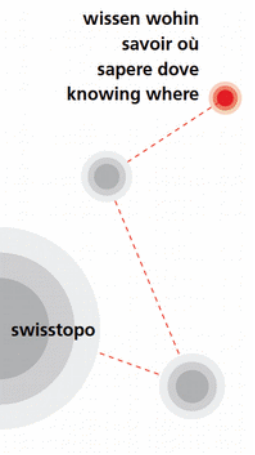
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

armasuisse
Bundesamt für Landestopografie swisstopo



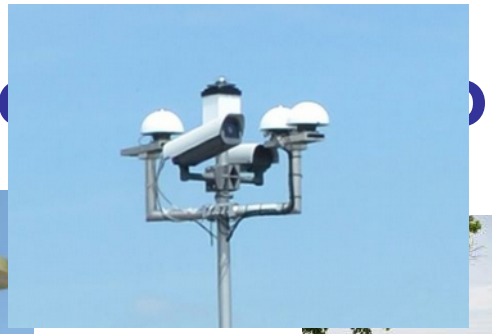
GNSS and Tachymetry for Monitoring the stability of Permanent Reference Station

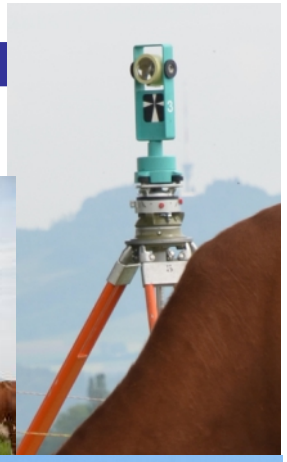
Example Zimmerwald

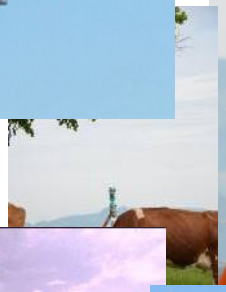
E. Brockmann, D. Ineichen, P. Mahler

n d monito or


Trimble



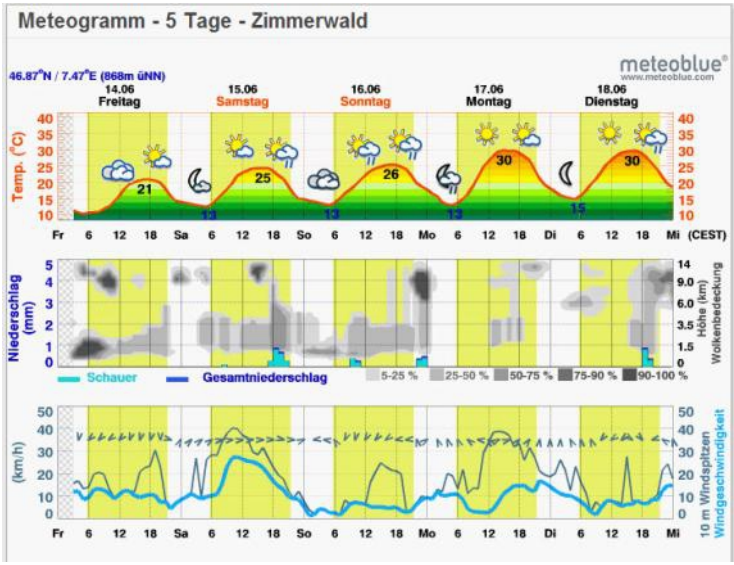


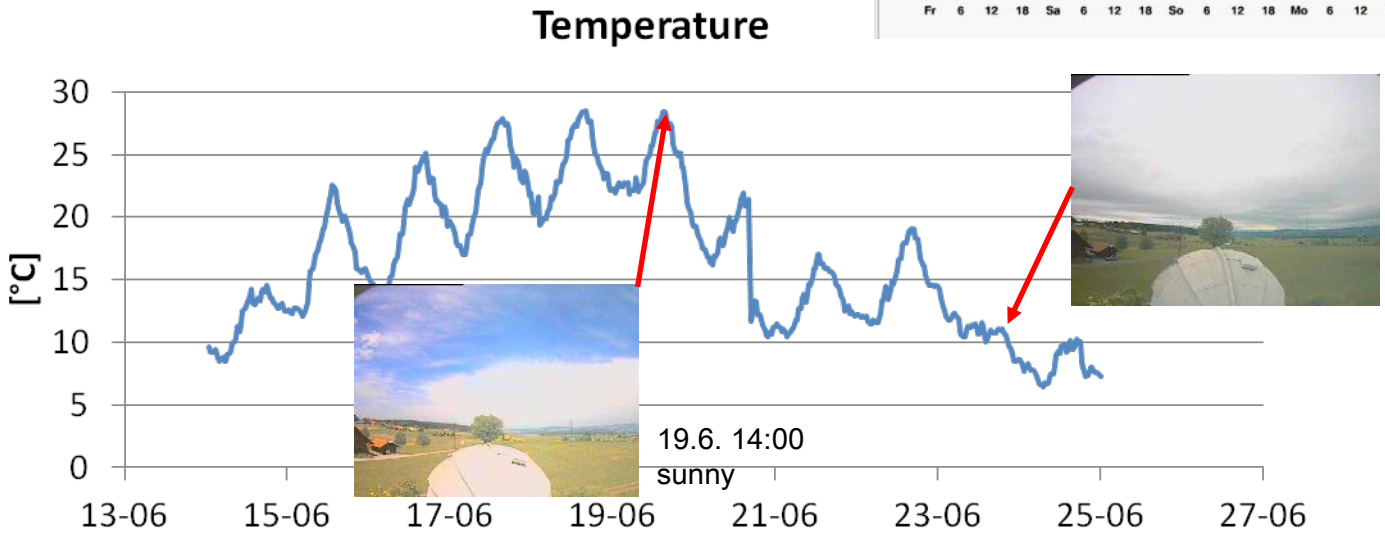


ZIM2
