Chair of Landslide Research
Department of Civil, Geo and Environmental Engineering
Technische Universität München

Potential of multisensor assessment using digital image correlation for landslide detection and monitoring

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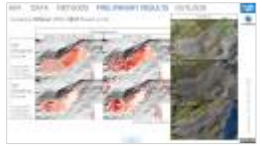
AIM

use to navigate

DATA

METHODS

PRELIMINARY RESULTS



OUTLOOK & YOUR IDEAS

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Assessment of pre-event landslide behaviour for different multispectral, optical remote sensing techniques

- Detection of hot-spots
- Understanding of slope displacement evolution
- Monitoring of slope response to meteorological influences

What are the capabilities and limitations of UAV and satellite imagery for monitoring purposes?

Can a deeper understanding be achieved?

Is it possible to define thresholds of acceleration displacement?

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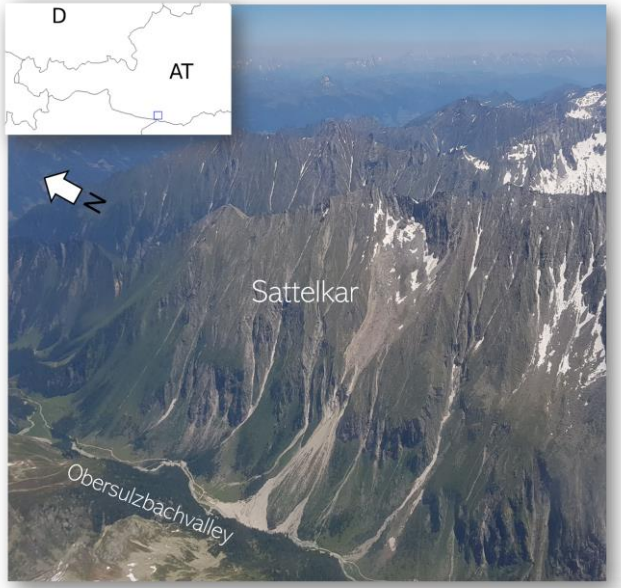
Study site: Sattelkar, Obersulzbach-valley, Austria



- Glacial and periglacial structures, abundant rock debris (Anker et al., 2016)
- highly dynamic mass wasting processes (since 2003)
- 2012 - 2015: ≤ 30ma^{-1}
- 08/2014: debris slide -> debris flow (170.000 m³)
- 2015: 130.000 m², 10 ma^{-1}, 1 mio³ m³
- Boulder blocs: 31 m: 7/18-7/19; 18 m: 7/19 – 9/19
- Varnes classification: slow to moderate velocities (Hungr et al., 2014)

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Resolution

UAV [0.08 m]: 13.7.2018, 24.7.2019, 04.09.2019 (DJI Phantom 4, fixed GCP's)

PlanetScope [~ 3.7-5 m]

RapidEye [~ 5-6.8 m]

Sentinel-2 [10 m]

– Measured GCPs, bloc movement

https://www.esa.int/var/esa/storage/images/esa_multimedia/images/2008/11/sentinel-2/9773238-3-eng-GB/Sentinel-2_printlarg.jpg; https://www.flickr.com/photos/jurvetson/15823803245; https://i.ytimg.com/vi/6733yN3EAQ8/maxresdefault.jpg, https://www.geoimage.com.au/images/Galleries/Rapid-Eye/new_rapideye.jpg

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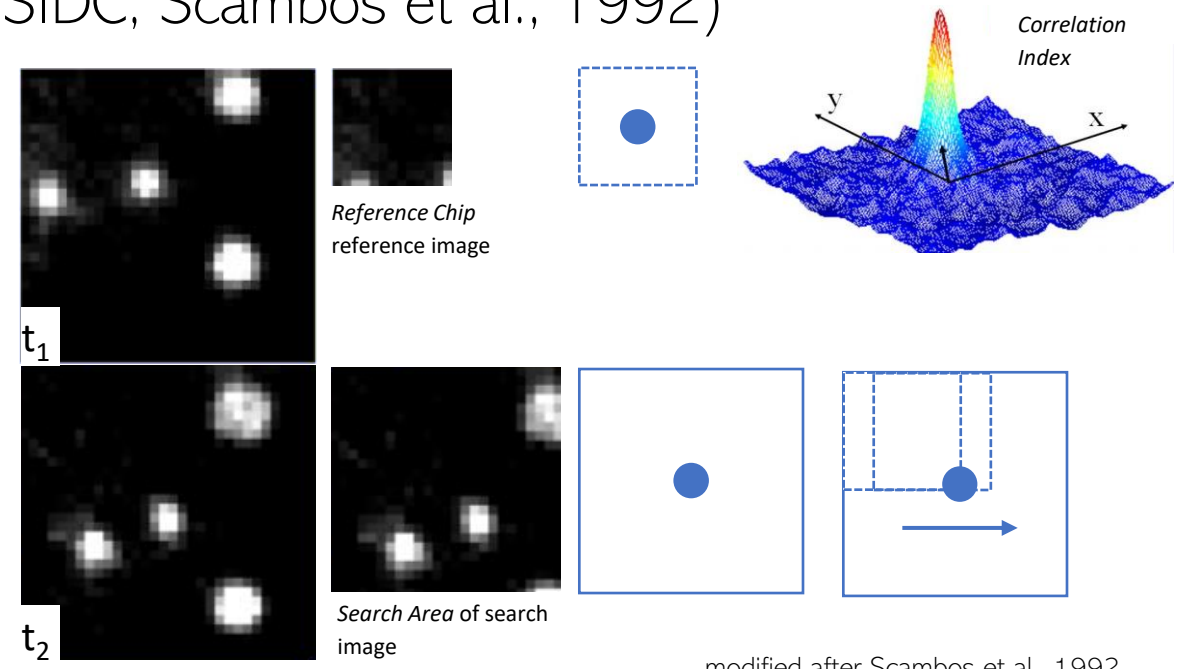
Digital Image Correlation (DIC)/Subpixel Image Correlation

- COSI-Corr (Leprince et al., 2007)
- DIC-FFT (Bickel et al., 2018, Manconi et al., 2018)

