– COLD MAGICS –

COntinuous Local Deformation Monitoring of an Arctic GeodetIC Fundamental Station

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Overview

- Motivation
- ARCFAC project 026129-2008-58
- Conclusions and outlook

Motivation (1/3)

- The GGOS aims at a combination and integration of observations and results of various space geodetic techniques
- An important ingredient for the GGOS are geodetic co-location stations
- The accurate knowledge of the local geodetic relations between the reference points at these geodetic co-location stations is required
- => accurate ”local-ties” are needed for GGOS & ITRF
- Requirements: 0.1 mm accuracy and full variance-covariance information

Motivation (2/3)

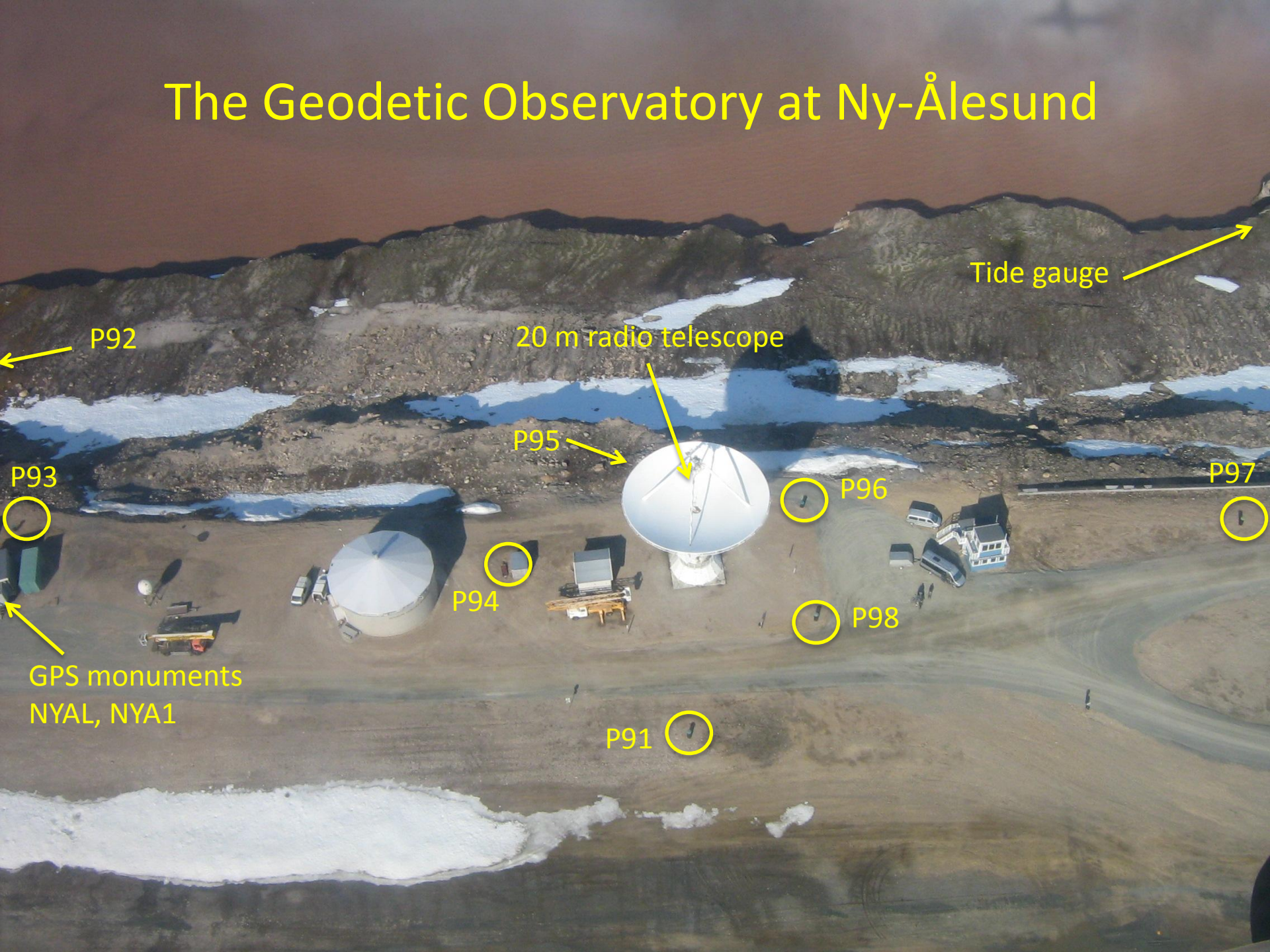
- Local ties surveys at fundamental stations are traditionally performed every couple of years only
- Reason: Local tie survey is a difficult and time consuming engineering task
- Traditionally, local tie surveys often are a combination of direction and distance measurements with tachymeters and height differences from spirit levelling
- Some problems with this approach are:
  - Inconsistent results from different campaigns and survey teams
  - Did something change, and if so, when?
  - Not necessarily ‘cartesian local systems’ that can be transformed easily to a global cartesian system (i.e. ITRF)

Motivation (3/3)

- Possible solution:
  - Continuous local tie monitoring
  - Automated operation
  - Only angles and distances, no spirit levelling
- Where to test this idea?
  - At the Ny-Ålesund Geodetic Observatory
  - Co-located VLBI, GNSS, Gravimetry, tide gauge,…
  - A very important co-location site due to its northern location (79 deg. N)

