

Understanding the landslide dynamics with corner reflector SAR interferometry

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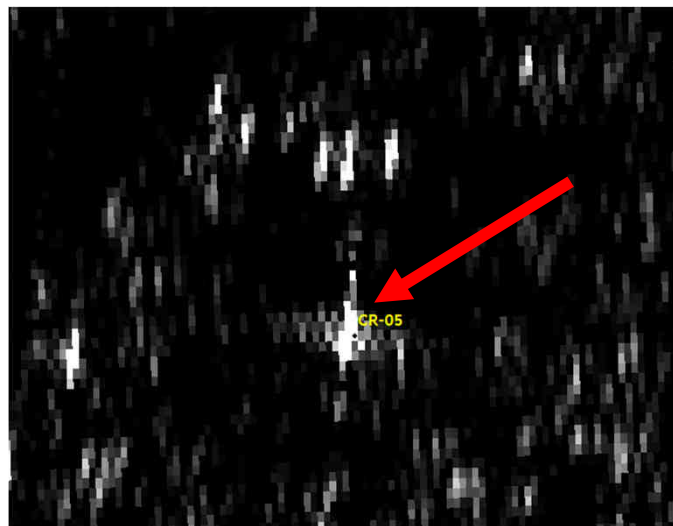
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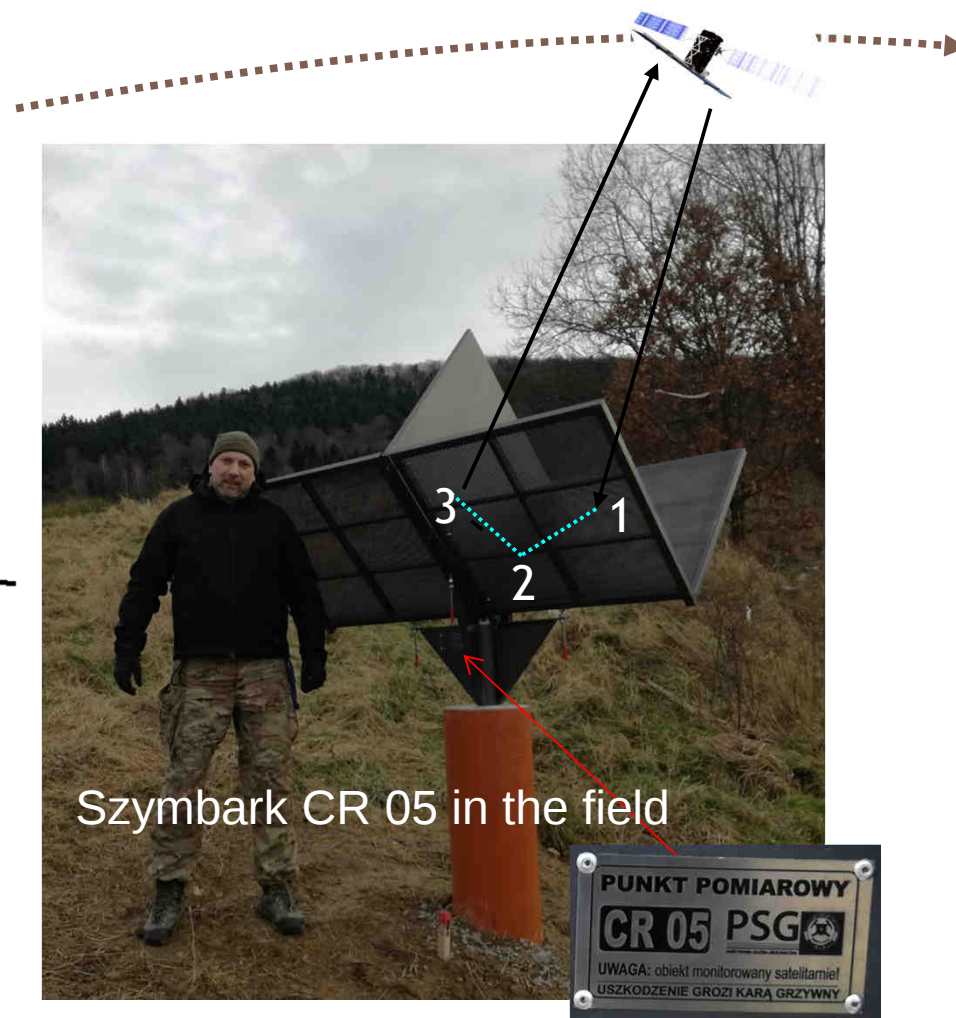
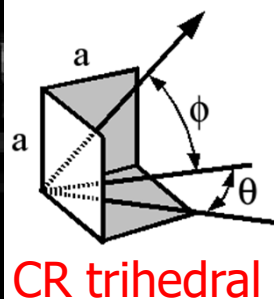


Corner Reflector – the real thing

We know exactly from where the radar reflection come from!