Feature Tracking/Pixel offsets

- IMCORR: fast fourier transformation (NSIDC, Scambos et al., 1992)



modified after Scambos et al., 1992

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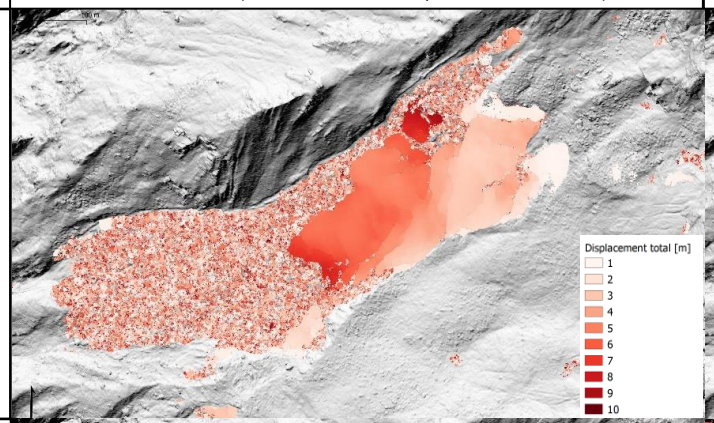
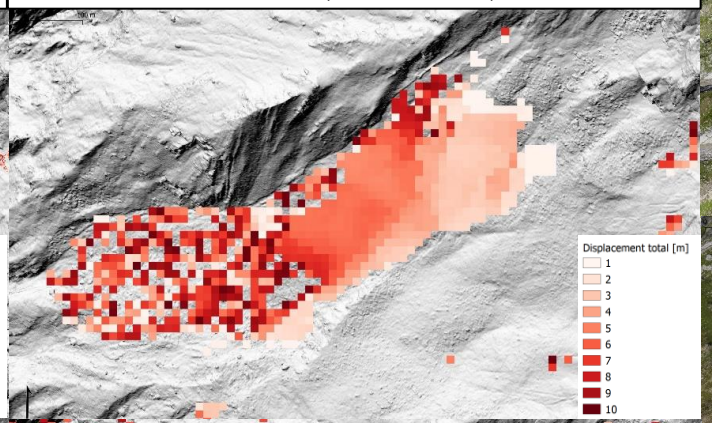
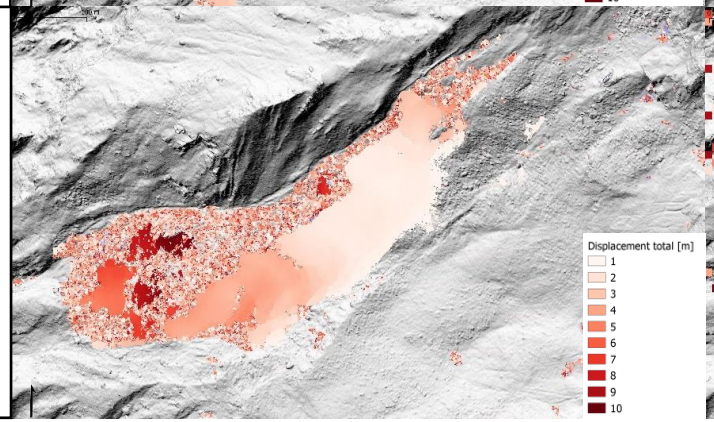
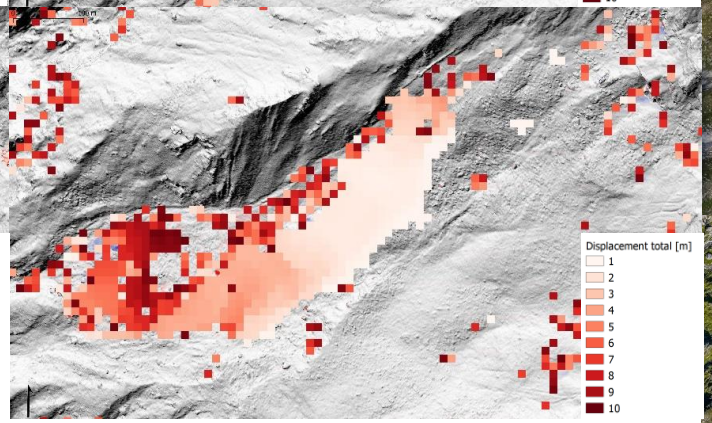
Comparison **COSI-Corr** (ENVI), **DIC-FFT** based on UAV

Total Displacement

	COSI-Corr (128 x 32, Step 2, no NLFM)	DIC-FFT (window 140)
UAV Orthophoto 0.16 m 13.07.2018 – 24.07.2019 (1. time intervall)		
UAV Orthophoto 0.16 m 24.07.2019 – 04.09.2019 (2. time interval)		

