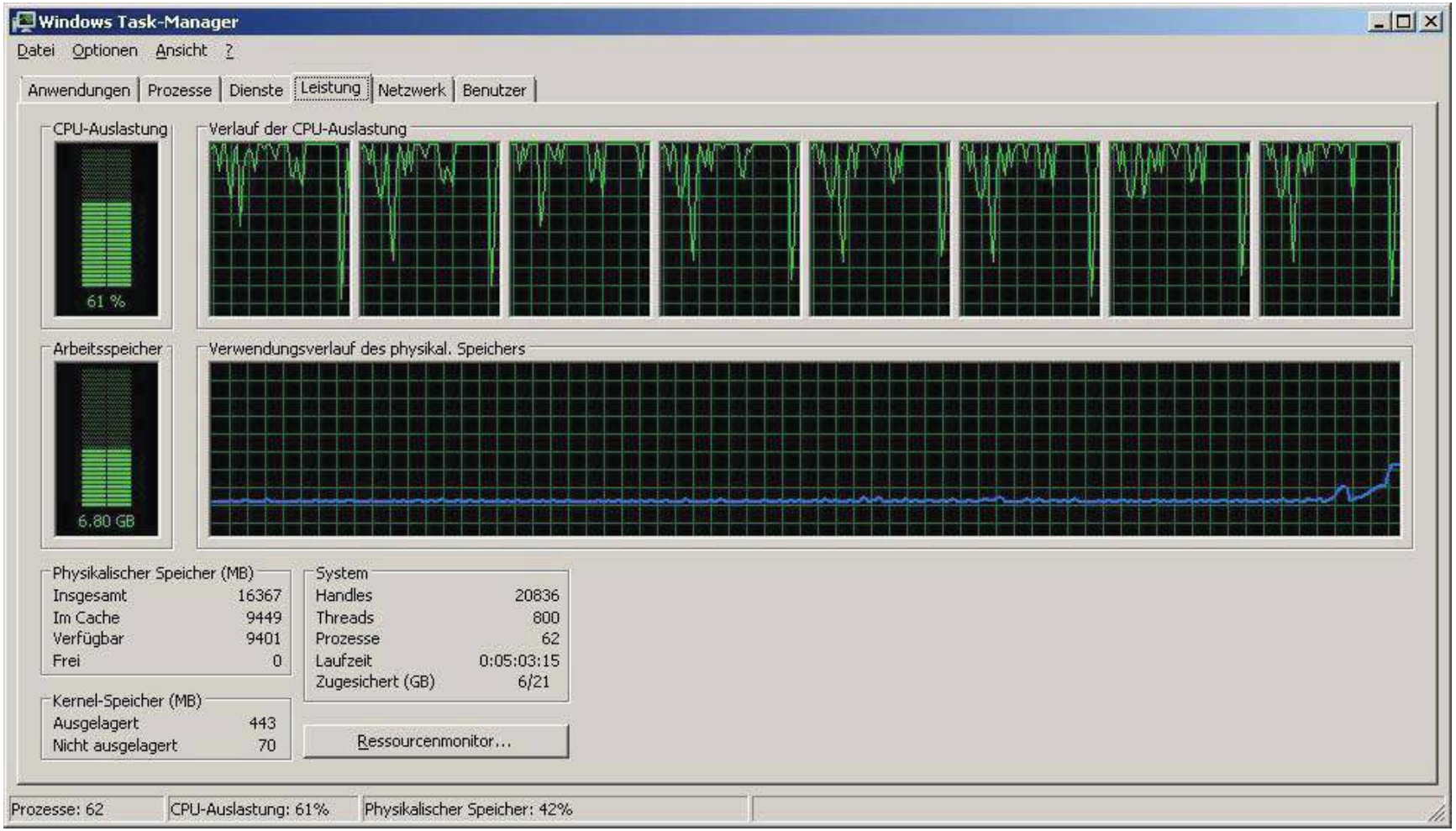
SGM Processing

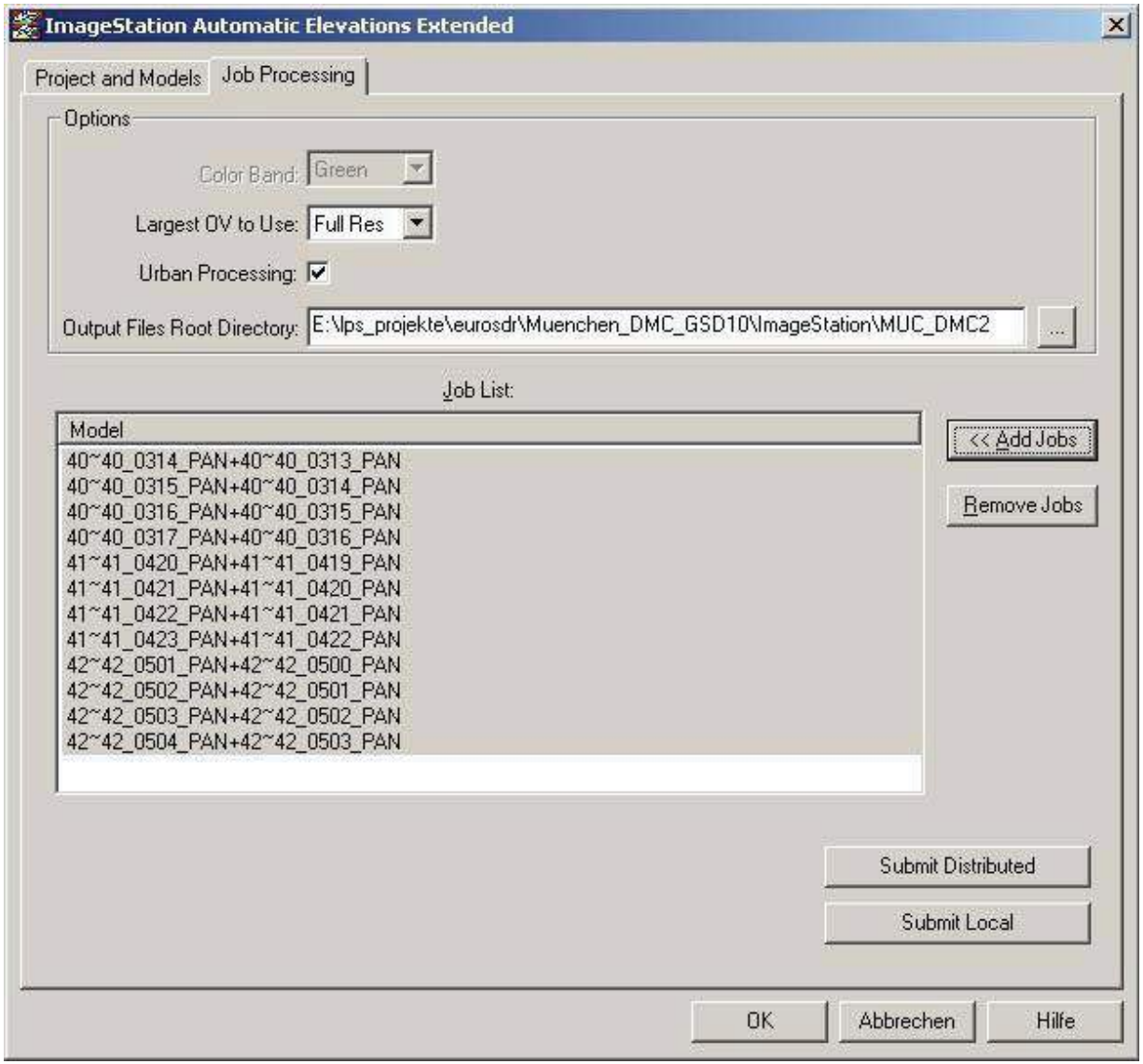
- Load of the 2 Intel Xeon Quadcore Processors, 16 GB RAM available



Computation Time Vaihingen

- Camera UltracamX
- 33 Stereo Models processed
- Computation time per stereo model: 20 minutes, 11 hours totally
- Computation time for the 20 cm grid interpolation of 580 millon points, 21 hours
  - Tiling of the whole area into more than 400 tiles
  - Computation of a TIN network for each tile
  - Linear interpolation of grid points

ISAE-E Eingabeparameter



ISAE-E Workflow

- Automatic creation of a LPS Blockfile from Inpho projectfile, export of the orientation parameters
- Manual creation of an IS Project and building of stereo models
- Modelwise computation of LAS DSM files
- Merge and interpolation of LAS files with LPS Terrain Prep Tool

LPS eATE Workflow

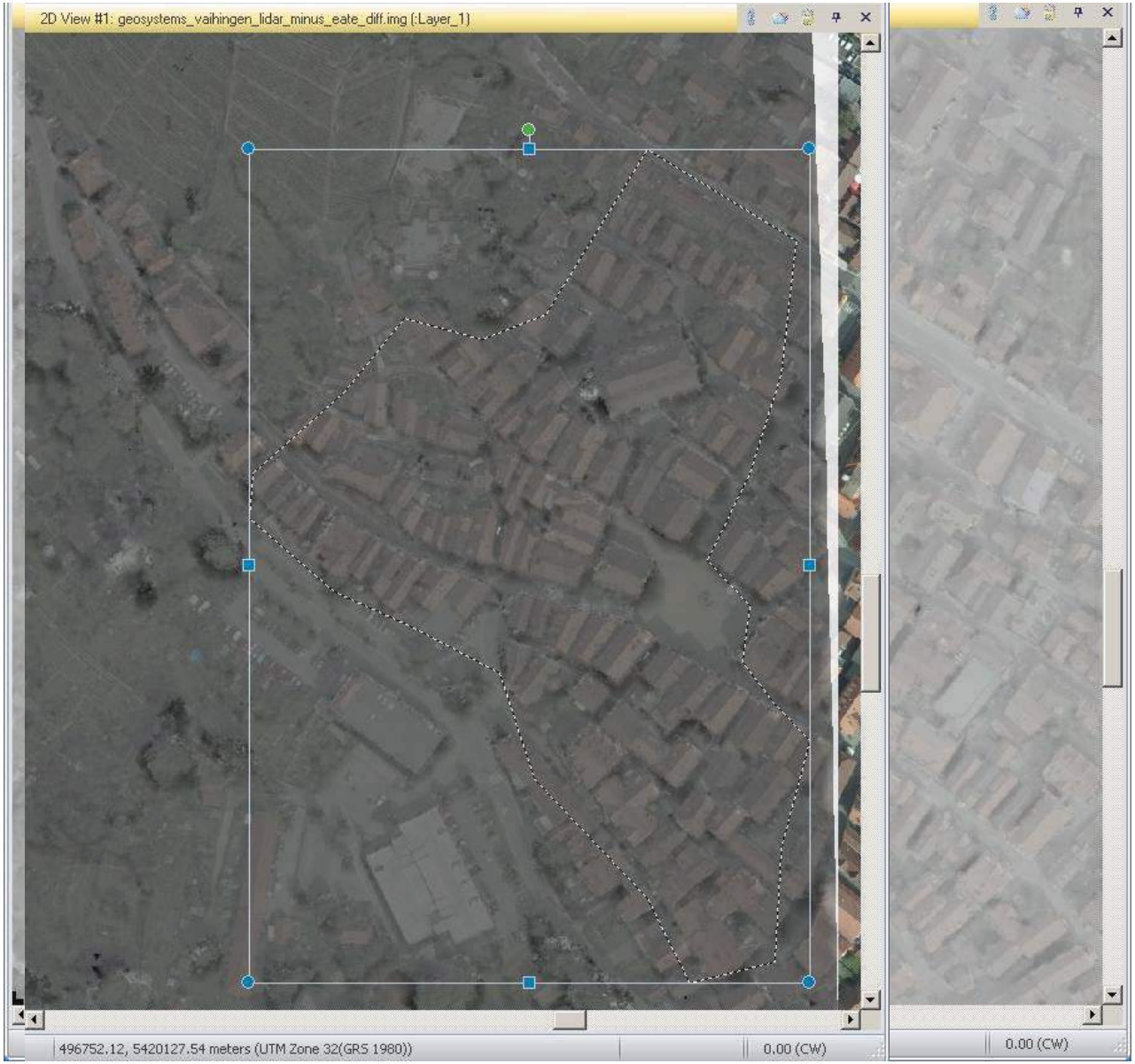
- Automatic creation of a LPS Blockfile from Inpho projectfile
- Automatic creation of an eATE project from the LPS Blockfile
- Manual adjustment of strategy parameters
- Automatic creation of merged LAS and interpolated grid DSM

DSM Analysis Vaihingen

- SGM and eATE DSM

DSM Analysis Vaihingen

- SGM and eATE DSM Reference Differences



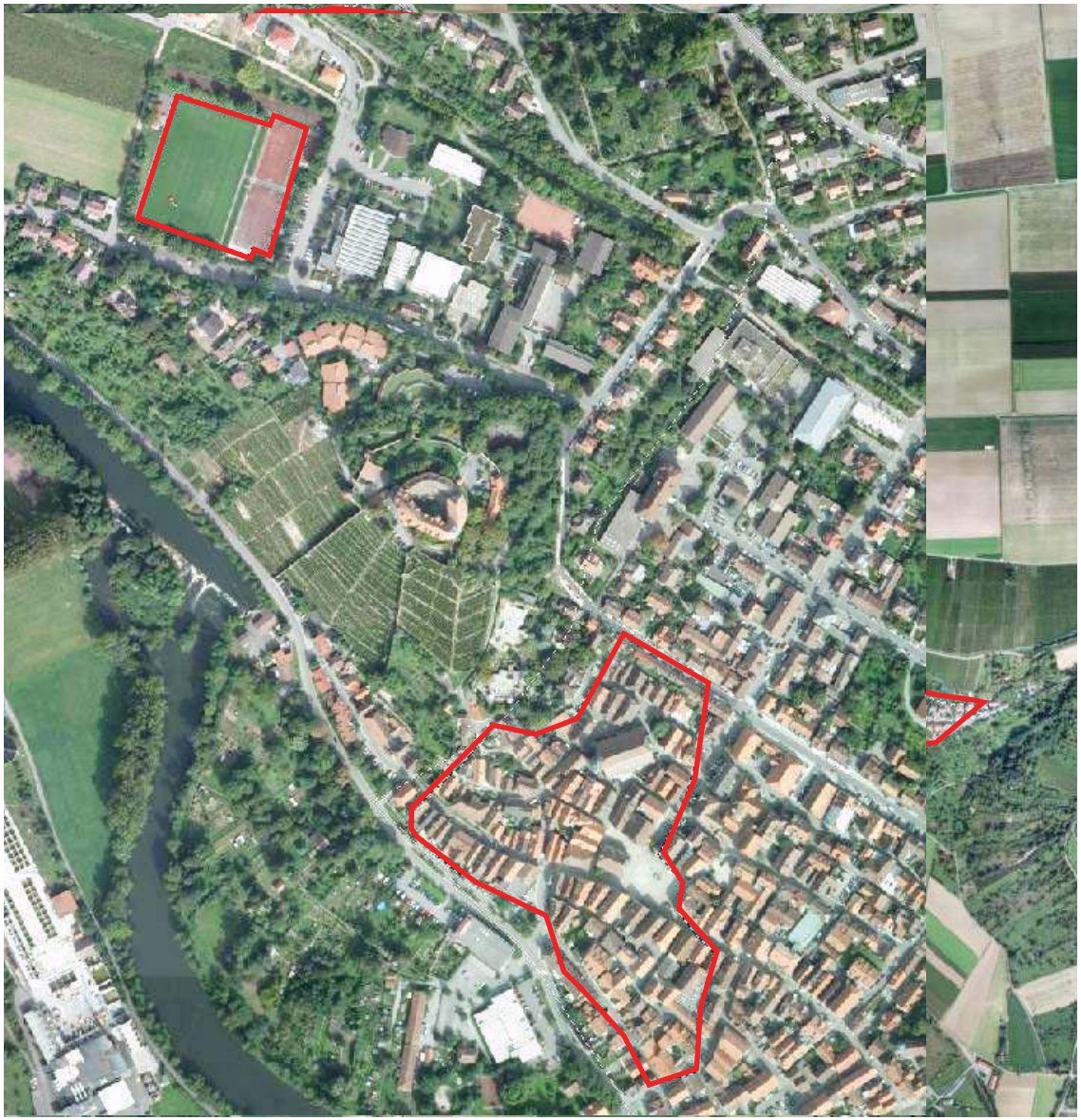
DSM Analysis Vaihingen

- Reference Areas

  AOI sport area, 0.9 ha

  AOI buildup area, 3.5 ha

  AOI buildup area, 2 km²



DSM Analysis Vaihingen

- Difference 0.2 m LiDAR DSM minus SGM DSM
  - AOI sport area, 0.9 ha, mean difference -0.087 m, Std.Dev. 0.20 m
  - AOI buildup area, 3.5 ha, mean difference -0.81 m, Std.Dev. 1.9 m
  - AOI buildup area, 2 km², mean difference -0.52 m, Std.Dev. 26.8 m

- Difference 0.2 m LiDAR DSM minus eATE DSM
  - AOI sport area, 0.9 ha, mean difference 0.060 m, Std.Dev. 0.30 m
  - AOI buildup area, 3.5 ha, mean difference -0.82 m, Std.Dev. 2.6 m

Vielen Dank für Ihre Aufmerksamkeit!

Forest Mapping Management Ges.m.b.H.
CEO Wiltraud & Ing. Hermann Novak

EuroSDR - project

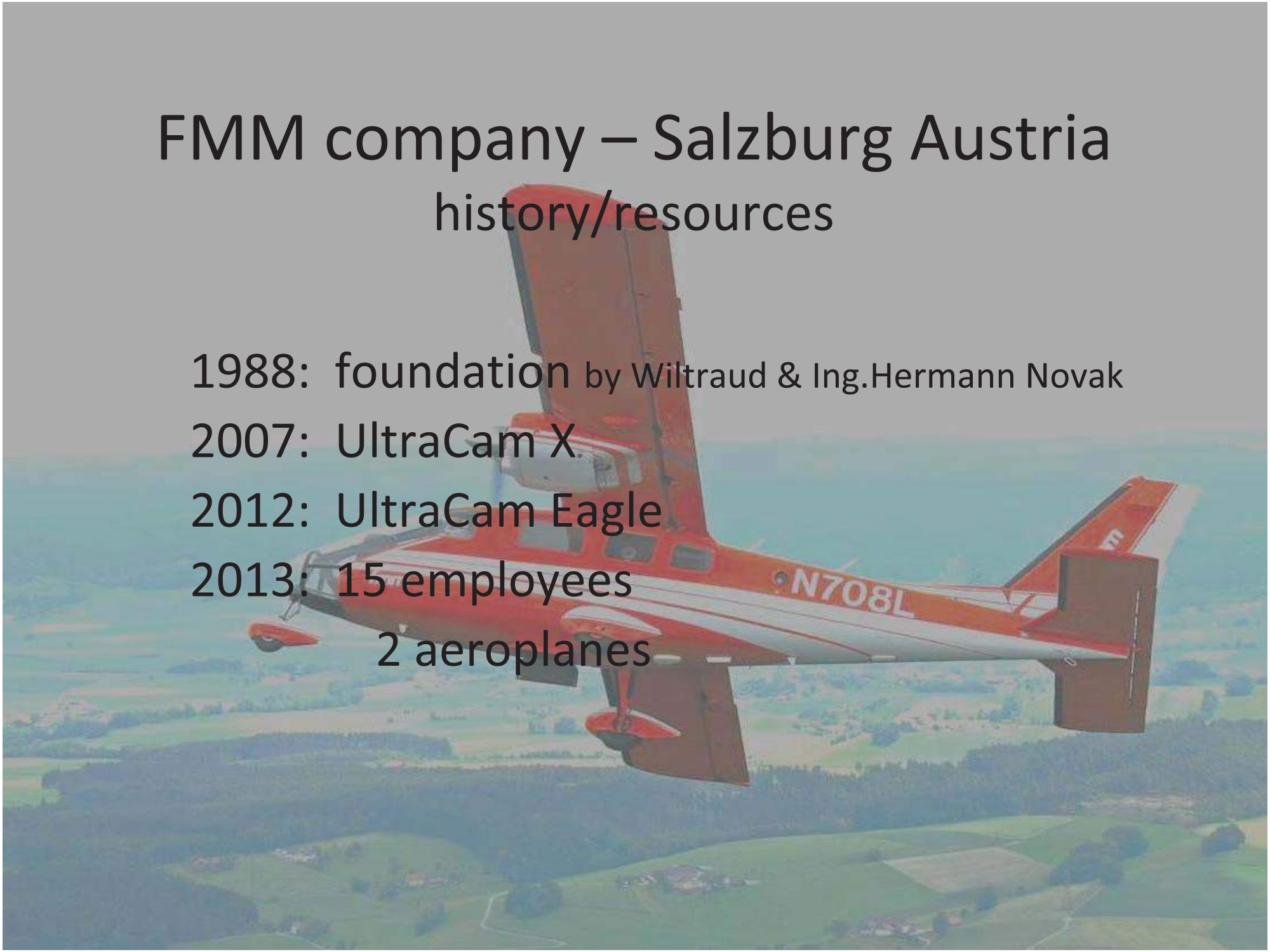
Benchmark on Image Matching

13th/14th of June 2013

DI Bernhard Brunner

FMM company – Salzburg Austria

history/resources



1988: foundation by Wiltraud & Ing.Hermann Novak

2007: UltraCam X

2012: UltraCam Eagle

2013: 15 employees

2 aeroplanes

FMM company – Salzburg Austria

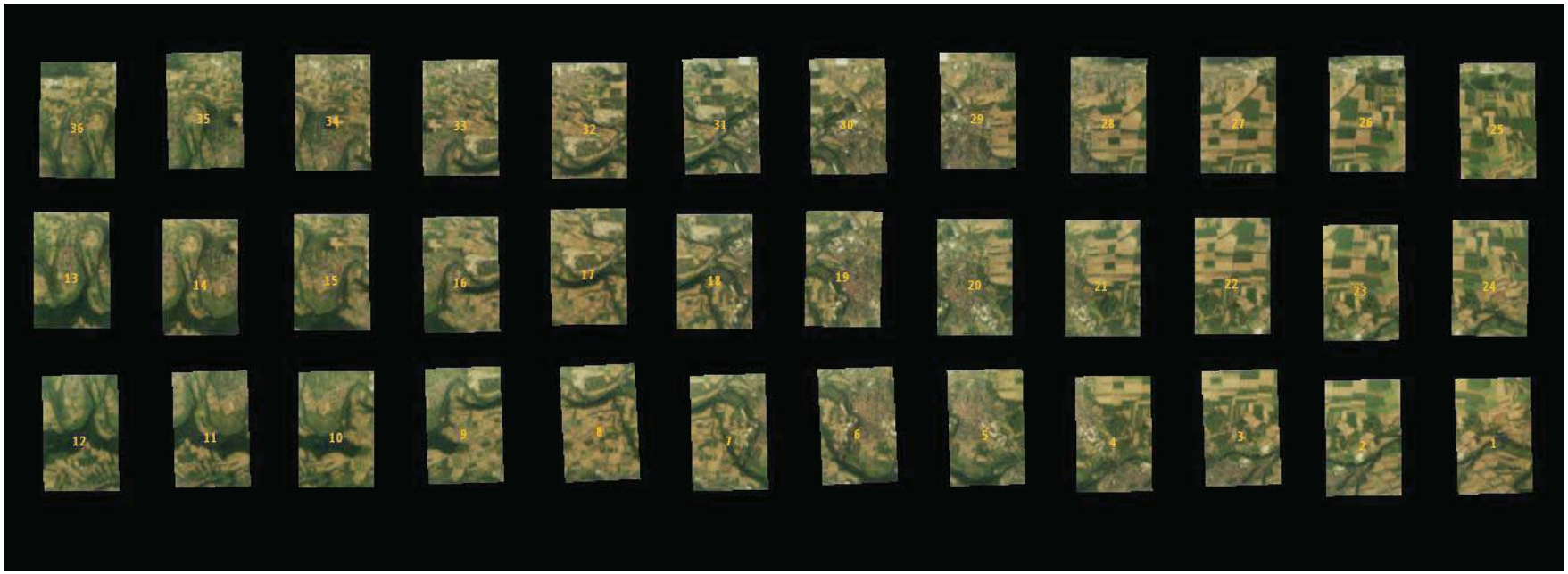
services

- forestry management
- photoflights for official and private customers
- airborne laser scanning
- true ortho and dsm production
- fleet management

Vaihingen/Enz – test area

Test-dataset : 36 UCX – images (GSD 20cm)

flight height about 2800 m AGL



UCX: 9420*14430/ f=100.5mm
/pix=7.2µm

Software and workflow

Microsoft UltraMap V3.1 with Modules:

0) „Lvl02“-data required

1)UltraMap AT

valid calibration files

here: ready made eo-data

tiepoint matching

bundle-adjustment with BINGO

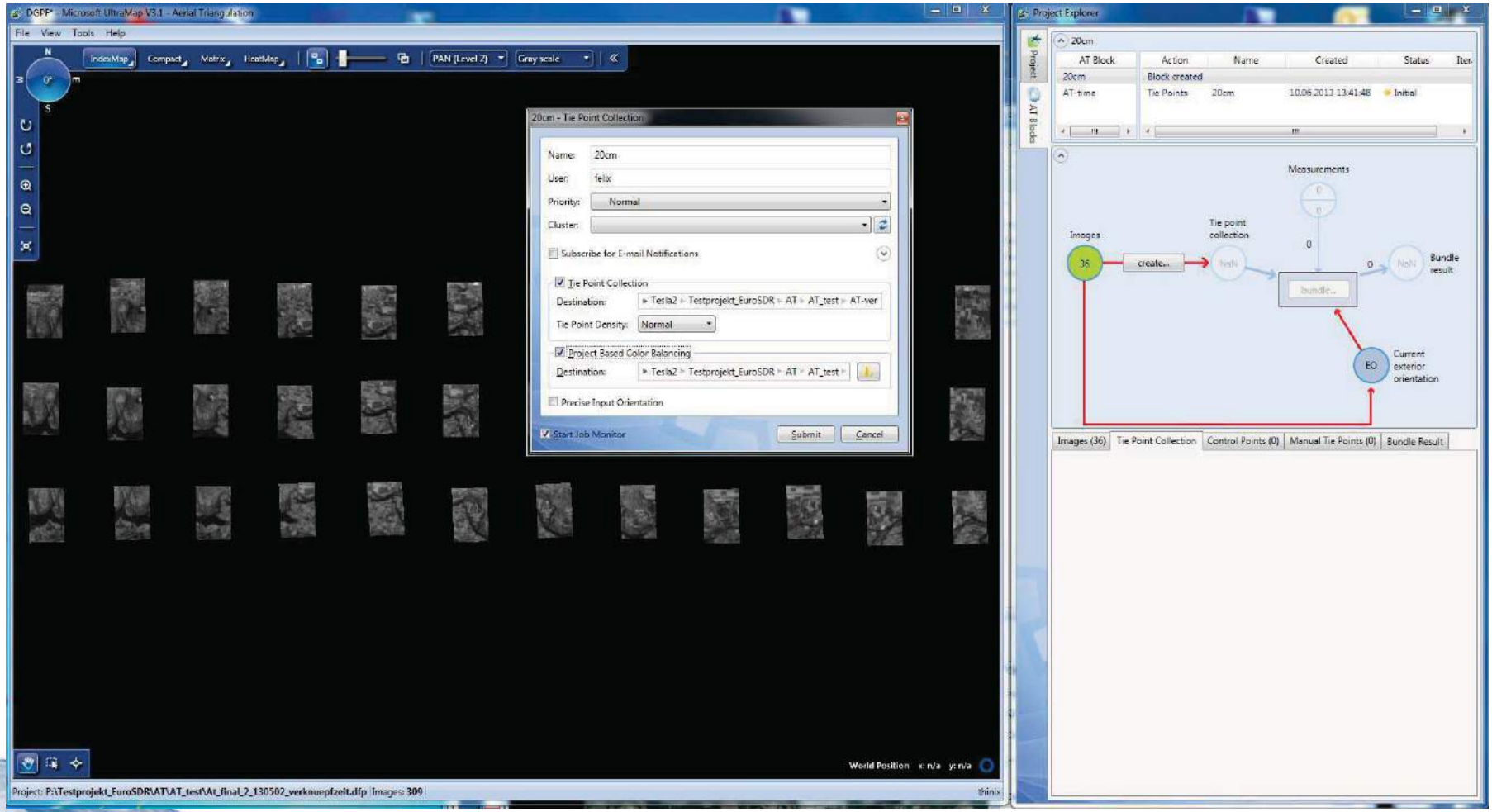
2) UltraMap Radiometry

color adjustment (especially for DOP)

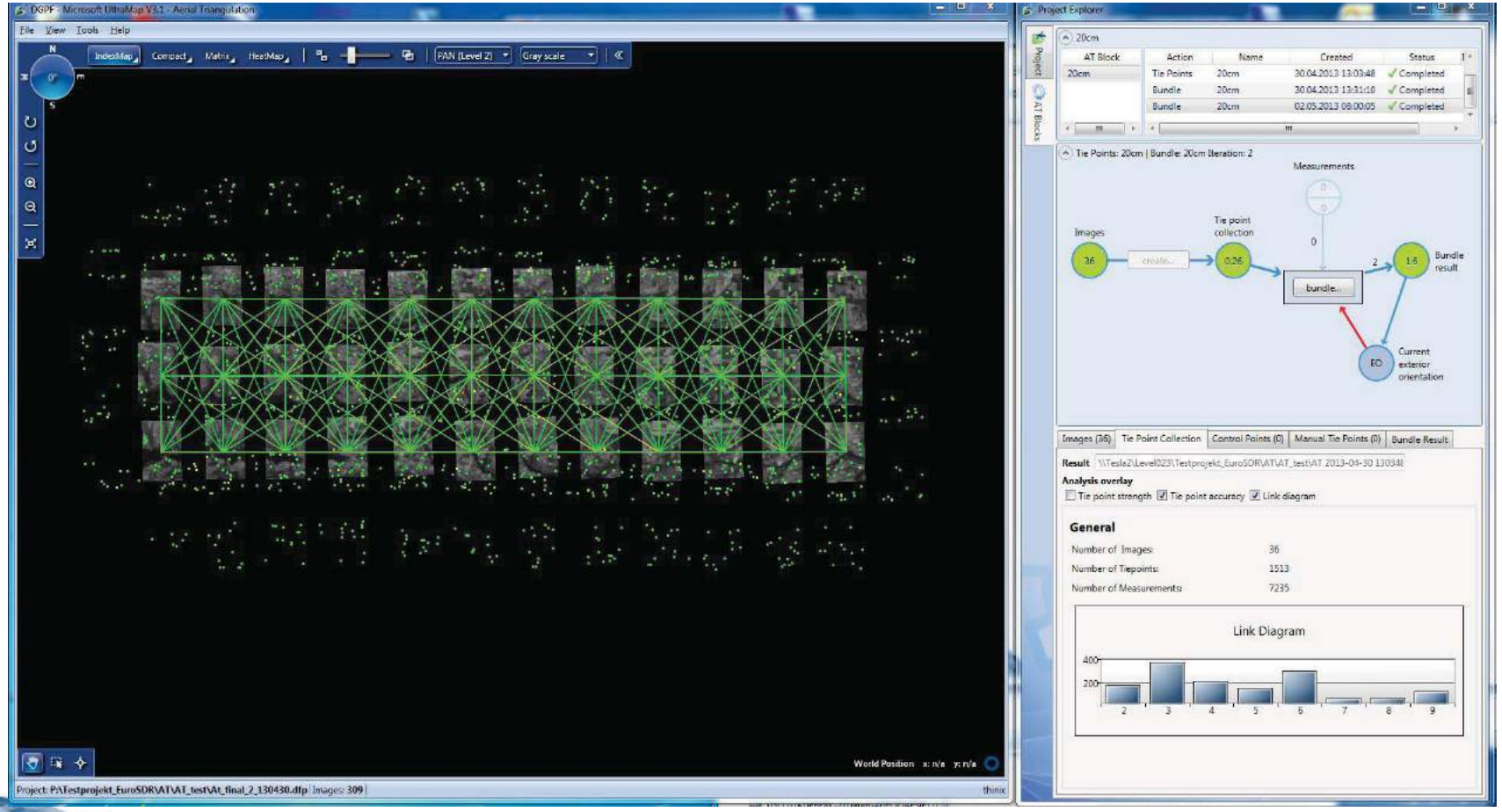
3) UltraMap OP

DSM and Ortho-production with AT and colouradj.

