MPIC-SAR
(Analysis of Massive Time-series of Remote sensing Datasets)

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MPIC-SAR

processing pipeline for automated processing of large image time-series.

Data & Problem 1
Work Flow
Results
Pas de l'Ours landslide

- Detection of motion and the space-time analysis of the changes in motion.
  - **SAR** + **Optical** Camera Amplitude
- Focus on two types of geological objects: **glaciers** and **landslides**
- Exploiting different motion estimation methods
  - **MicMac**, **GeFolki**, etc.
- Spatio-Temporal Clustering for information extraction of time-series derivatives
  - Velocity, Angle, etc.

Motion Estimation

Sentinel-1: Rink Glacier (South-west Greenland)

Data & Problem
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Determining motion vectors that describe the transformation from one image to another.

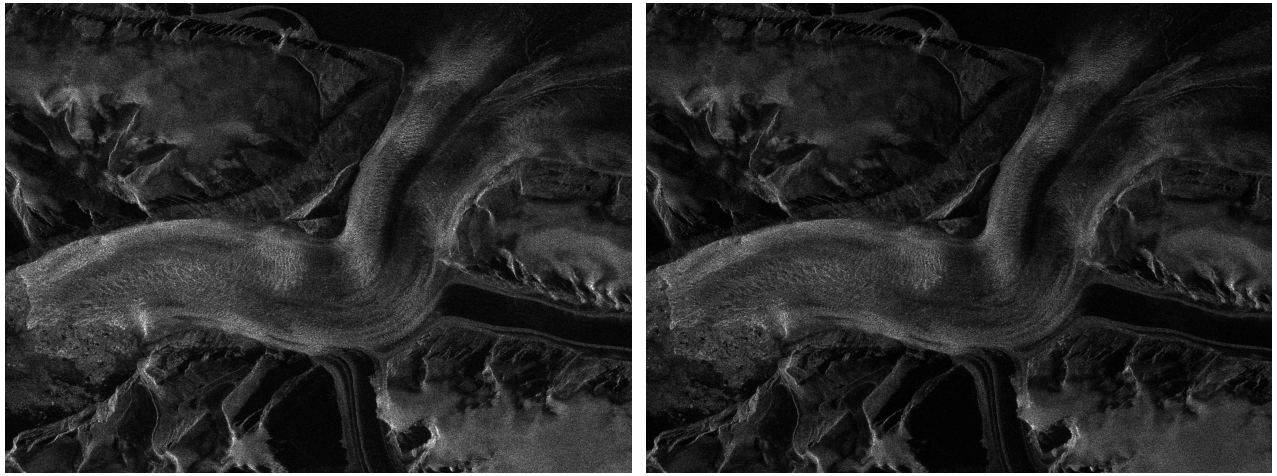

Figure: **Left:** Master, **Right:** Slave

Motion Estimation

Data & Problem 3
Work Flow
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Motion Estimation (ME) is an **ill-posed** problem.

Possible approaches

- **Direct Methods**
  - Block-matching
  - Optical flow
  - Frequency domain methods
- **Indirect Methods**
  - Feature based methods (RANSAC etc.)

