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Geodetic monitoring of land subsidence due to fluid withdrawal: the Houston-Galveston region case study

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Land subsidence represents the main response to deformations induced by multiple natural and anthropic phenomena (i.e. solid and fluid extraction, soil consolidation, aquifer compaction, load-induced compaction, etc.) which take place at different spatio-temporal scales (e.g. Bonì et al., 2017). The impacts of land subsidence can be infrastructural, economic, environmental, and social, and it enhances the risk of floods, affecting the human life and activities. Several localities are affected by land subsidence occurring at high rate (e.g., up to 11 cm/year as observed for instance on the Lorca basin, SE Spain; Fernandez et al., 2018).
The Houston-Galveston region represents one of the largest subsidence areas in the USA. Here, land subsidence is caused by compaction of fine-grained aquifer sediments (silts and clays) below the surface due to groundwater withdrawal. Groundwater withdrawal from local aquifers has been the primary source of water for municipal supply, commercial and industrial use, and irrigation since the early 1900s. In order to regulate it (e.g., policy, groundwater regulation and permits) the Texas Legislature created the Harrise-Galveston Subsidence District in 1975 and the Fort Bend Subsidence District in 1989. A surveying network of permanent GPS stations was established in the early 1990 with the purpose of preventing future land subsidence and better securing the local infrastructure. In the last decade, additional networks have been established by international and local agencies, reaching as of 2017, the approximatively number of 200 permanent GPS stations.
Here we updated the displacement field over the study area by analyzing an extensive GPS dataset covering the 2010.00-2019.00 time interval. Raw GPS observations have been processed by using the GAMIT/GLOBK software adopting the procedure described in Fernandez et al., (2018). Achieved results, referred to a local reference frame, are presented and discussed along with groundwater level information coming from well observations.

References

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