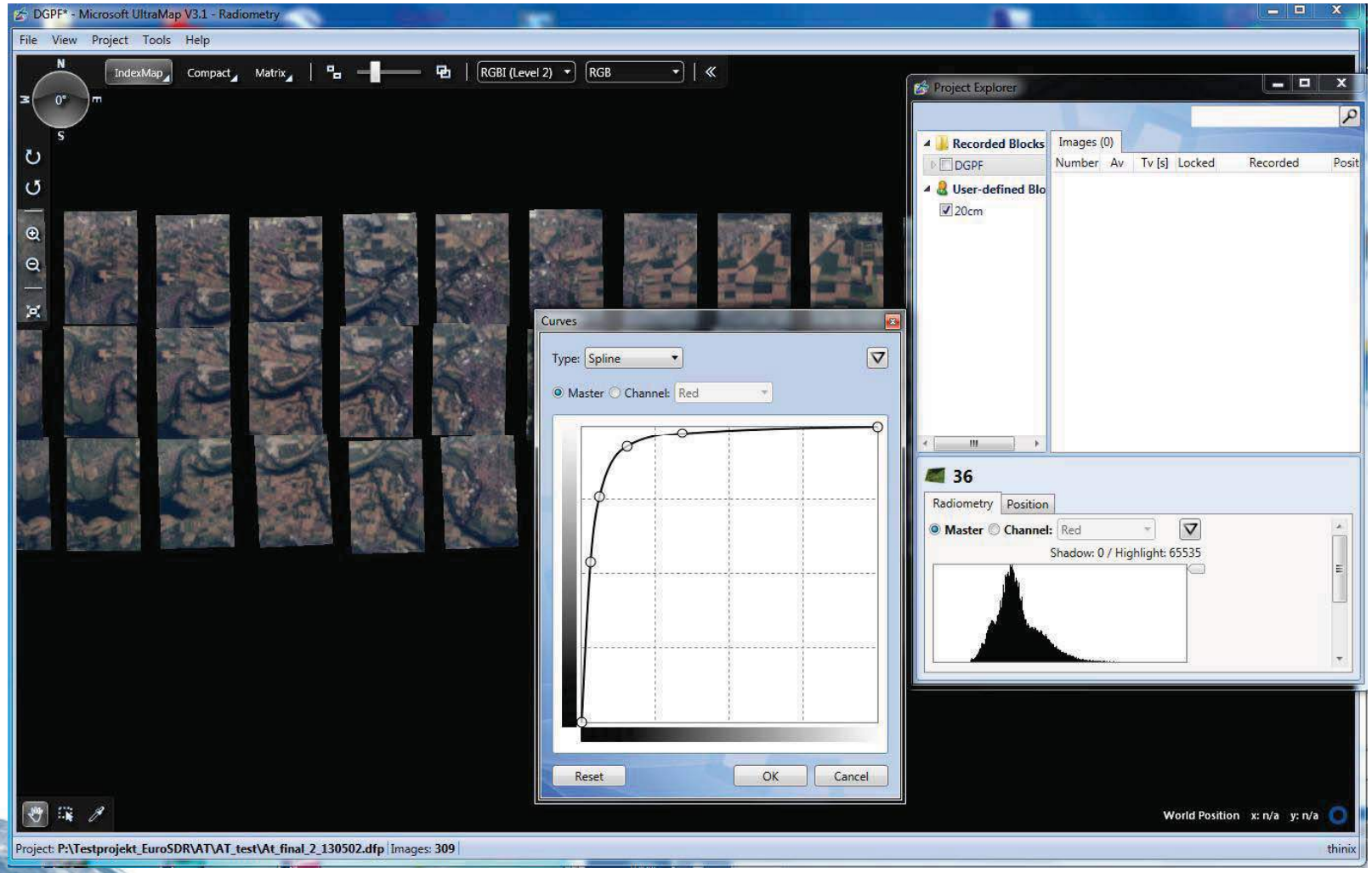
1) UltraMap AT – tiepoint collection



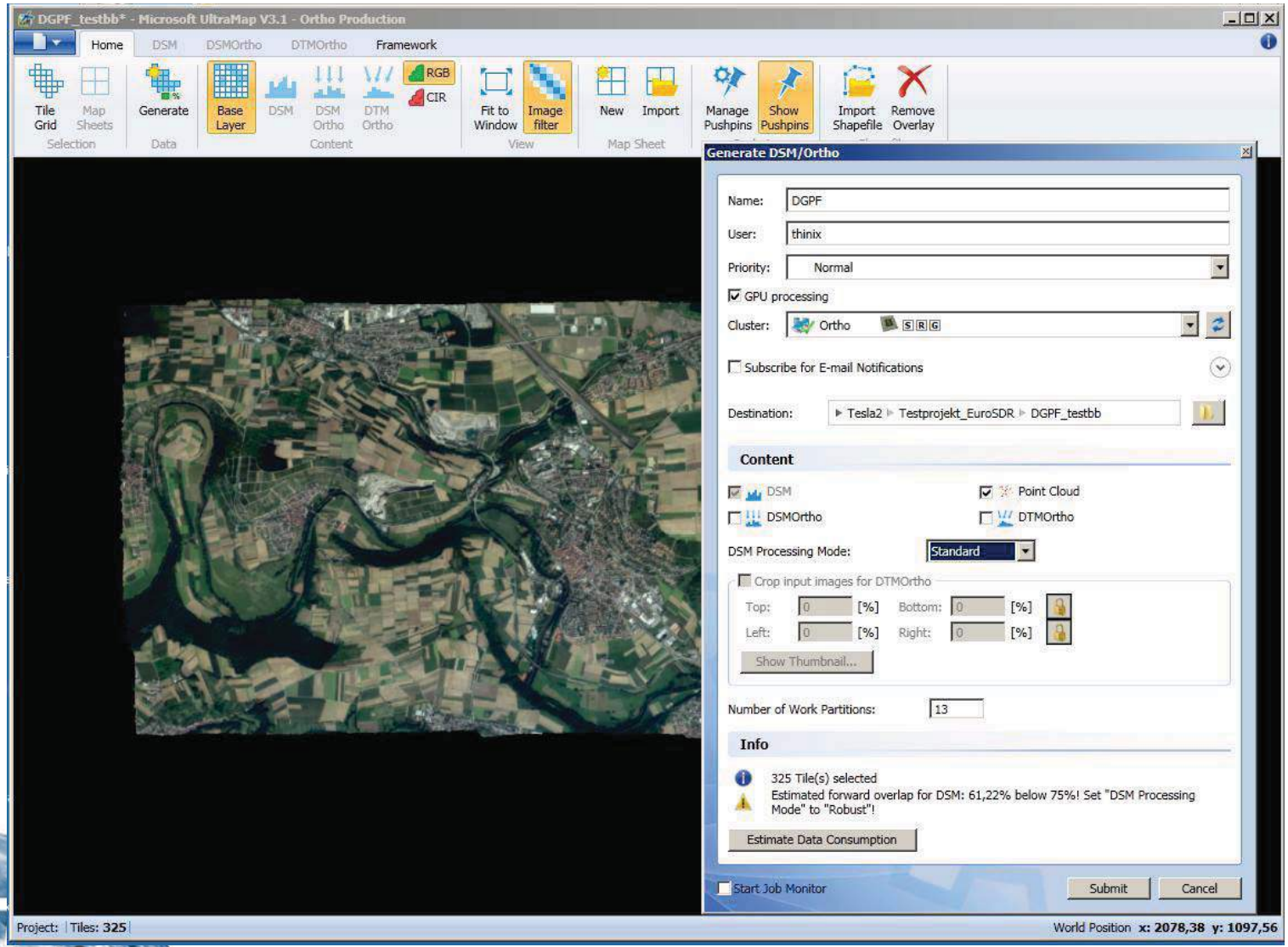
1) UltraMap AT – bundle adjustment



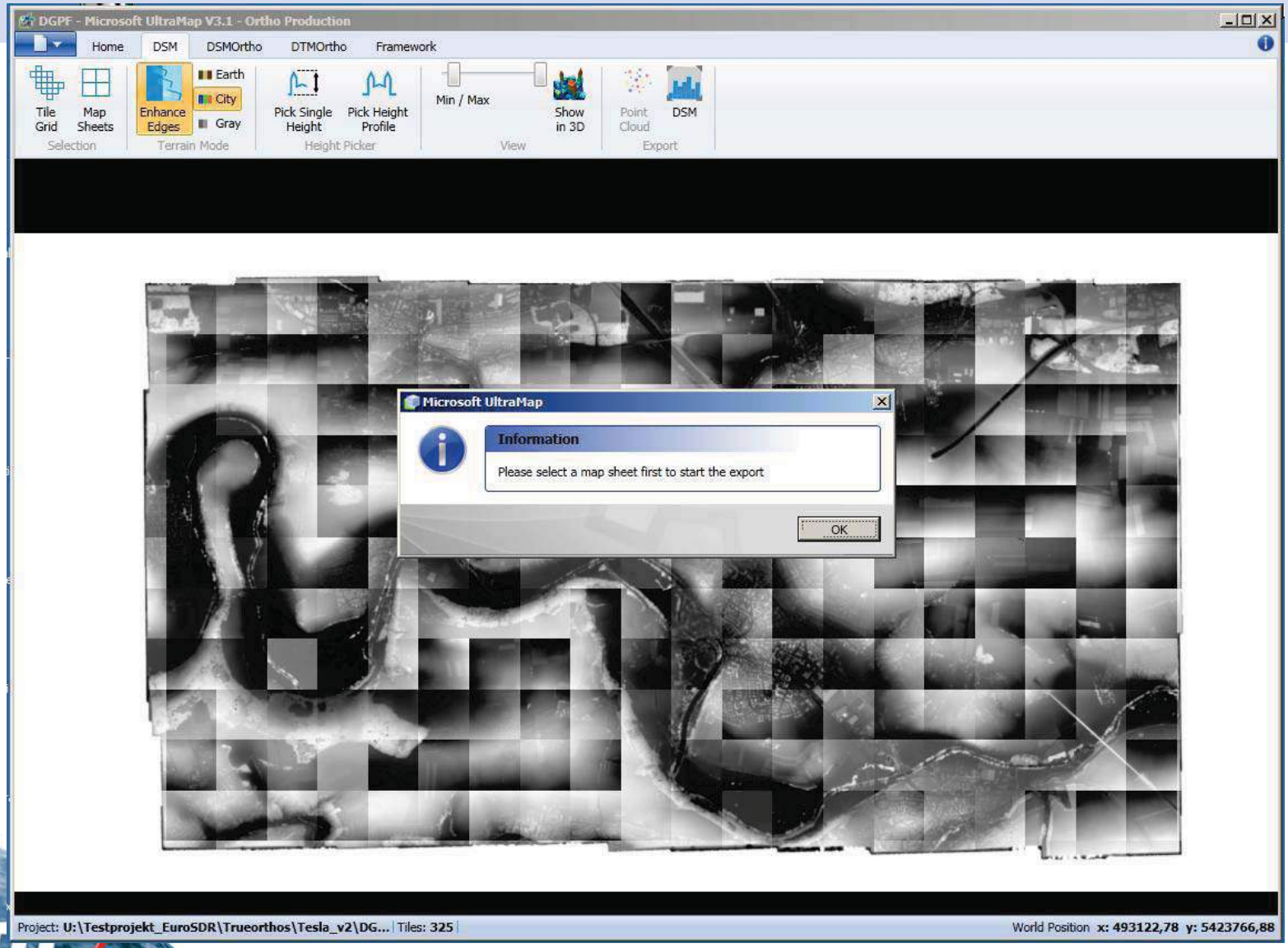
2) UltraMap Radiometry



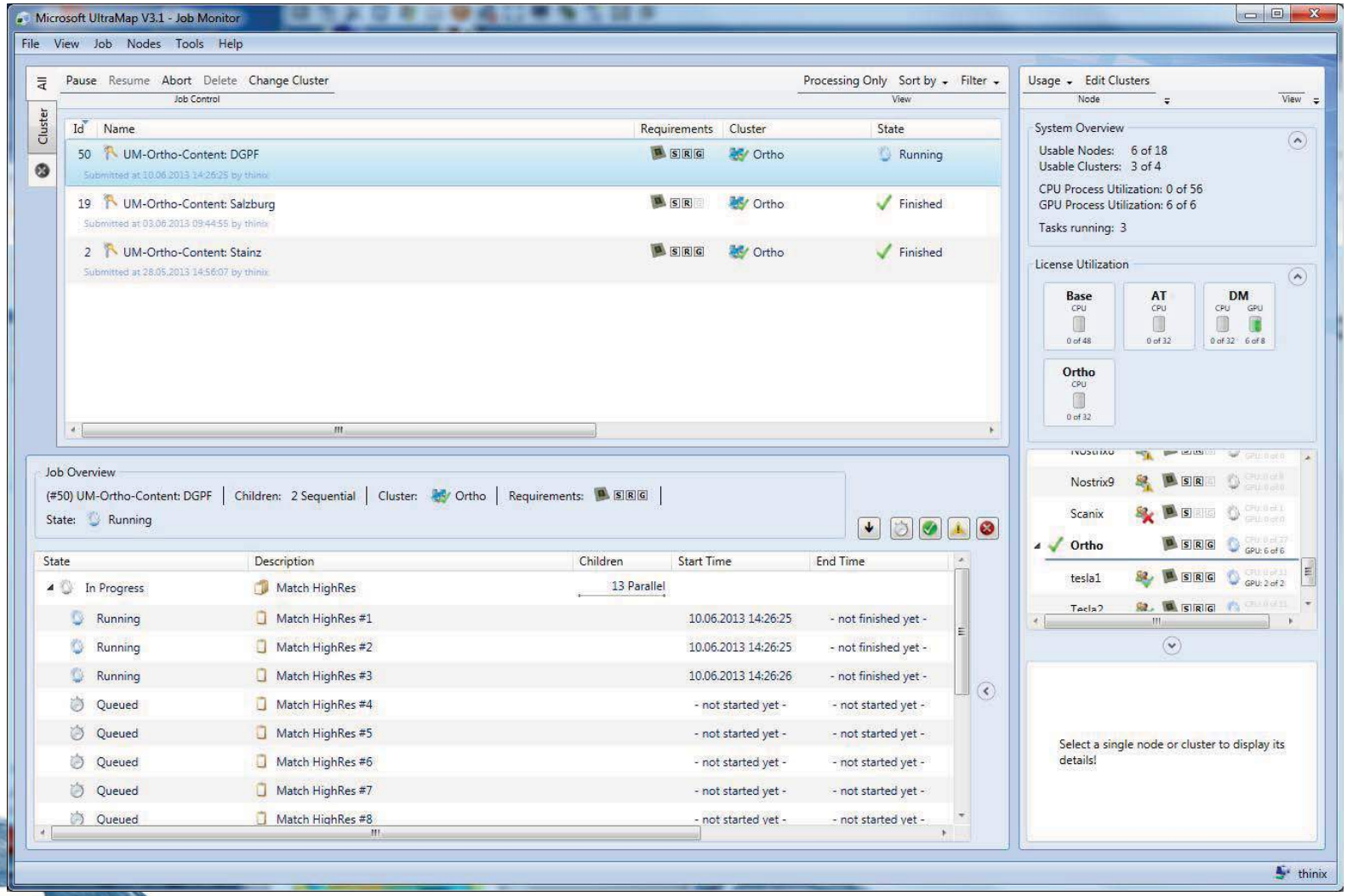
3) UltraMap OP – dsm production



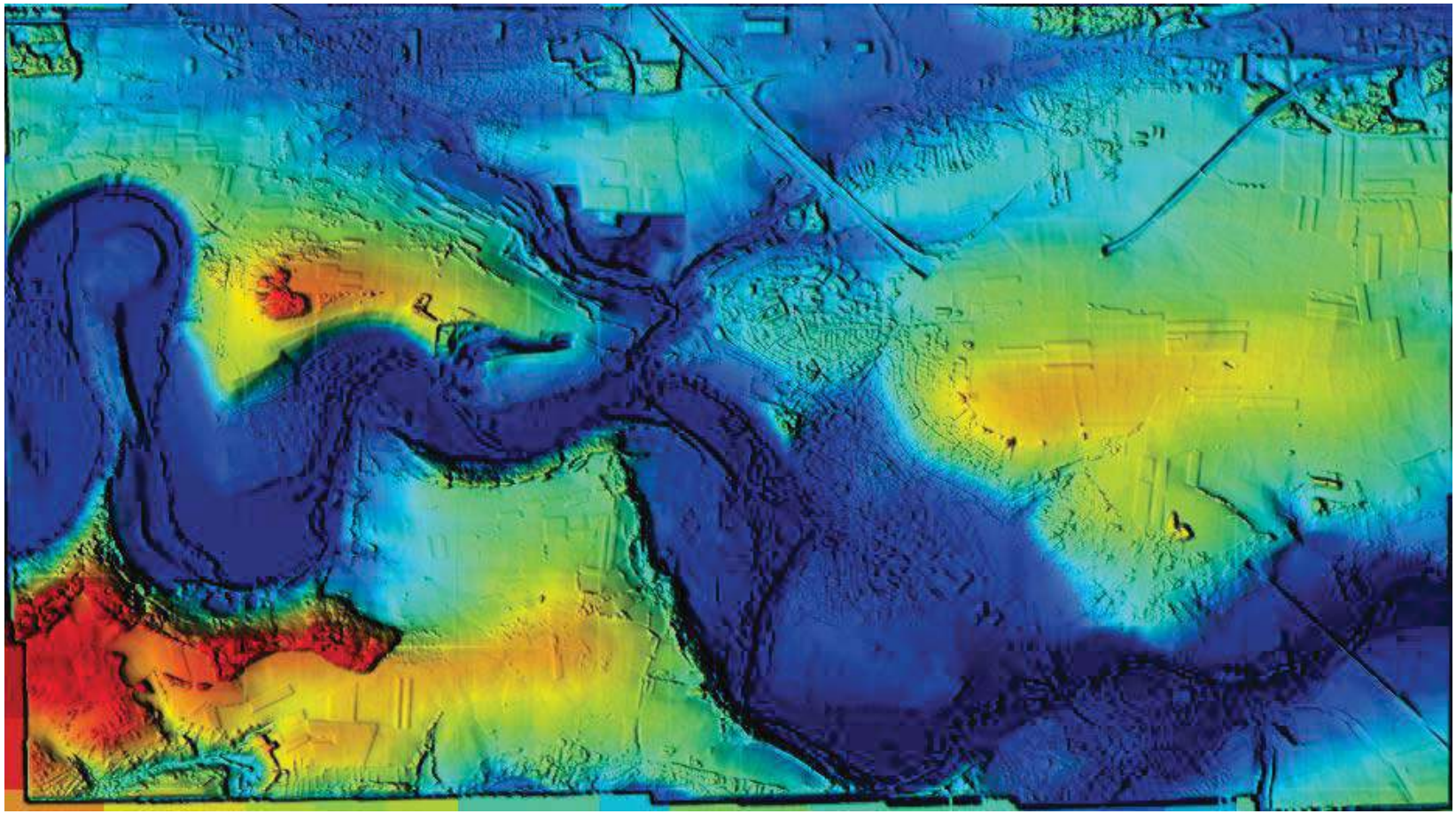
3) UltraMap OP - export



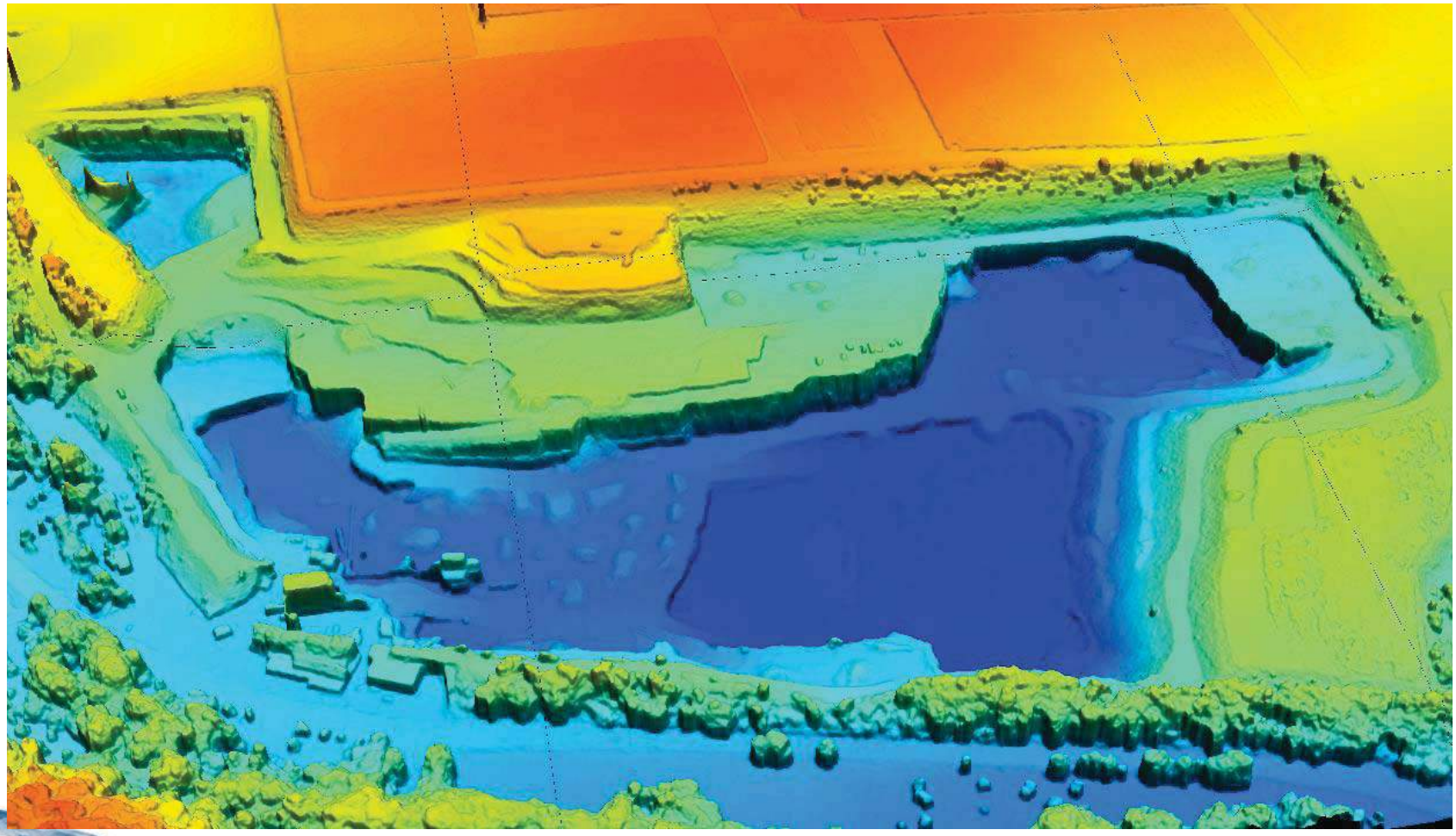
UltraMap – distributed processing



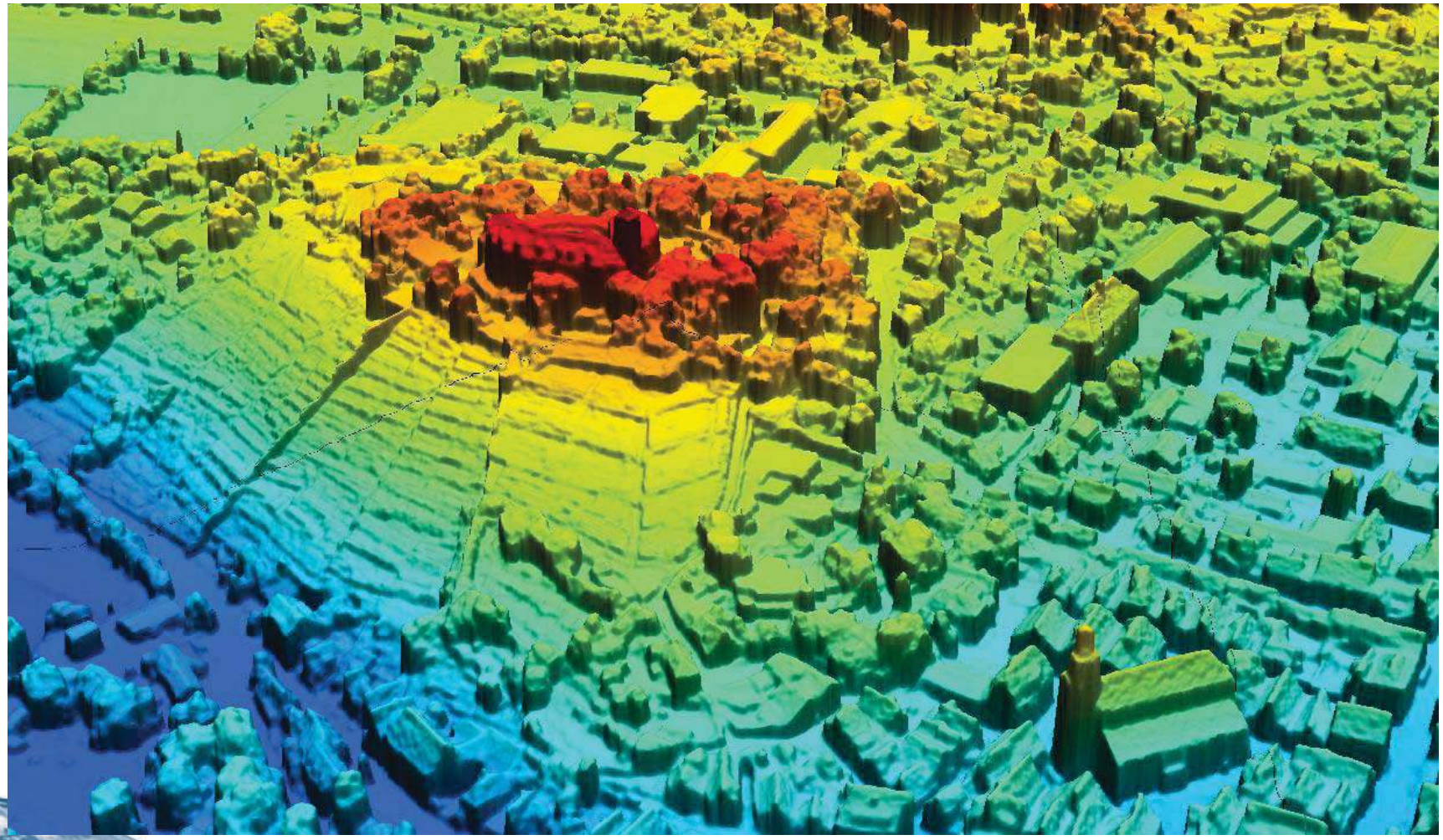
Resulting DSM (8km*4.5km)



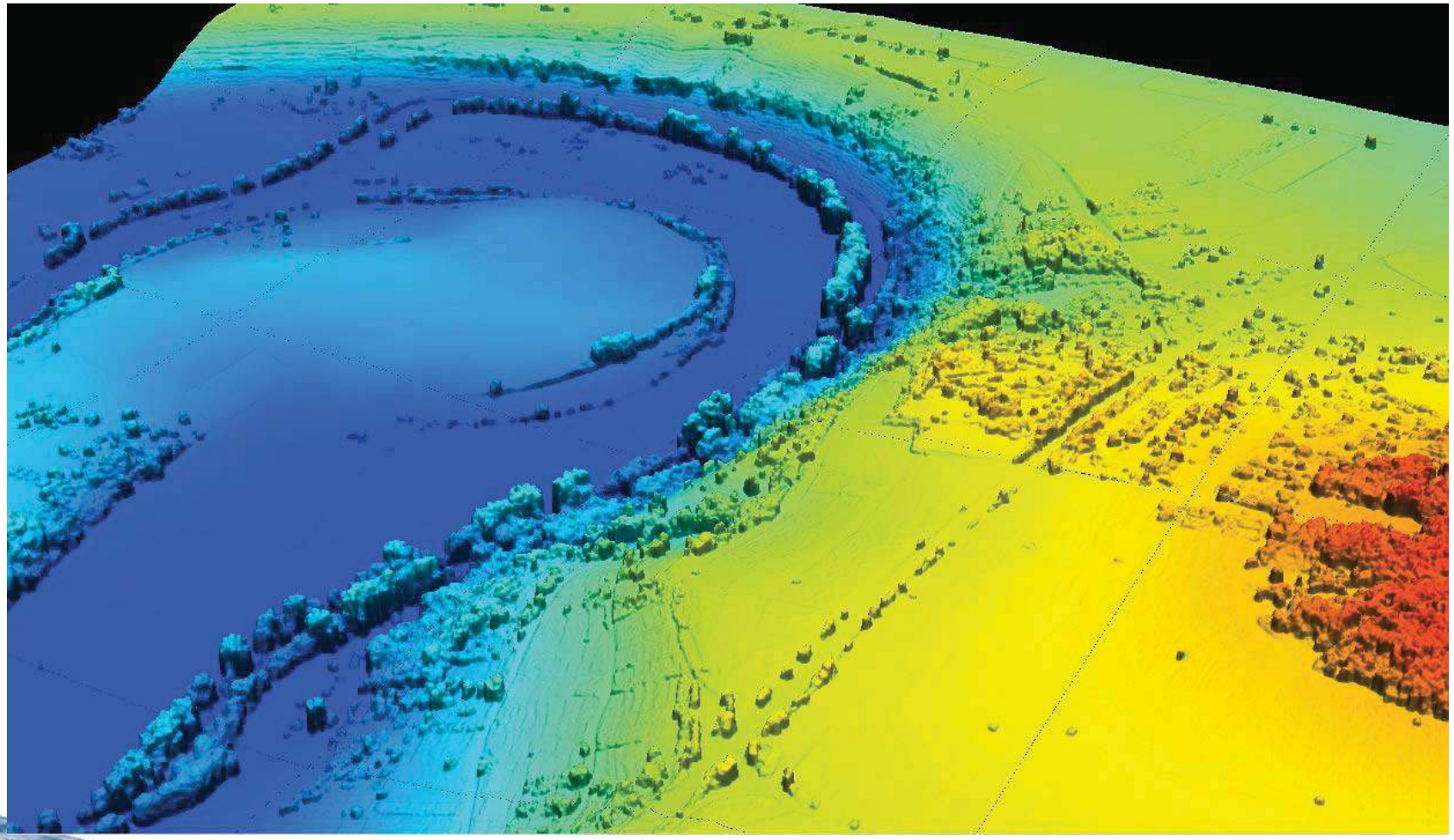
DSM-Example: quarry



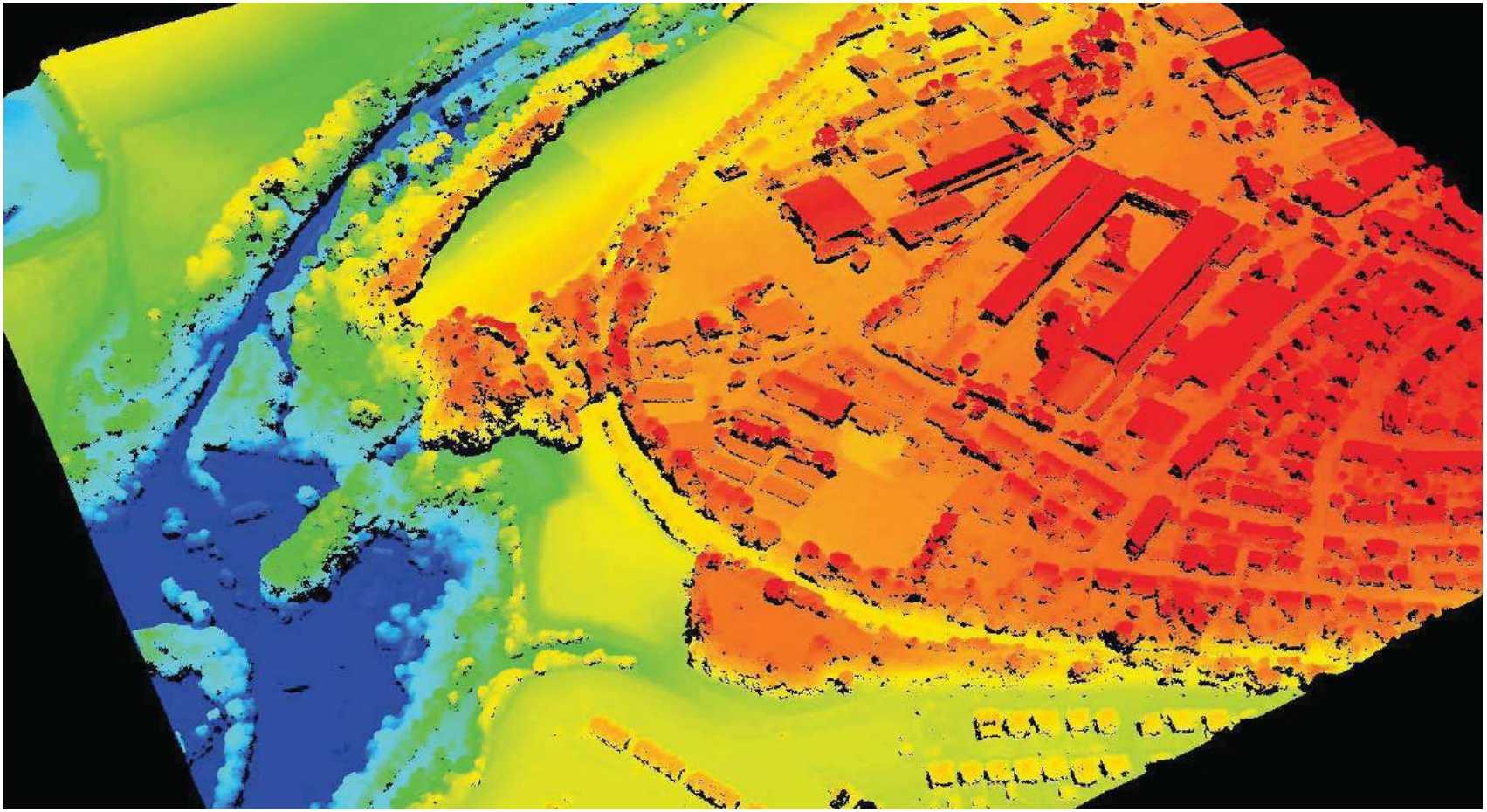
DSM-Example: part of city



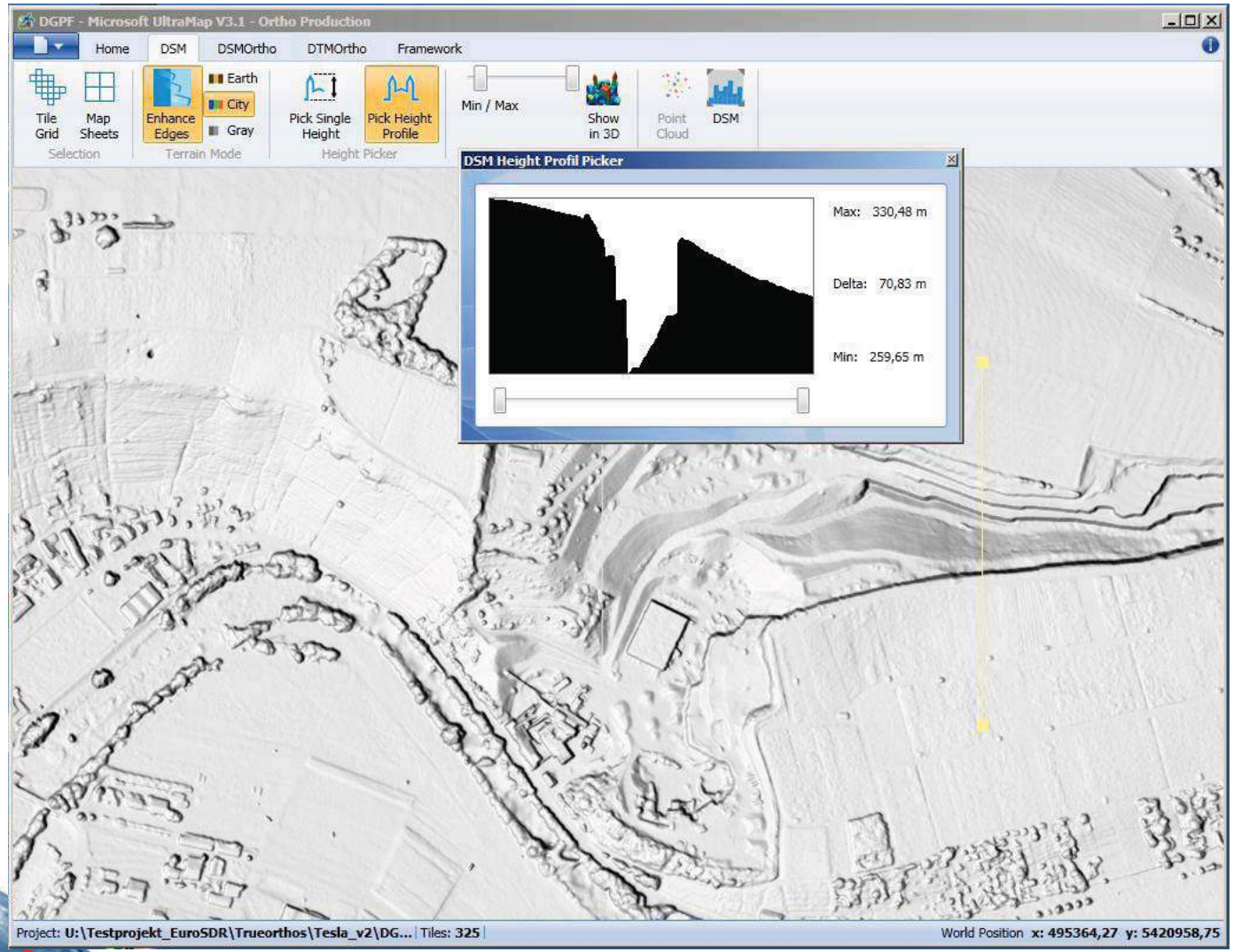
DSM-Example: hills & river



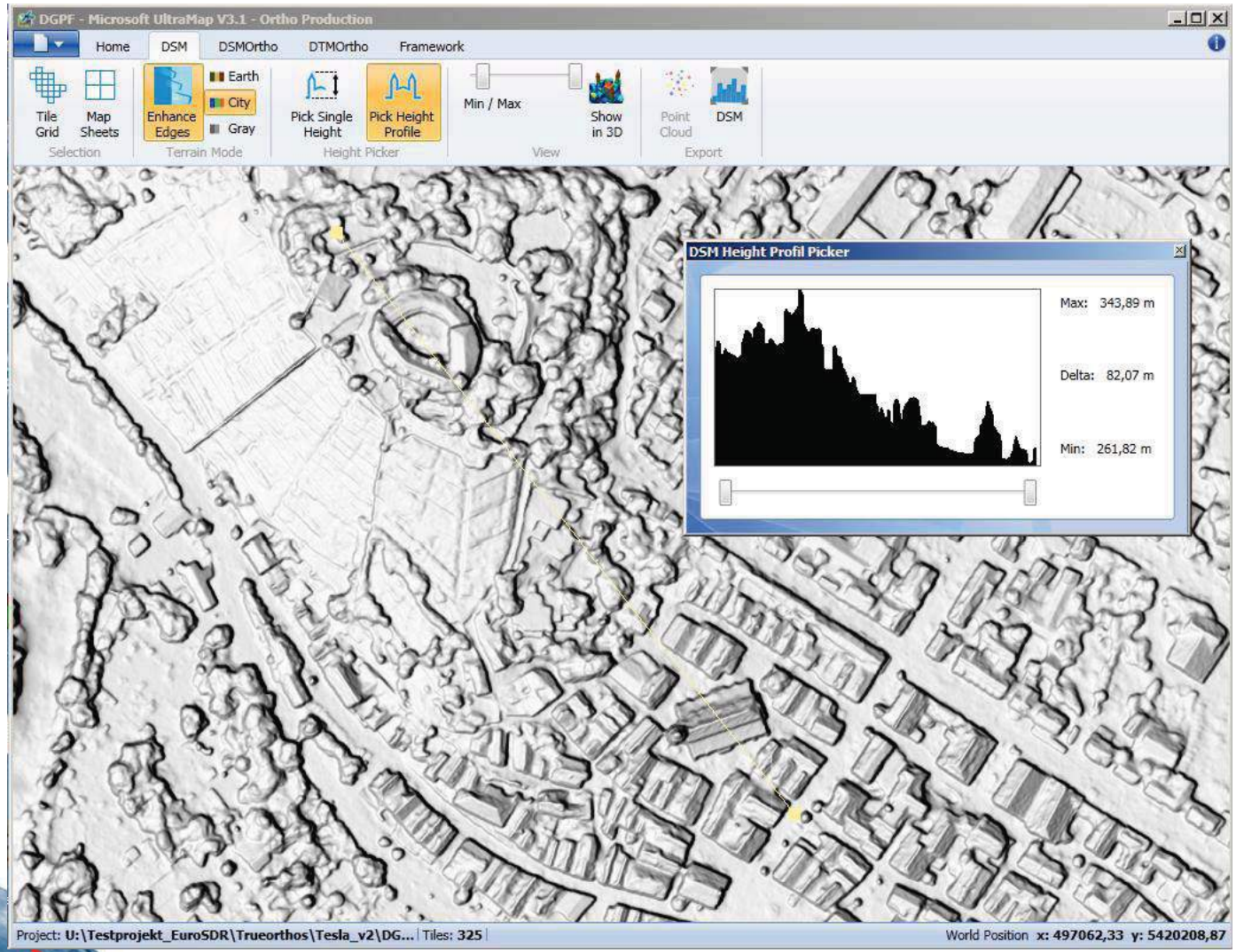
Point cloud-example



Profile –example 1



Profile –example 2



DSM-matching method

1) Range-image computation using image pairs
   (Image based correlation methods are used)

2) Range-image fusion with optimization

3) Representation as 2.5D(DSM) or 3D (point-cloud)

Processing – time for 36 images

Data-ingest …. About 35 min copying lvl02 images to server
(from lvl00: copying 1min from rec
processing lvl02 10min)

AT (tiepoints) … 13 min
AT (bundle) … 1 min (but several iterations)

DSM … 27 min (Tesla)
Output (DSM or pointcloud) … 2 min

(DSM-Ortho … 34 min)

IT environment / computer system

32 Xeon E5-2630/i7 cores - 2,3 GHz

64 Gbyte RAM (DDR3 DIMM 1600MHz) each workstation/server

5 GPU`s (1 Tesla K10, 4 Tesla M2090)

IT environment / storage system

RAID – System (SAS Mega-Raid Controller)

Speed: 7200 RPM

Size: 104 TB

IT environment / network

LAN - Network

Transfer speed : 1 Gb

Competence of operator

Flight design – overlap (ideal 80% / 70%)

Quality of aerial images (free of shadows/clouds..)

Quality of AT

Problems

Many parallel processes -> overload of network (sometimes)

Crash of coordinator -> complete reprocessing of projects

Errors in DSM -> no editing possible at the moment

Summary

Complete workflow with UtraMap (acquisition of images -> DSM)

Scaleable system (licenses / hardware)

Highly automated workflow (important block design/overlap)

Very detailed and accurate DSM (about GSD)

Sometimes problems with missmatches (lakes/rivers)

EuroSDR project

Benchmark on Image Matching

Christian Ginzler

Swiss Federal Institute for
Forest, Snow and Landscape Research
CH-8903 Birmensdorf

EuroSDR

WSL

Who we are:

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs FDHA

ETH-Domain

Federal Institutes of Technology and Research Institutes

Strategic management: ETH Board

EPF Lausanne

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

ETH Zürich

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

EMPA
Materials Science & Technology

eawag
aquatic research

PAUL SCHERRER INSTITUT
PSI

WSL

EuroSDR

WSL

What we do:





- Landscape research
- Forest ecology and forest management
- Natural hazards and integral risk management
- Snow, ice, avalanches and permafrost

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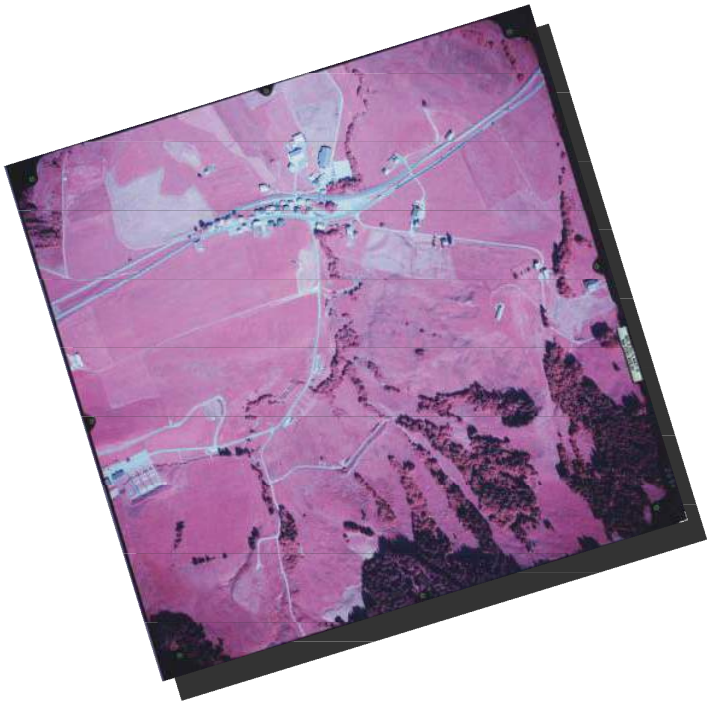
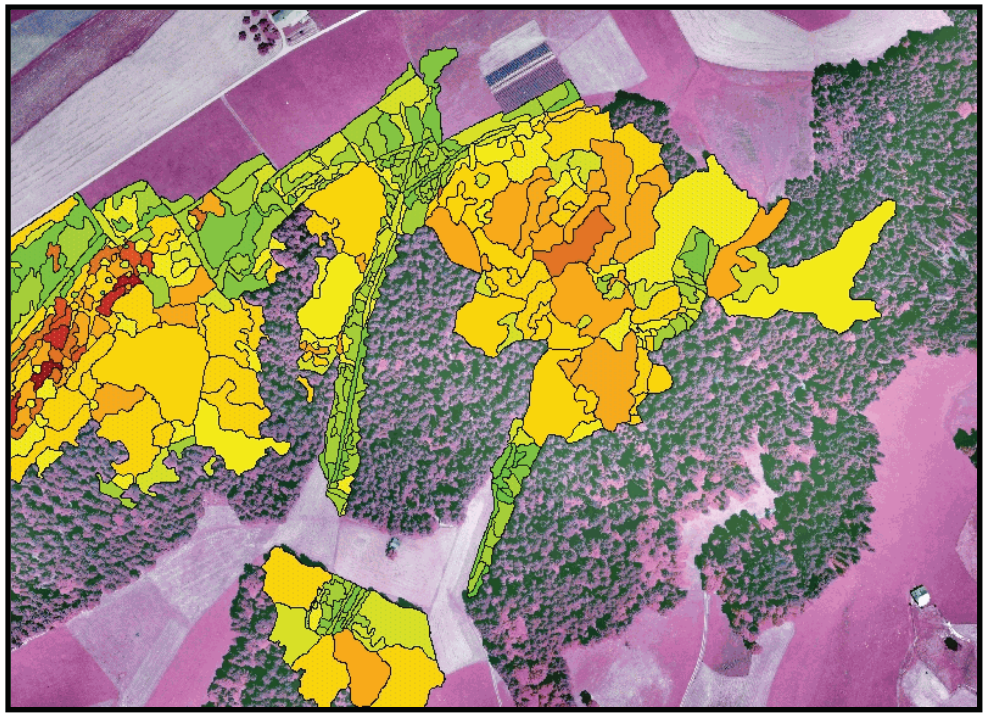
Remote Sensing Group

Image matching since ~1995: e.g. Wetland monitoring

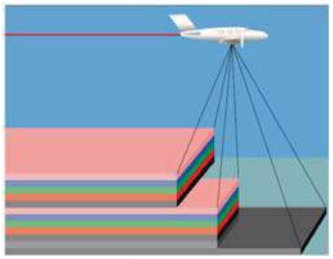




Scanned RC30 images

ADS80 from swisstopo

Since 2008: Countrywide image matching



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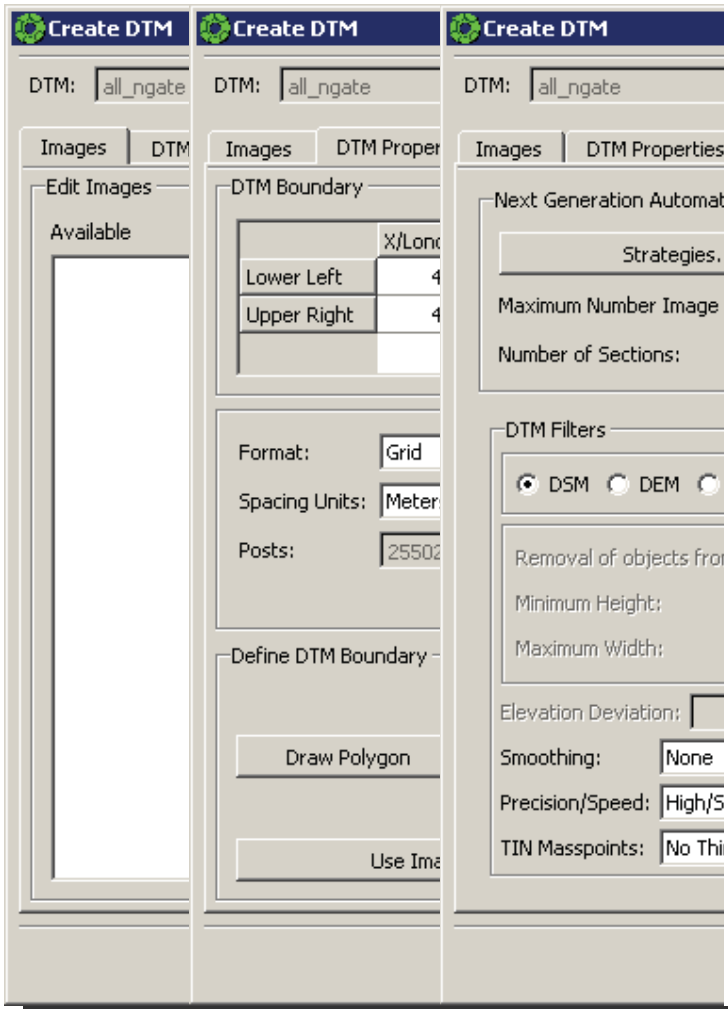
IT Environment for the matching:

Intel Xeon CPU X5570	2.93 GHz
Memory:	24 GB
Used CPUs:	1
HD:	Samsung SSD
Harddisk:	HP Blades BL465 MSA2012i (7'200)
Network:	10 Gb / 1 Gb
Software:	SocetSet 5.6 (BAE Systems)

SocetSet 5.6 (NGATE):




```
-#  5.  Signal power cutoff value.
-#      In desert areas, this value should be small from 2
-#      In other areas, the suggested values are from 3 to
-#      still points on water bodies, you need to increase
-#      If your image is of high radiometric quality, you c
-#      If your image is noisy, you should use larger value
-#
-#  6.  Large signal power cutoff value.
-#  7.  Image correlation back matching cutoff value.
-#  8.  Edge matching back matching cutoff value.
-#  9.  X parallax difference cutoff value.
-#         Suggested values: 0.5 - 1.0.
-#         1.0 is for extremely steep terrain or urban area
-#         and buildings.
-#         It is the ratio of the difference of x parallax
-#         the difference of samples.
-#      In other words, it is similar to the HIGH_SLOPE det
-#      uses the slope limit in degree (0-89).
-#  10. Minimum correlation coefficient difference.
-#      For noise images or images not well triangulated, w
-#      value at the last two passes. Or if there are blund
-#      this value to remove some of the blunders. Suggeste
-#         0.155 to 0.25
-#  11. Maximum percent edge value difference / 100.
-#  12. Signal power difference cutoff value.
-#  13. Second peak difference cutoff.
-#  14. Rough terrain lower FOM cutoff value.
-#  15. Invalid precision distance factor. The default valu
-#      To assign more invalid precision 32767 to posts whi
-#      you need to decrease this number.
-#
-#                 1     2     3     4     5     6      7    8    9

DOUBLE_STRAT0    0.30  0.20  0.70  0.80  10.0  54.0   3.0  3.0  1.0
DOUBLE_STRAT1    0.30  0.20  0.70  0.80  8.0   54.0   3.0  3.0  1.0
DOUBLE_STRAT2    0.30  0.20  0.70  0.80  6.0   52.0   3.0  3.0  1.0
DOUBLE_STRAT3    0.30  0.20  0.70  0.75  4.0   60.0   3.0  3.0  5.0
DOUBLE_STRAT4    0.30  0.20  0.70  0.75  3.0   68.0   3.0  3.0  10.0
DOUBLE_STRAT5    0.30  0.20  0.70  0.75  2.5   96.0   3.0  3.0  20.0
DOUBLE_STRAT6    0.30  0.20  0.70  0.75  2.0   192.0  3.0  3.0  30.0
```

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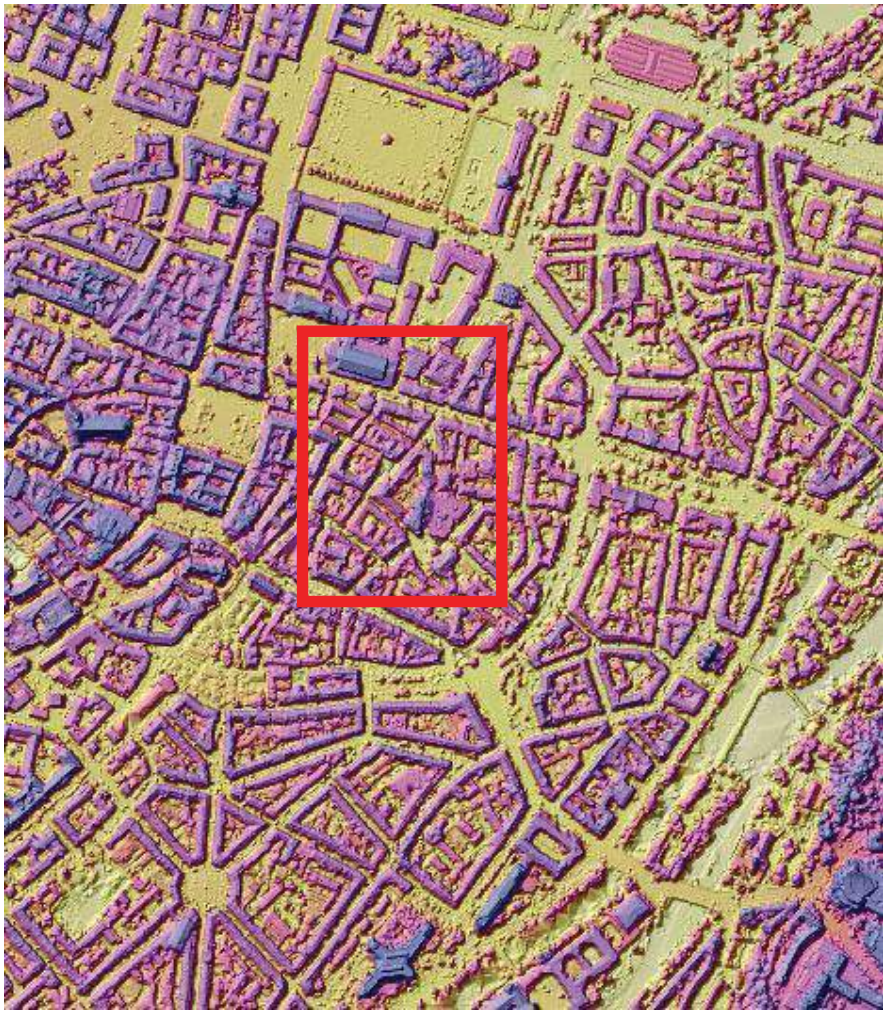
SocetSet 5.6 (NGATE): München (25h)



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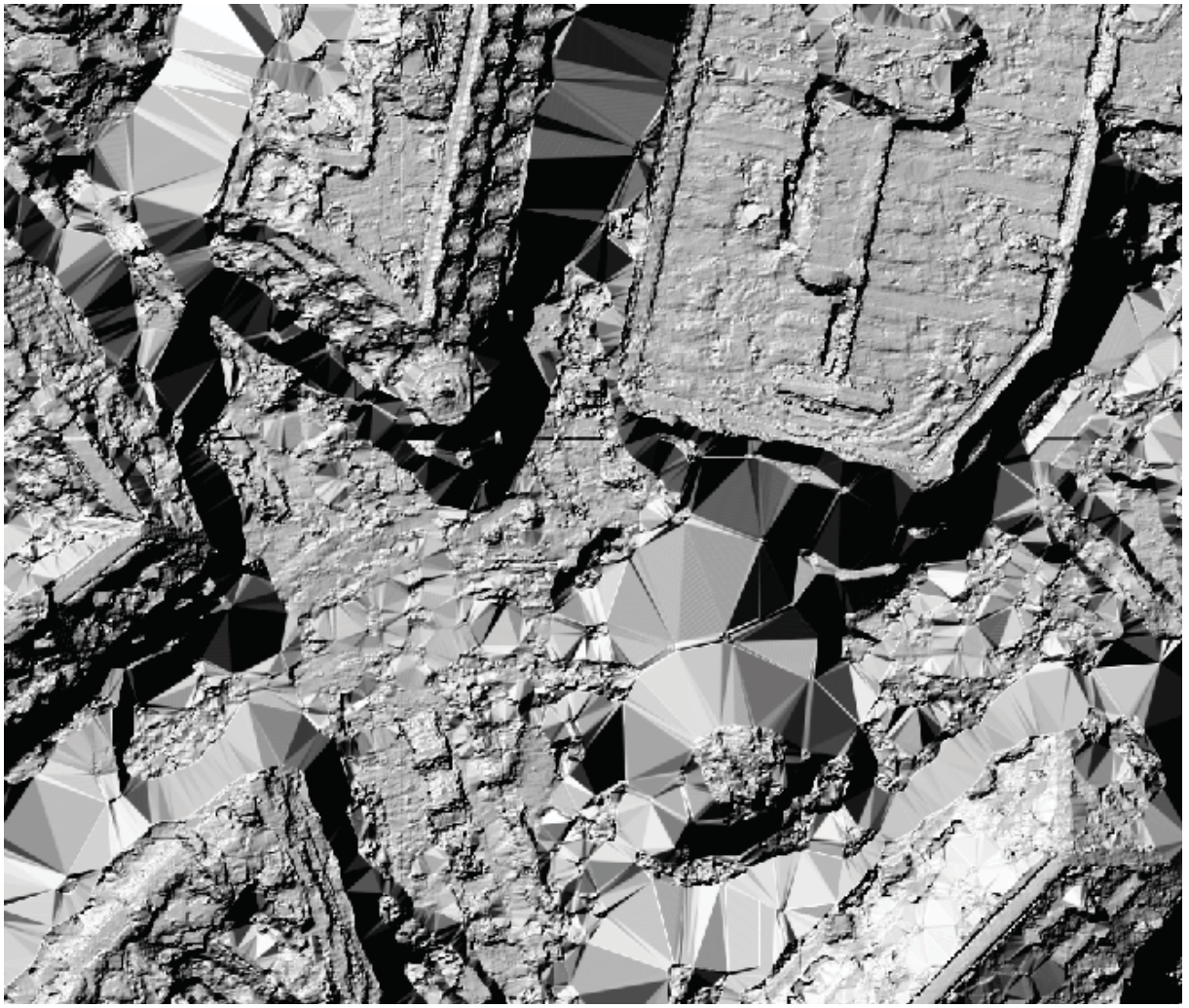
SocetSet 5.6 (NGATE): München / 1 Image pair



