



Precise height determination with single frequency GNSS receivers

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Height determination – vertical datum

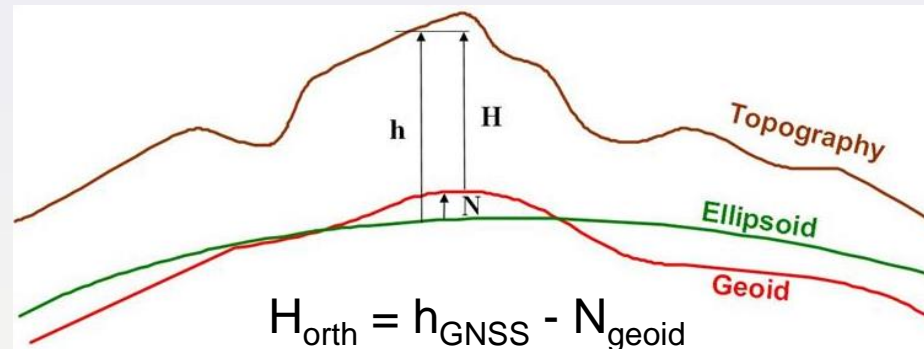


Image: NRCan

• Levelling

- **Physical (orthometric) height**
- Different reference points – tide gauges (Amsterdam, Kronstadt)
- Several national height systems
- EVRS

• GNSS measurements

- **Geometrical (ellipsoidal) height**
- Satellite geometry, atmospheric errors, etc.
- ETRS89

• Monitoring - height changes

- Does not matter if physical or geometrical height differences

GNSS for height determination



- Measurement campaigns
 - 48 hrs measurements to get precise height information from GNSS
 - Error budget – atmosphere, satellite geometry
 - L1/L2 receivers, geodetic (choke ring) antennas
 - Data storage on a notebook, data management, post processing
 - Control points – no permanent observation



Image: UNAVCO

Alberding GmbH developed a more attractive and more efficient solution for monitoring applications - the **A07 monitoring system**.

A07 Monitoring System



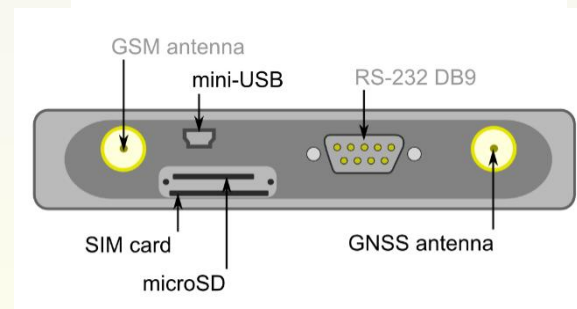
- Permanent solution for height determination for an affordable price
 - Use of single frequency low-cost receivers
 - GNSS data management at the station
 - Power management at the station
 - Management of additional sensor data (meteorology)
 - Data communication to a server (domestic roaming)



Alberding A07-MON sensor: hardware



- Integrated L1 GNSS multi-constellation receiver with raw data interface
- External GNSS antenna connector
- Integrated battery (rechargeable via mini-USB)
- Integrated GPRS modem with antenna (optional: external GSM antenna connector)
- Integrated memory (MicroSD card)
- Integrated processor (data management)
- Integrated Bluetooth module with antenna
- RS232 serial port
- Integrated IMU sensor board (optional)
- Membrane keypad with On/Off button and status LEDs
- CE certified



