



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Federal Office of Topography swisstopo

wissen wohin
savoir où
sapere dove
knowing where

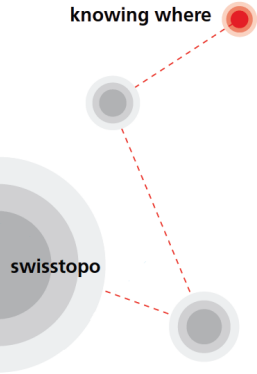
EuroSDR 2nd Workshop on Point Cloud Processing

Point cloud processing at a national scale – advantages and challenges

December 4th 2019, Stuttgart

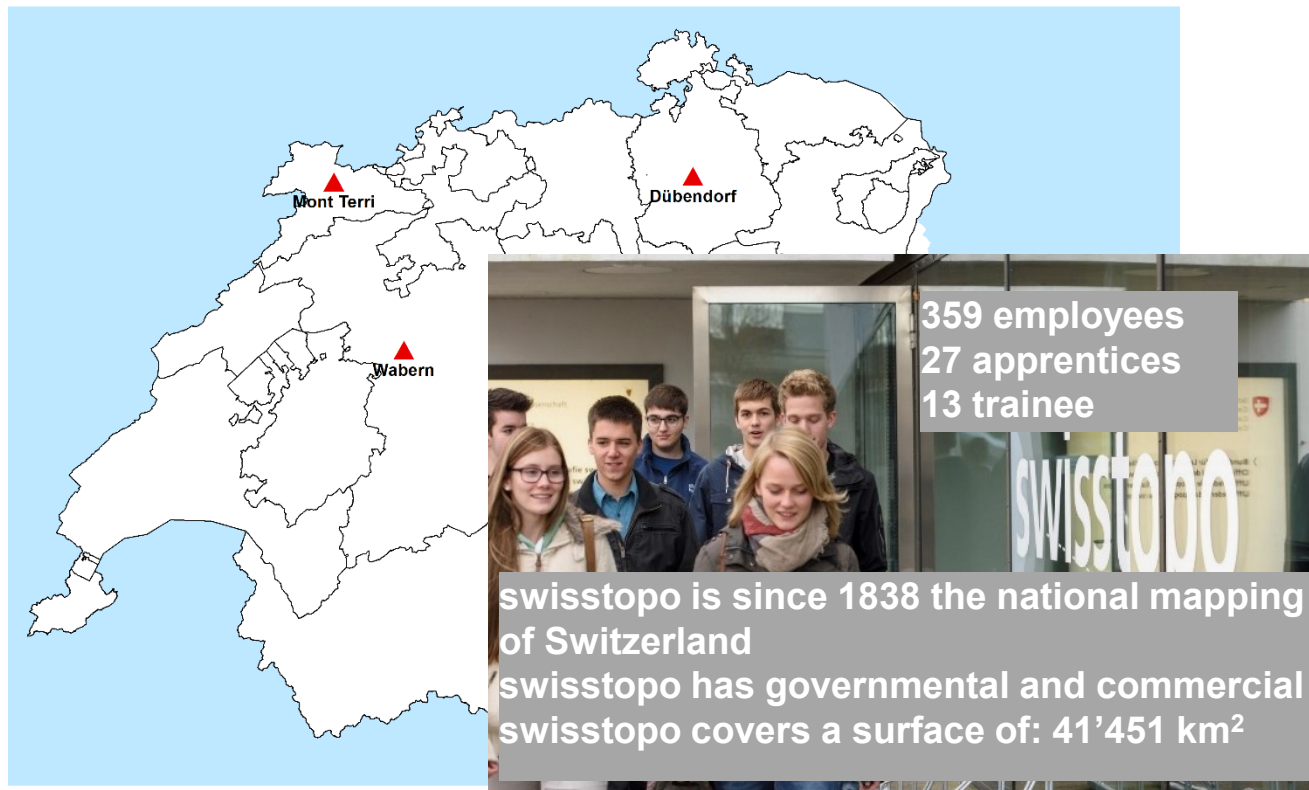
Florian Gandor, Roberto Artuso, André Streilein

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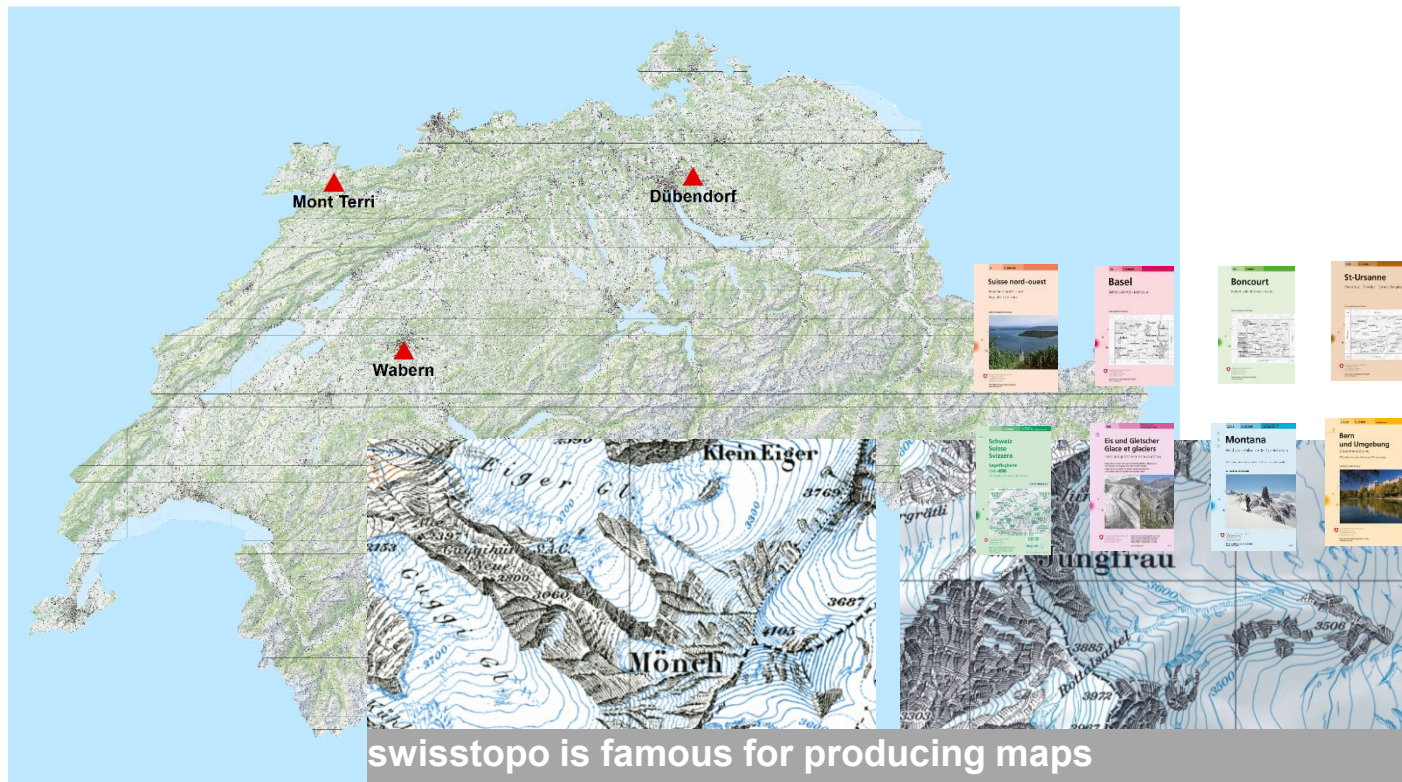


