Precision prediction of drone mapping in the mountains

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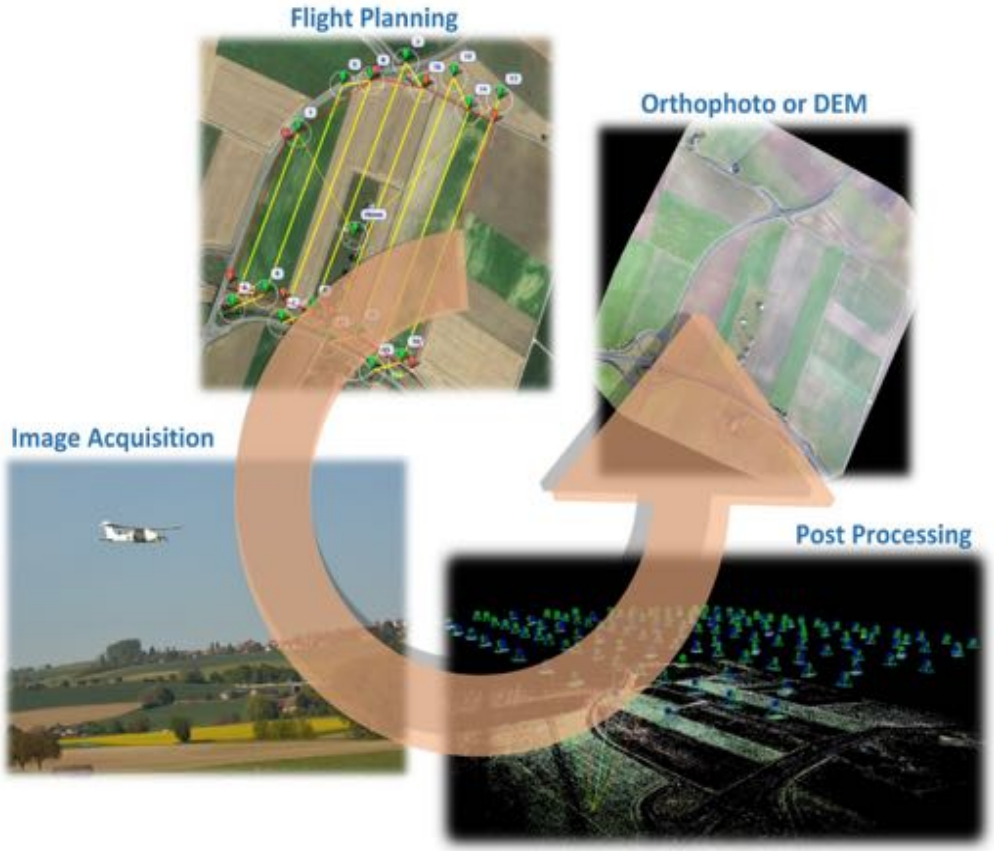
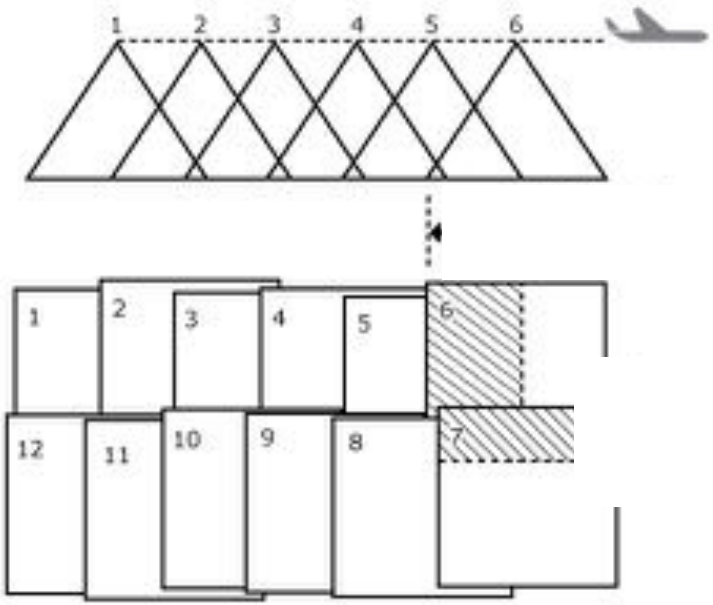
Airborne MAVs Mapping: general context