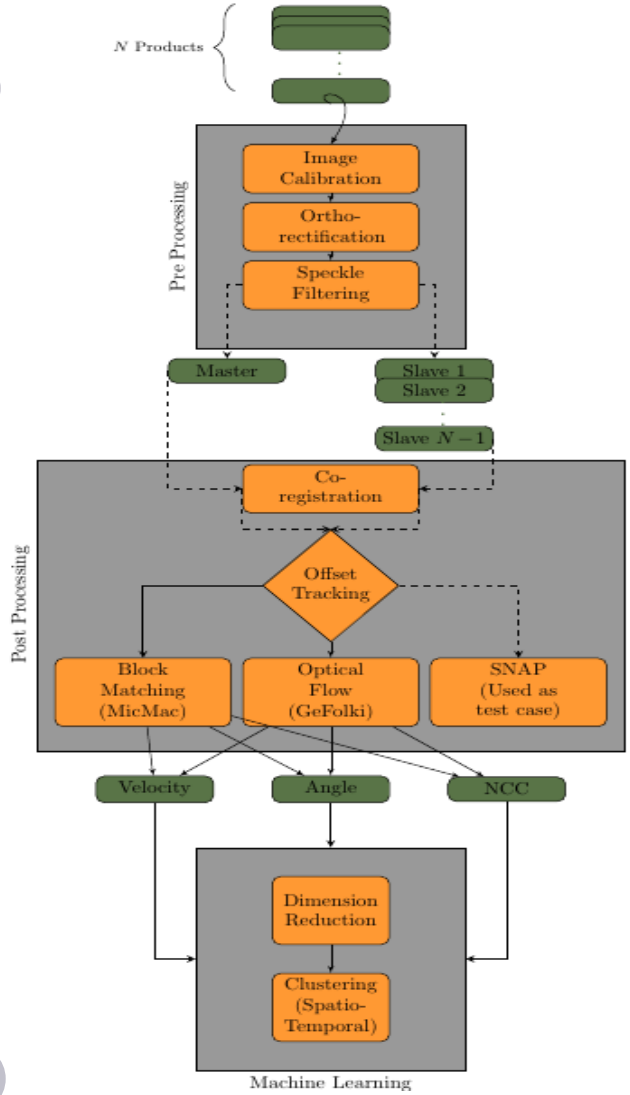
† One more step...

- Exploiting **unsupervised** machine learning methods to retrieve hidden patterns from the ME maps over time series of Images.

Work Flow

Motion Estimation with Offset Tracking

Data & Problem
Work Flow 4
Results
Pas de l'Ours landslide



- Pre-processing
  - SAR Calibration
  - Ortho Rectification
  - Speckle Filtering
- Post Processing
  - Co-registration
    - **MPIC-SAR**
  - Offset-tracking
    - MicMac (Block Matching)
    - GeFolki (Optical Flow)
    - Other available Options (SNAP, COSI-Corr, etc)
- Machine Learning
  - Dimensionality Reduction
  - Spation-temporal Clustering for segmentation