Introducing swisstopo





Introducing swisstopo



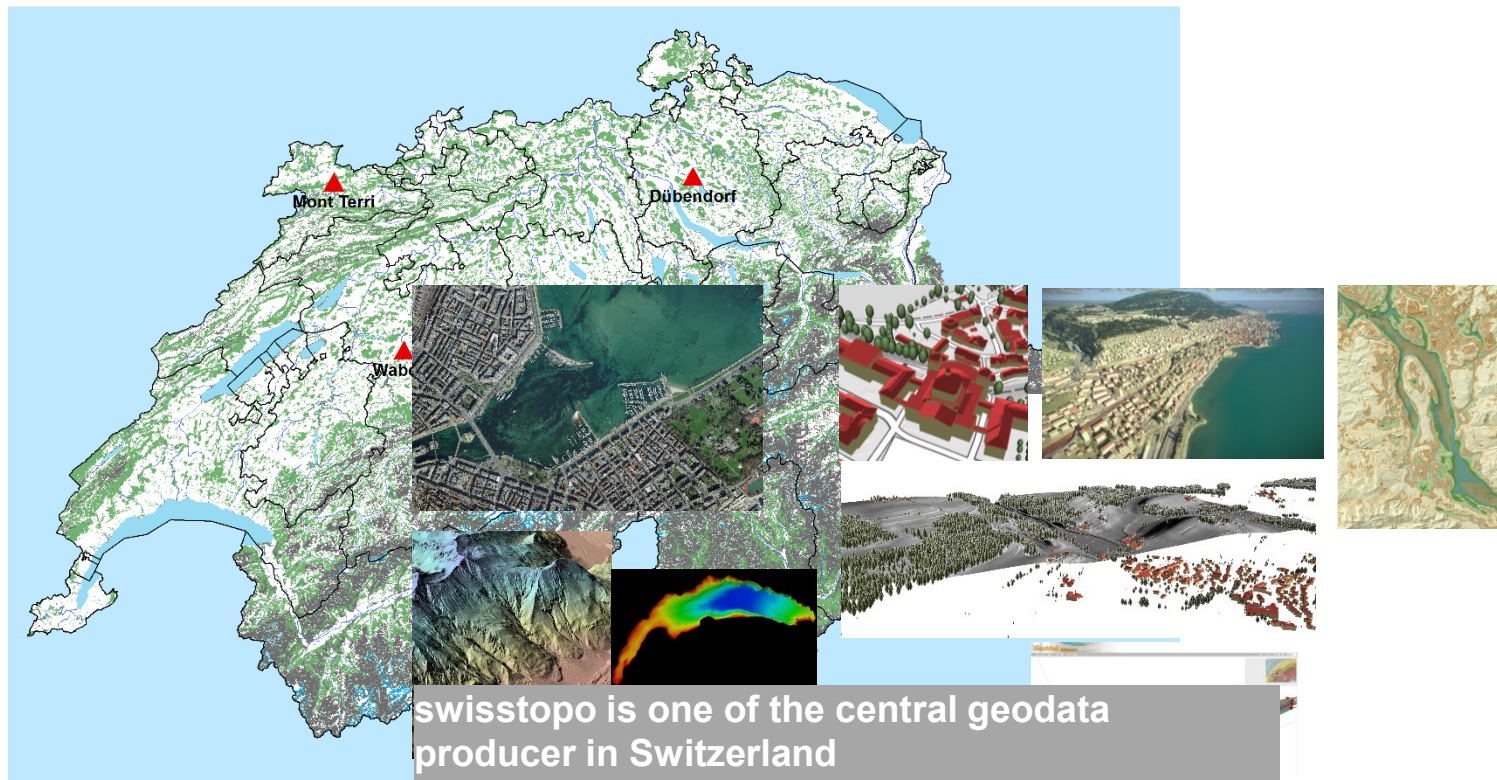


Introducing swisstopo



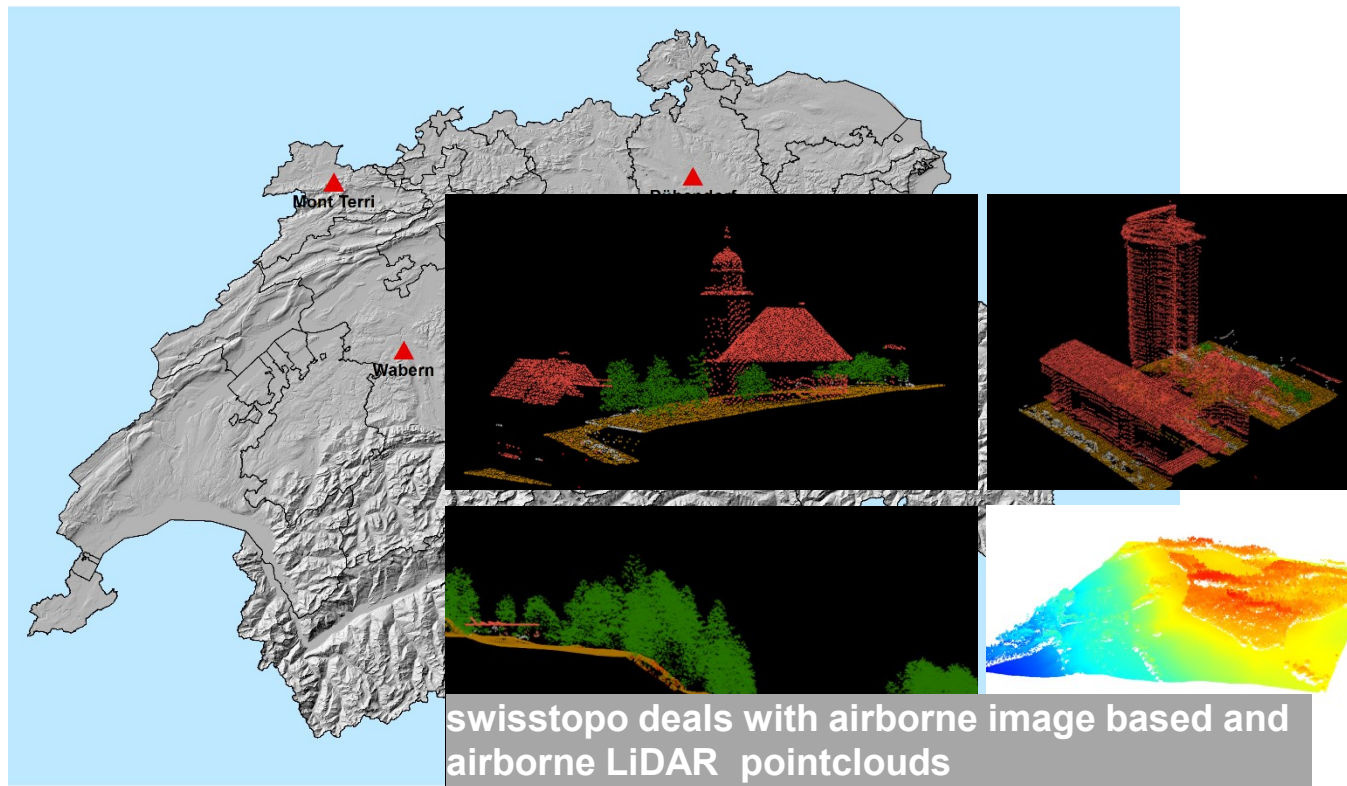


Introducing swisstopo





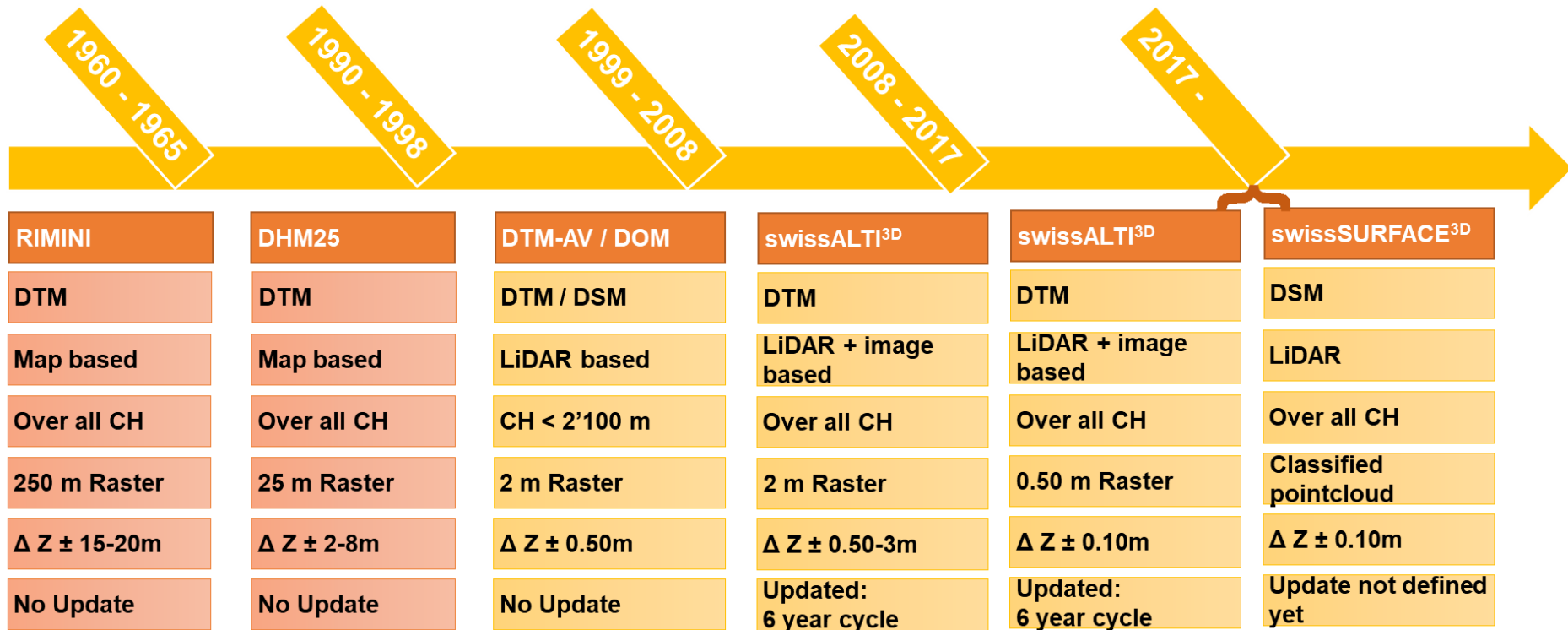
Introducing swisstopo



Dachstein für Landesvermessung Geodäsie



Whole digital elevation model generation at swisstopo





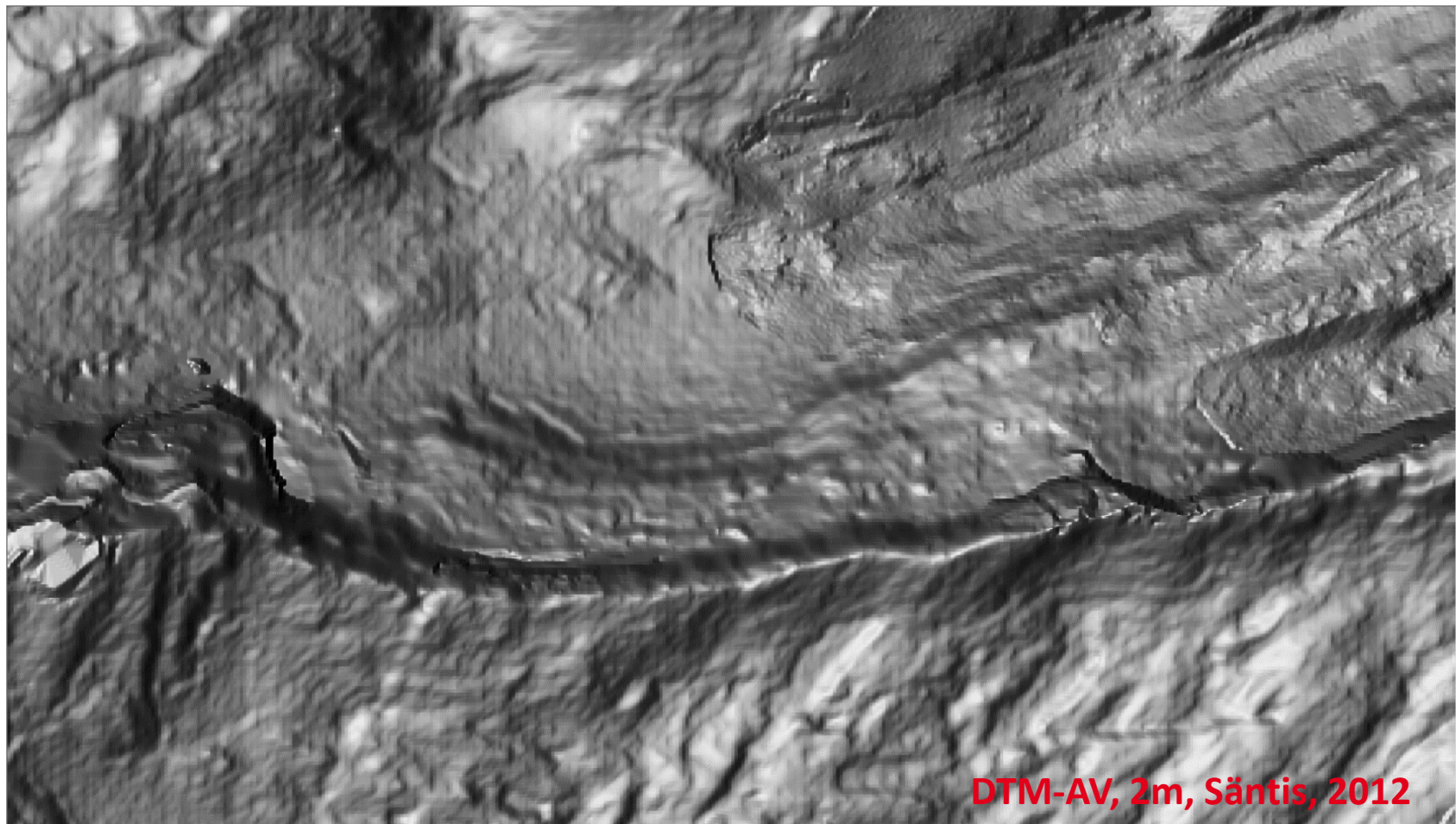
Digital Terrain Model rapid evolution



MNT25, 25m, Säntis, 2001



Digital Terrain Model rapid evolution



DTM-AV, 2m, Säntis, 2012