Szymbark CR 05 – SAR amplitude S1



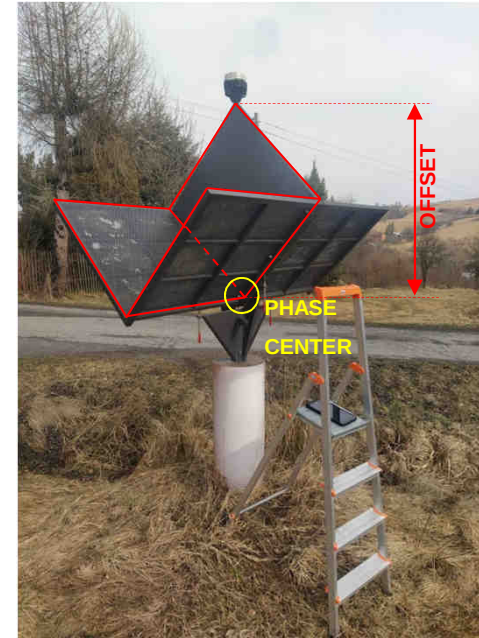
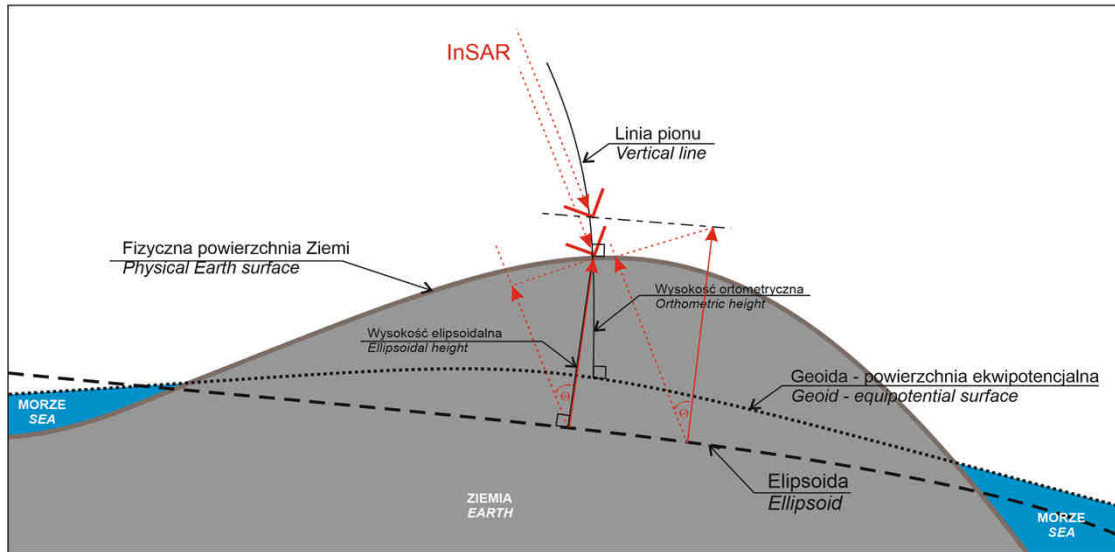
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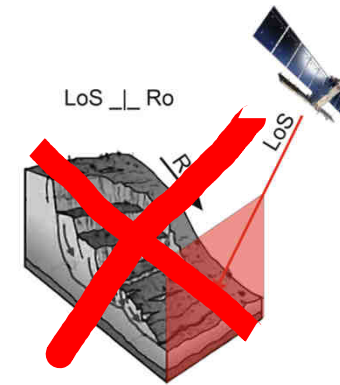
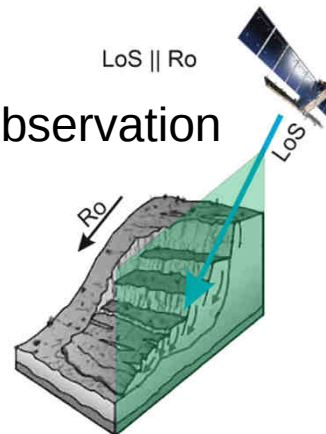


InSAR <-> GNSS validation

Leveling, GNSS, CRInSAR are measuring different things!



importance of orientation v.r.t. SAR observation



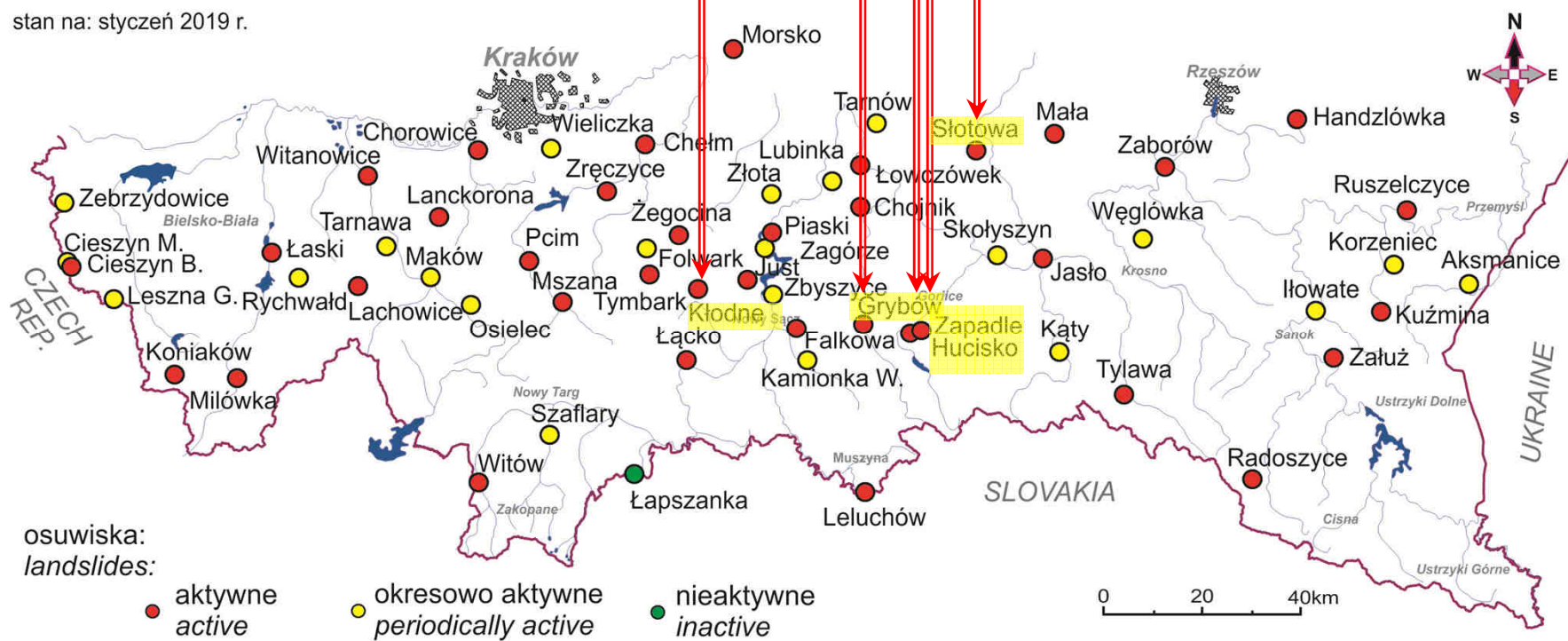
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POLAND – landslide monitoring

+ CRInSAR monitoring

stan na: styczeń 2019 r.



