The gPhone-solar-cube: an energy self-sufficient mobile container for monitoring gravity and climate parameters at remote field sites

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Abstract

Throughout the last years, there is an increasing interest of the geoscientific community in using terrestrial gravimetry as an integrative and non-invasive method for observing mass change and mass redistribution in the environment due geophysical processes. The nature of the observed processes and the need for nearby data collection often require the gravimeters to be installed at remote field sites. In contrast to classical deployment at permanent observatory sites, this often is a challenge because there are three main requirements to be fulfilled for continuous high-quality operation of the gravimeter: electrical power, stable site conditions, and data connection. Whereas the latter can usually be accomplished by wireless solutions, the second requirement is more demanding as it requires an adequate design of a gravimeter enclosure and a stable pillar, while the first requirement so far has been practically insolvable in the absence of a power line. Here, we present the prototype of a mobile field container for gravity monitoring that fulfils all above requirements: the gPhone-solar-cube. The container consists of a cubic steel container as used by ships and trucks with edge length of about 2 meters. We optimized all components to host a continuously operating gPhoneX. Components include temperature shielding, ventilation, solar panels, power management and monitoring, storage batteries and an integrated backup generator to guarantee self-sufficient power supply, data loggers and wireless data transfer components. Furthermore we developed a new type of gravimeter pillar which is simple to install and to remove, without connection to the container floor to avoid vibration transfer. The pillar is large enough to accommodate two CG-6 field gravimeters, next to the gPhoneX. Other instruments integrated are a complete weather station and a cosmic ray neutron probe. The gPhone-solar-cube has been installed in the Ore mountains, Germany, as a continuously operating gravity reference station for time-lapse field surveys with CG-6 gravimeters to assess water storage changes in the course of heavy precipitation events. After 6 months of field operation, all requirements concerning data transmission, remote access, energy consumption, pillar stability and reliable gravity data were continuously met.

THE gPHONE SOLAR CUBE

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MOSES Modular Observation Solutions for Earth Systems

General Setup

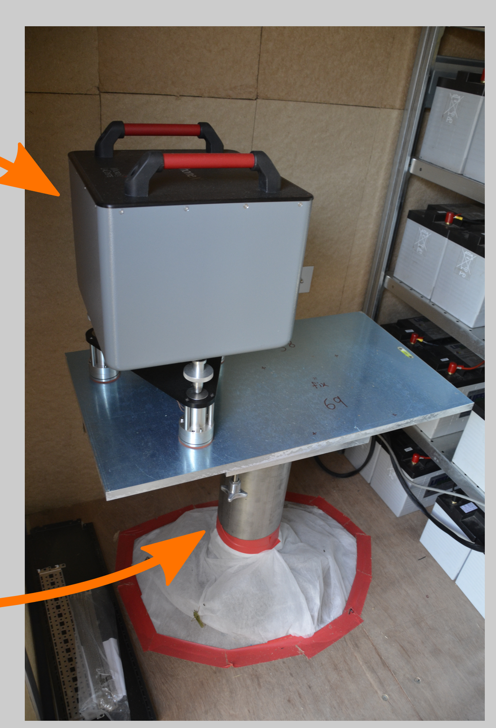
- steel container: 2 x 2 x 2 m
- inside temperature control:
  - temperature shielding
  - ventilation
- 8 solar panels for energy input
- comprehensive monitoring of state conditions
- data transfer via double sim router up to LTE
- transportable with installation time of 3 days

Sensors

- wind speed & direction
- precipitation
- net radiation
- temperature
  relative humidity
- air pressure (inside)
- cosmic ray neutrons (soil moisture)

Gravity

- gPhoneX141
- resolution: 0.1µGal
- precision: 1 µGal
- drift: < 16 µGal / day
- power needed (avg): 100 W
- thermal tilt compensation
- new pillar design:
  - easy and fast setup
  - removable
  - can host gPhone + 2 CG-6 gravimeters