P3
ZIMJ
ZIMM
Meteo
Sensor
webcam
P3
P2
P2
P1
P1
Ref.
Ref

Campaign details

- Dates:14. – 25. June 2013
- Temperatures: 5-30 ˚C





Automatic measurements using (parts of) Leica GeoMoS

every 30 Minutes all points

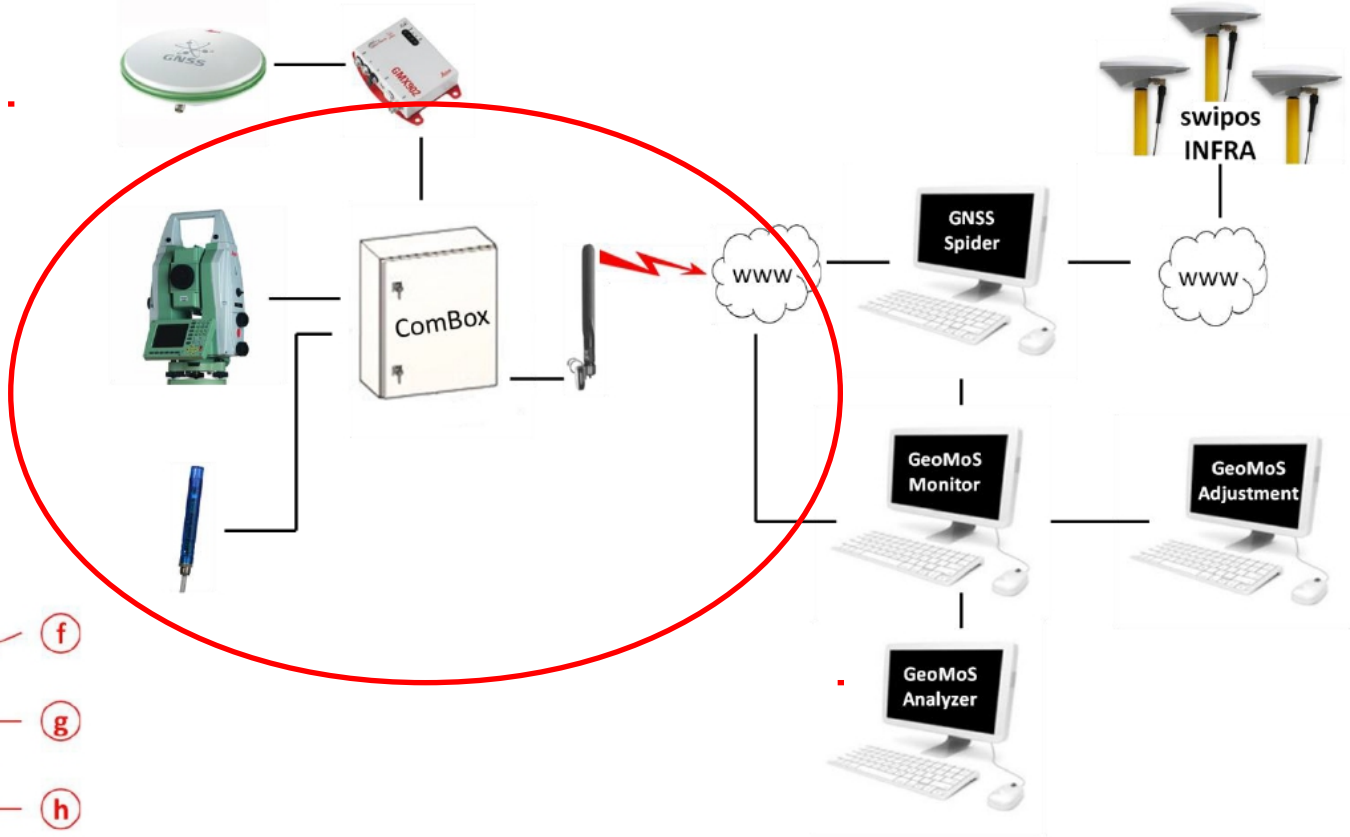
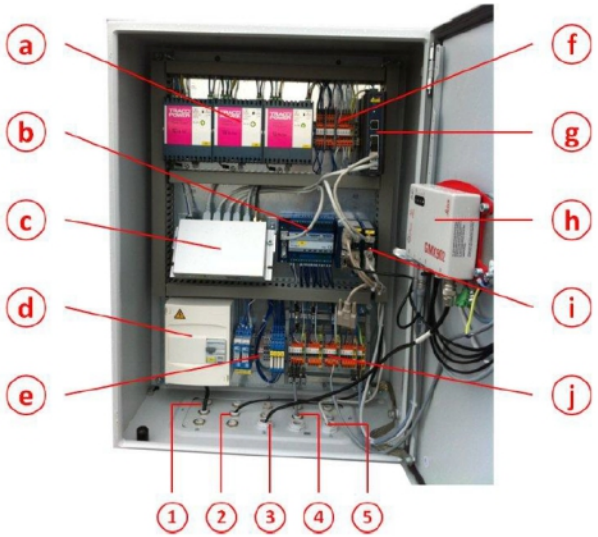


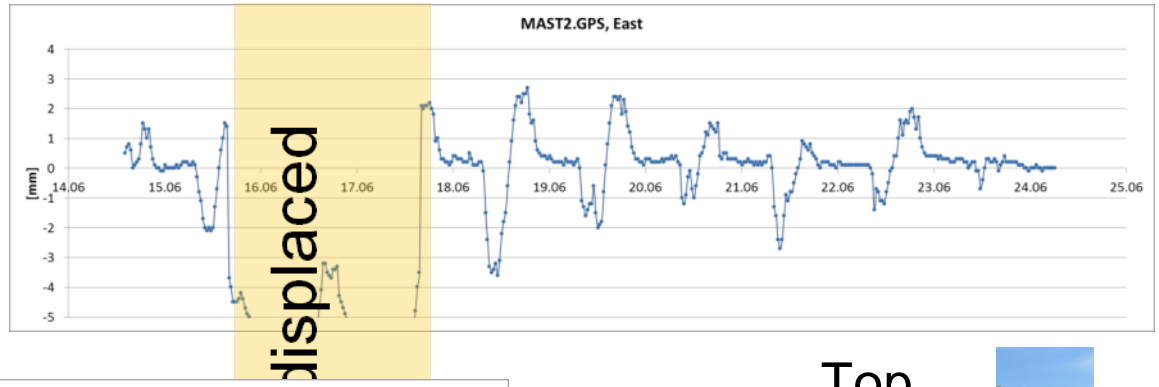
Abbildung 2 Aufbau des Monitoringsystems an der FHNW

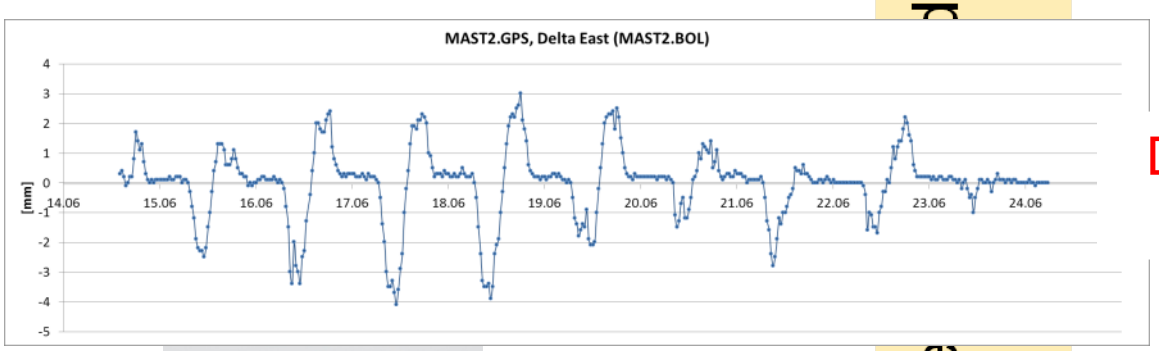


bbildung 1 Aufbau der ComBox20 des Instituts für Vermessung und Geoinformationstechnologie