UAV DTM Shade, 04.09.2019

Orthophoto

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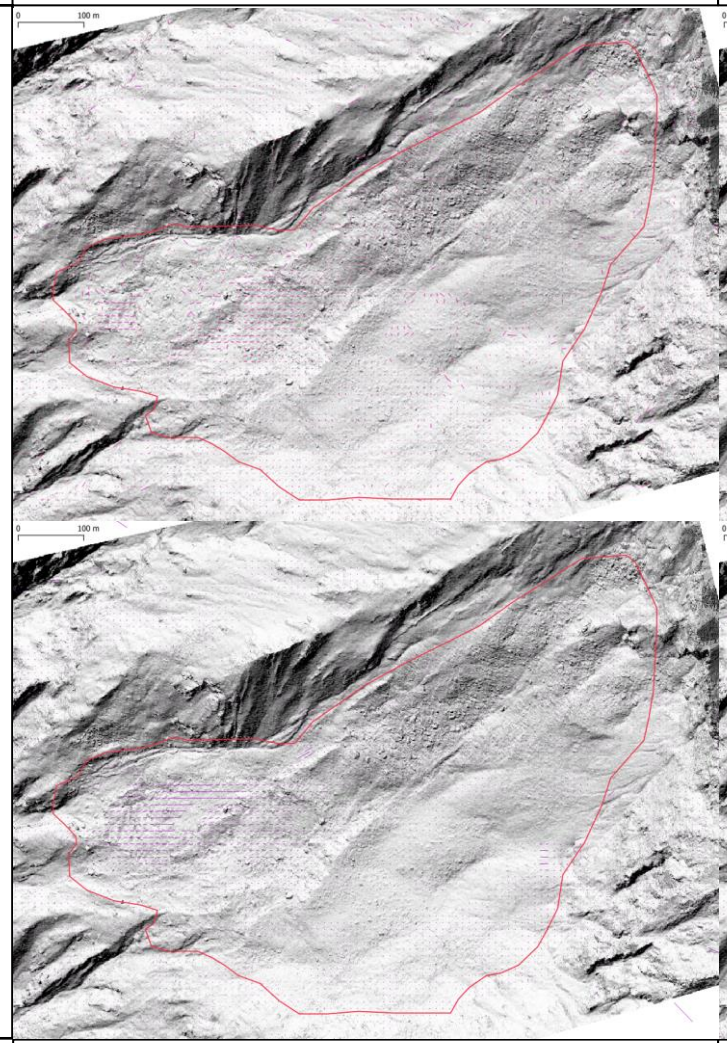
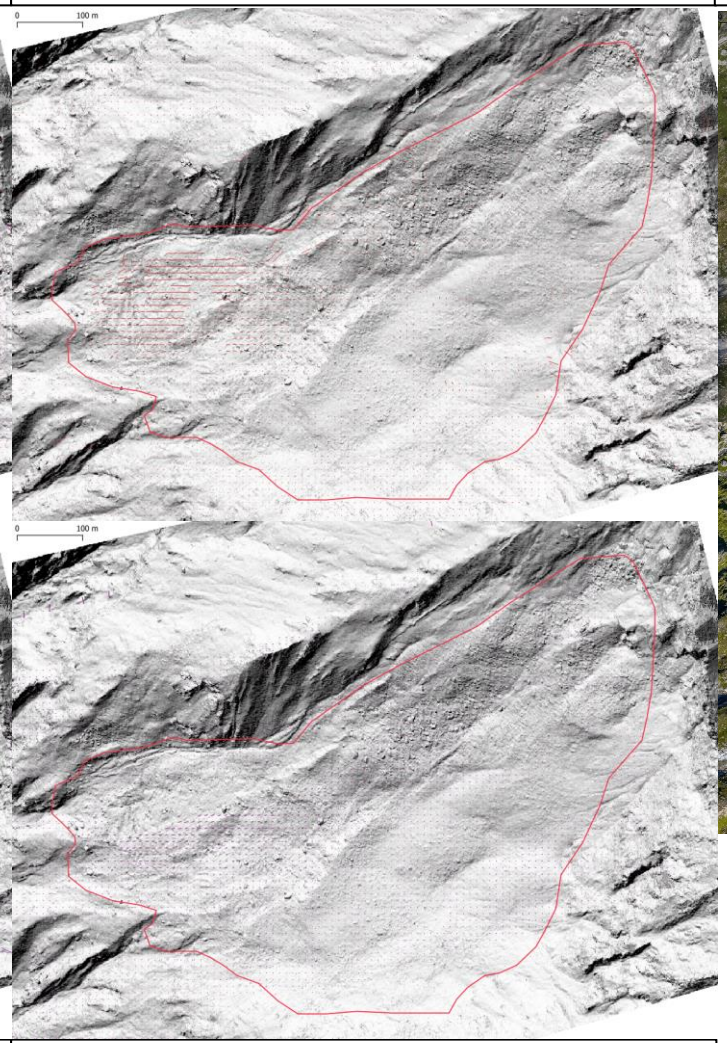
Comparison IMCORR parameters based on UAV

	IMCORR (16 x 32, spacing 10)	IMCORR (32 x 64, spacing 10)	Orthophoto
UAV Orthophoto 0.16 m 24.07.2019 – 04.09.2019 (2. time intervall) UAV DTM Shade 04.09.2019			
	IMCORR (64 x 128, spacing 10)	IMCORR (128 x 265, spacing 10)	

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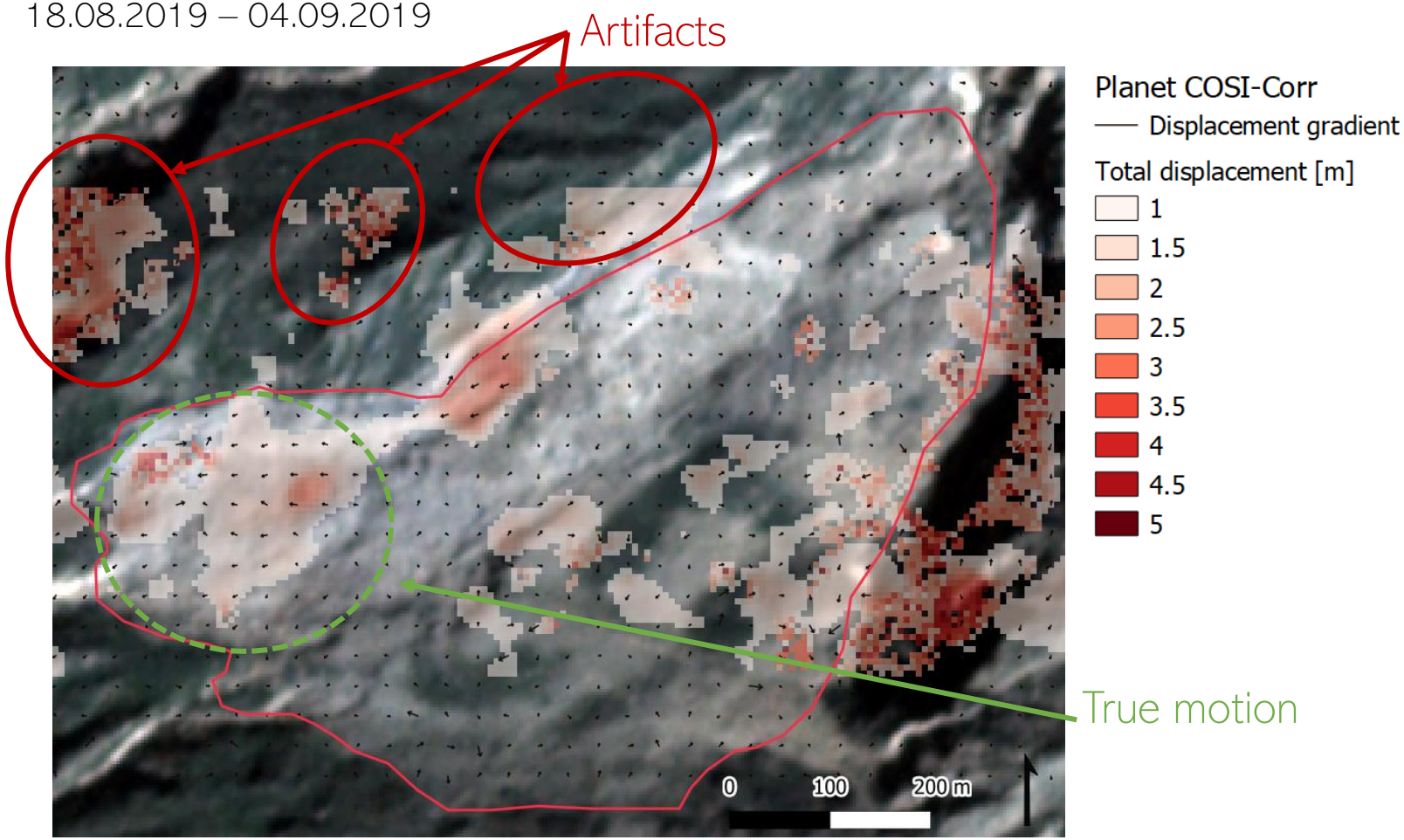
Result COSI-Corr of PlanetScope