The ARCFAC project

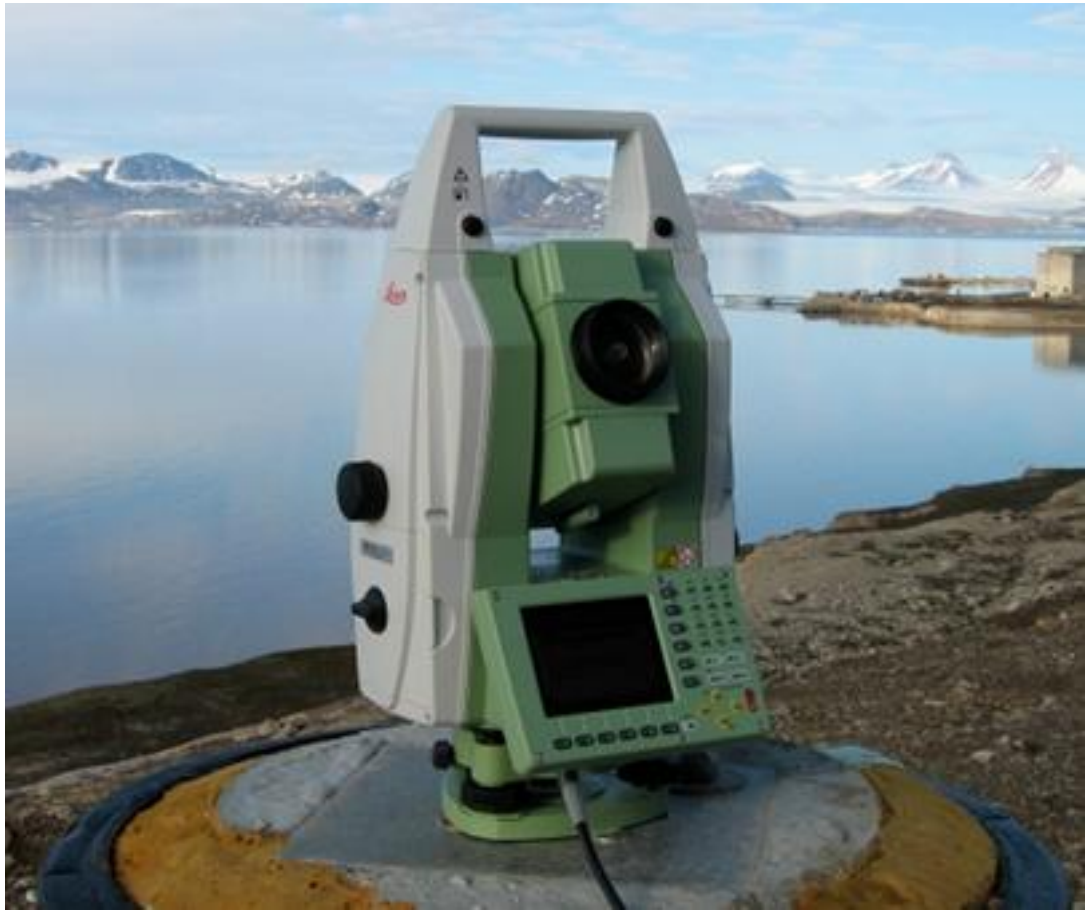
- ARFAC = European Centre for Artic Environmental Research
- Supports access to research facilities at Ny-Ålesund (Spitsbergen)
- Application to ARCFAC submitted in September 2008
- Project granted late 2008
- Project work July 6-16, 2009


The Geodetic Observatory at Ny-Ålesund
Tide gauge
P92
20 m radio telescope
P95
P93
P96
P97
P94
P98
GPS monuments
NYAL, NYA1
P91

The instrumentation

- 1 programmable total station (Leica TM30)
- 14 retro-reflecting prisms (Leica GPR112)
  - 6 mounted on the VLBI radio telescope, using magnets (T1, T2, T3, T4, T5, T6)
  - 1 attached to one of the GPS-monuments (NyA)
  - 1 close to the tide gauge in the harbour (Kai)
  - 6 on survey pillars (P91, P92, P94, P95, P96, P97)
- Meteorological sensors
- Laptop and software (Leica GeoMos)

The total station Leica TM30



Performance specifications:

Measurement accuracy for

Horizontal angles 0.15 mgon

Vertical angles 0.30 mgon

Distances 0.6 mm ± 1 ppm

- Programmable
- Automized operation
- Automated target recognition

Total station and prism on pillars

The TM 30 on survey pillar P93.

A prism on one of the survey pillars.

The prism at the GNSS-monument NYAL

Mounting the prism.

The prism on the GNSS monument.

The prisms at the telescope

Prisms T1, T2, T3, T4, T5 at the telescope tower (not moving).