Digital Terrain Model rapid evolution



swissALTI^{3D}, 0.5m, Säntis, 2019



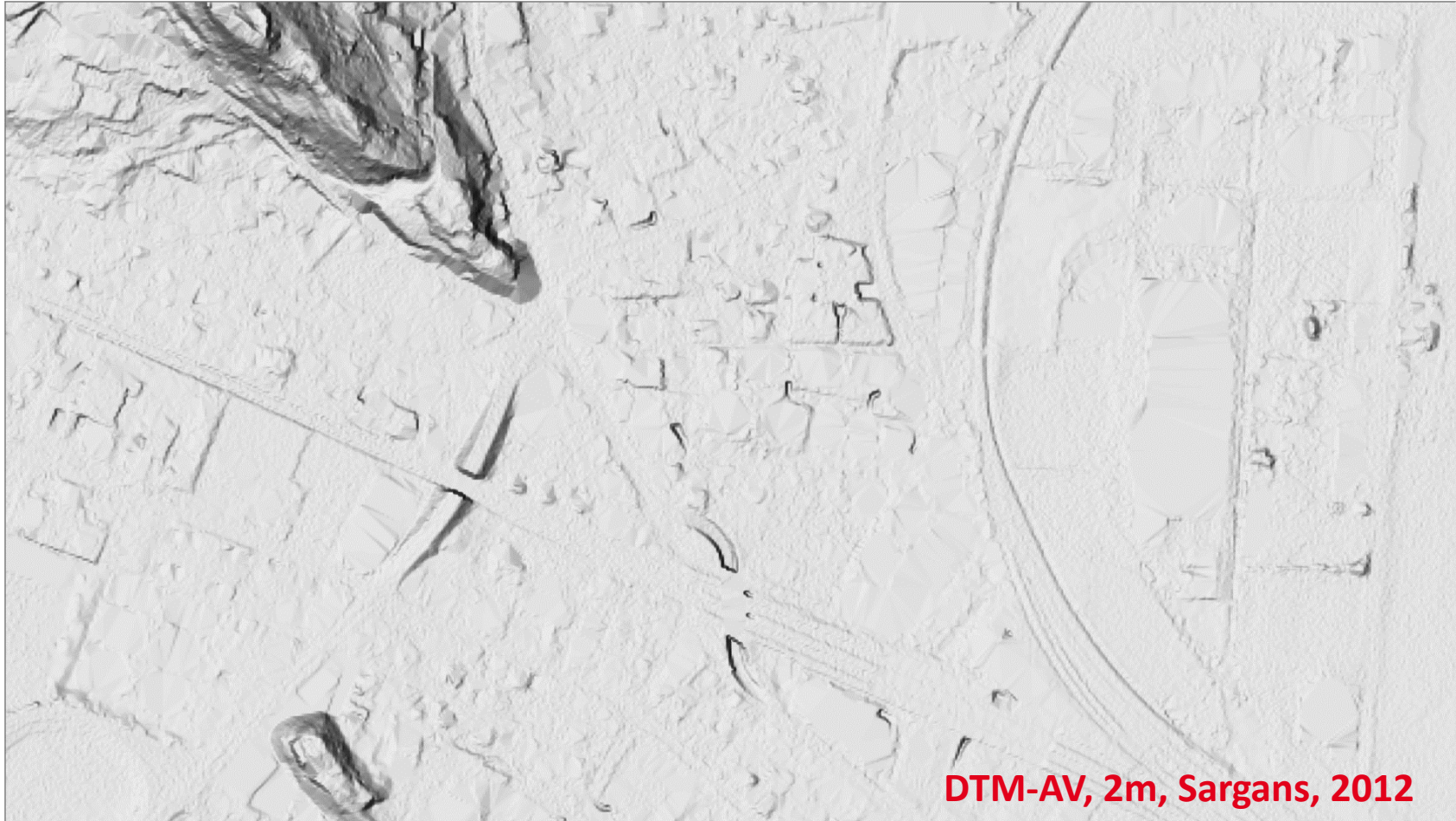
Digital Terrain Model rapid evolution



MNT25, 25m, Sargans, 2001



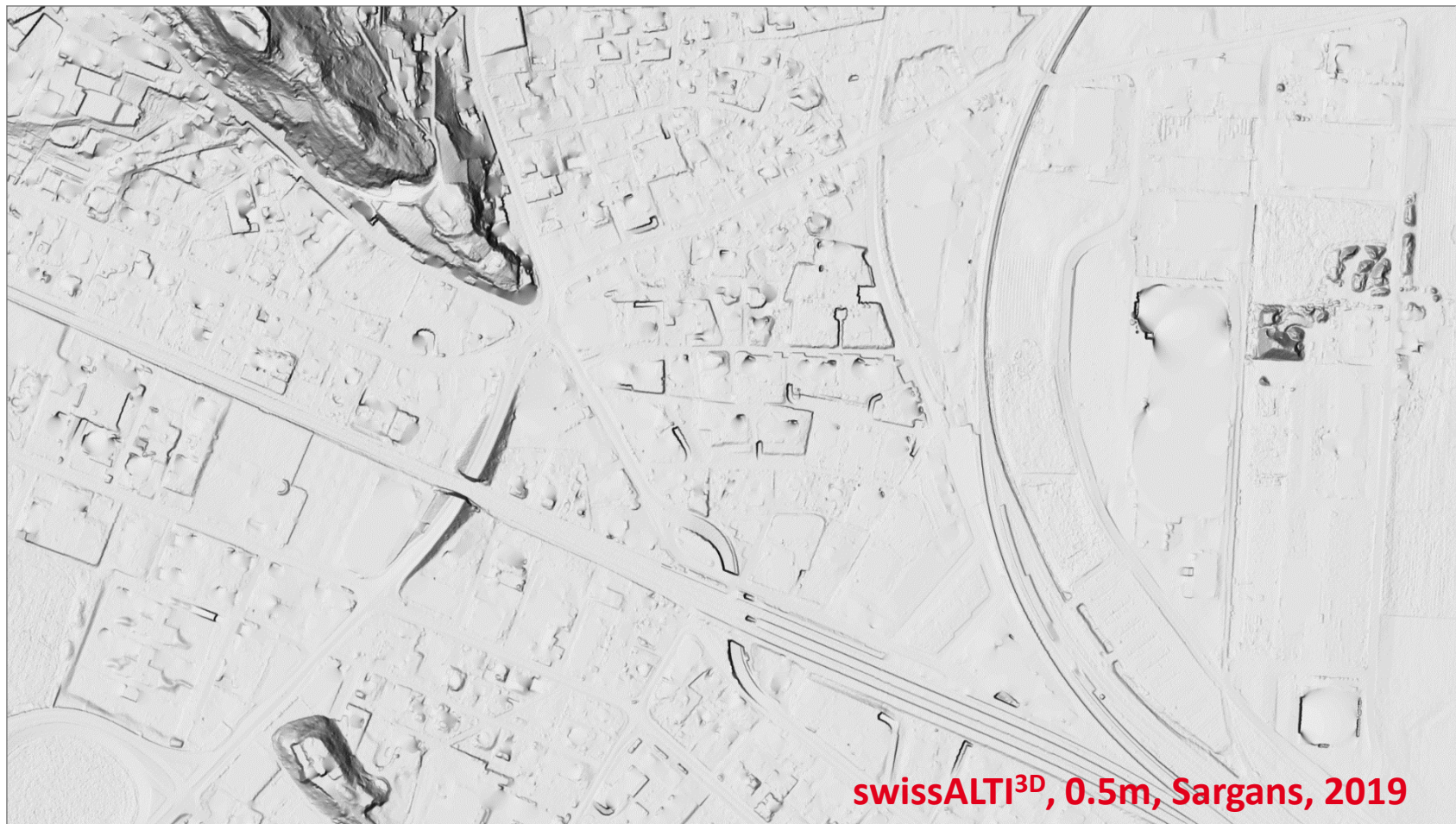
Digital Terrain Model rapid evolution



DTM-AV, 2m, Sargans, 2012



Digital Terrain Model rapid evolution



swissALTI^{3D}, 0.5m, Sargans, 2019



Pointclouds treated at swisstopo

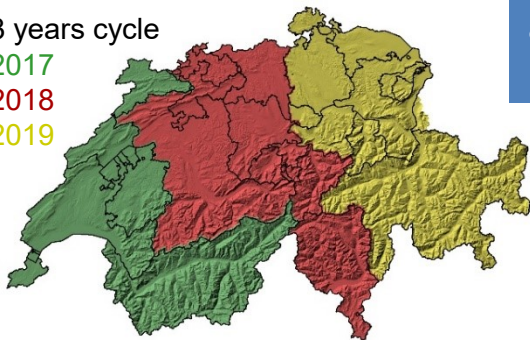
- Two production lines using pointclouds (ADS100 DIM and Lidar)