Offset Tracking SAR

MicMac: Block-matching using NCC as pixelwise similary measure

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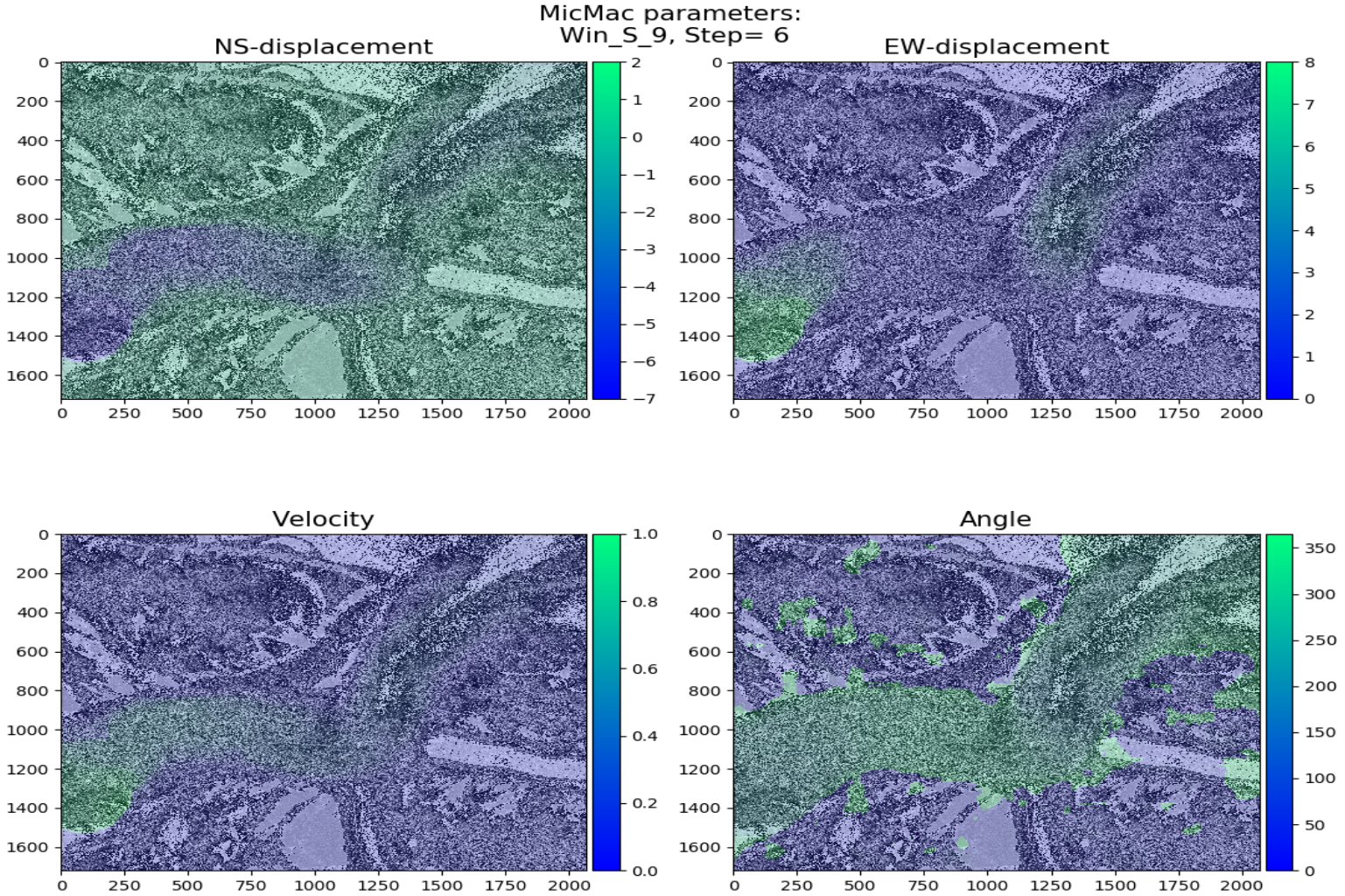