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CRInSAR on landslides: DATA INTEGRATION



CRInSAR– relative deformation (LOS / Y-East + Z-Up) [mm]

GNSS RTK - relative defo. Y (East) [mm] Z (Up) low accuracy

Piezometer - groundwater level - daily average[m]

Rain gauge – precipitation, daily sums [mm]

Temperature – daily average [°C] – for reference only!

Temperature: data from Kraków Balice airport

Global Historical Climatology Network (GHCN) – noaa.gov

CRInSAR decomposition

LoS =>> 3D

Sentinel-1 SAR data

2x asc + 2 x desc



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CRInSAR: setup & implementation

6 CRs / landslide

2 CRs – ref.

(outside landslide area)

4 CRs – defo.

(inside landslide area)

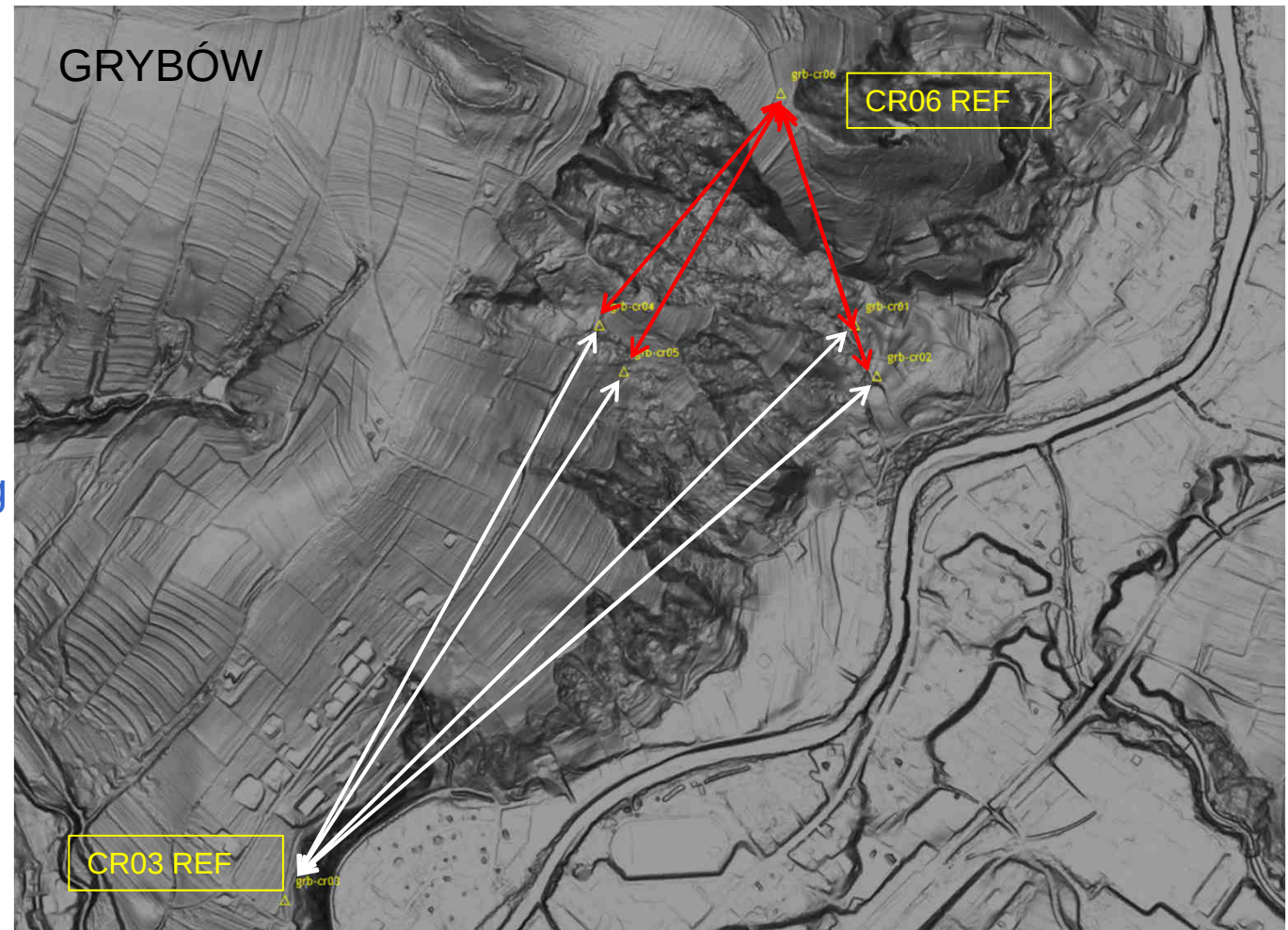
CRInSAR DD processing

Double Differences

- W.r.t. time (1st scene)
- W.r.t. reference CR

Data analysis

- Visual: plot comparisons
- Numerical: time series analysis (ongoing)