SocetSet 5.6 (NGATE): München / >1 Image pair

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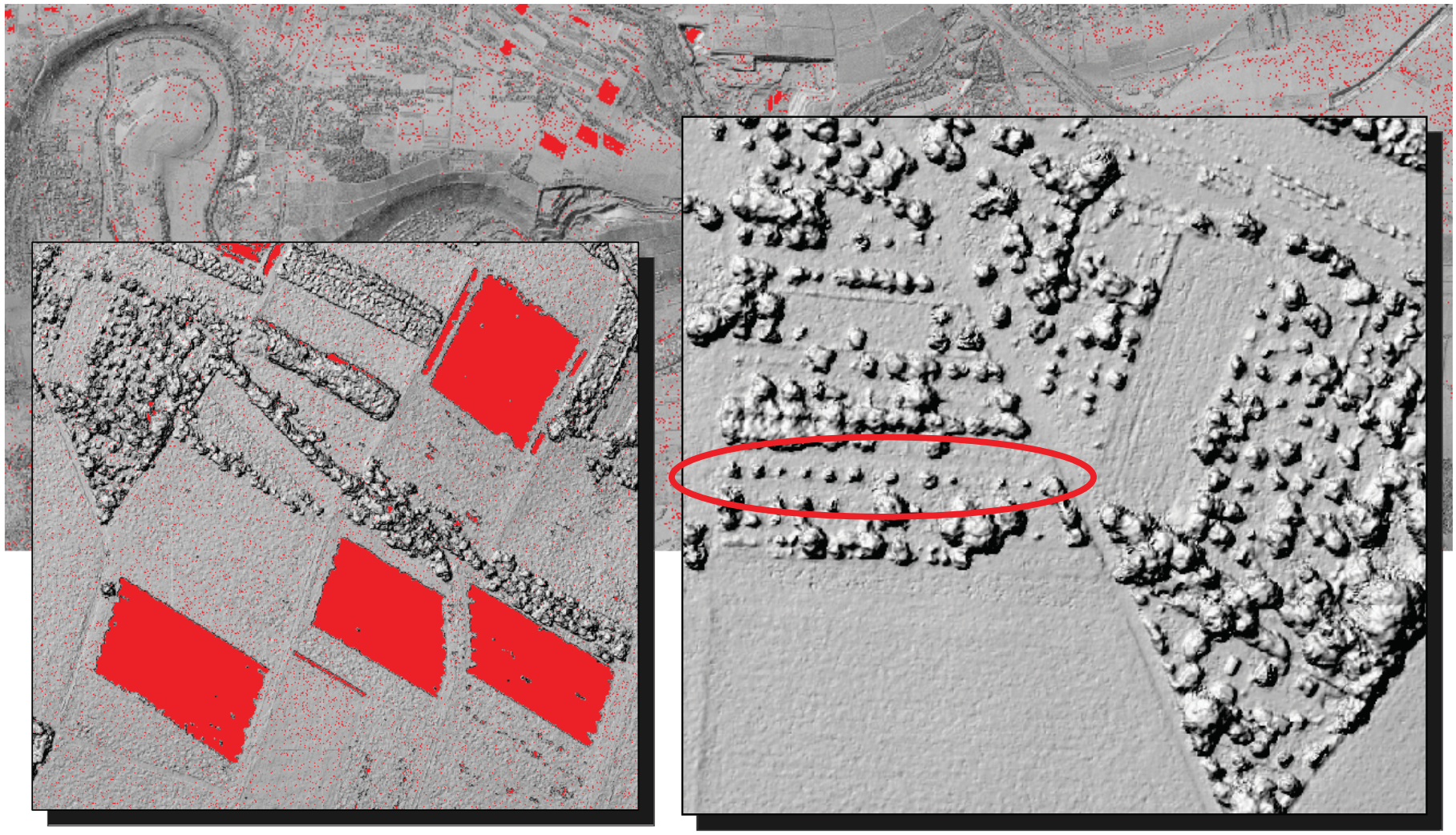
SocetSet 5.6 (NGATE): Vaihingen / Enz (36h)



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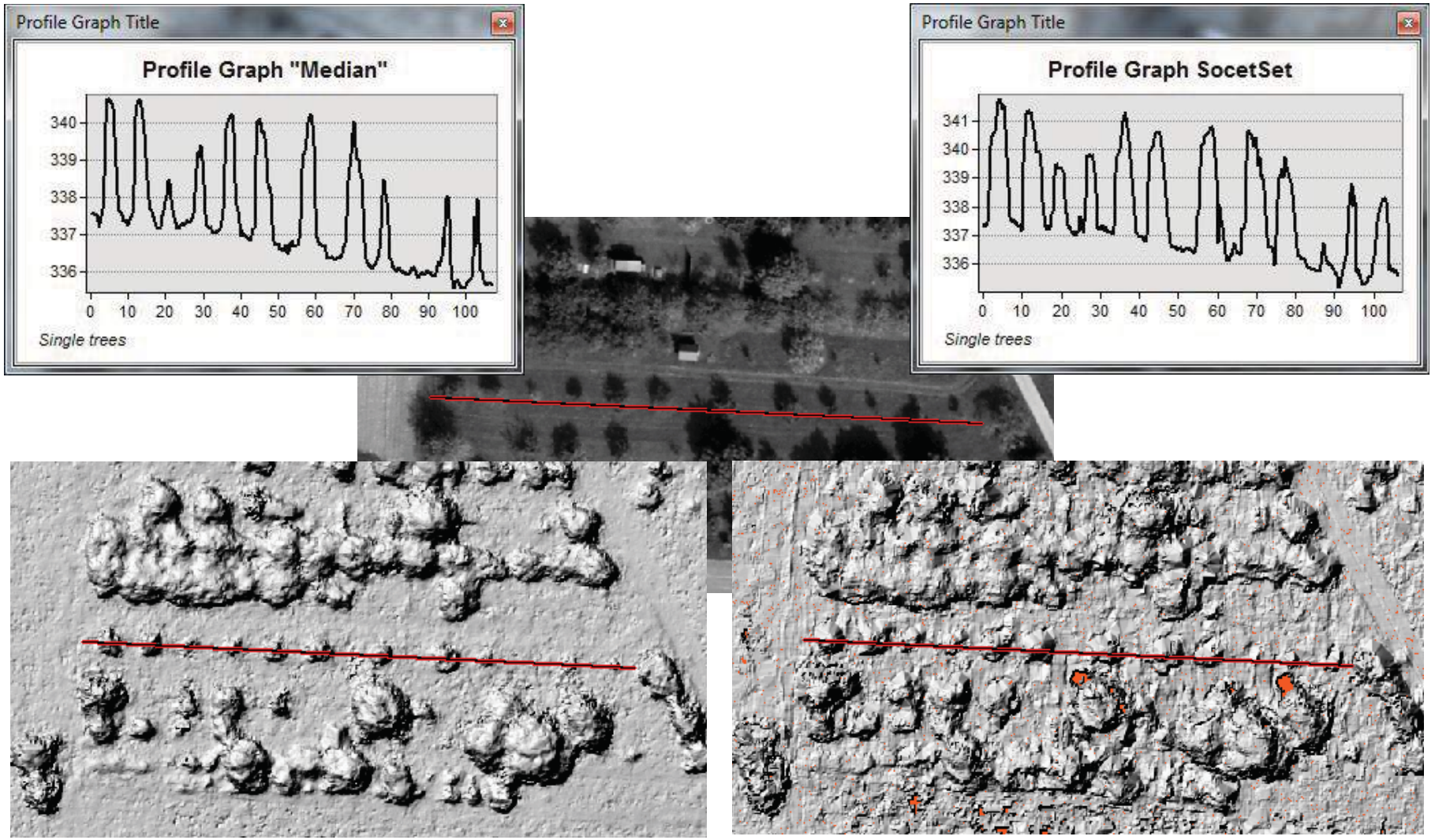
SocetSet 5.6 (NGATE): Vaihingen / Enz (36h)



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EuroSDR project

Benchmark on Image Matching

Thank you

Christian Ginzler

Swiss Federal Institute for
Forest, Snow and Landscape Research
CH-8903 Birmensdorf

EuroSDR

WSL

Institut für Photogrammetrie

Benchmark on Image Matching – the Current State

Norbert Haala

Institute for Photogrammetry

University of Stuttgart

Universität Stuttgart

Benchmark on Image Matching
State – Results - Evaluation

- 8:30 – 10:30 Benchmark State – Results - Evaluation
- Benchmark on Image Matching – Implementation and current state
  - N. Haala (ifp, Stuttgart)
- Presentations of results from participating groups:
  - C. Ginzler (WSL - Swiss Federal Institute for Forest, Snow and Landscape Research)
  - B. Brunner (FMM - Forest Mapping and Management, Salzburg)
  - R. Schneider (Digital Photogrammetry GEOSYSTEMS GmbH, Germany)
  - P. Nonin (GEO-Information Services Astrium Services)
  - C. Ressl (GEO TU Wien, Vienna)
  - M. Idrissa (Royal Military Academy, Brussels)
  - K. Gutjahr (Joanneum Research, Graz)
  - M. Pierrot-Deseilligny (IGN France)
  - M. Rothermel (ifp, University of Stuttgart)
- 10.30 – 11.00 Coffee break
- 11.00 – 11.30 Comparison and discussion of computed DSM results
  - N. Haala (ifp, Stuttgart):
- 11:30 – 12:45: Break-out session
  - Future of the EuroSDR Image Matching Benchmark

Benchmark on Image Matching: Data sets and deliverables

- Implementation of the benchmark
  - Provide aerial images as joint test data set for potential participants
  - Limit costs and time of data processing by restriction to two representative data sets of different landuse and block geometry
- Data set Vaihingen/Enz
  - semi-rural, moderate ground sampling distance and image overlap
  - representative for statewide data collection
- Data set München
  - high overlap and resolution
  - applications in densely built-up urban area
- Deliverables
  - DSM grids, raster width corresponding to image GSD
    - Evaluate available data quality
  - Questionaire on used IT infrastructure
    - Computational effort with respect to time and hardware

Questionaire on IT Infrastructure: Presentations from participating groups

Universität Stuttgart

Participant IT declaration form

1) Software Product:

The following SW product was used during the test

.....

2) Test data set:

The test data set (....., # of images ...., GSD ....., total size of image data)

was used for the evaluation.

3) IT Environment

The test was carried out on the following IT Environment

Computer System

# of cores 1 2 4 8 16 other

.....

Type of processors

.....

Speed rate of processors (GHz)

.....

RAM (GByte), Type of RAM

.....

GPU (if available)

.....

Type of GPU

Storage System

Type of Storage Media

.....

Speed of Storage Media (RPM)

.....

Size of Storage System (available)

.....

Network

Type of Network

.....

Transfer Speed of Network 100 Mb 1 Gb 10 Gb other

.....

Environmental requirements

special rewquirement if ther are any

.....

.....

Processing time

Data Ingest ..... h ..... min

AT ..... h ..... min

DSM ..... h ..... min

Output ..... h ..... min

Other comments and remarks

.....

.....

.....

.....

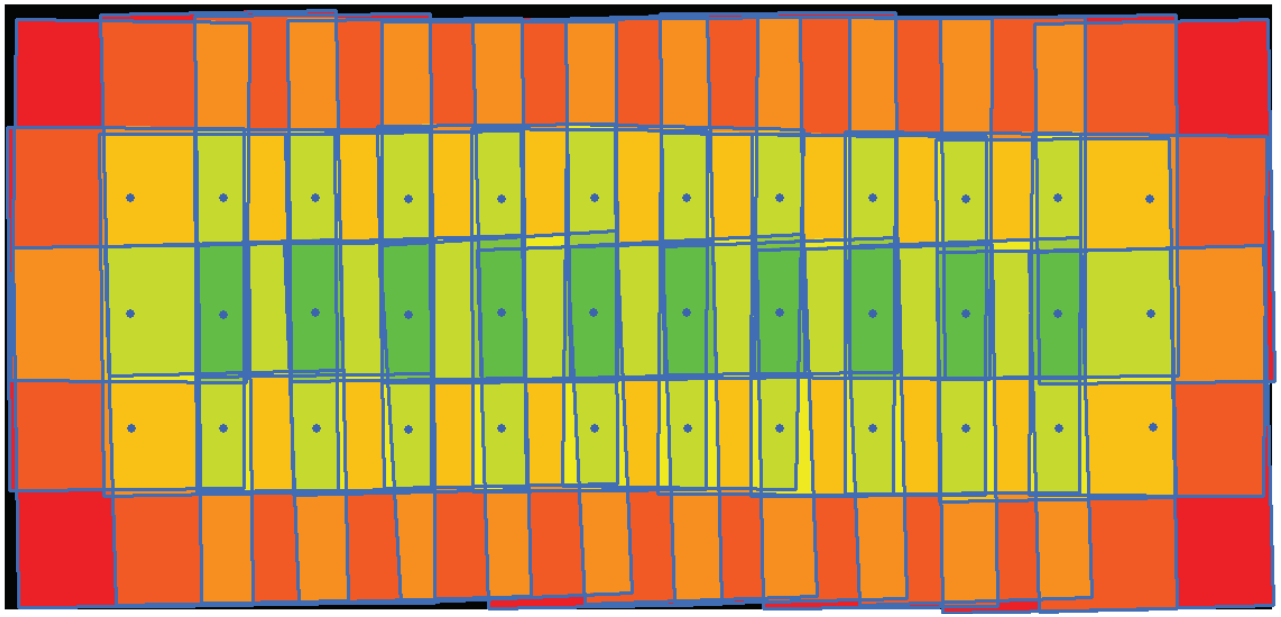
Data sets: Vaihingen/Enz

- DSM area 7.5kmx3.0km
- Semi-rural landuse, hilly area

Data sets: Vaihingen/Enz

- DSM area 7.5kmx3.0km, 20cm grid width, central part
  - four-folded to nine-folded overlap
- Semi-rural landuse, hilly area

Data sets: Vaihingen/Enz



- Block of 3 strips with 12 images each
  - Overlap 63% in flight and 62% cross flight
  - Up to nine-folded overlap (dark green).
- Flight captured on September 11, 2008 (DGPF Camera Test)
- Camera UltraCam-X, 16 bit, GSD 20 cm
  - PAN images, Tiled Tiff uncompressed 8 bit/pix
  - 9420x14430 pixel at a data volume of 180 Mbyte/image

Data sets: Vaihingen/Enz

- DSM size 7.5kmx3.0km, grid with of 20cm central part
  - four-folded to nine-folded overlap

Data sets: München

- Block of 3 image strips with 5 images each
  - 80% in flight 80% cross flight overlap
  - up to fifteen-folded areas
- DMC II 230, GSD of 10cm
  - March, 3 2011
  - 15552x14144 pix,16 bit
- Central part of the city

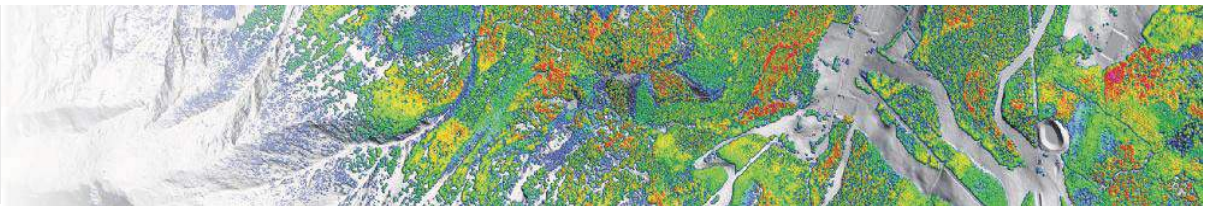
Data sets: München

- Central part of the city
  - Occlusions
  - Shadows
- High overlap, small GSD
  - Applications in urban environments

Delivered data sets

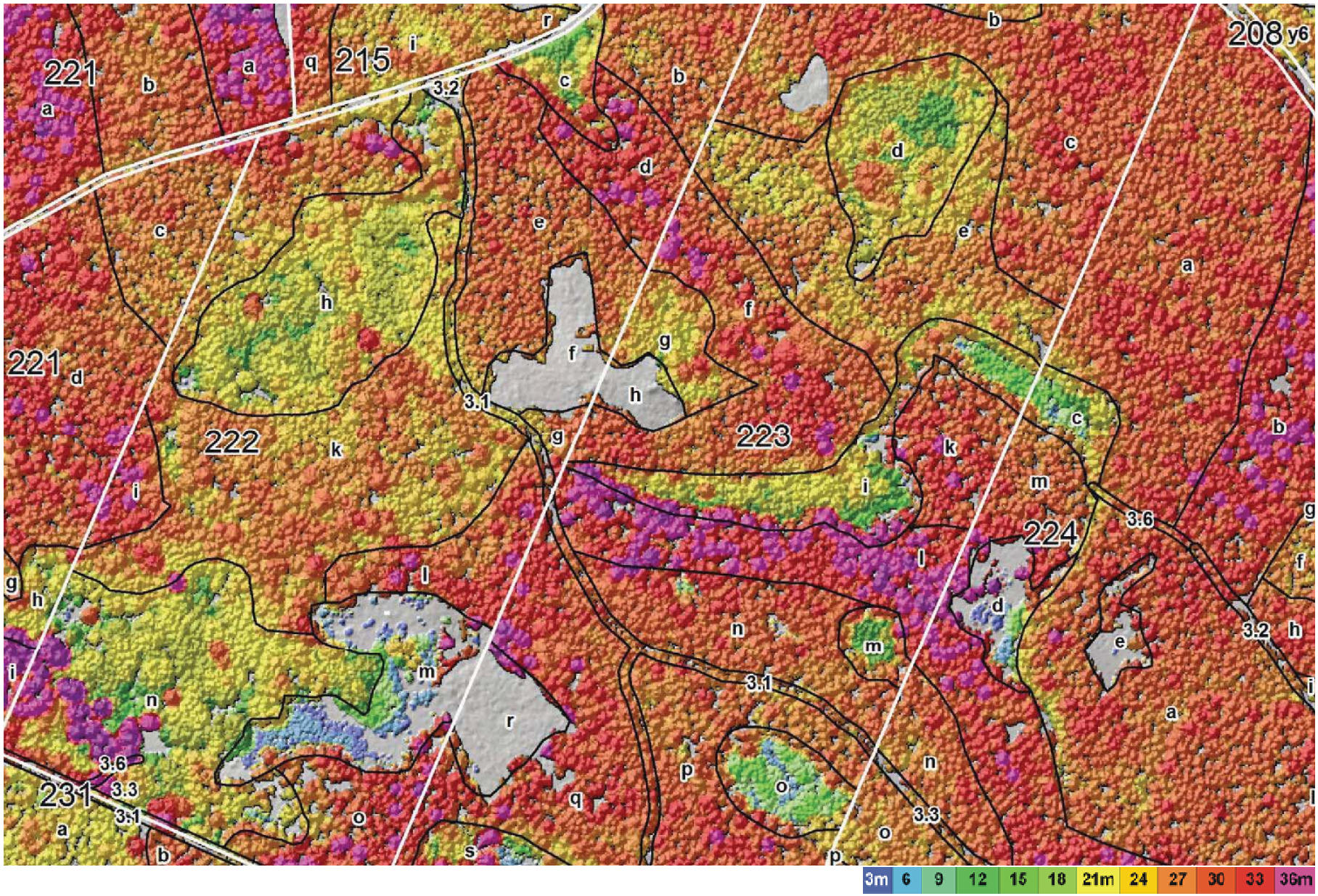
- Results presented during workshop
  - C. Ginzler (WSL - Swiss Federal Institute for Forest, Snow and Landscape Research)
  - B. Brunner (FMM - Forest Mapping and Management, Salzburg)
  - R. Schneider (Digital Photogrammetry GEOSYSTEMS GmbH, Germany)
  - P. Nonin (GEO-Information Services Astrium Services)
  - C. Ressl (GEO TU Wien, Vienna)
  - M. Idrissa (Royal Military Academy, Brussels)
  - K. Gutjahr (Joanneum Research, Graz)
  - M. Pierrot-Deseilligny (IGN France)
  - M. Rothermel (ifp, University of Stuttgart)
- Results made available to project team
  - H. Hirschmüller German Aerospace Center (DLR)
    - DLR-SGM
  - K. Legat (AVT Photogrammetrie und Bildflug)
    - Ultramap, Match-T
  - J. Gonçalves (University of Porto)
    - AgiSoft

Sustainability:
Monitoring
Mapping
Modelling
Management



DSM‘s for Forestry

Requirements in operational Forest Management, Planning and Monitoring


221
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223
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9
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15
18
21m
24
27
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33
36m

LIDAR

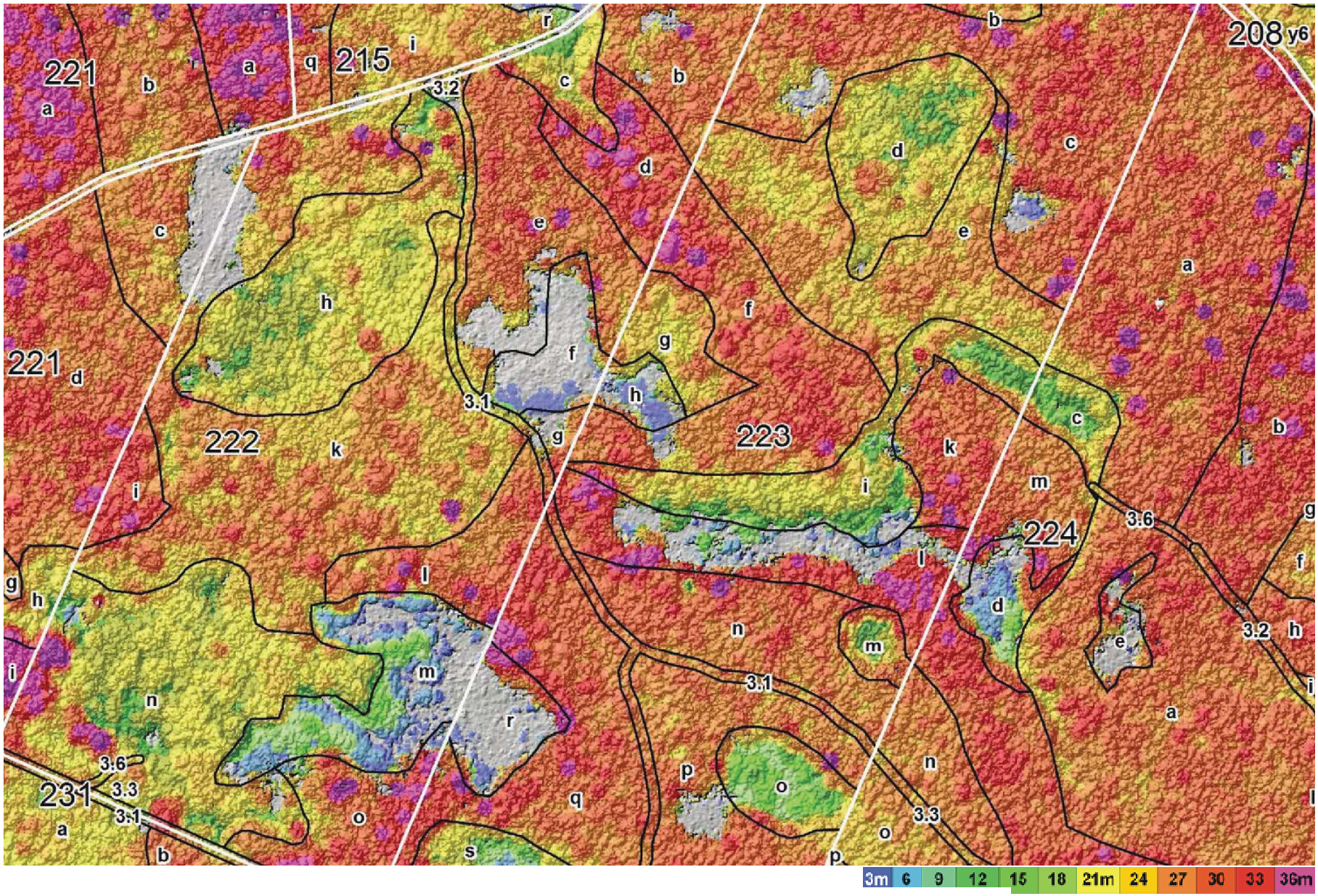
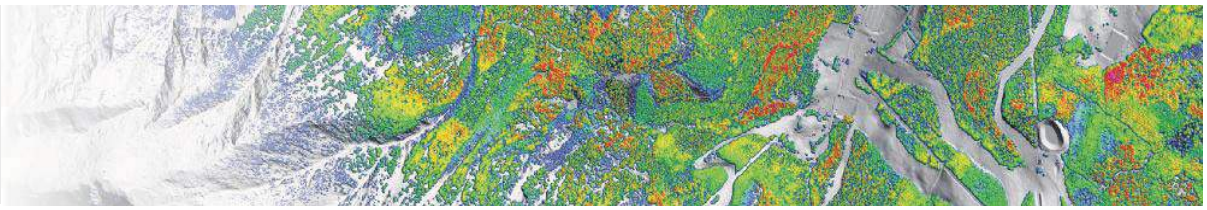
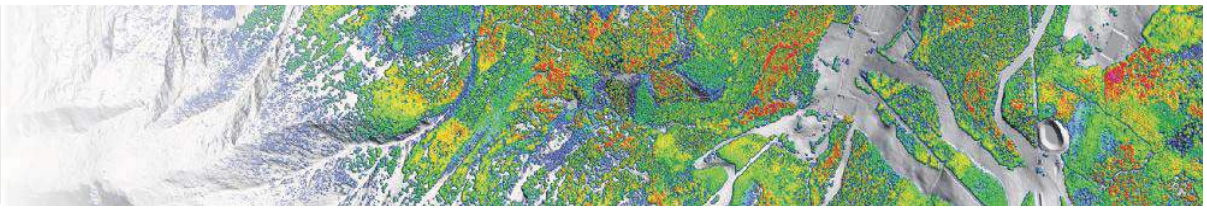


Image Matching (<= 70% overlap)



Forest Enterprises expect from RS (1)

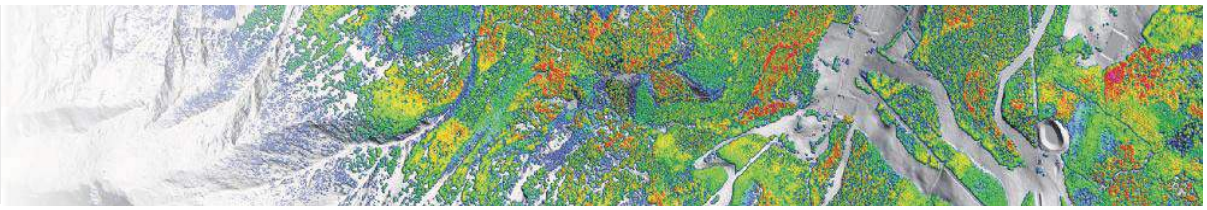
- Estimating the Stock Volume
  and its spatial distribution
- Estimating the Annual Yield
  and its spatial distribution
- Monitoring the Felling Activity
  in its spatial distribution



Forest Enterprises expect from RS (2)

- Information about Forest Density
  and its spatial pattern (CHM)
- Information about Tree Species
  and its spatial distribution (spectral analysis)
- Information about Site and Relief
  (DTM => LIDAR; ~stable)

Sustainability:
Monitoring
Mapping
Modelling
Management

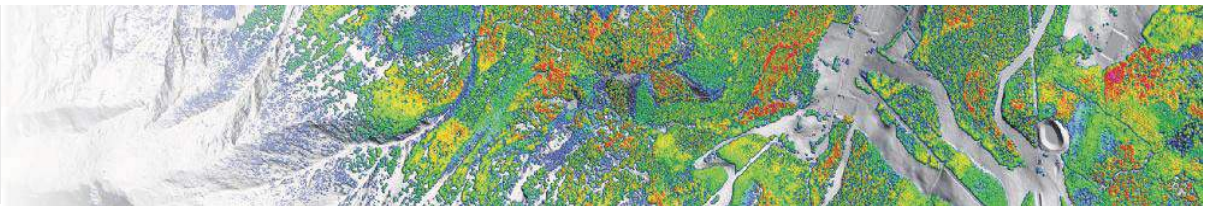


Estimating the **Stock Volume**
and its spatial distribution

$$V_{stock} = f(V_{CHM}, tree\mathbf{S}pecies, \ldots\ldots)$$

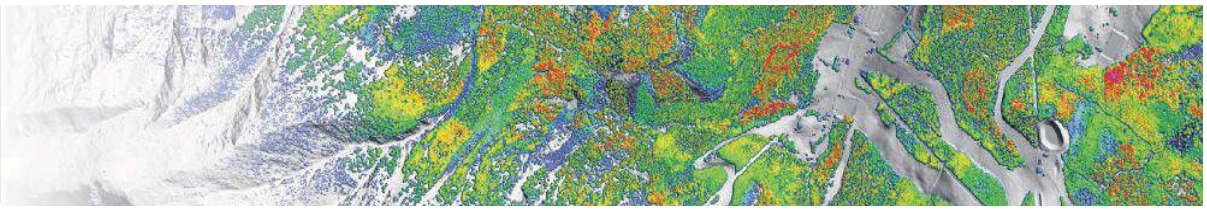
Hollaus et al.

Methods from LIDAR will probably not work in the same way!



Estimating the Annual Yield (Tree Growth)

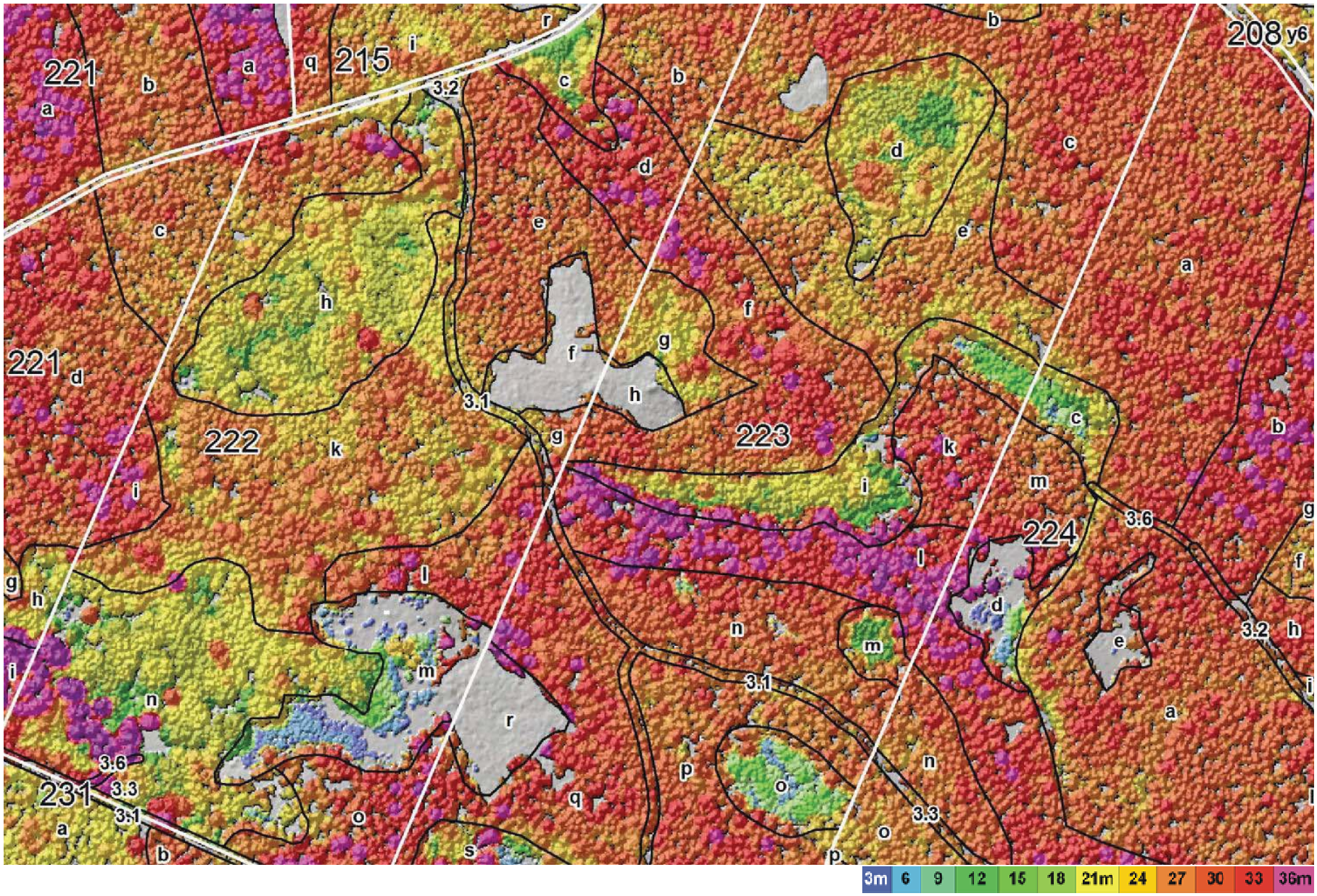
- Growth of height, growth of basal area of stems
- ΔCHM = delta canopy height model
  multi temporal canopy height models
- Comparing treetops:
  Problem: Identification of trees is necessary
- Comparing the whole CHM:
  Problem: Reference area has to be identified
- Comparing upper parts of highest trees
- Considering dimension of individual crowns



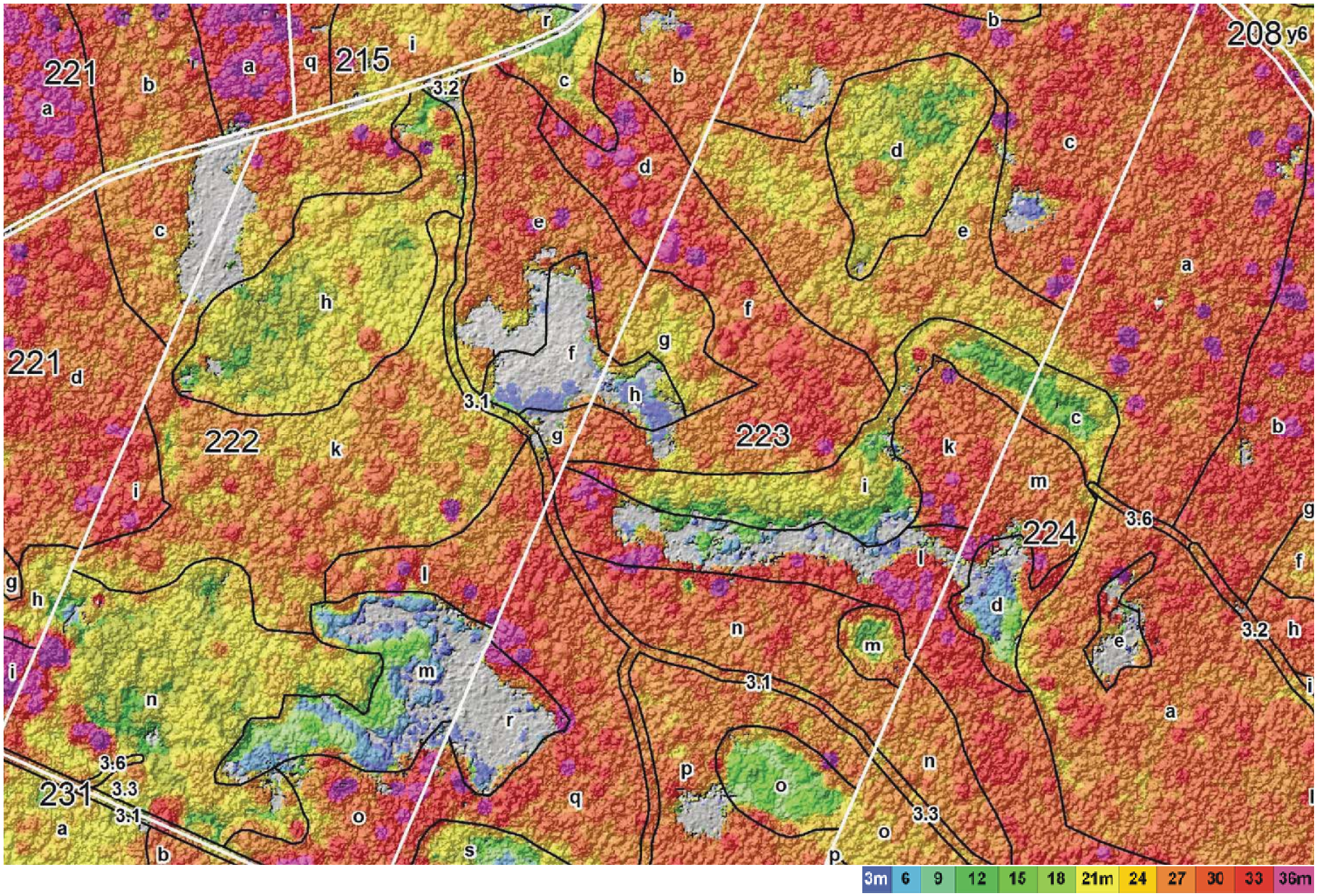
Monitoring the Felling Activity

in its spatial distribution

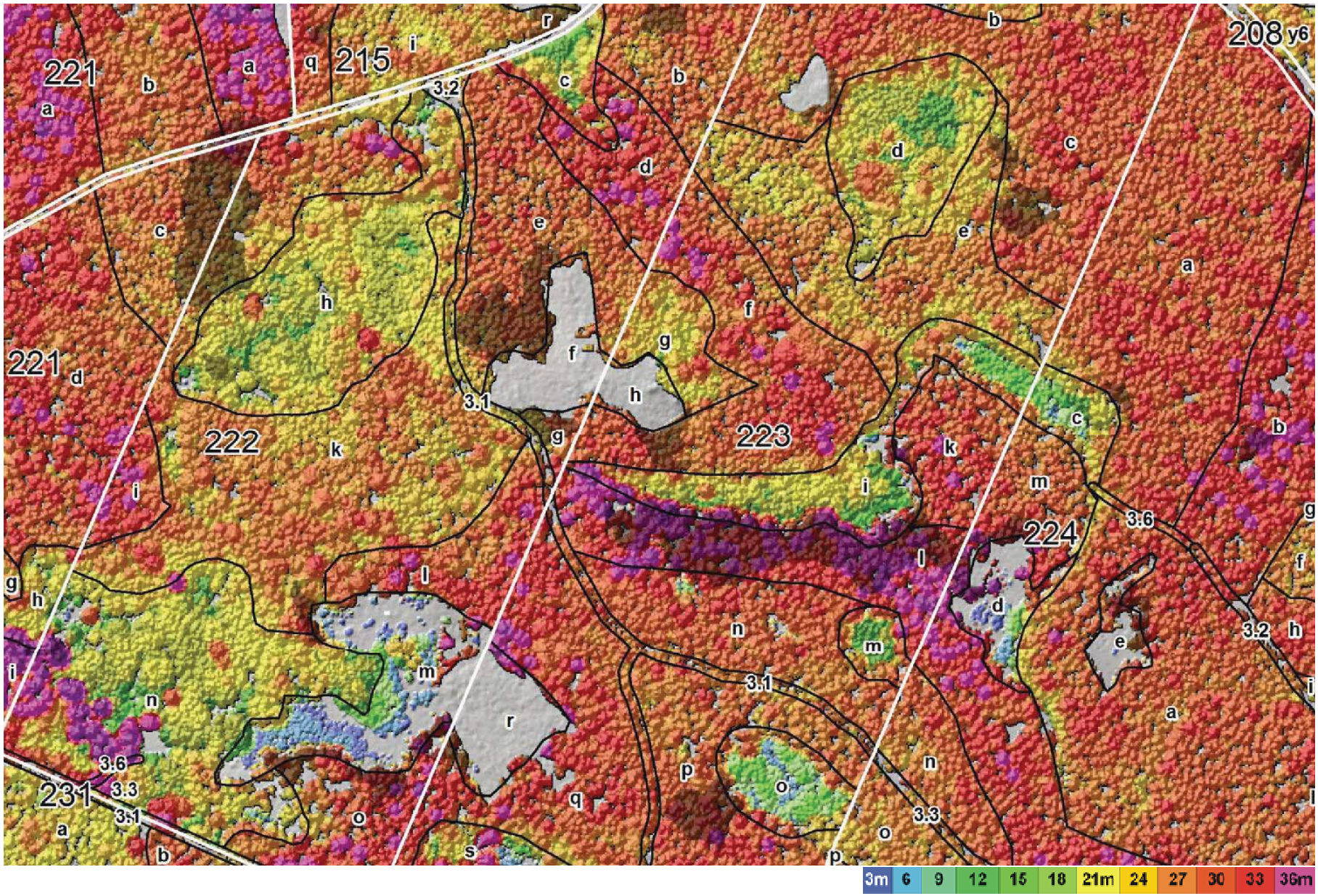
- Questions of sustainability:
  Balancing site qualities, contribution margins, …
- Auto-calibration of stand data by:
  - log records from sawmills
  - log records from harvesting machines
- Semi-automatic updating of forest inventory
- Get rid of uncontrolled timber loss



Tree Heights from LIDAR 2006

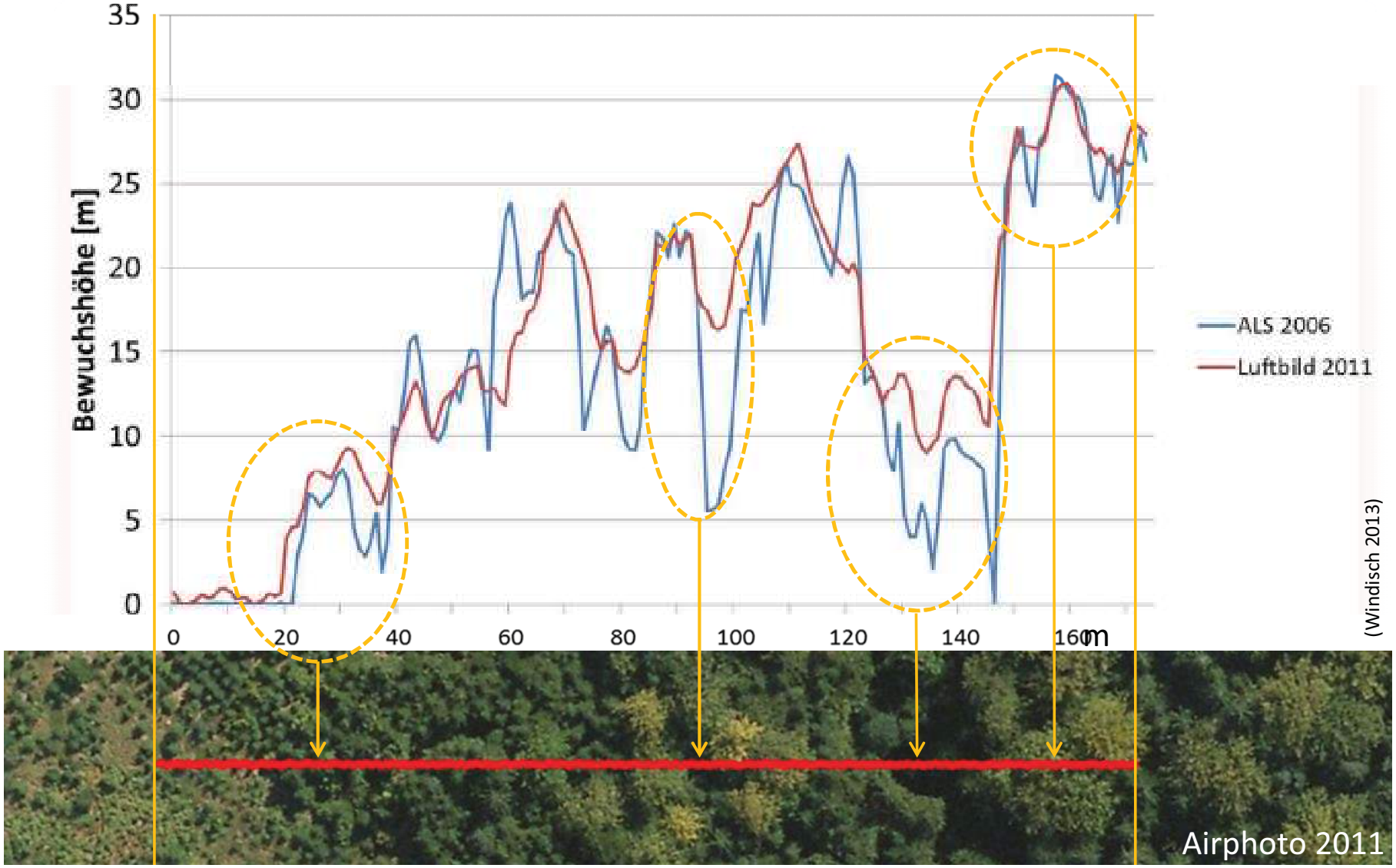


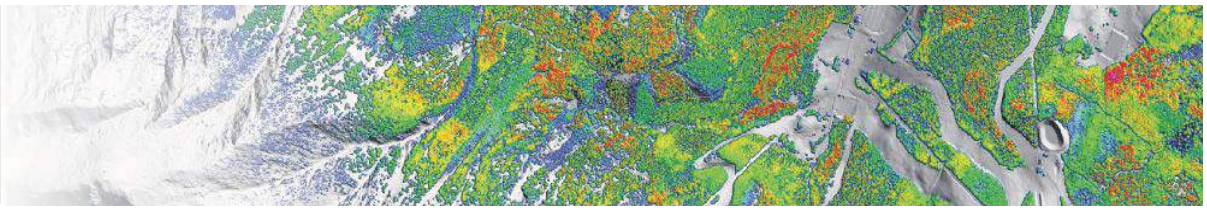
Tree Heights from Image Matching 2011



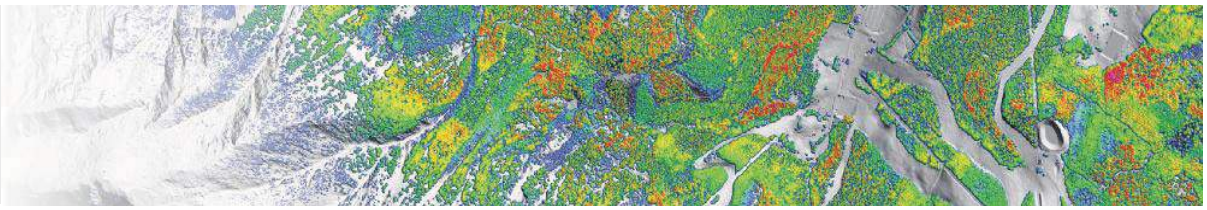
Felling Activity 2006-2011

Delta Canopy Height Models from different technologies





Political and social background:
Transparency
in the forest areas
makes discomfort,
more than ever in times of
tax estimation!
=> questions of **data privacy**



Thank you for your attention!


Austrian Research Centre for Forests
BFW.
Serving Forest & People
Research - Monitoring - Training

Exploiting the DSM for vegetation analysis: example from forestry

Klemens Schadauer, Christoph Bauerhansl and Christian Ginzler (WSL)

2ndEuroSDRWorkshop on High Density Image Matching for DSM Computation

Federal Office of Metrology and Surveying (BEV) 13. 06. 2013

Multifunctional Forests

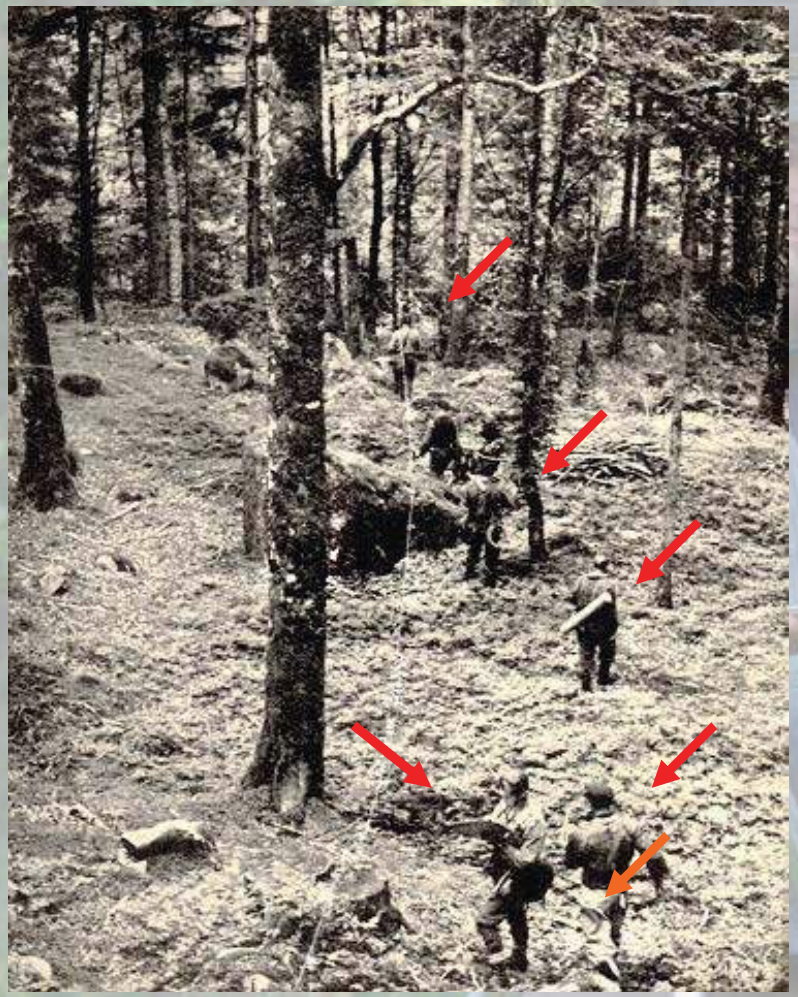
- As stated in the Austrian forest act
  - biodiversity function
  - well fare function
  - recreation function
  - protective function
  - economic function

- Information on all topics is needed

BFW.