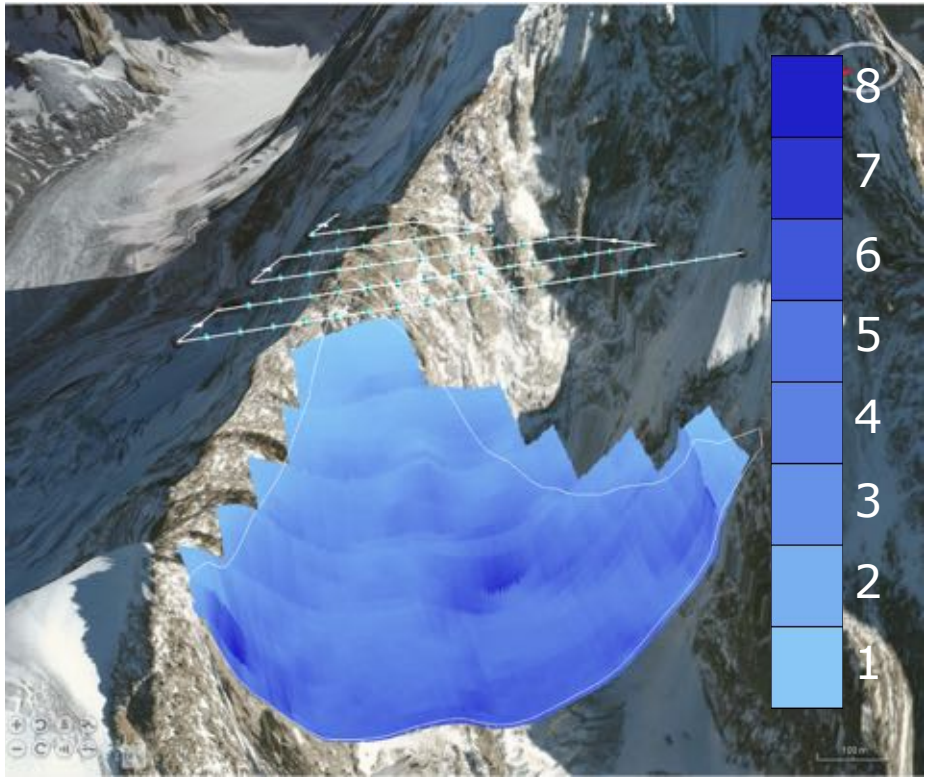
- Agenda
  - main challenges
  - answers / local example
  - details & verification