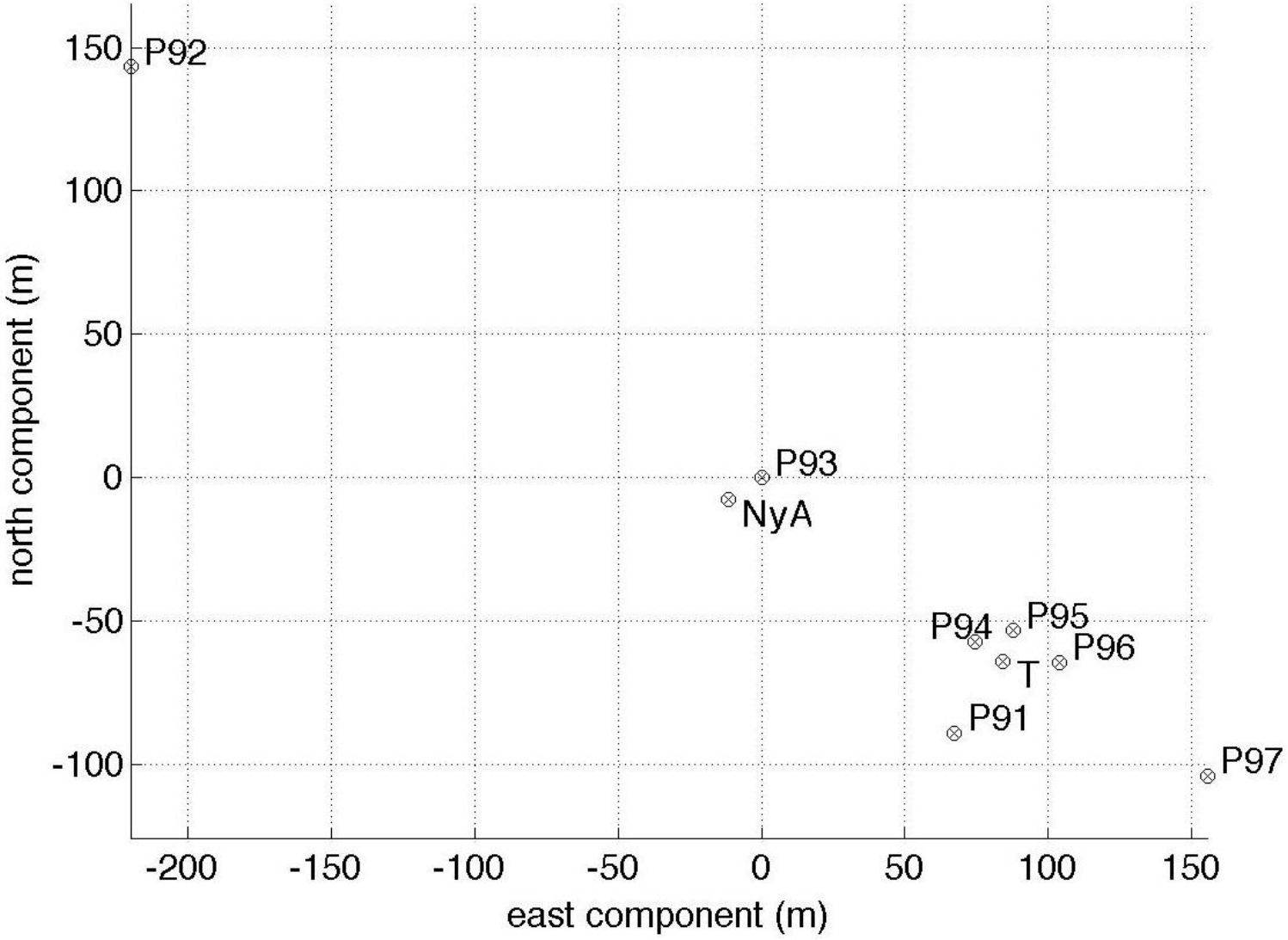
Prism T6 on the upper moving part of the telescope.

The prism at the tide gauge

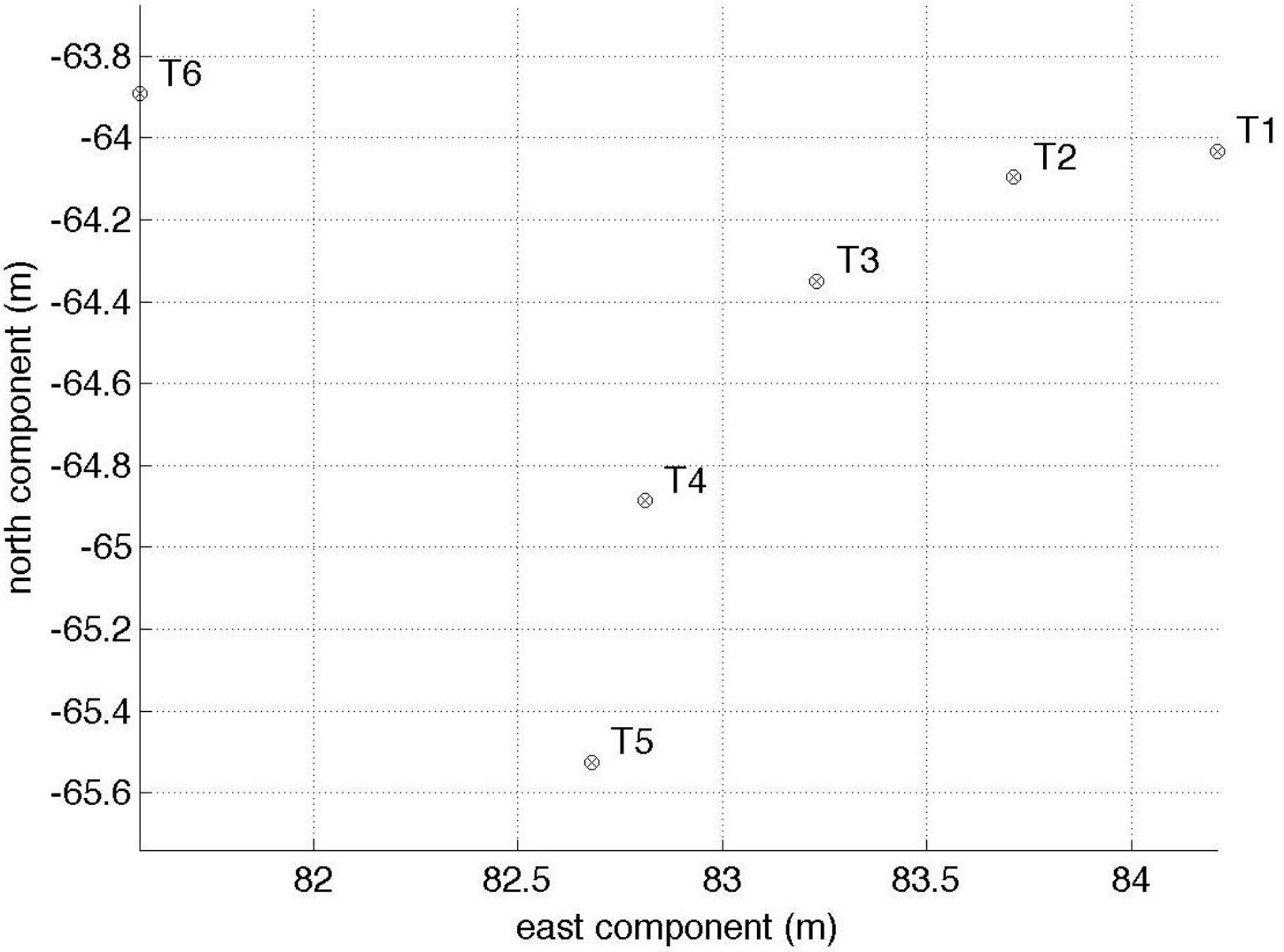
The tide gauge in the harbour.