Old European NFIs ~1925

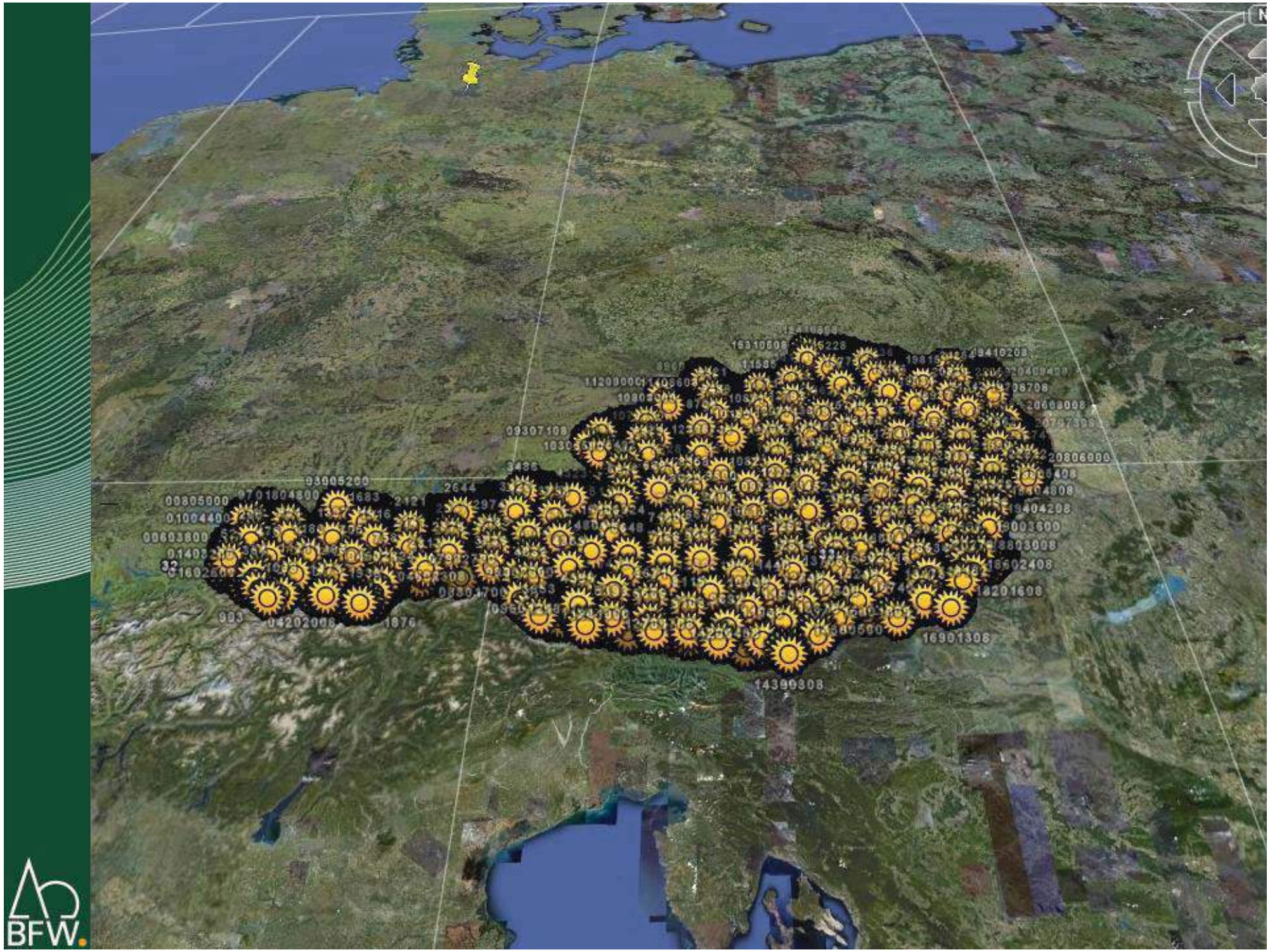
Swedish NFI

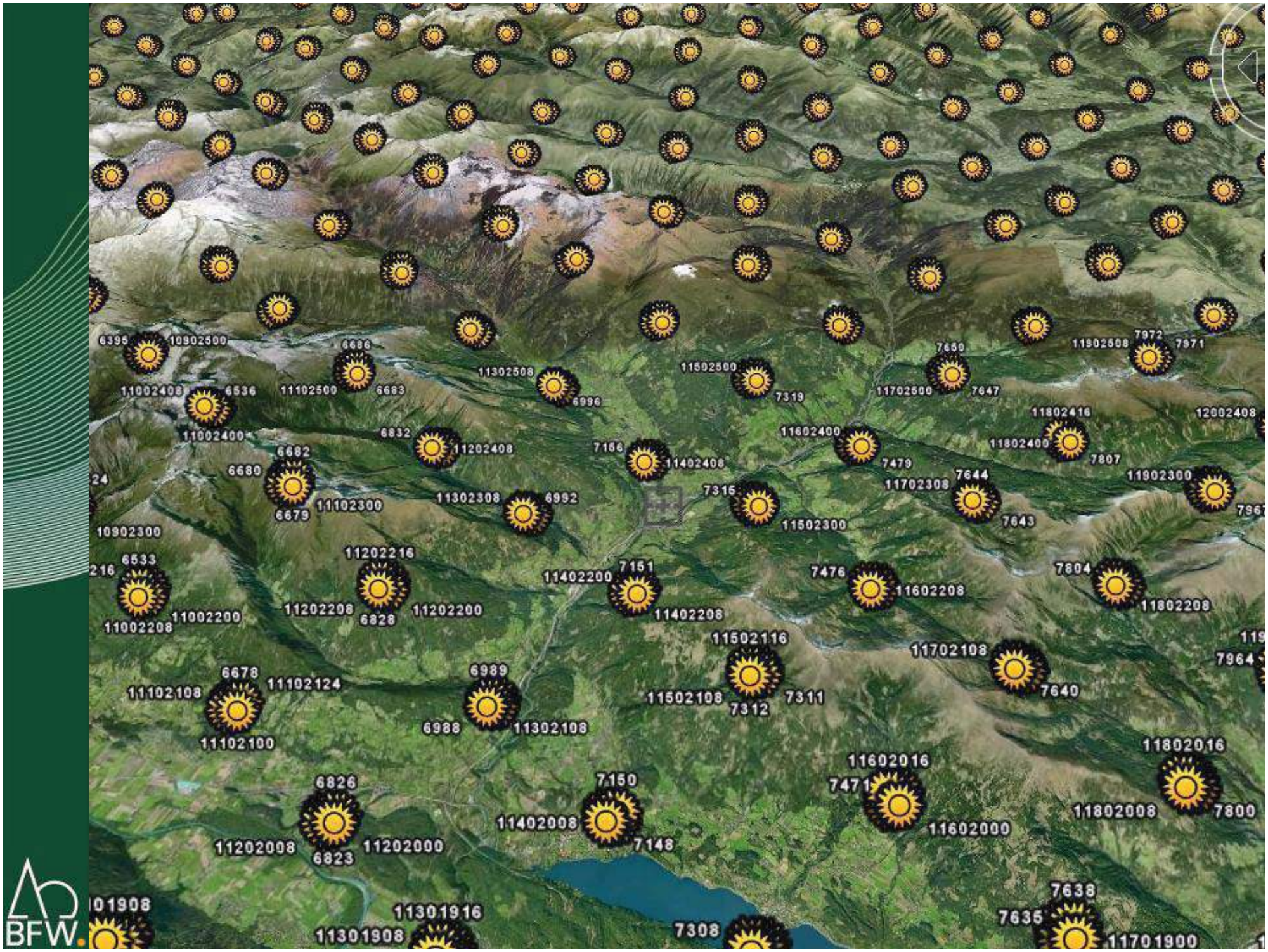


Finish NFI

Statistical based forest inventories in Austria

- 1961 - 1970 temporary Design
- 1971 - 1980 temporary Design
- → 1981 - 1985 start permanent Inventory
- 1986 - 1990 first re-assessment
- 1992 - 1996 second re-assessment
- 2000 - 2002 third re-assessment
- 2007 - 2009 fourth re-assessment
- 2011 - 2013 Kyoto Inventory

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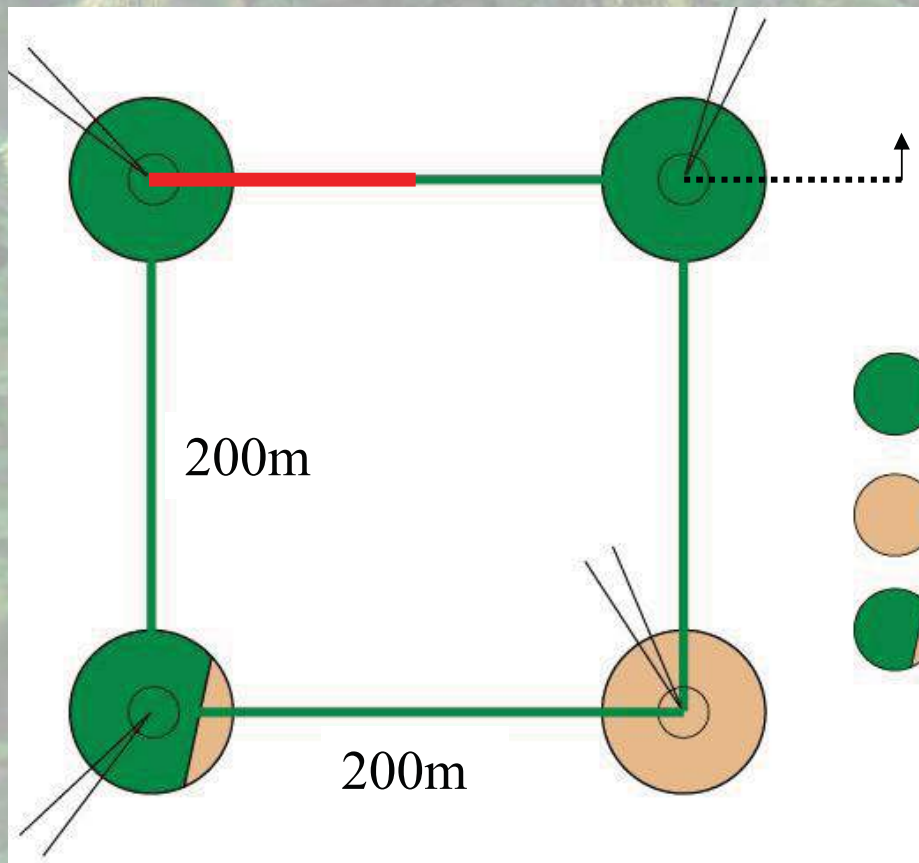


Tract

Forest plot

Non-forest plot

Partitioned plot

Angle Count System (BAF=4, Sample trees > 10,5 cm

Line Taxation for Biotope Diversity

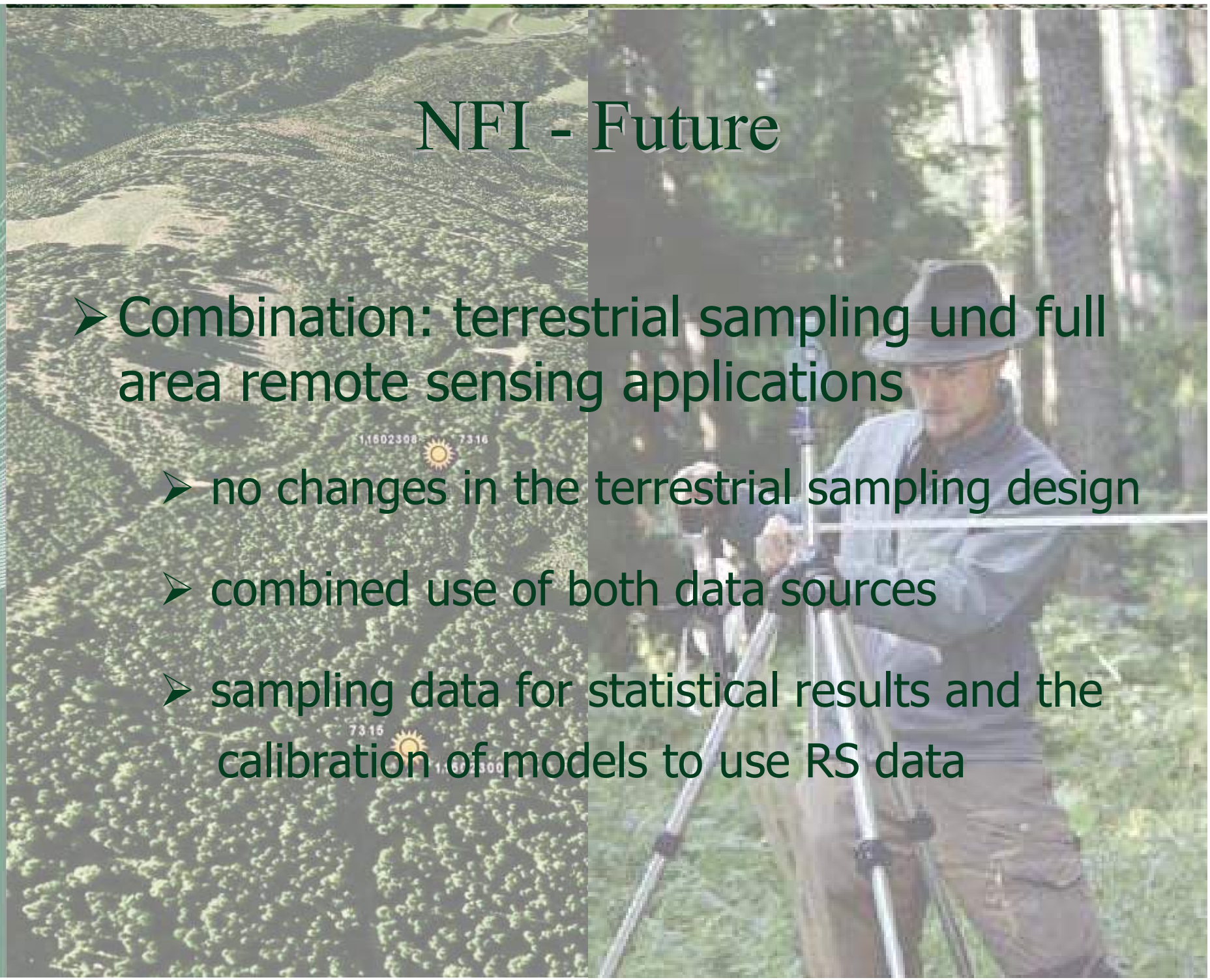
Fixed Area Plot r= 9,77 A=300 m^2

Fixed Area Plot r= 2.60 Sample trees > 5 and < 10.5 cm

Distance Sampling

NFI - Future

- Combination: terrestrial sampling und full area remote sensing applications
  - no changes in the terrestrial sampling design
  - combined use of both data sources
  - sampling data for statistical results and the calibration of models to use RS data



Use of remote sensing

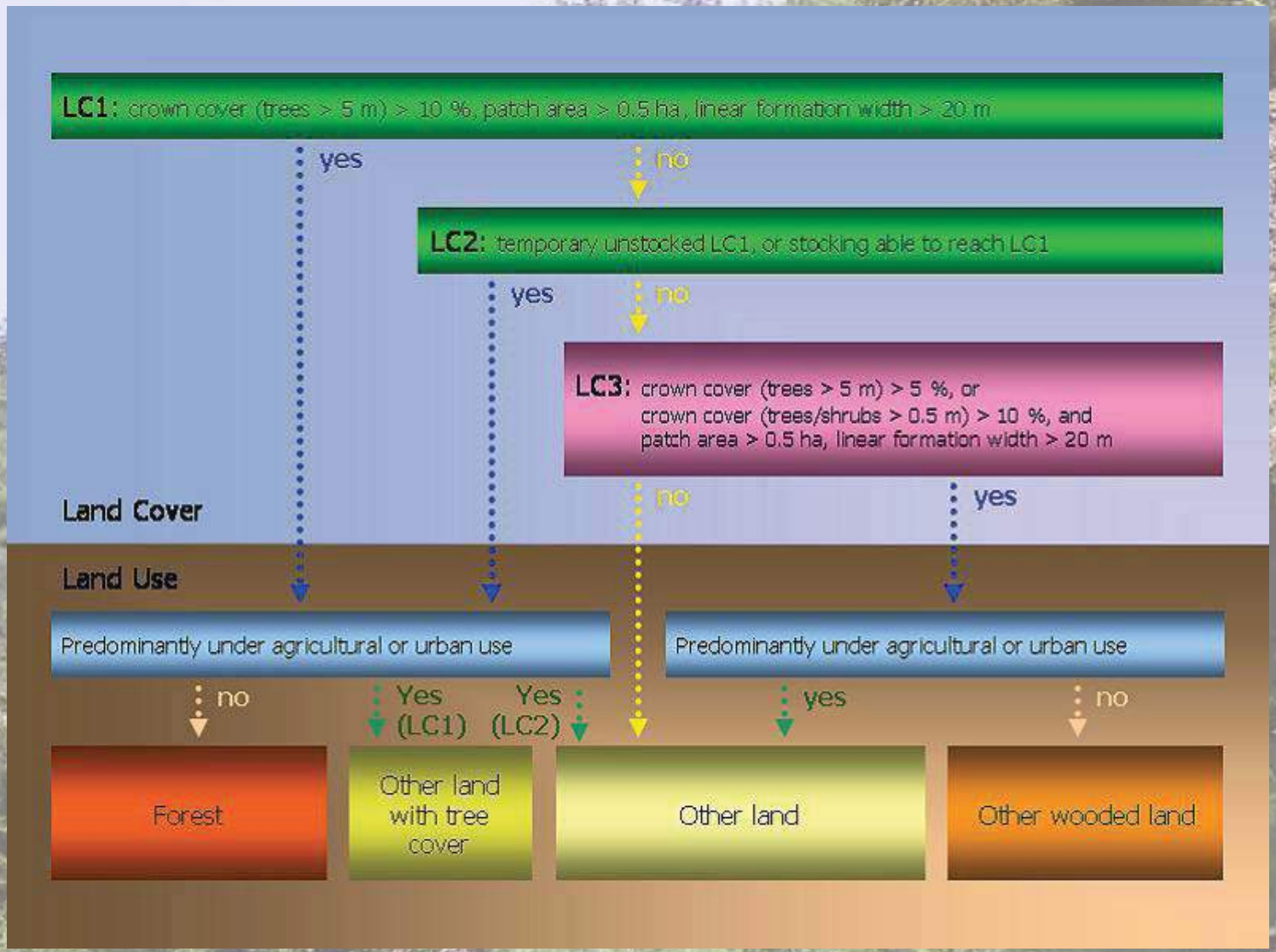
- Spawning bridges in space and time
  - Space
    - Small area estimates
    - Wall to wall mapping
  - Time
    - 6 years cycle for terrestrial sampling
    - 3 years cycle for aerial photos
    - Yearly estimates for some main parameters?

BFW.

Use of remote sensing

- Airborn Laserscanning – actual
  - Forest area
  - Growing stock (modelling)
  - Tree biomass (modelling)
- Matching – additional for future
  - Harvests
  - Increment?

Forest area - Definition



Lanz, 2008

Forest area - Definition

Forest {{LC[Tree 10%] □ LU[*tua]}
□ LU(□*pau)}* □ *LC[wsc]* □ *LU(add)*

where the square brackets, [.], indicate that quantitative thresholds must be considered and parentheses, (.), indicate that qualitative criteria (nominal scale) must be considered.

Gabler et. al. 2012

Forest area – Definition Land Cover

- Threshold approach with minimum criteria
  - minimum area
  - minimum crown cover
  - minimum height
  - minimum width

Forest area – Match

- Aerial photos
  - UltraCam XP 2009
  - 20cm GSD
  - RGBI
  - 80/30 overlapping
- MatchT
  - undulating
  - each third pixel
  - balanced – only image pairs

BFW.