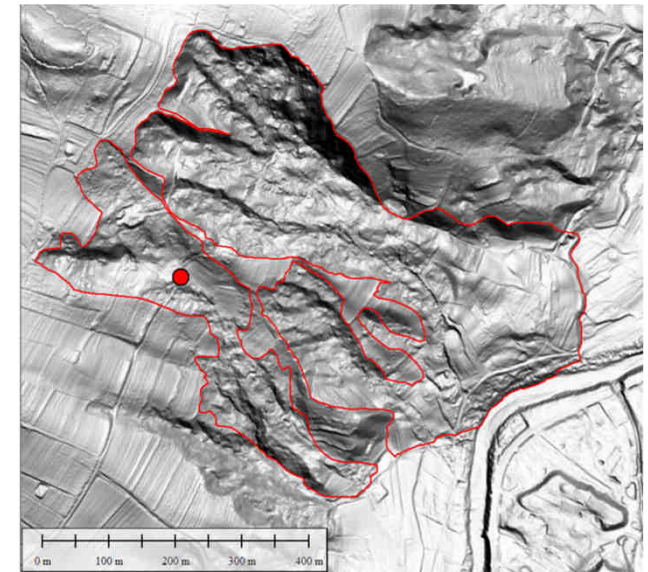


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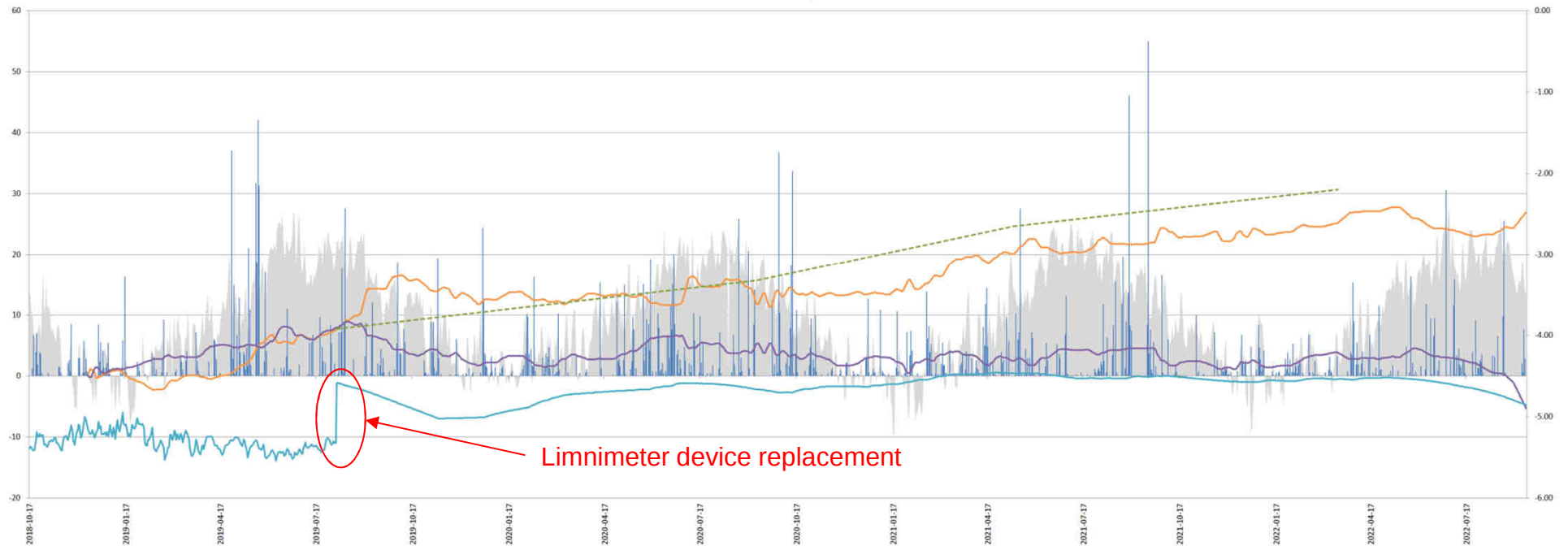
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Results: Grybów

- Temperature, daily avg. oC
- Precipitation, daily sum [mm]
- Ground water level depth [m]
- CR09 GNSS EAST [mm]
- CR InSAR EAST [mm]
- CR InSAR UP [mm]