18.08.2019 – 04.09.2019



PlanetScope, 3 m, 18.8.2019

Initial Window	Final Window	Step
64x64	16x16	1x1

Non local means filter
Displacement Gradient, Step 5

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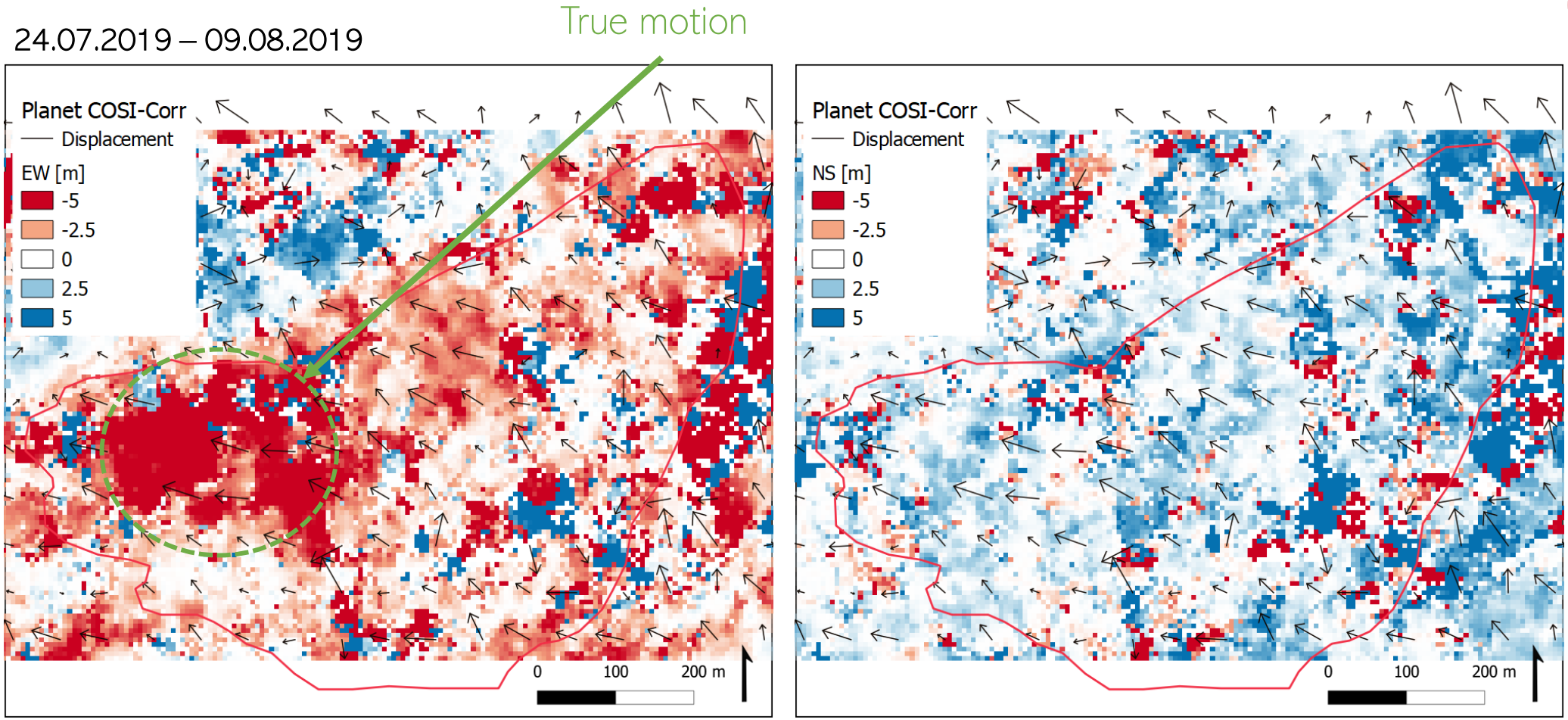
Result COSI-Corr of PlanetScope

24.07.2019 – 09.08.2019



What is outside of motion cluster? Wrong movement!