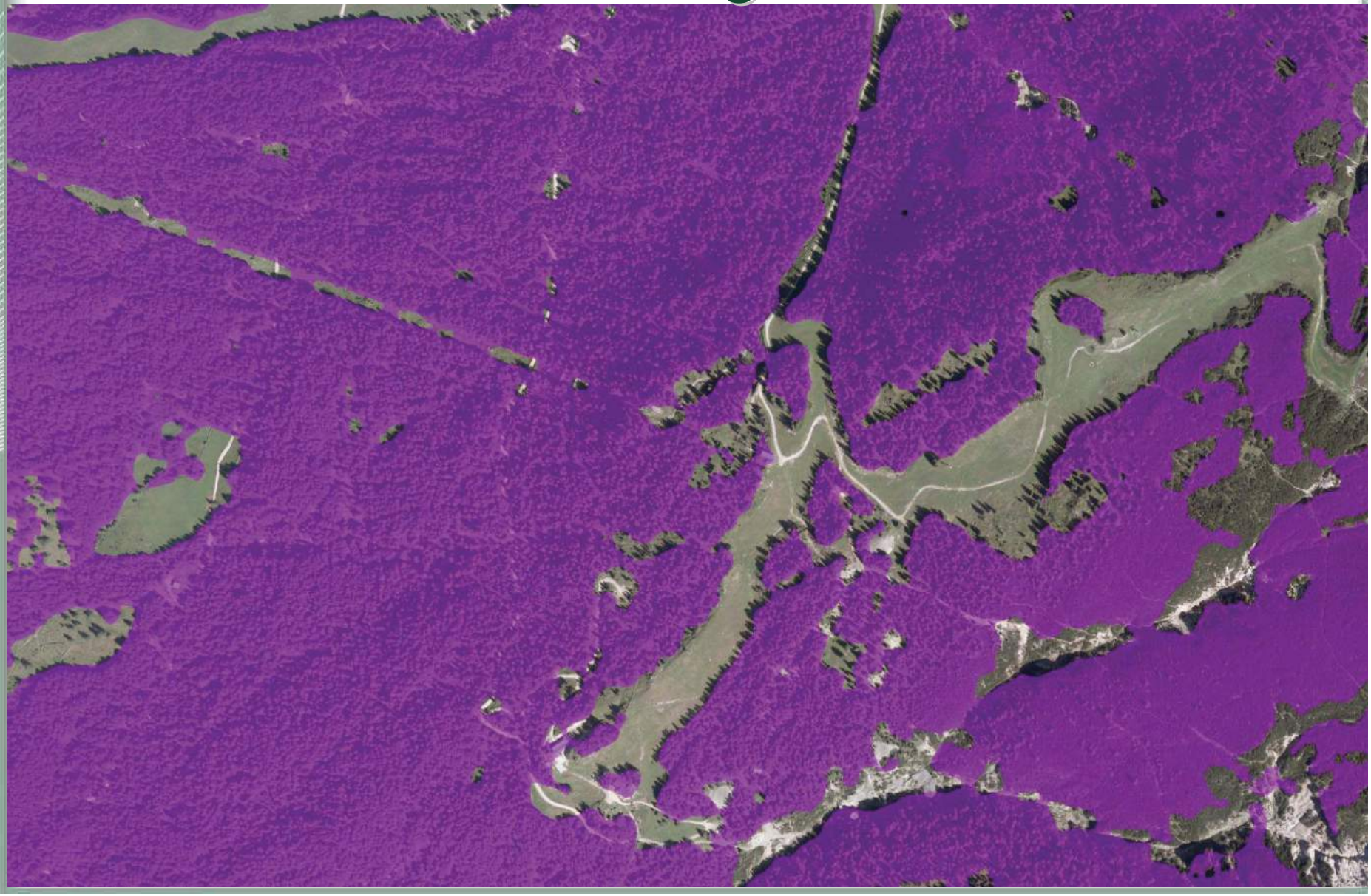
Forest area – ALS - Match

Forest area – ALS

min. height 2m

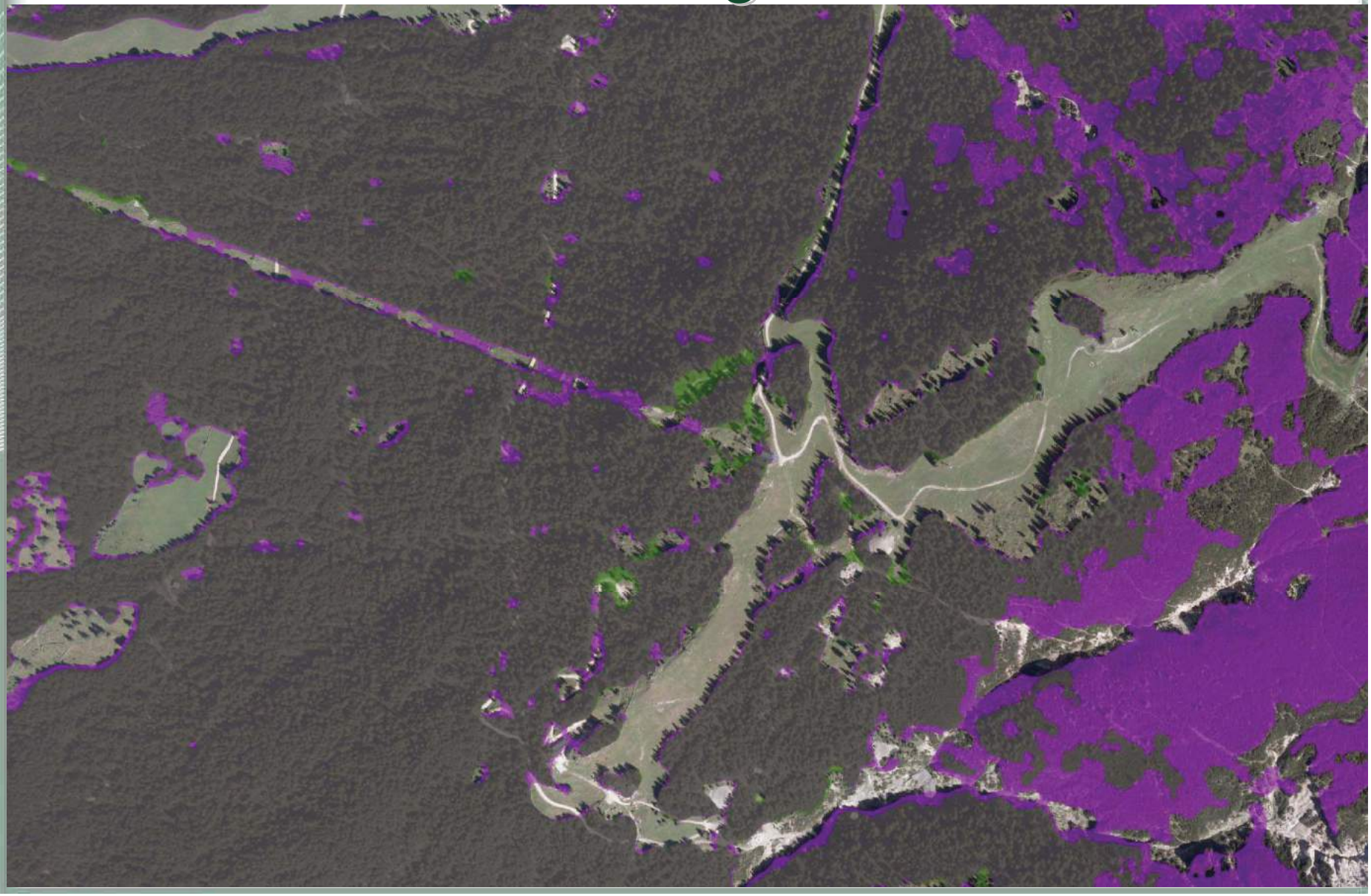
Forest area – Match

min. height 2m



Forest area – ALS – Match

min. height 2m



Forest area – ALS – Match

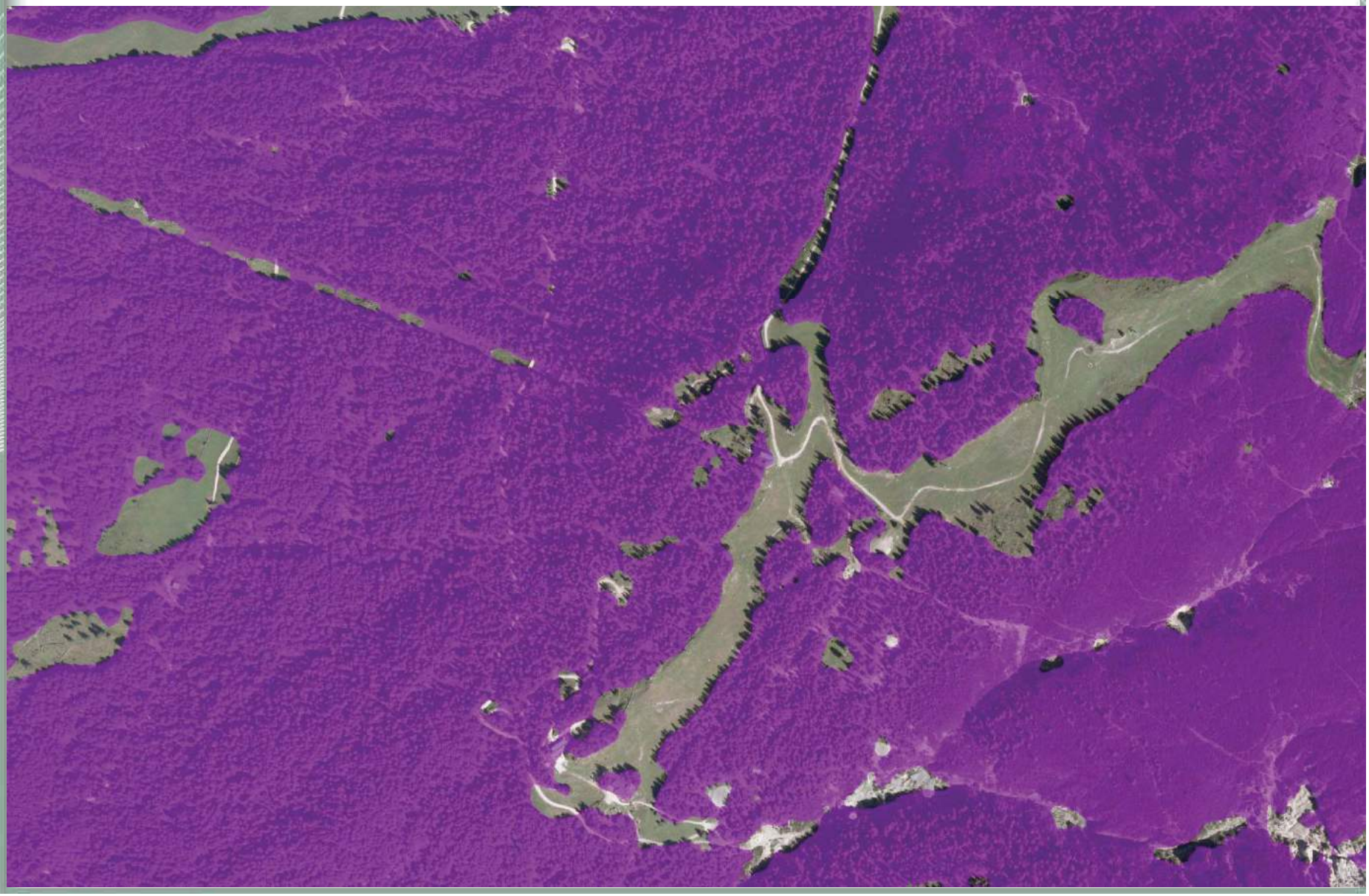
min. height 2m

Forest area – ALS

min. height 0,5m

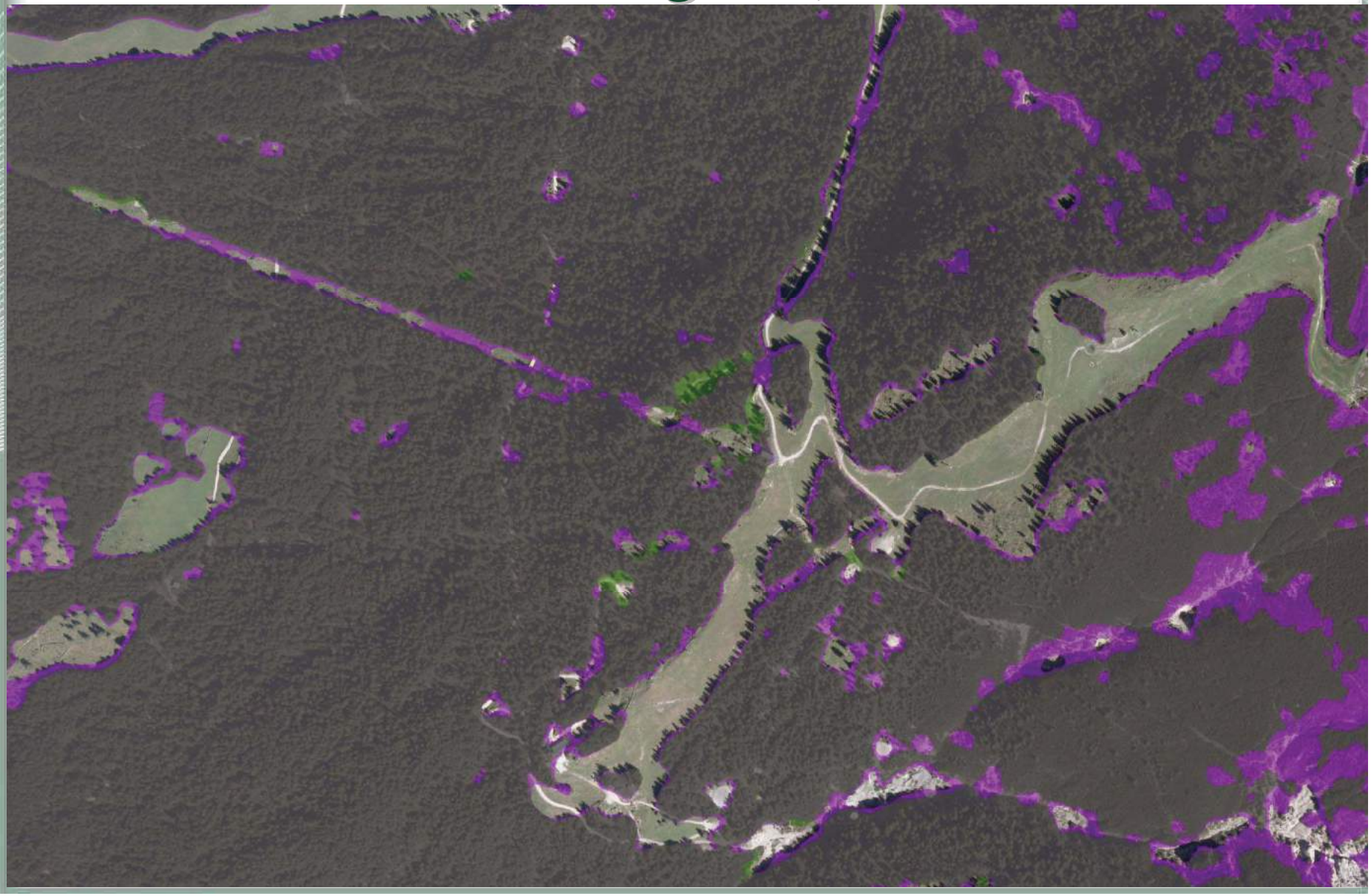
Forest area – Match

min. height 0,5m



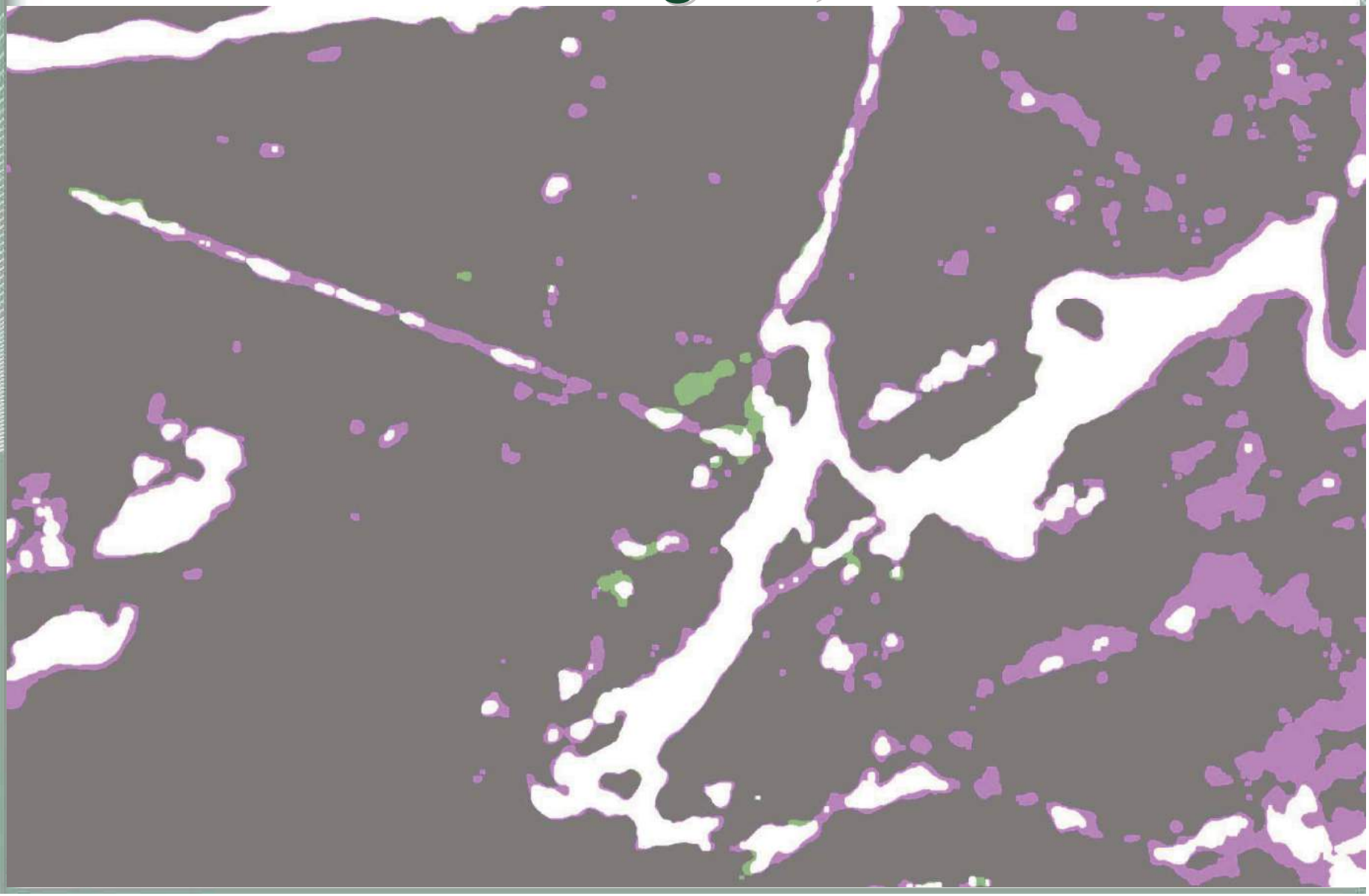
Forest area – ALS - Match

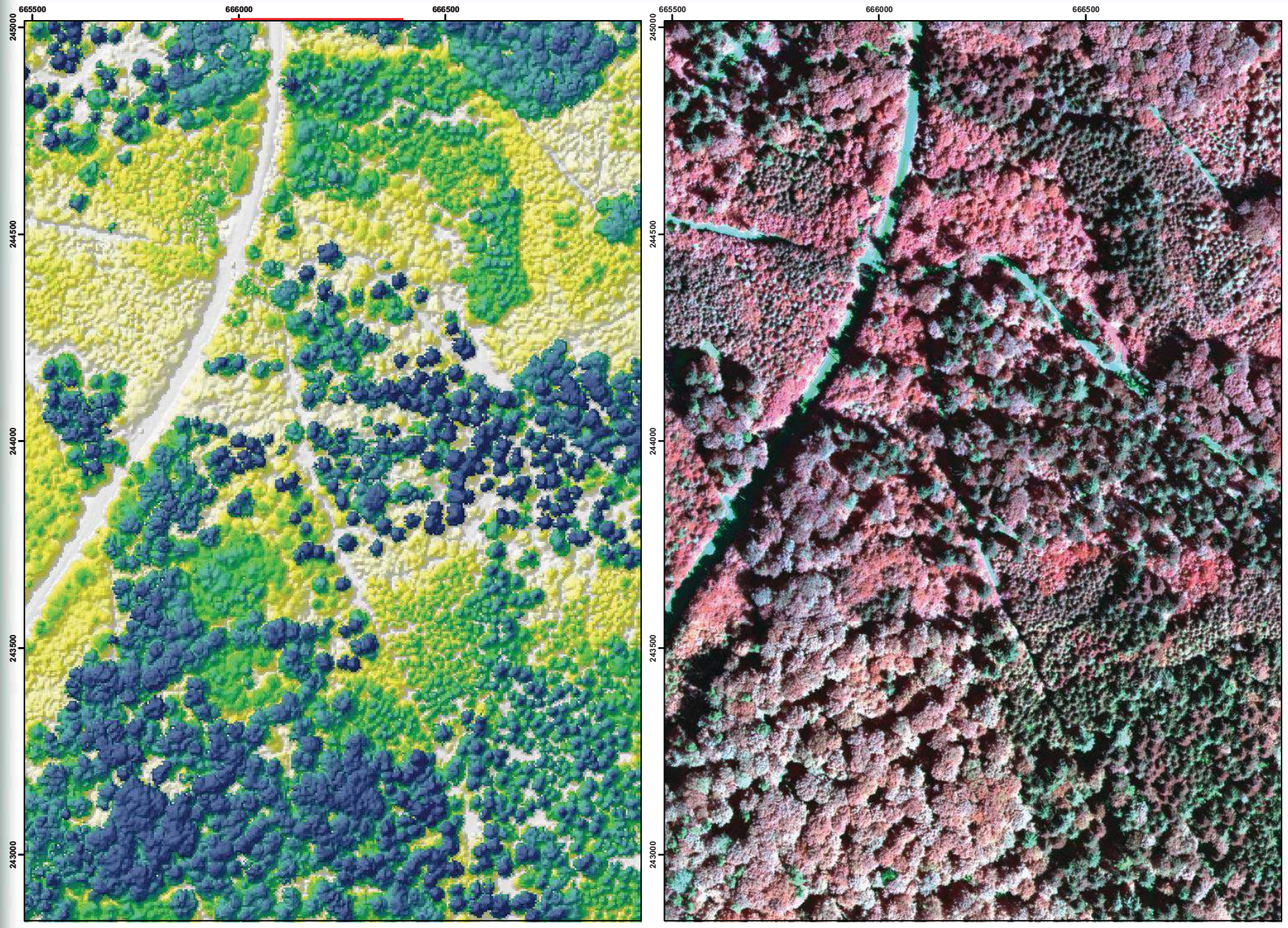
min. height 0,5m



Forest area – ALS - Match

min. height 0,5m

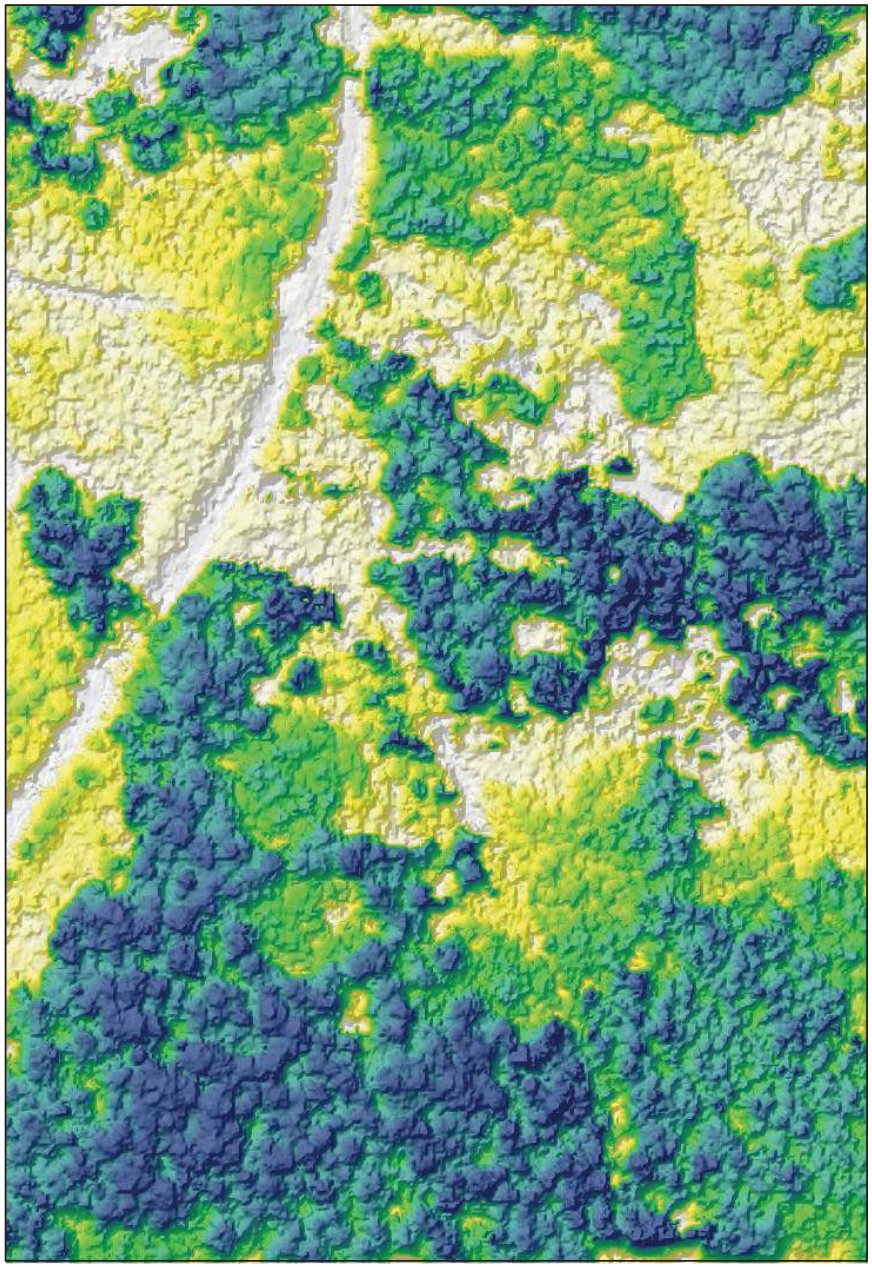




Bremgarten (AG): Flugdatum 24.06.2010

Bremgarten (AG): Flugdatum 09.09.2011

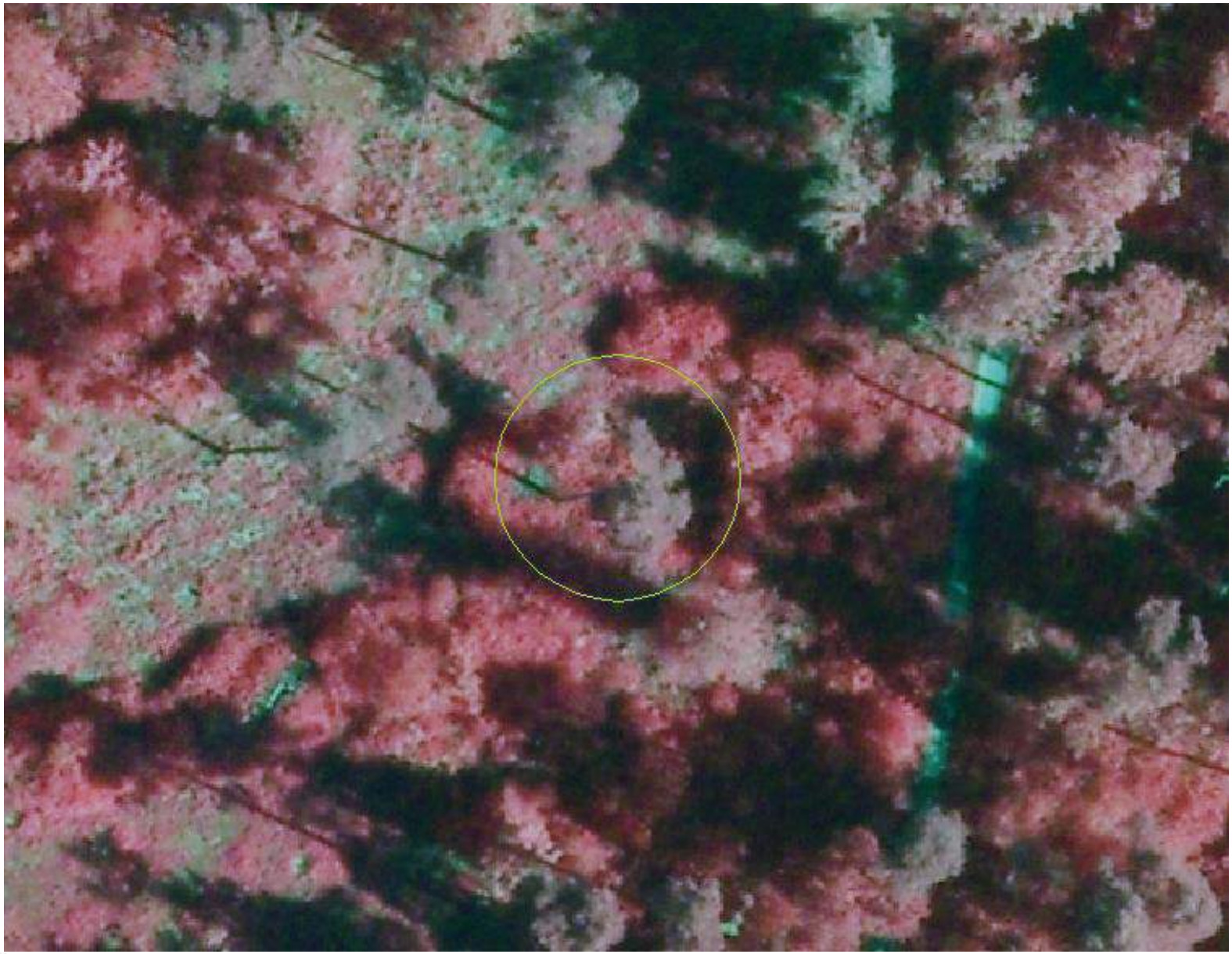
ALS



Flugdatum 24.06.2010

Match - SocetSet

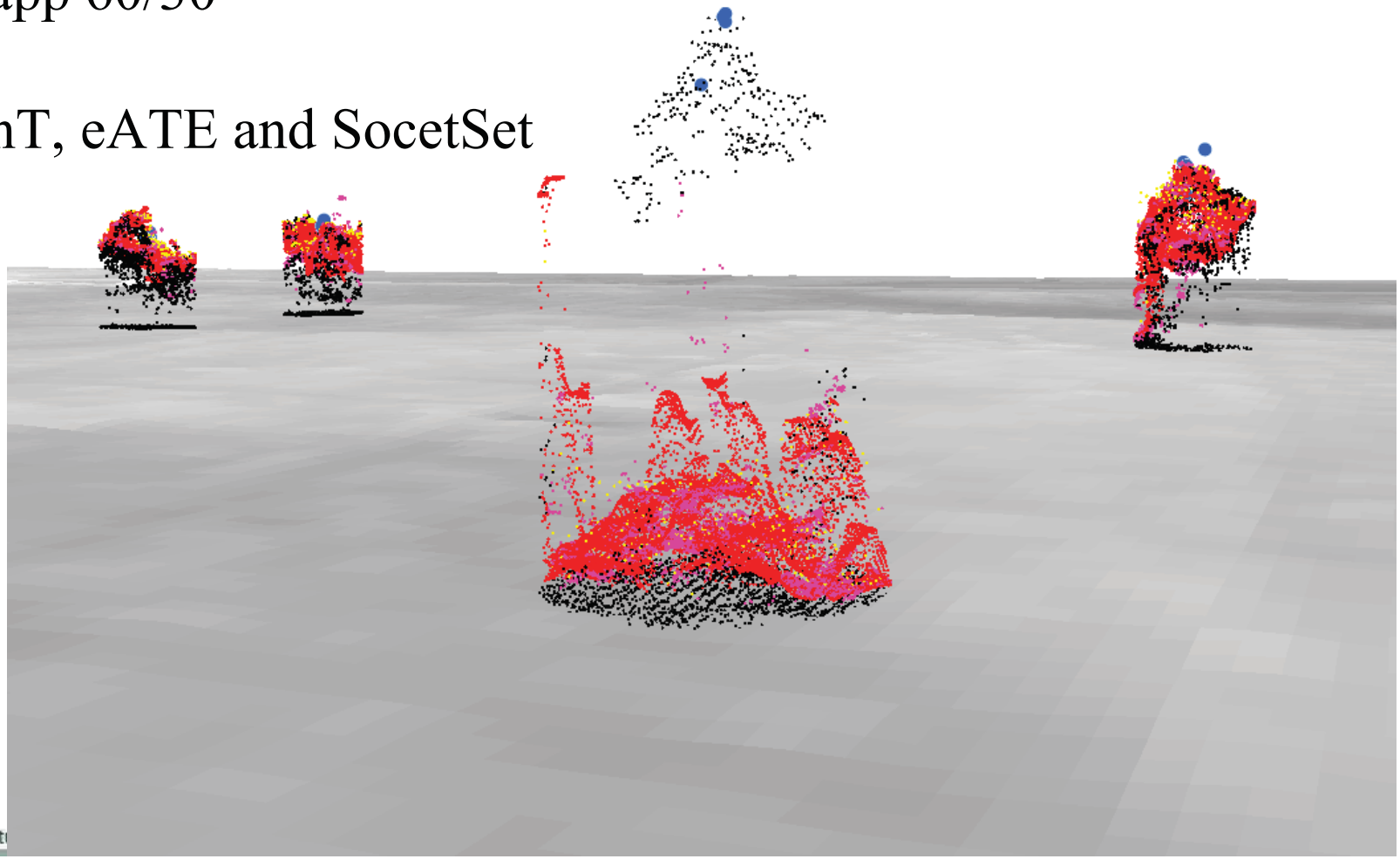
Missing Pinus tree



Missing Pinus tree

UltraCam XP 2009
RGBI 8bit
20cm
overlapp 60/30

MatchT, eATE and SocetSet



Combined use - modelling

- Ground measurements are diameter based
  - Flugsand- und Flugerdeböden
  - Verkarstungsgefahr
  - Seichtgründigkeit
  - schroffe Lagen
  - Abrutschungsgefahr
  - Kampfzone
- Remote sensing is height based

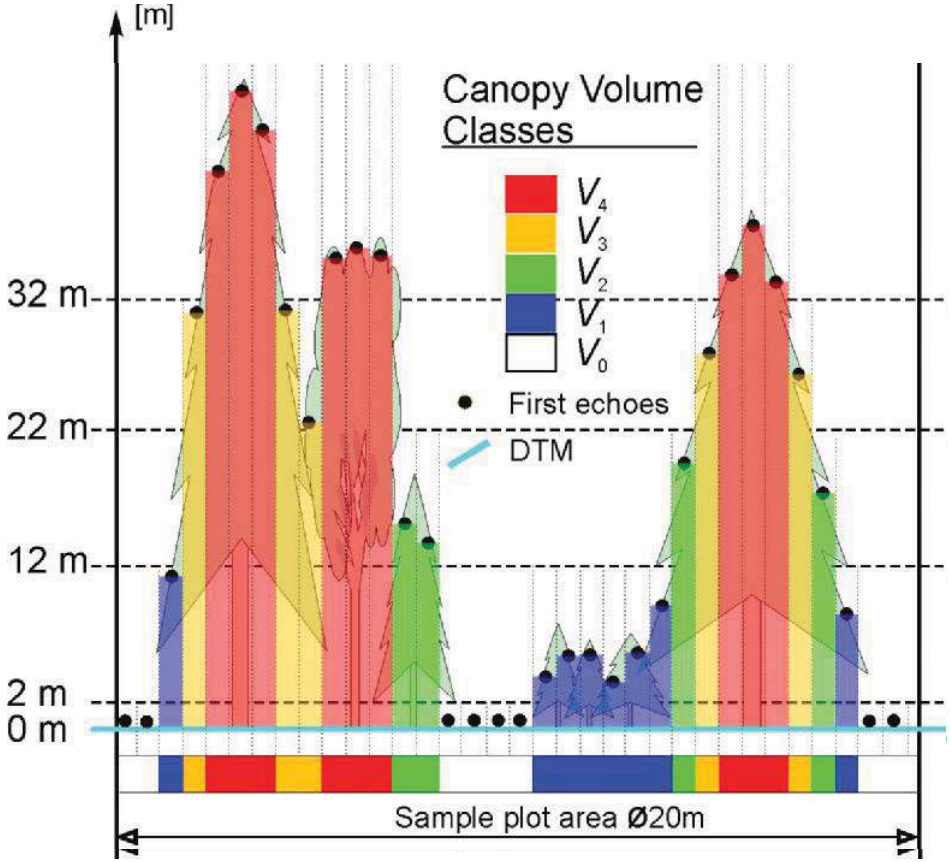
BFW.

Combined use - modelling

Stem volume = Function (canopy volume)

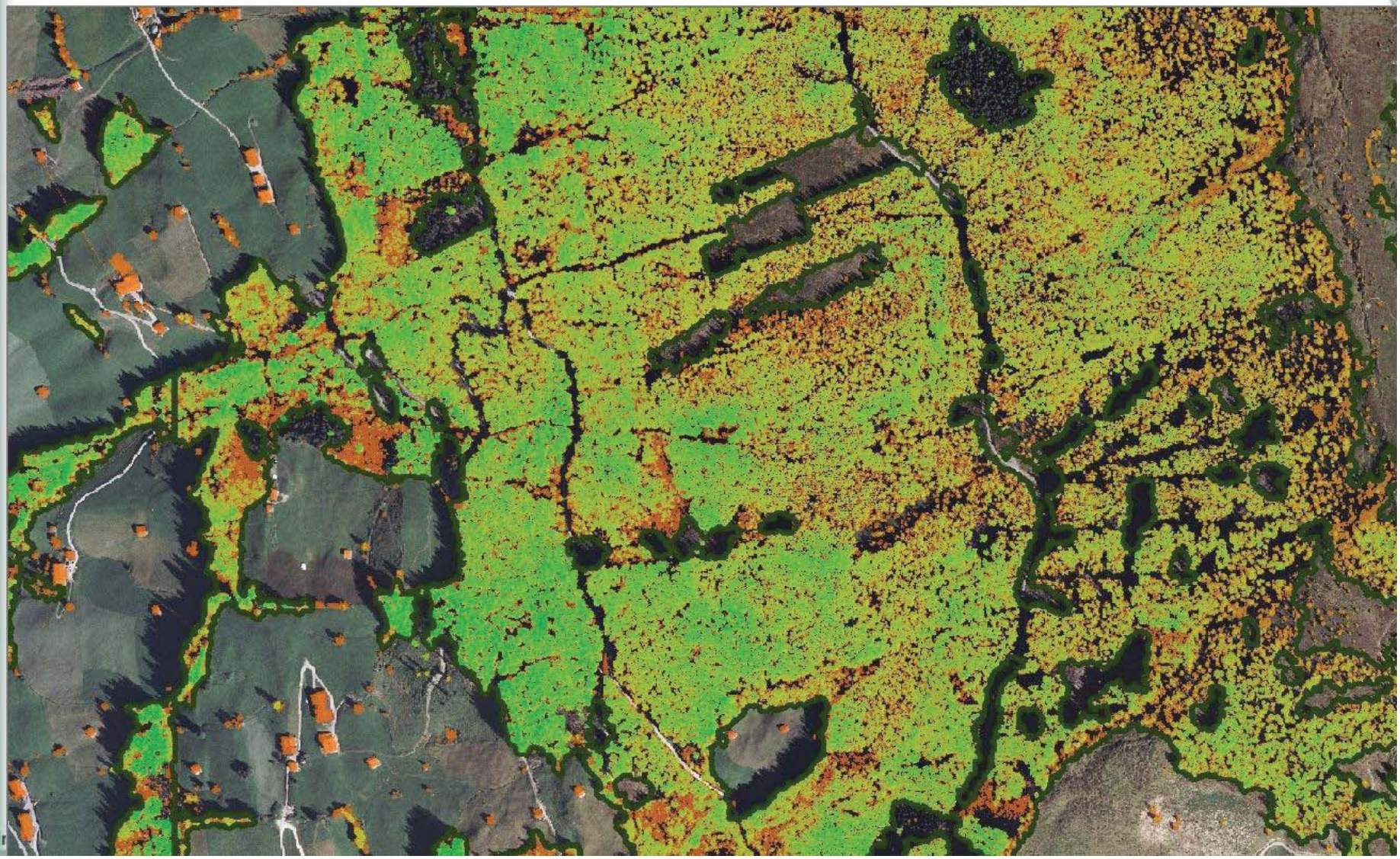
$$v_{\text{stem,fi}} = \sum_{i=1}^{n} \beta_i \cdot v_{\text{can},i}$$

$$v_{\text{can},i} = f_{\text{first-echo},i} \cdot ch_{\text{mean},i}$$



Hollaus et al., 2007

ALS stem volume map



Matching as alternative for ALS DSM for forests

- Yes
  - availability of aerial photos
  - high degree of automatisation
  - radiometric and 3D information from the same date
  - accuracy is high enough for many applications

Matching as alternative for ALS DSM for forests

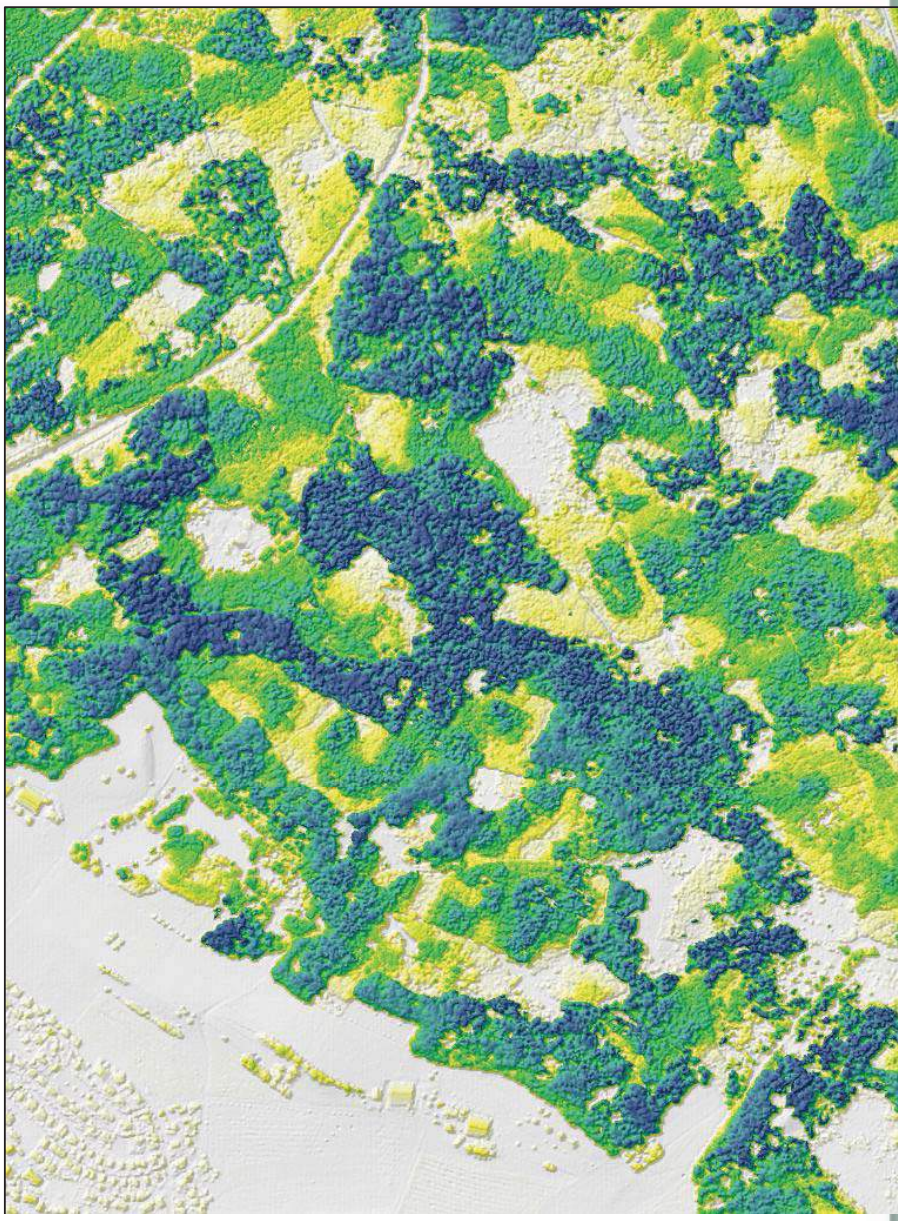
- No
  - for information below the forest canopy
  - terrain information is needed
  - to detect single trees
- Unclear
  - shadows at the forest borderline and inside the forest (forest gaps)

Challenges for matching applications

- Homogenous data sets for all of Austria
  - different qualities of aerial photos
  - different overlaps, light conditions, …
  - software solutions for harmonization?
- Homogeneity in time – change estimation
- huge datasets – hard- and software
  - performance versus quality

BFW.

Thank you for your attention!