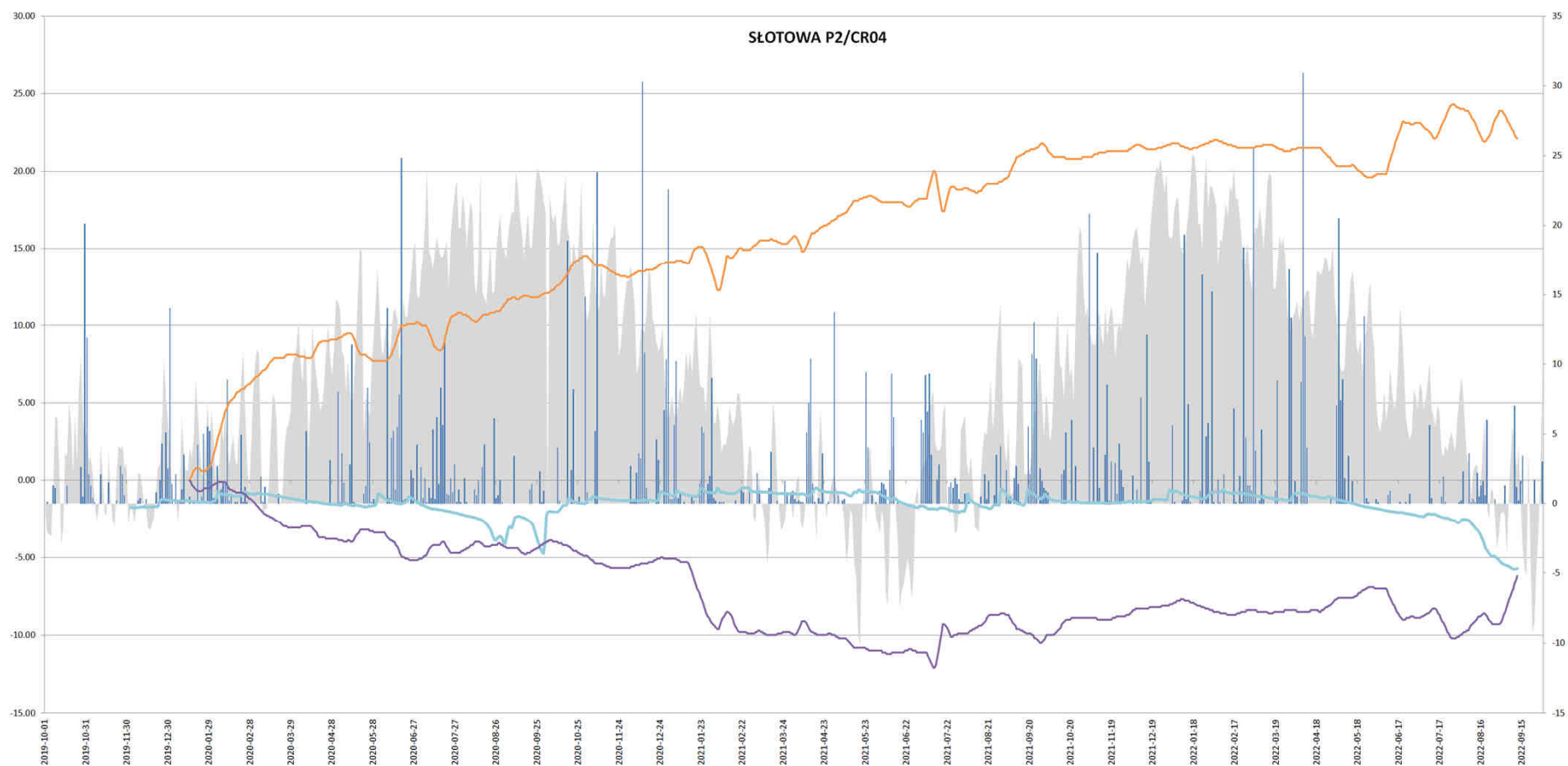
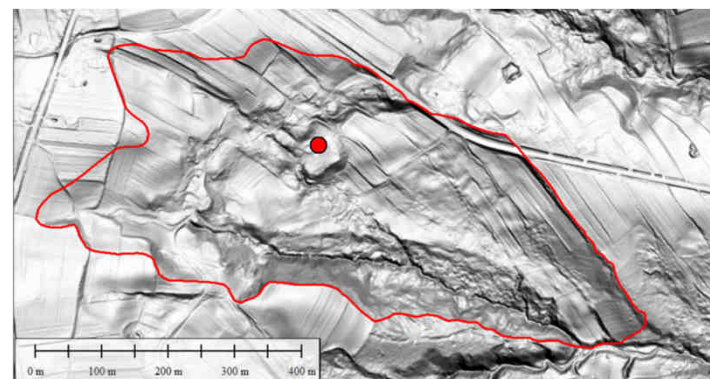