Offset Tracking SAR

GeFolki: Base on Optical Flow

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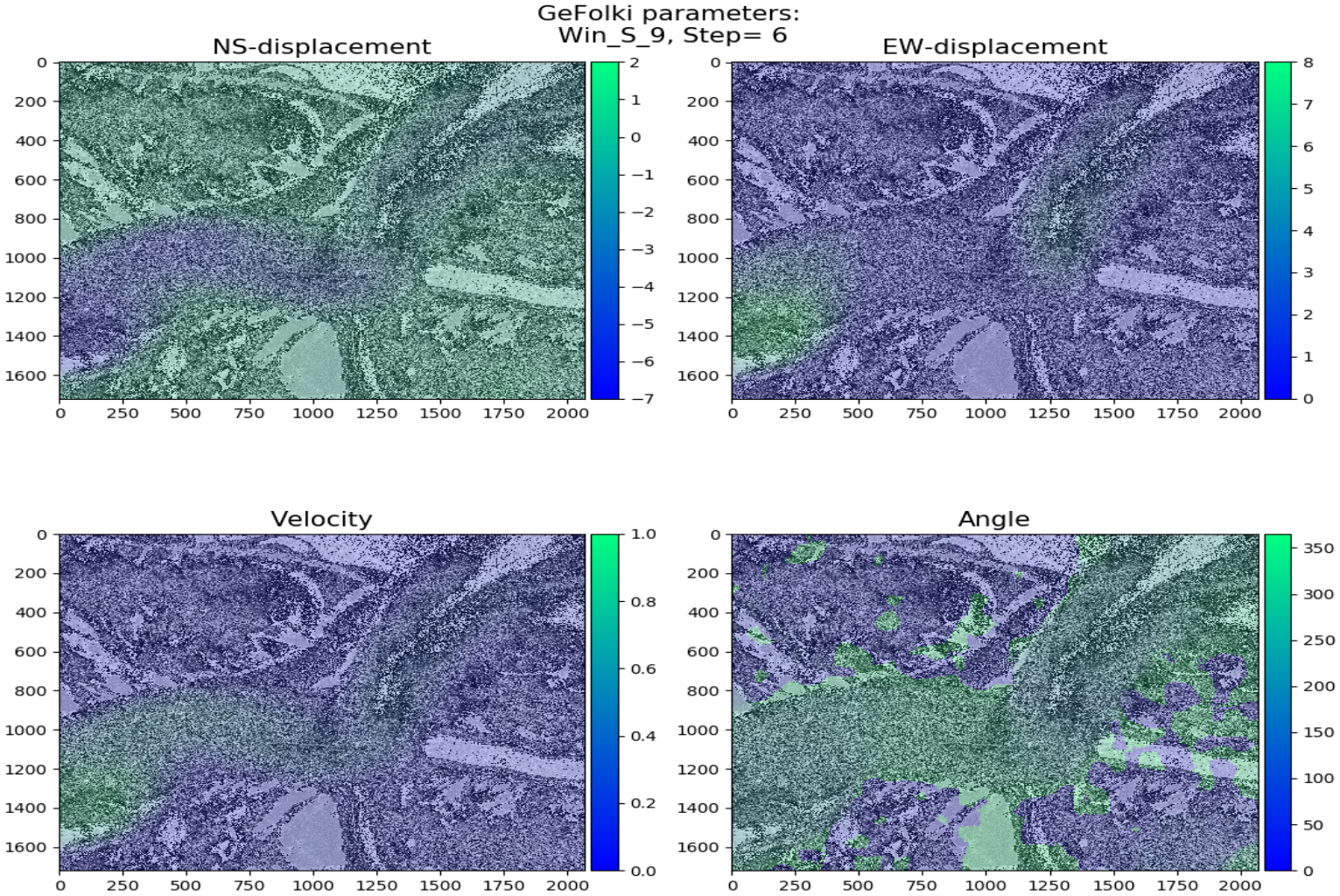

Offset Tracking SAR
Comparison of Algorithms (MicMac - GeFolki)

