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Towards integration of GNSS and GB-SAR measurements: Exemplary monitoring of a rock fall at the Yangtze River in China

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Structure

- Introduction and motivation
- Test Scenario
- Processing and analysis
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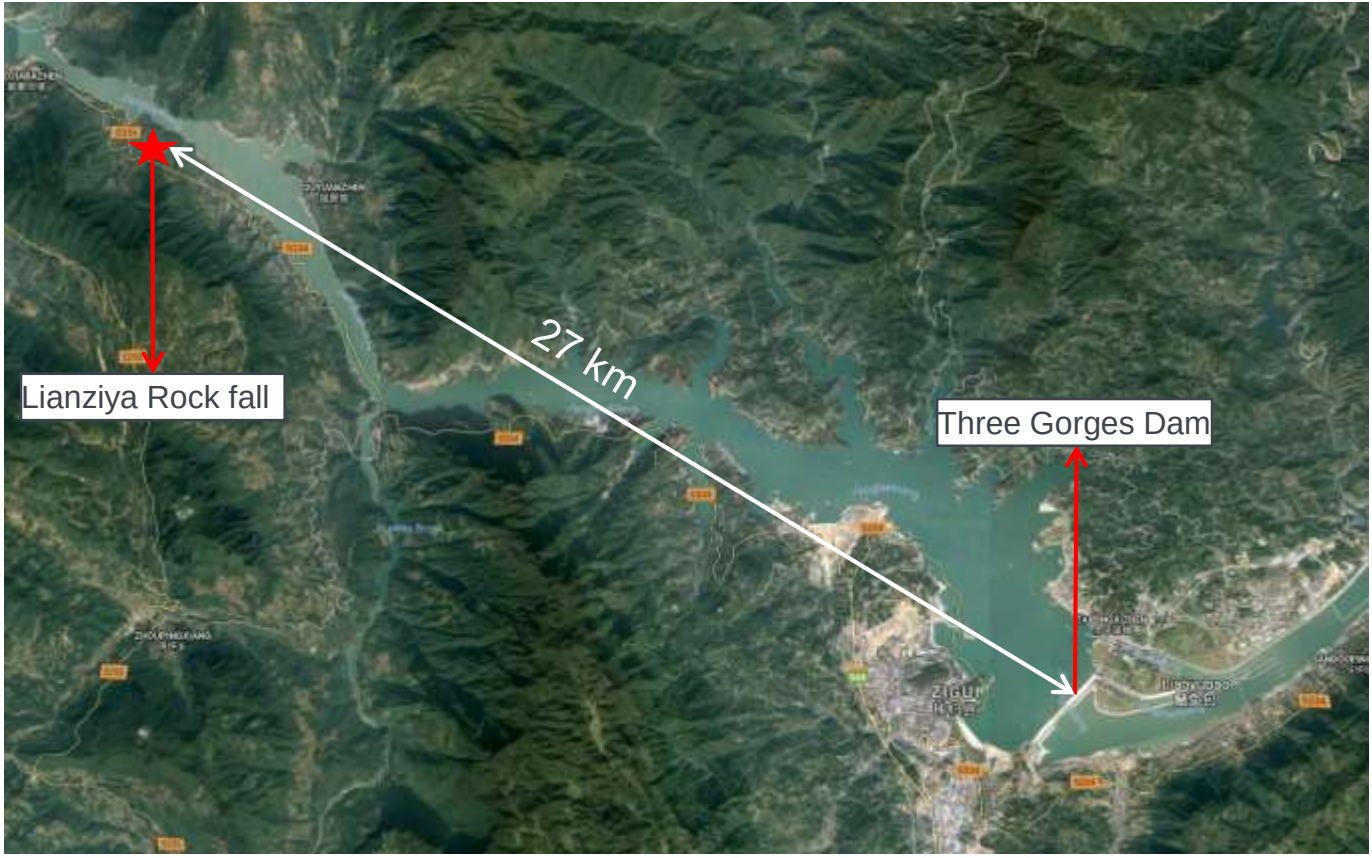
- Conclusion and outlook

Introduction and motivation

Rock fall description



Introduction and motivation

Rock fall description

Area 3 still active!!