Bremgarten (AG): Flugdatum 09.09.2011 Flugdatum 24.06.2010

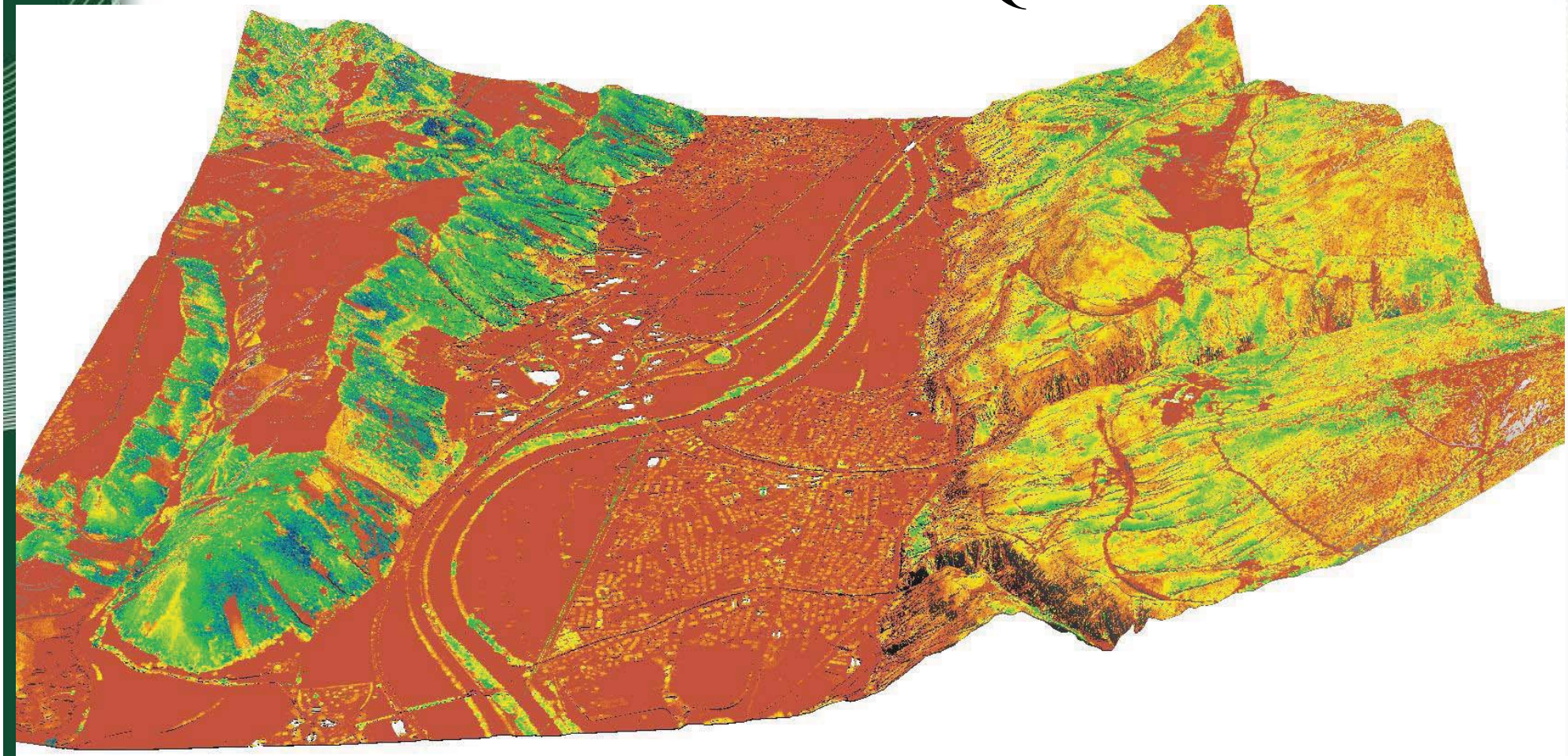
3D Daten aus Luftbildern

Zusätzliche Rauminformationen

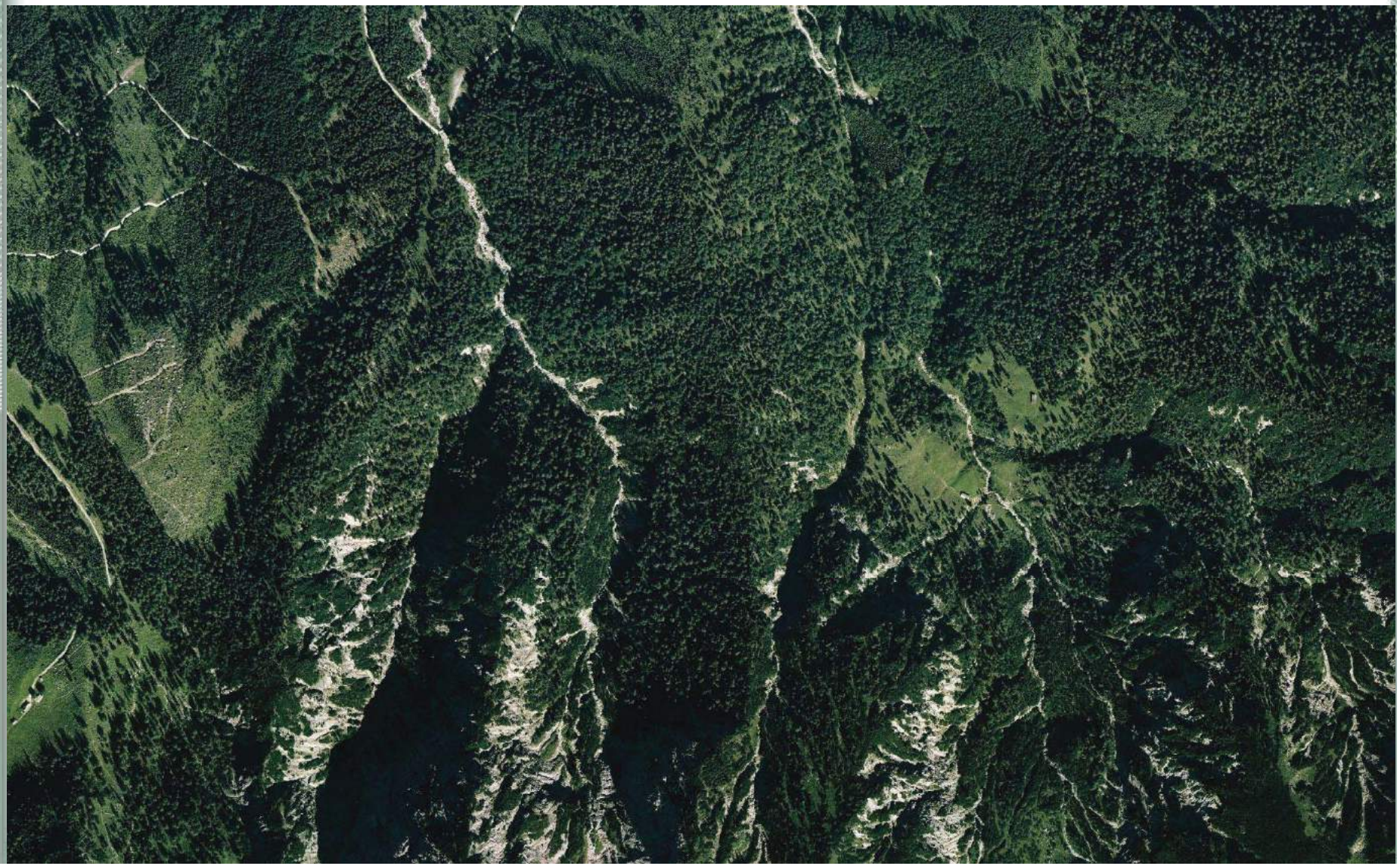
Wildtierhabitate - Qualität

Zusätzliche Rauminformationen

Wildtierhabitate - Qualität

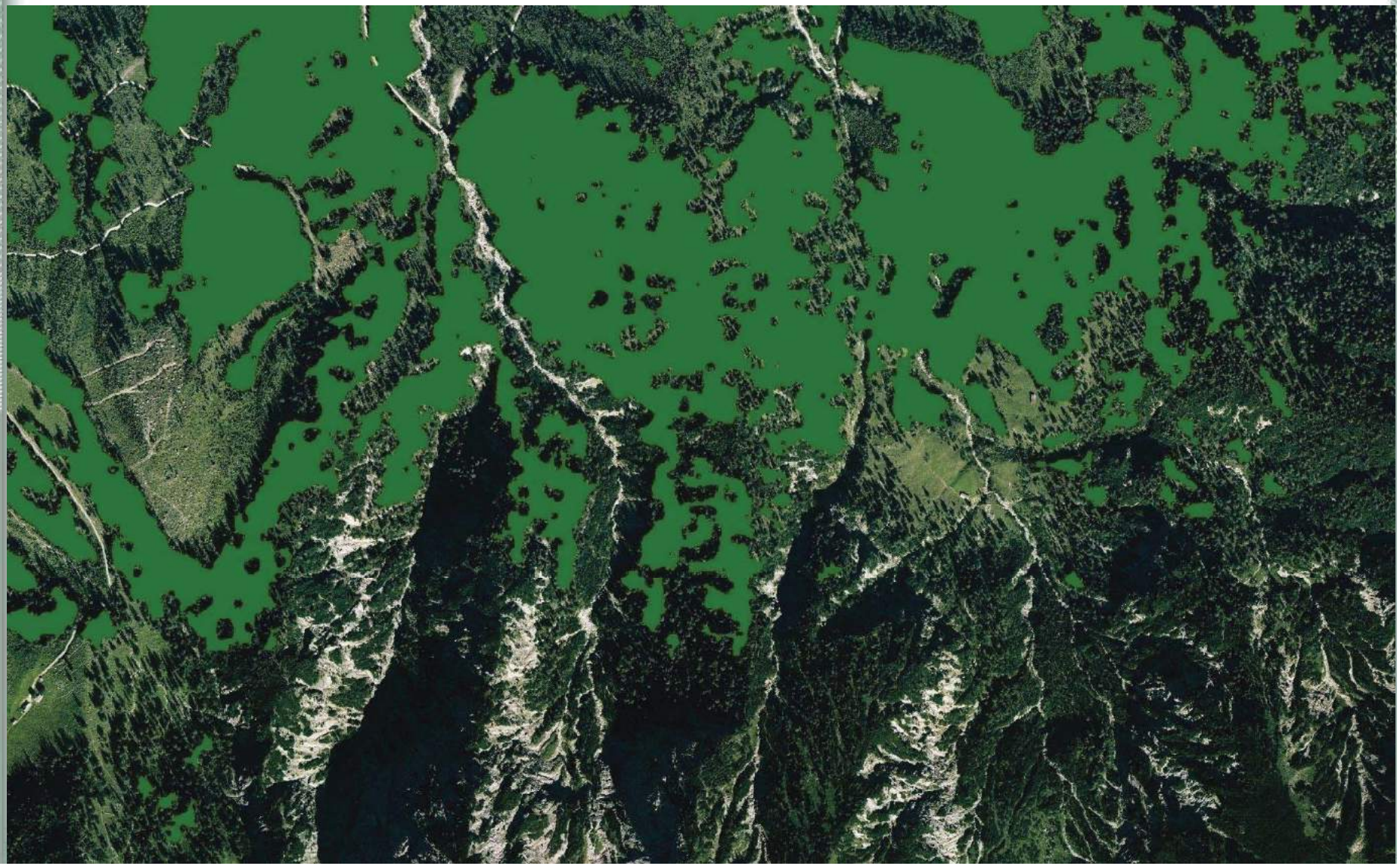


ÖWI Laser-Waldkarte - Walddefinition



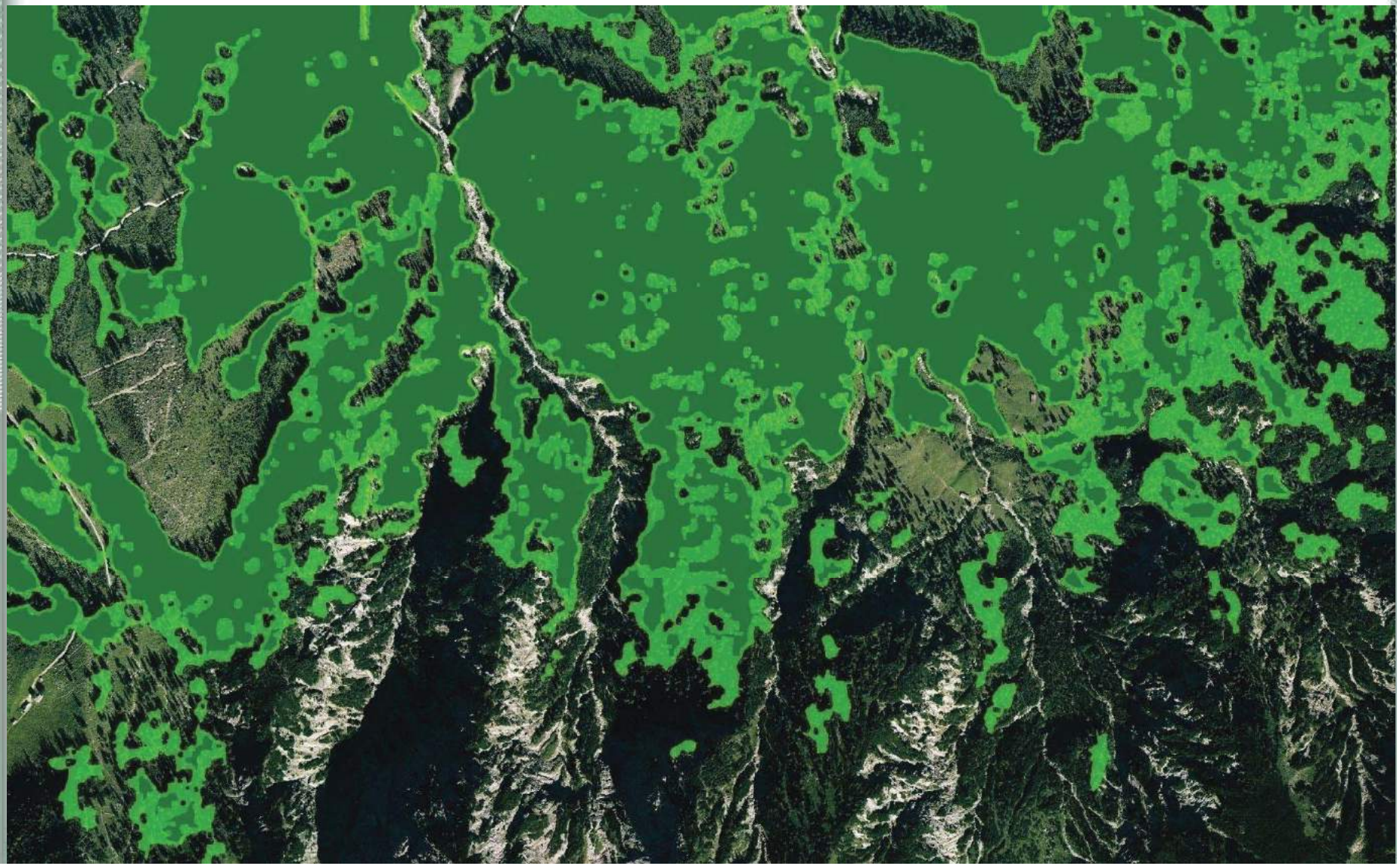
ÖWI Laser-Waldkarte - Walddefinition

Überschirmung 50% Höhe > 2m



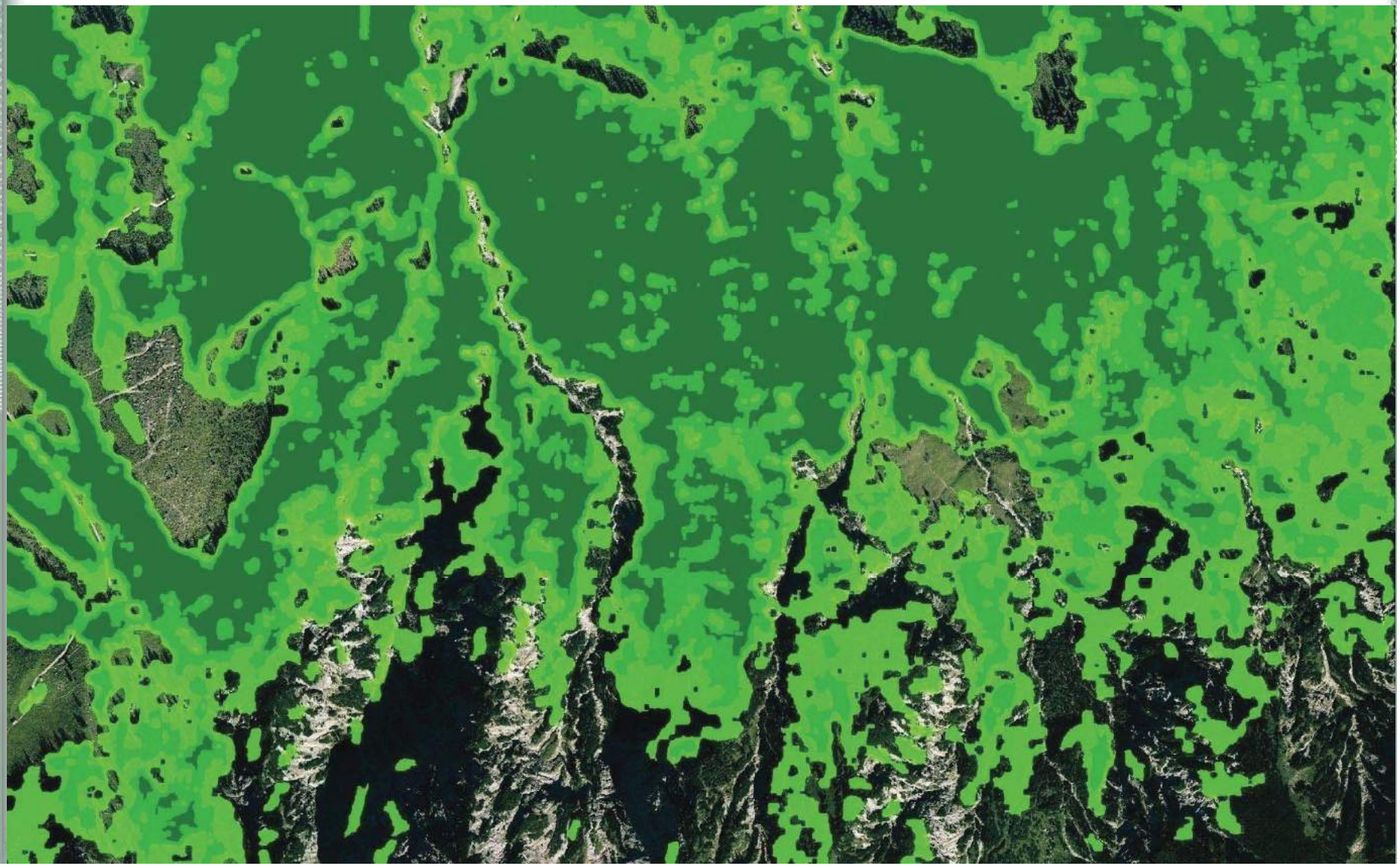
ÖWI Laser-Waldkarte - Walddefinition

Überschirmung 50%, 30% Höhe > 2m



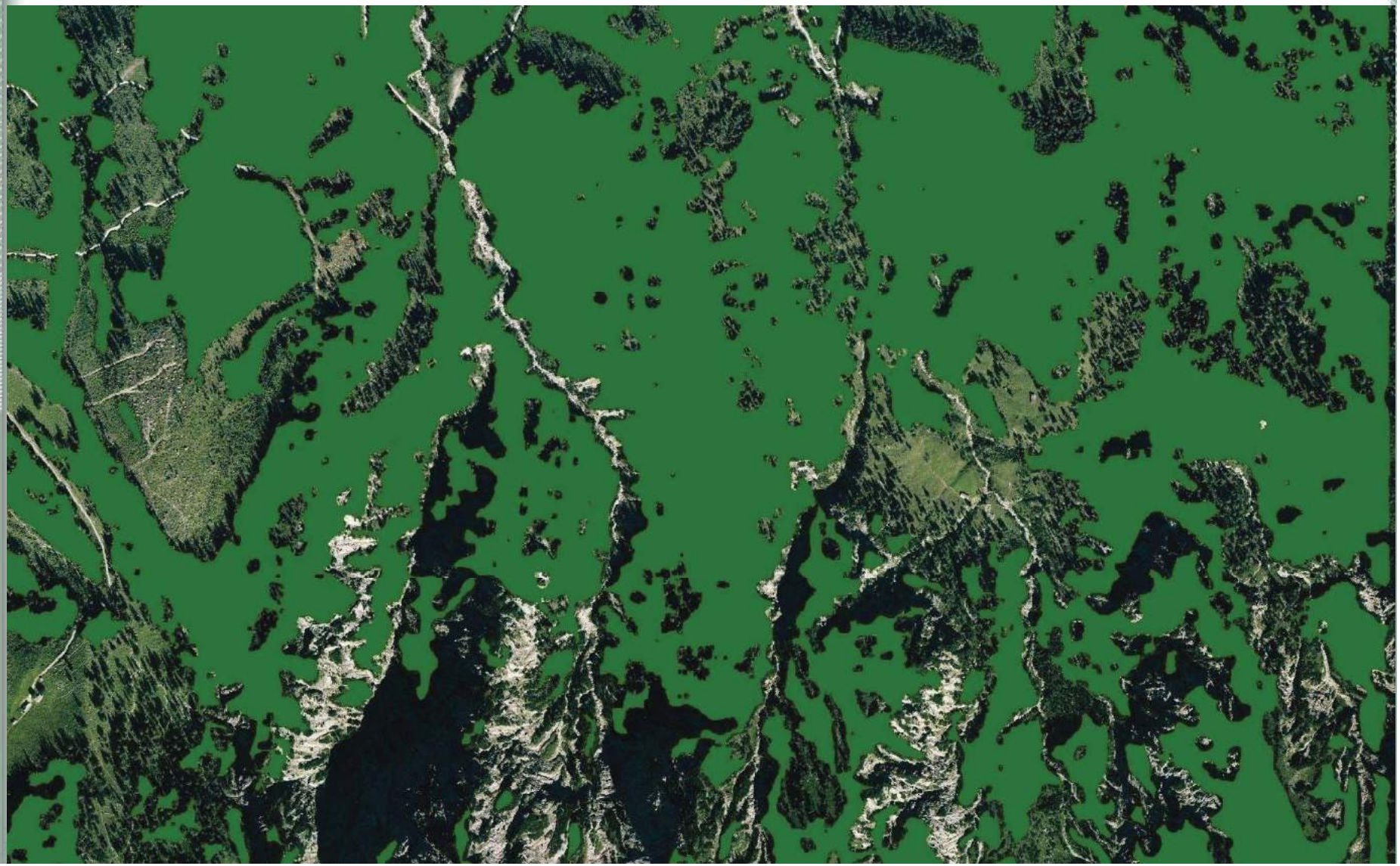
ÖWI Laser-Waldkarte

Überschirmung 50%, 30%, 10% Höhe > 2m



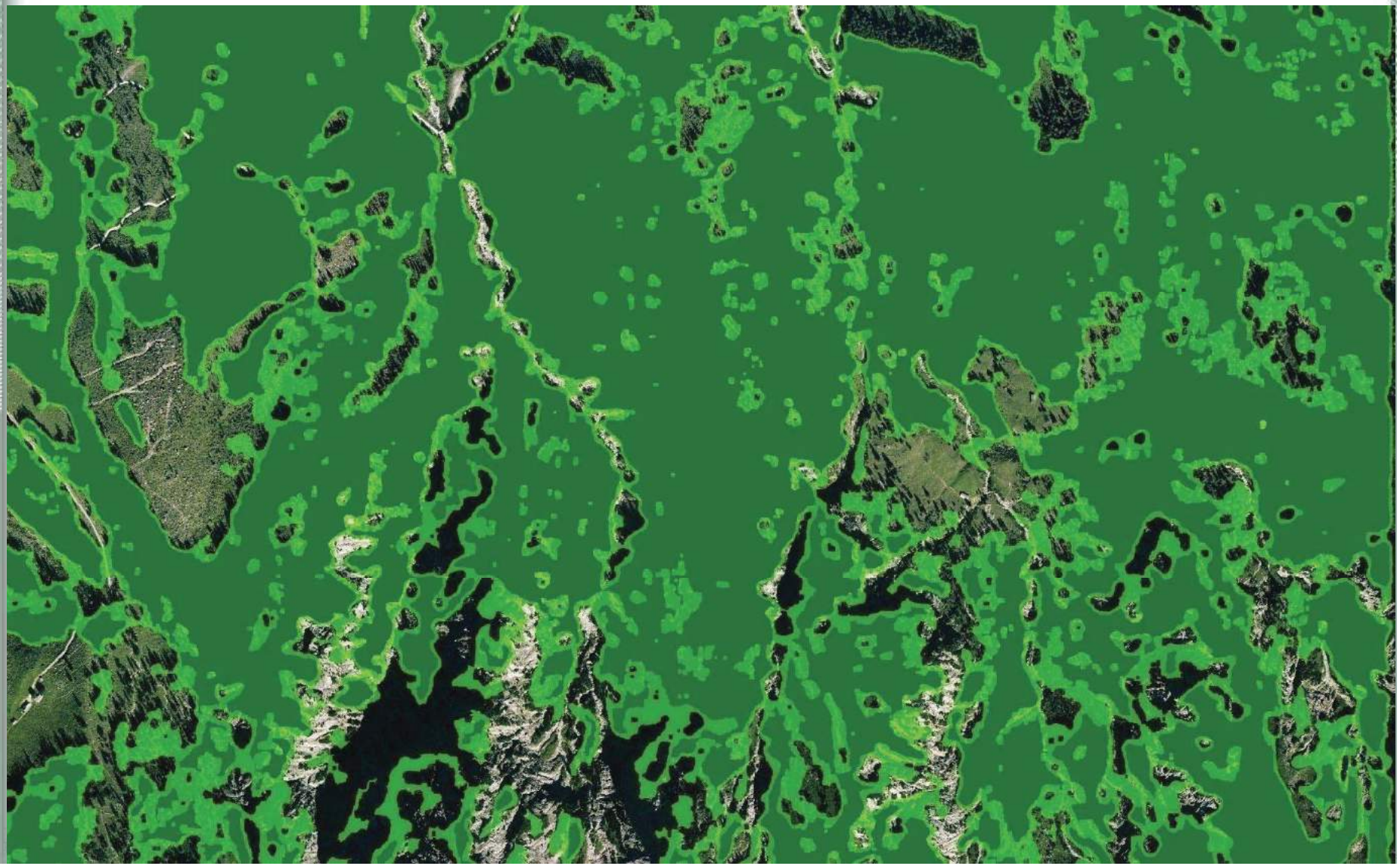
ÖWI Laser-Waldkarte

Überschirmung 50% Höhe > 0,5m



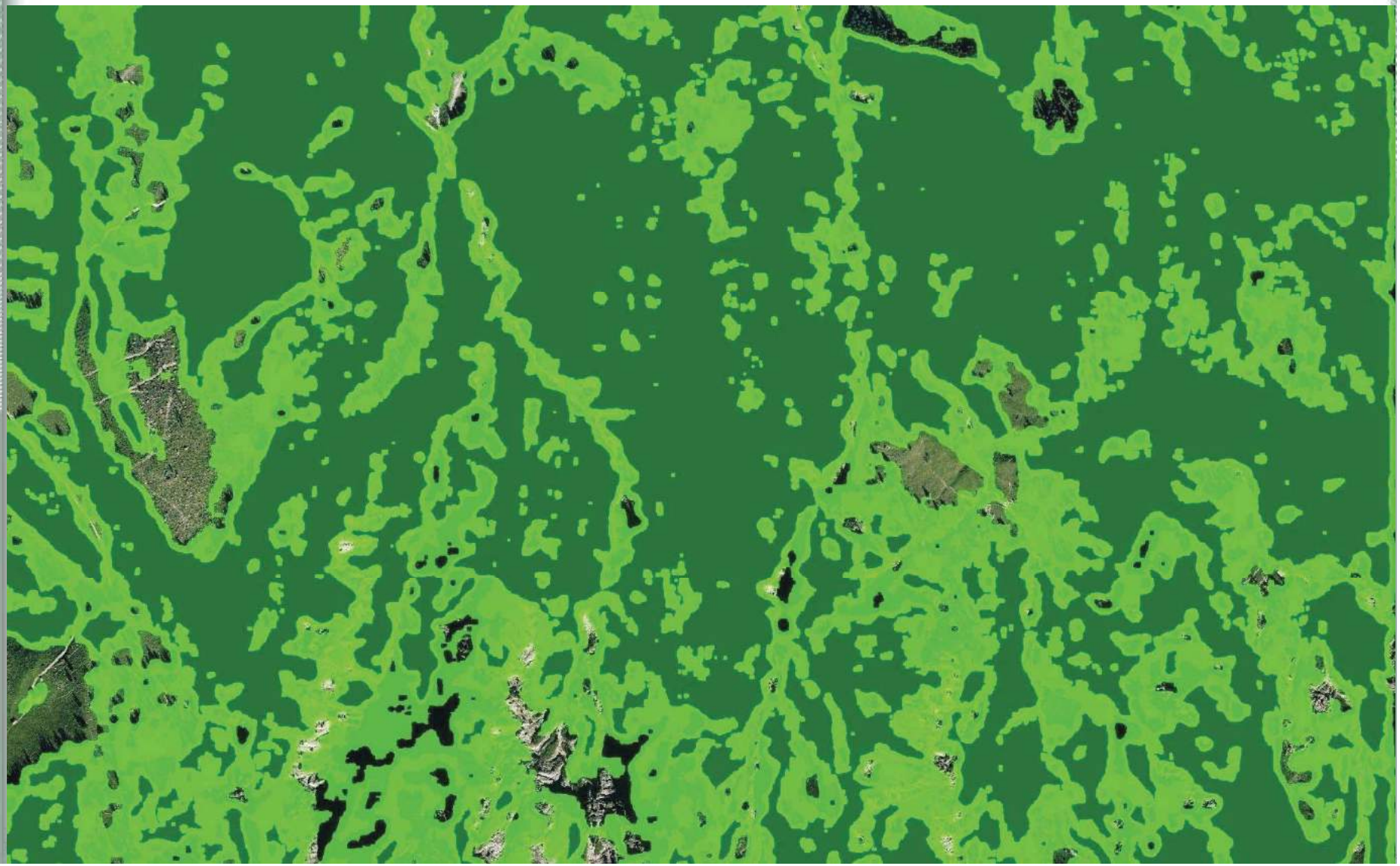
ÖWI Laser-Waldkarte

Überschirmung 50%, 30% Höhe > 0,5m



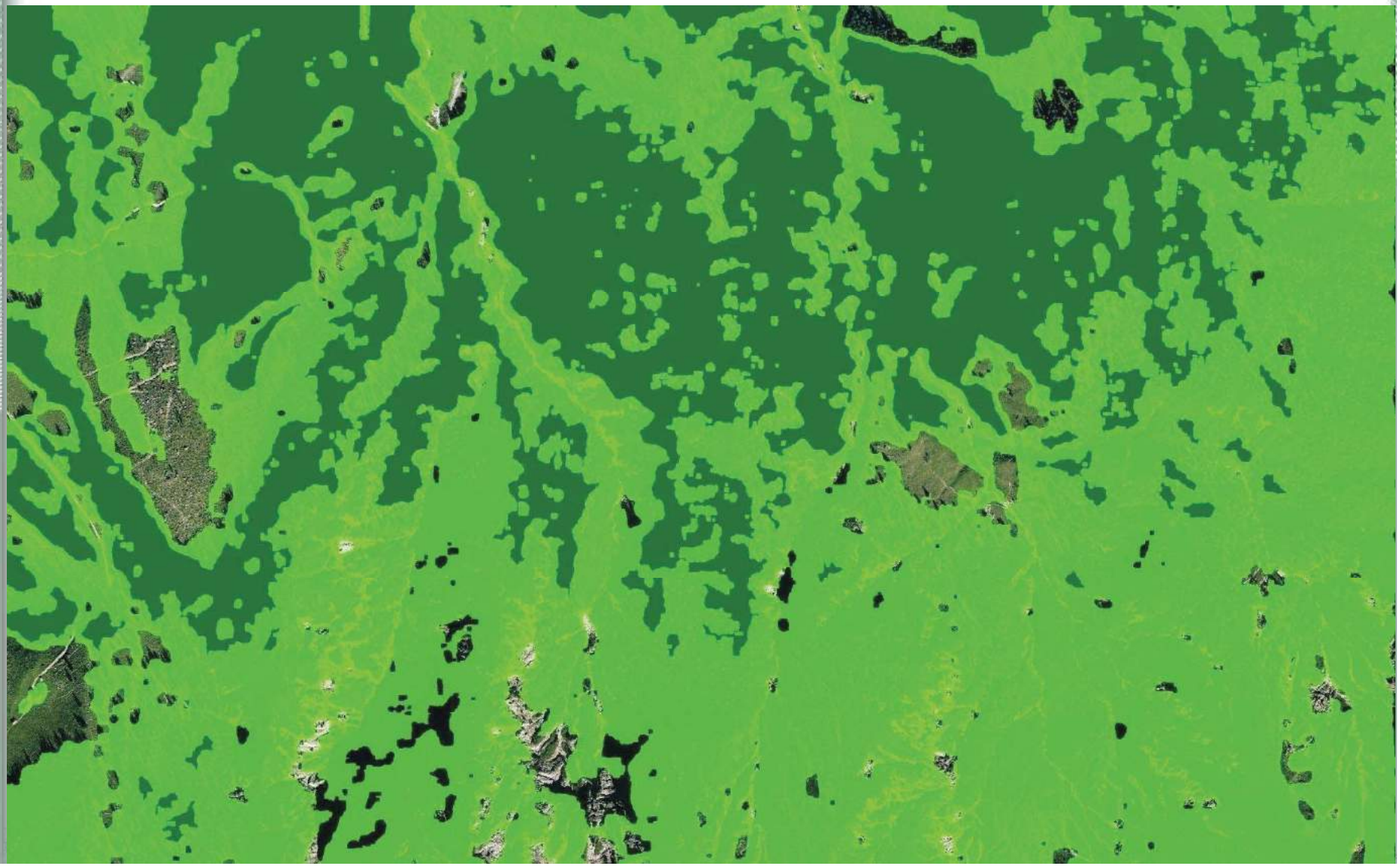
ÖWI Laser-Waldkarte

Überschirmung 50%, 30%, 10% Höhe > 0,5m



ÖWI Laser-Waldkarte

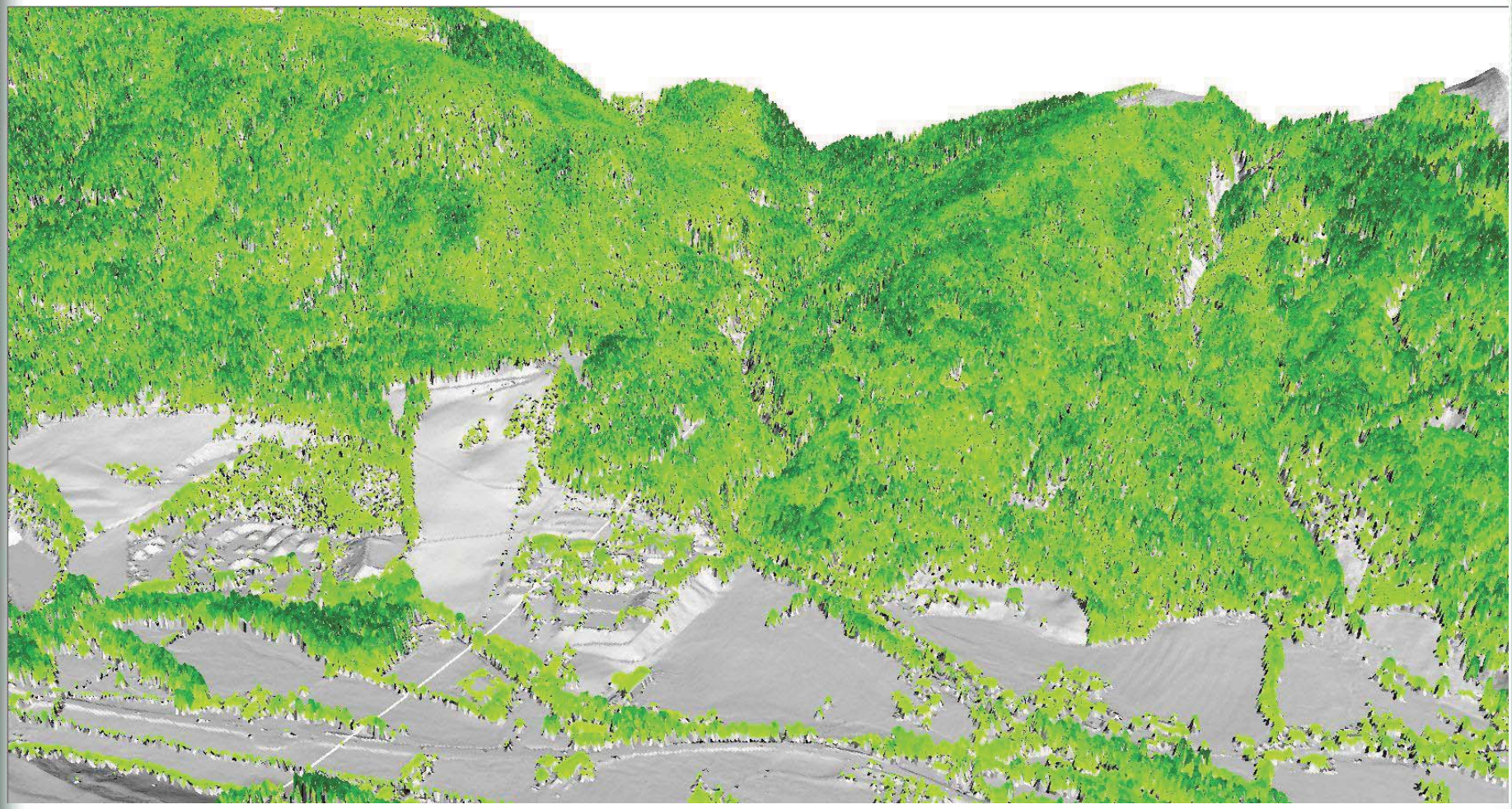
Überschirmung 50%, 10% Höhe > 2m, 0,5m



ÖWI - Zukunft - Fernerkundung

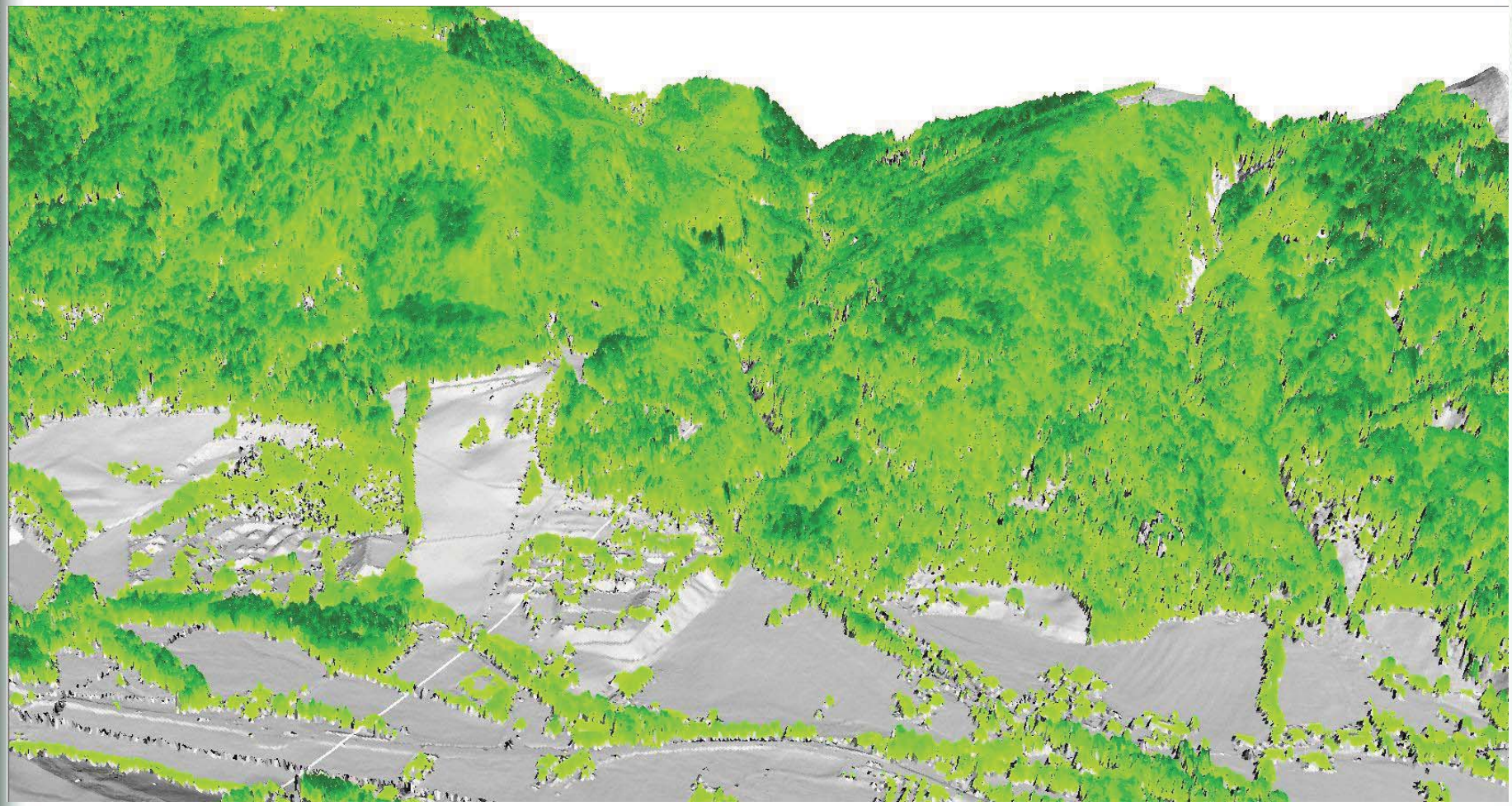
ÖWI - Zukunft - Fernerkundung

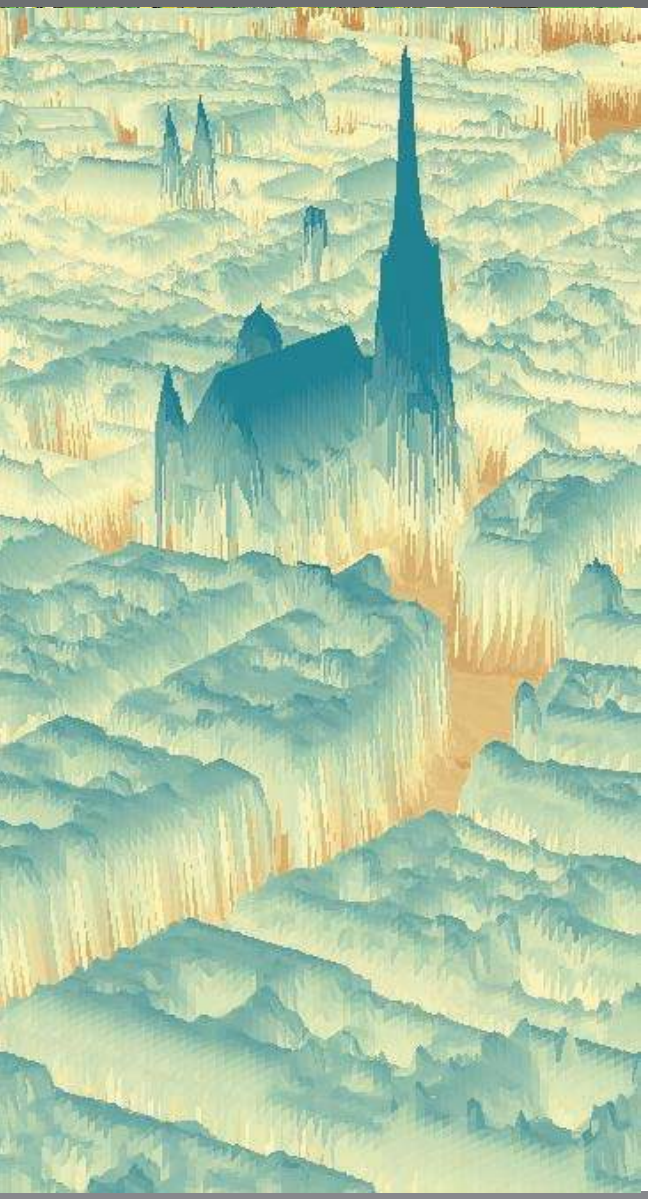
Laser Oberflächenmodell



ÖWI - Zukunft - Fernerkundung

Luftbild Oberflächenmodell





DSM – Applications and Requirements

from the perspective of the Vienna City Administration

Dipl.-Ing. Hubert Lehner
hubert.lehner@wien.gv.at

Wien! voraus Stadtvermessung

StaDt Wien

Visibility studies

Schönbrunn

objective verification
for sensitive
building projects

protection of World
Heritage Sites

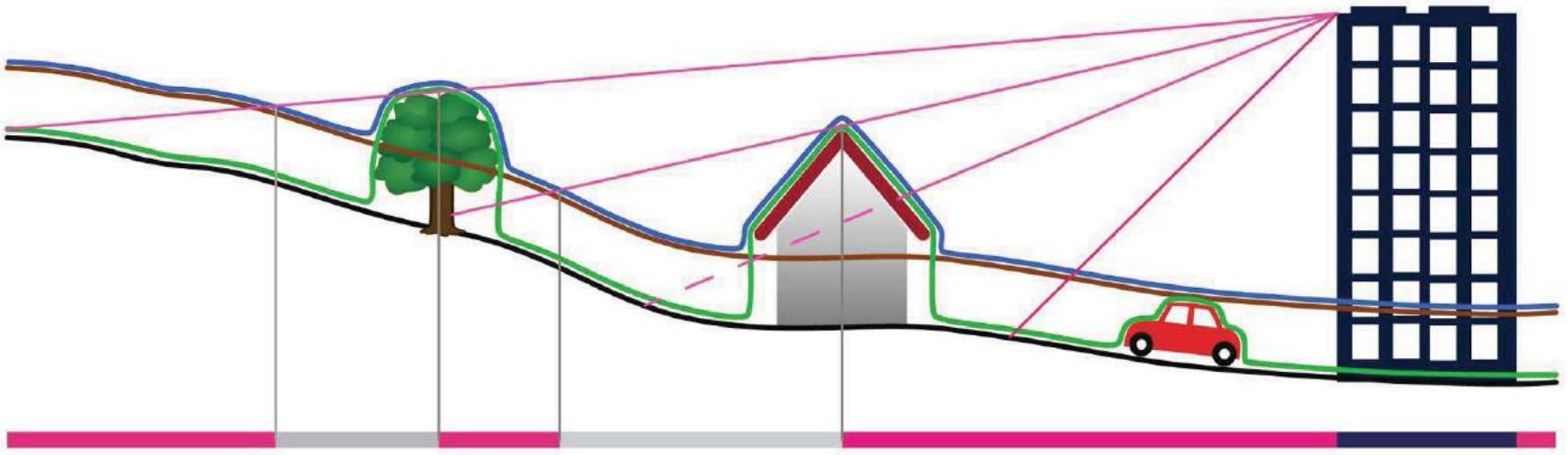
Wien! voraus
Stadtvermessung

StaDt Wien

Visibility studies

Principle

DTM
DSM
DTM raised to eye level
Combined model for visibility studies



visible not visible

Wien! voraus Stadtvermessung

StaDt Wien

Visibility studies

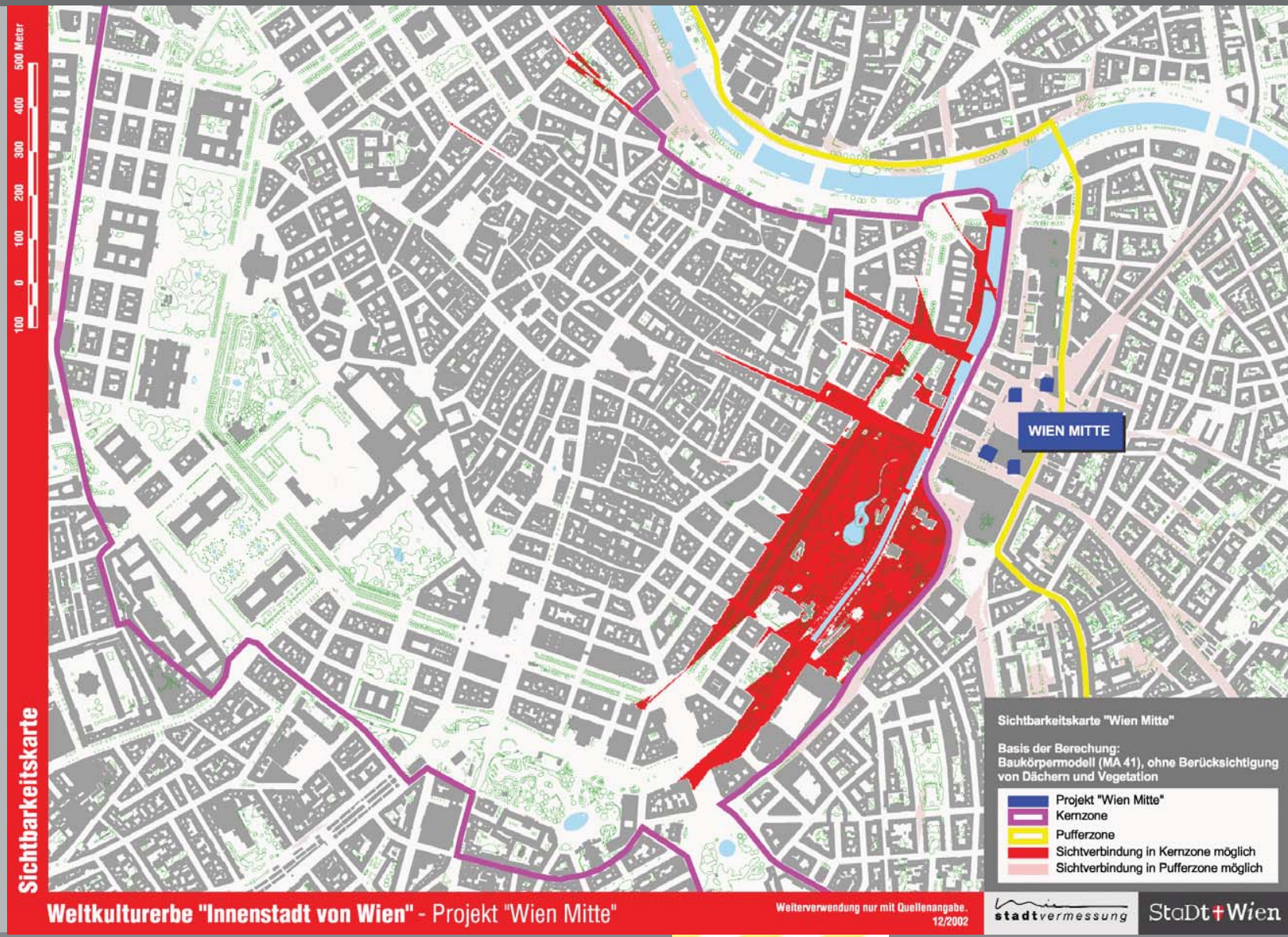
Historic Centre of Vienna

2002

DSM = DTM + building polygons and building heights

vegetation not represented

see Stadtpark



Visibility studies

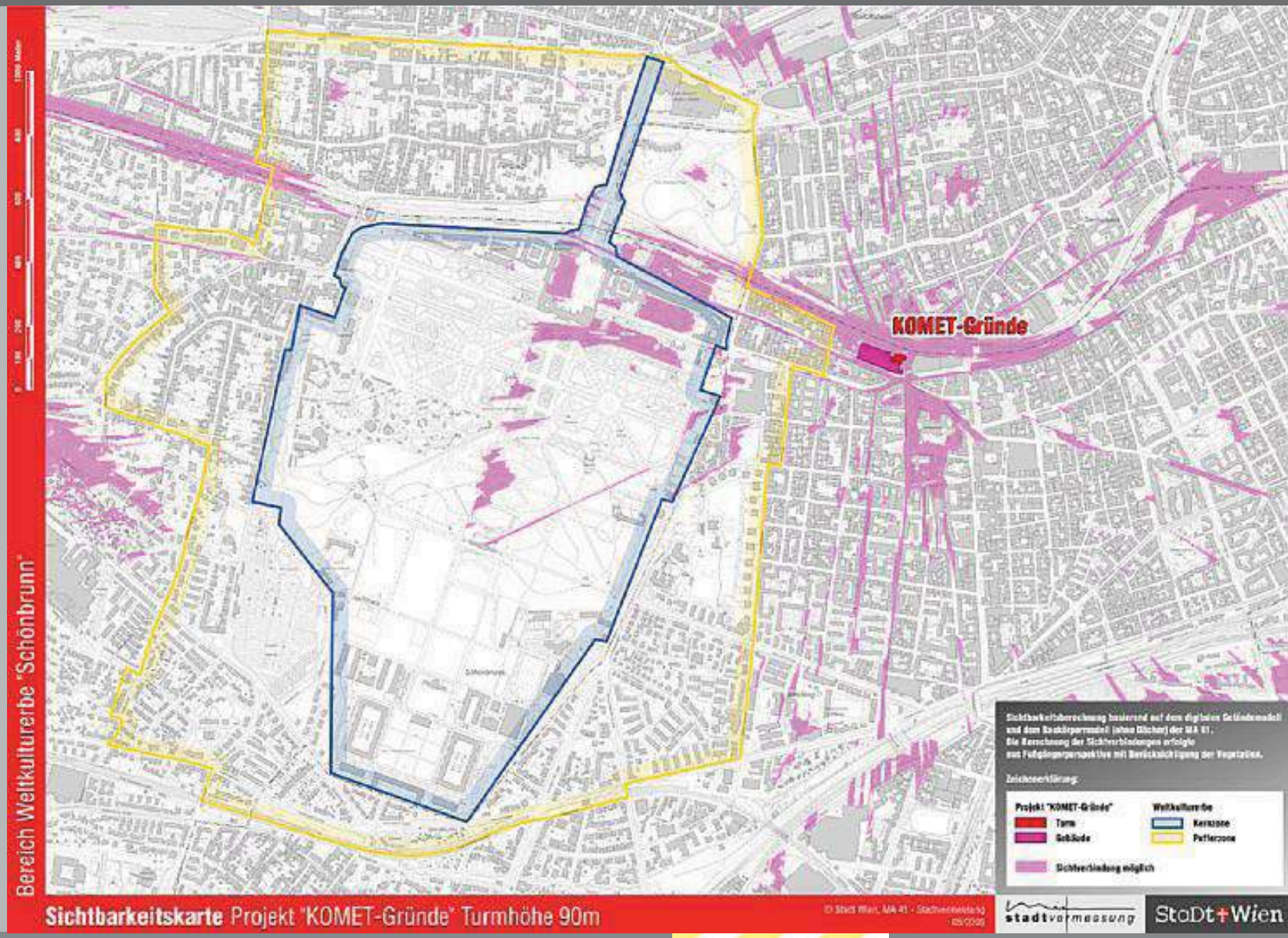
Schönbrunn

2007

ALS based DSM

vegetation is represented

height of the project: **90 meters**



Wien! voraus Stadtvermessung

StaDt+Wien

Visibility studies

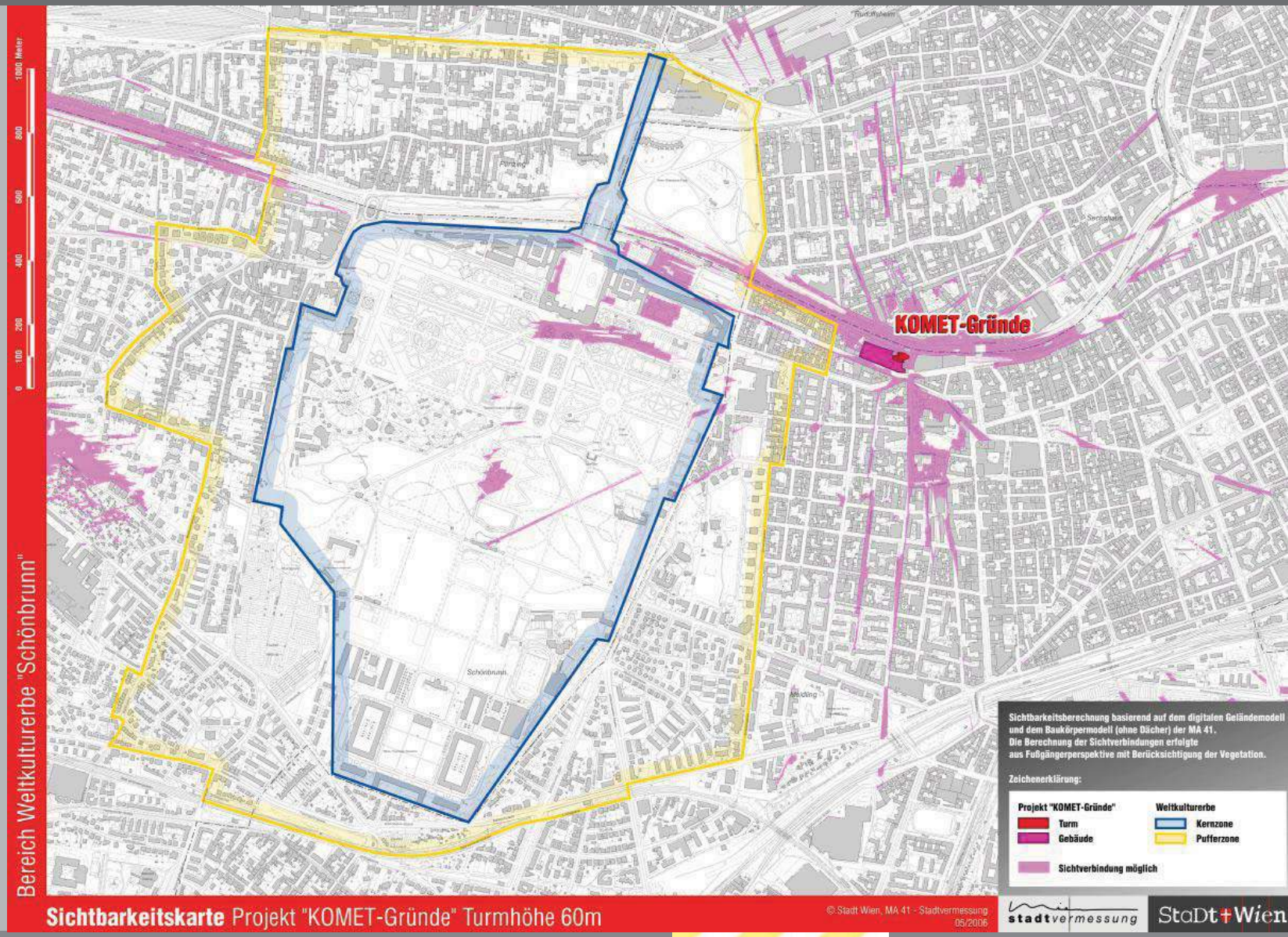
Schönbrunn

2007

ALS based DSM

vegetation is represented

height of the project: **60 meters**



Wien! voraus Stadtvermessung

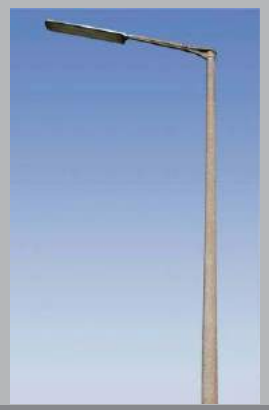
StaDt+Wien

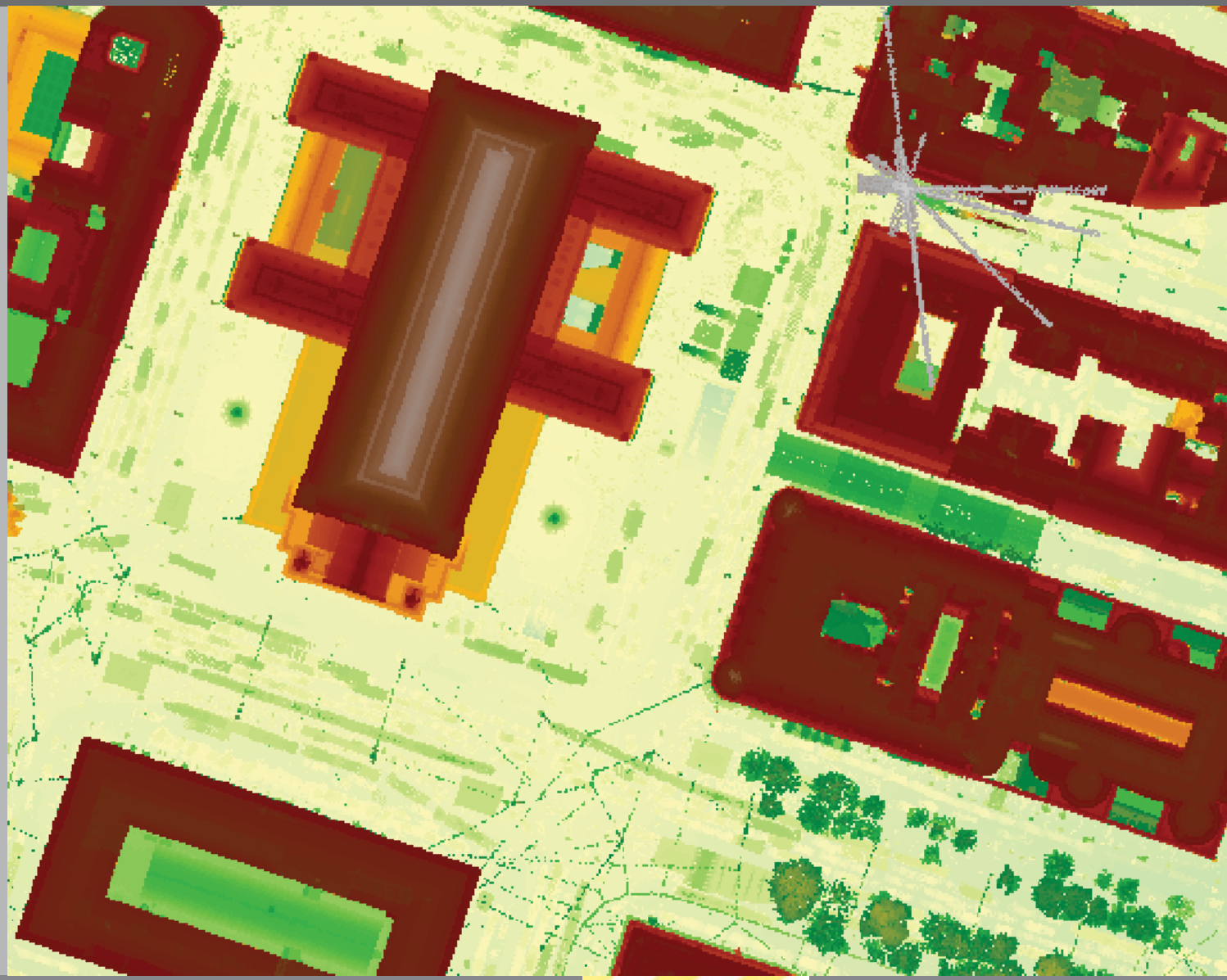
Visibility studies

challenges:

cranes
open wires of trams
street lamps

⇨ act as
nontransparent
curtains





Wien! voraus
Stadtvermessung

StaDt Wien

Potential for Roof Greening (MA22 - Environmental Protection)

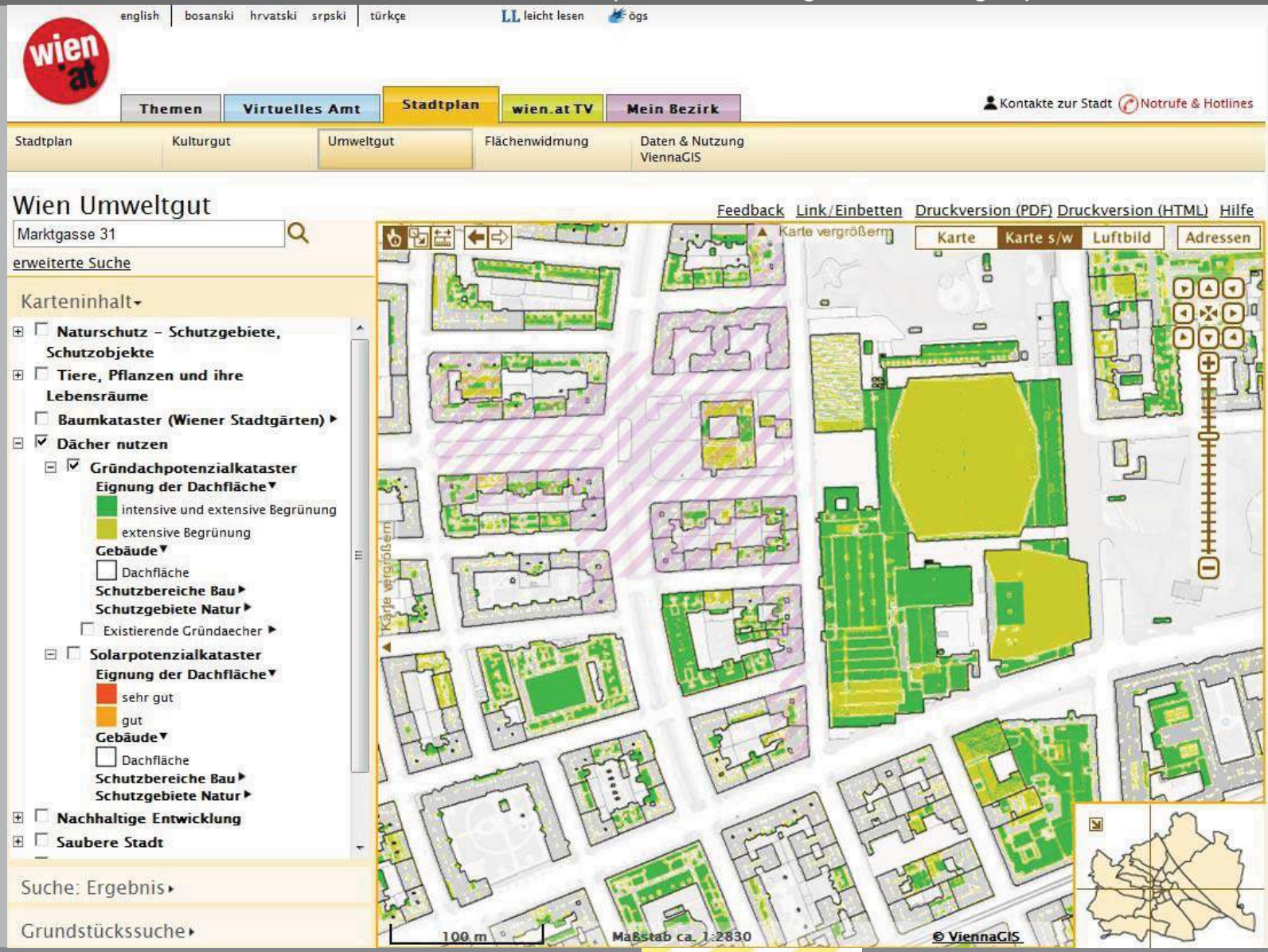
http://www.wien.gv.at/umweltgut/public/

2011

ALS based DSM

⇨ inclination of roof surfaces

⇨ classified for the potential for roof greening



Wien! voraus Stadtvermessung

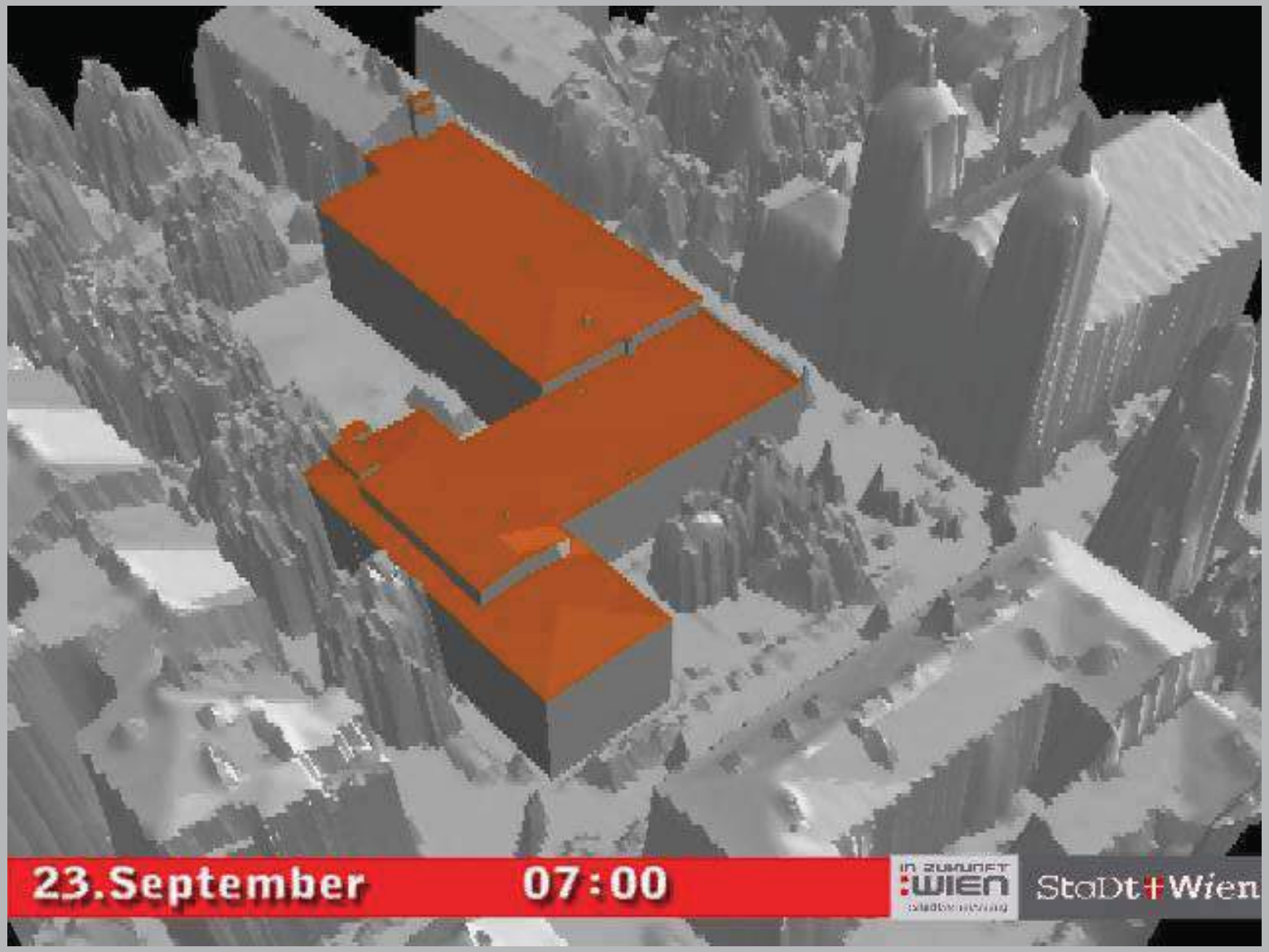
StaDt Wien

Shadow Analysis

2010

ALS based DSM

building model of
a school building



Wien! voraus
Stadtvermessung

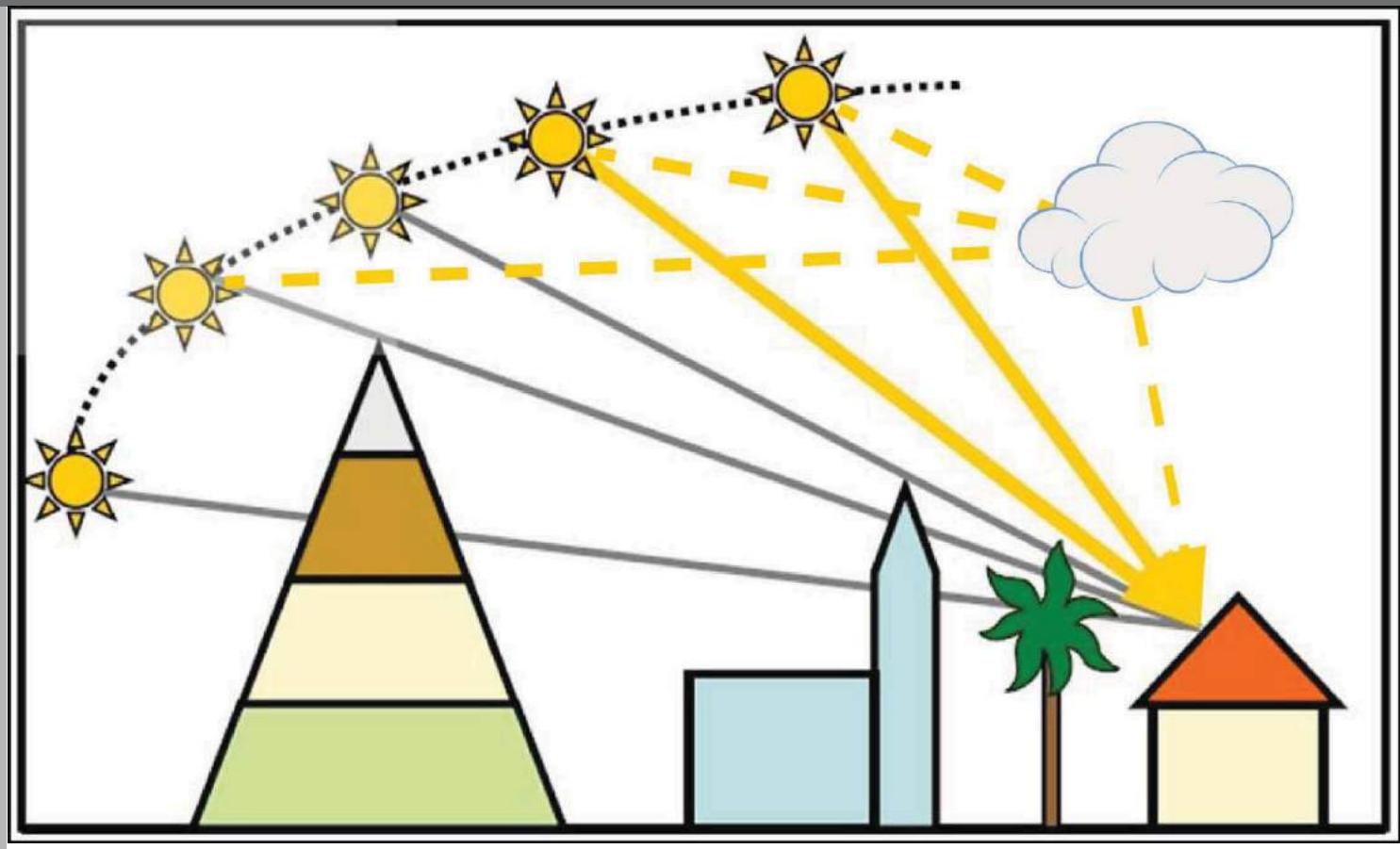
StaDt+Wien

Potential for photovoltaic and solar heat

Principle

modelling of solar radiation (direct and scattered)