Initial Window	Final Window	Step
32x32	16x16	1x1

← < 5m

Non local means filter

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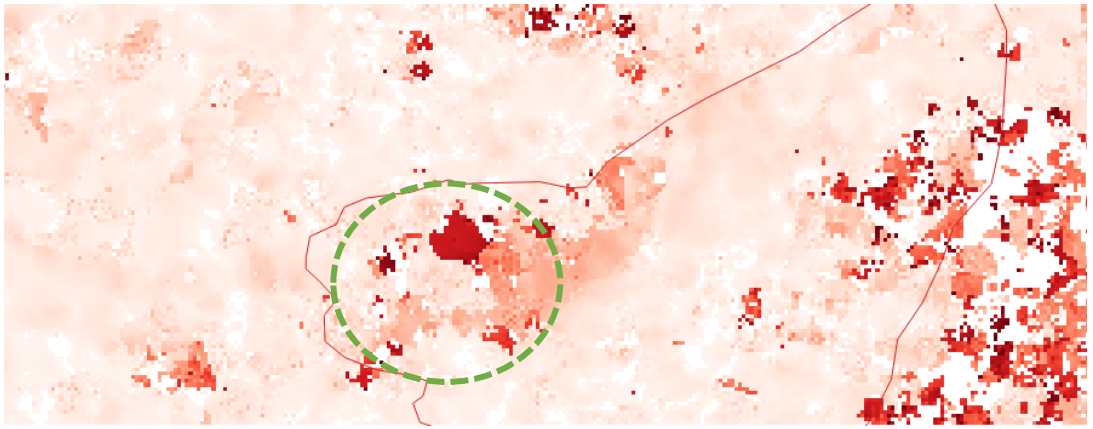
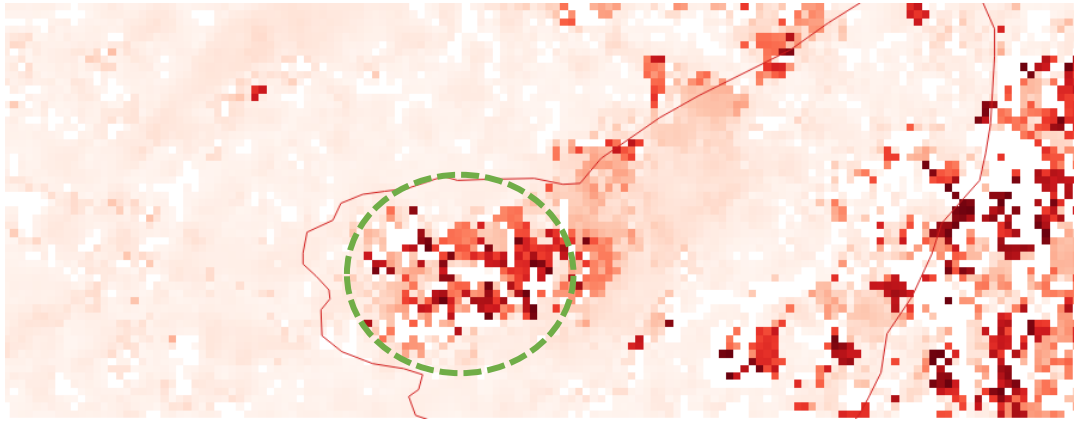
Result COSI-Corr of **RapidEye**

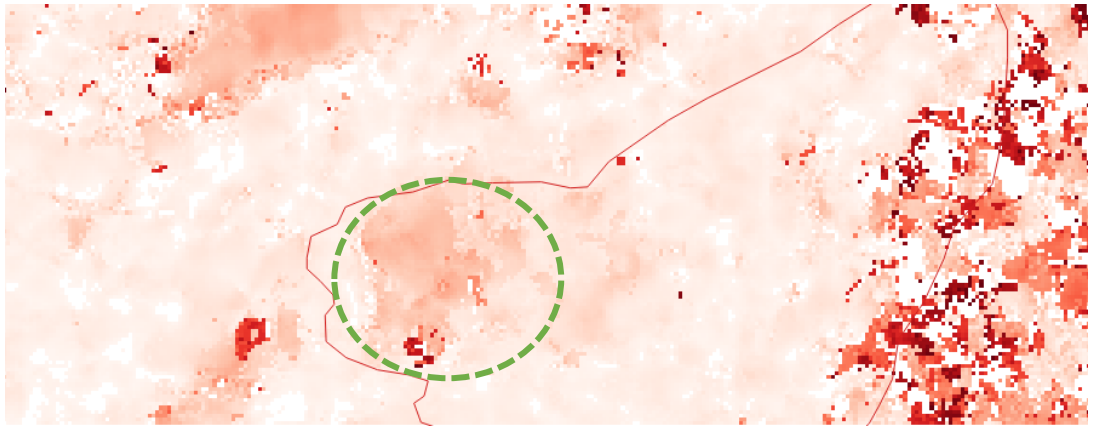
24.09.2014-17.07.2015



31.08.2015-10.07.2016

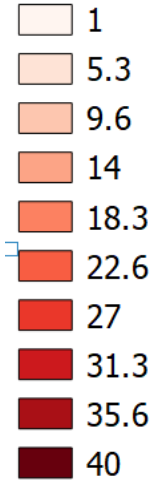


17.07.2015-13.08.2015



True motion

Displacement total [m]



Initial Window	Final Window	Step
32x32	16x16	1x1

Non local means filter

What is outside of motion cluster? >5.3 m! Everything moves?