Data & Problem
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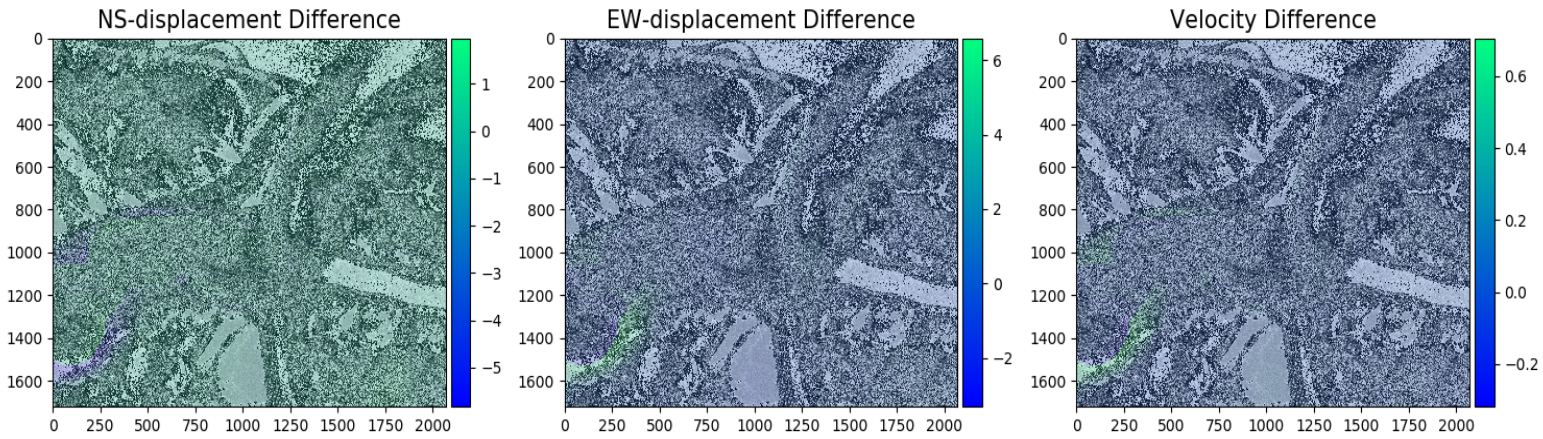
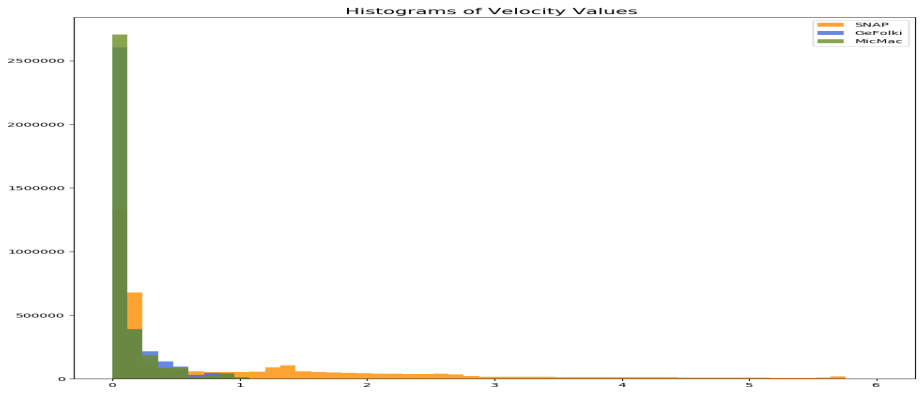
Pas de l'Ours landslide



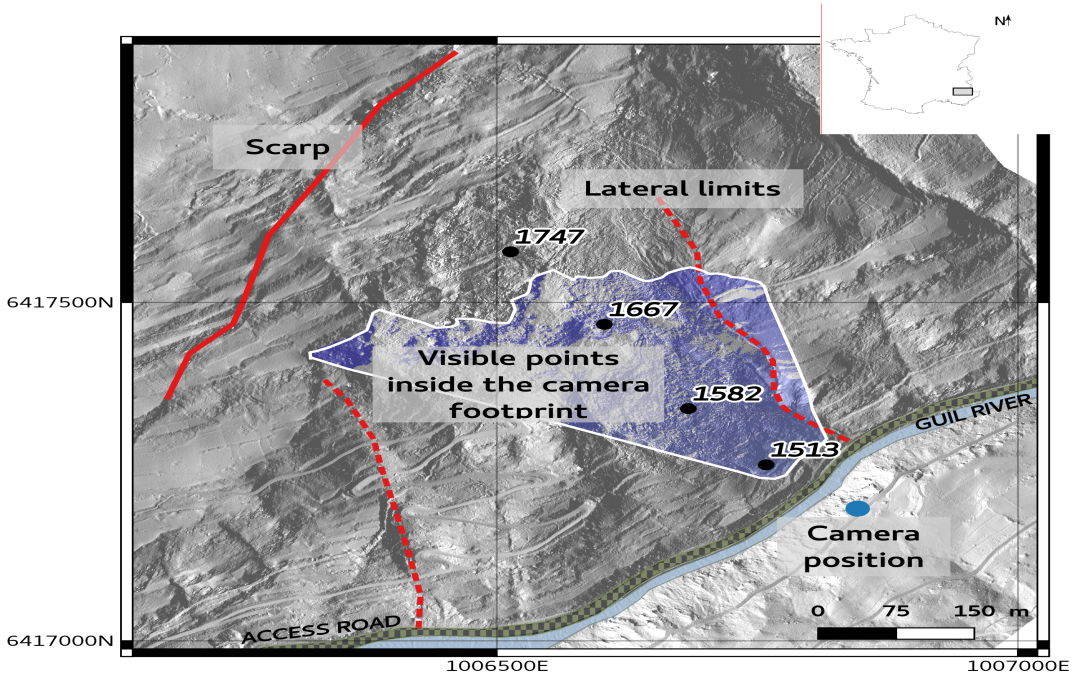
Histogram of Velocities



Pas de l'Ours

Characteristics of the landslide

- **Location:** Aiguilles, Alpes de Hautes Provence Fr.
- **Dimensions:** ≈ 640m length and ≈ 410m width.
- **Geology:** Alternance of Layers schist/limestone dating from lower Creataceous.