Terrestrial: absolute versus relative

Example ZIM2, East



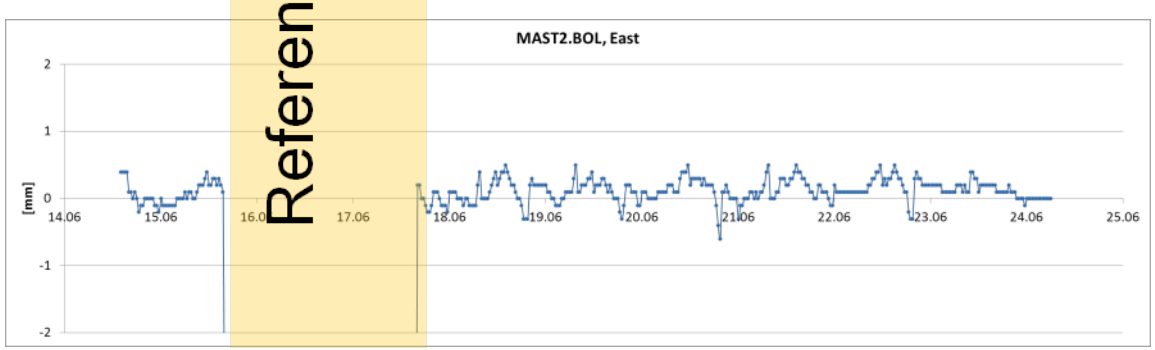


Differential: Top-Ref

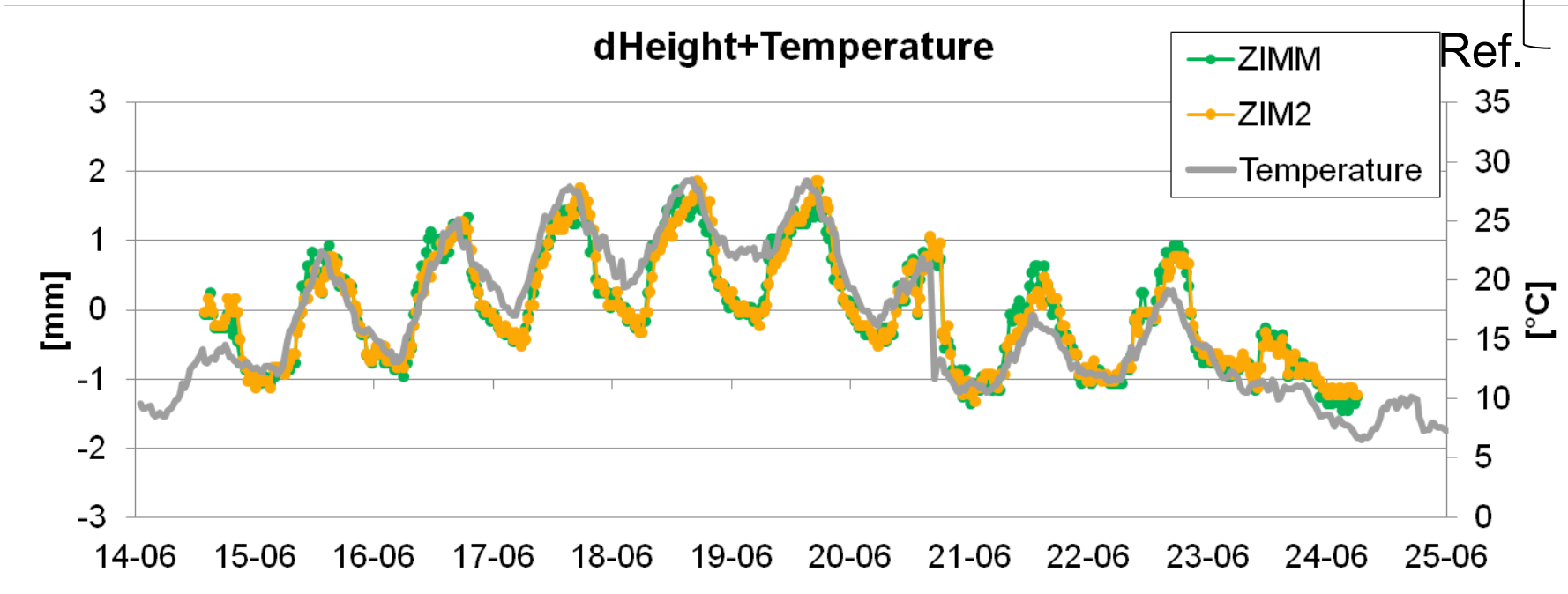
Top

Ref

Not guilty!



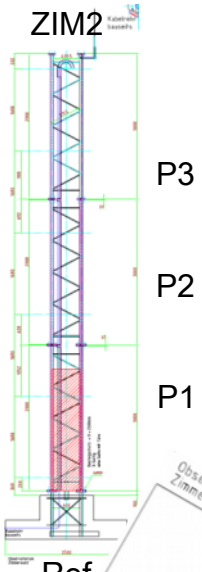
Terrestrial results ZIMM+ZIM2: Height

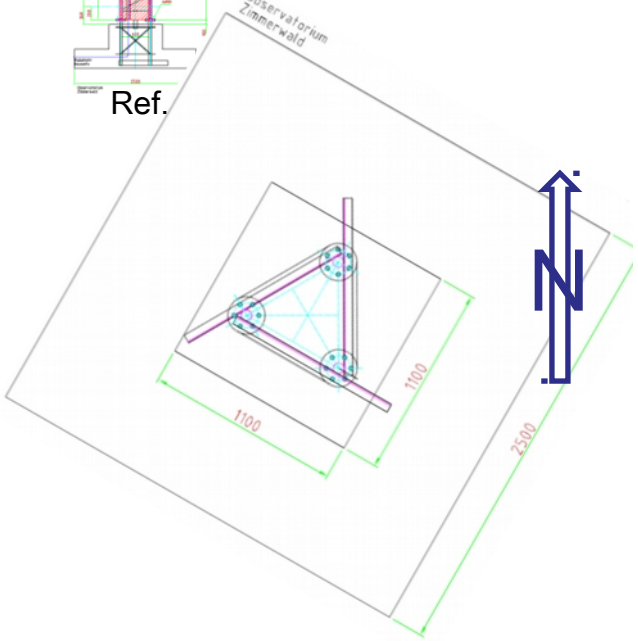


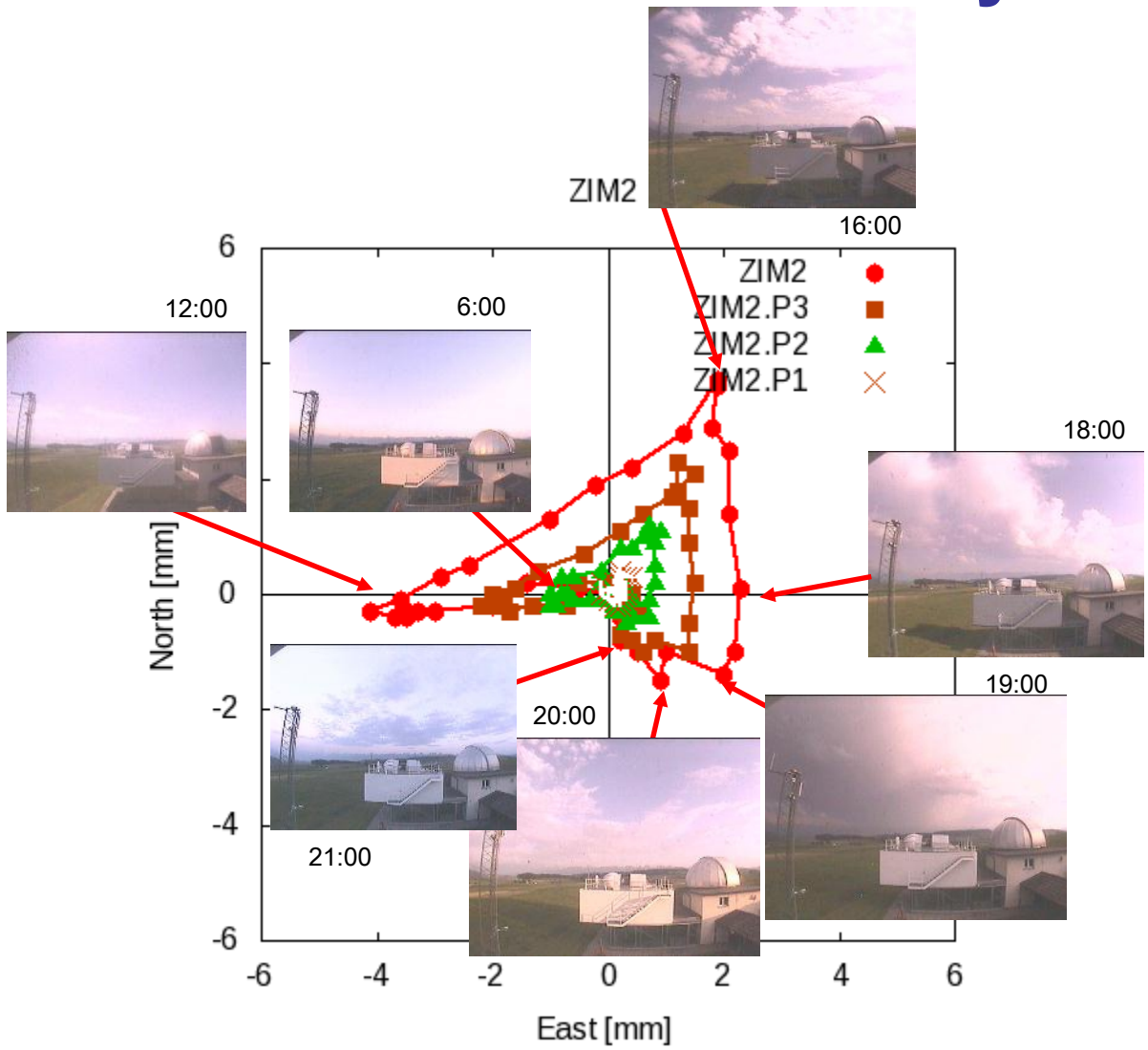
dHeight= f (Temp) -> extension coefficient of steel
$11.8e^{-6}K^{-1}$: dT 10 ˚C -> dh 1.2 mm