Prism mounted at the harbour pier behind the tide gauge.

The survey network

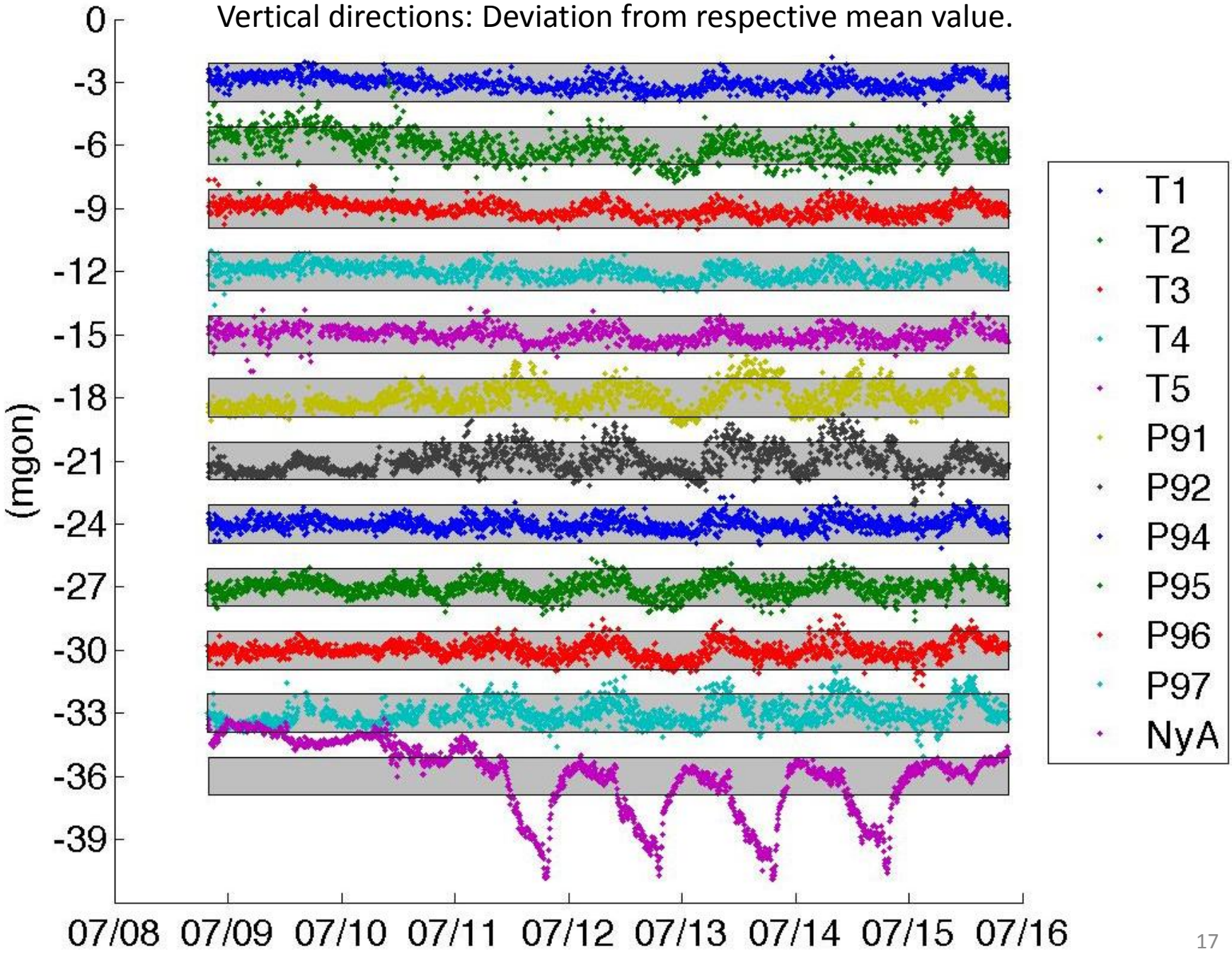


Zoom-in to the telescope

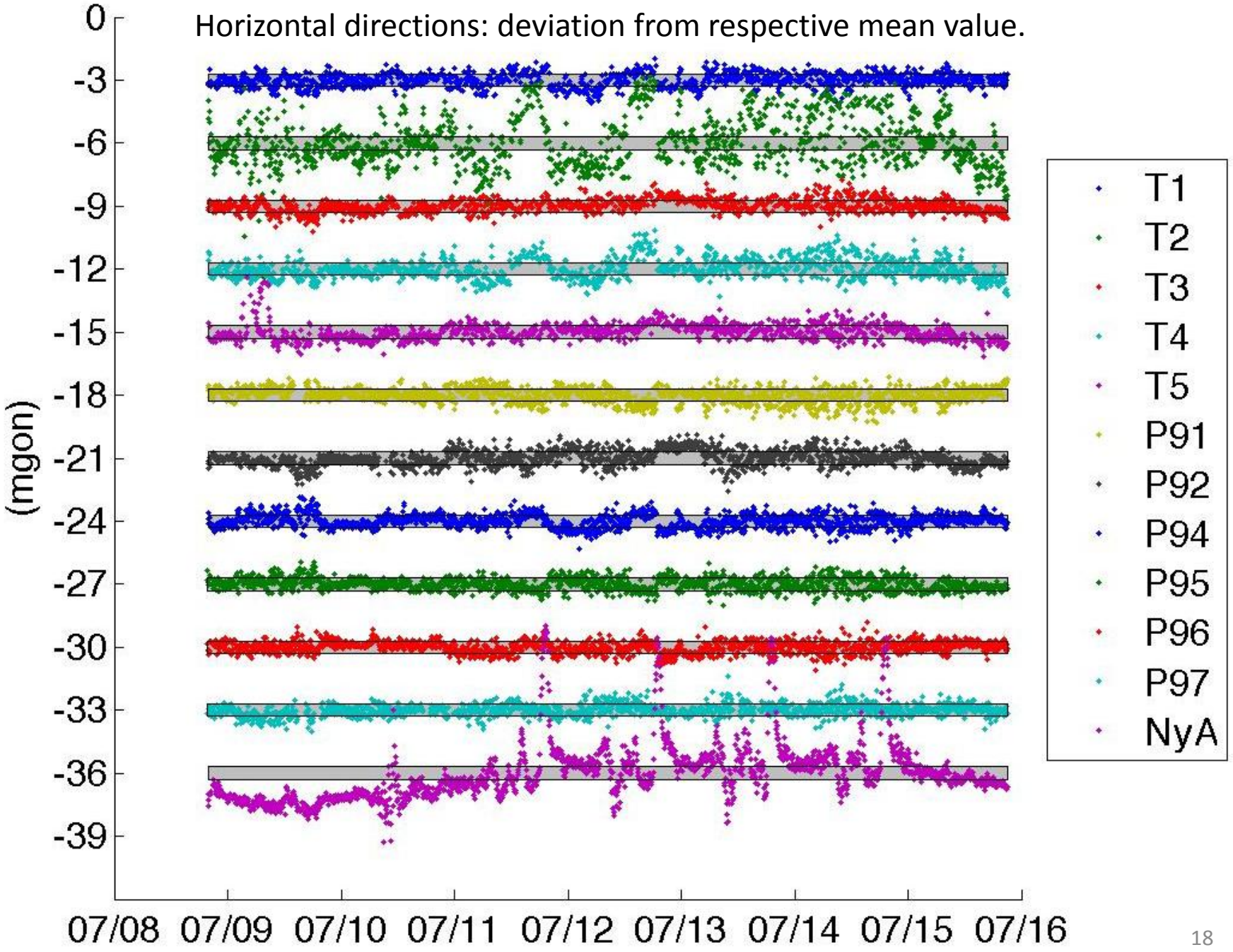


The measuring program:

