individual calibration and GNSS receivers.

References:

[1] EMRP-JRP SIB60 Surveying (2013-2016) Metrology for Long Distance Surveying. European Metrology Research Programme H2020/EURAMET. (https://www.euramet.org/research-innovation/search-research-projects/details/project/metrology-for-long-distance-surveying/?L=0&tx_eurametctcp_project%5Baction%5D=show&tx_eurametctcp_project%5Bcontroller%5D=Project&cHash=0d07c7b88988146cc4c589ccdff84995)

[2] EMPIR 18SIB01-GeoMetre (2019-2022) Large-scale dimensional measurements for geodesy. European Metrology Programme for Innovation and Research H2020/EURAMET. (https://www.euramet.org/research-innovation/search-research-projects/details/project/large-scale-dimensional-measurements-for-geodesy/?L=0&tx_eurametctcp_project%5Baction%5D=show&tx_eurametctcp_project%5Bcontroller%5D=Project&cHash=7bbe3c07d9bea4b52c35fff5e8bde0a1

[3] Bauch, B. et al. (2016). Good practice guide for high accuracy global navigation satellite system based distance metrology. EMRP-JRP SIB60 Surveying

[4] Baselga, S., García-Asenjo, L. and Garrigues, P. (2014). Submillimetric GPS distance measurement over short baselines: noise mitigation by global robust estimation. Meas. Sci. Technol. 25, pp.1-6.

[5] Baselga, S., García-Asenjo, L. and Garrigues, P. (2015). Submillimetric GNSS distance determination for metrological purposes. 5th International Colloquium Scientific and Fundamental Aspects of the Galileo Programme. (27 - 29 October 2015, Braunschweig, Germany). (https://gssc.esa.int/activities/science-colloquium/)