Challenge 1: GSD

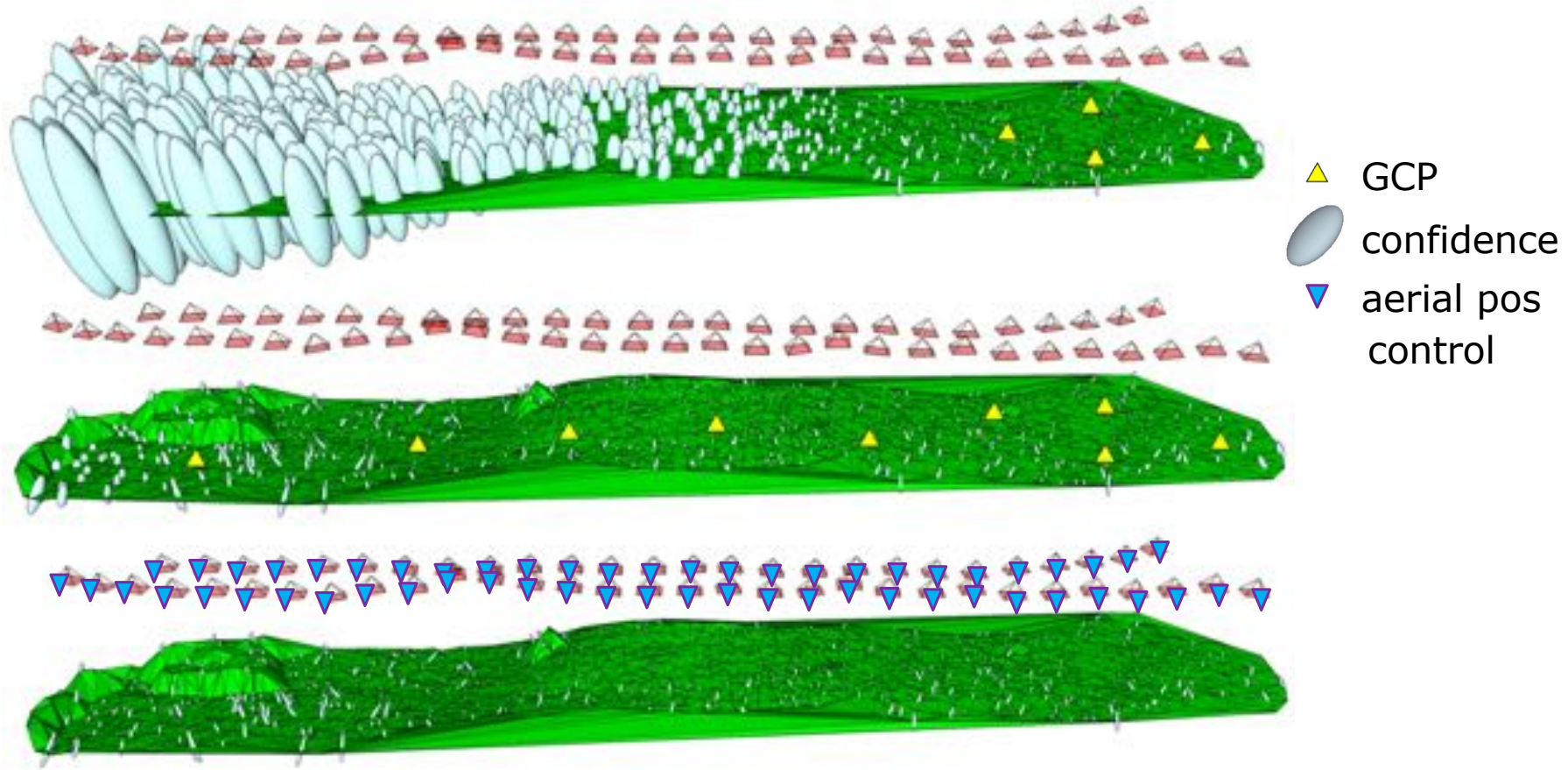
- Flat terrain
  - GSD = h * px / c



- Mountains ?