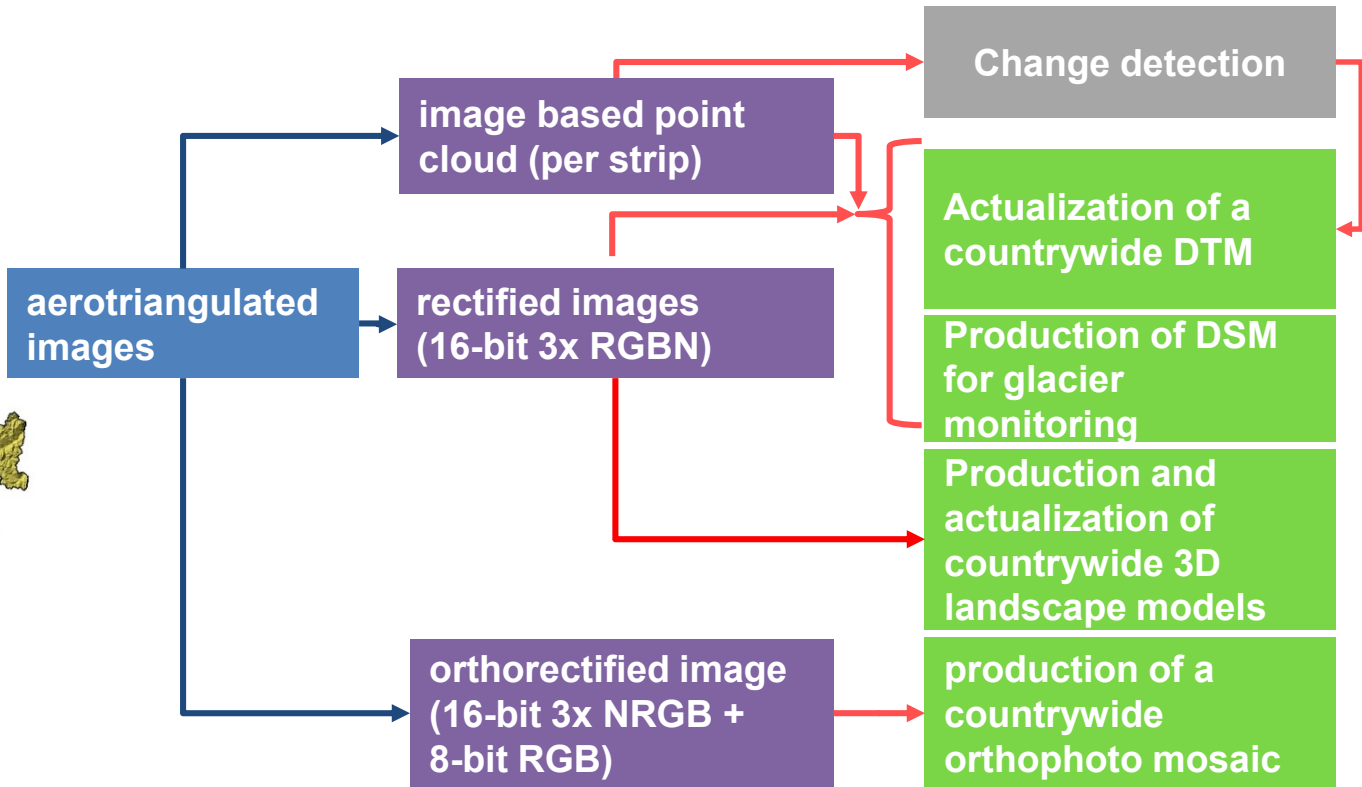
swisstopo main production is based on aerial imagery



3 years cycle
2017
2018
2019

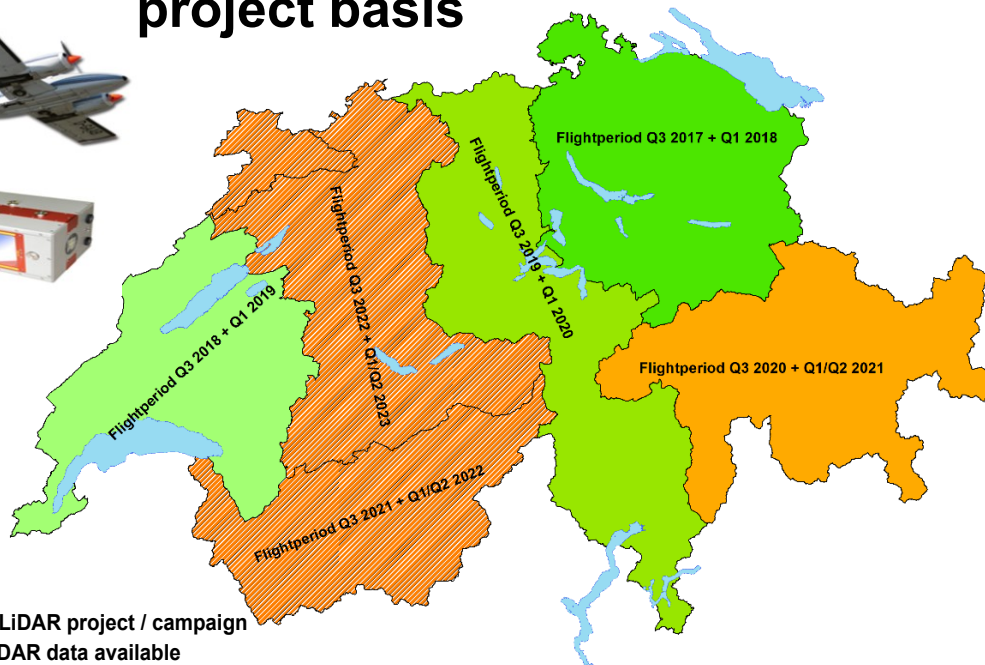
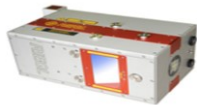


GSD 10 cm in the flat areas
GSD 25 cm in the alps





swisstopo manages countrywide LiDAR external acquisition on project basis



Status LiDAR project / campaign

- LiDAR data available
- processing of LiDAR data on going
- acquisition of LiDAR on going
- LiDAR campaign im preparation
- LiDAR campaign planned

LiDAR point cloud
5 to 20 pts/m²

- 1 unassigned
- 2 ground
- 3 vegetation
- 6 building
- 7 noise
- 9 water
- 17 bridge deck

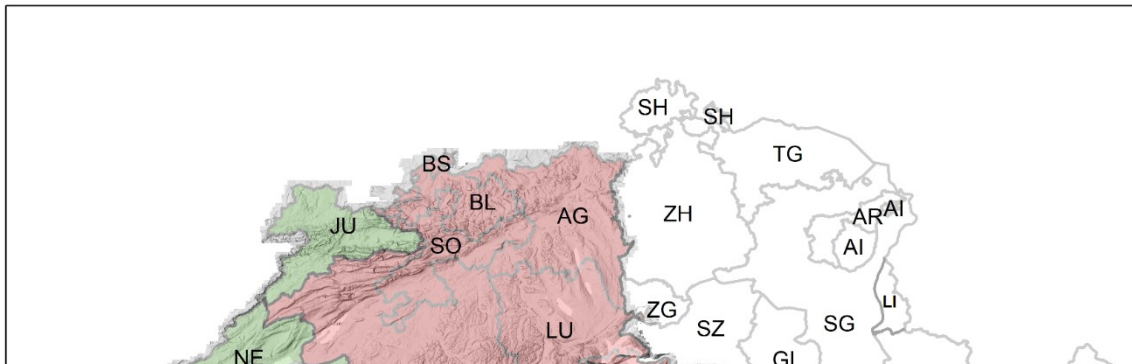
swissSURFACE^{3D}
classified pointcloud

Change Detection
for 3D Landscape
Model and DTM
production

Improvement and
updating of the
countrywide DTM
swissALTI^{3D} with
the class ground



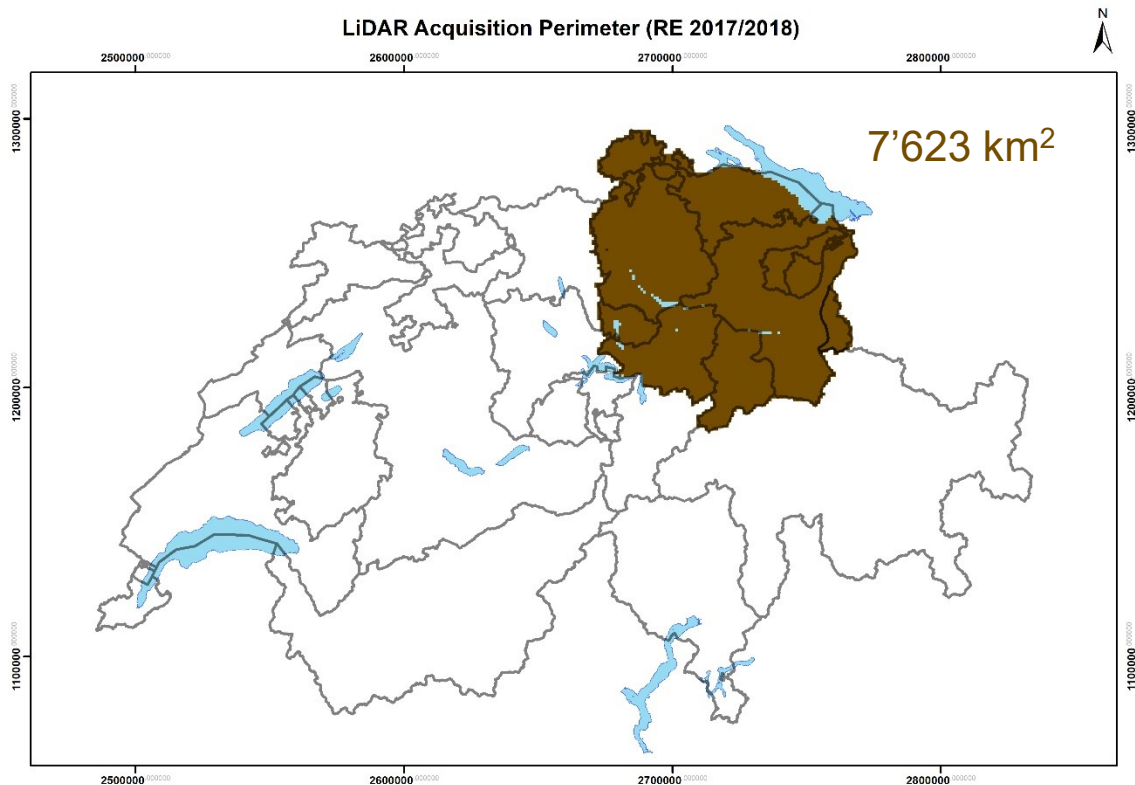
Pointclouds treated at swisstopo



	2017	2018
Point cloud processes (clipping, tiling, etc...)	542 600	705 800
Point processed	1.07E11 (hundred billions)	1.21E11(hundred billions)
Data size [TB]	3.7	6.6
Number of flightlines	293	402



Pointclouds treated at swisstopo



Specifications:

Accuracy:

Planimetry: ± 0.2 meter (1σ)

Elevation: ± 0.1 meter (1σ)

