C06: Groundwater gravimetry with innovative quantum gravimeter in the Elbe-Weser coastal region

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Motivation

Ensure availability and sustainable management of fresh water and its sanitation:

- interdisciplinary task deploying various geophysical methods

Introduce the new potential of quantum gravimeters to hydro-geophysics for monitoring the dynamics of groundwater:

- storage of rainfall water
- sustainable use of water reservoirs (withdrawal for irrigation, drinking water, industrial use, etc.)
- rationing of non-polluted groundwater (eutrophication)

Demonstration Project

- Monitoring gravity variations caused by groundwater mass changes (seasonal and annual signals) deploying the atomic quantum gravimeter QG1 of LUH
- Contributing to TOPSOIL (*EU INTERREG* programme *North Sea Region*) "groundwater management and evolution of salt-/freshwater- interface under climate scenarios"
- Study the effectiveness of the new technology compared to classical gravimetry

Overcome the Shortcomings of Classical Absolute and Relative Gravimetry with QG1 (→ Project A01)

Economic process for geodynamic applications

- Less time and personal expenditure (faster progress)
- Better accuracy
- More flexible w.r.t. location and setup conditions

Freefall g-experiments with quanta and integrated frequency standard:

- Datum definition (scale and level) intrinsic to the instrument
- No reference points needed
- Avoiding the ambiguity problem about variations of gravity differences (increase/decrease of each point)
- Accuracy independent of network extension/gravity range

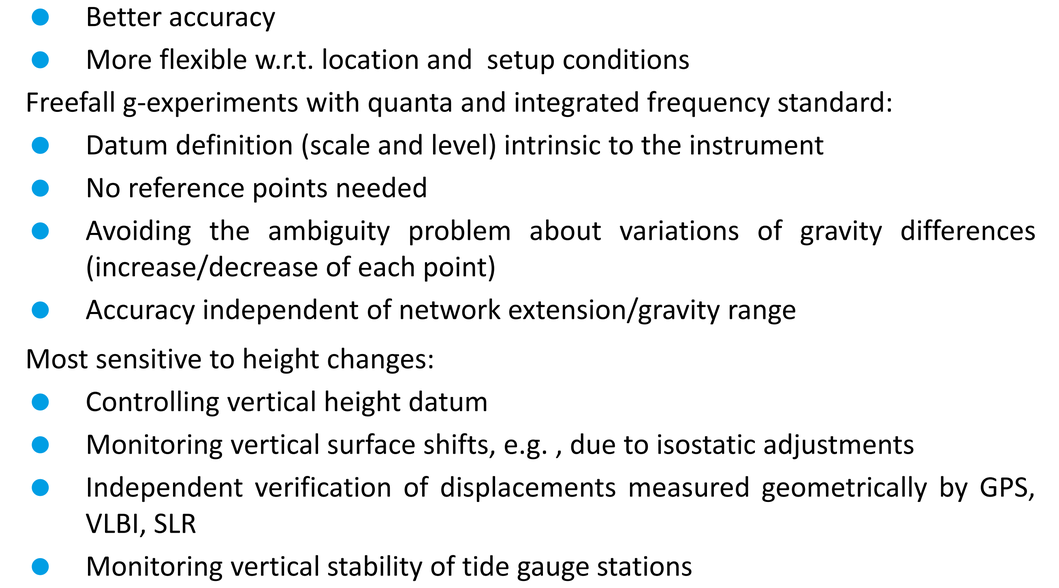
Most sensitive to height changes:

- Controlling vertical height datum
- Monitoring vertical surface shifts, e.g. , due to isostatic adjustments
- Independent verification of displacements measured geometrically by GPS, VLBI, SLR
- Monitoring vertical stability of tide gauge stations

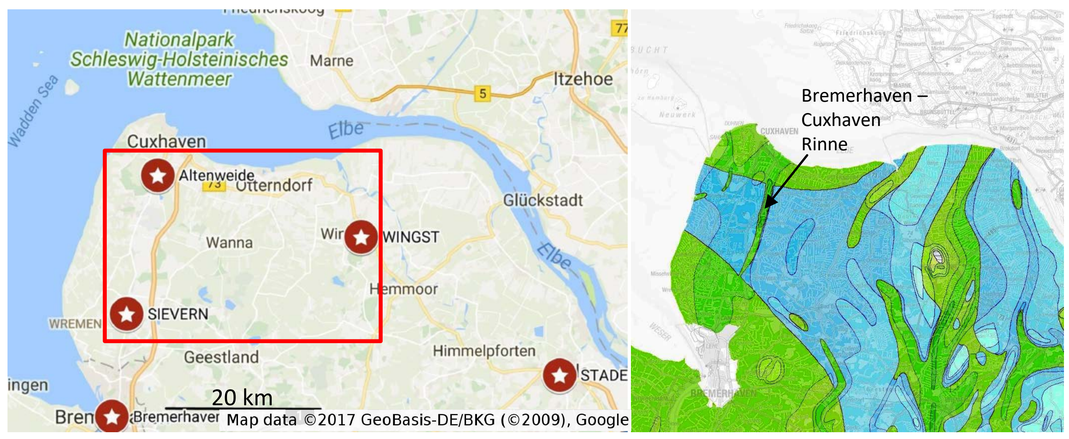
Combination of gravimetric and geometric measurements:

- Discriminating among subsurface mass movements with or without surface deformation
- Monitoring changes in aquifers and deep water reservoirs

Collaborations within geo-Q



Investigation Area



(left) The planned study area is part of the TOPSOIL project region within the Elbe-Weser triangle of the North Sea coastal region

(right) Green colors: areas with a single ground water aquifer (base between 50 and 400 m depth)
Blue colors: aquifer complex structured in an upper and lower aquifer with no hydraulic contact (more saturated blue means deeper base level of the upper aquifer (up to 100 m)
Buried Pleistocene subglacial valley (Bremerhaven-Cuxhaven Rinne): special candidate for freshwater supply

Classical Equipment in Gravimetry for Indoor and Outdoor Points

Absolute gravimeter FG5X-220 of IfE measuring at the Instituto Nazionale di Ricerca Metrologica (INRIM, Torino)

Relative gravimetry with field gravimeters and GNSS positioning

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