Pas de l'Ours
Data acquisition

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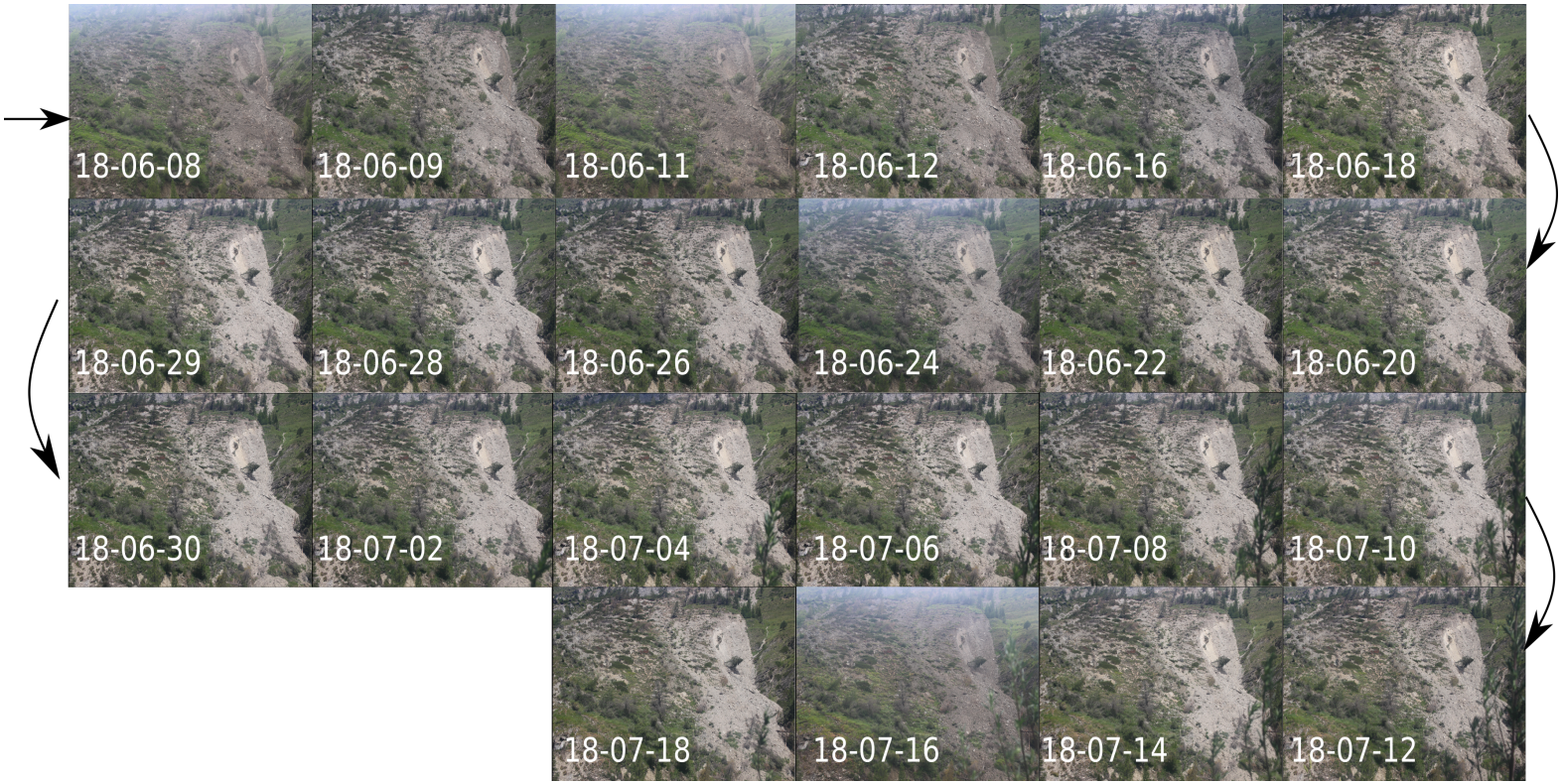
- **Acquisition System:** Canon 100D, 24mm connected to an acquisition center.
- **Distance camera-object:** From $\approx$ 100m to $\approx$ 360m.
- **Acquisition Frequency:** 10 images per day.