- Average horizontal displacement 1.0~4.2 mm/year
- Average vertical displacement 0.3~2.9 mm/year

Test Scenario

Test Scenario

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Test Scenario

- Measurement of temperature, humidity and pressure on the GB-SAR station and in the monitoring area
- 2 days measurements (due to data gaps just 27 hours has been processed)

Processing and analysis

GB-SAR

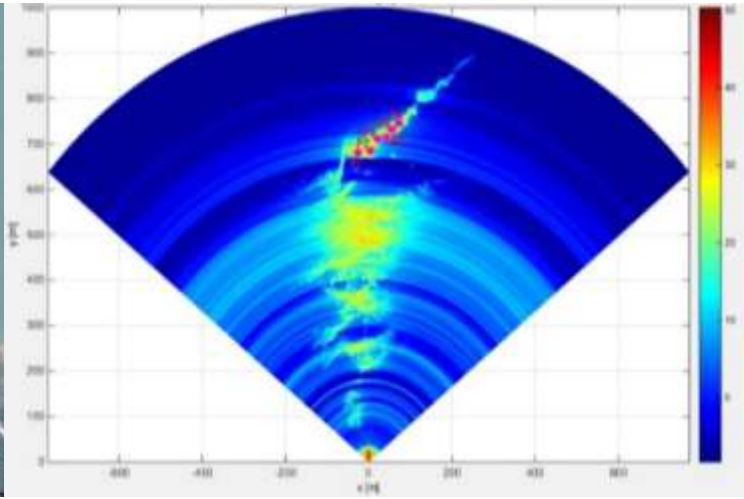
- Interferometric phase to determine the LOS-displacement

$$\varphi_w = \varphi_{disp} + \varphi_{atm} + \varphi_{noise} - 2N\pi \qquad (1)$$

- The relationship between displacement Δ and interferometric phase:

$$\Delta = -\frac{\lambda}{4\pi}\varphi_{disp} \qquad (2)$$

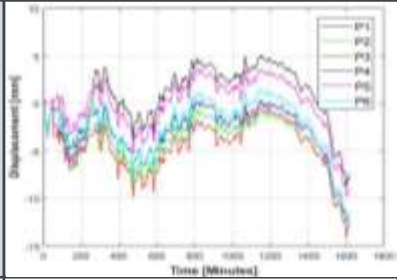
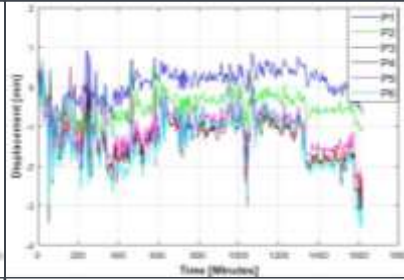
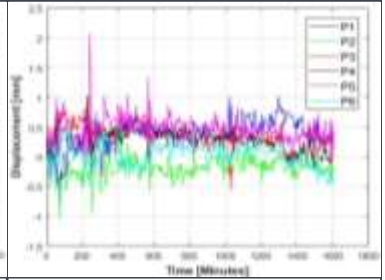
- Correction of atmospheric influence using GCPs (Ground Control Points)



Processing and analysis

GB-SAR

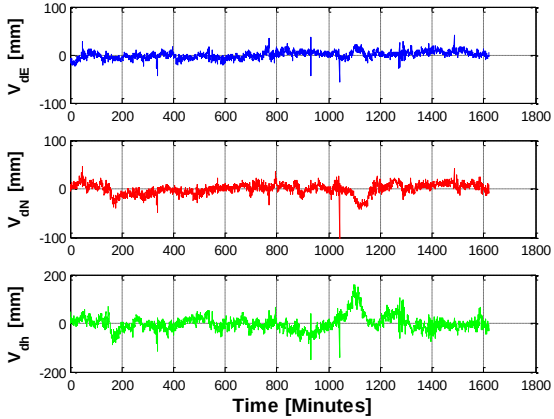
- Correction of atmospheric influence using GCPs

	No correction	Correction using stable GCPs	Correction using unstable GCPs
Time series (LOS)			
Mean correlation with humidity	0.80	0.53	0.18
Mean correlation with temperature	-0.73	-0.50	-0.20
Mean correlation with air pressure	0.09	0.07	-0.11