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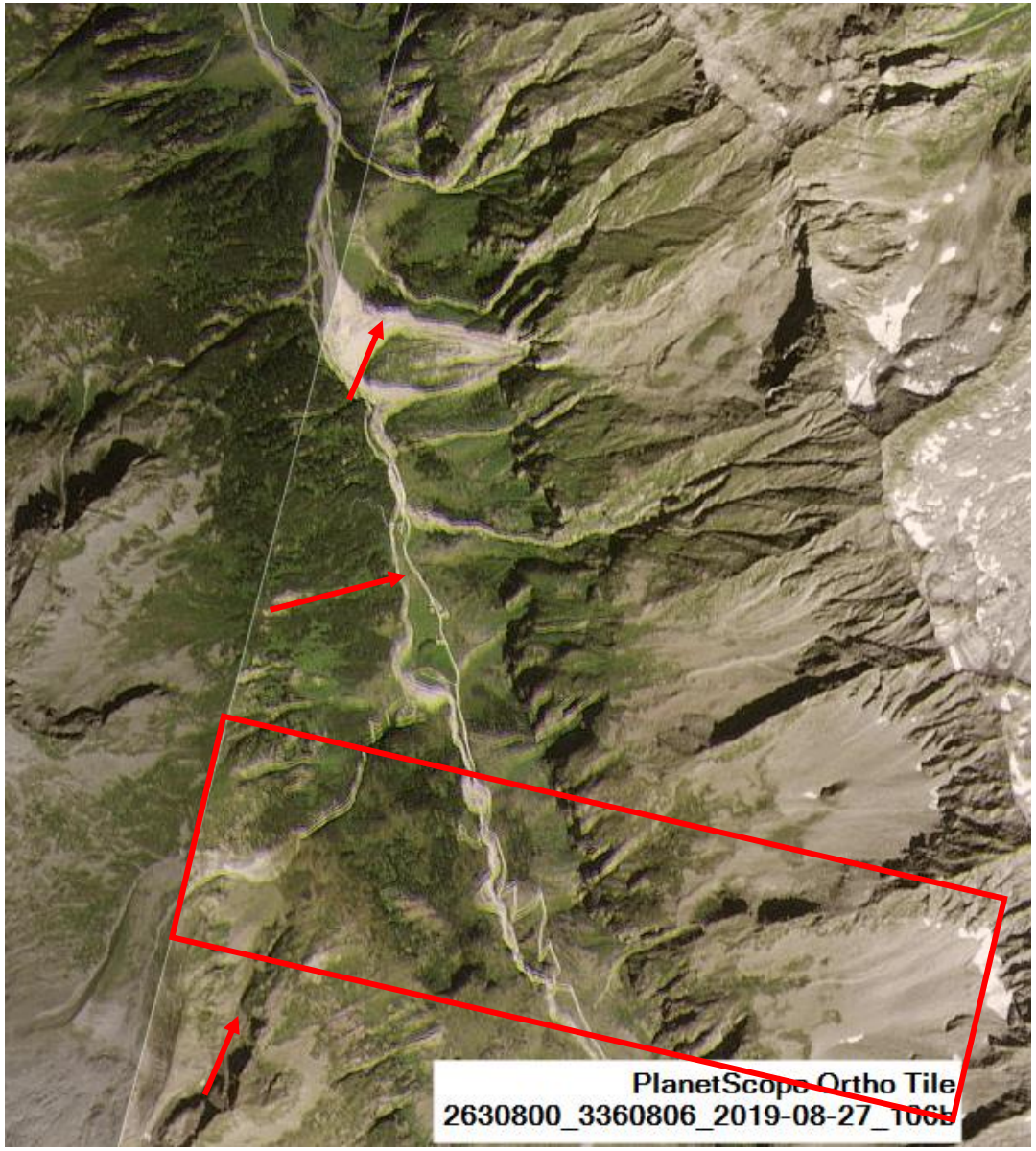
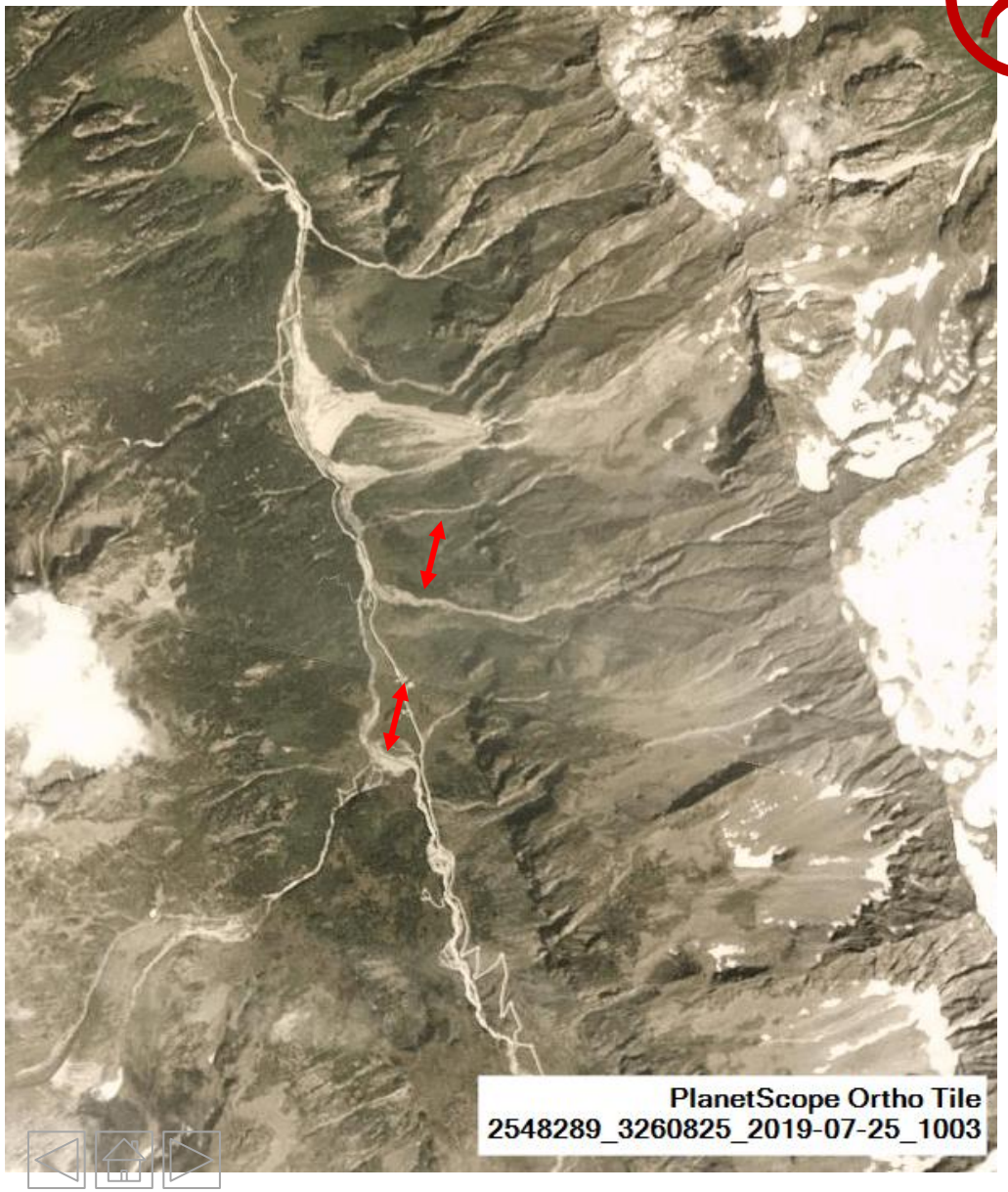
PlanetScope





Root cause for bad result? Garbage in, garbage out!

