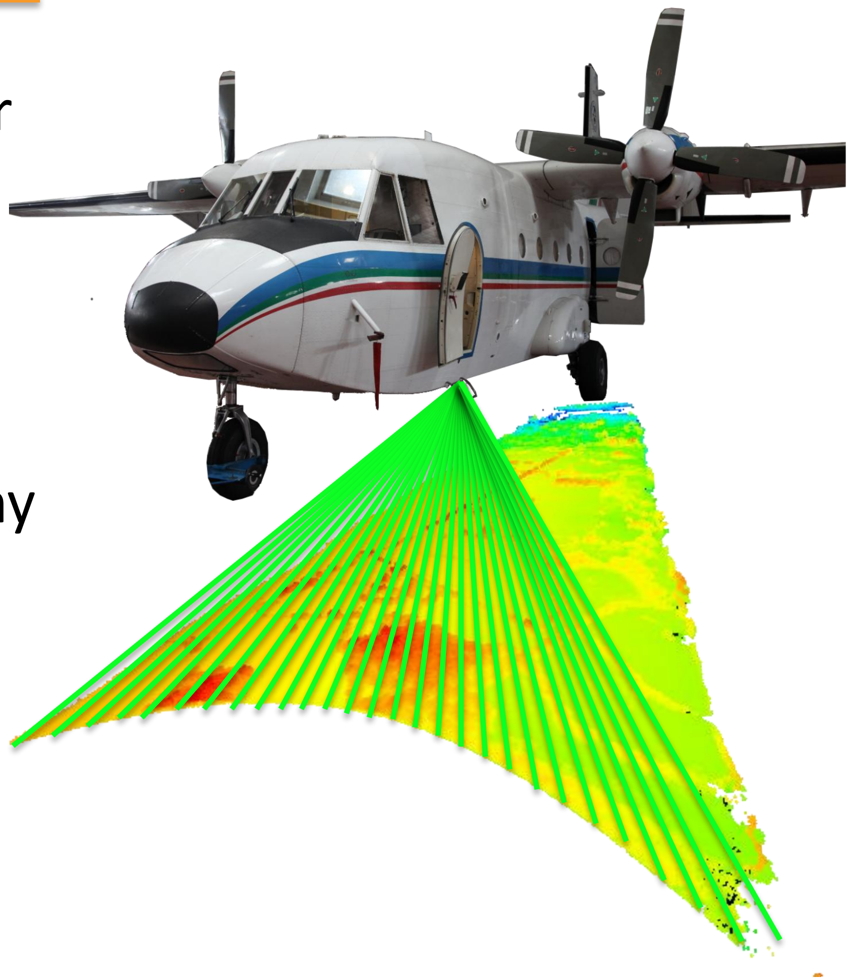
RIEGL Bathymetry Hard- and Software Solutions

Andrea Spitzer, MASc
Application Engineer
aspitzer@riegl.com

May 27th, 2014

AGENDA

- *RIEGL* VQ-820-G topo-bathy laser scanner
    - product specifications
    - results
- software add-ons for hydrography
    - clutter filtering
    - point classification
    - water surface modeling
    - refraction correction



RIEGL VQ-820-G

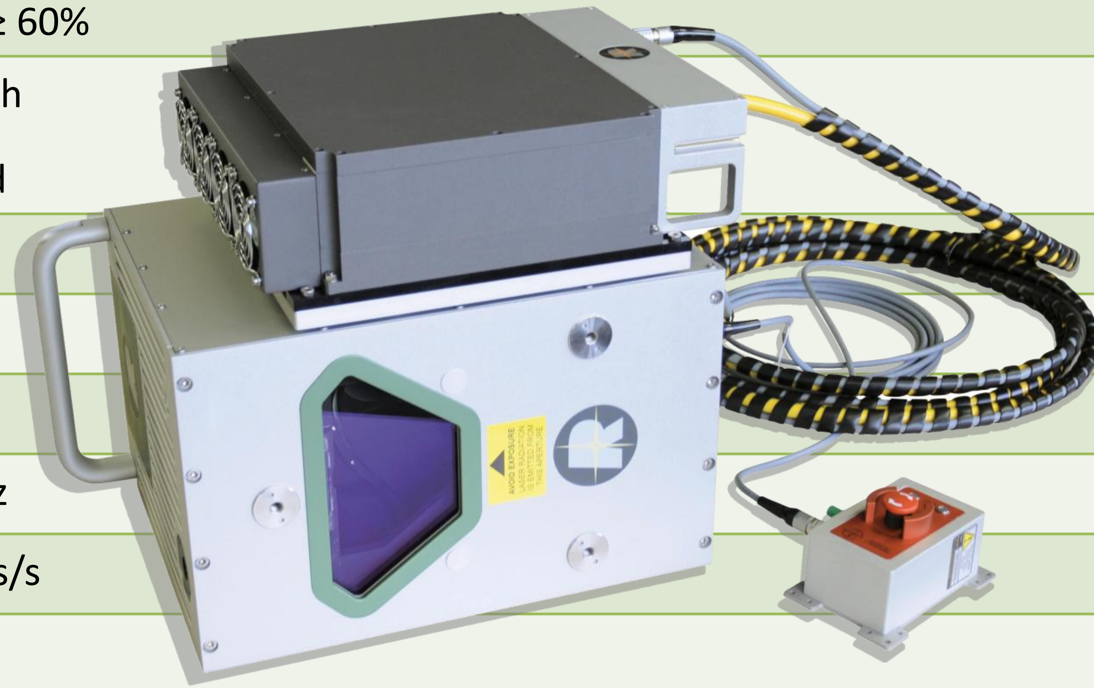
laser scanner for combined topographic and bathymetric applications

RIEGL VQ-820-G concept

- combined hydrographic and topographic laser scanner with
  - narrow laser beam
  - high range resolution
  - high measurement rate
  - compact and lightweight design
- dedicated for
  - high-resolution mapping
  - of shallow waters with
  - low turbidity

VQ-820-G product specifications

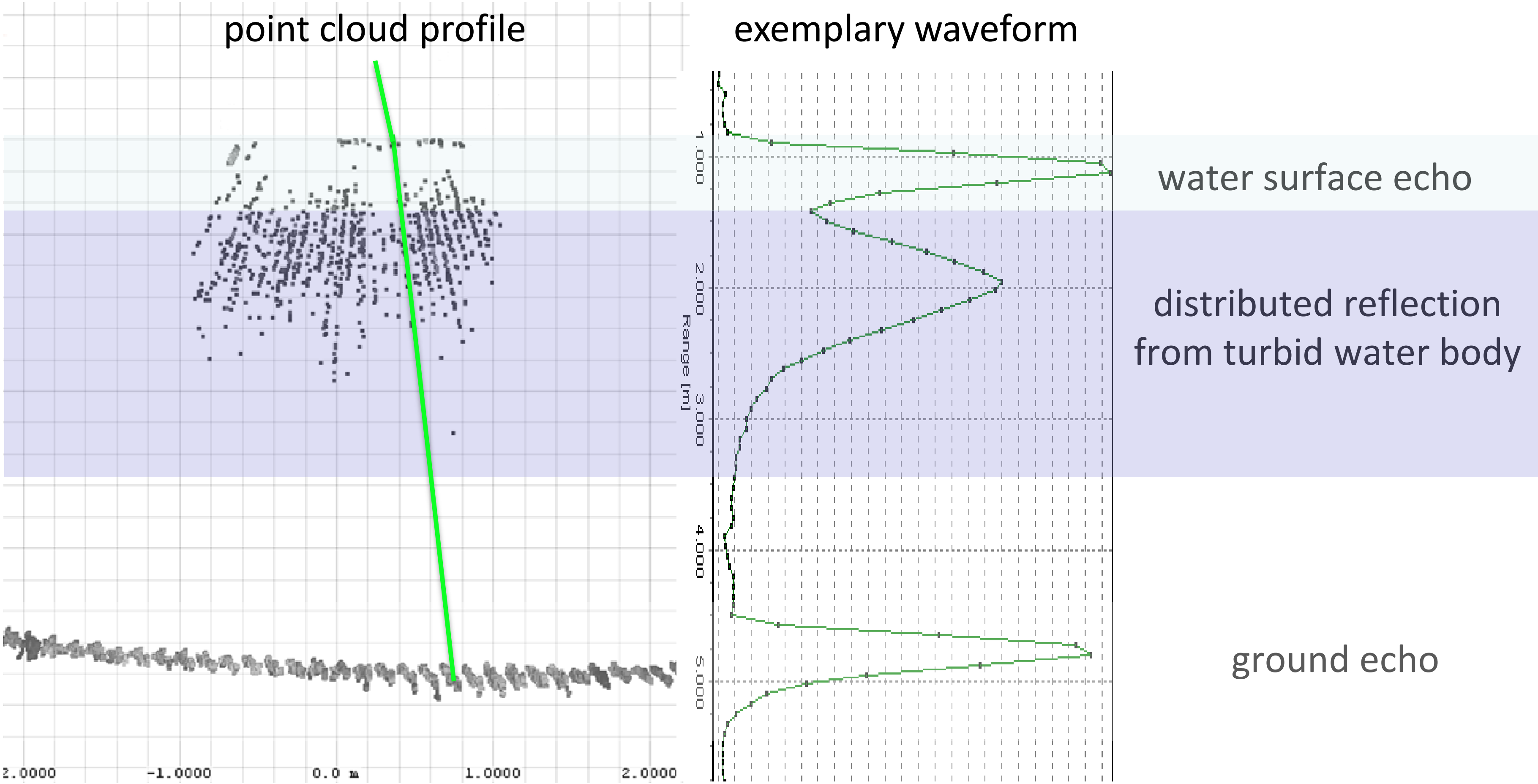
wavelength	**532 nm (visible green light)**
measurment range topography	1500 m at ρ ≥ 20% 2500 m at ρ ≥ 60%
water penetration	1 Secchi depth bright ground
ranging accuracy	25 mm
FOV	42°
beam divergence	1 mrad
measurement rate	up to 195 kHz
scan speed	50 – 200 lines/s
laser Safety	laser class 3B
multiple time around	yes, up to 4 pulses in the air