Alberding A07-MON sensor: firmware



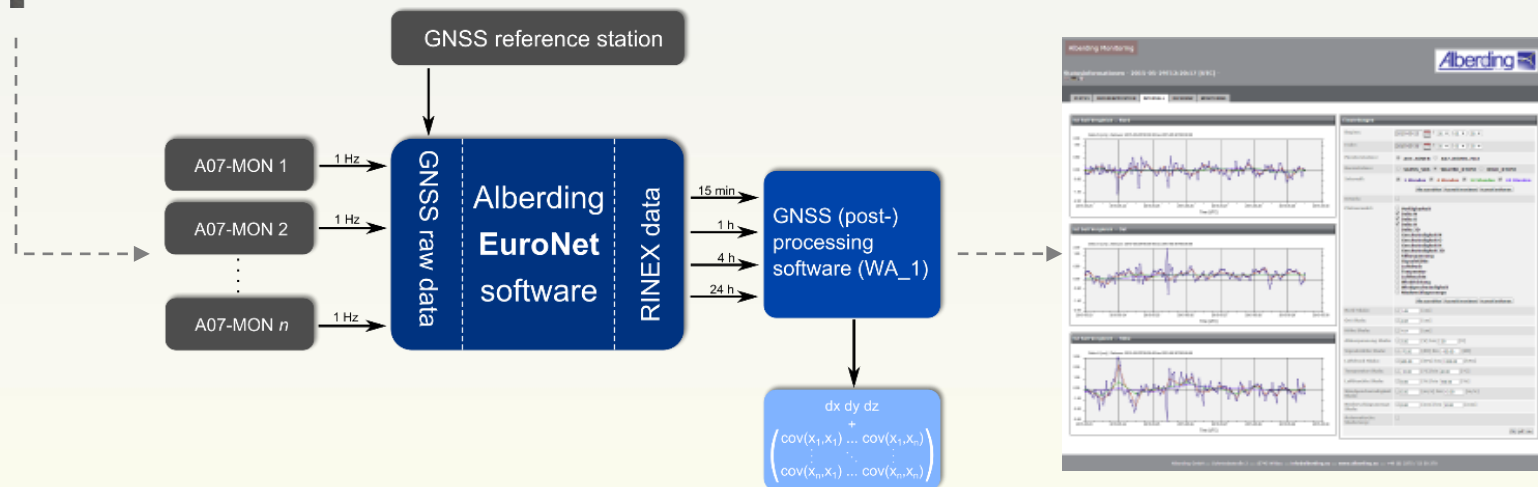
- GNSS raw data streaming (Ntrip)
- File storage and file transfer
- Setting operating times to plan measurements
- External sensor data acquisition via serial port (RS232)
- Power and data management
- Configuration via SMS
- Configuration tool
- Intelligent algorithm supporting domestic data roaming



Alberding GNSS monitoring software



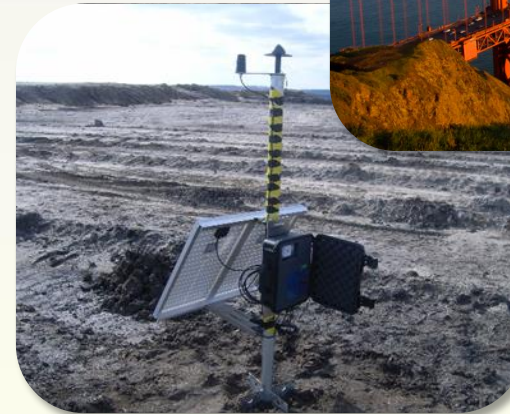
- GNSS data management
- Automatic processing at user-definable intervals
- Short or medium baselines, VRS
- Solution comparison: 1h, 12h, 24h
- Comfortable access via the web interface
- Visualisation of time series, PDF reports, CSV output, database
- Alarming – email/SMS



