ETH zürich

Institute for Geodesy und Photogrammetry

MPGNET:
A multi-purpose low-cost GNSS collocation station network

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Agenda

- Motivation for a multi-purpose GNSS network
- Instrumentation
- Prototype station Zürich-Affoltern
- First results
- Outlook on future activities

MPGNET: Multi-Purpose GNSS NETwork

Motivation: ⟶ **GNSS: a very versatile sensor for monitoring**

- ❑ Environmental processes
- ❑ Natural hazards
- ❑ Climate change

Especially in remote/alpine areas!

Several applications/products:

- ❑ Ground movements (for landslide or seismic monitoring)
- ❑ Tropospheric delays (ZTD, ZWD) and integrated water vapor (IWV)
- ❑ Soil moisture and snow properties (height and snow-water-equivalent (SWE))

Pilot study in cooperation with MeteoSwiss: Collocation of GNSS payload at SwissMetNet (SMN) sites

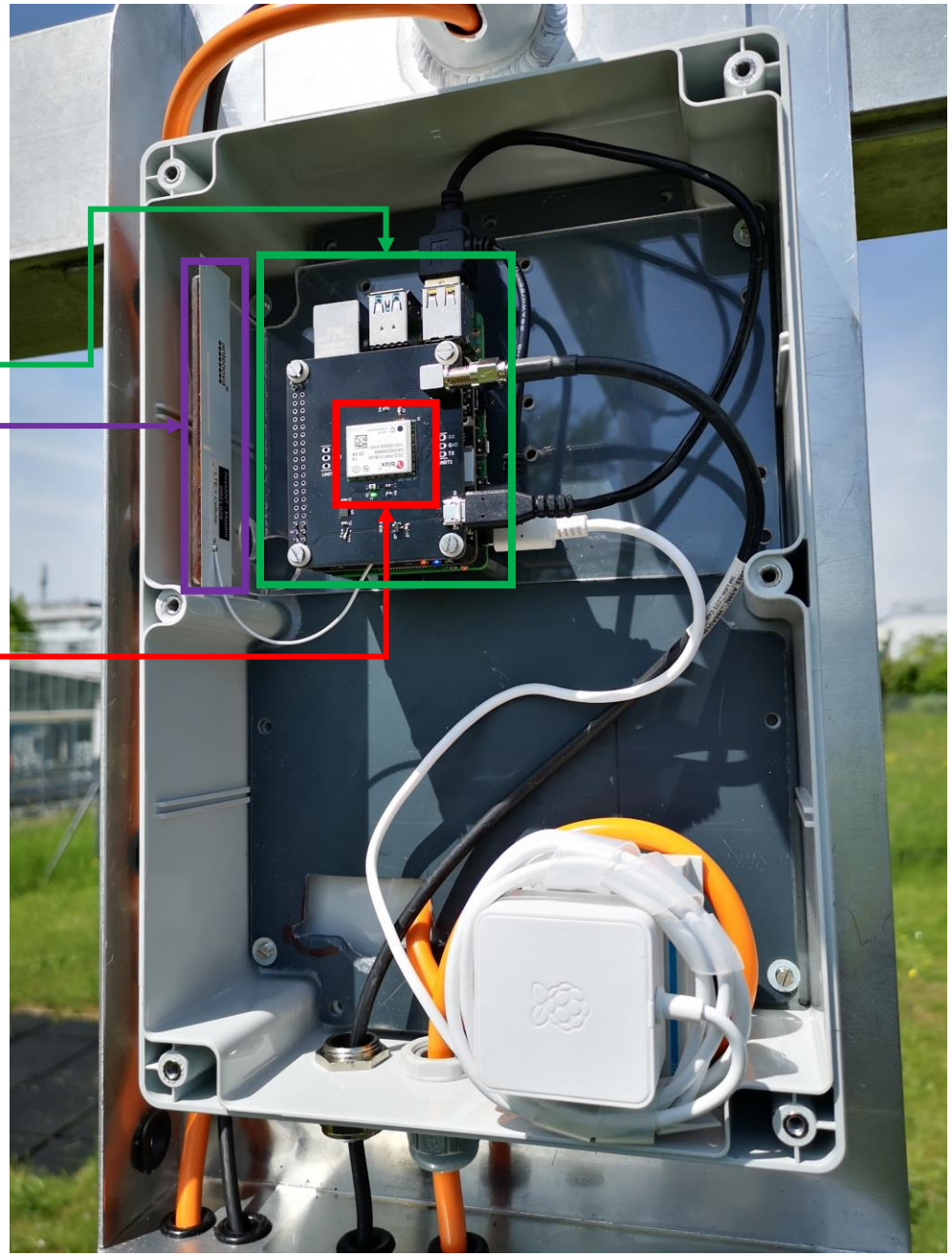
- ❑ Pilot project covers equipment of 10 dedicated sites
- ❑ Test setup at prototype site
- ❑ Long-term vision: collocation at > 100 sites in Switzerland