VQ-820-G features

- excellently suited for combined land and hydrographic airborne survey
- high-accuracy ranging based on **echo digitization** and **online waveform processing** with multiple target capability
- high spatial resolution due to laser repetition rate up to 520 kHz, high scanning speed up to 200 scanlines/second and a wide field of view 42°
- compact, rugged and light-weight modular configuration, compatible with standard airborne platforms.
- optional **waveform data output**, data accessible via RiWAVELiB
- seamless integration with other *RIEGL* ALS Systems and software packages

RIEGL echo waveform



RIEGL's complete system solution

VQ-820-G

DR-680 (optional)

various
topo-infrared
laser scanners
(optional)

complete
software solution

system integration

different ways of using *RIEGL* ALB systems

VQ-820-G integrated in a helicopter

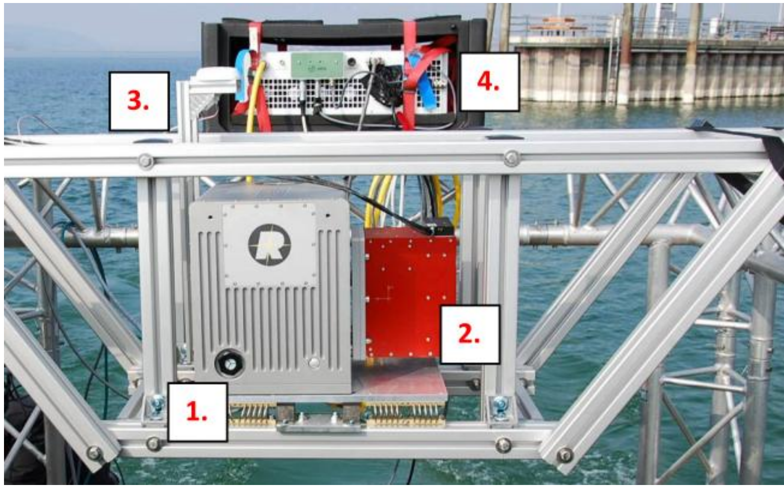