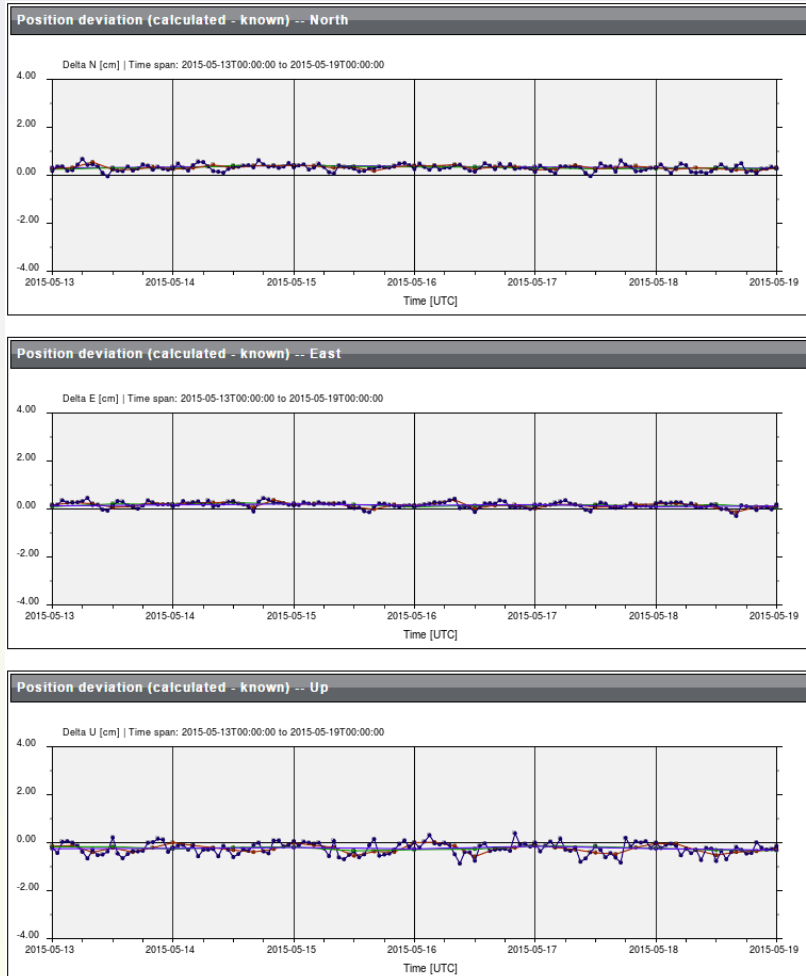
Application fields



- Landslide monitoring
- Surface subsidence monitoring of underground operations
- Open-cast mine highwall stability monitoring
- Long-term deformation monitoring of abandoned mines
- Deformation monitoring of:
 - Dams
 - Bridges
 - Tunnels
 - Embankments
 - Storage caverns
- Glacier flow monitoring
- ...



Processing example – short baseline



Period: 13.05.2015 – 19.05.2015

Baseline: approx. 200 m

Y scale: ± 4 cm

Reference station: Trimble BX982

Rover: Alberding A07

Processing intervals:

Blue: 1 hour

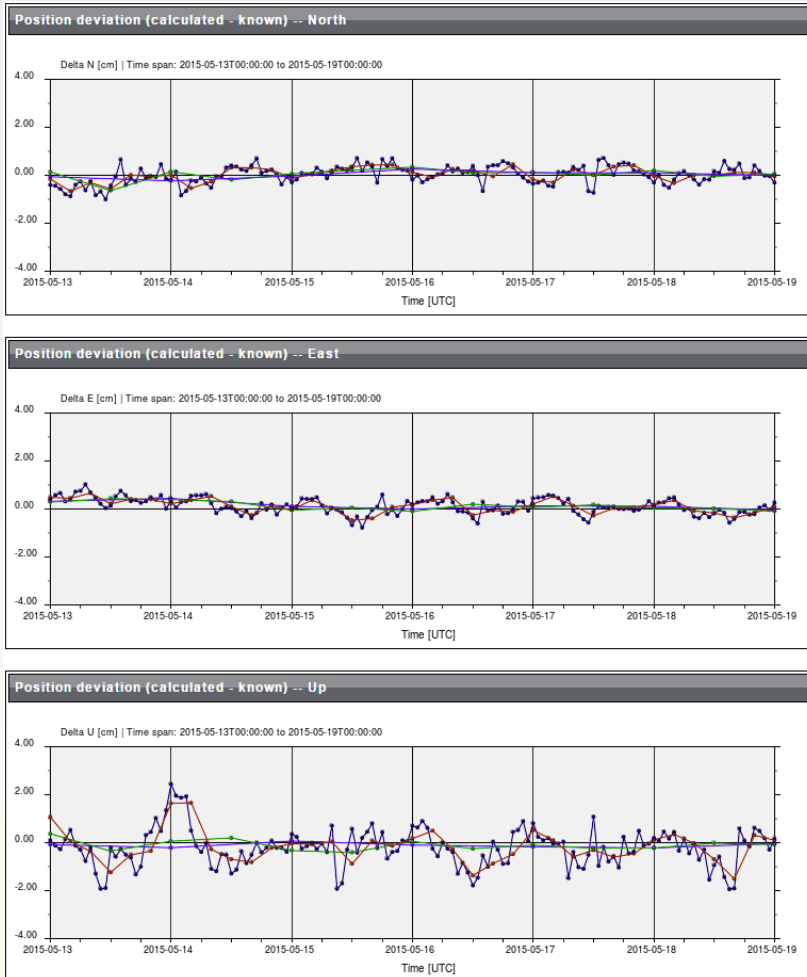
Red: 4 hours

Green: 12 hours

Purple: 24 hours

On short baselines (here: 200 m) a positioning accuracy of 5 mm or higher can be achieved with one-hour processing intervals.

Processing example – longer baseline



Period: 13.05.2015 – 19.05.2015

Baseline: approx. 6500 m

Y scale: ± 4 cm

Reference station: Trimble BX982

Rover: Alberding A07

Processing intervals:

Blue: 1 hour

Red: 4 hours

Green: 12 hours

Purple: 24 hours

On longer baselines (here: 6500 m) the positioning accuracy decreases for short processing intervals. However, the 24-hour solution still provides accuracies of approx. 5 mm.

Processing example – longer baseline



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Baseline: approx. 6500 m

Y scale: ± 4 cm

Reference station: Trimble BX982

Rover: Alberding A07

Processing intervals:

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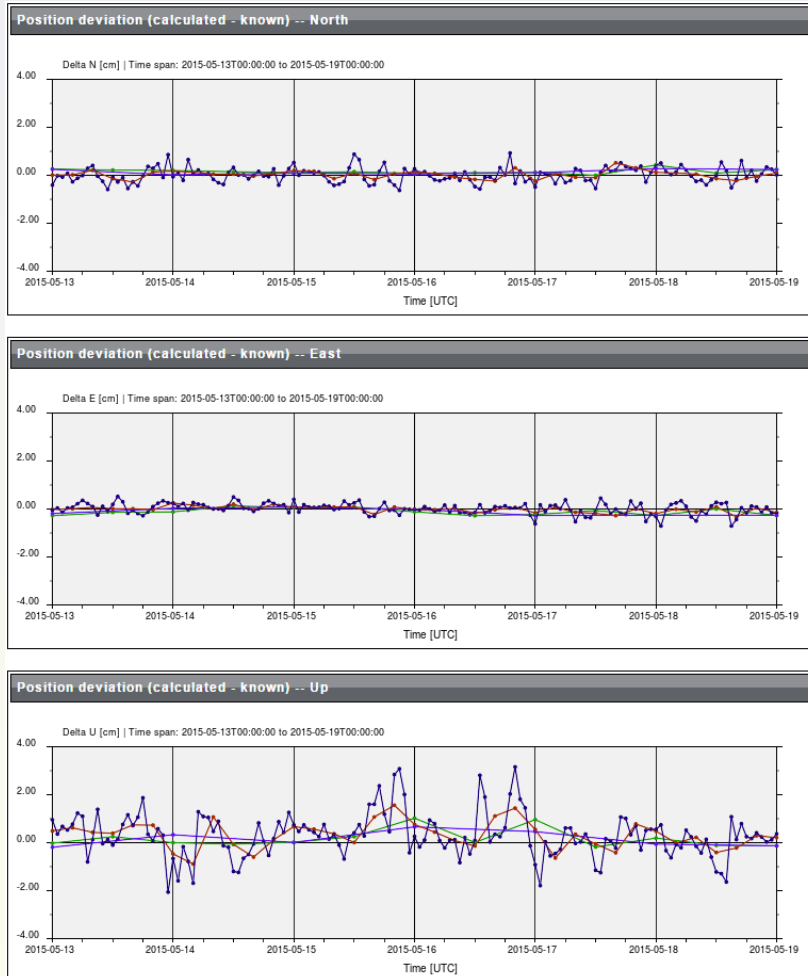
Red: 4 hours

Green: 12 hours

Purple: 24 hours

On longer baselines (here: 6500 m) the positioning accuracy decreases for short processing intervals. However, the 24-hour solution still provides accuracies of approx. 5 mm.