Point density: 5 - 20 points/m²

Classes: Unassigned, ground, vegetation, building, noise, water, bridges

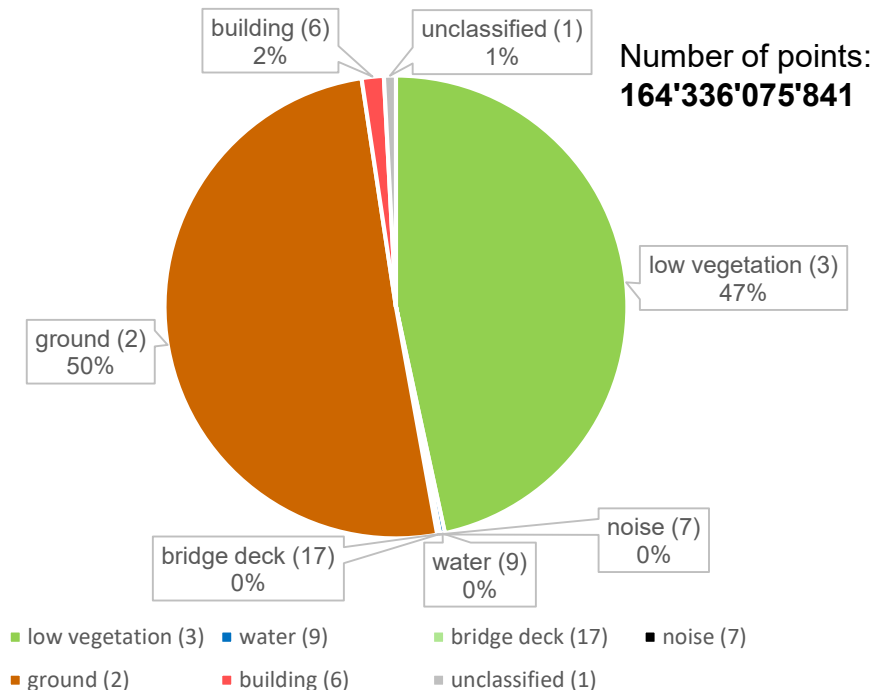
Flight requirements:

Focus on DTM: no snow, no leaves, no inundation



Pointclouds treated at swisstopo

Classification distribution on 7'623 km²





Pointclouds quality

- Dense image matching: use as intermediate dataset

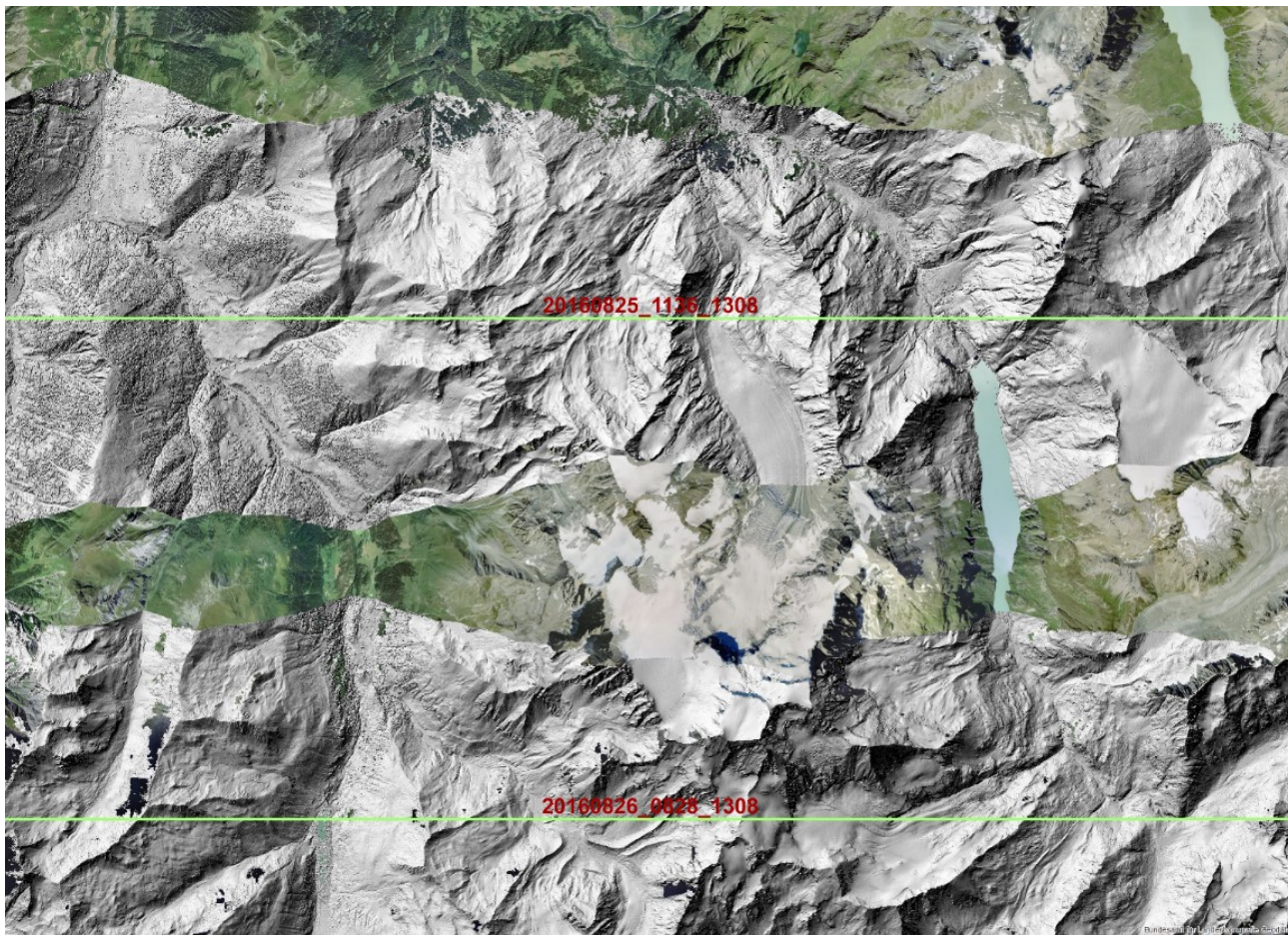
Quality expectation is middle to high: Precision, accuracy is controlled, artefacts are tolerated. No classification yet performed.

- LiDAR classified pointcloud after correction and standardization is a final dataset.

Quality expectation is high: Precision, accuracy is controlled, artifacts are not tolerated. Classification is controlled.