VQ-820-G integrated in a Tecnam P2006T

RIEGL®

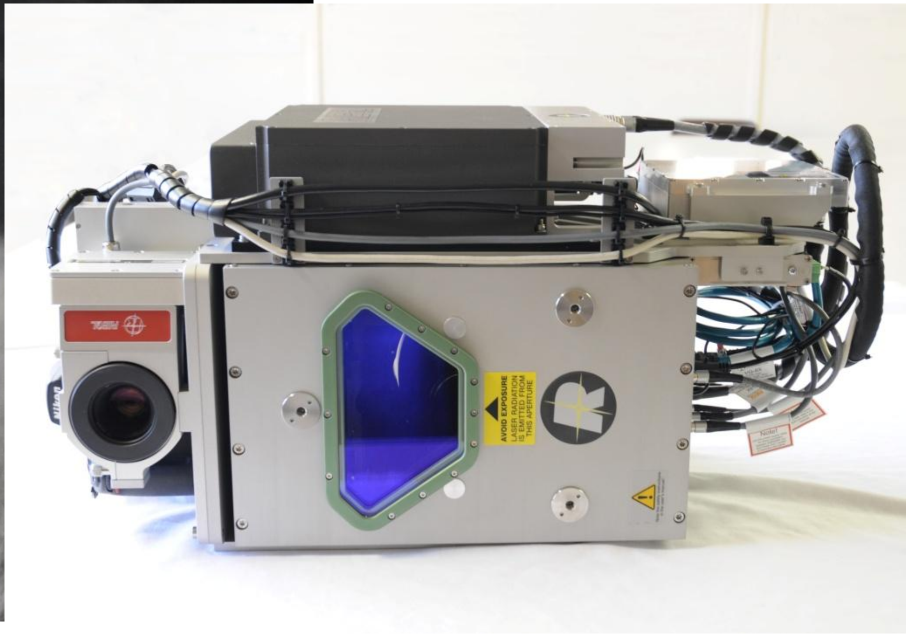
VQ-820-G integrated in a CASA 212

ship-borne integration of VQ-820-G

- hydro-archeological survey
- pile dwellings at the Lake Constance



VQ-820-G integrated in a UAV – Schiebel Camcopter



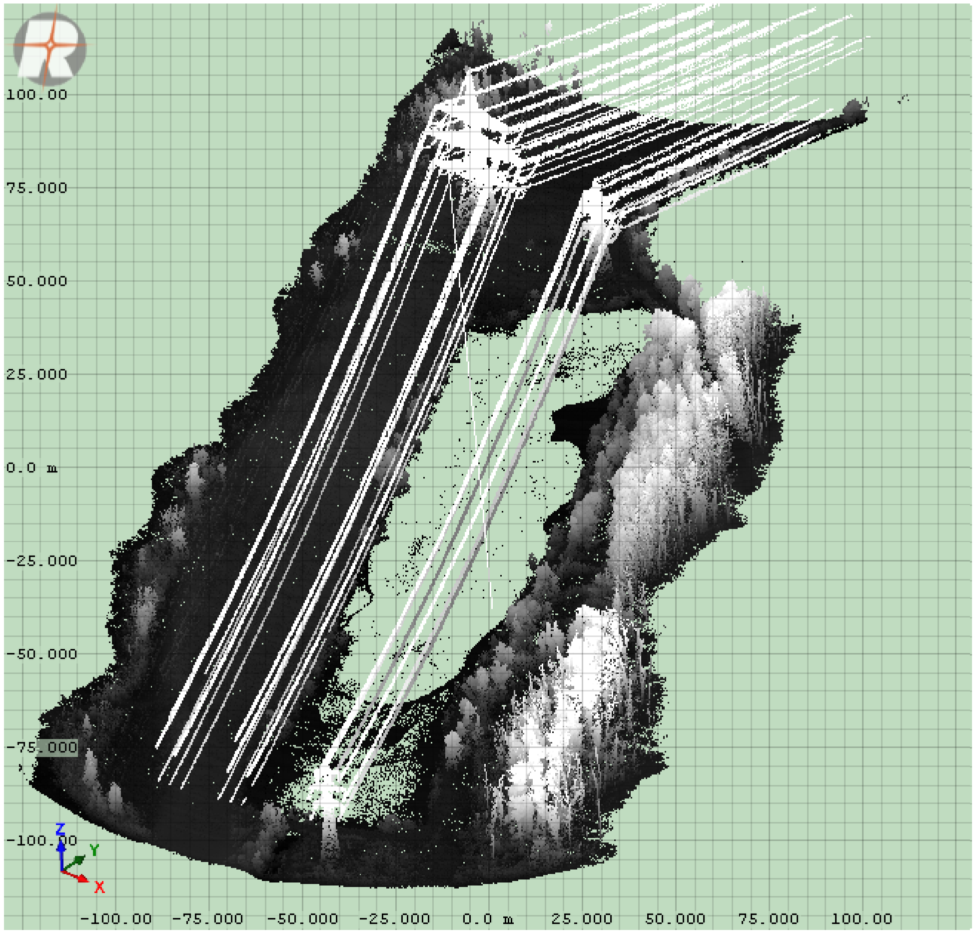
results

Baltic sea, Atlantic
floodplains, rivers

floodplains example project

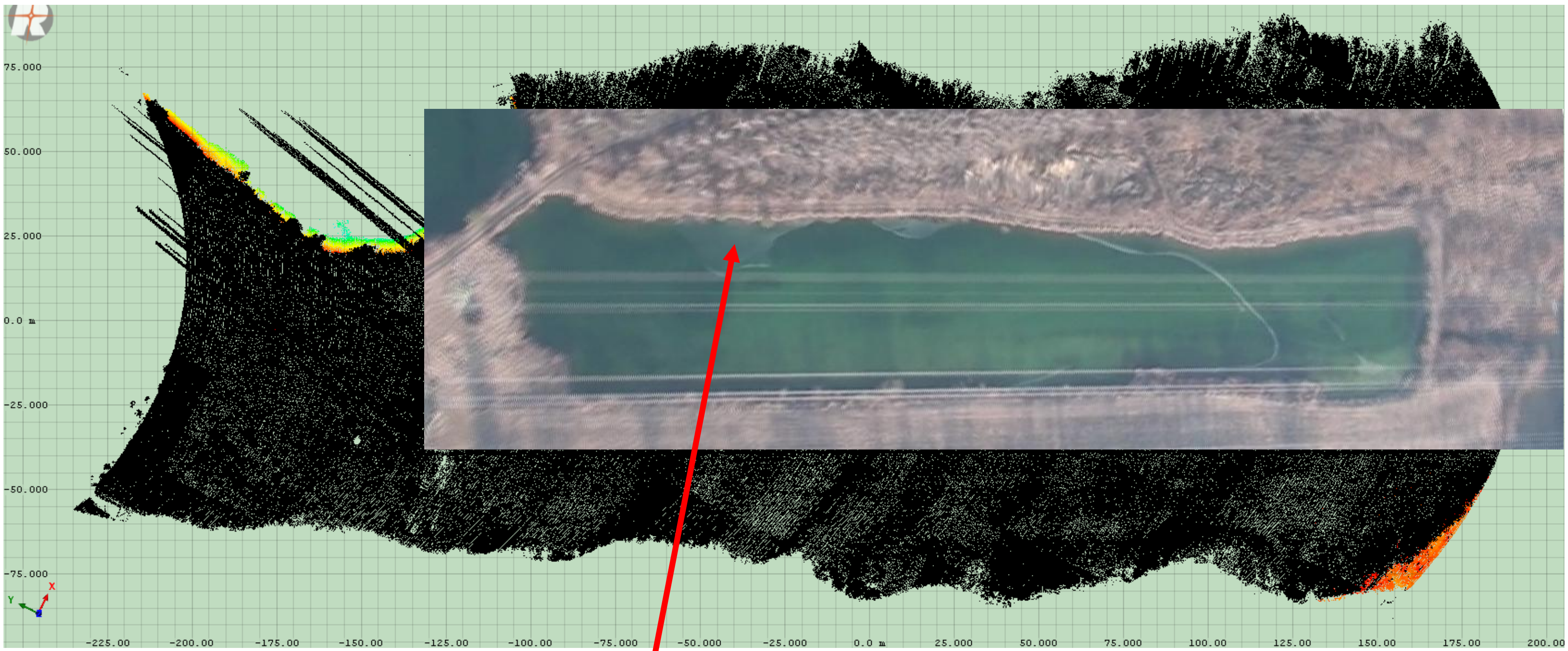
floodplain near the Danube / Austria

floodplains example data - analyzed waterbody



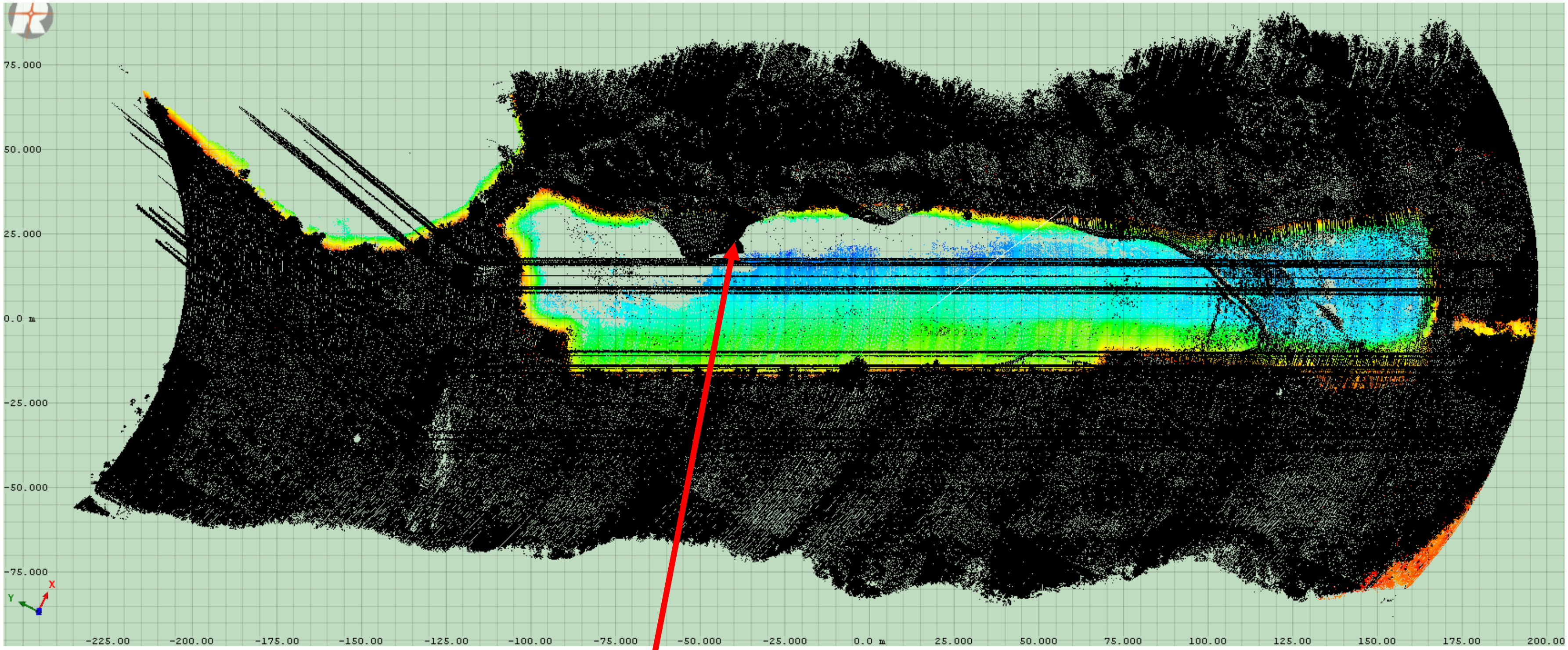
- waterbody 250 m x 50 m x 4 m
- partly covered with ice
- surrounded by mixed vegetation
- powerlines
- 2,500 measurements from surface
- 400,000 subaqueous points

floodplains example data - surveying area



partly covered with ice

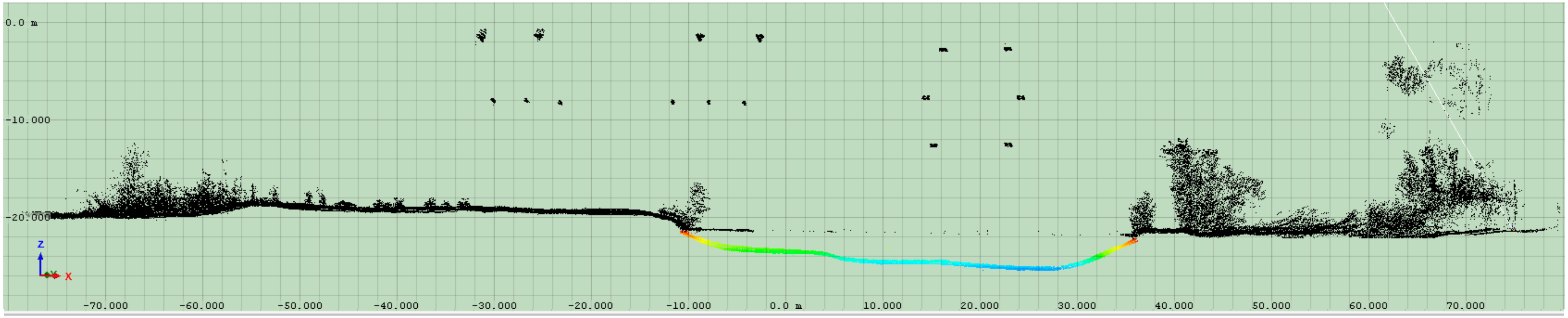
floodplains example data - surveying area