Build-up of a cost-effective, sustainable GNSS network, providing a variety of high-quality products for environmental monitoring

Instrumentation

Data logging system:

- **Raspberry Pi 4**: for data logging/transfer and basic scripting
- **LTE modem and antenna** for data transfer
- **Ublox ZED-F9P** dual-frequency, multi-GNSS board
- **Septentrio PolaNt* MC** multi-frequency, multi-GNSS antenna



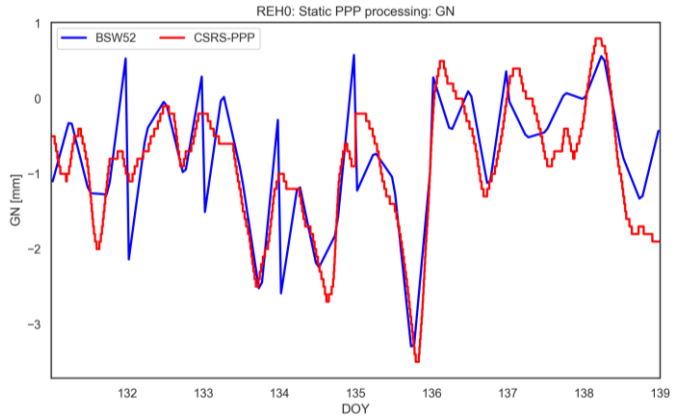
Prototype station Zürich-Affoltern

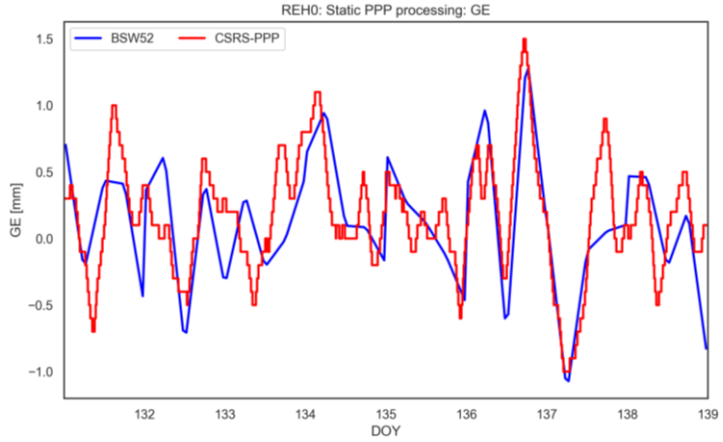
- MPGNET prototype station
  - At SMN site Zürich-Affoltern
  - Installed on 10.05.2022
  - Location nearby ETH: -----> Easy access
- Construction:
  - Dedicated measurement arm, specifically designed at ETHZ
  - Easily deployed at existing infrastructure
  - System uses existing power supply from SMN
- Data logging, transfer and processing
  - Logging 1Hz binary raw data (.ubx) on the Raspberry Pi using pyubx2 (https://pypi.org/project/pyubx2/)
  - (At the moment) hourly data transfer via FTP
  - Automated Precise Point Positioning (PPP) processing routine
    - (Hourly) Estimation of coordinates and troposphere parameters
    - Using Bernese GNSS software 5.2

First results

- Tropospheric parameters
  - Static PPP estimation using
    - Bernese GNSS software 5.2 (hourly)
    - CSRS-PPP (epoch-wise ---> 30sec)