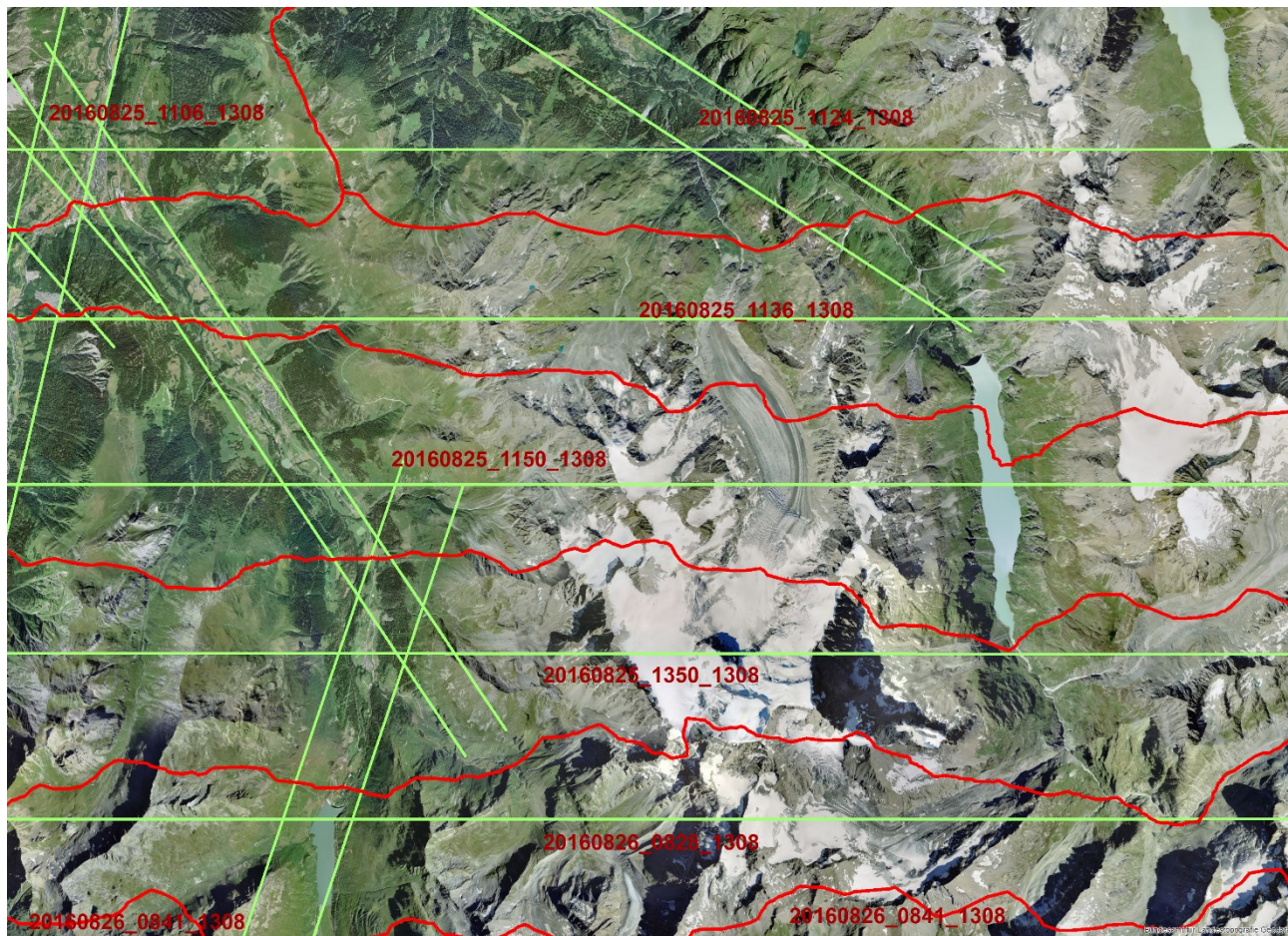


Pointclouds quality: Dense Image Matching



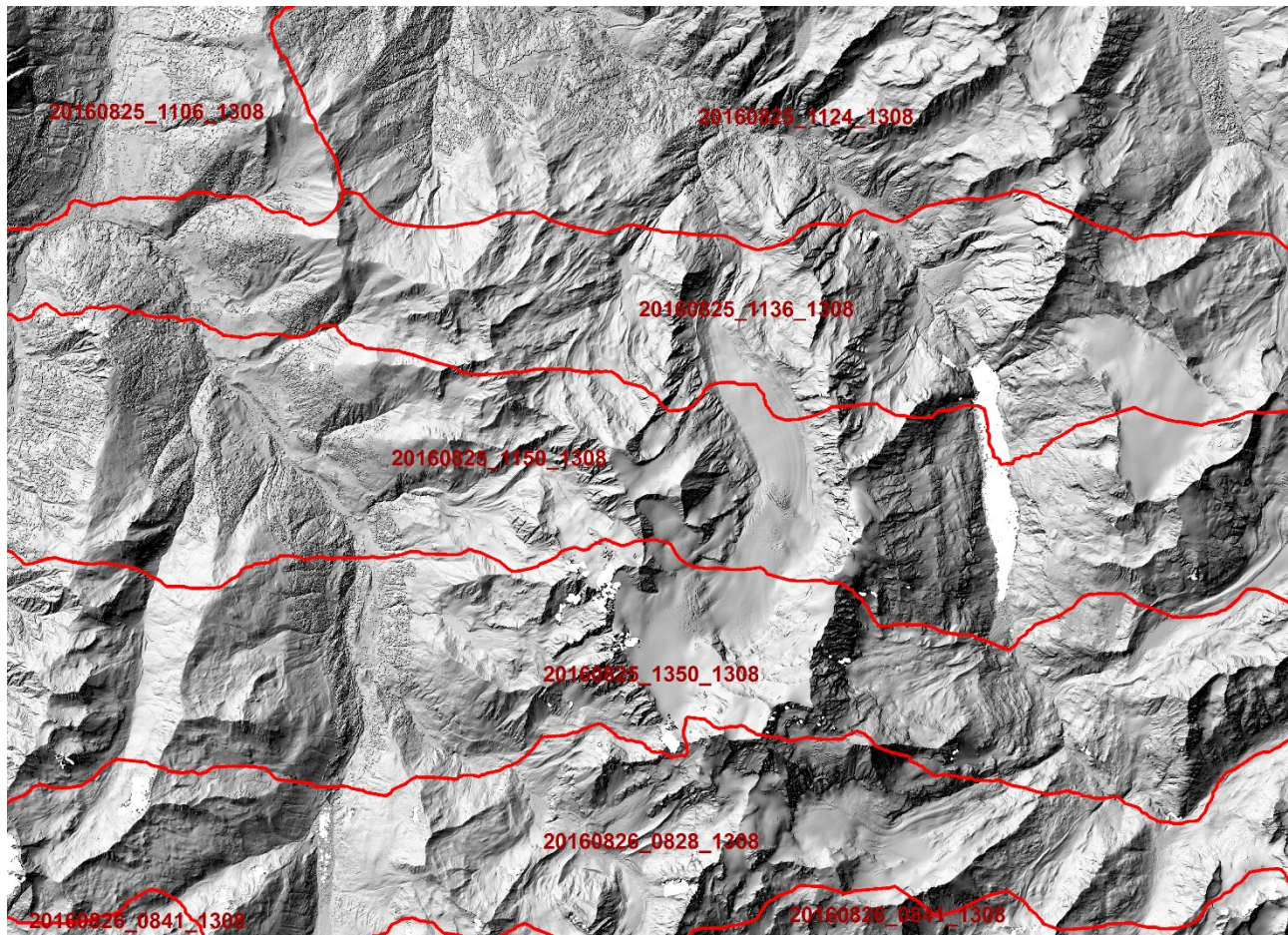


Pointclouds quality: Dense Image Matching



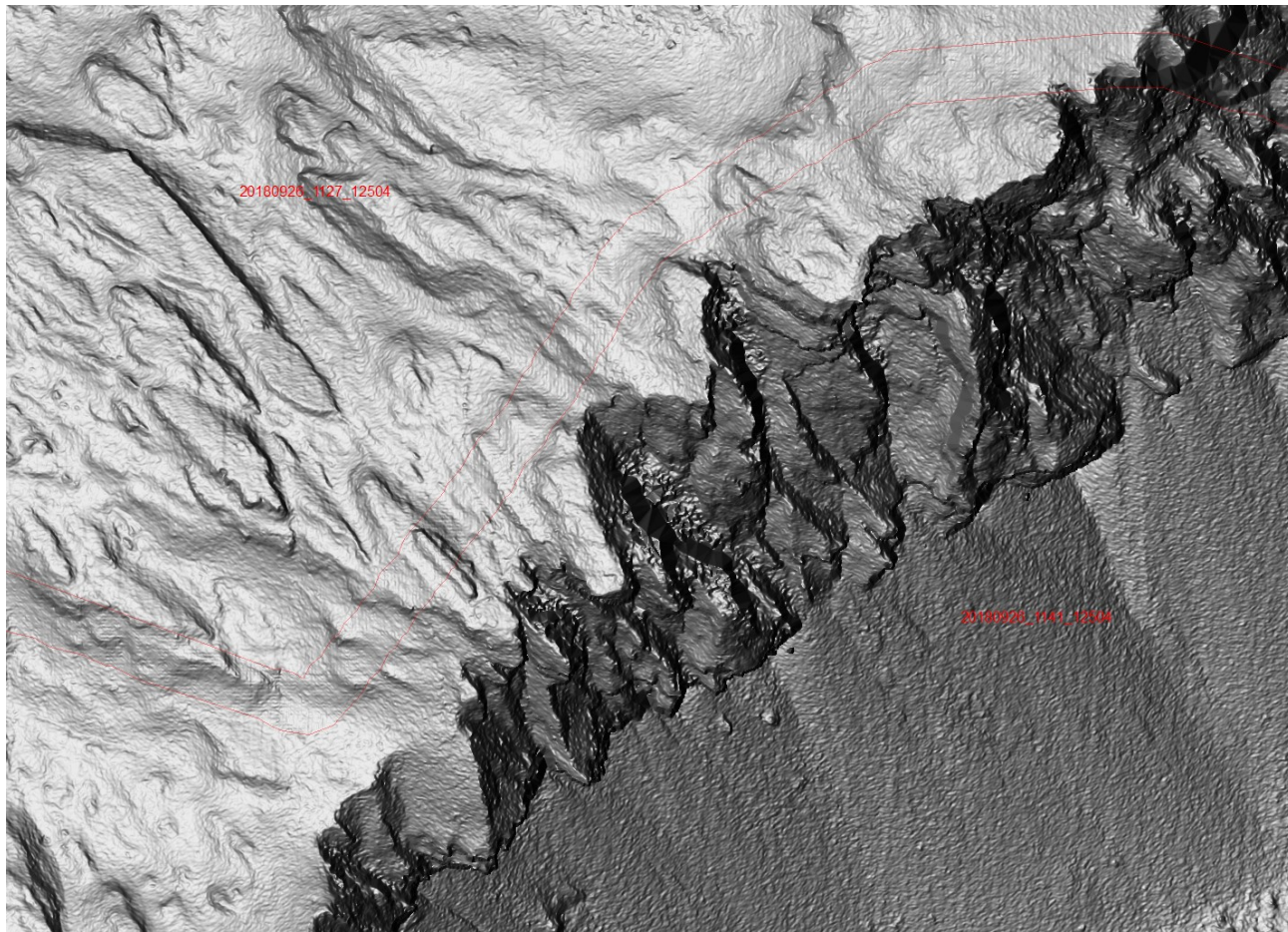


Pointclouds quality: Dense Image Matching



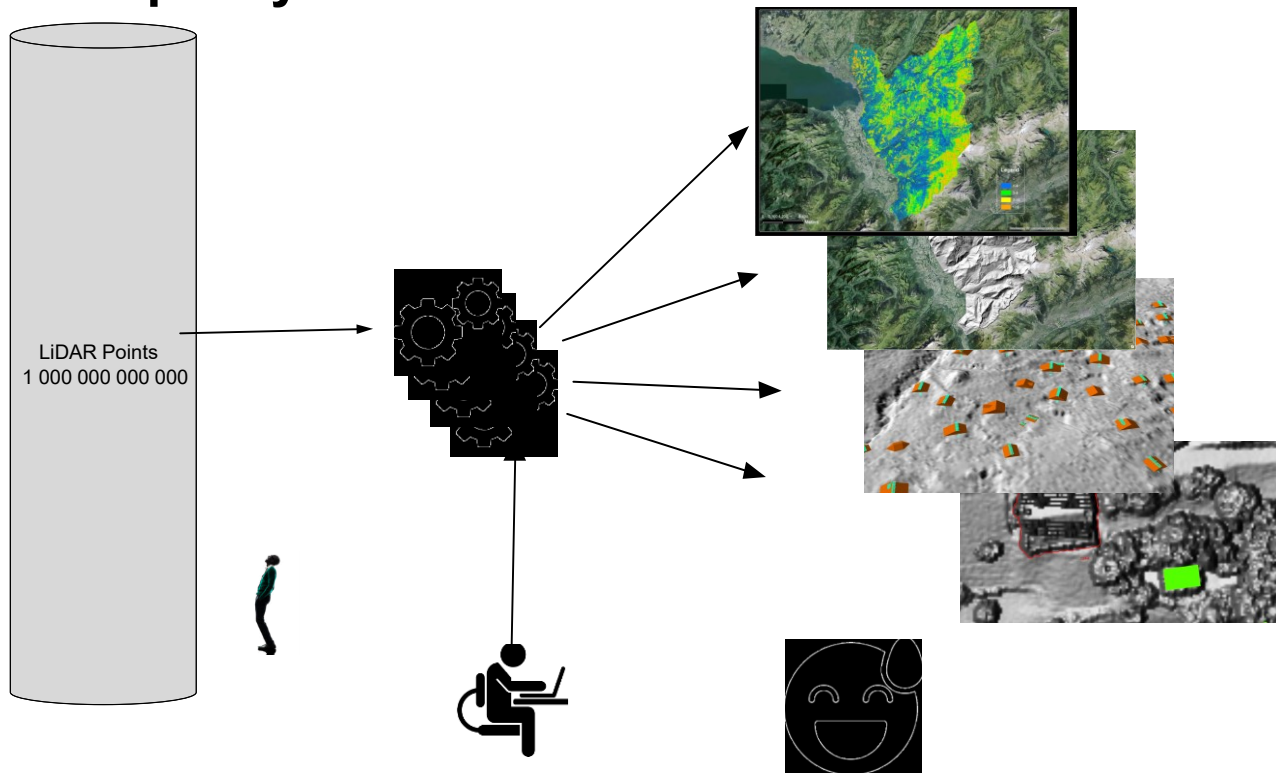


Pointclouds quality: Dense Image Matching





Pointclouds quality: LiDAR





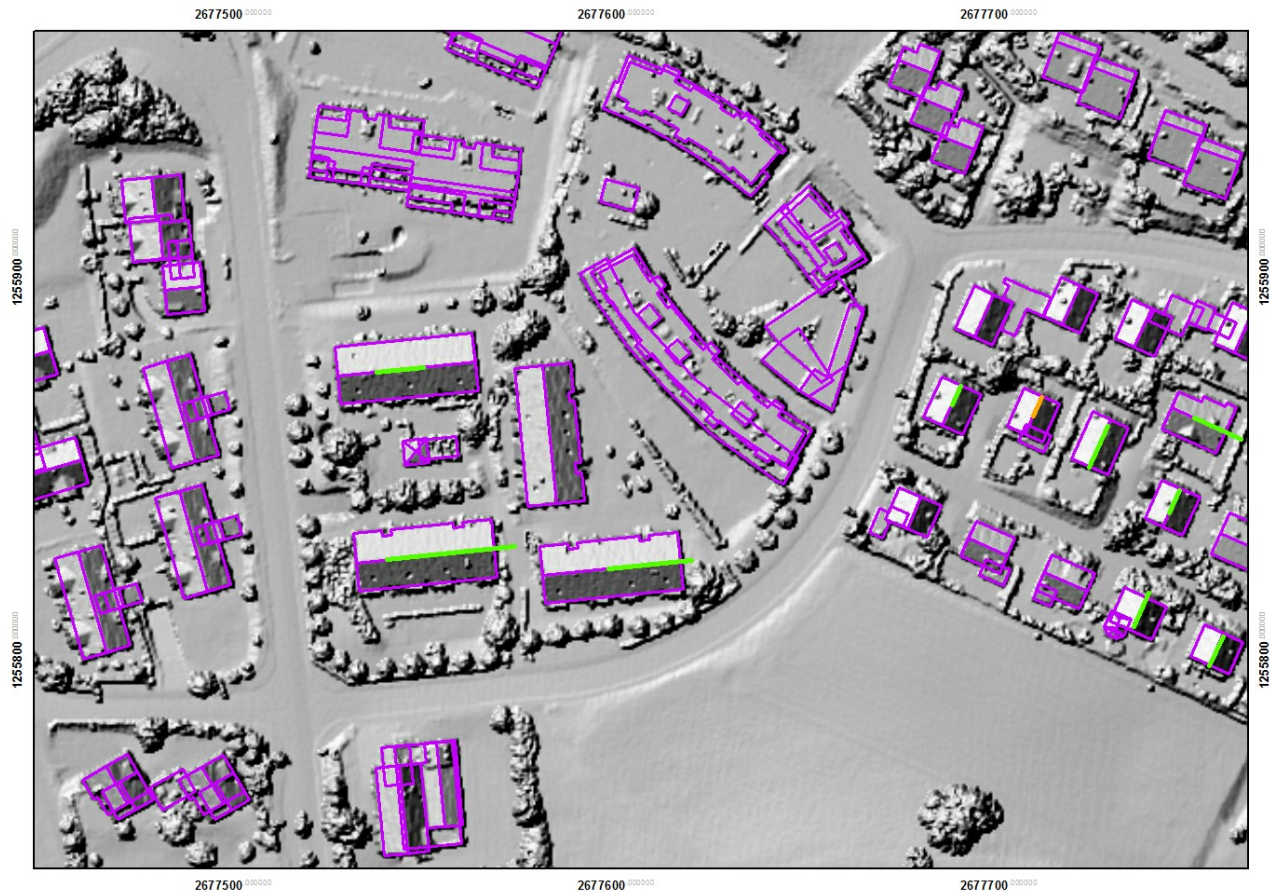
Pointclouds quality: LiDAR

19 controls belonging to 4 categories:

Integrity / Completion / Precision (file delivery, file information, perimeter, density (x3), interline precision, overlap of swath)	8
Accuracy (Elevation accuracy (x2), planimetric accuracy)	3
Classification (Water, building, vegetation, bridge, unassigned, noise)	6
Quality of products (Hillshade of DTM, Hillshade of DSM)	2



Pointclouds quality: LiDAR

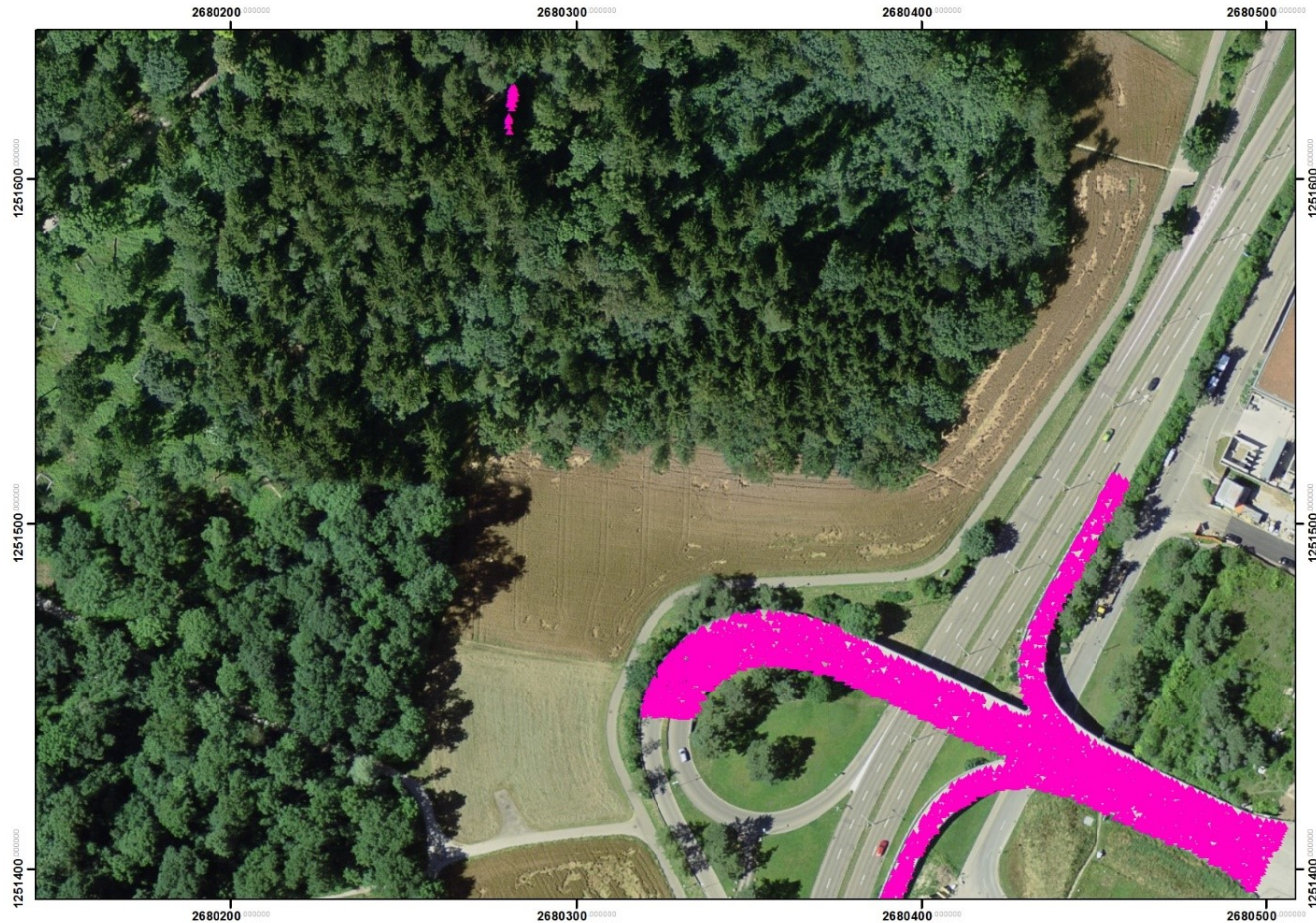


Planimetric accuracy:
Reference vs LiDAR

Focus on systematic shift



Pointclouds quality: LiDAR



Classification bridge:
Reference vs LiDAR

Bridge (Lidar)