partly covered with ice

floodplains example data - results

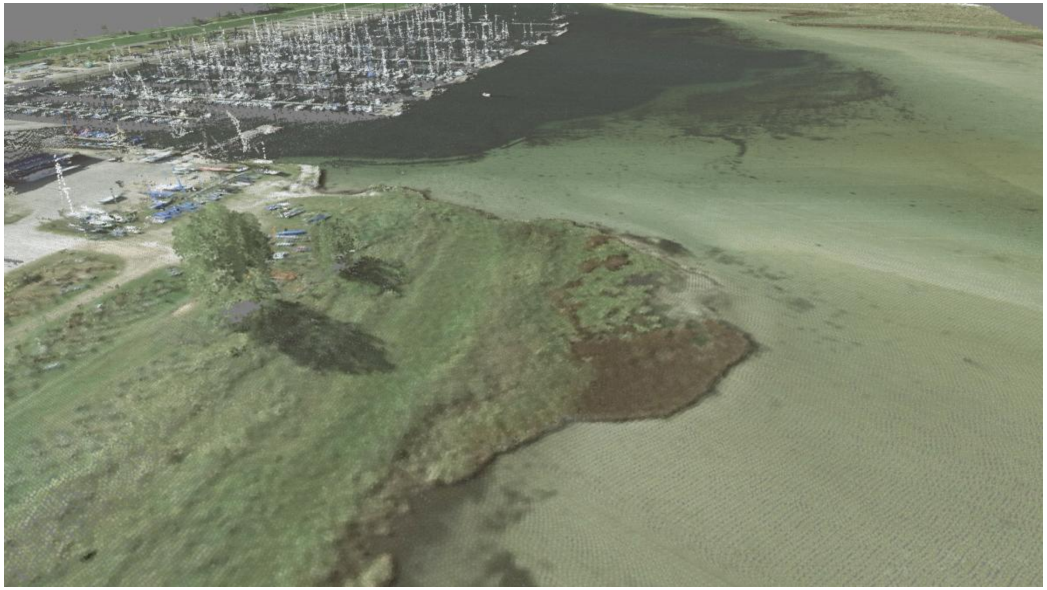
- cross-section of the detailed topo-bathy point cloud
- data acquired in a single fly-by