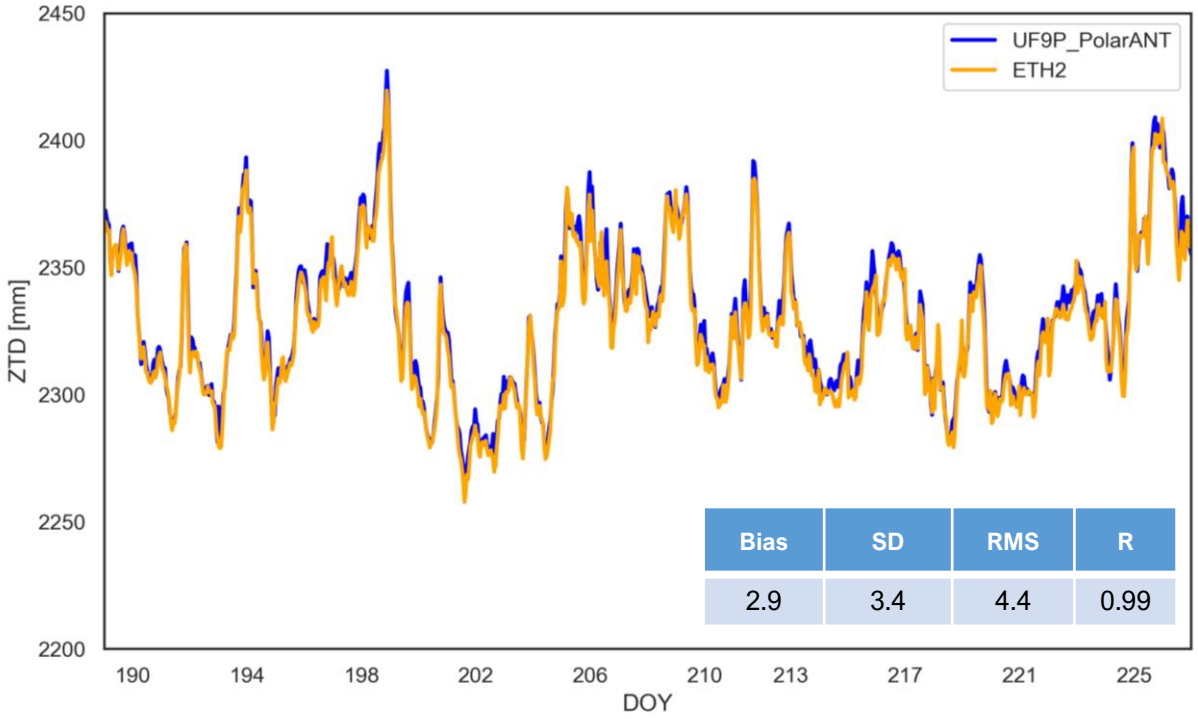
Gradients





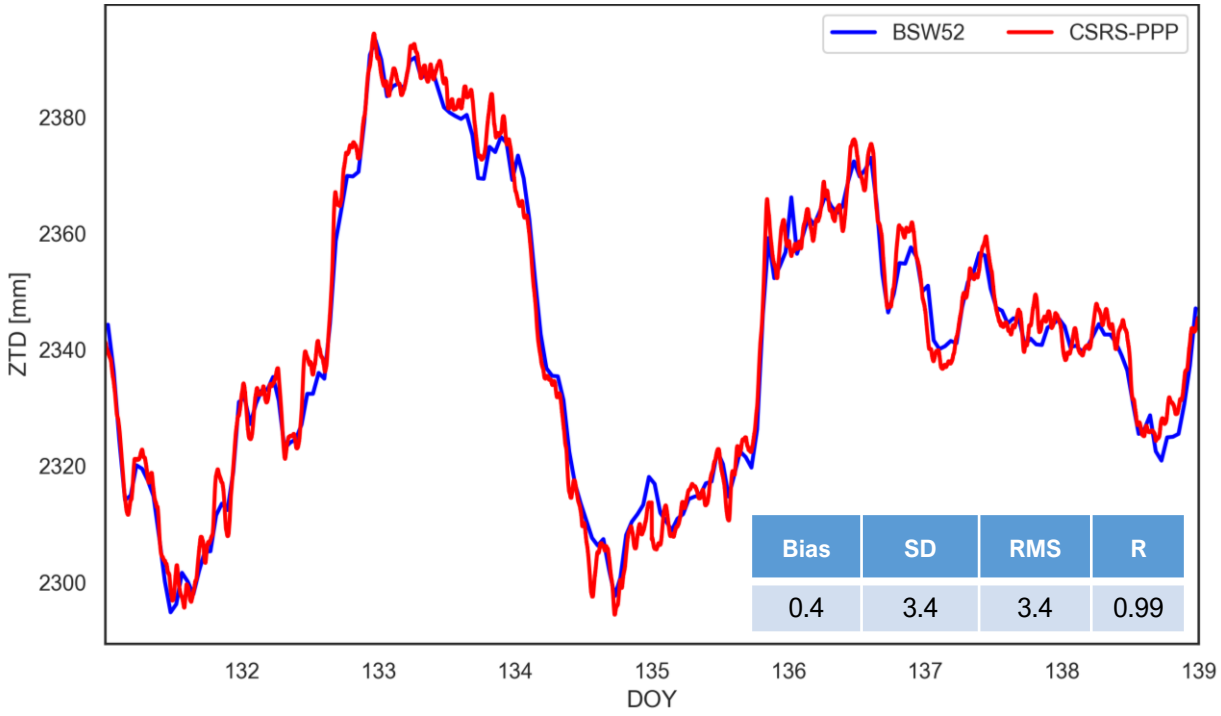
Zenith Total Delay

MPGNET payload vs geodetic-grade (ETH2, AGNES)