GRYBÓW P1/CR04



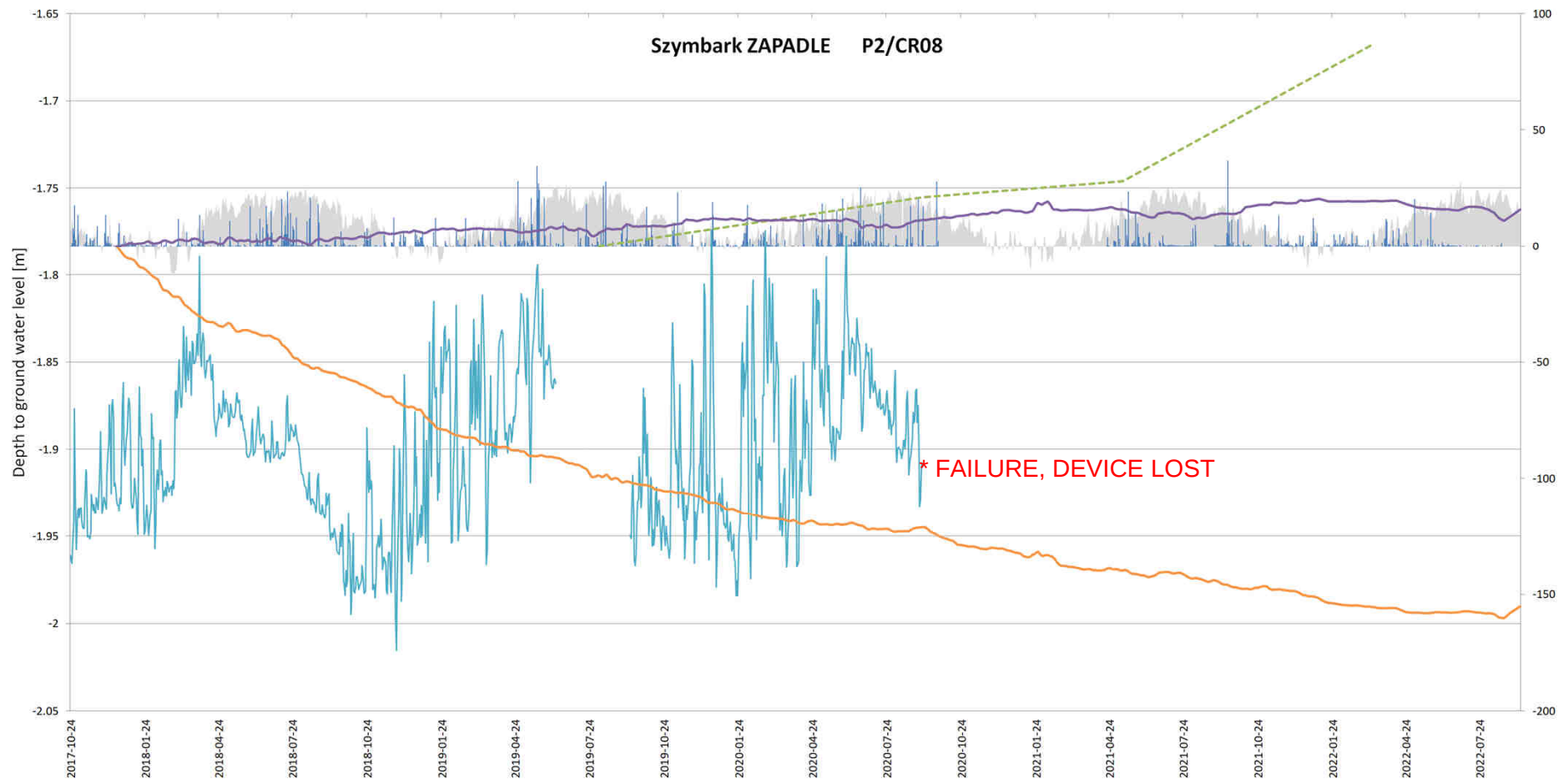
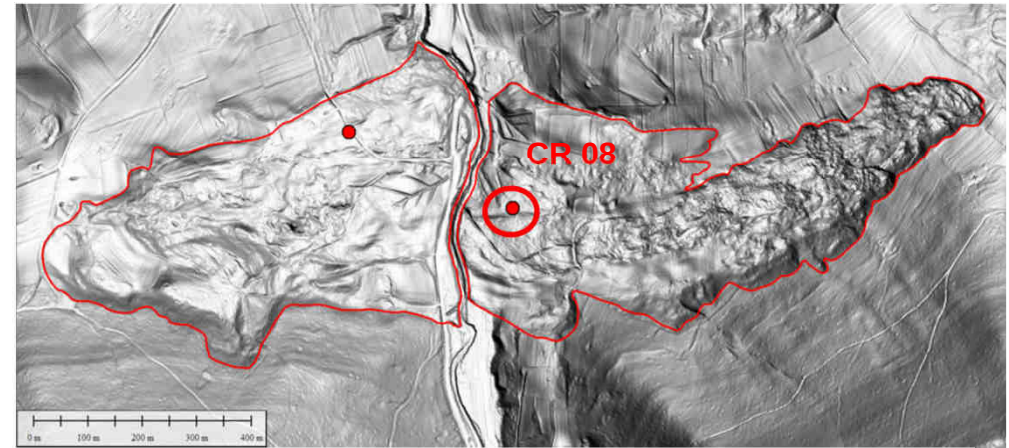
WYNIKI: Słotowa

- Temperature, daily avg. oC
- Precipitation, daily sum [mm]
- Ground water level depth [m]
- CR09 GNSS EAST [mm]
- CR InSAR EAST [mm]
- CR InSAR UP [mm]



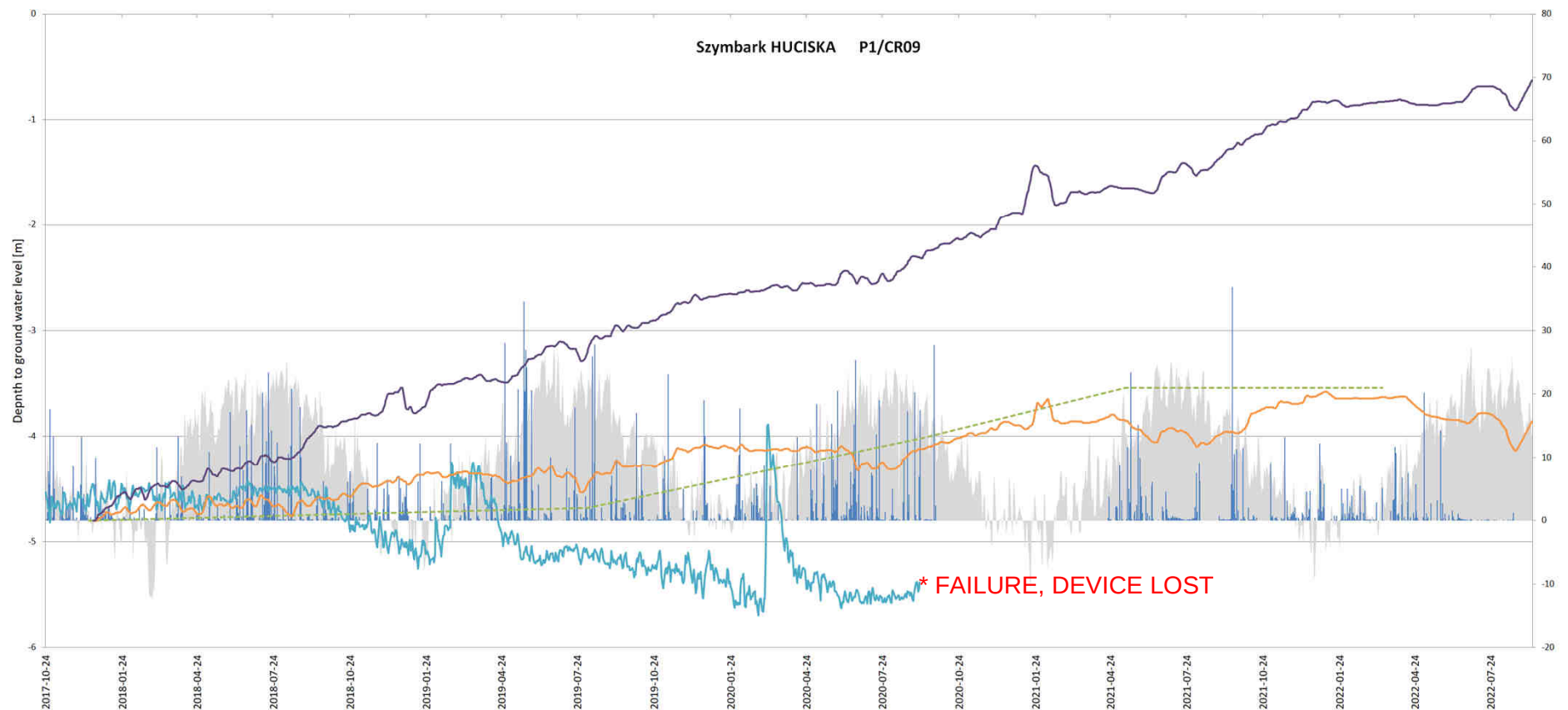
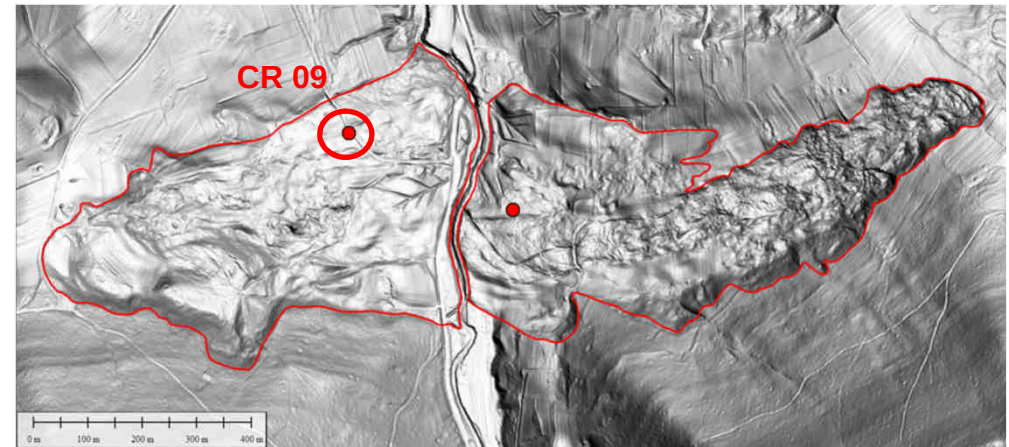
Results: Szymbark ZAPADLE