Processing example – SAPOS VRS



Period: 13.05.2015 – 19.05.2015
 SAPOS VRS 5 km
 Y scale: ± 4 cm

Reference station: SAPOS VRS
 Rover: Alberding A07

Processing intervals:

Blue: 1 hour

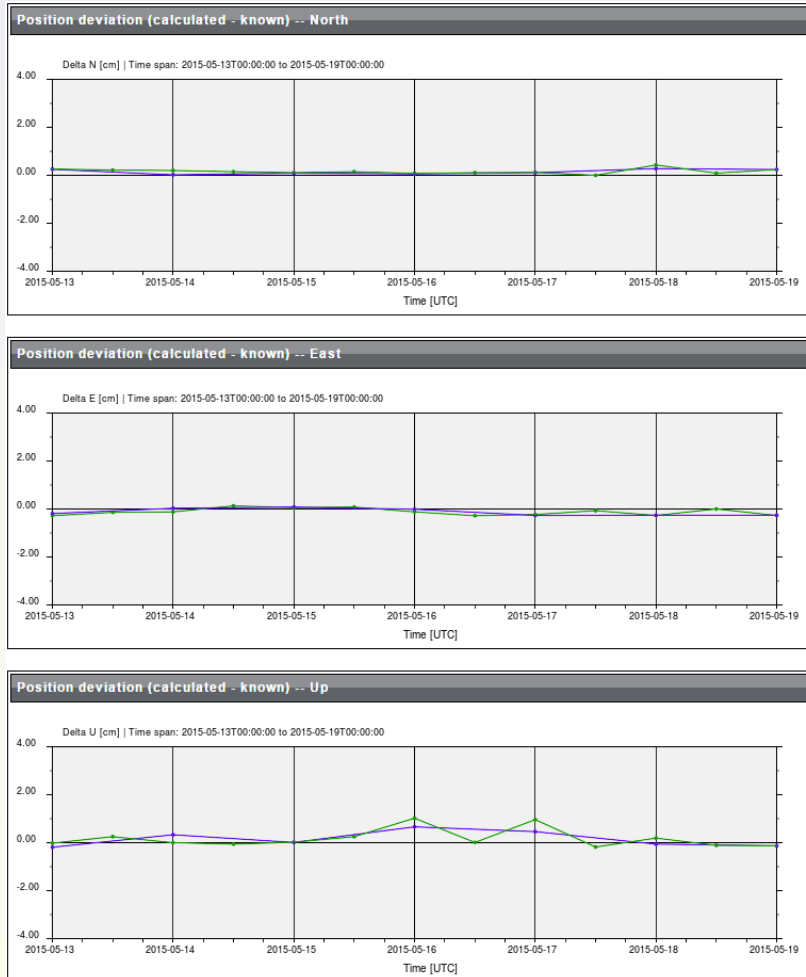
Red: 4 hours

Green: 12 hours

Purple: 24 hours

There is no need to set up your own reference station when using a reference service, e.g. SAPOS. The 24-hour solution is still in the range of approx. 5 mm.

Processing example – SAPOS VRS



Period: 13.05.2015 – 19.05.2015
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 Rover: Alberding A07

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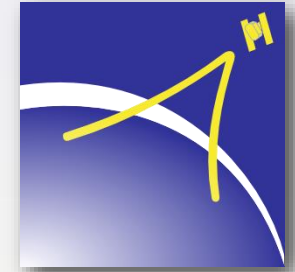
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Results and outlook



- Single frequency GNSS receivers could have a benefit for height measurements
- Today: a turn-key solution for different applications (e.g. monitoring)
- Future: PPP data stream with ionosphere information
- Dual frequency when prices and power consumption are going down





Thank you for your attention!



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Solutions for infrastructure operators



- Alberding Ntrip Caster
- BKG Ntrip Caster web interface
- Alberding-QC
 - Checkstream: Ntrip stream monitoring
 - RTK-Check: positioning accuracy and TTFA monitoring
 - InspectRTCM: GNSS data decoding and visualisation
- Alberding DataConv
- PPP-based reference station coordinate monitoring