Differential to bottom point

Terrestrial results ZIM2: Horizontally

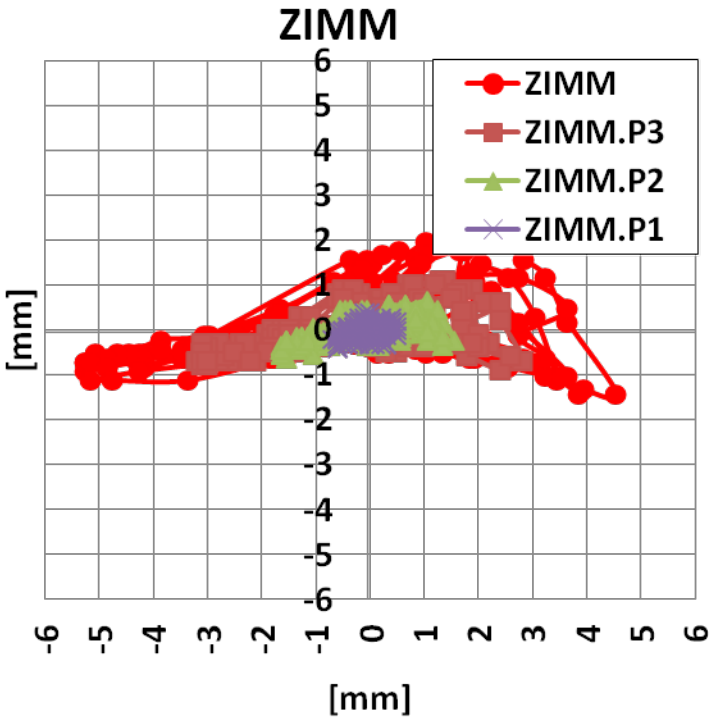


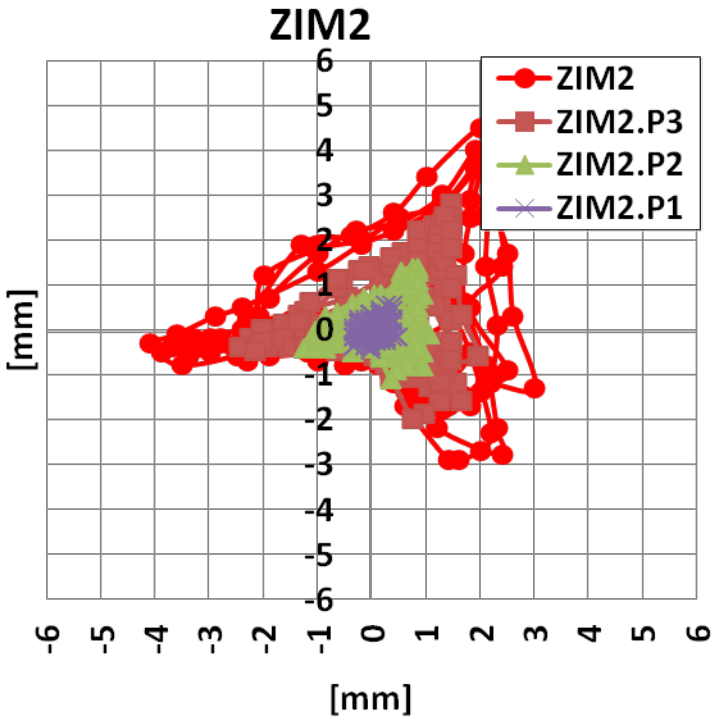




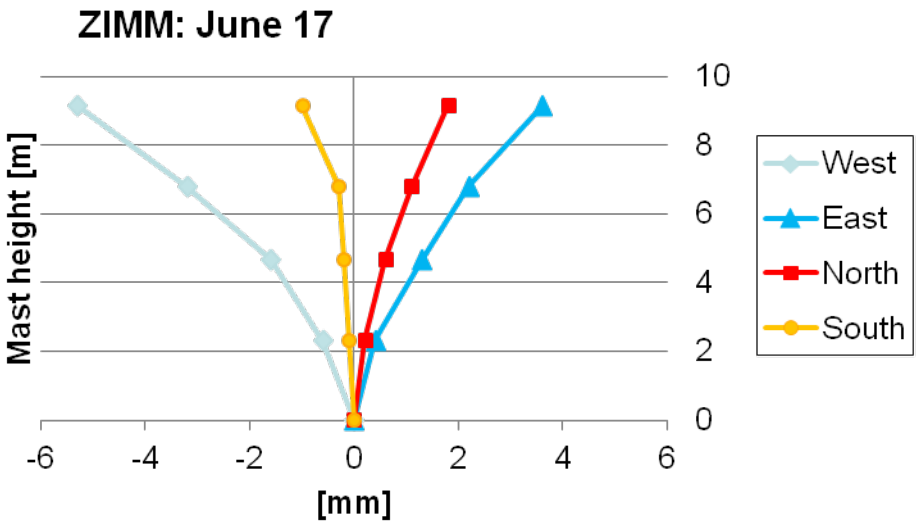
Differential to bottom point

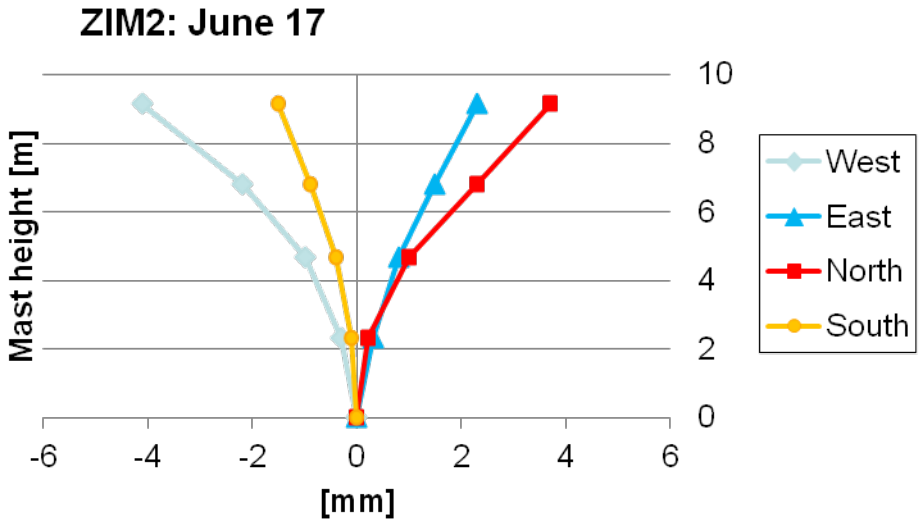
Terrestrial results ZIMM+ZIM2: Horizontally, June 17