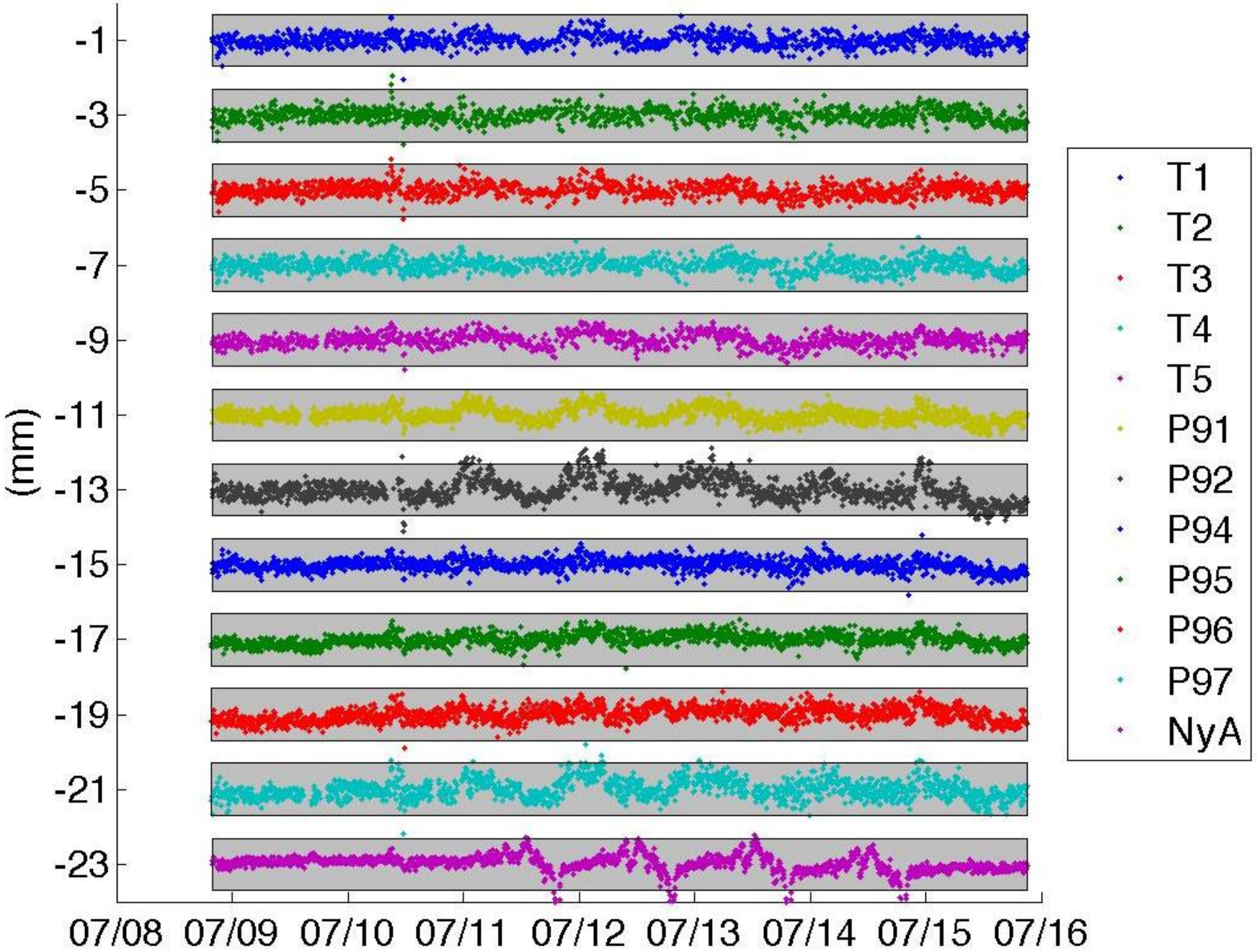
- Measurements in two faces (angles and distances)
- Repetition cycle every 6 minutes
- Meteorological data recorded every 1 minute
- Continuous measurements for more than 7 days