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Offset Tracking Optical

Ground-based Image time-series

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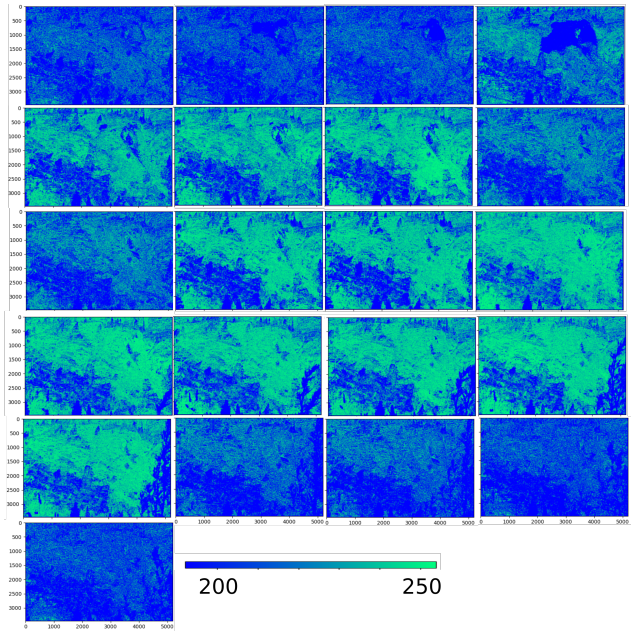

- Stacks of **motion maps** based on pairwise analysis of image **Time-series**:
  - Pairwise similarity maps based on NCC measure.
  - Pairwise displacement maps along U direction.
  - Pairwise displacement maps along V direction.