- Temperature, daily avg. oC
- Precipitation, daily sum [mm]
- Ground water level depth [m]
- CR09 GNSS EAST [mm]
- CR InSAR EAST [mm]
- CR InSAR UP [mm]



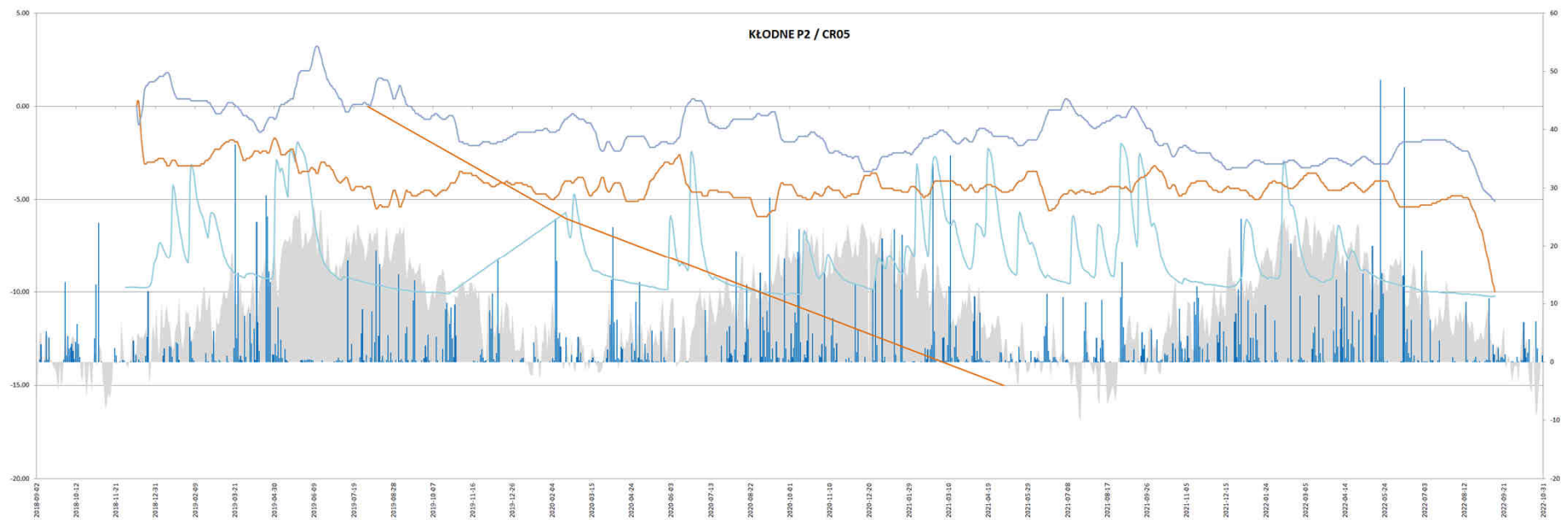
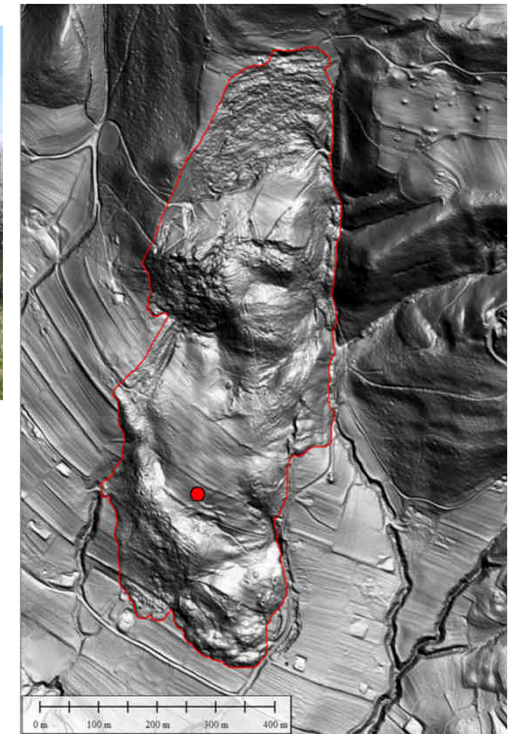
Results: Szymbark HUCISKA