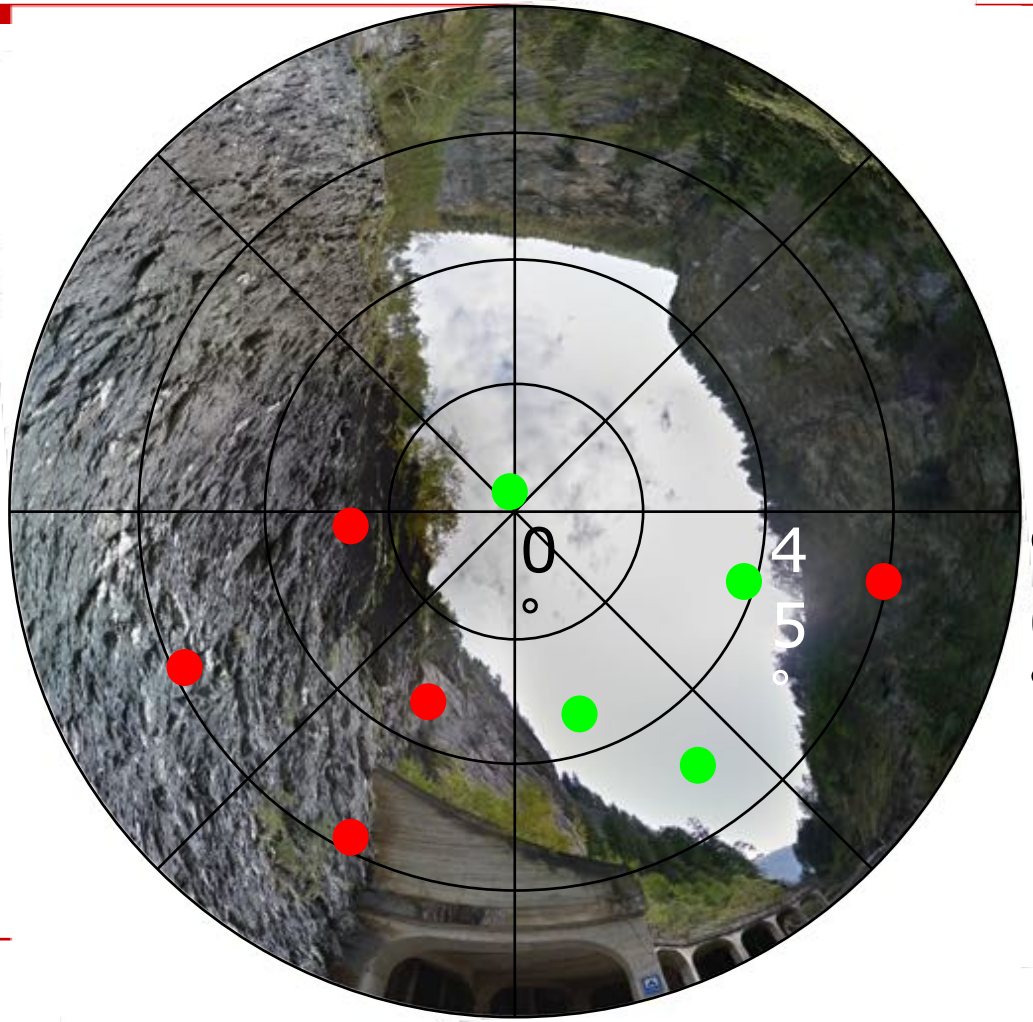
Challenge 2: “Bierbauch” rise and fall

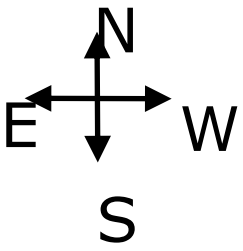


Challenge 3: GNSS satellite coverage

- Sky view

Mountain canyon





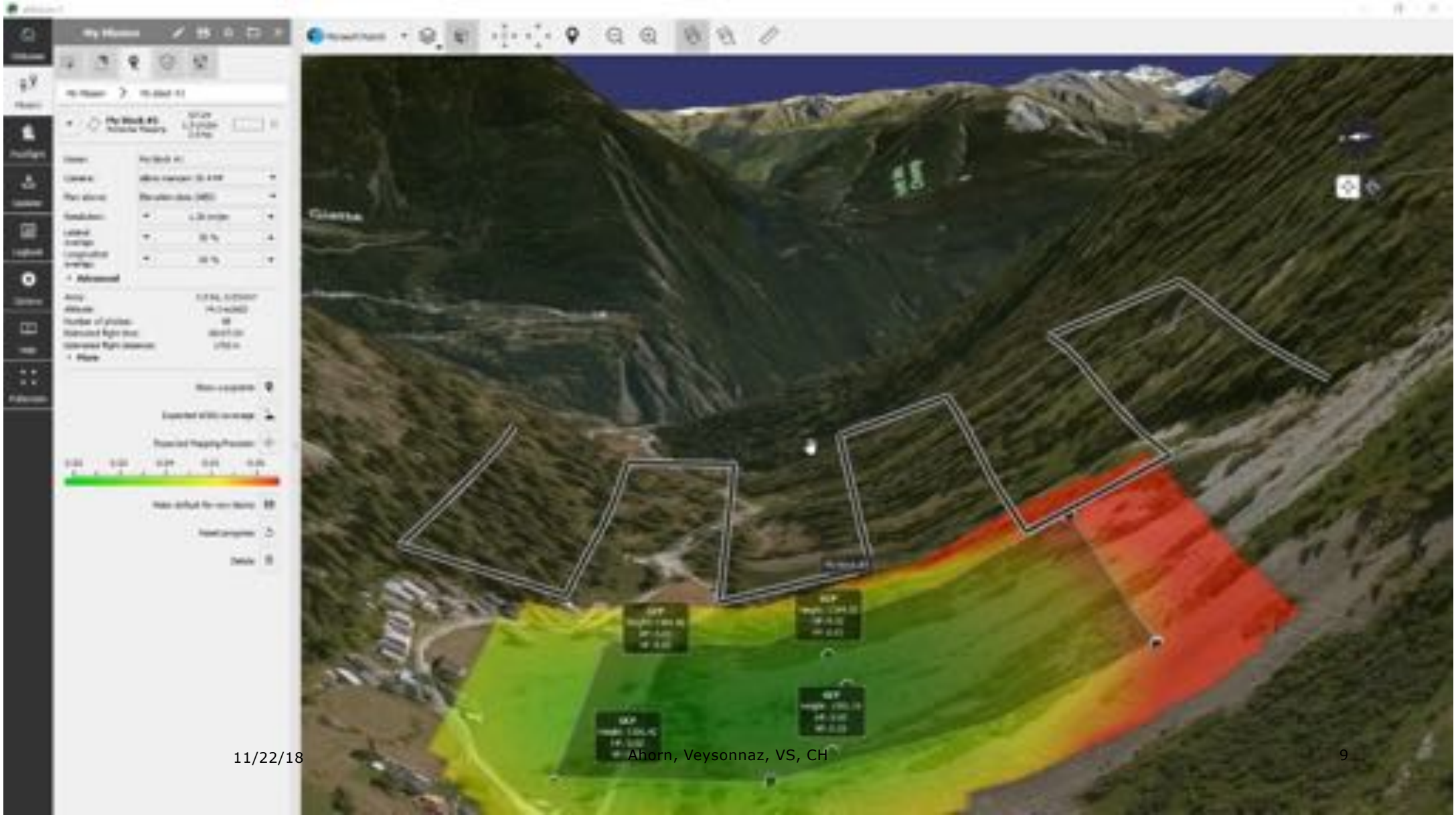
- Visible satellite
- Non visible satellite