shadows



Potential for photovoltaic and solar heat

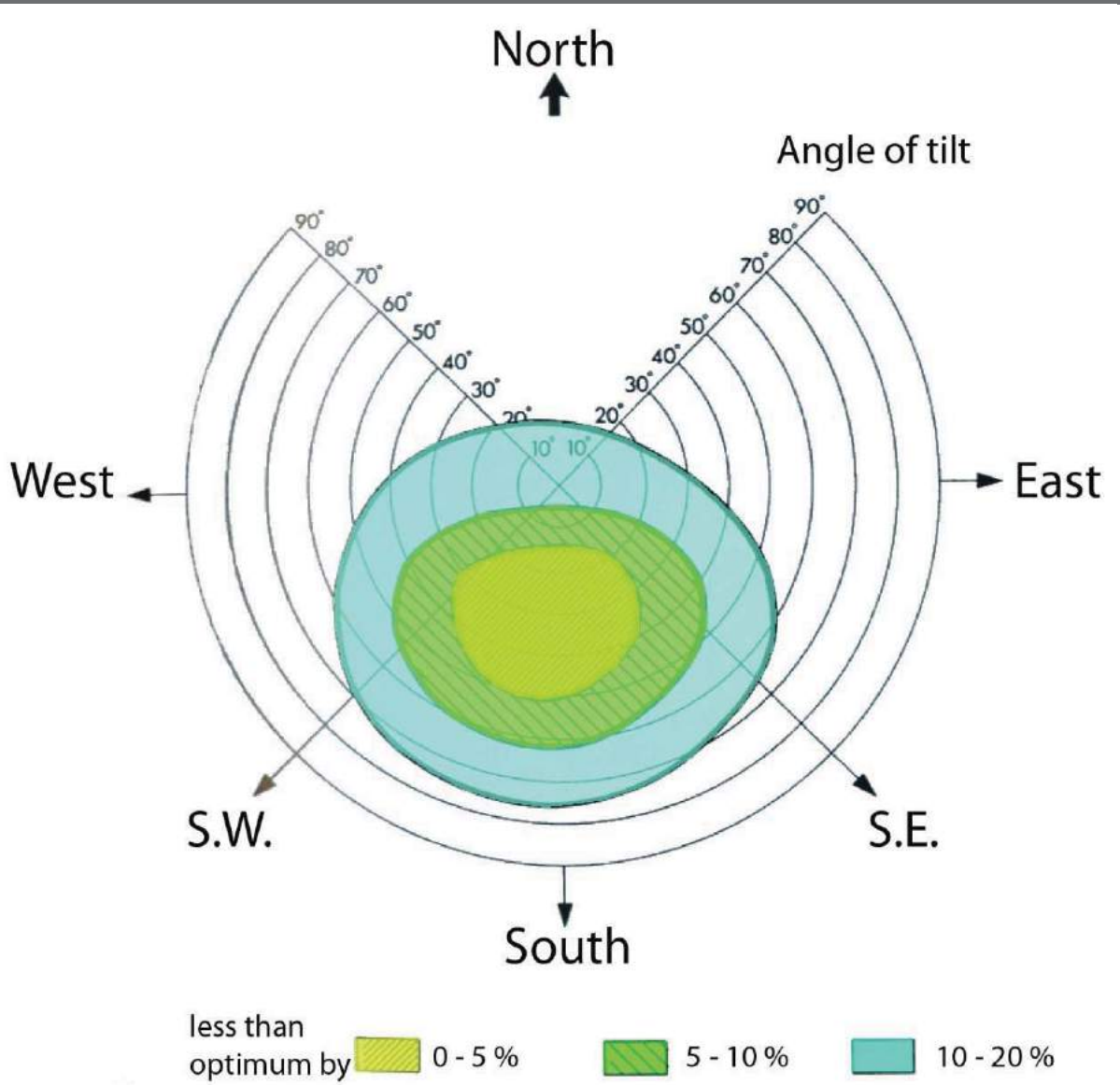
Principle

modelling of solar radiation (direct and scattered)

shadows

orientation

inclination



Wien! voraus Stadtvermessung

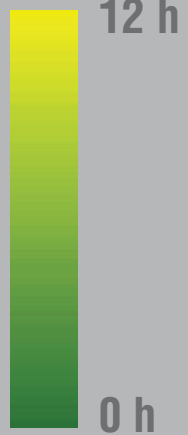
StaDt Wien

Potential for photovoltaic and solar heat

2010

ALS based DSM

calculation of average daily sunshine per year



Wien! voraus Stadtvermessung

StaDt Wien

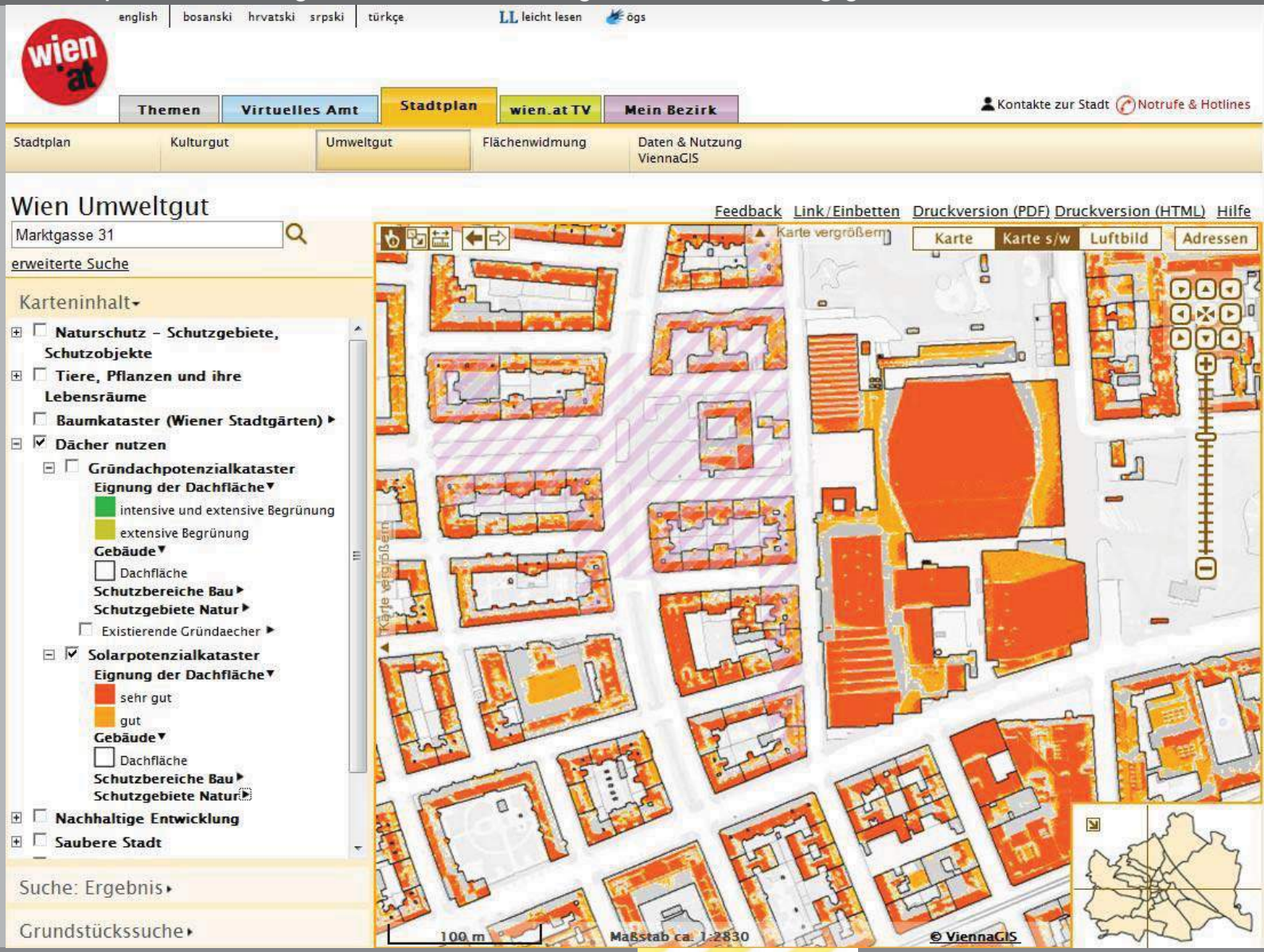
Potential for photovoltaic and solar heat

http://www.wien.gv.at/stadtentwicklung/stadtvermessung/geodaten/solar/index.html

2010

ALS based DSM

calculation of solar potential

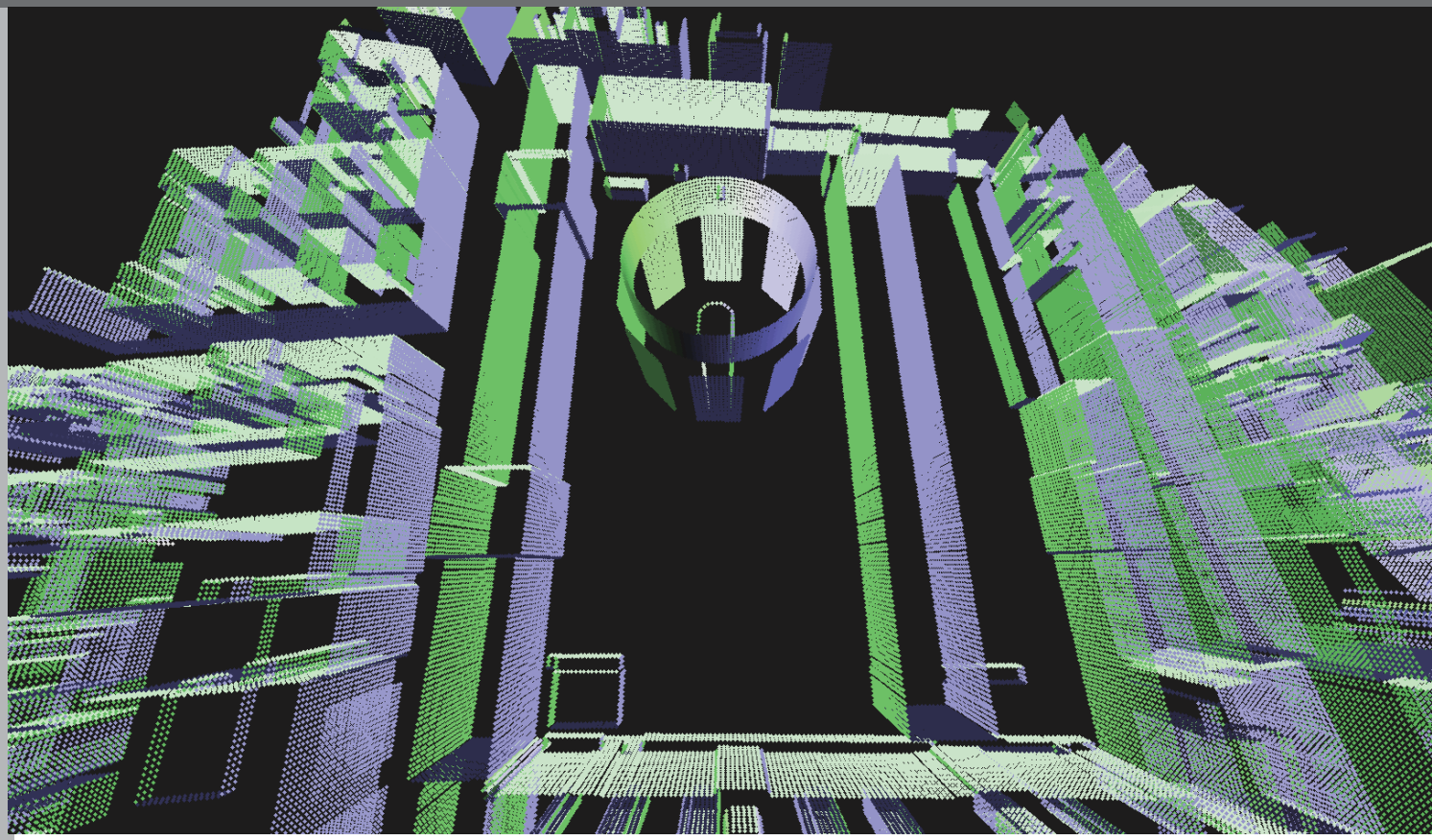


Wien! voraus Stadtvermessung

StaDt+Wien

Potential for photovoltaic and solar heat 3D

orientation of the building facades



Wien! voraus Stadtvermessung

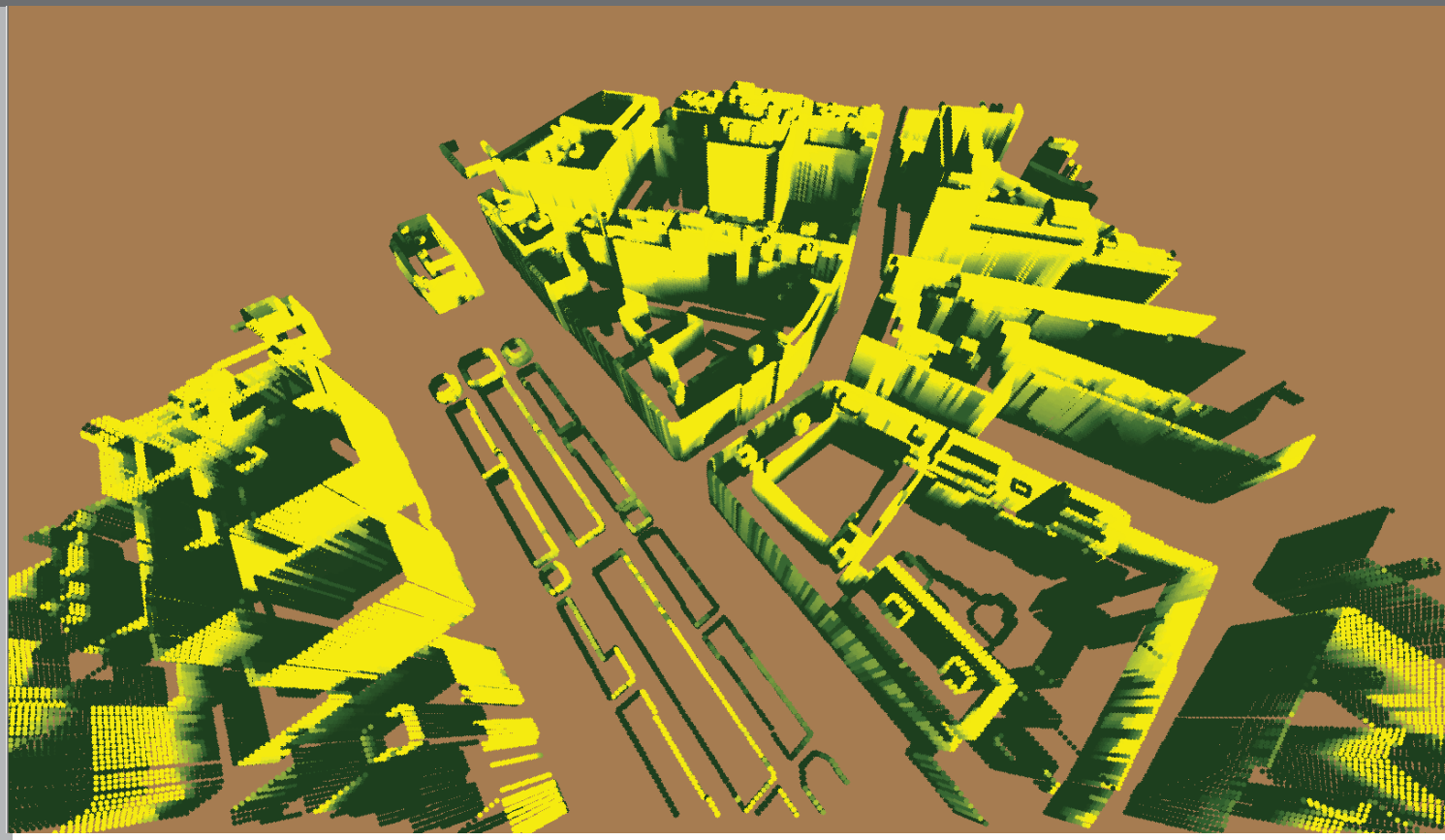
StaDt Wien

Potential for photovoltaic and solar heat 3D

2010

ALS DSM

average hours of sunshine per day



0 hours of sunshine per day 12

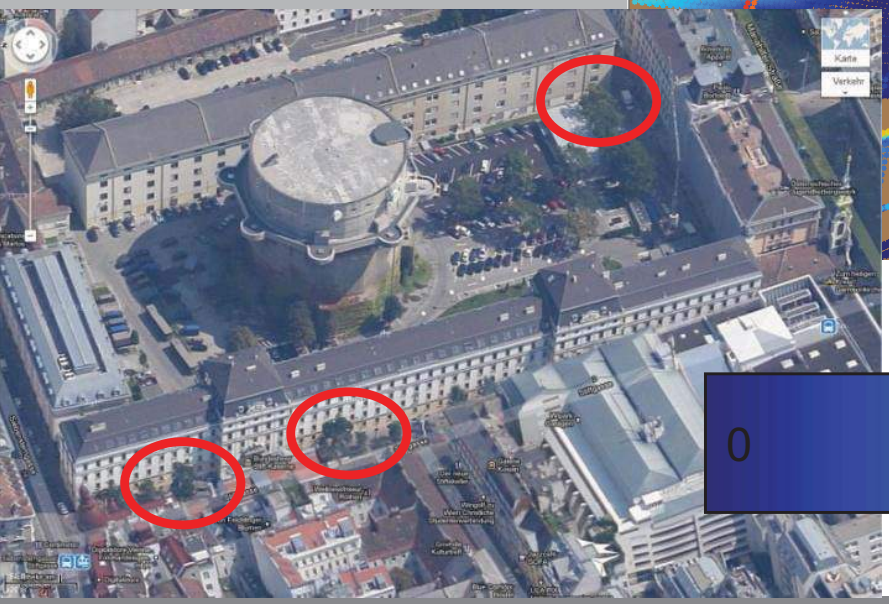
Wien! voraus Stadtvermessung

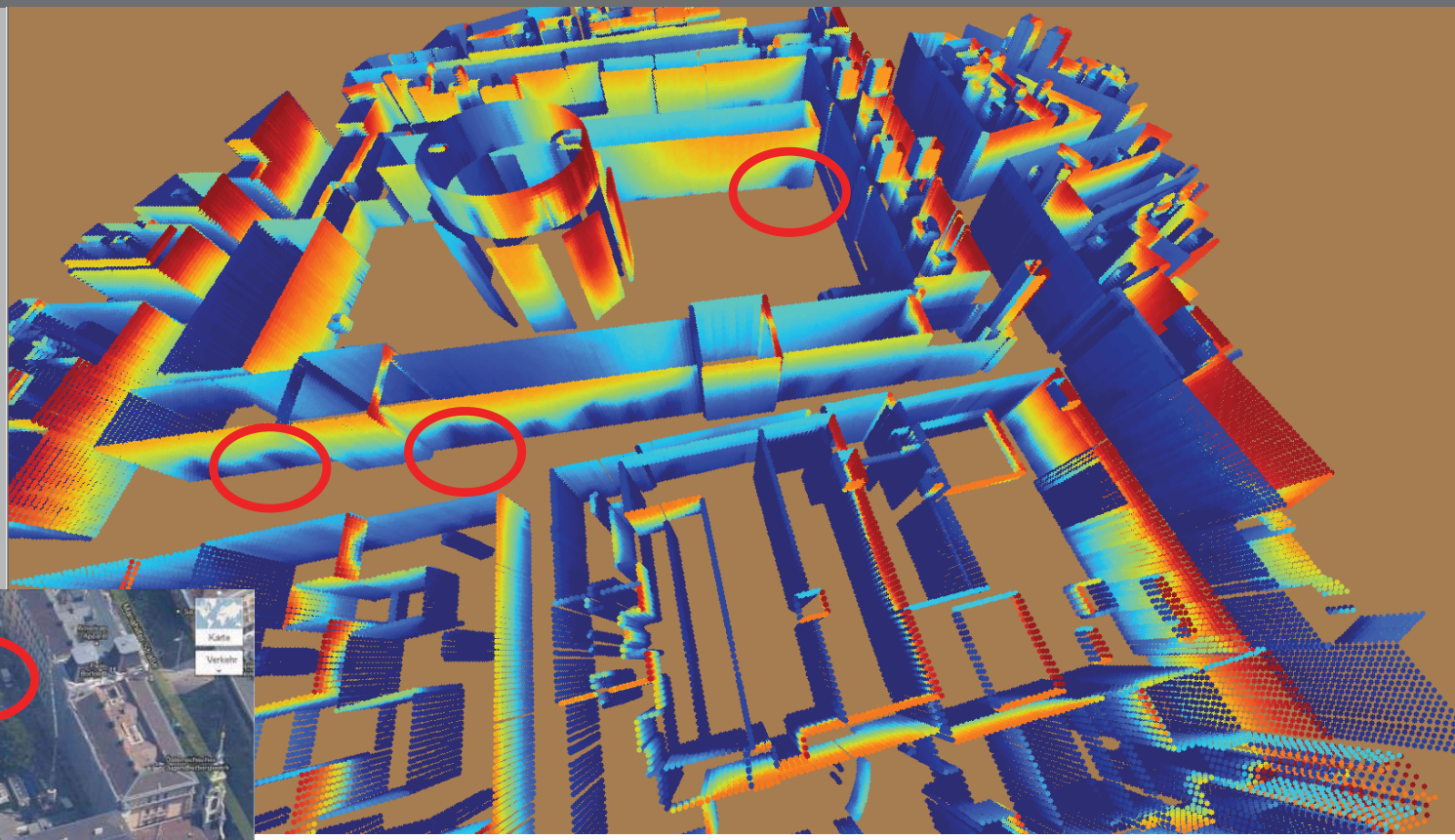
StaDt Wien

Potential for photovoltaic and solar heat 3D

Solar potential per day [kWh/m²]

shadows caused by trees



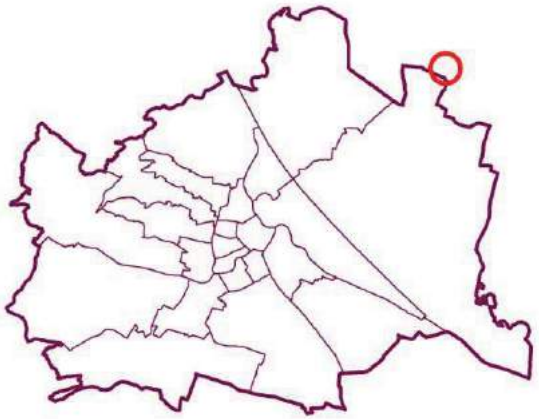


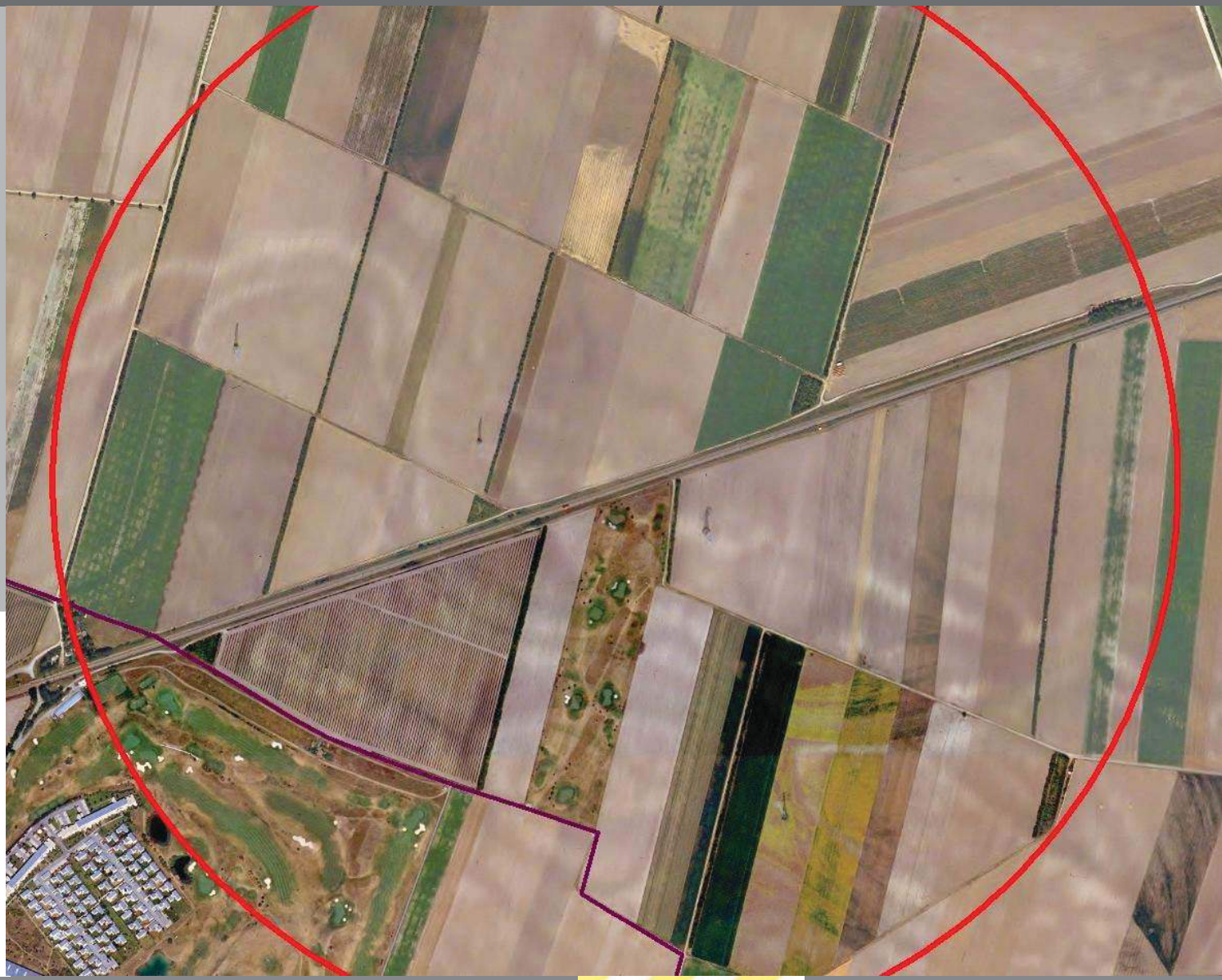
Wien! voraus Stadtvermessung

StaDt Wien

Updating DTM

Orthophoto 2003





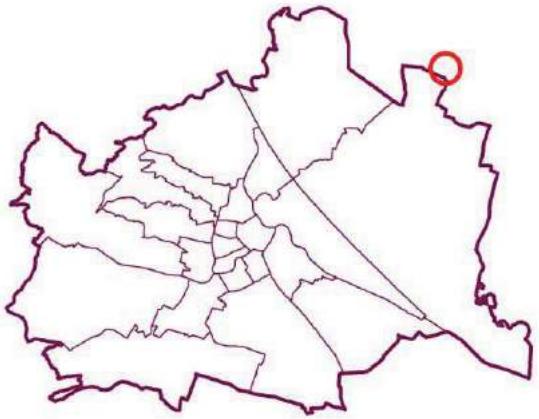
Wien! voraus
Stadtvermessung

StaDt Wien

Updating DTM

Orthophoto 2003

Orthophoto 2012



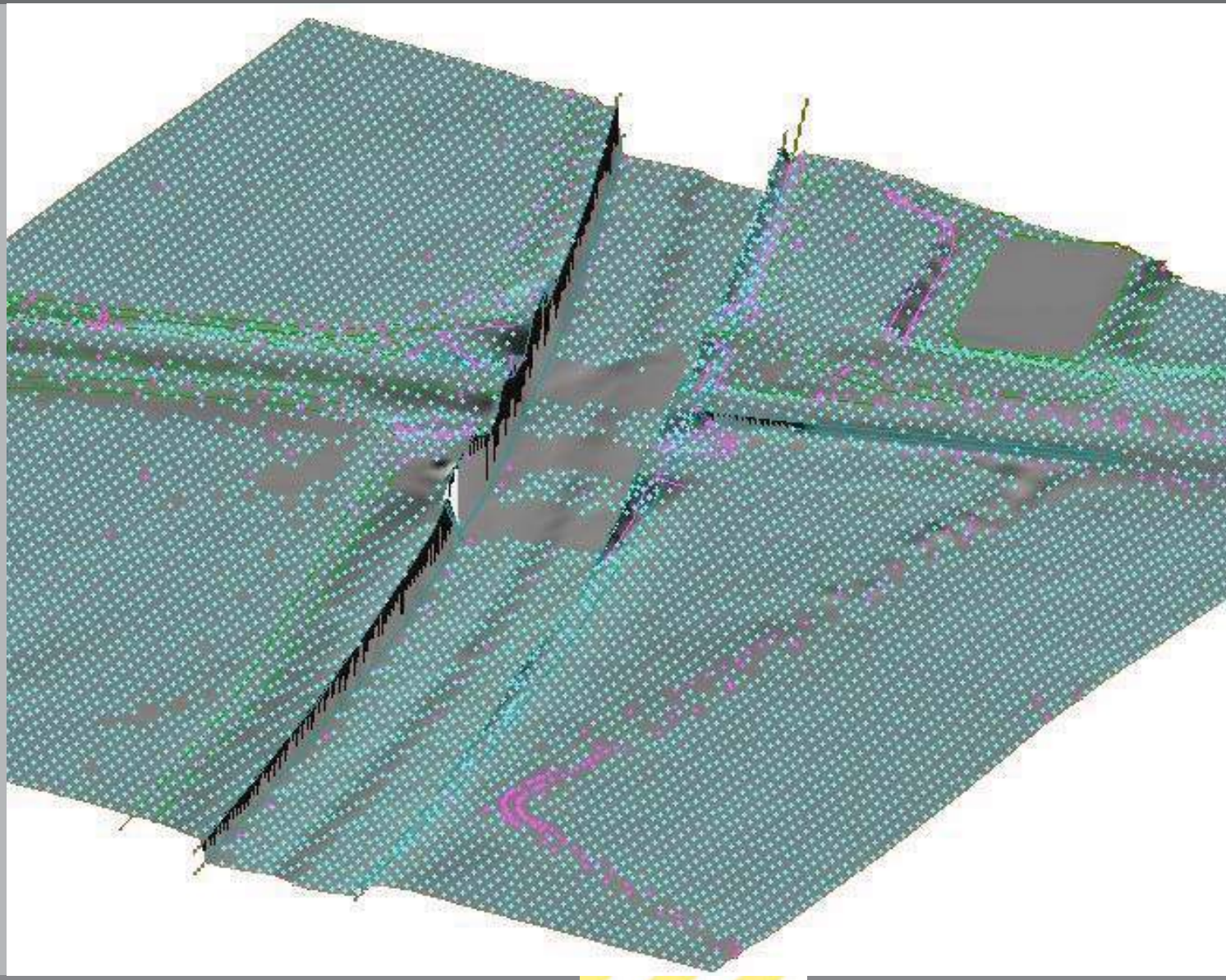
Wien! voraus
Stadtvermessung

StaDt Wien

Updating DTM

2013

image based DSM



Wien! voraus Stadtvermessung

StaDt Wien

Updating DTM

2013

image based DSM

Wien! voraus
Stadtvermessung

StaDt Wien

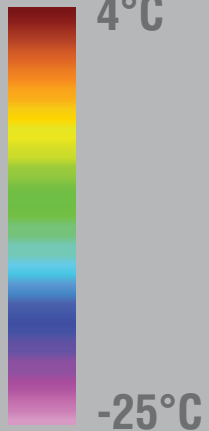
Orthorectification

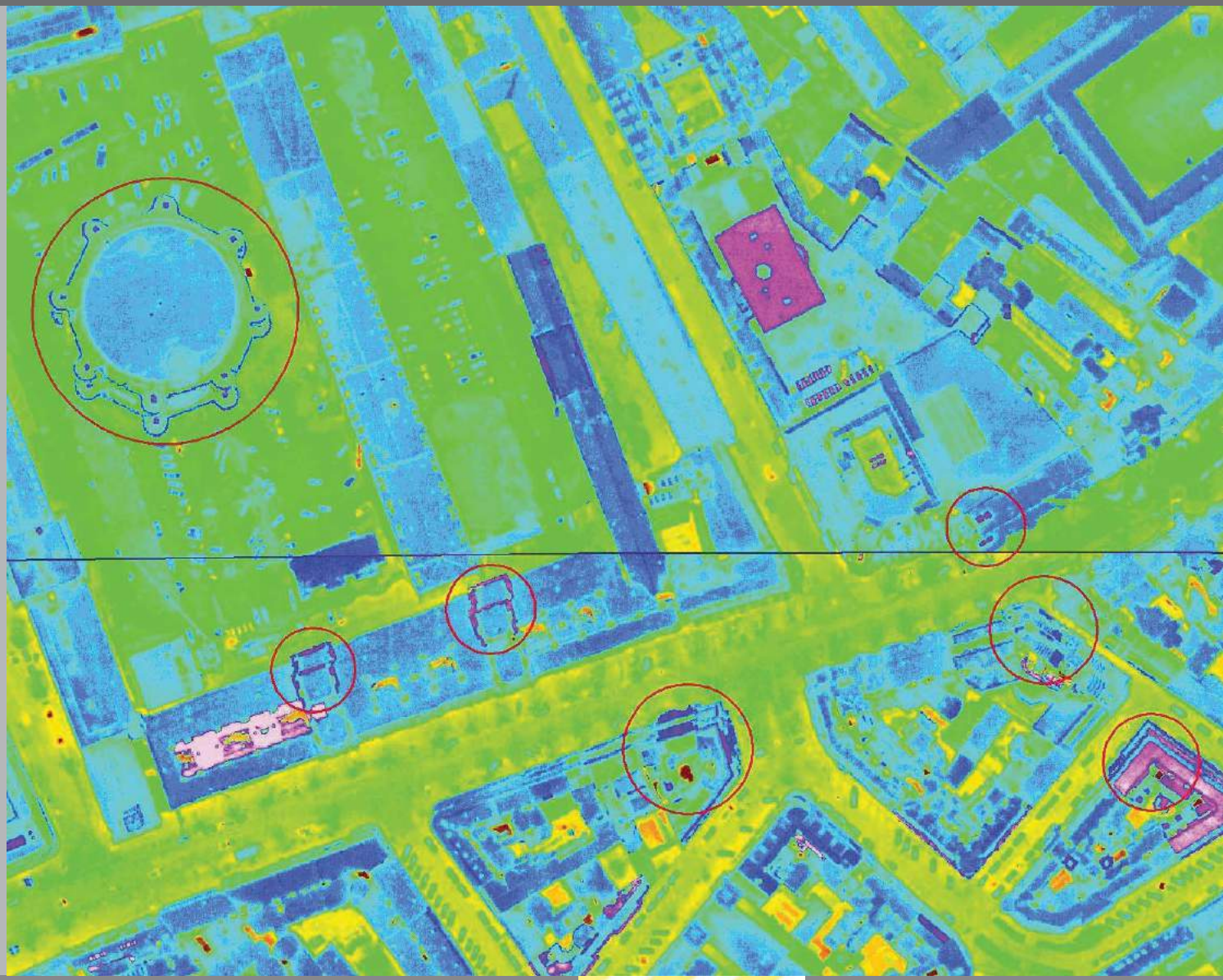
Thermal Image Campaign

2012

ALS based DSM

no line of sight analysis
⇨ roof artefacts next to the buildings





Wien! voraus
Stadtvermessung

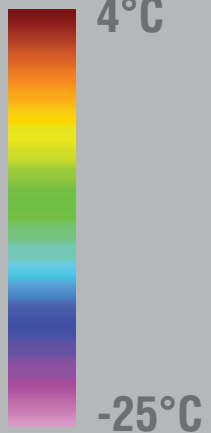
StaDt Wien

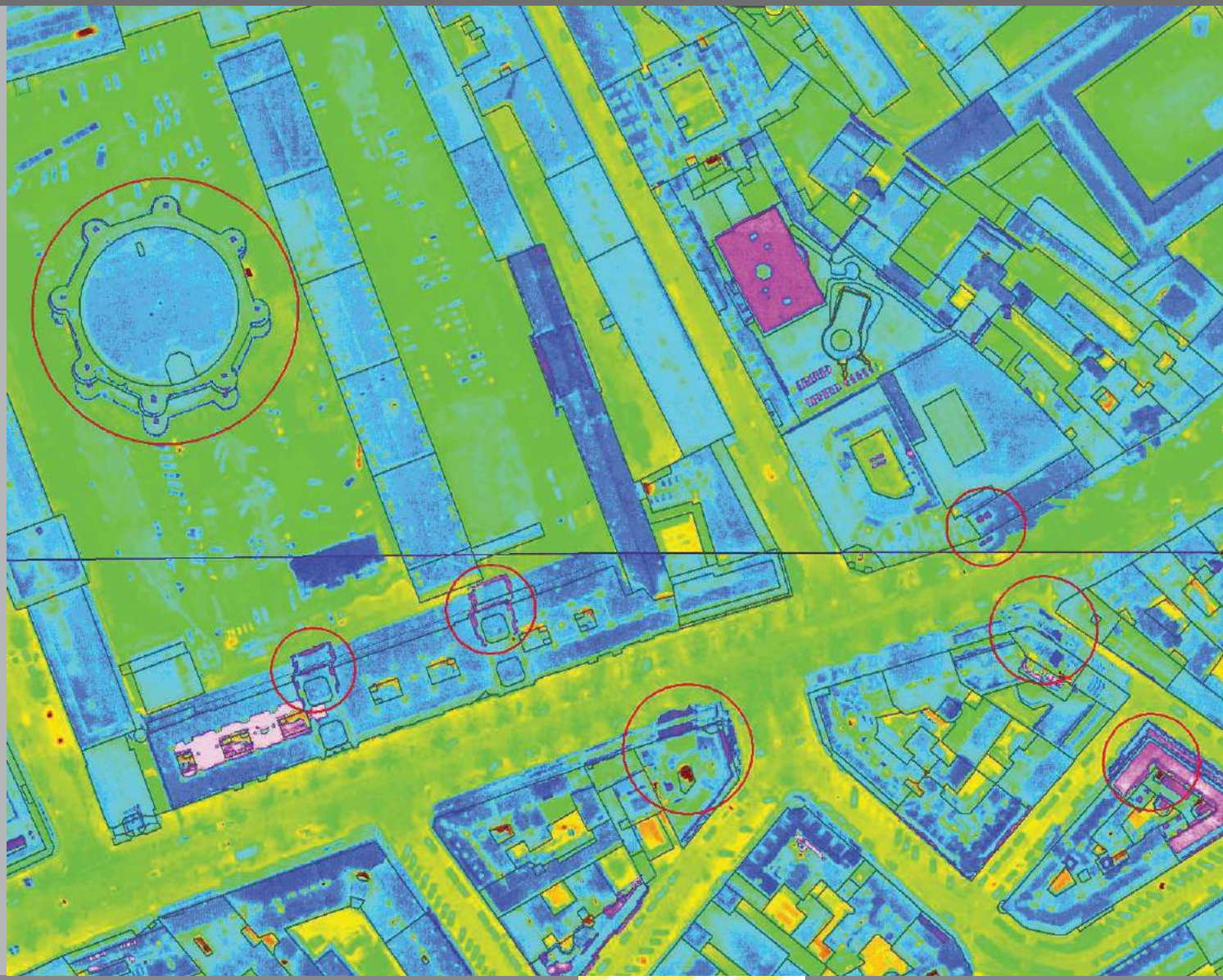
Orthorectification

Thermal Image Campaign

+ automatic analysis based on building polygons is possible

- temporary objects (cranes)