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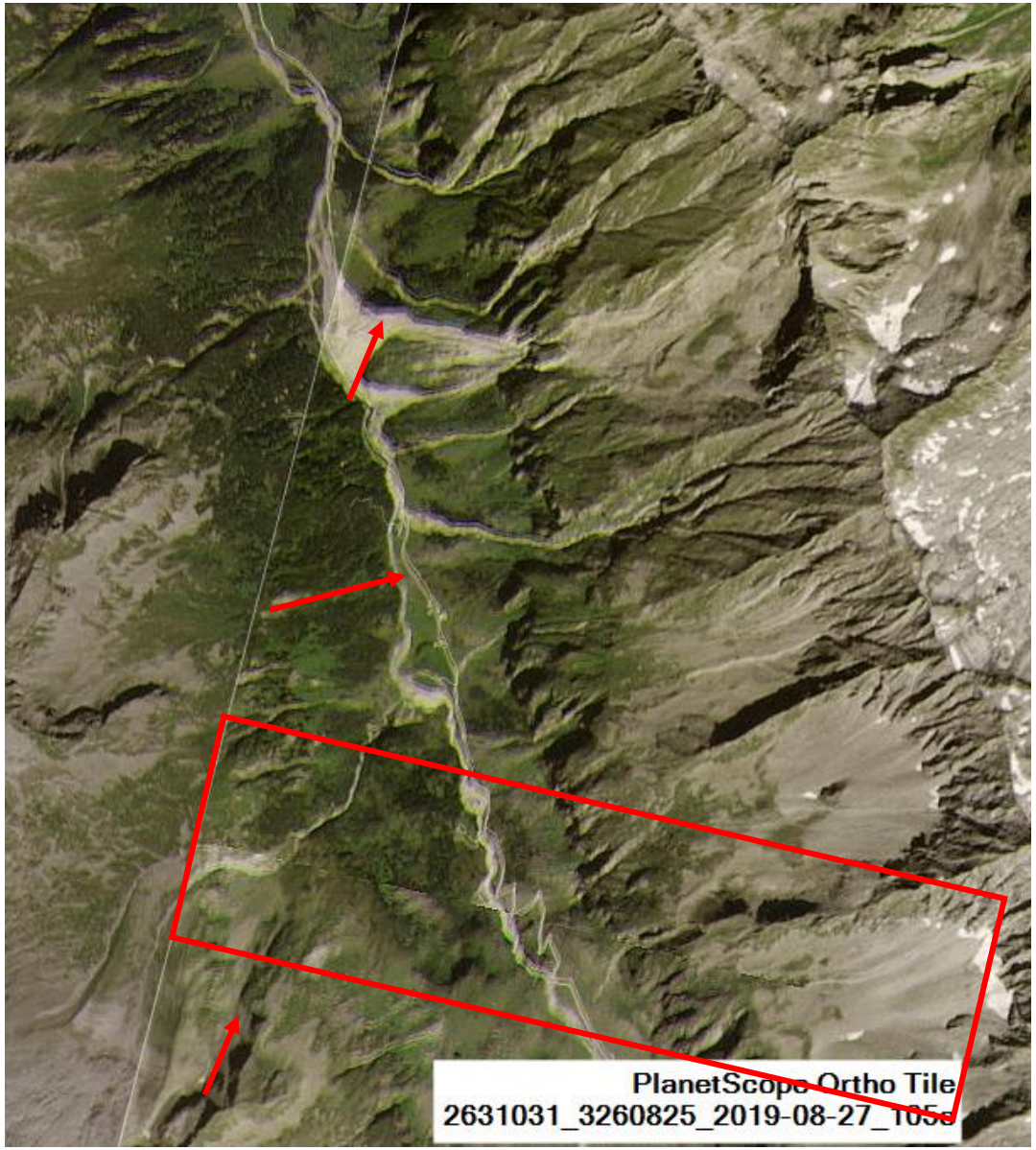
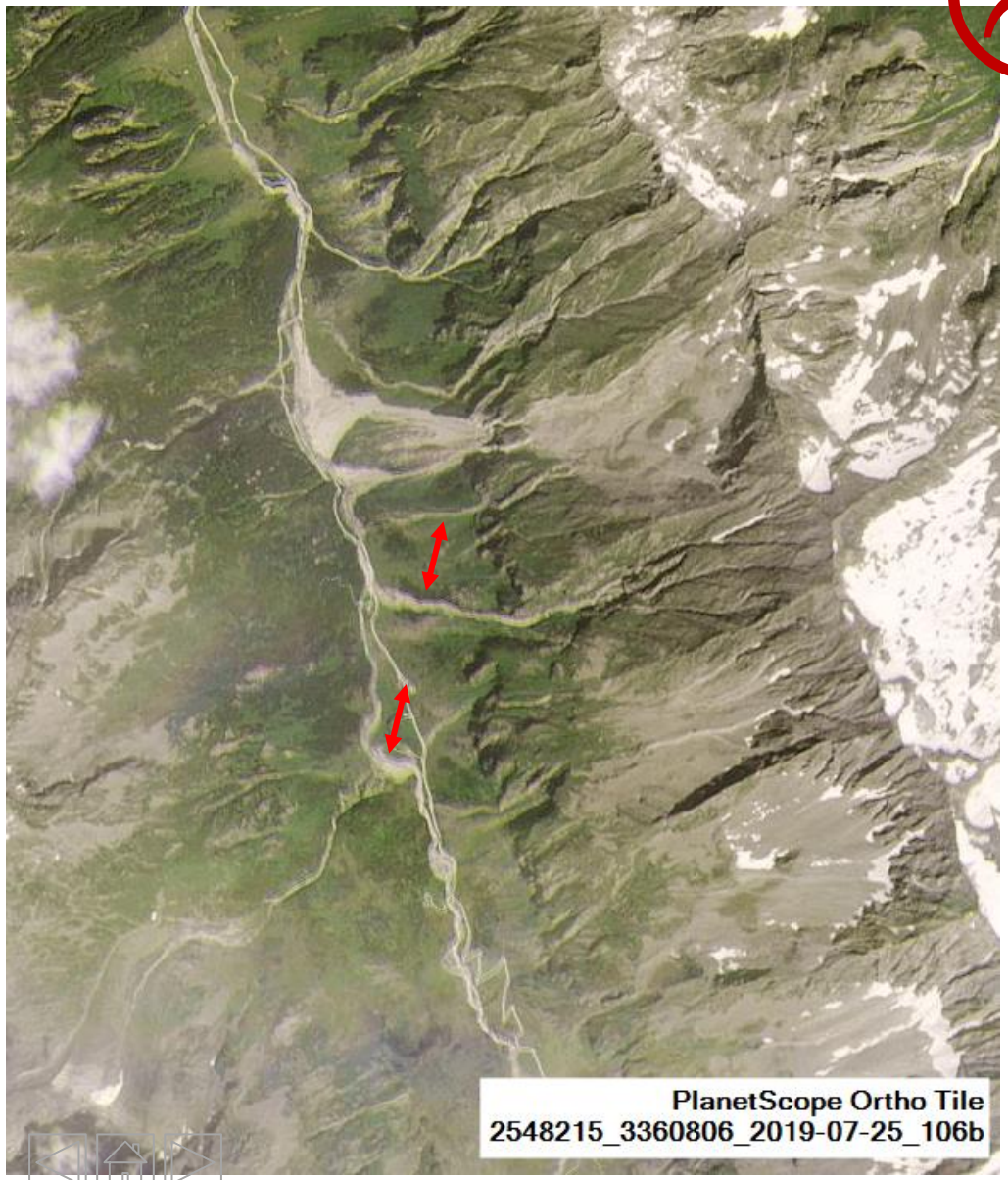
PlanetScope