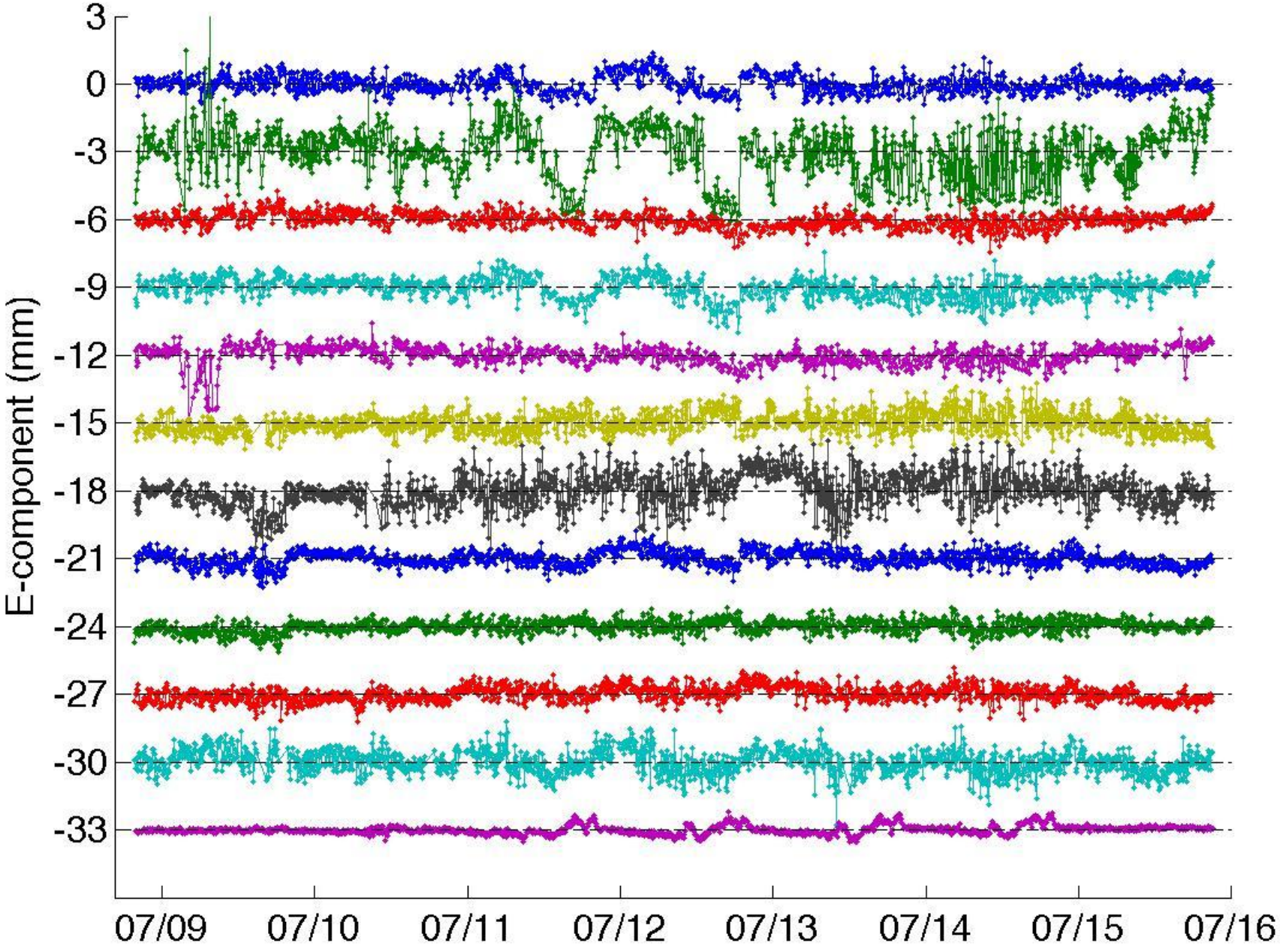

Vertical directions: Deviation from respective mean value.
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
(mgon)
07/08
07/09
07/10
07/11
07/12
07/13
07/14
07/15
07/16
T1
T2
T3
T4
T5
P91
P92
P94
P95
P96
P97
NyA