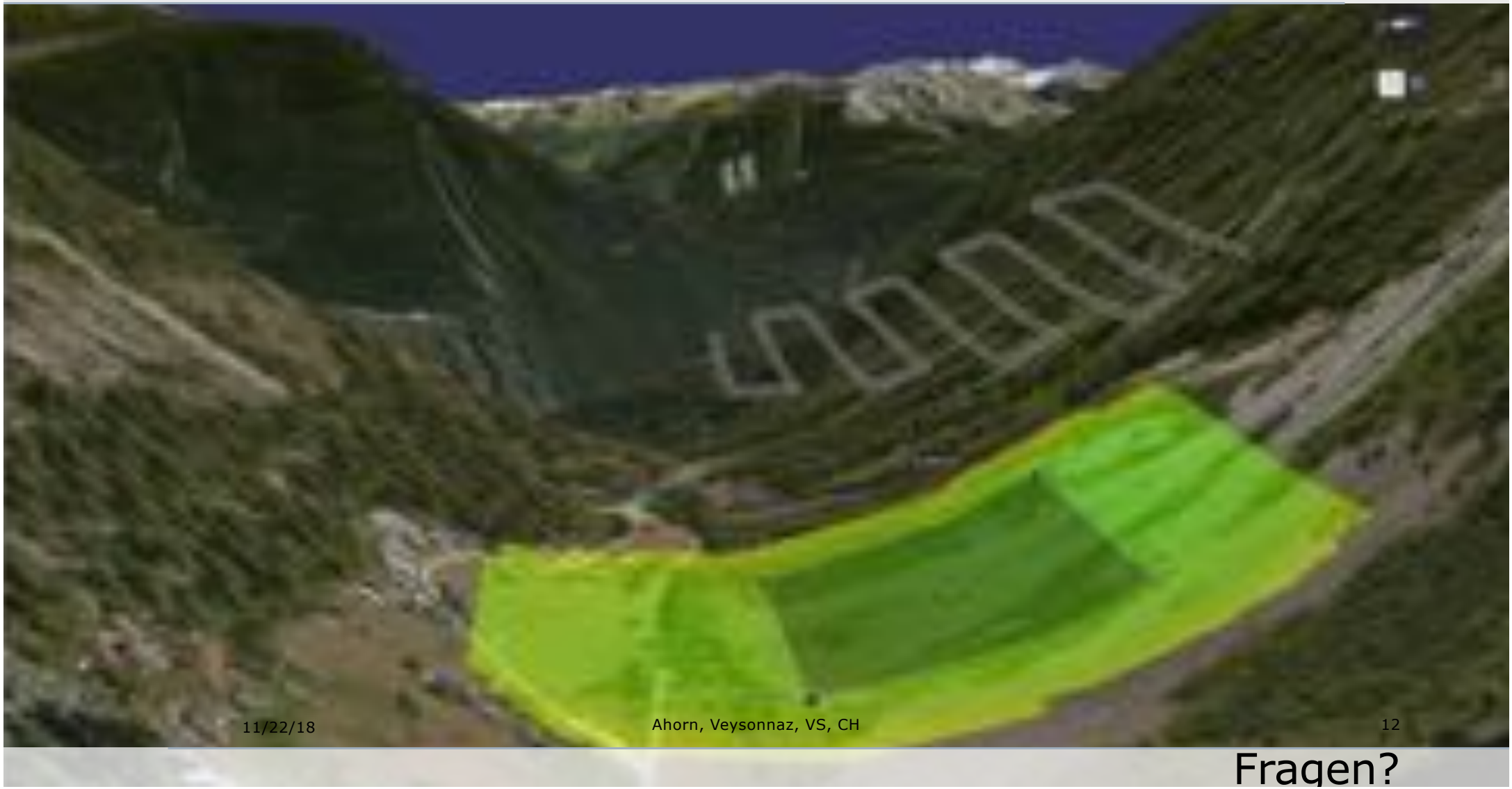
Challenge 4: computer vision

- Automated tie-points
  - Area dependences
  - #
  - Quality

Answers

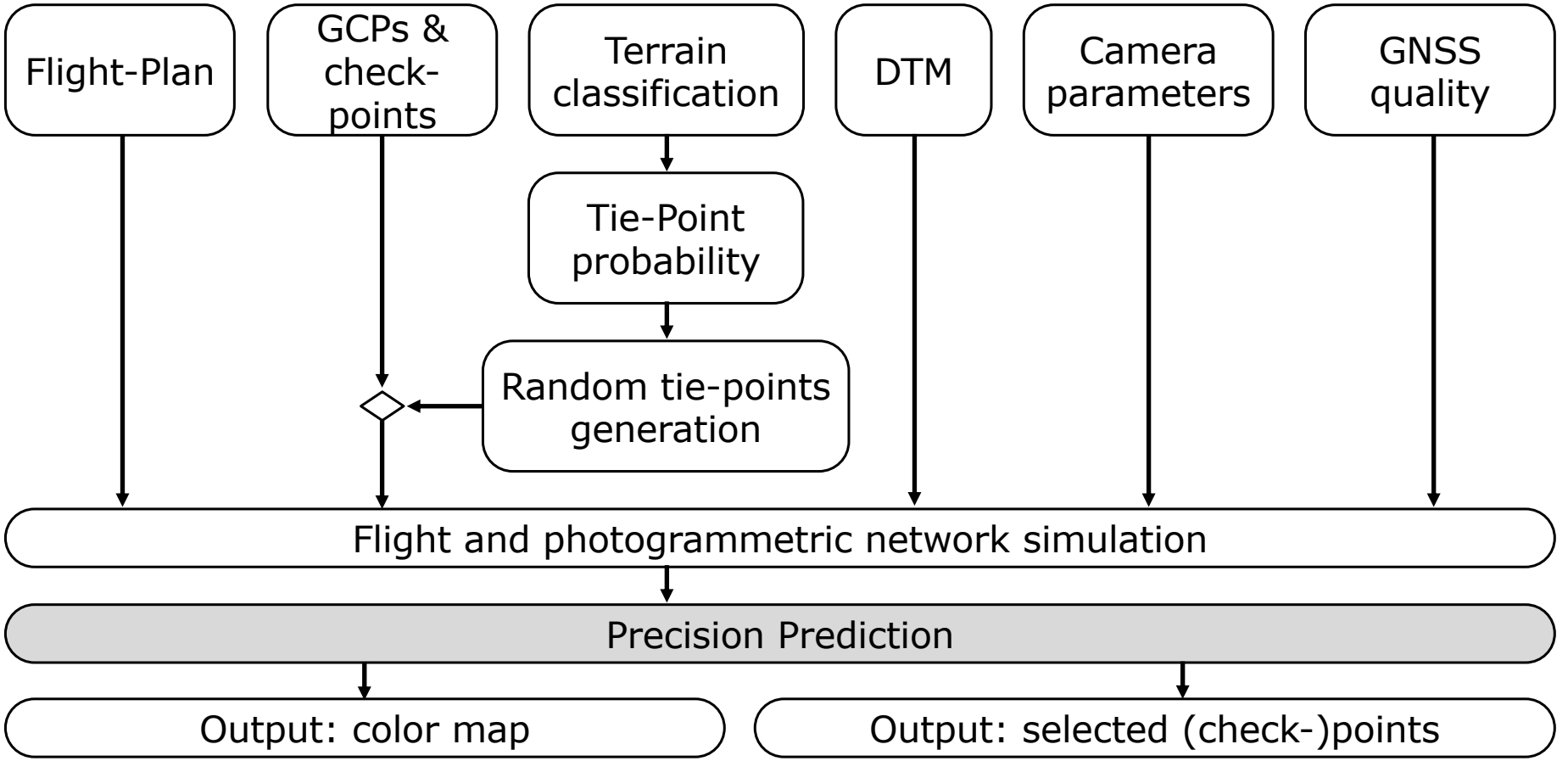
- A local example …





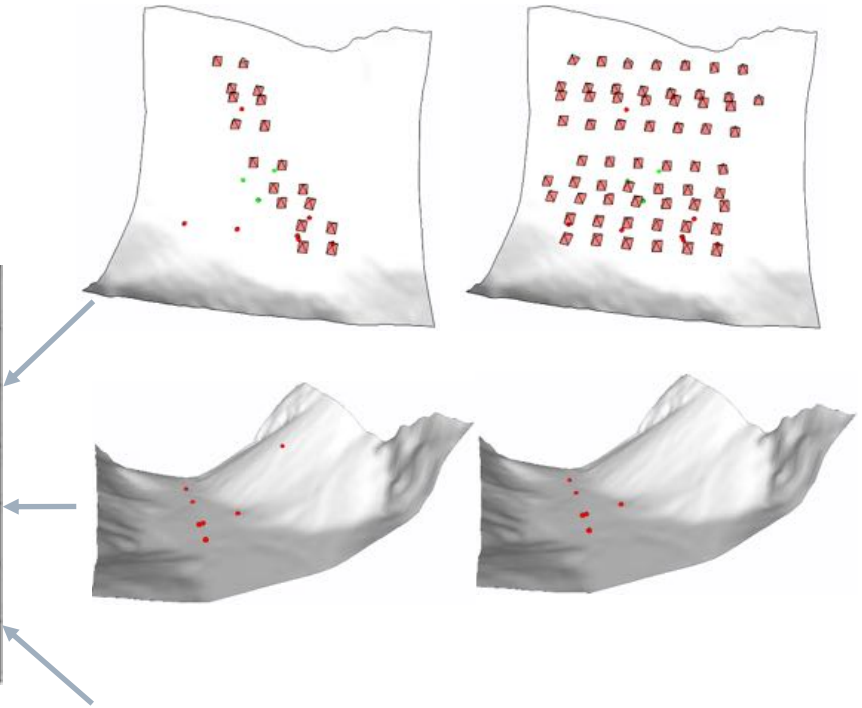
Fragen?

Implementation details



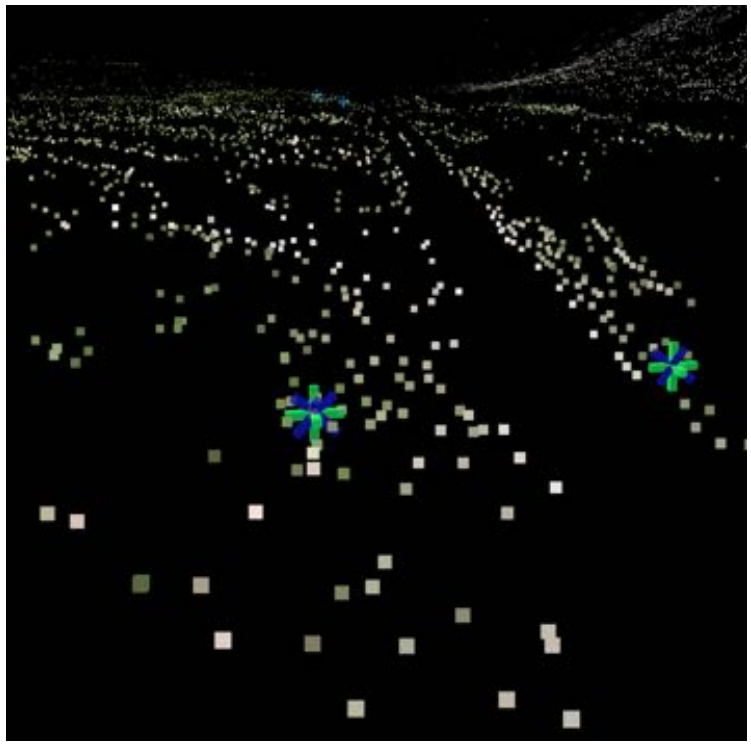
Studied cases

Test Case		1	2	3	4	5	6	7	8
Flight- Plan	Block	✓		✓		✓		✓	
	Corridor		✓		✓		✓		✓
GCP configuration	Good	✓	✓			✓	✓		
	Bad			✓	✓			✓	✓
Aerial Control	Yes	✓	✓	✓	✓				
	No					✓	✓	✓	✓



Verification: check point misclosure

photogrammetric 3D model



Photogrammetry

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External control

$\overrightarrow{w}$: Check-Point misclosure.

"Czech" points

Prediction verifications: methodology

- Predicted precision
  - Flight plan ”bundle adjust”.
- True precision
  - ChkPts misclosure

GCP Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
11 (3D)	0.020/ 0.030	0.005	-0.001	0.000	0.591	13 / 13
14 (3D)	0.020/ 0.030	-0.000	0.002	-0.000	0.646	17 / 17
195 (3D)	0.020/ 0.030	-0.005	-0.001	0.000	0.676	15 / 15
Mean		-0.000024	-0.000027	0.000068		
Sigma		0.003914	0.001569	0.000299		
RMS Error		0.003914	0.001569	0.000312		

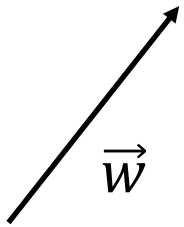
0 out of 2 check points have been labeled as inaccurate.