- Temperature, daily avg. oC
- Precipitation, daily sum [mm]
- Ground water level depth [m]
- CR09 GNSS EAST [mm]
- CR InSAR EAST [mm]
- CR InSAR UP [mm]



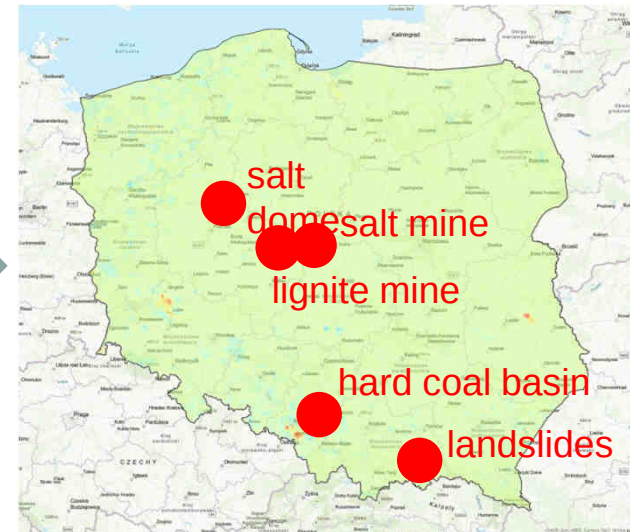
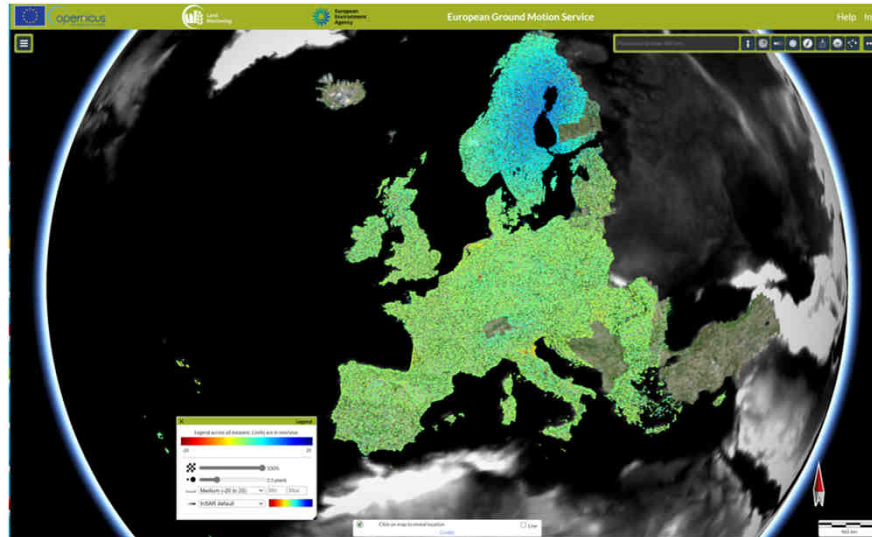
RESULTS: Kłodne

- Temperature, daily avg. oC
- Precipitation, daily sum [mm]
- Ground water level depth [m]
- CR09 GNSS EAST [mm]
- CR InSAR EAST [mm]
- CR InSAR UP [mm]



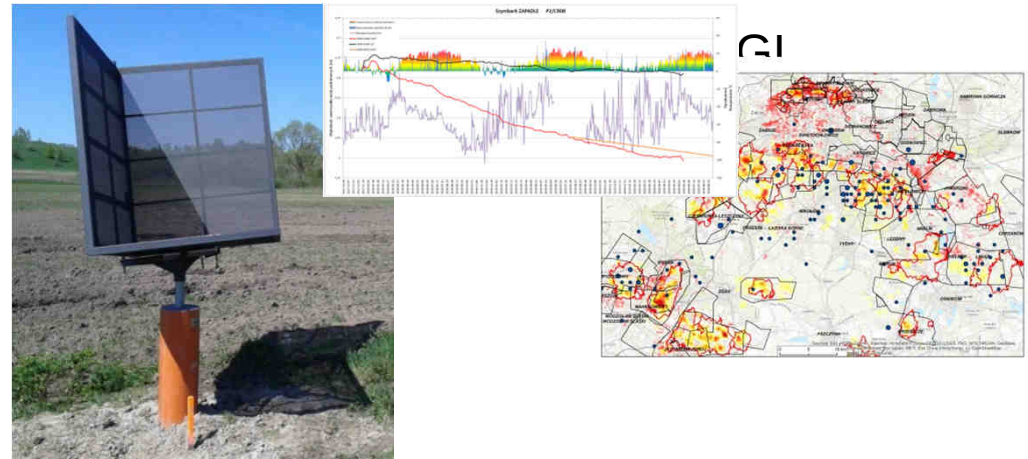
Interferometric Monitoring of the Surface of Poland (InMoTeP) – stage II

<https://www.pgi.gov.pl/monitoring-osiadan/o-projekcie.html>



From European Ground Motion Service

Additionally a detailed analysis of selected areas with corner reflectors, detailed displacement research and comparison of timeseries with other data



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