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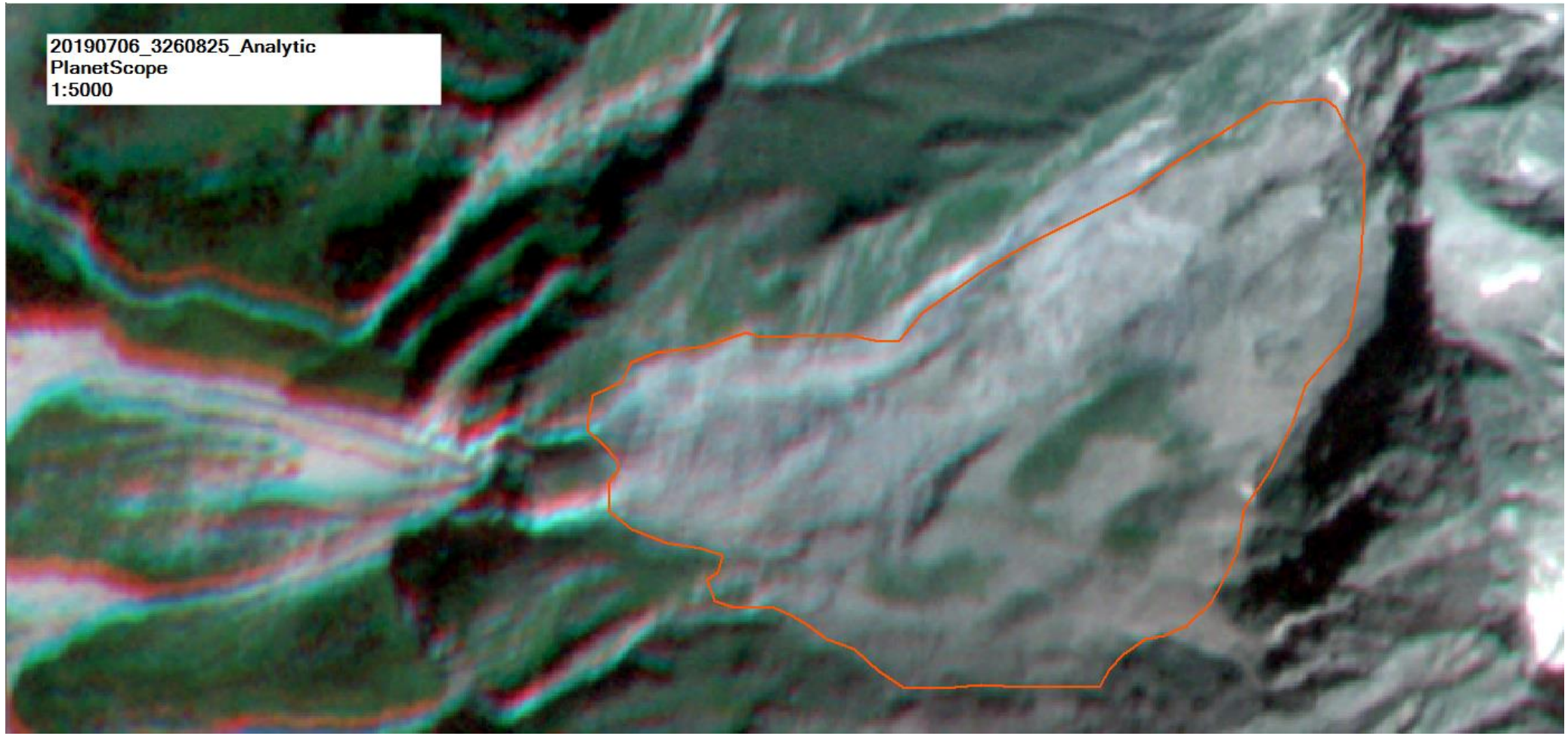
PlanetScope



Root cause for bad result? Garbage in, garbage out!

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Preliminary results

- Good performance of COSI-Corr, DIC-FFT & IMCORR
- Detection of hot-spots:
  - UAV images show differences in motion, clusters & clearly define displacement area
  - Sat. Images: messy, no clear distinction – everything moves?!
- Understanding of slope displacement evolution:
  - UAV images: shorter time intervals? Coarser resolution?

How to untangle issues with PlanetScope and RapidEye data?

Please visit also our display EGU2020-17267 in session NH6.1 on a conceptual approach for the lead time optimisation.

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Scambos T. A., Dutkiewicz M. J., Wilson J. C. & Bindschadler R. A. (1992): Application of image cross-correlation to the measurement of glacier velocity using satellite image data. Remote Sensing of Environment 42(3): 177–186.