Pointclouds quality: LiDAR

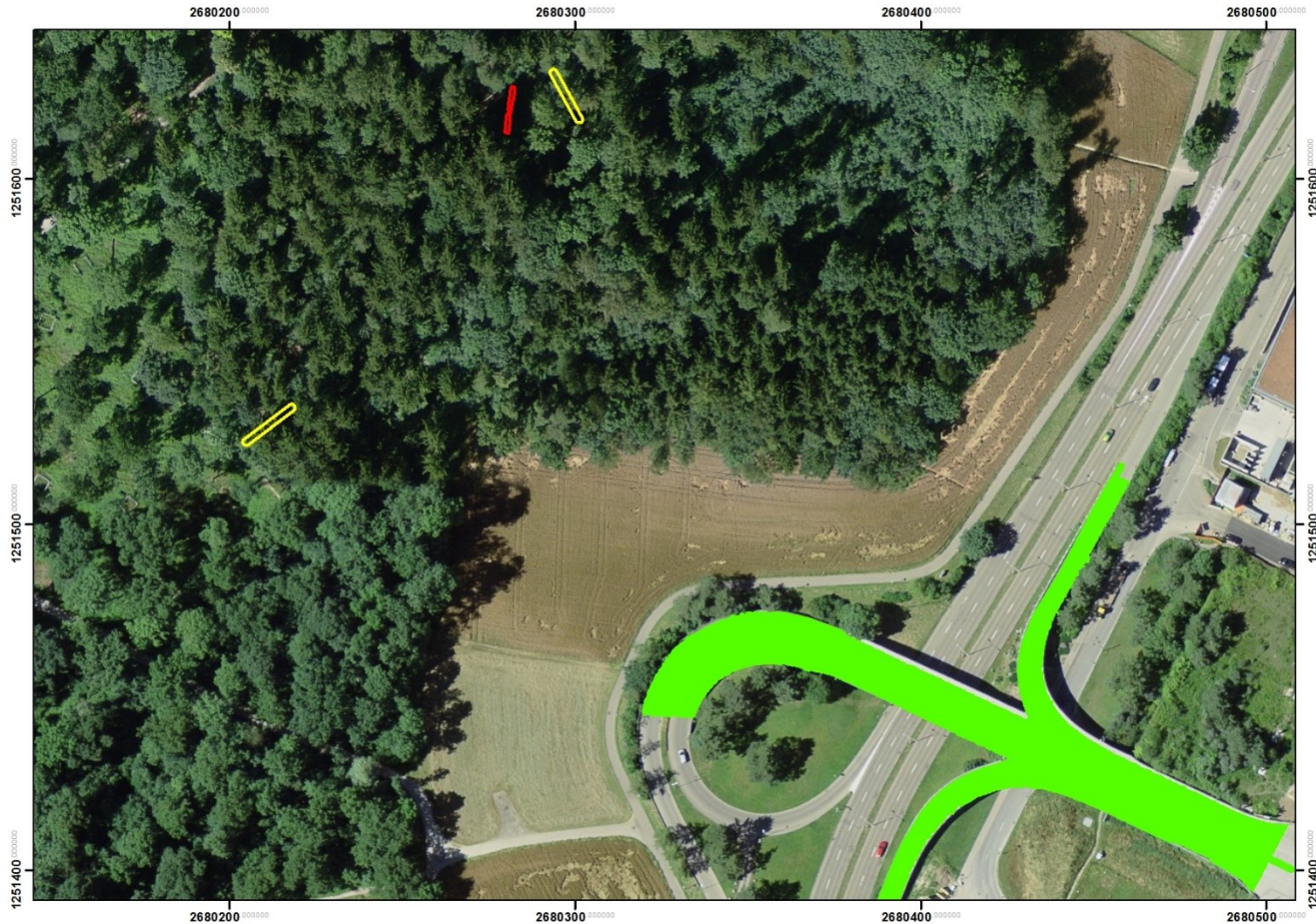


Classification bridge:
Reference vs LiDAR

Bridge (Reference)



Pointclouds quality: LiDAR



Classification bridge:
Reference vs LiDAR

Bridge (Lidar) overlaps
bridge (Reference) ?

Yes : No/No



Pointclouds quality: LiDAR



Bridge:
Reference vs LiDAR

Building(Lidar) overlaps
Building(reference)?

Yes : No/No

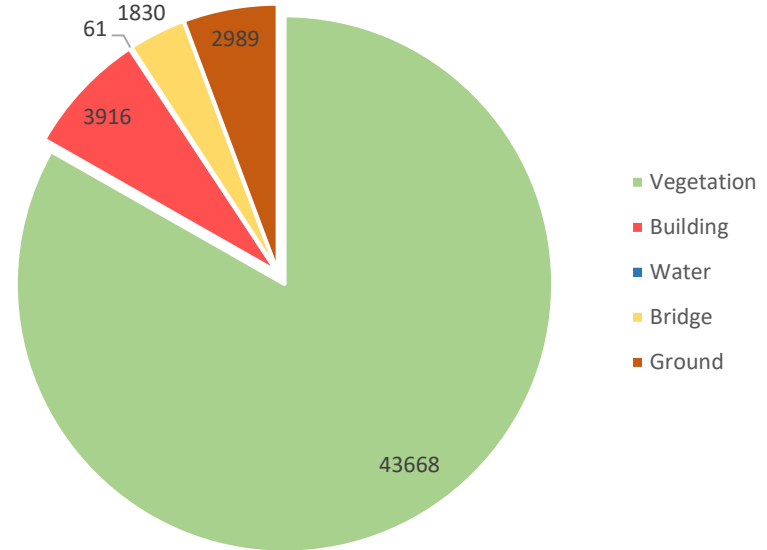


Pointclouds quality: LiDAR



- 98 % of errors in classification.
- Classification errors often related with vegetation classification. Errors are of different severity depending on applications.

Repartition of classification errors





Pointclouds quality: LiDAR

- Prime Tower and error severity vs user precision (F1-precision)

Classification

- 1 Unassigned
- 2 Ground
- 3 Low Vegetation
- 6 Building
- 7 Noise
- 17 Bridge Deck



0.00048% of
building
classification
points

→ high severity
(air traffic
obstacles, view
analysis, etc...)



Data management

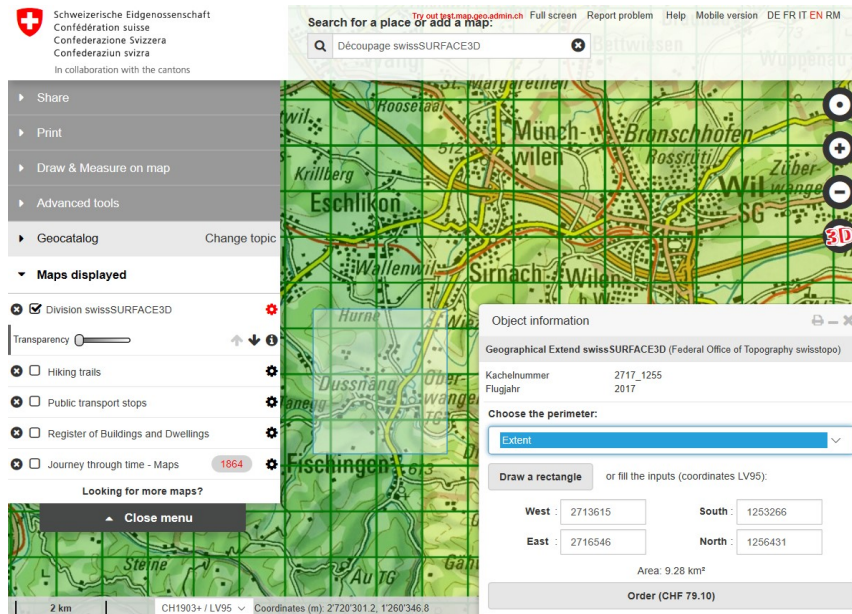
→ swissSURFACE^{3D} :

Huge data storage is essential

Distribution: 1 binary format (~ 25 TB)

Long-Term archive: plain text (~ 230TB)

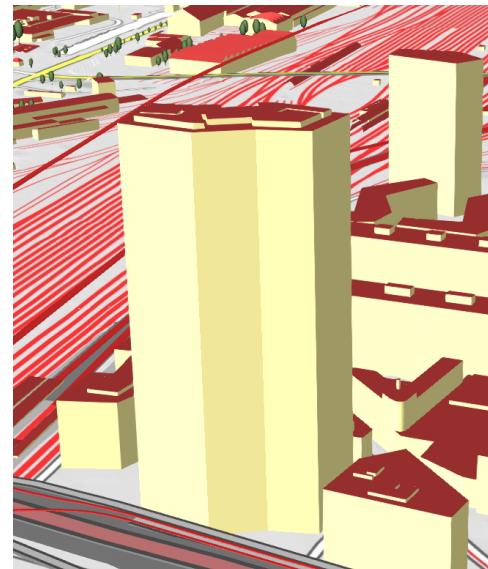
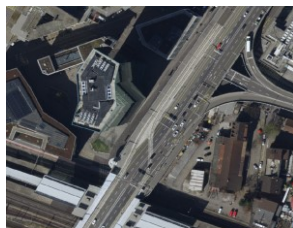
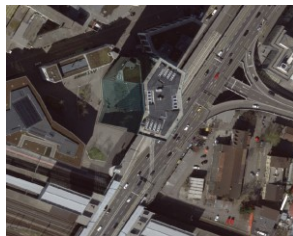
→ Pointcloud are stored by square kilometers tiles for distribution and archiving.





Vector – Pointcloud complementarity

- Different «standard», vector vs pointcloud vs imagery
- Digital Twins





Incremental Updating: Challenge

For DTM:

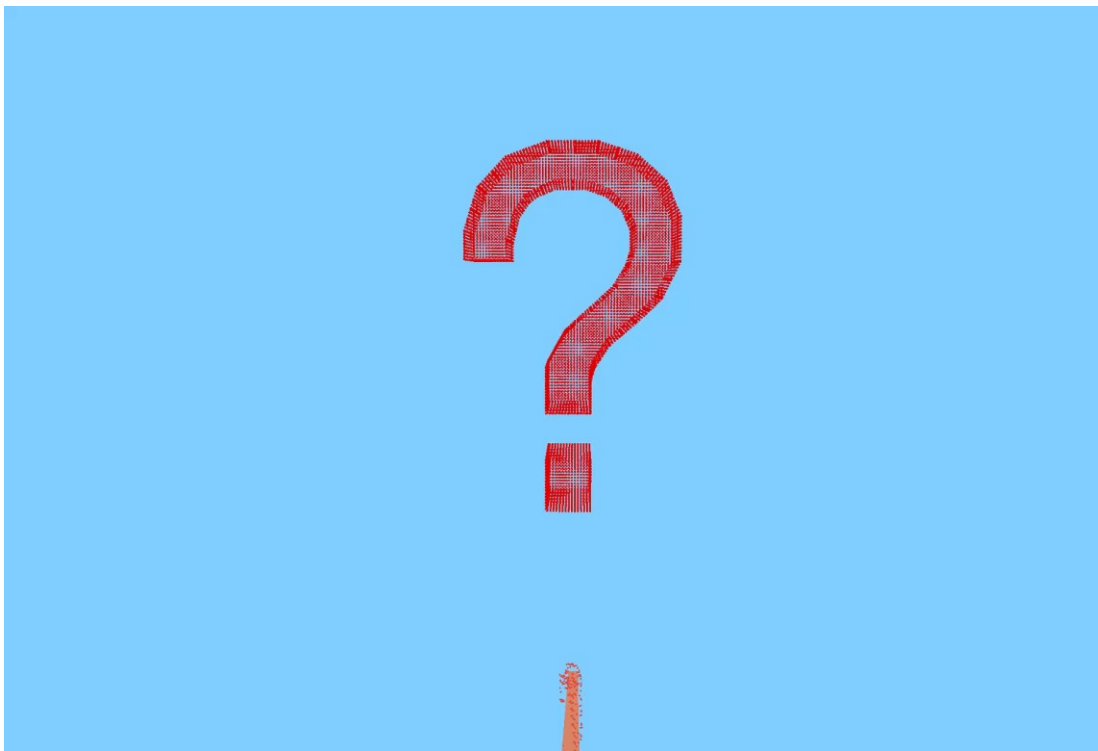
- Current solution for generation step: «Old out, new in»
- For local update: find changes and update with DIM or stereo images (mainly manual). Nearly no update possibility beneath forest.

Vision for swissSURFACE^{3D}:

- Will full waveform LiDAR (FWL) acquisition become cheaper and faster (current : ~150 CHF / km²) to meet imagery acquisition pace and price?
- How accurate, precise and accessible will become Single Photon LiDAR, Geiger-Mode LiDAR or Dense Image matching to compete with FWL (with similar point density)?



Thank you for your attention! Any questions?



Visit us at: www.swisstopo.ch