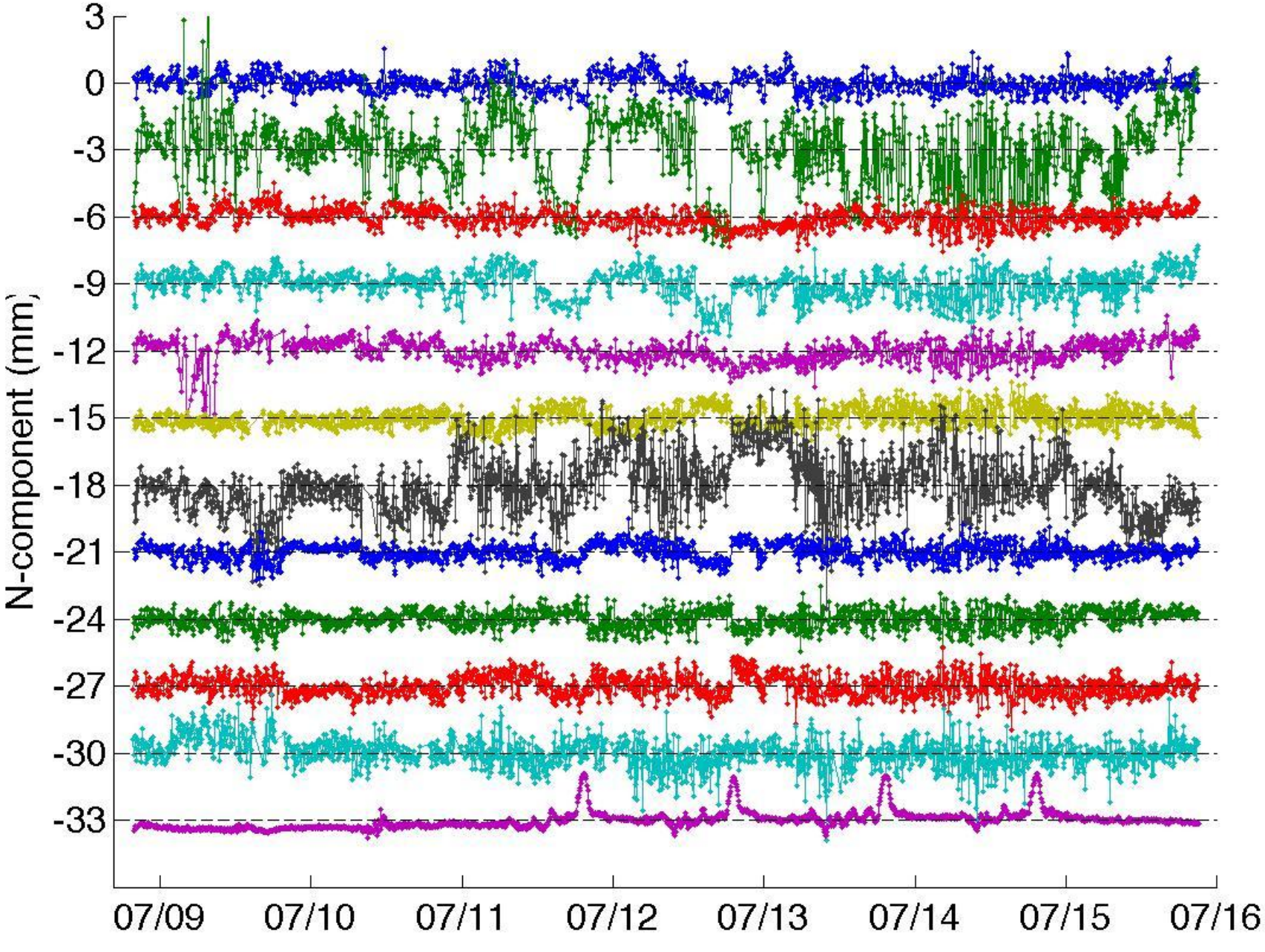
Horizontal directions: deviation from respective mean value.

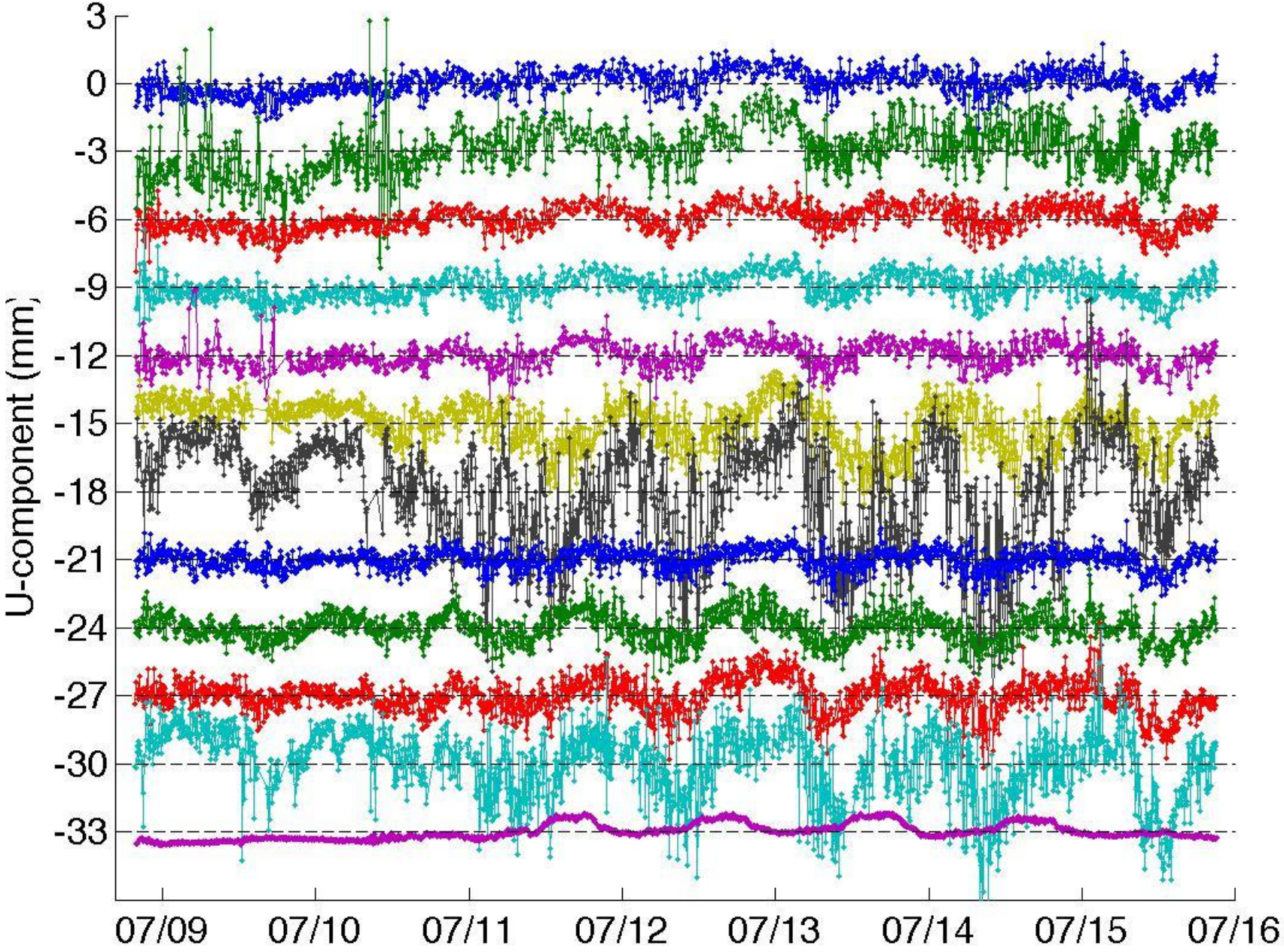


Distances: deviation from respective mean value.