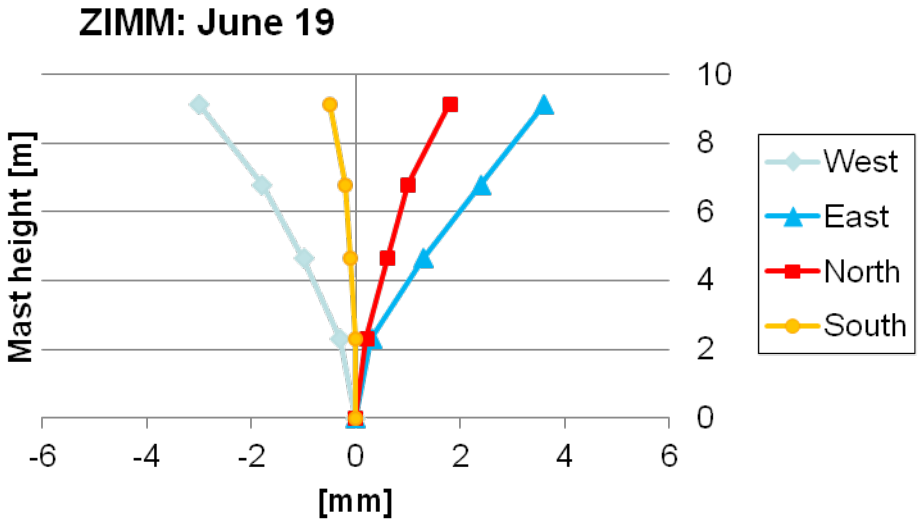


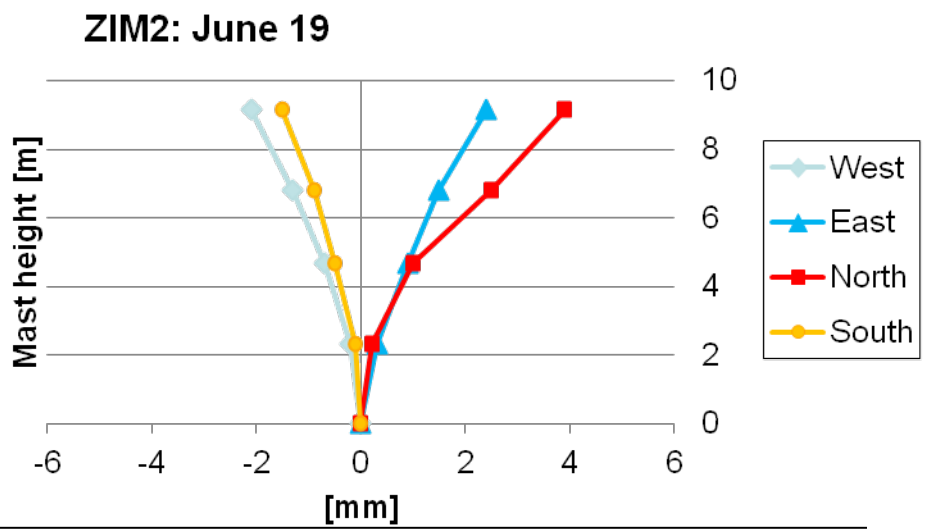


Terrestrial results ZIMM+ZIM2: max. horizontal movements 2 hot days



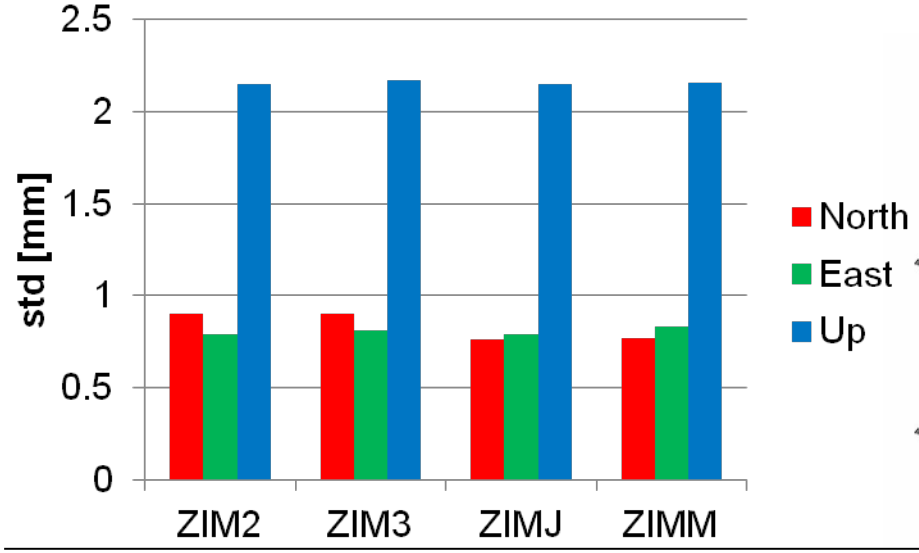


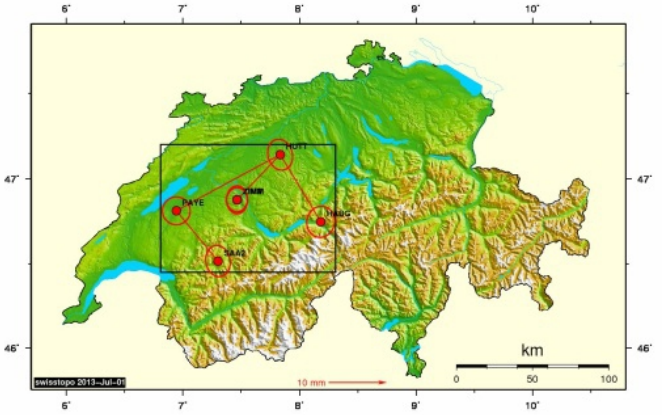




GNSS Analysis

- ZIMM, ZIM2, ZIMJ – nested in 3 AGNES stations
- ZIM3=Galileo receiver at ZIM2 antenna
- L1 short baselines
- 2 weeks (June 11-25; DOY 162 – 176)
- No troposphere estimation for short baselines
- **Daily repeatability**: 0.8 mm horizontally, 2.2 mm vertically