MOBILE CONTAINER

ENERGY SELF-SUFFICIENT

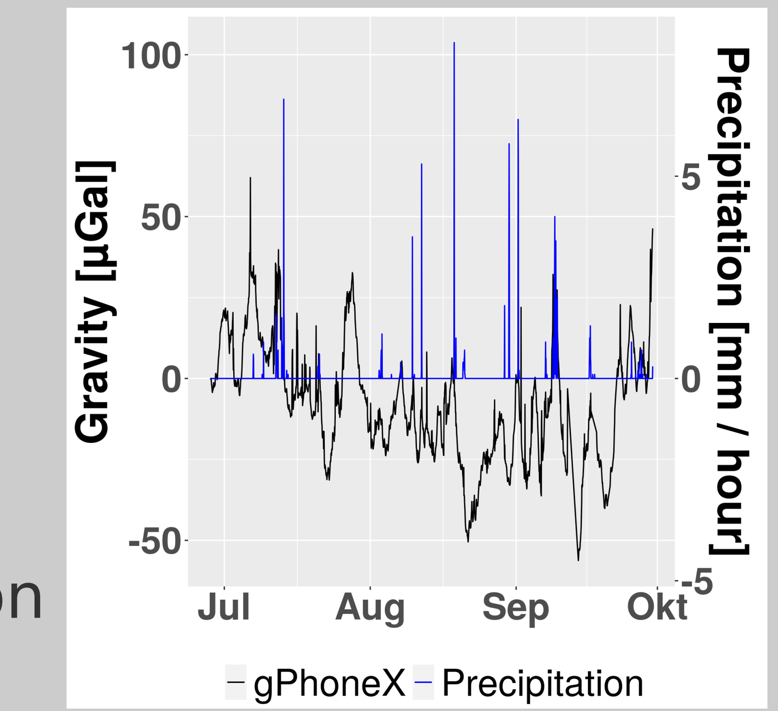
MONITORING GRAVITY

MONITORING CLIMATE

FOR REMOTE FIELD SITES

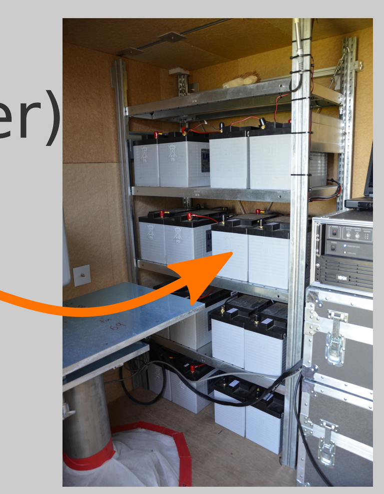
Data

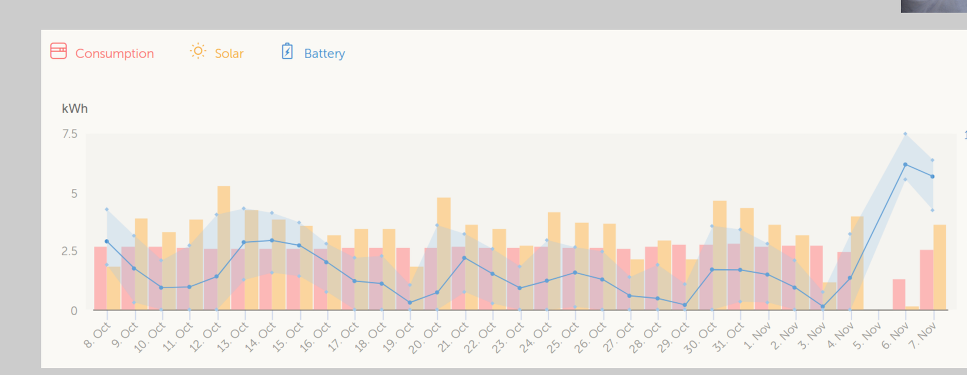
- comprehensive data storage (postgres) and reduction concept
- so far no independent correction of instrumental drift
- high stability of pillar
- first use as reference station for CG-6 field campaigns



Energy

- total power demand (avg): 112 W
- solar input >> 112 W (up to end october)
- solar panels: 8 x 365 W = 2920 W
- energy storage: 16 x 105 Ah batteries
- backup generator to bridge power gaps





Purpose

- reference gravity station for field campaigns
- long-term monitoring of water storage changes
- deployable at any remote field site
- gravity network of 4 containers in Germany
- investigating flood generation processes (MOSES)
- understanding larger scale water storage dynamics (GRACE-FO)