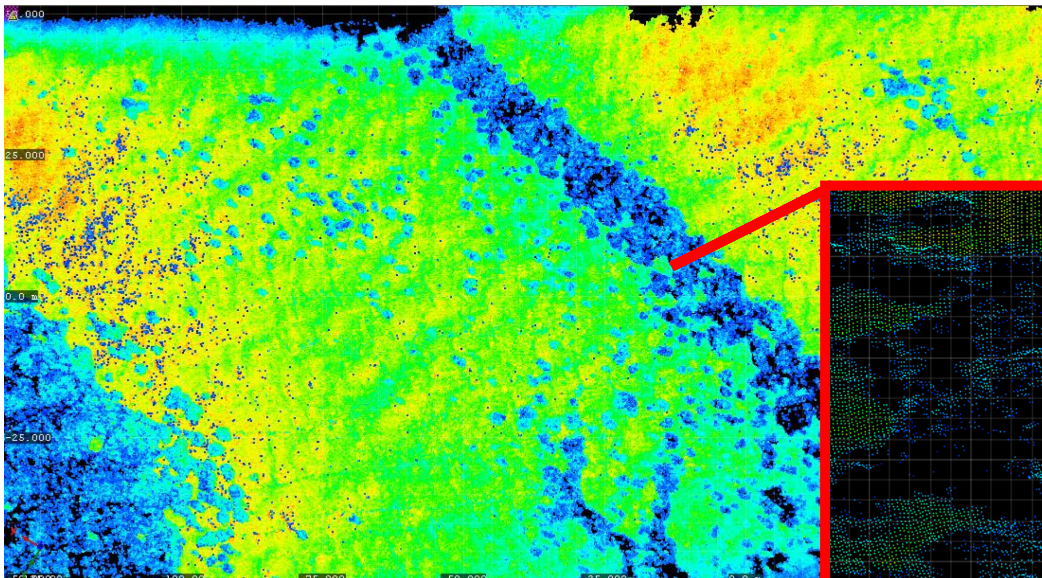
costal survey example data

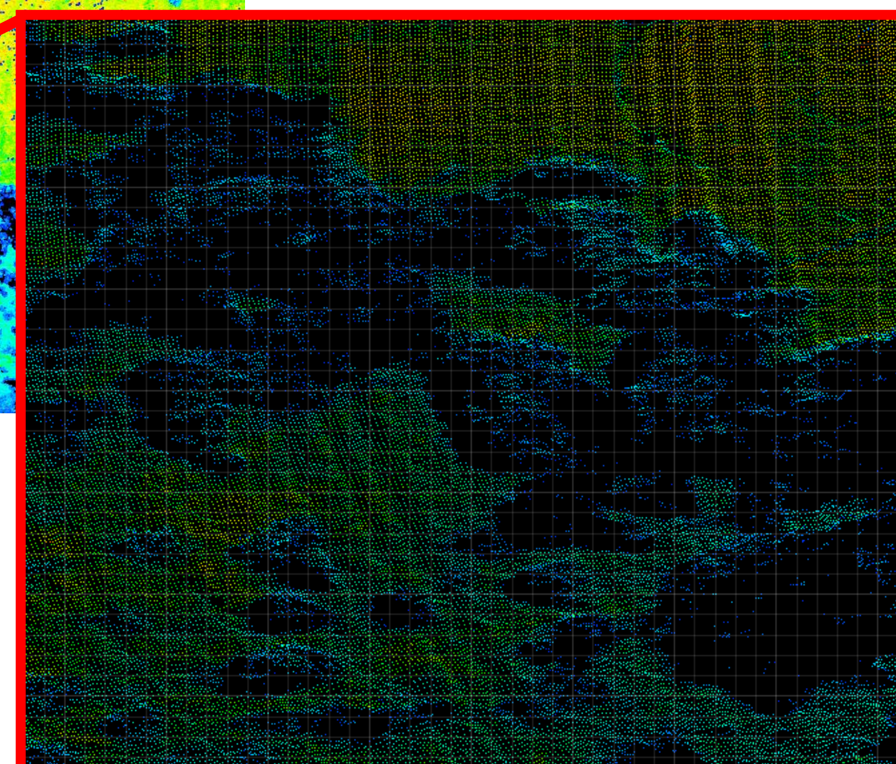
surf zone and beach

near Rostock/Germany



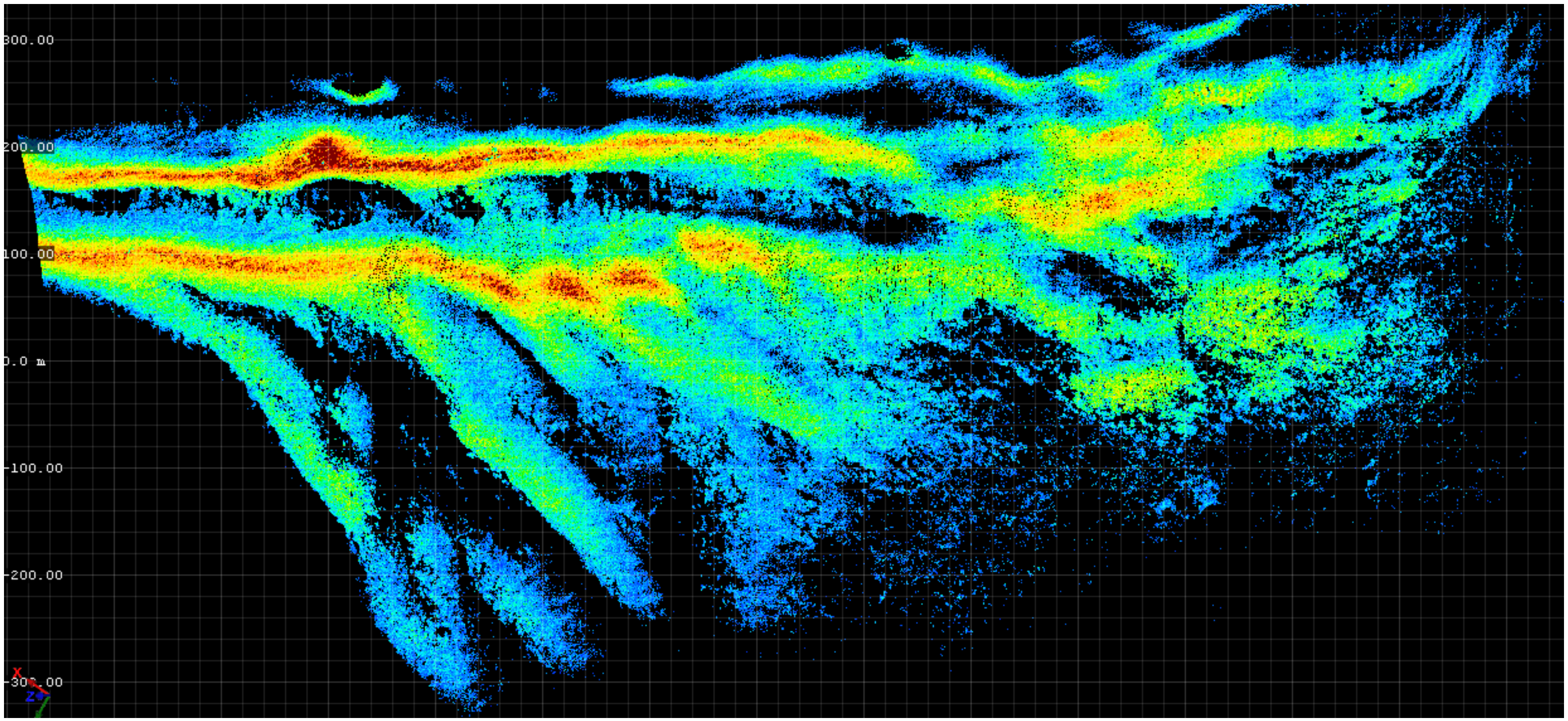
sand banks in 4m depth





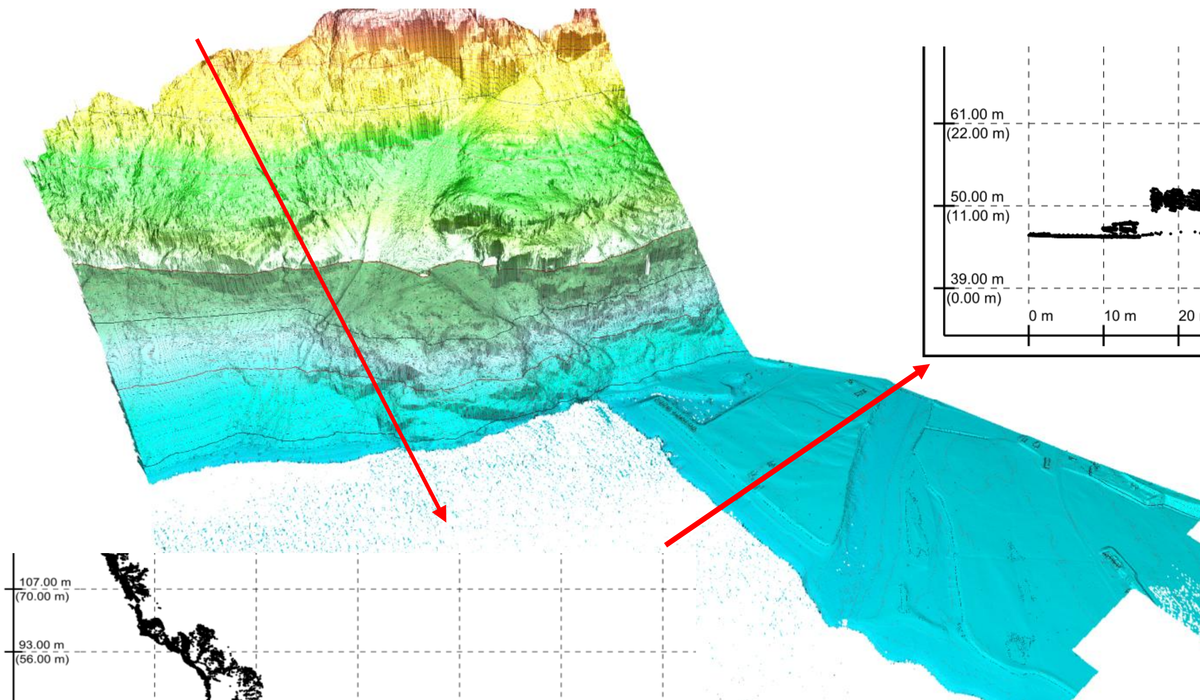
high point density on small structures

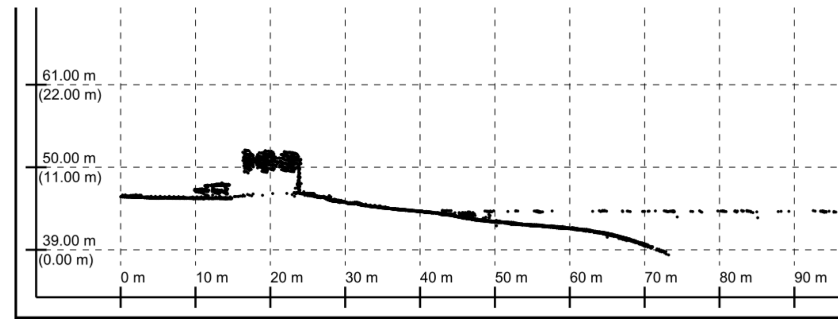
measurement from eyesafe hight