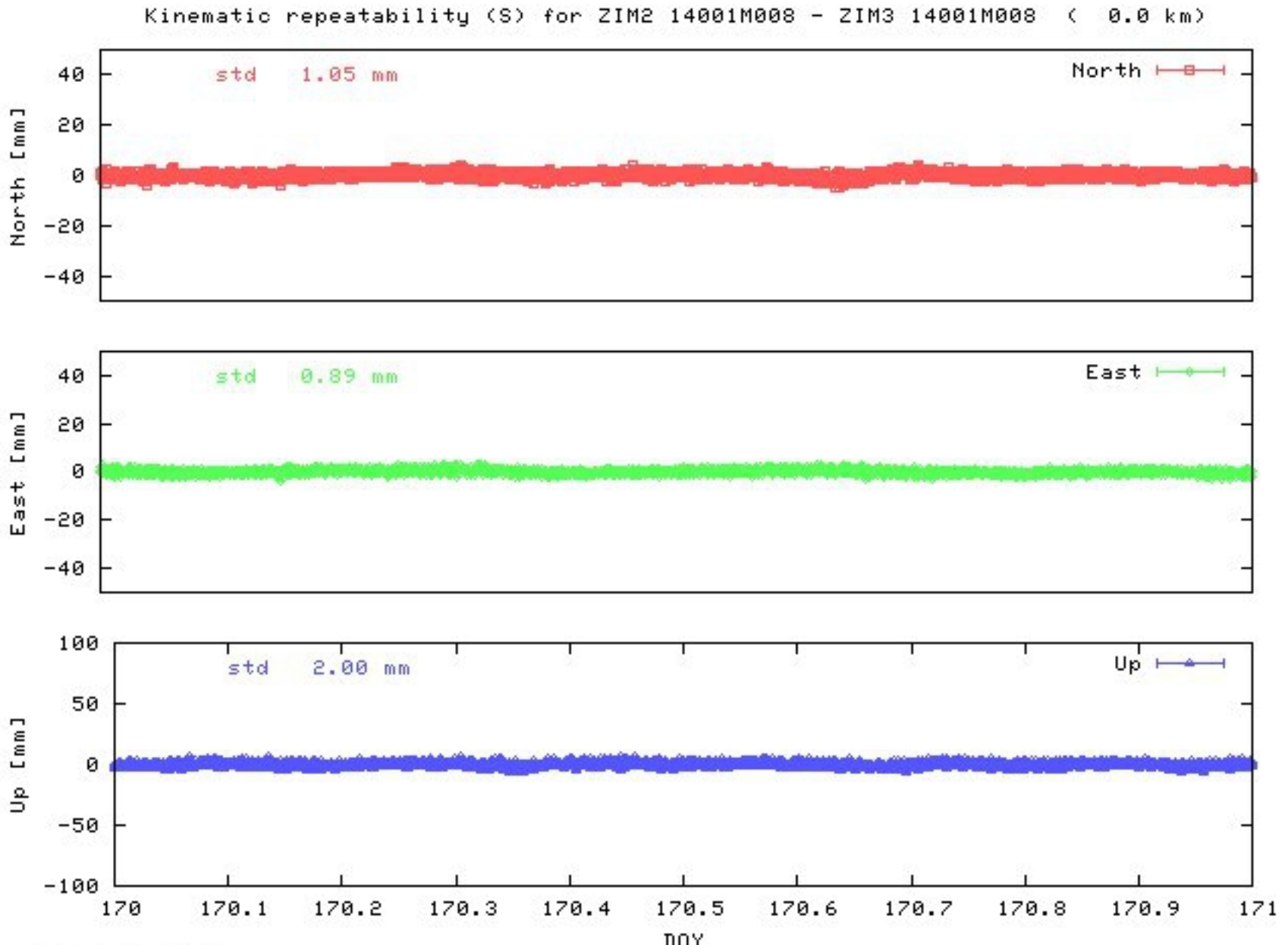




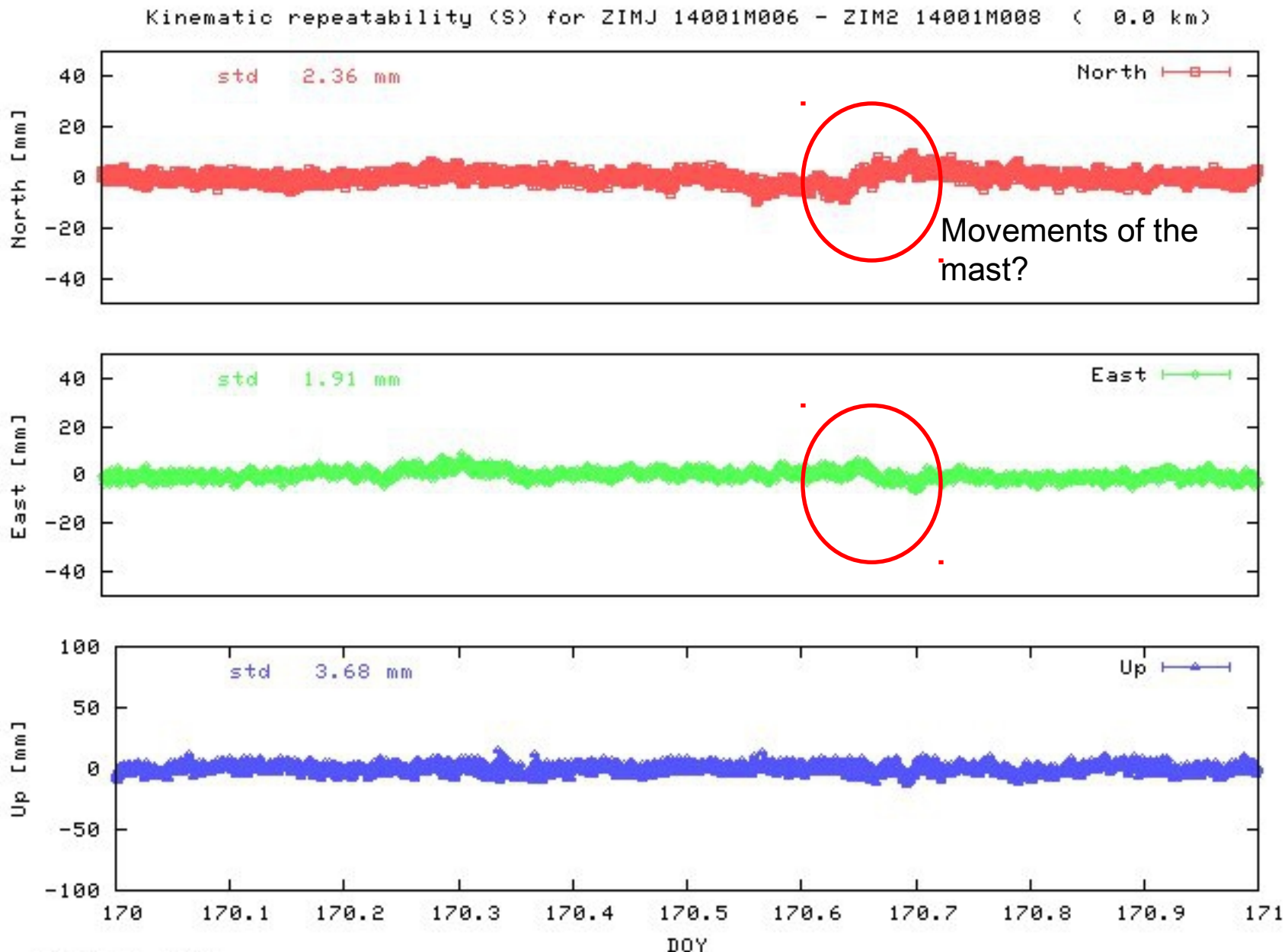
ZIM2=ZIM3 ! (identical coordinates)