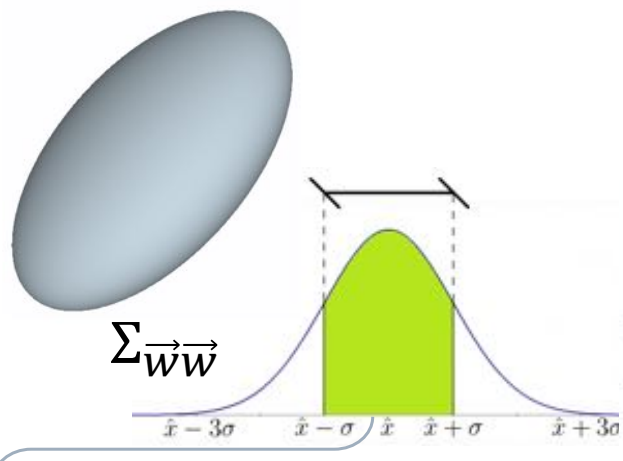
Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
10	0.0200/0.0300	-0.0285	-0.0146	0.0068	0.4136	11 / 11
15	0.0200/0.0300	-0.0047	-0.0083	-0.0077	0.7282	9 / 9
Mean		-0.016608	-0.011466	-0.000422		
Sigma		0.011875	0.003176	0.007238		
RMS Error		0.020417	0.011897	0.007251		

Verification: distribution of norm. misclosures

Misclosure

Covariance





Malahanobis distance

+

normalization

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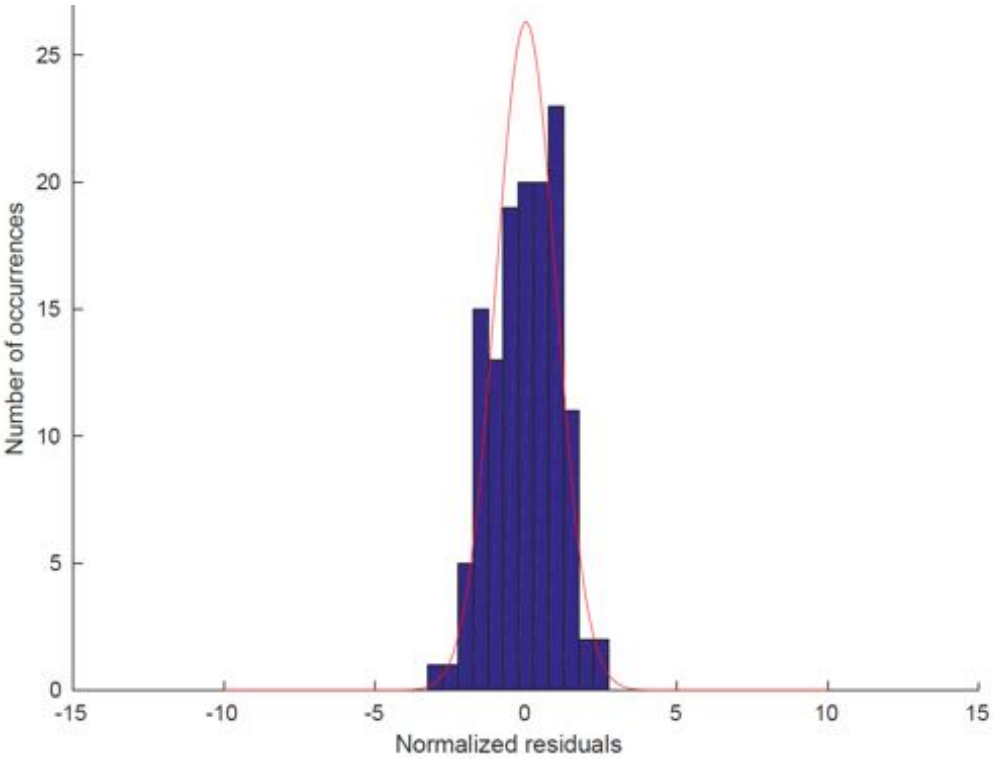

Conclusion

- Mountains: challenges also for drone-mapping

- Methodology
  - Before flight: simulate: TP distrib., ChkPts, aerial control
  - After flight: repeat with real image pos + aerial control quality
  - Field decision: + GCP, +photo, +RTK /vs different time

- Verification
  - > 10 flights in mountain environments under different conditions (visibility, terrain, GNSS coverage)

Acknowledgement

- CTI (Innosuisse), project 18442.1 PFIW-IW