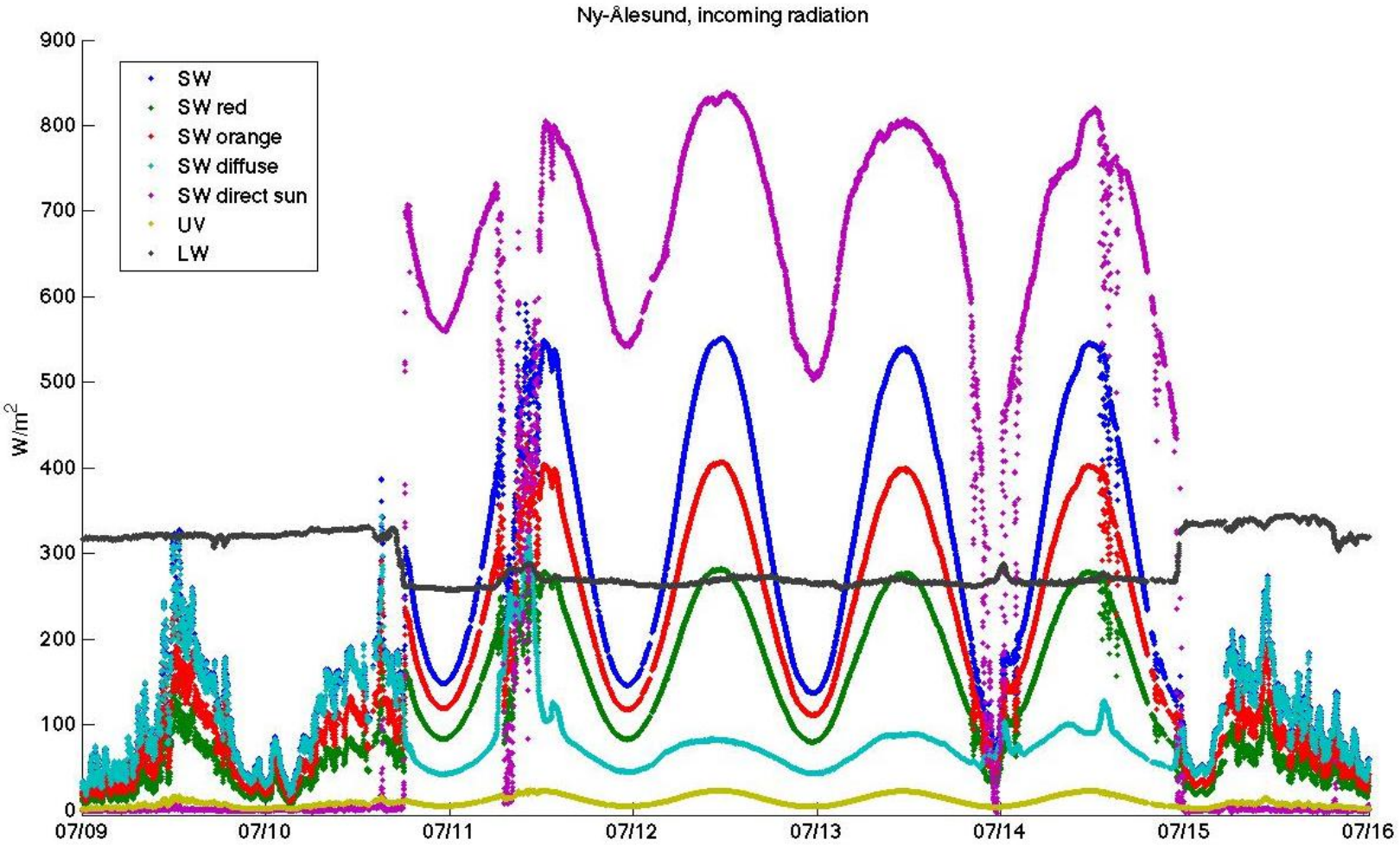



E-component (mm)
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
07/09
07/10
07/11
07/12
07/13
07/14
07/15
07/16


3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
N-component (mm)
07/09
07/10
07/11
07/12
07/13
07/14
07/15
07/16


3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
U-component (mm)
07/09
07/10
07/11
07/12
07/13
07/14
07/15
07/16

Solar radiation



The solar radiation data were kindly provided by AWIPEV.

Conclusions and outlook (1/2)

- We appear to detect deformations at the 1 mm level for several targets
- In particular the GNSS-mast shows deformations, but also the targets on the telescope
- The targets on the survey pillars show less signature
- These signatures are detected during the period of continuous solar radiation
- We cannot distinguish between motions of the targets and motion of the tachymeter

Conclusions and outlook (2/2)

- We need at least a second monitoring instrument for redundancy
- We think a setup of 3 total stations, distributed well geometrically and also able to survey each other should be optimal
- This concept could allow Continuous-Cartesian-Connections (CCC) at geodetic co-location sites
- The concept should be included in the planning and the construction of VLBI2010 stations

Acknowledgements

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  - ARCFAC for supporting the project
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Thank you for your attention!