Zero baseline: Hot day June 19

Kinematic coordinates: ZIM2-ZIM3

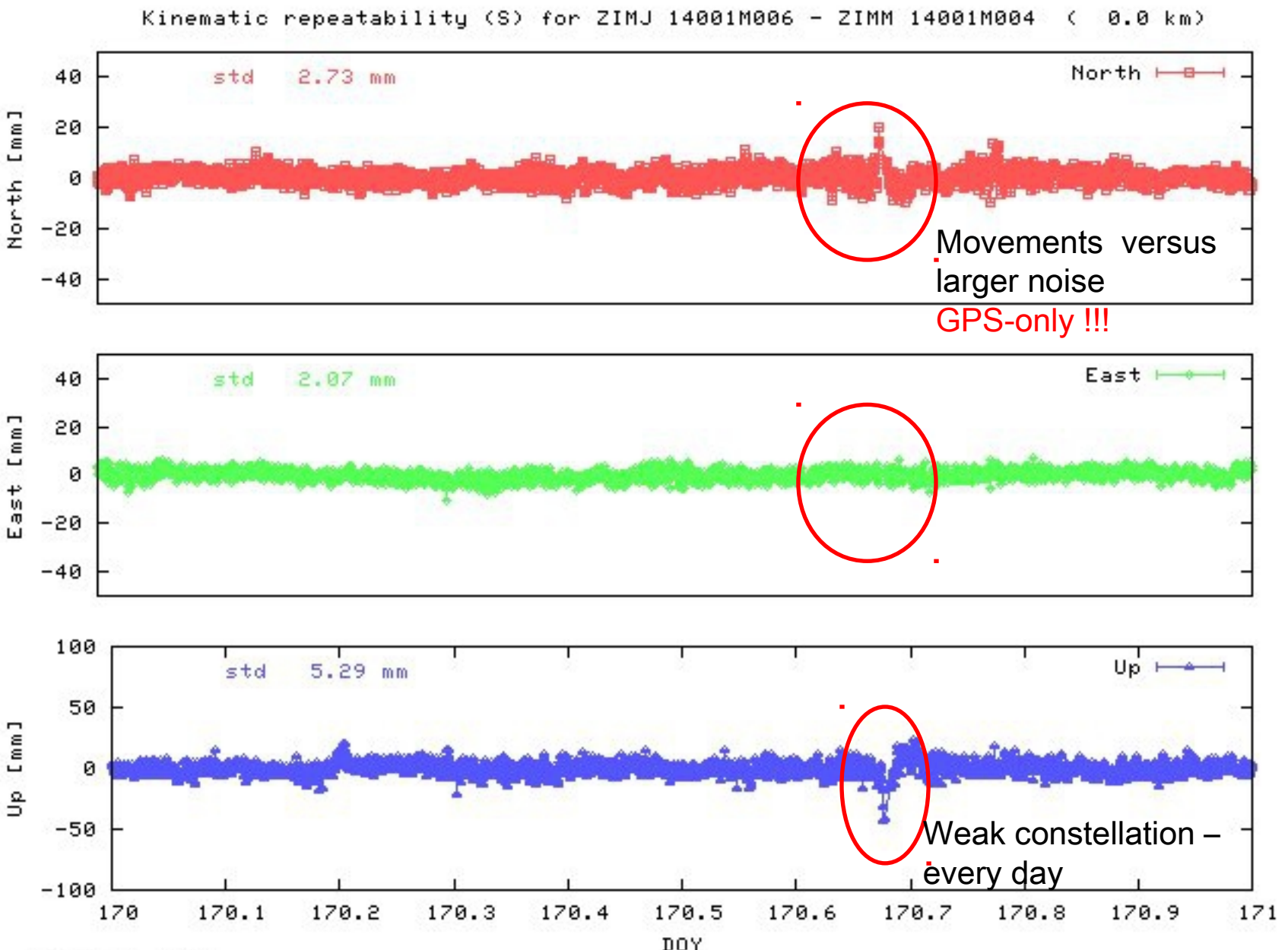


Kinematic coordinates: ZIM2-ZIMJ



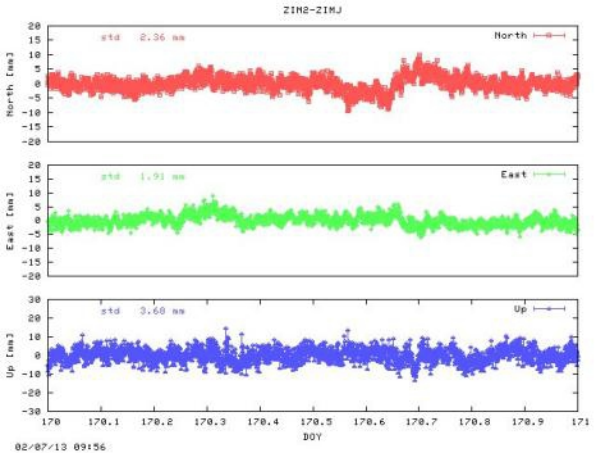
Real baseline GPS: Hot day June 19

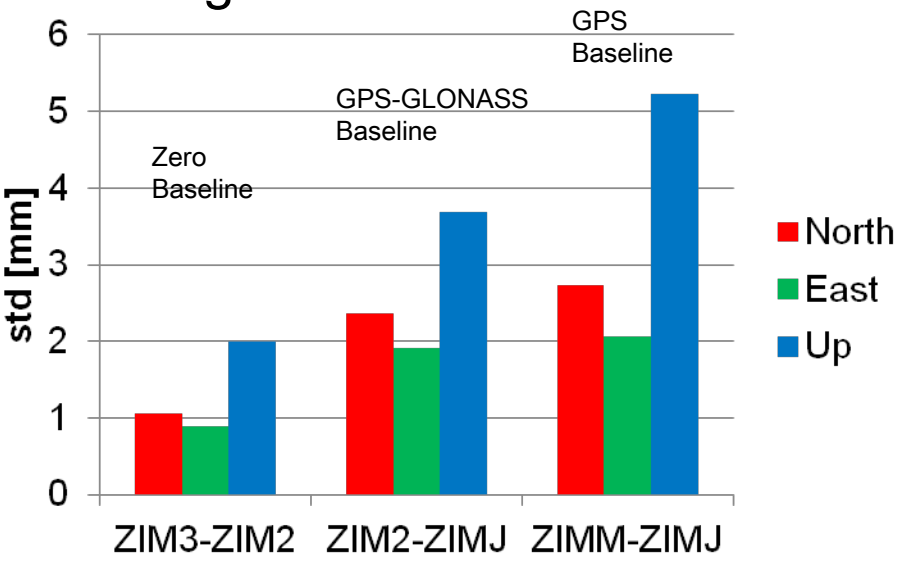
Kinematic coordinates: ZIMM-ZIMJ

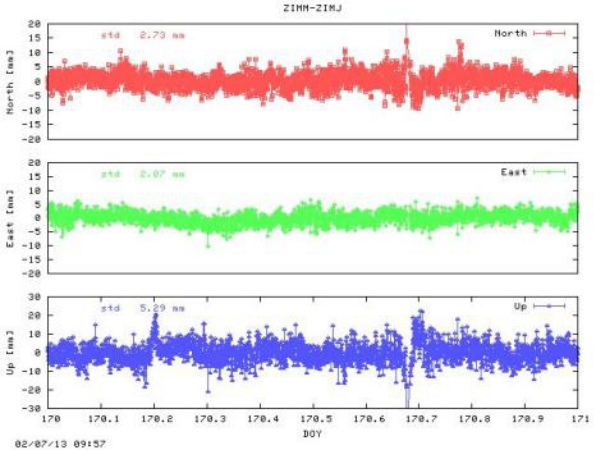


Repeatability kinematic coordinates

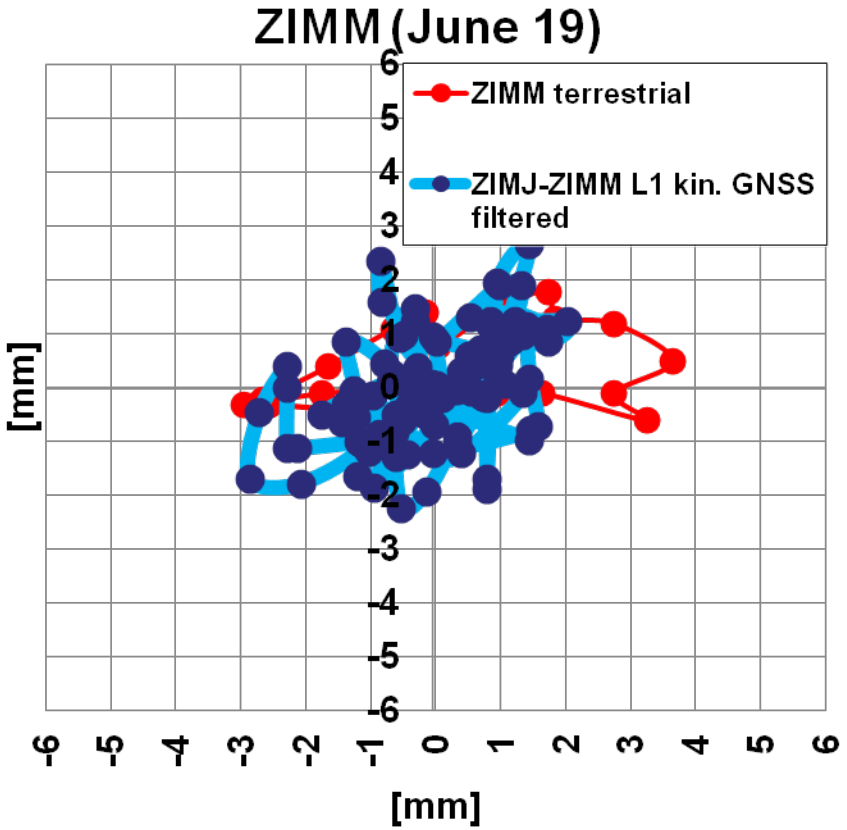
- Example day June 19 (hot day)
- Horizontal repeatability 2 mm enough?
  - GNSS: less noise – some signals visible (temperature movements?)
  - GPS: more noise – difficult to see signals