Processing and analysis

GNSS

- Processing by the software Grafnav



Baseline	Standard deviation in East [mm]	Standard deviation in North [mm]	Standard deviation in Height [mm]
Base 1-Rover 1	6.9	9.8	24.8
Base 1-Rover 2	13.4	19.0	32.3

Integration and comparison

Integration

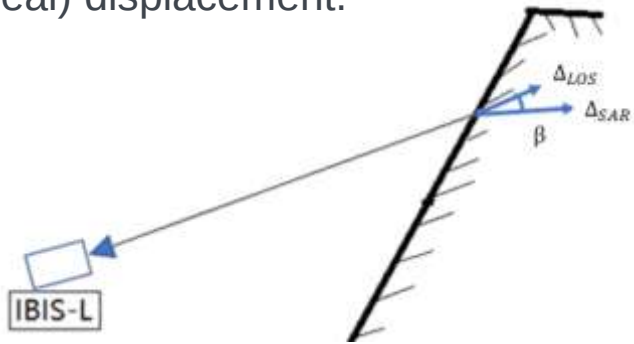
- Besides of using GNSS for the term of atmospheric correction.
- Transformation of LOS-displacement to (real) displacement.

$$\cos(\beta) = \alpha_{LOS}.\alpha_{GNSS} \quad (3)$$

$$\alpha_{LOS} = \left(\frac{N_{SAR} - N_{Mo}}{S}, \frac{E_{SAR} - E_{Mo}}{S}, \frac{H_{SAR} - H_{Mo}}{S}\right) \quad (4)$$

$$\alpha_{GNSS} = \left(\frac{\Delta N_{GNSS}}{\Delta_{GNSS}}, \frac{\Delta E_{GNSS}}{\Delta_{GNSS}}, \frac{\Delta H_{GNSS}}{\Delta_{GNSS}}\right) \quad (5)$$

$$\Delta_{SAR} = \frac{\Delta_{LOS}}{\cos(\beta)} \quad (6)$$



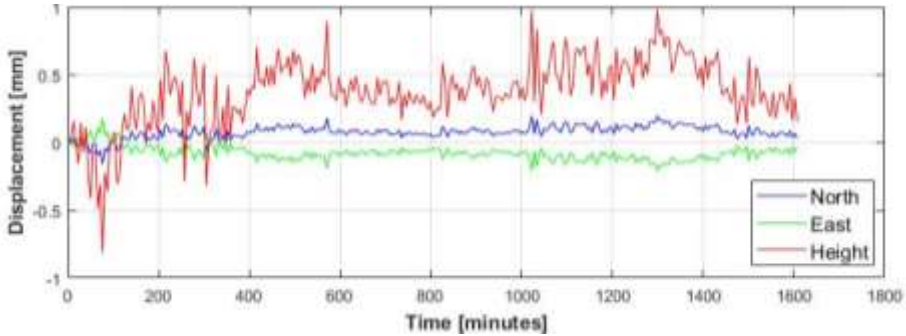
- Decompose of Δ_{SAR} in 3D displacement using GNSS-coordinates

$$\Delta N = \Delta_{SAR}.\cos(Z).\cos(\mathrm{A})$$
$$\Delta E = \Delta_{SAR}.\cos(Z).\sin(\mathrm{A}) \quad (7)$$
$$\Delta H = \Delta_{SAR}.\sin(Z)$$

Integration and comparison

Results and comparison

- 3D GB-SAR displacement for pixel P1



Component	East	North	Height
Standard deviation [mm]	0.05	0.05	0.24

- No significant difference between GNSS and GB-SAR at P1

Conclusion and outlook

Conclusion

- Importance of atmospheric corrections of GB-SAR data.
- Best results in this paper through using GCPs within the monitoring area.
- Determination of the displacement of theses GCPs through GNSS.
- Similar displacement results from GNSS and GB-SAR.

Outlook

- Further investigation regrading tropospheric influence (GNSS).
- Improving the reliability through further techniques e.g. TLS.
- Integration of GNSS, GB-SAR and TLS.
- Development of deformation analysis method.

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