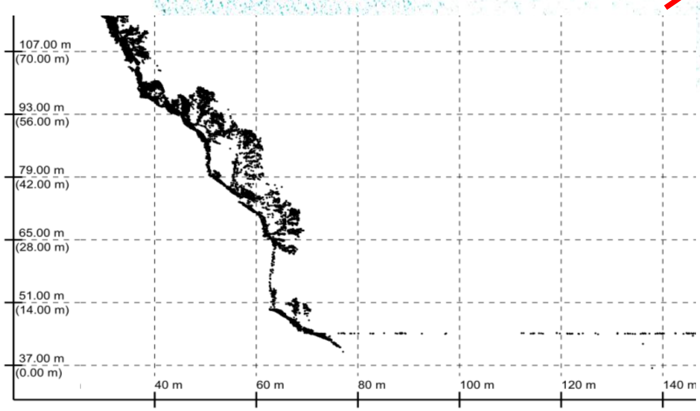


- broad flight strip from 600 m AGL
- still satisfactory penetration

Fjord Mapping – near Stavanger

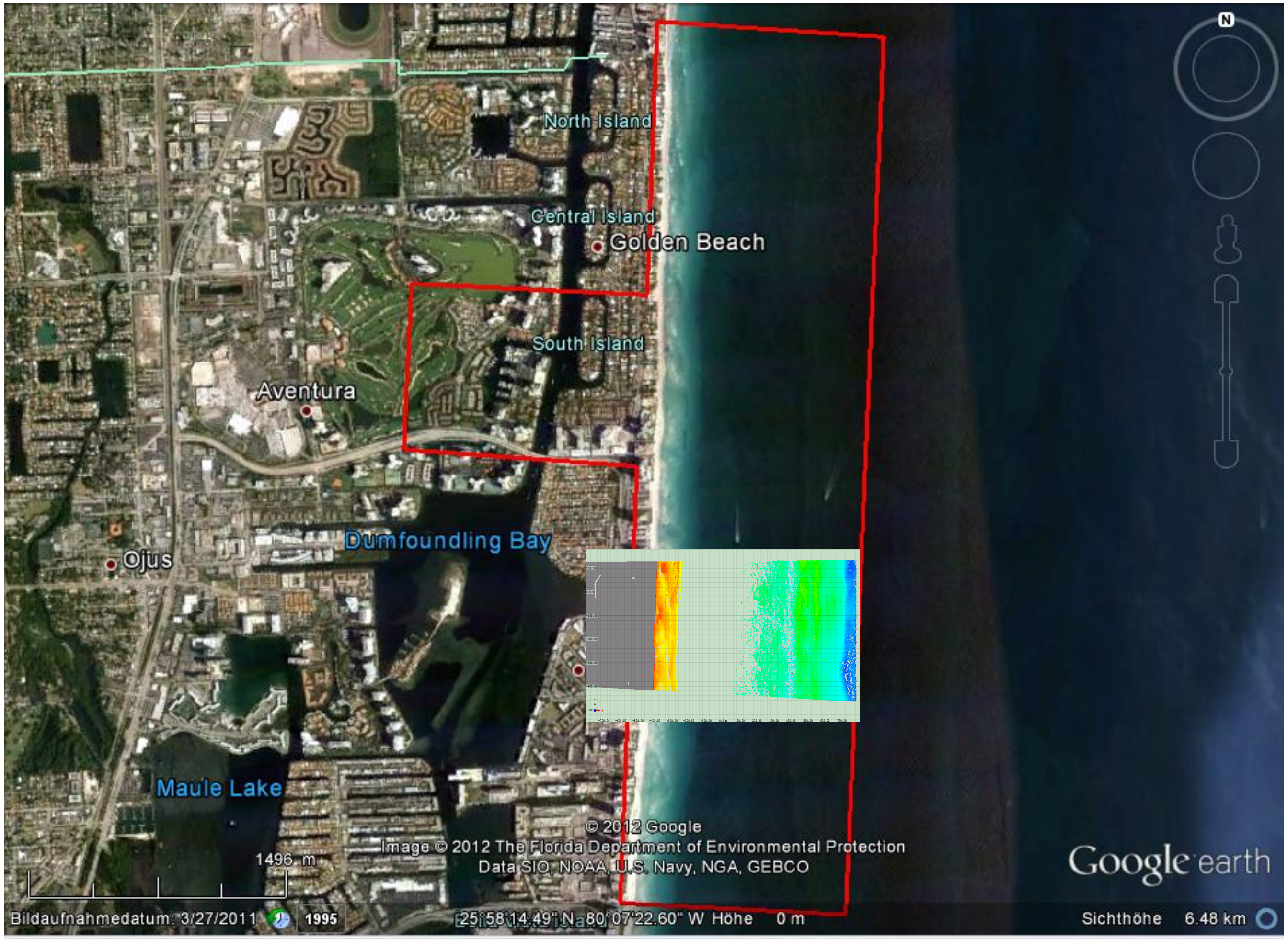




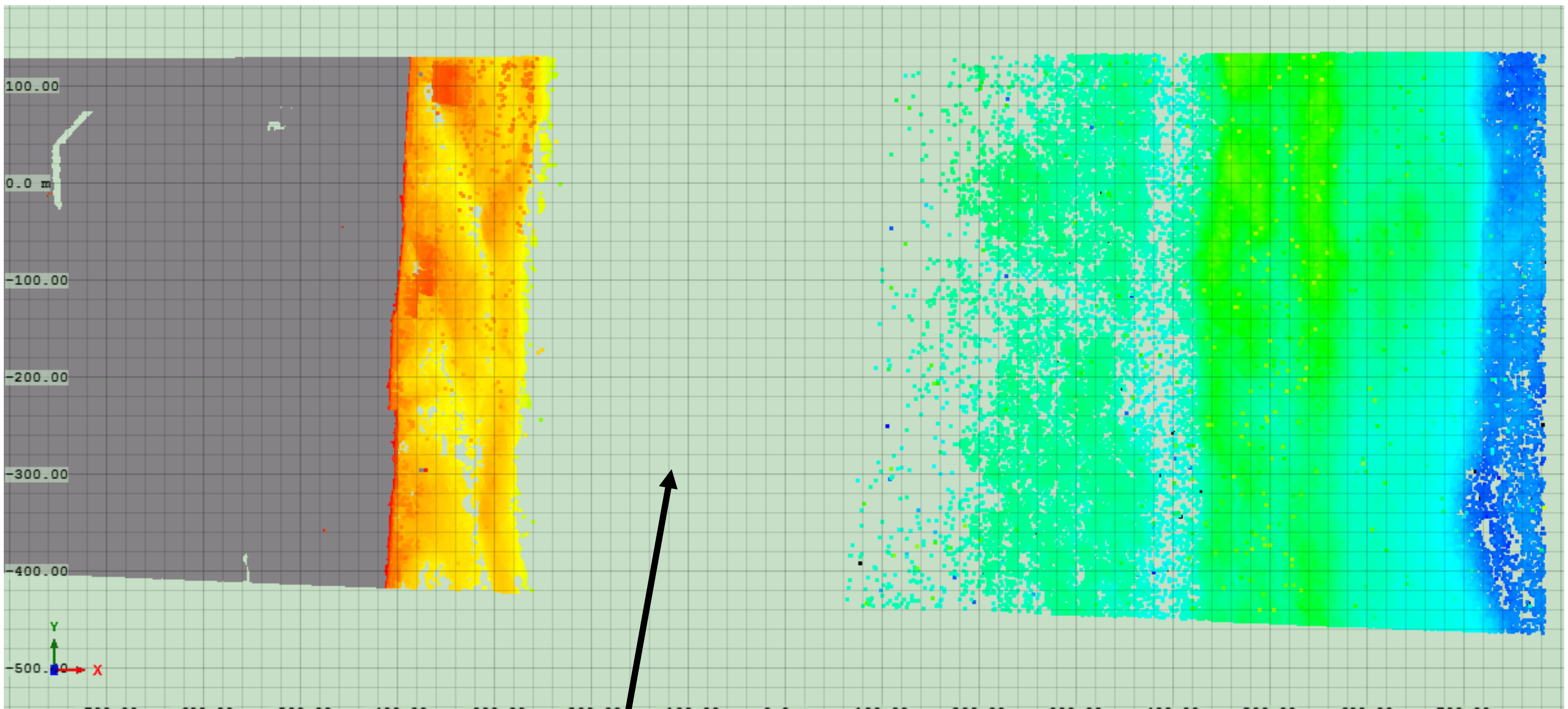


from ~1000m cliffs down to ~10m below sea surface within one flight by

Ft. Lauderdale – test project together with NOAA