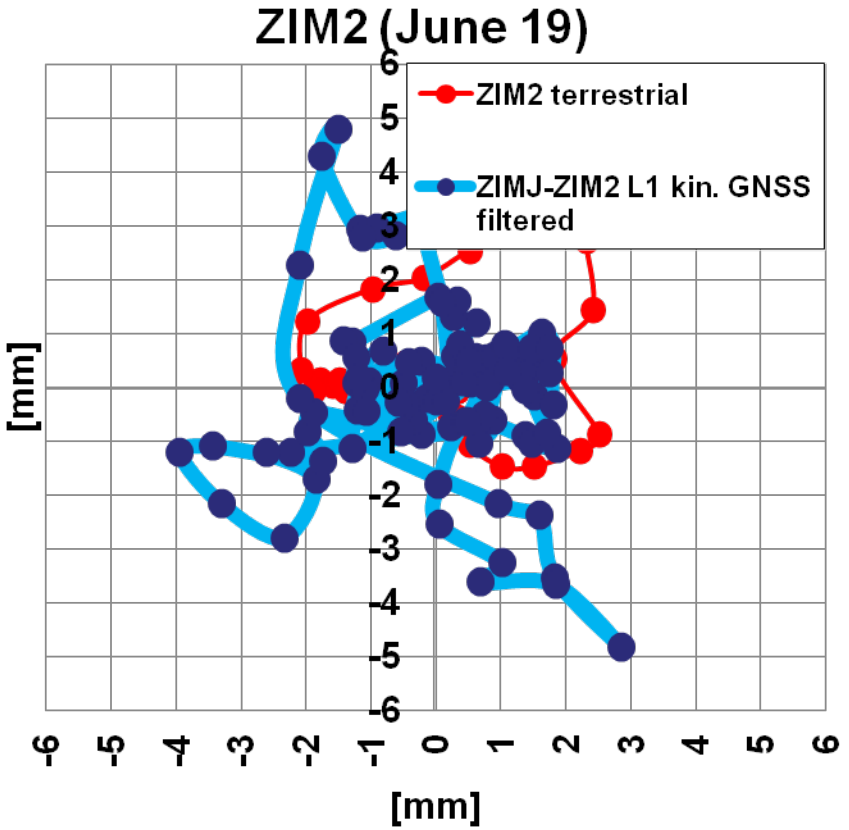






Comparison GNSS with terrestrial ground truth: ZIMM/ZIM2 June 19





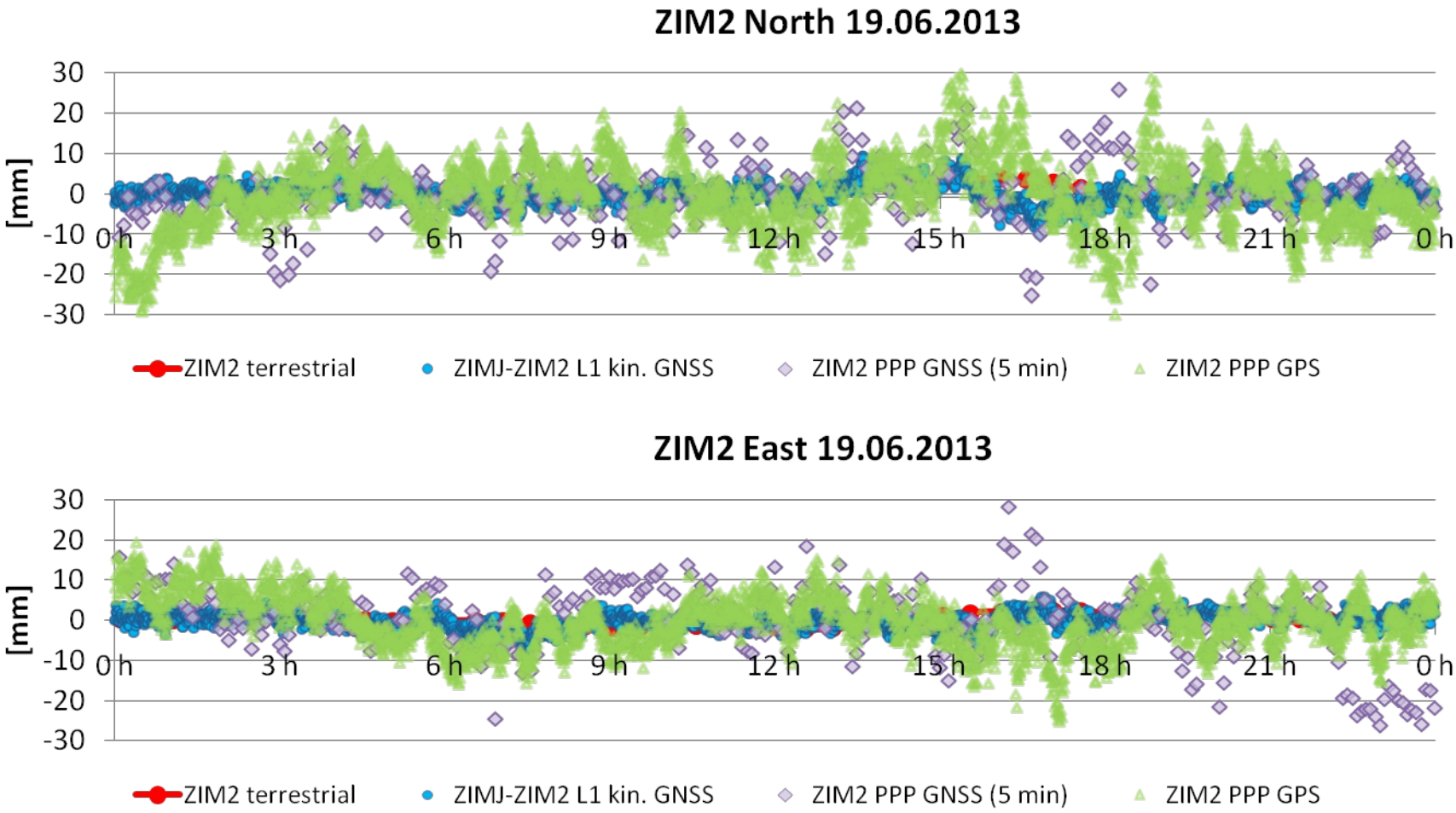
PPP solutions

- Absolute station monitoring – no reference station – no baselines! – results in ITRF2008!

PPP solutions:

- CODE: GNSS with 30 second clocks, every 5 min. CRD
- swisstopo: GPS with 30 second clocks, every 30 sec. CRD

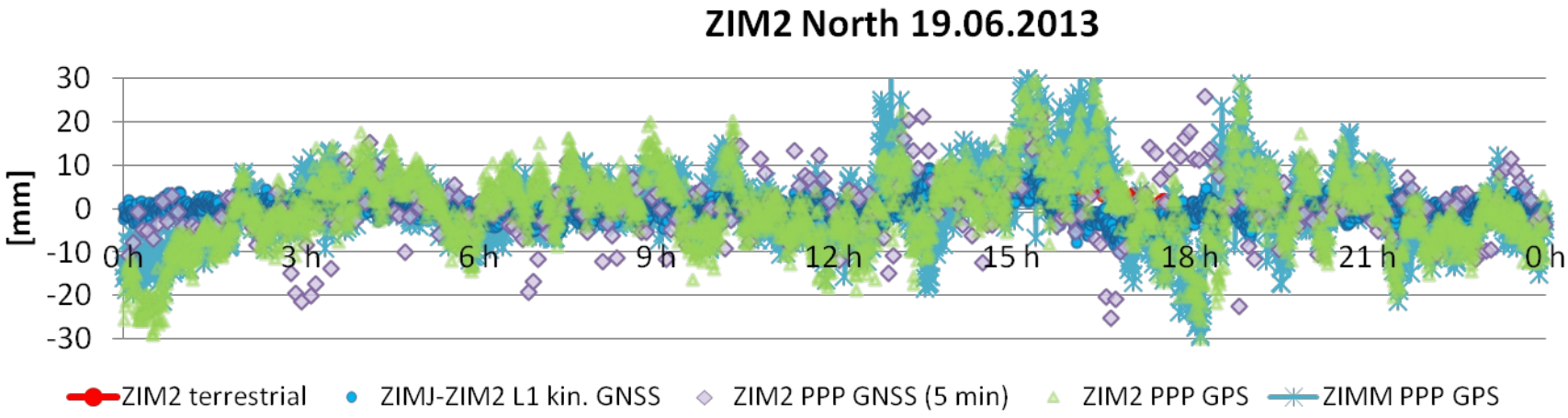
All solutions: ZIM2 June 19

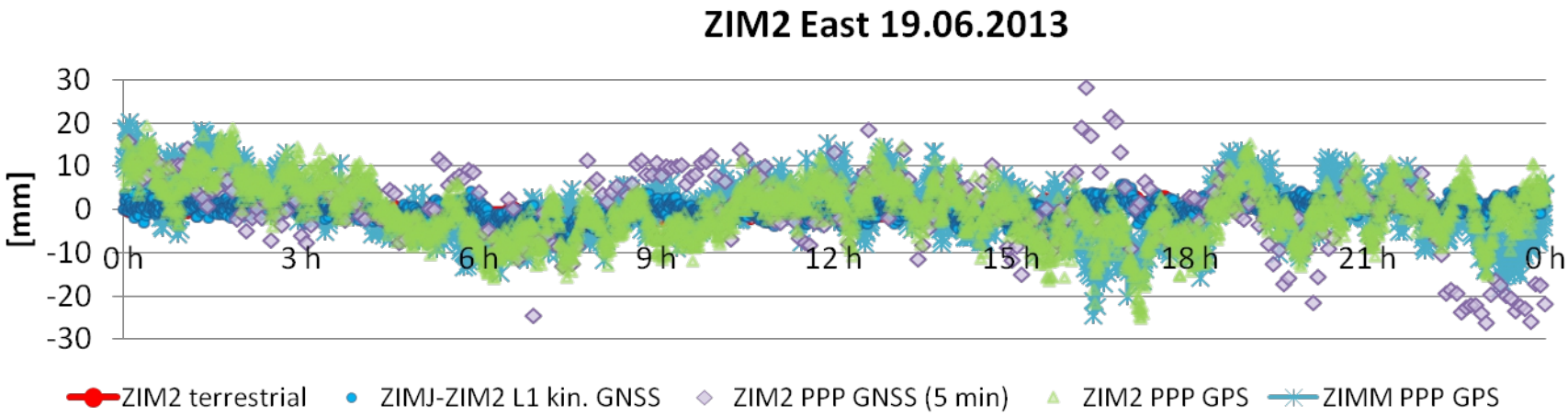


All solutions: ZIM2 June 19

Common mode residuals for PPP !

GNSS slightly less epoch-to-epoch noise





Conclusions

- 9-Meter mast movements of peak-to-peak
  - 8 mm horizontally during hot, sunny days
  - 2 mm vertically (temperature depended dT)
  - Terrestrial estimation precision of ~0.2 mm!
- Daily mean horizontal positions + night observations are not biased -> local tie measurements under cloudy condition
- GNSS not able to reliably measure these horizontal movements
  - GNSS kinematic baselines L1
    - Std of 2 mm horizontally, but not precise enough
    - GNSS kin. results less noise compared to GPS-only
  - PPP kinematic solutions GNSS+GPS
    - Std of 10 mm horizontally
    - Attractive for larger movements (>5 cm) without reference stations


Thank you for your attention!