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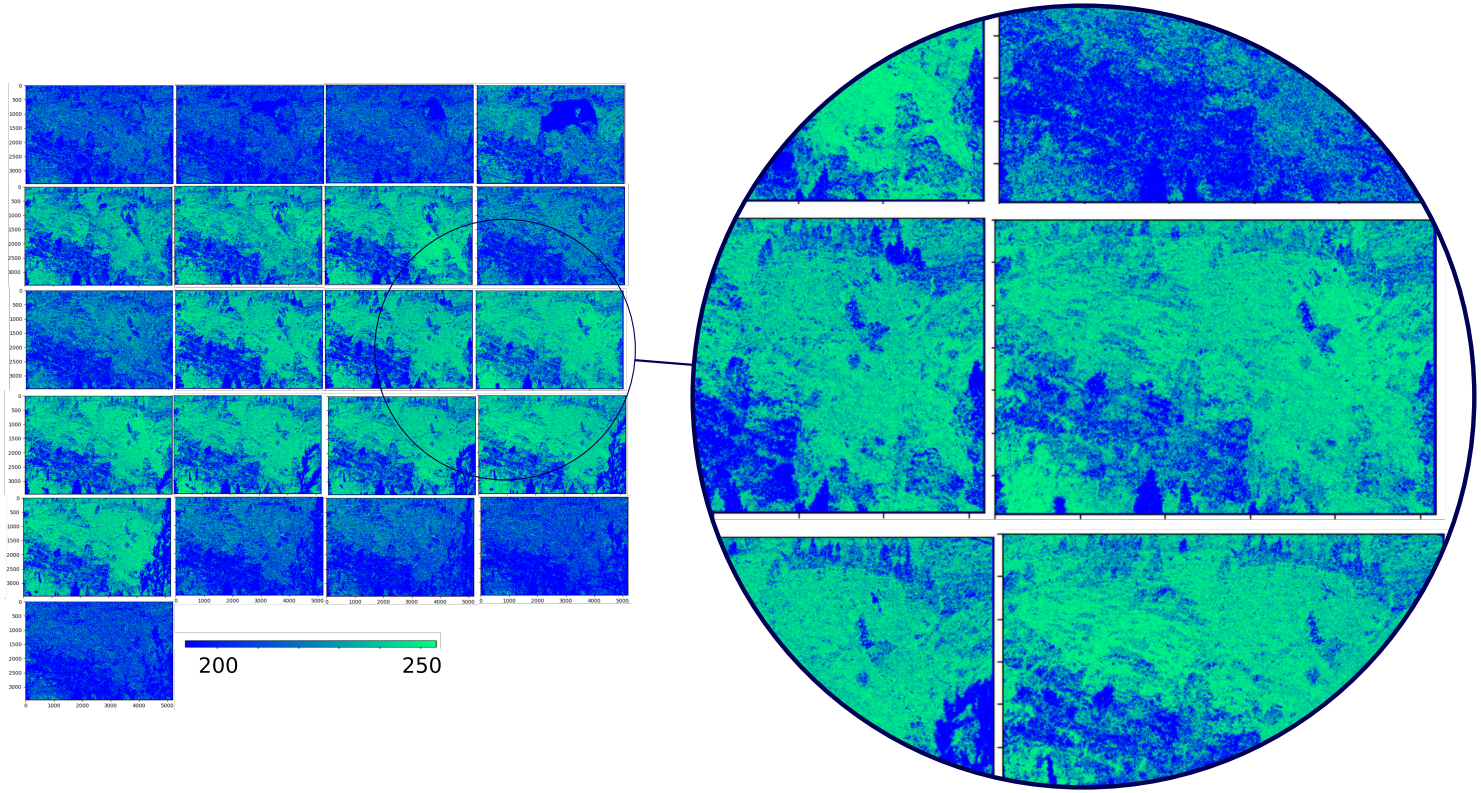

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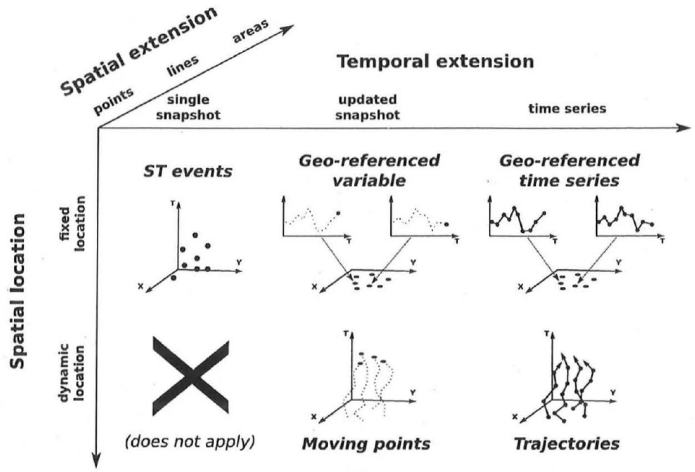
Future Work

Spatio-temporal clustering for Trajectory clustering

Challenges

- How the weight of the time dimension should be reflected within distance metrics?
- Two geographically close sample points co-occurring within a temporal profile could be **not** belonging to the same trajectory clusters.

ST Clustering domain



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Clustering approaches

- CANDECOMP/PARAFAC Tensor Decomposition
  - Representing the motion features(velocity, norm, angle etc) across the time dimention as an n-way Tensor.
  - Decomposing tensor into a sum of outer products of the vectors, in order to find the underlying feature modes.
- ST-DBSCAN

Thank you!

For questions please contact

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