A decade of international cooperation dedicated to geodynamical research

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At the end of 2011 two spring type LCR gravimeters (LCR) from Hungary were installed in the gravimetric laboratory of Conrad Observatory next to the superconducting gravity meter (SG) GWR SG025 in order to check the characteristics of these instruments. It was the beginning of a fruitful cooperation between Austria and Hungary. Later on in 2014 it was extended to a third party and nowadays global and local geodynamical phenomena are investigated by a team of Austrian, Finnish and Hungarian researchers. For this purpose, gravimetric measurements are integrated with high-resolution tilt sensors, exploiting the excellent natural and technical environment provided by the Conrad Observatory.

Almost ten years ago a research group of the Geodetic and Geophysical Research Institute (Hungarian Academy of Sciences, Sopron) and the Eötvös Loránd Geophysical Institute Budapest installed LCR G gravimeters next to the SG for testing the capabilities of LCRs equipped with a conventional CPI readout and with a CCD ocular, respectively. The latter made the LCR G949 capable to produce continuous gravity records. The chance to compare LCR observations with a leading edge instrument was unique. Although the measuring system of G949 was not yet complete, all results of the 6 months parallel observations were promising. They allowed to start a project (NKFIH-OTKA K101603) for mapping and checking tidal gravity effects in the Pannonian basin along a nearly 600 km long line extending from west (CO, Austria) to east (TRPA, Hungary) (Papp et al., 2018).

In 2014 – 2015, a 5.5 m long interferometric hydrostatic (iWT, Finnish Geodetic Institute) and a pendulum type 2D tiltmeter (LTS, LGM Lippmann, Germany) was installed in the seismological tunnel of CO. These instruments are sensitive to tilts of either the solid ground or the potential surface as small as 1 nanoradian, which is equivalent to 1 mm height change over 1000 km. The instruments are operating on the same 6 m long pier in co-located and co-oriented positions, providing consistent tilt data since April, 2016 at 15 Hz (iWT) and 1 Hz (LTS). In addition to the observation and modelling of the global tidal tilt and loading effects at the site, very interesting phenomena related to local hydrological processes have been recorded (Meurers et al., 2021). Based on the positive experience regarding both scientific and technical aspects, a new project was funded in 2018 (NKFIH-OTKA K128527), with the aim to improve the iWT system and to obtain sub-nanoradian resolution. In November 2017, the G949 tidal recording gravimeter completed by an autonomous tilt compensation platform and a remote control unit for the micrometer dial was re-installed next to SG025. Based on the parallel recorded data, an inter-comparison can be repeated and the results can be used to validate the location dependence of the ratio of tidal constituents O1/M2 which is expected to increase slightly ($< 1\%$) going from west (CO) to east (TRPA). Earlier results (Papp et al., 2018) indicated this tendency in spite of the incomplete G949 system in 2011 – 2012.

On request from The Peters Seismological Observatory (TPSO), Australia, operated by the Seismological Association of Australia, the team offered help to organize the acquisition, transfer, preparation and interpretation of tilt data recorded by a Lippmann type 2D sensor in 2018. The team was therefore handling tilt data for two years and made the first tidal analysis presented at IUGG Gen. Assembly, Montreal, 2019 (Papp et al, 2019). Right now the "Australian" sensor is hosted by CO and operates side-by-side with the "Sopron" sensor enabling an inter-comparison.

The aim of project K128527 is to build a complete biaxial and differential iWT system which is intrinsically free of instrumental drift by symmetry principles. Therefore, it may serve the investigation of long-term geodynamic processes in the future.

References:

Papp, G., Benedek, J., Varga, P., Kis, M., Koppán, A., Meurers, B., Leonhardt, R. and Baracza, M.K., 2018: Feasibility study applied to mapping tidal effects in the Pannonian basin – An effort to check location dependencies at μGal level, Geodesy and Geodynamics, 9, 237-245, https://doi.org/10.1016%2Fj.geog.2017.10.003

Papp, G., Ruotsalainen, H., Meurers, B., Benedek, J., Leonhardt, R., Hutchinson, P. and Szántó, M., 2019: Analysis of Environmental and Loading Effects in Tilt and SG Gravity Observations at Conrad (Austria) and Peters Seismological (Australia) Observatories, IUGG19-2837, Session G06l, IUGG XXVII General Assembly, Montreal

Meurers, B., Papp, G., Ruotsalainen, H., Benedek, J. and Leonhardt, R., 2021: Hydrological signals in tilt and gravity residuals at Conrad Observatory (Austria), Hydrol. Earth Syst. Sci., 25, 217–236, https://doi.org/10.5194/hess-25-217-2021

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