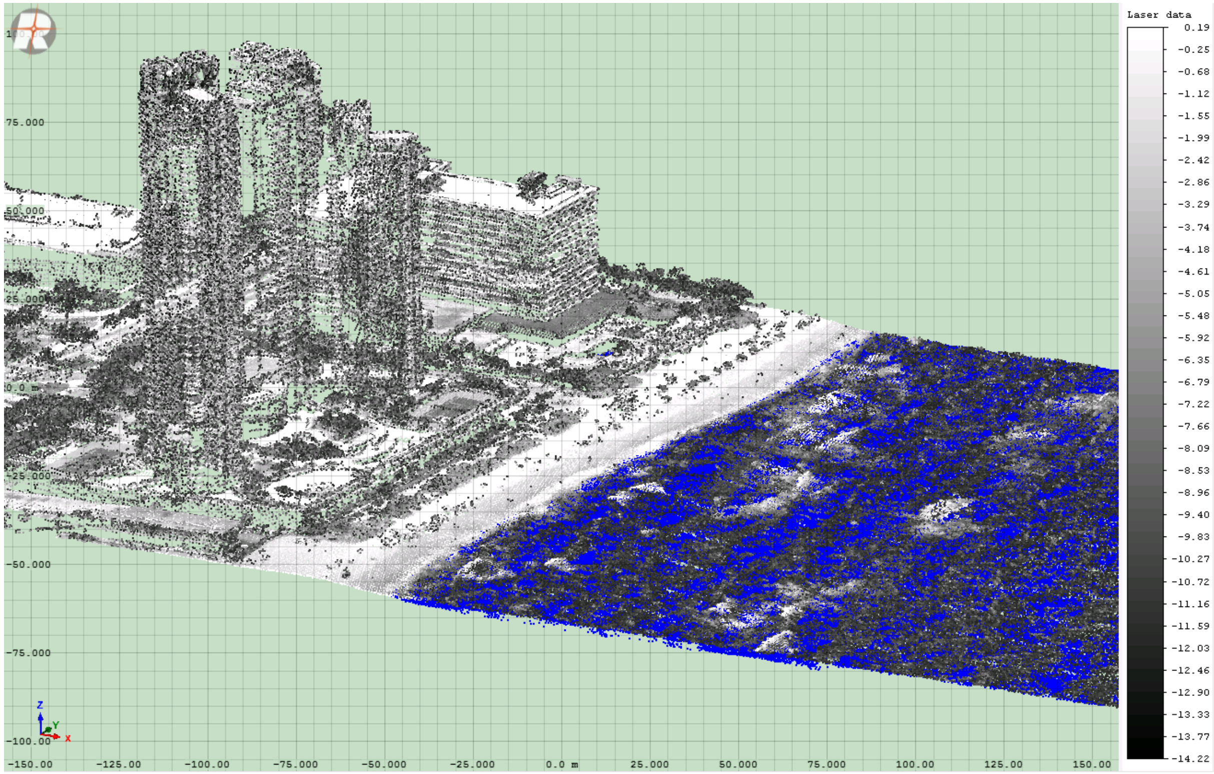


Ft. Lauderdale – example of the results

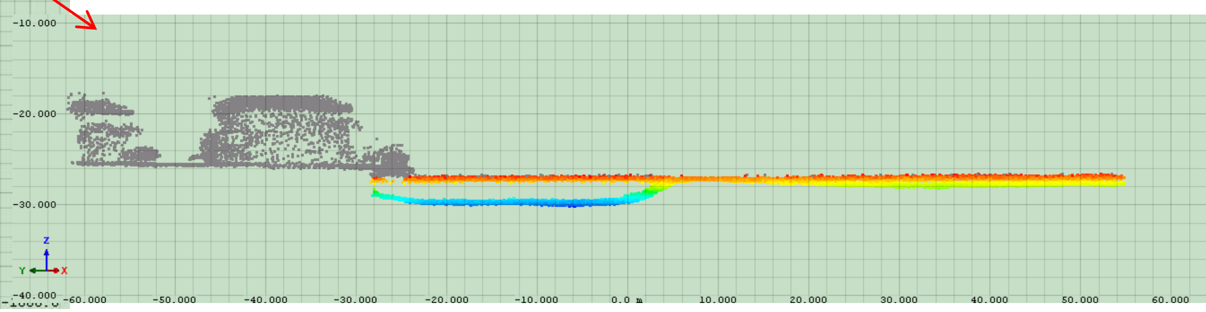


zone with lots of seaweeds / very dark sediment

Ft. Lauderdale – example of the results

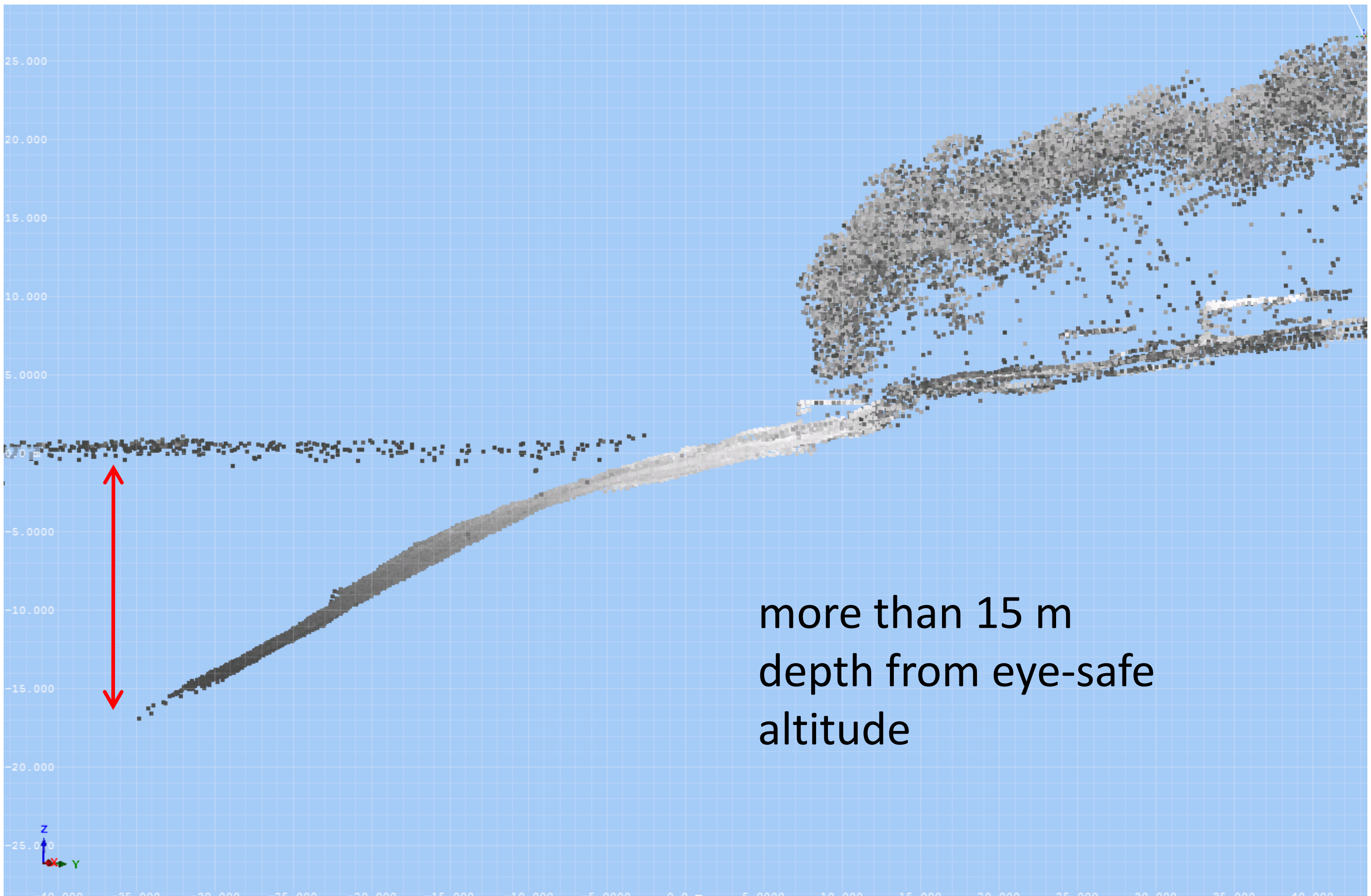


Florida Keys – example of the results

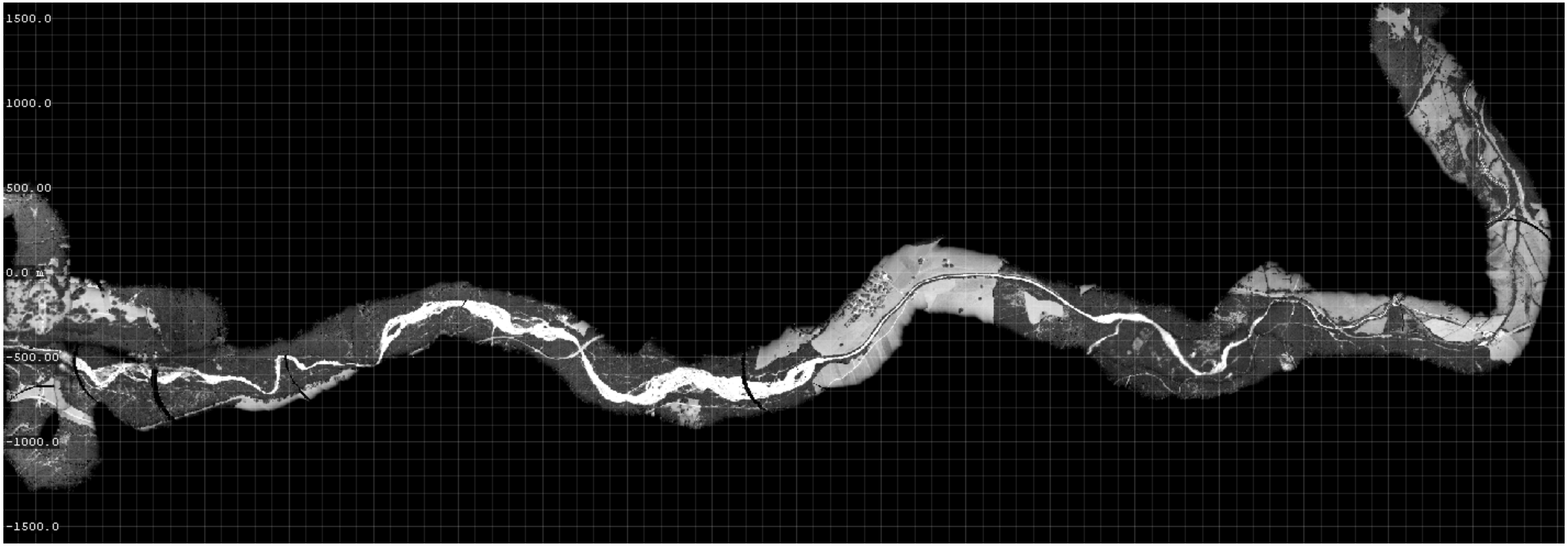


Adriatic Sea - example data