Wien! voraus
Stadtvermessung

StaDt Wien

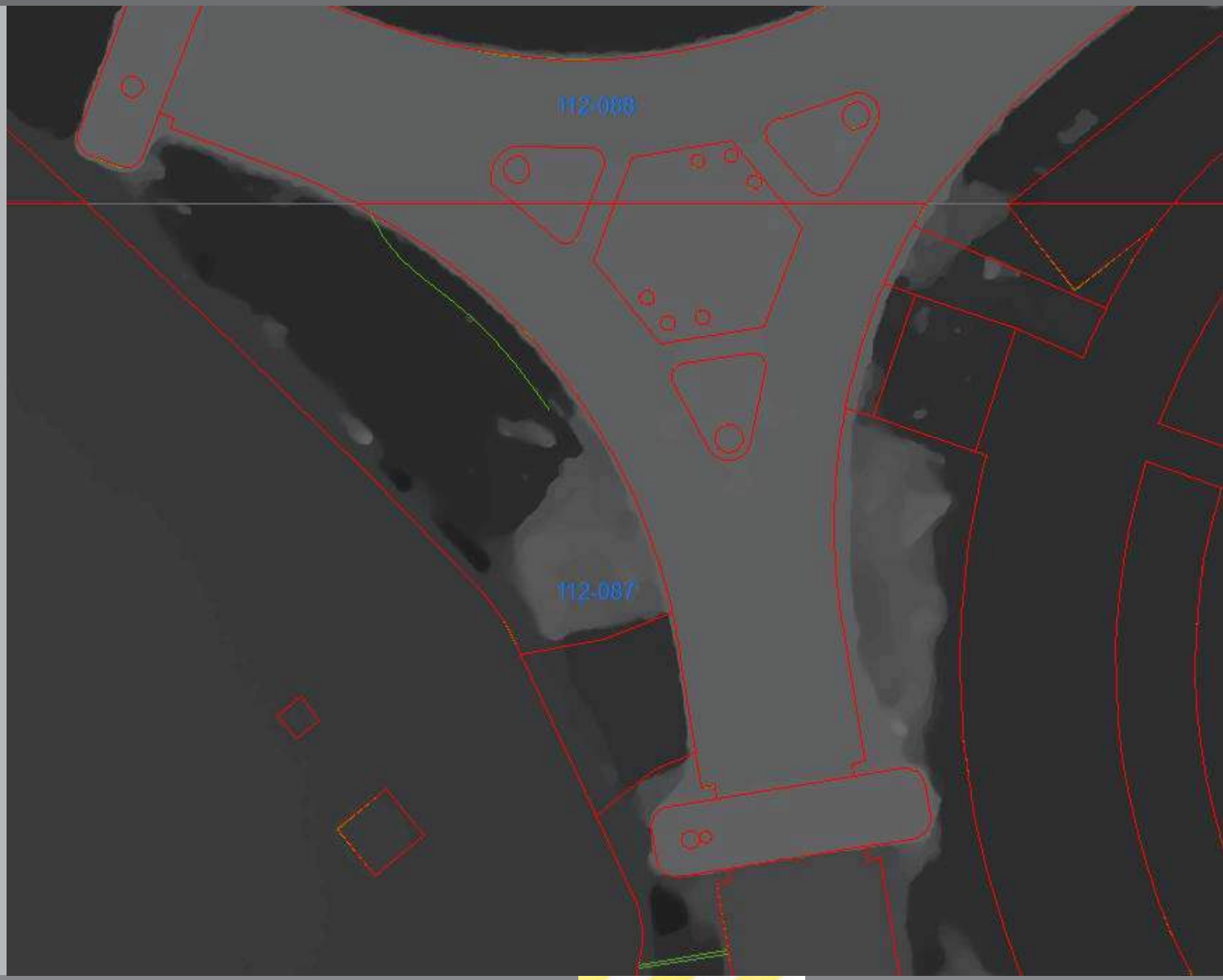
Orthorectification

True OP

2012

image based DSM

Uno City



Wien! voraus Stadtvermessung

StaDt Wien

Orthorectification

True OP

2012

image based DSM

Uno City

Wien! voraus Stadtvermessung

StaDt Wien

Orthorectification

True OP

2012

image based DSM

City Centre

Wien! voraus Stadtvermessung

StaDt Wien

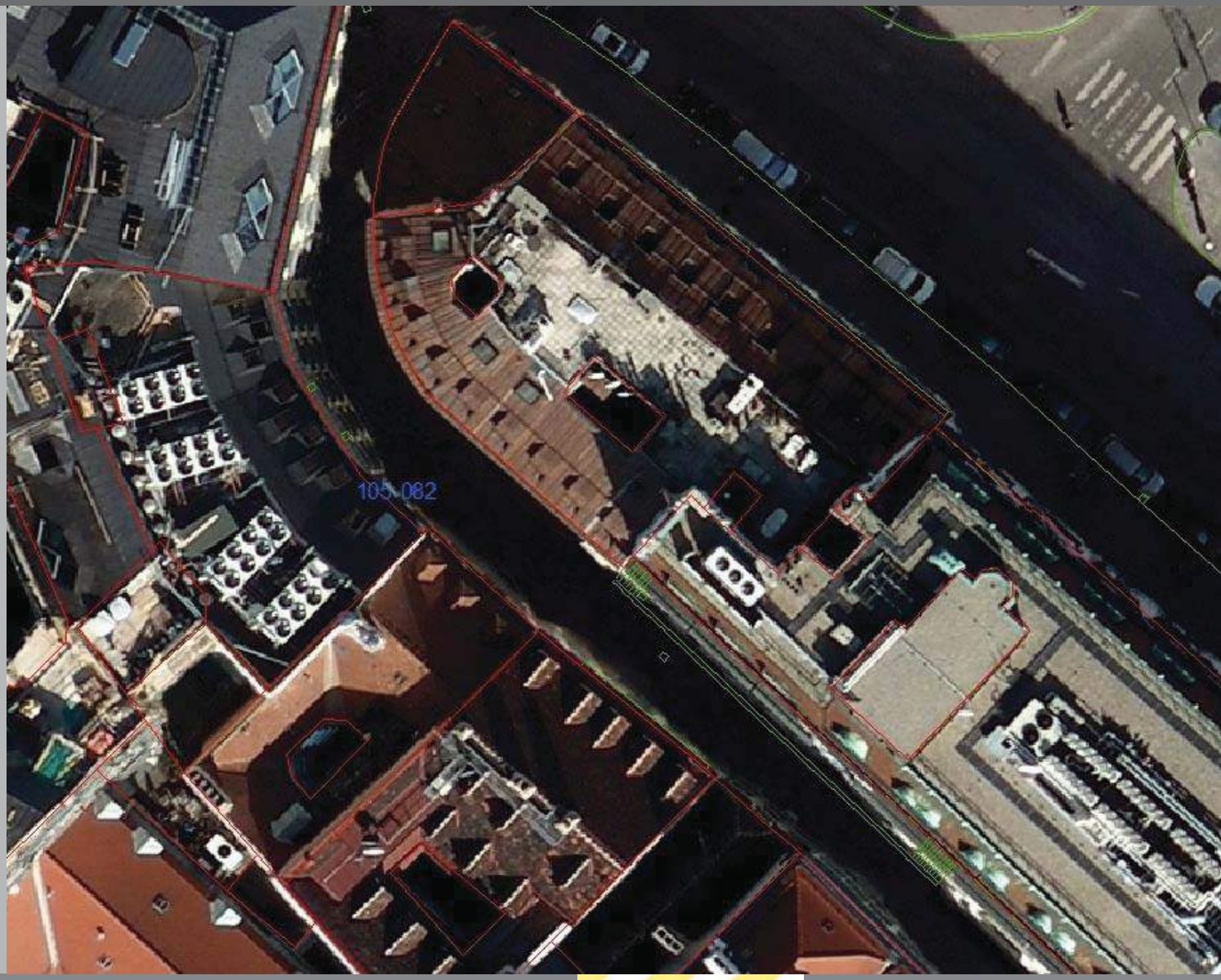
Orthorectification

True OP

2012

image based DSM

City Centre



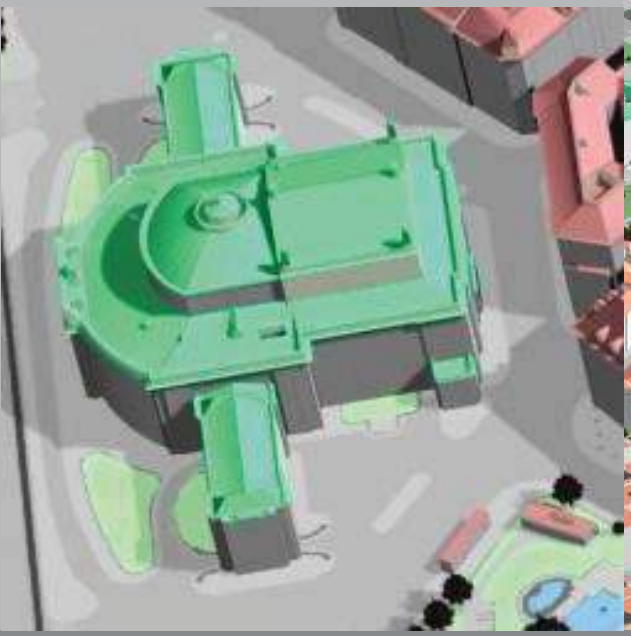
Wien! voraus Stadtvermessung

StaDt Wien

3D building models

photogrammetric models

city centre, important buildings , …



Wien! voraus Stadtvermessung

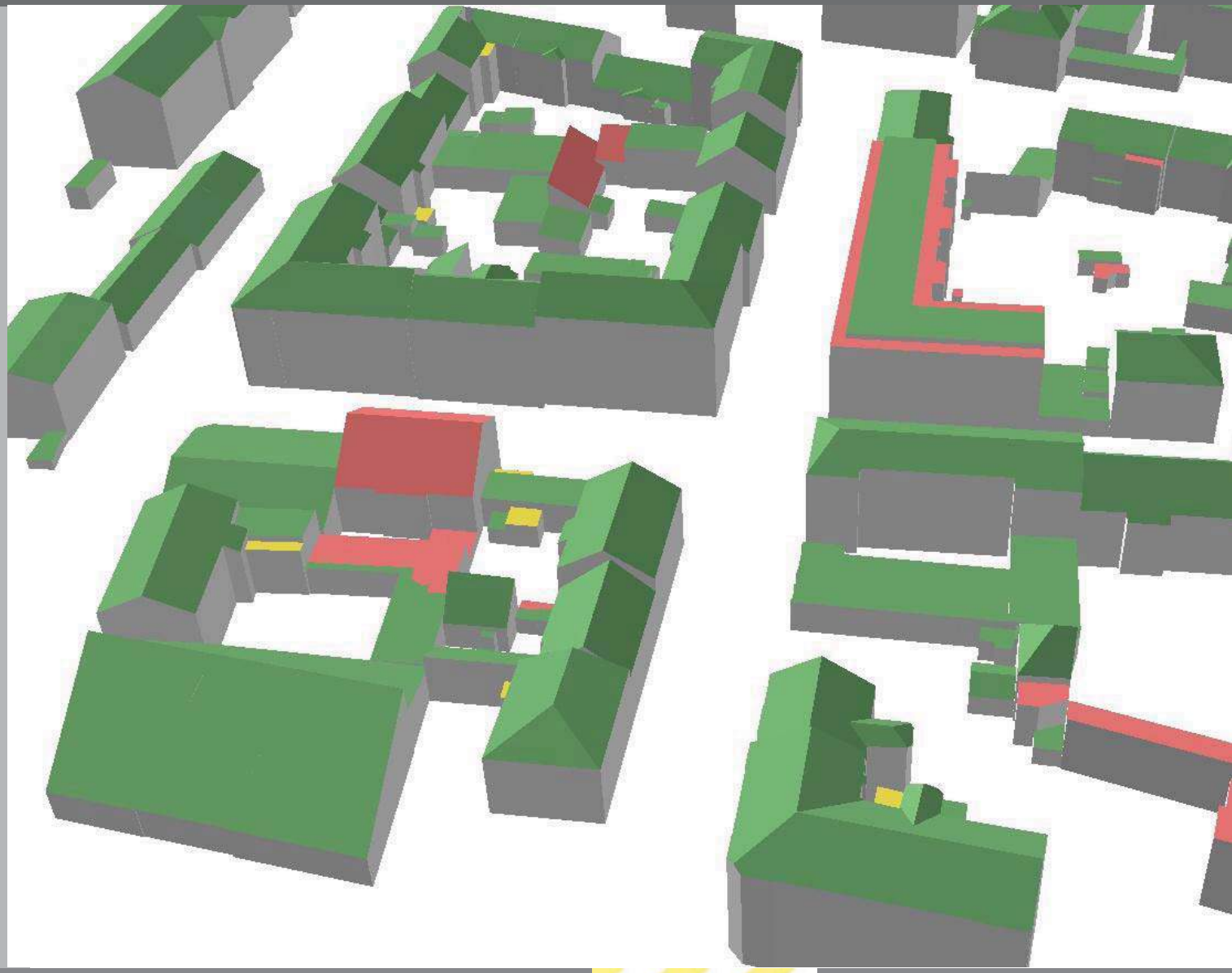
StaDt Wien

3D building models

2013

image matching DSM
+ building polygons

automatic estimation
of roof models



Wien! voraus
Stadtvermessung

StaDt Wien

3D building models

2013

image matching DSM
+ building polygons

automatic estimation
of roof models

Wien! voraus
Stadtvermessung

StaDt Wien

Outlook

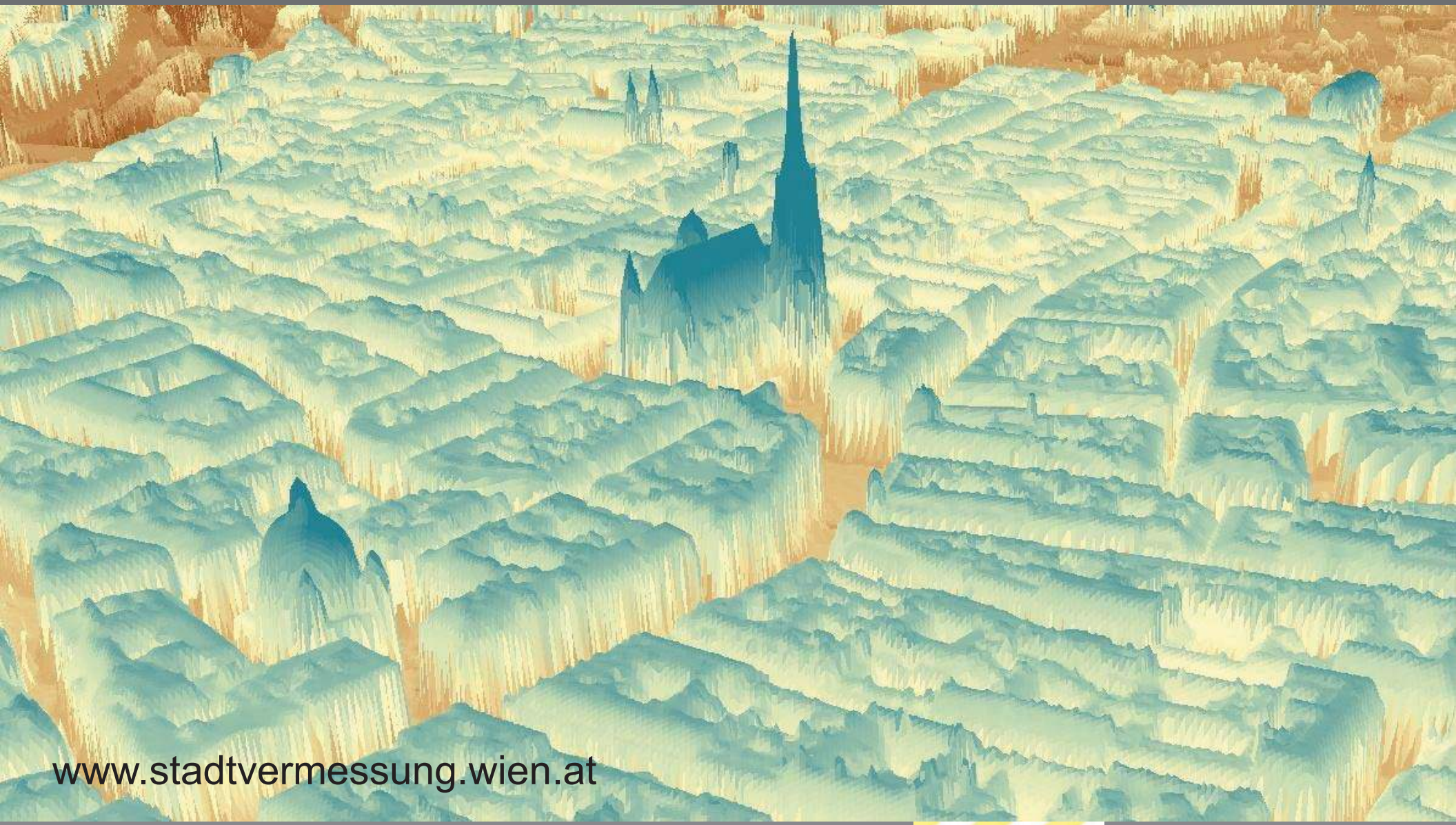
- change detection
  - currently photogrammetric update cycle for city map
  - based on height changes react faster on major changes

- surface classification (OBIA)
  - object heights (nDSM) enhance classification results

Conclusion

- vegetation
  - visibility maps
  - shadow analysis
  - analysis of solar potential
- quality measure for calculated height values
- correction procedure in processing workflow

Thank you very much for your attention!



www.stadtvermessung.wien.at

Wien! voraus Stadtvermessung

StaDt Wien

2nd EuroSDR Workshop

High Density Image Matching for DSM Computation

Motivation for a Dense Image Matching Workshop for Software Providers

Vienna, June 13th, 2013

Michael Gruber
michgrub@microsoft.com


OUT 12V 5A
SU
RESET
USB
OFF
ON
RPP
IN 24V
POWER
35
ULTRACAM
MODULE EAGLE
CE
ULTRACAM
CE

Promotion of the technology
showcase of the image based solution

Value added Image data (from pixel to information)

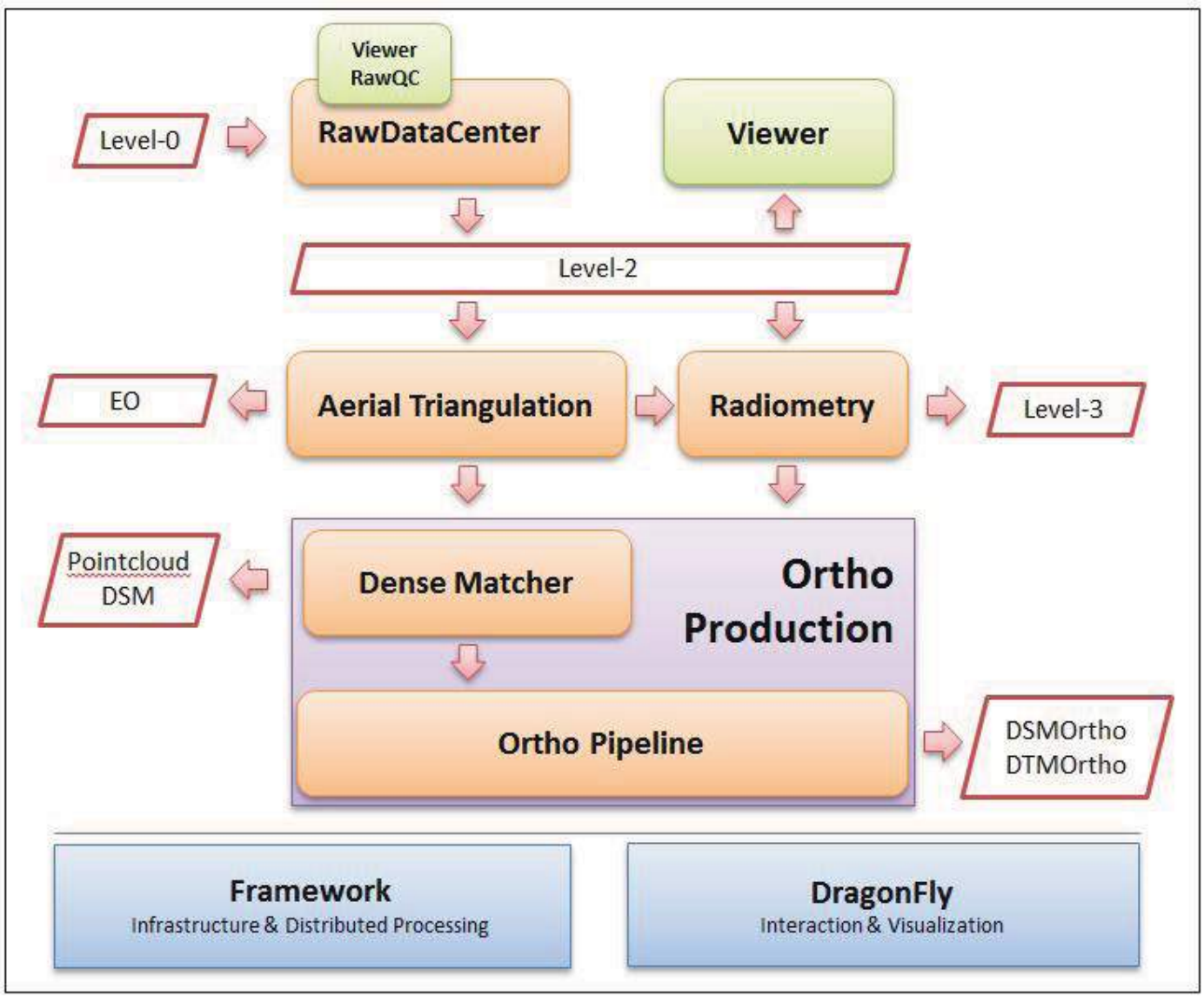
Number of Images versus Redundancy,
Quality, Automation etc.
Manual labor vs. Automation

Multi-Ray Photogrammetry

- Set of high resolution images
- 80% forward overlap
- 60% sideward overlap
- Up to 15 rays per point

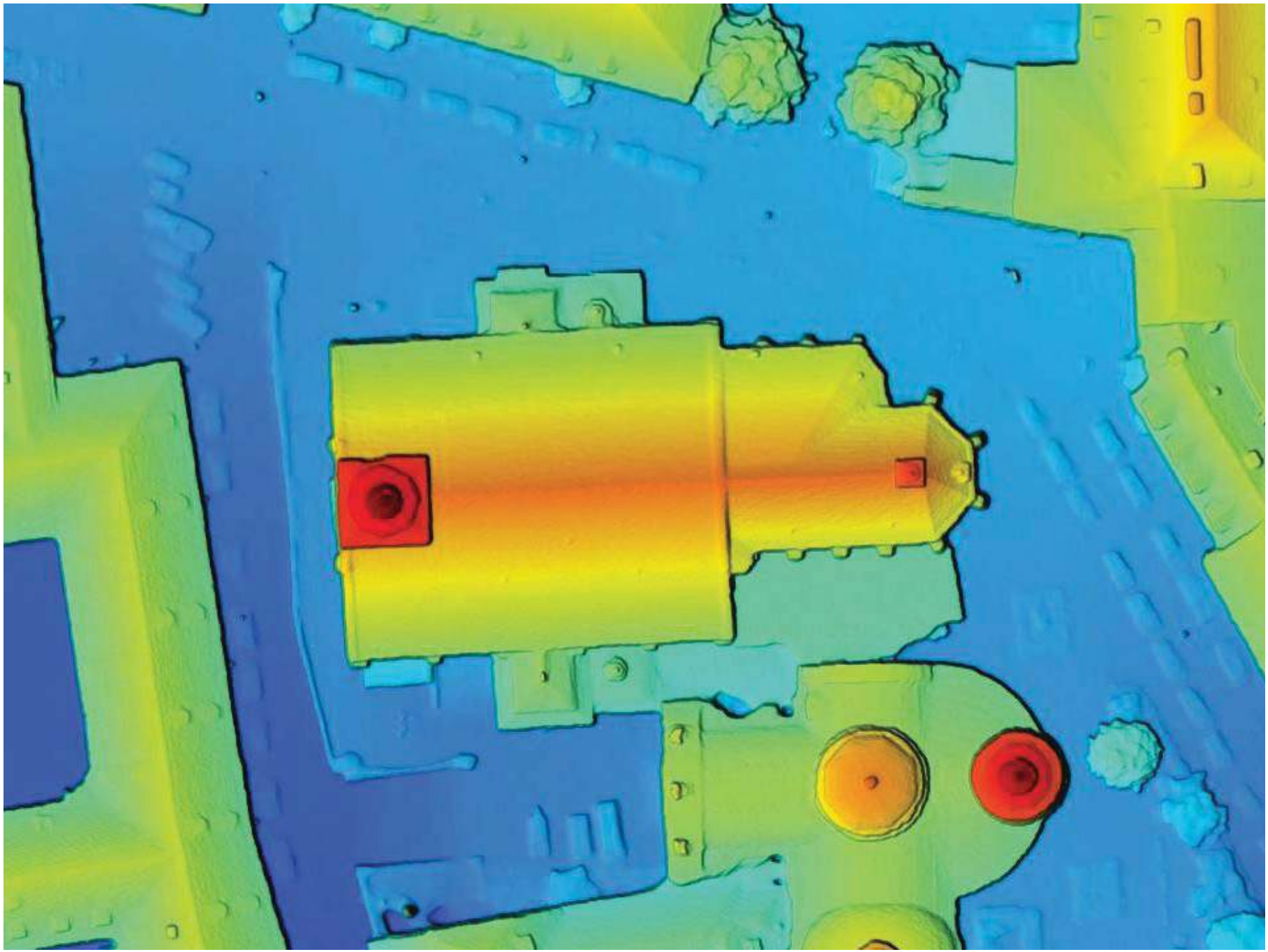
Camera manufacturer -> how to add value to the Camera
Supporting the Portfolio of Photogrammetry

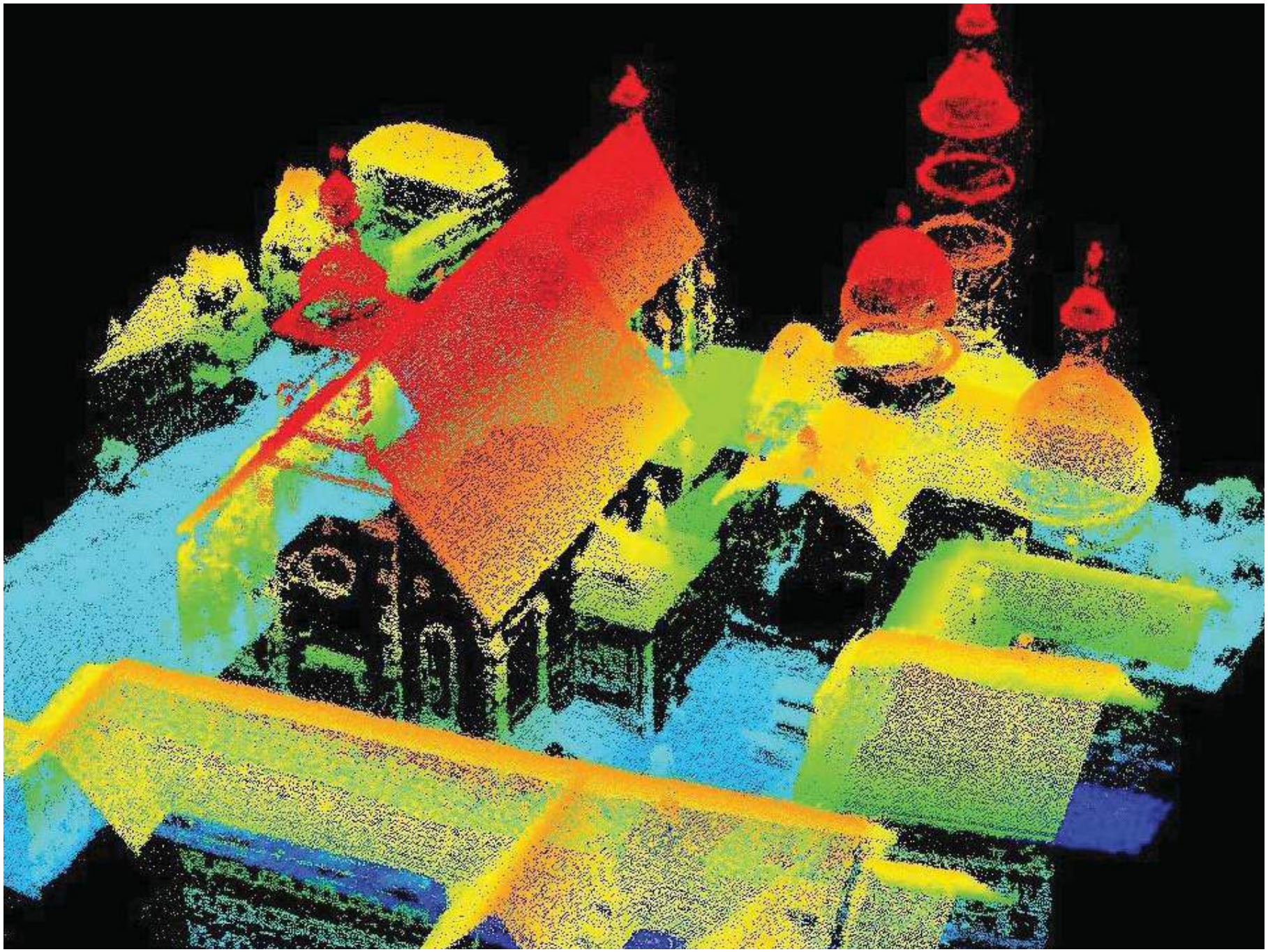
UltraMap Workflow



Dense Matching

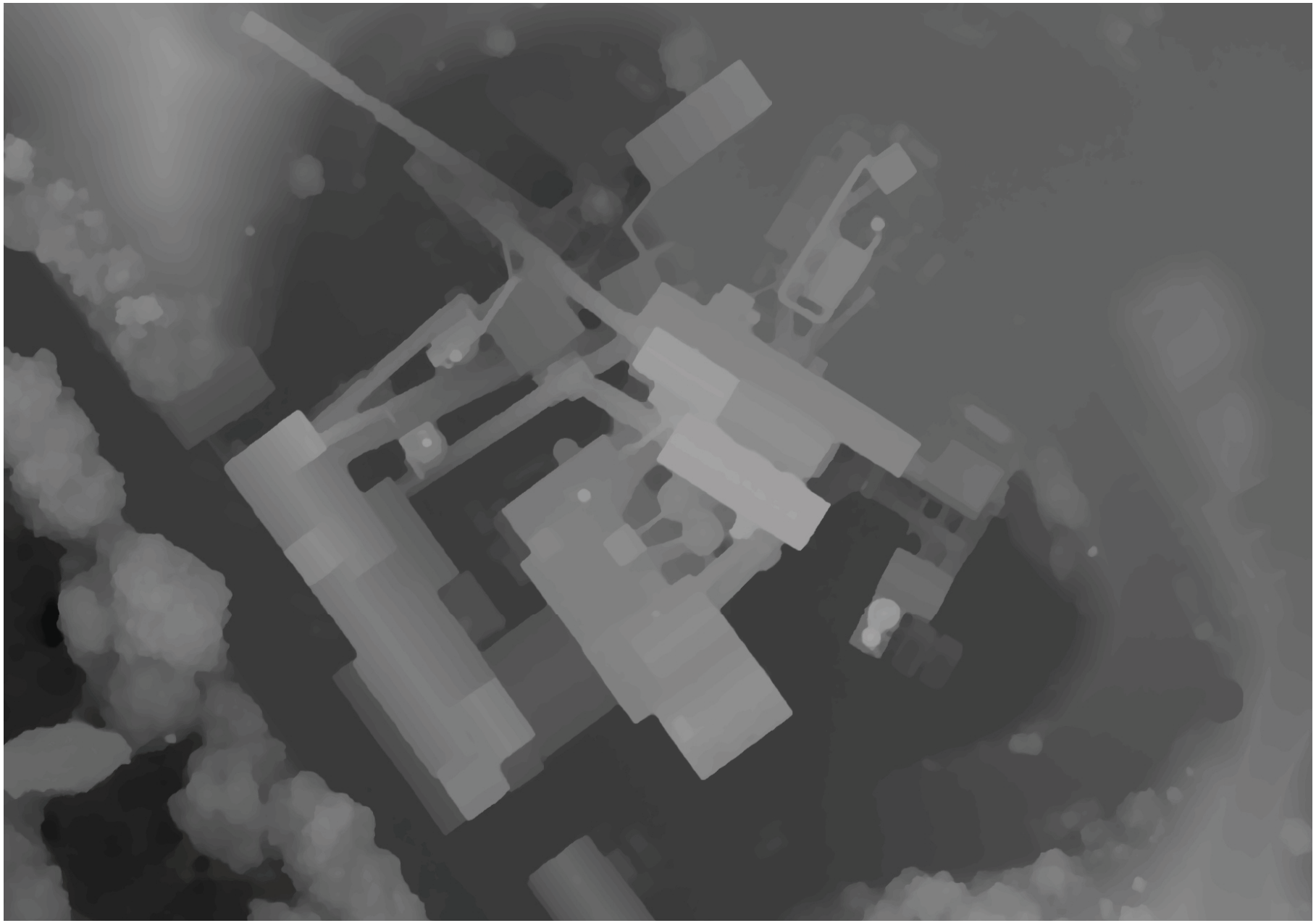
- **Highly redundant data set**
- **Pixel based matching between image pairs**
- **Result: point cloud**
    - Pixel location = x, y value
    - Dense matcher = z values per pixel
    - Point density >>100 points per square meter





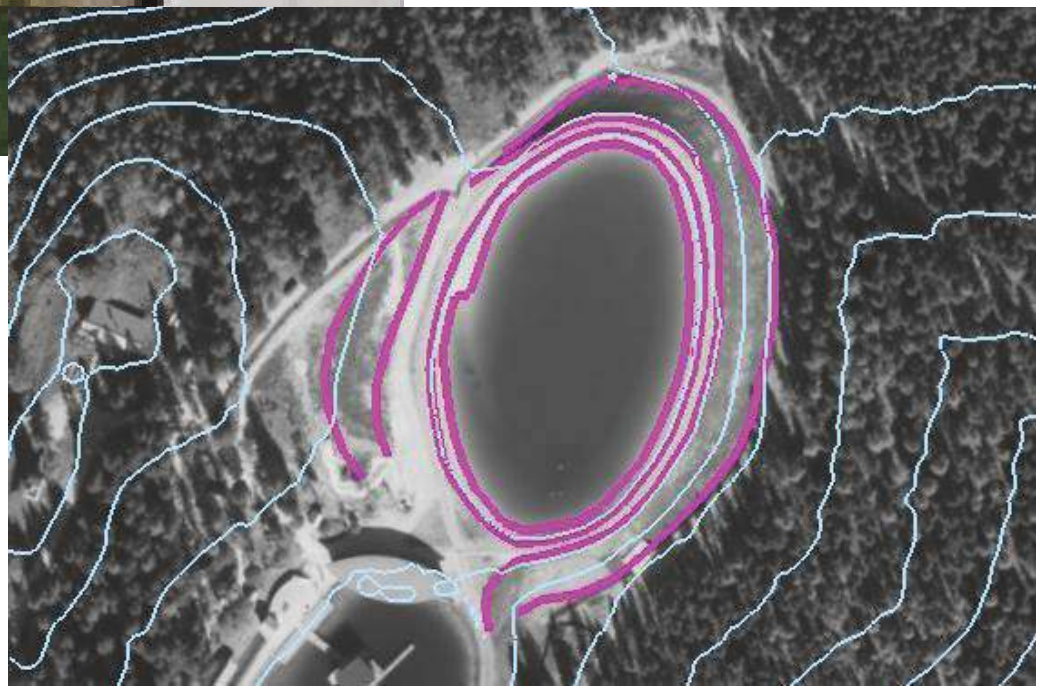
Qualified Feedback
Competitive Comparison
Photogrammetry vs. LIDAR

EuroSDR Testcase



UltraMap V3.0 DSM Ortho

UltraMap V3.0 DSM Ortho



LIDAR based DSM caused problems due to changes

UltraMap V3.0 DSM Ortho was correct (DSM from Images)


Thank you …

LANDESAMT FÜR VERMESSUNG UND GEOINFORMATION

EuroSDR

Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland

Motivation for dense image Matching workshop from LVG Bavaria and other NMCA in Germany and Europe

Wolfgang Stößel
Photogrammetry and Remote Sensing
Bavarian Agency for Surveying and GeoInformation

1.Benchmark on image matching Workshop 2012 in Vienna

5 Test Data Sets

- Vaihingen DGPF data set by IFP	20 cm + 8 cm
- Algorta Data set by IGN Spain	25 cm
- Ticino data set by swisstopo (ADS)	50 cm
- Marseille data set by IGN France	10 cm

2 Participants in benchmark
2 Software solutions

- SGM of DLR
- MicMac of IGN France

2. Benchmark on image matching Workshop 2013 in Vienna

2 Test Data Sets

- Vaihingen DGPF data set by IFP 20 cm
- Munich 10 cm

11 Participants in benchmark
9 Software solutions

- SGM of DLR
- MicMac of IGN France
- nGATE
- Dense Matcher Ultramap
- Match-T
- Joaneum Graz
- Astrium France
- Intergraph ISAE
- RMA Brusssels
- Sure of ifp Stuttgart

Annual aerial image flights

typically:
GSD = 20 cm
Summer or with vegetation
RGBI
16 bit (> 8 bit)
(+ PAN)
Cyle = 3 .. 2 years

Additonally:
GSD = 10 cm
Non vegation flight
RGBI
16 bit
(+ PAN)

Digital Aerial Cameras

Frame cameras with area sensors

Z/I Imaging DMC, DMC_{II}
Digital Mapping Camera

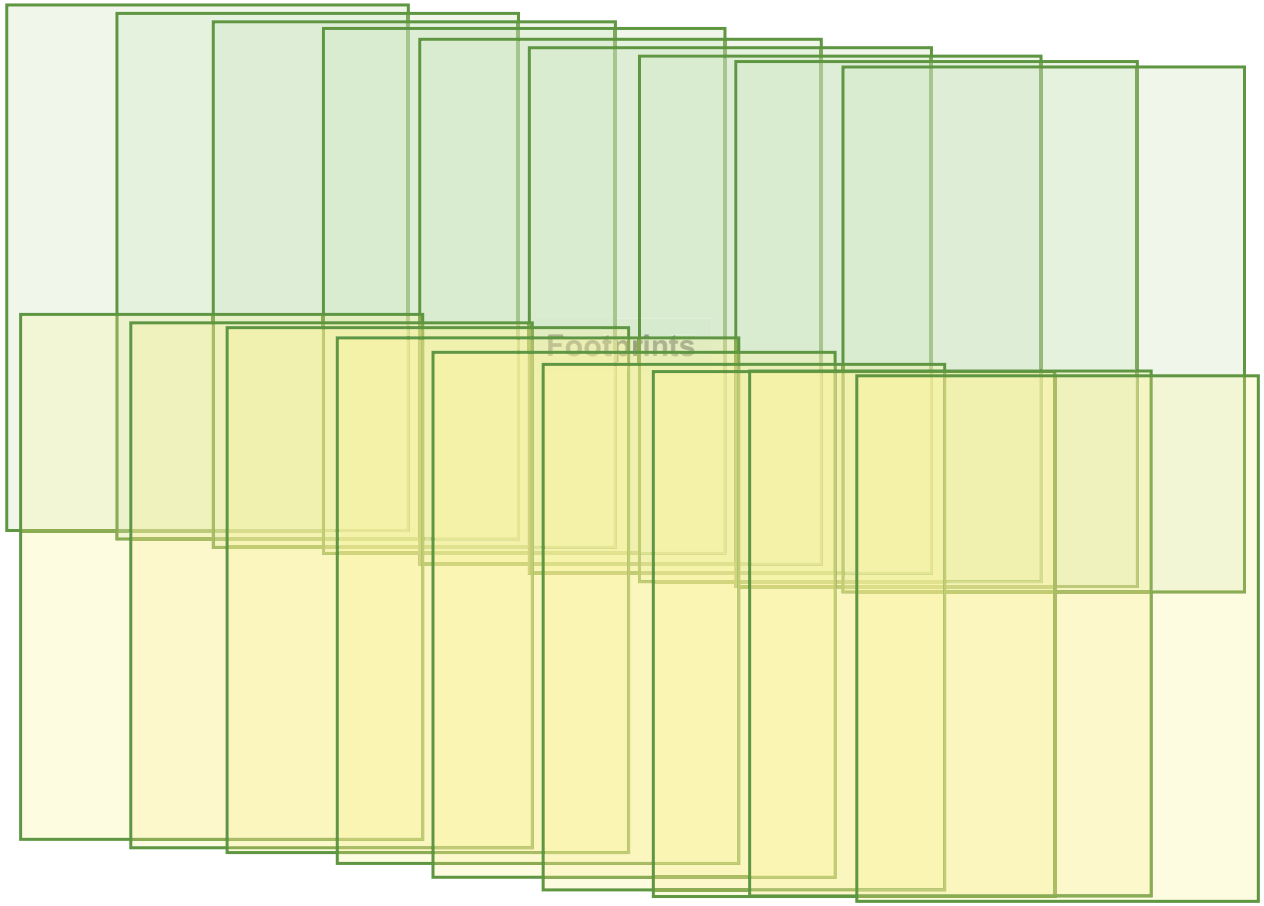
Vexcel / Microsoft
UltraCam XP, Eagle Falcon

line sensors
(not used in Germay)

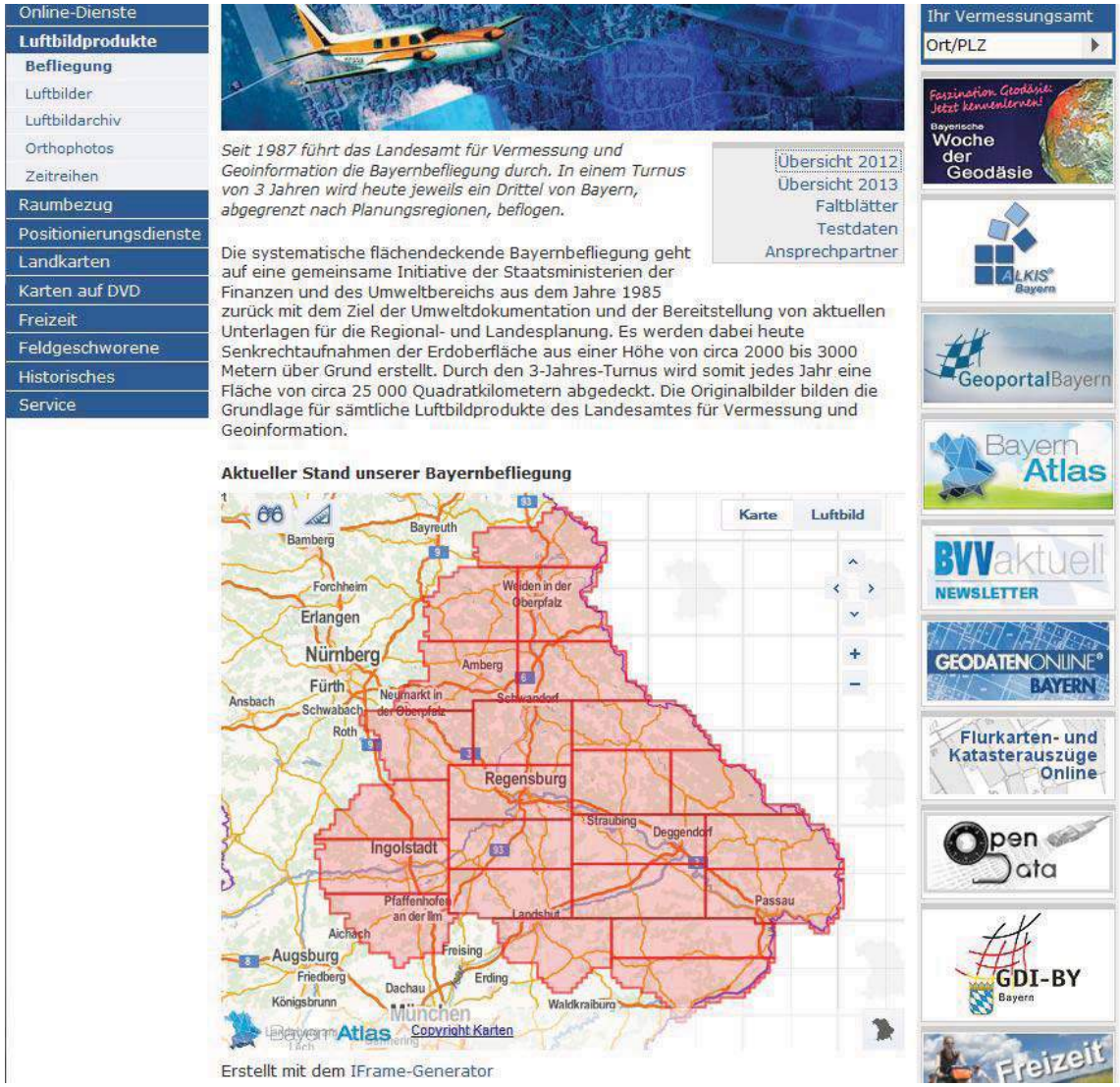
Leica ADS40/80
Airborne Digital Sensor

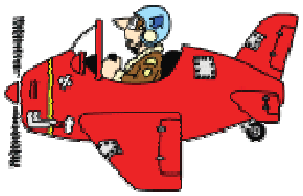
Flight parameters: Overlaps

Typic: GSD = 20/10 cm, long = 75-80% cross = 30%



Flight program and progress in the internet





Aerial images
+
Orientation (AT)
=
Oriented aerial image (OAI)

Classical product:
Digital OrthoPhoto DOP
In RGB and CIR

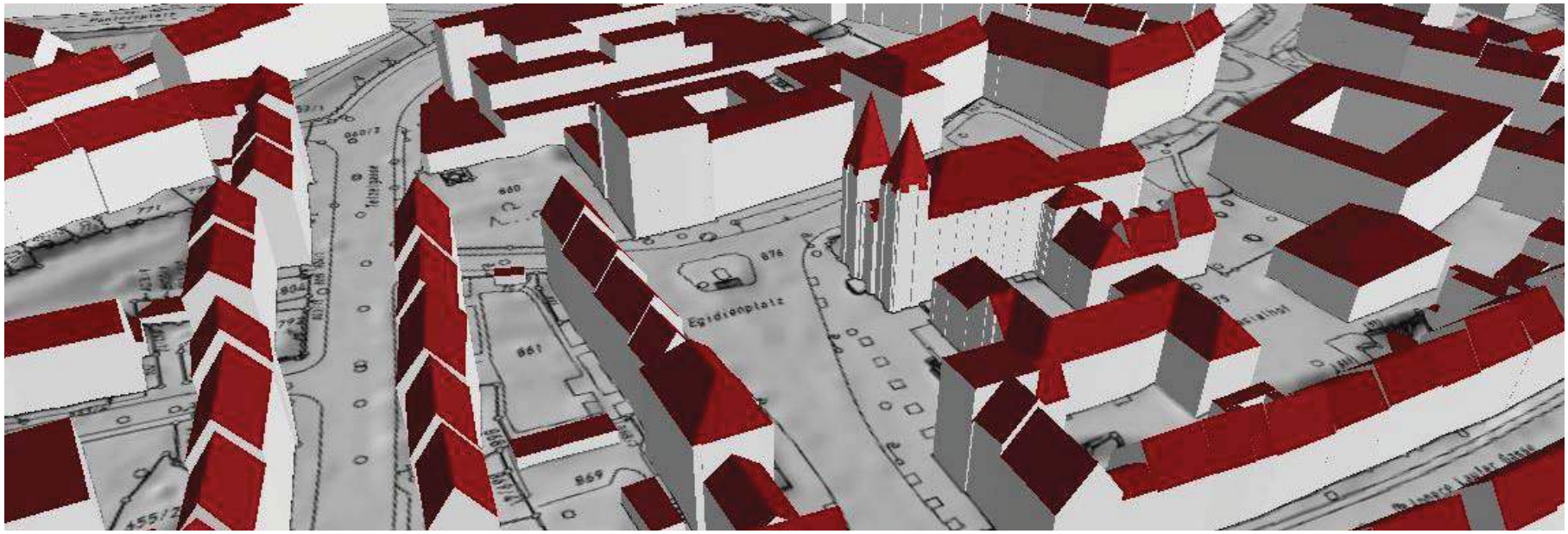
- **premium product**
- **Background infos**
- **viewing services**
- **classification**
- **almost all ressorts**
- **Google**
- **private users**

Stereoscopic use
on stereo stations
(3D-stations)
Stereo hardware
Good software
→ renaissance of
stereo interpretation

Dense Image Matching
to obtain
- 3D-Point clouds
- digital surface models iDSM
- NadirOrthophoto NOP

Use of iDSM by NMCA

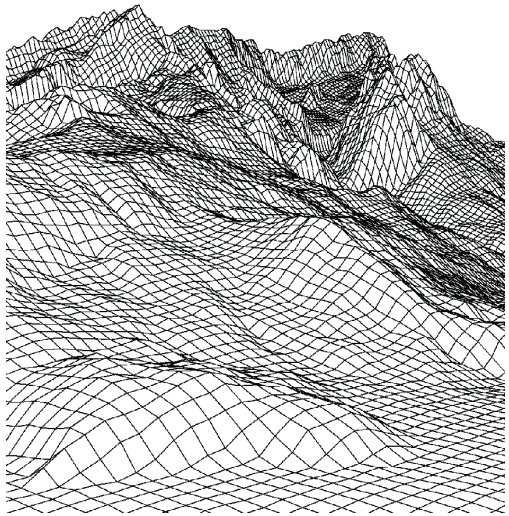
- 3D-building models LoD1 and LoD2

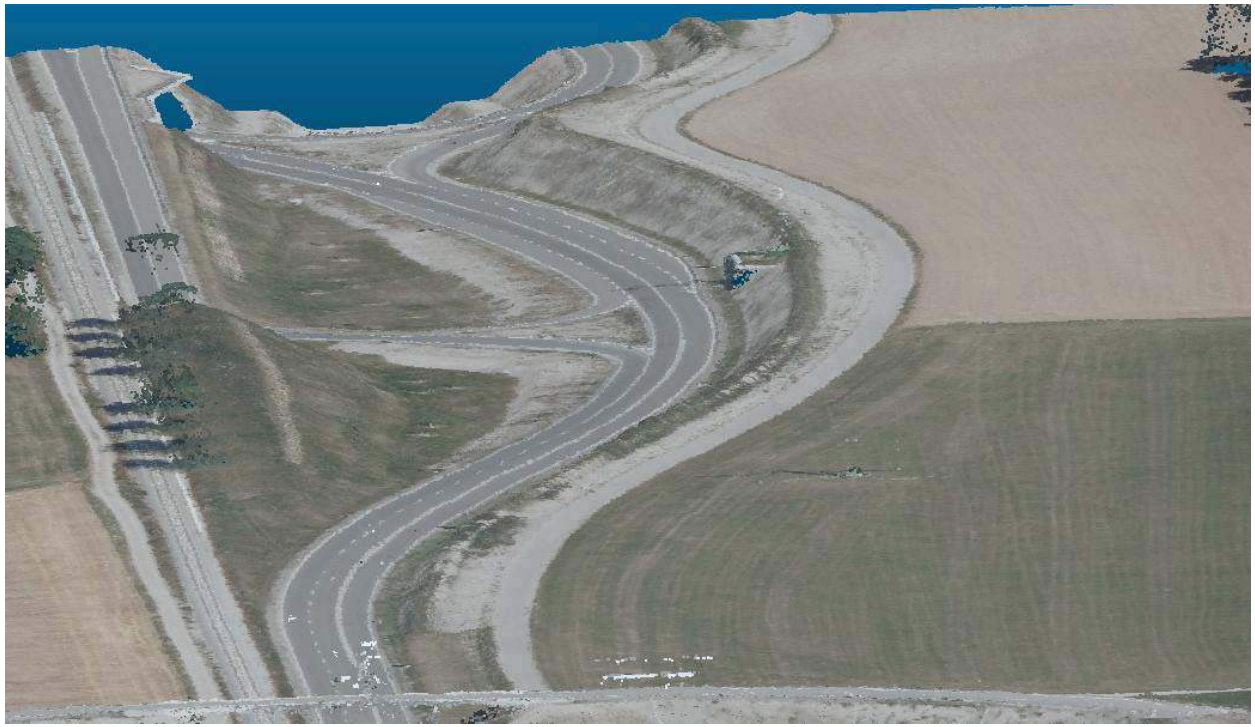


1. Generating 3D-Buildings in LoD1 and LoD2
2. first source for derivation: Lidar
3. gaps in lidar data are filled with iDSM
4. updating done by cadastral offices

Use of iDSM by NMCA

- DTM (if bare ground is visible/accessible)





Use of iDSM by NMCA

- DSM for visualisation
- with the joy stick through Bavaria

DSM grid spacing = 0.80 m
Texture:
DOP RGB GSD = 0.20 m
area of BY = 70.000 km²

partial updating possible

Use of iDSM by NMCA

- DSM as additional input for image analysis and classification
  Software: eCognition, Imagine Objectives, Monteverdi

Internal use of iDSM by NMCA

- LoD2, updating DTM, Geo-Visualisiation, analysis and classification
- .....

iDSM as a new product (similar to IDSM)

- forest administration
- landscape visualisation
- change detection and classification
- ..

Great interest in future developements:

- NadirOrthophoto NOP (gaps, radiometry, moving objects etc.)
- using 3D-Point clouds (viewer, editing tools etc.)
- ..

Open questions from the NMCAs:

- matching with PAN or RGB
- 8 or 16 bit
- Economical overlaps
- Vegetation versus non-vegetation image flights
- Influence of camera aperture angle on results
- Is multi stereo used? Redundancy
- What data format for storing DSM and point cloud is recommended
- Thinning out or resampling
- How to deal with data gaps
- Optimal hardware configuration
- …..


Thanks for your attention!

Stereo hardware


ngsverwaltung 2012
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Zum Au
Video