Bias	SD	RMS	R
2.9	3.4	4.4	0.99

BSW 5.2 vs CSRS-PPP

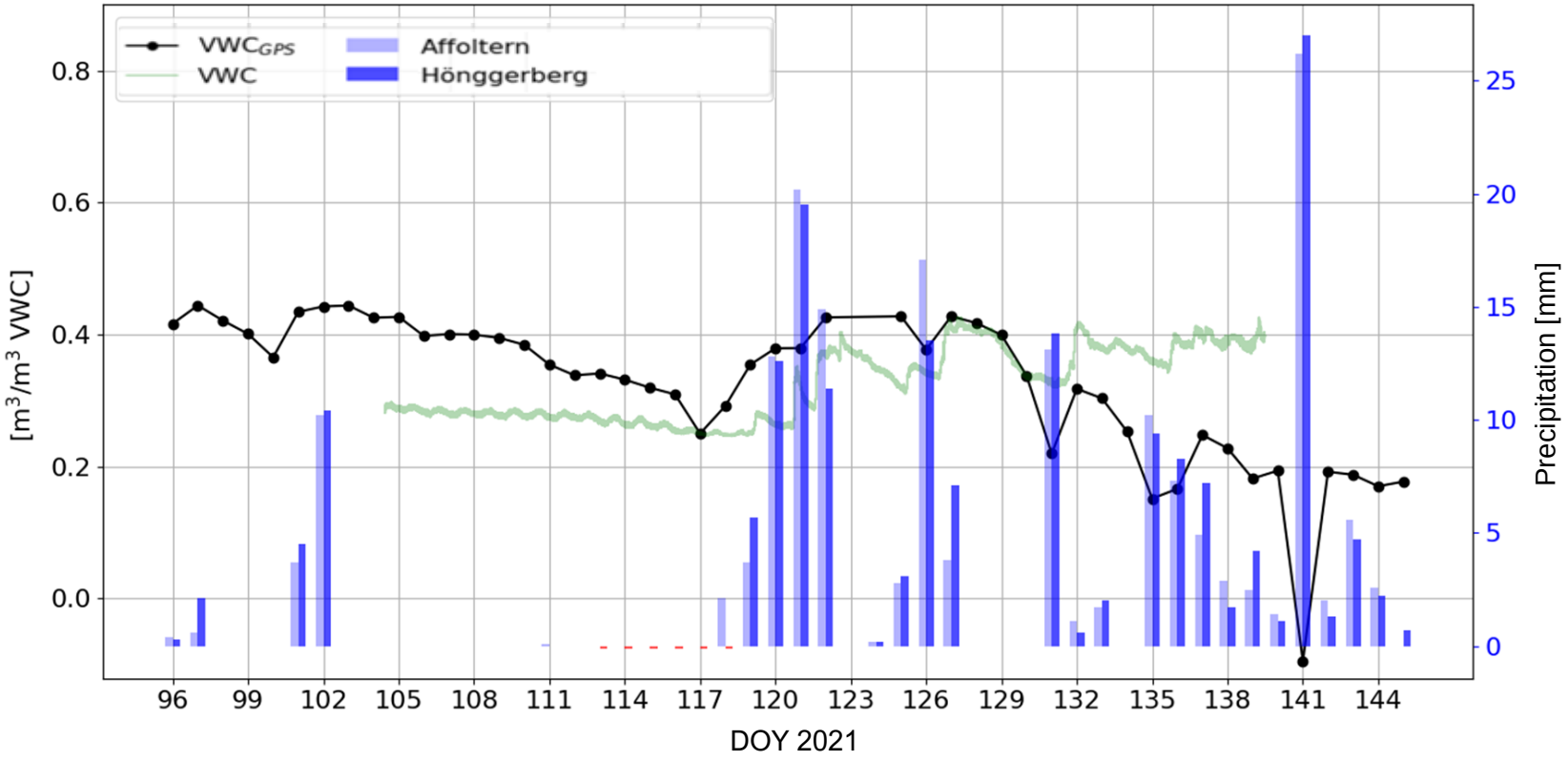


Bias	SD	RMS	R
0.4	3.4	3.4	0.99

First results

- Soil moisture
  - Setup at Hönggerberg
  - Estimation of Volumetric Water Content (VWC) from signal-to-noise ratio -----> GNSS Reflectrometry

$$VWC_{GPS} = \frac{\Delta\varphi}{65.1} + 0.25\ [m^3/m^3]$$



Ineichen (2021), BSc thesis, ETHZ

Outlook

- Network:
  - Fixing of initial problems/bugs encountered for prototype
  - Choice and equipment of another nine stations

- Processing and product provision:
  - Setup of near-real-time estimation procedure
  - Real-time streaming and parameter estimation
  - Setup of operational soil moisture (and snow properties) retrieval
  - Explore combinations of derived products for monitoring and early-warning purposes

- Project ideas
  - Further network extension through dedicated funding opportunities
  - Team-up with strong partners: both for product generation and usage

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