Adriatic Sea - example data

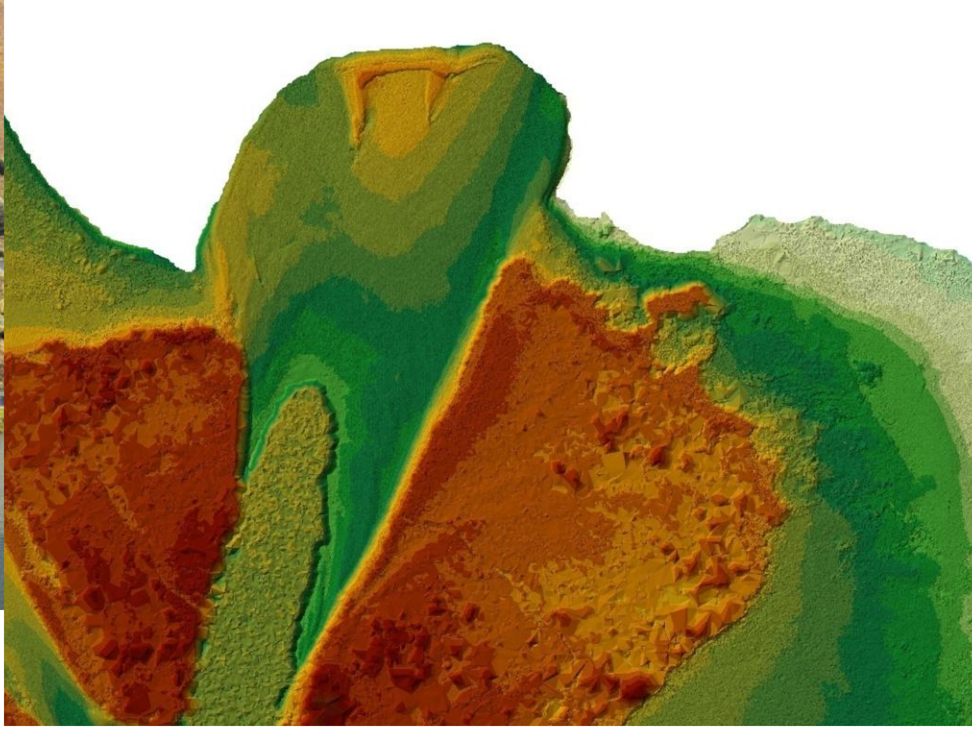


large-scale surveying of rivers

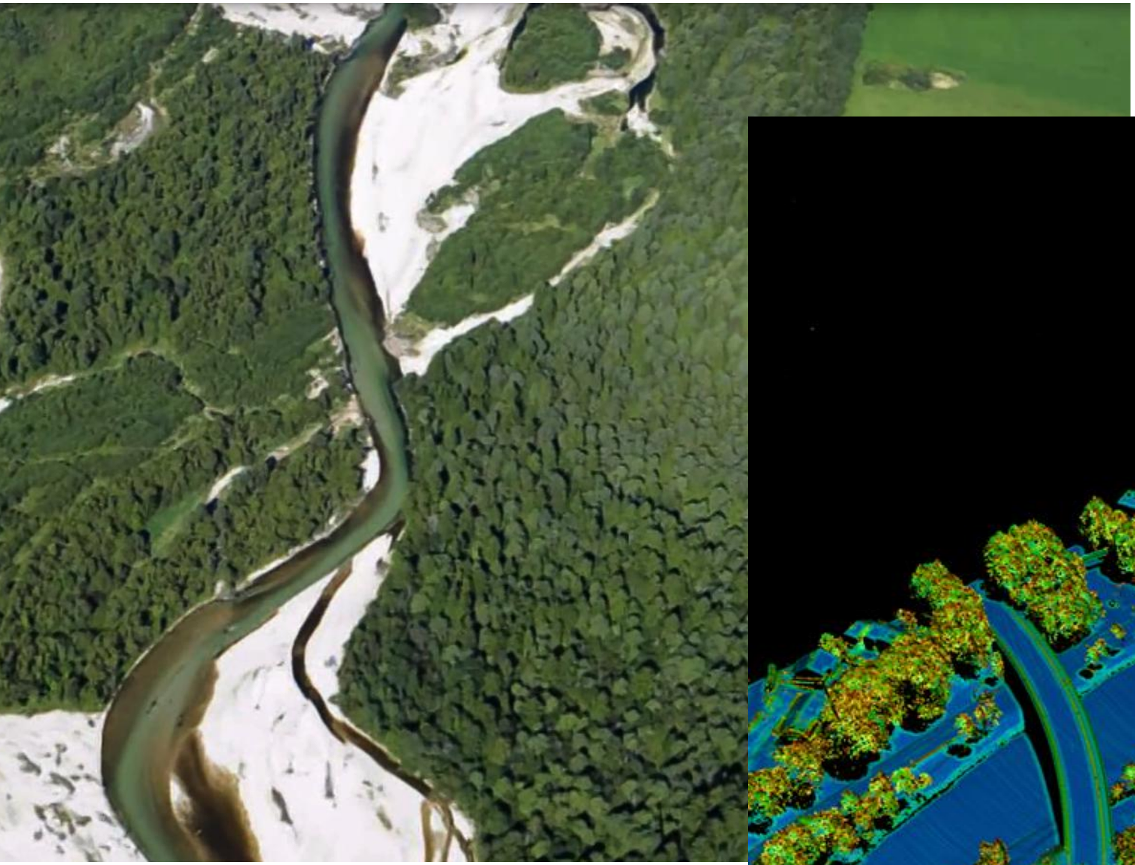


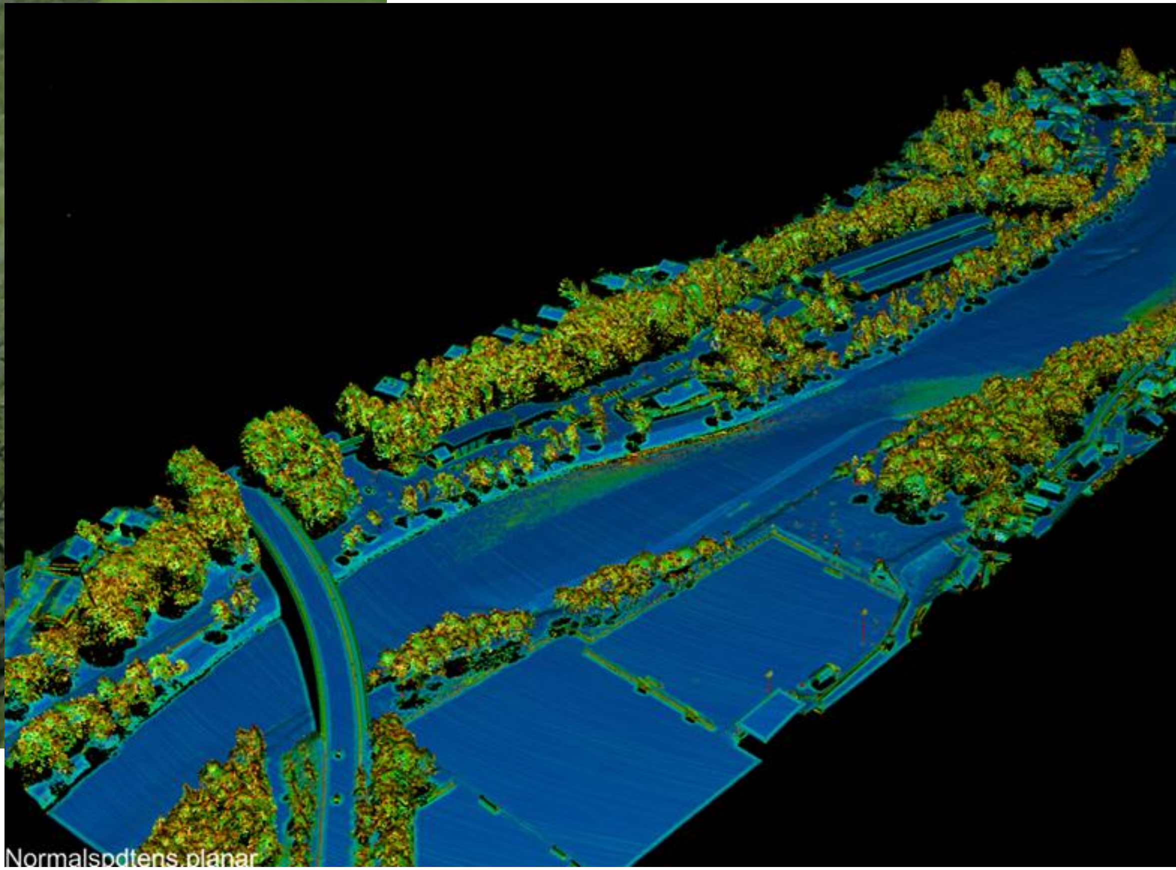
- full coverage of riverbed, riverbank, and surrounding area
- requires careful planning concerning precipitation, snowmelt etc.

river mouth of Lake Ammersee, Estuary

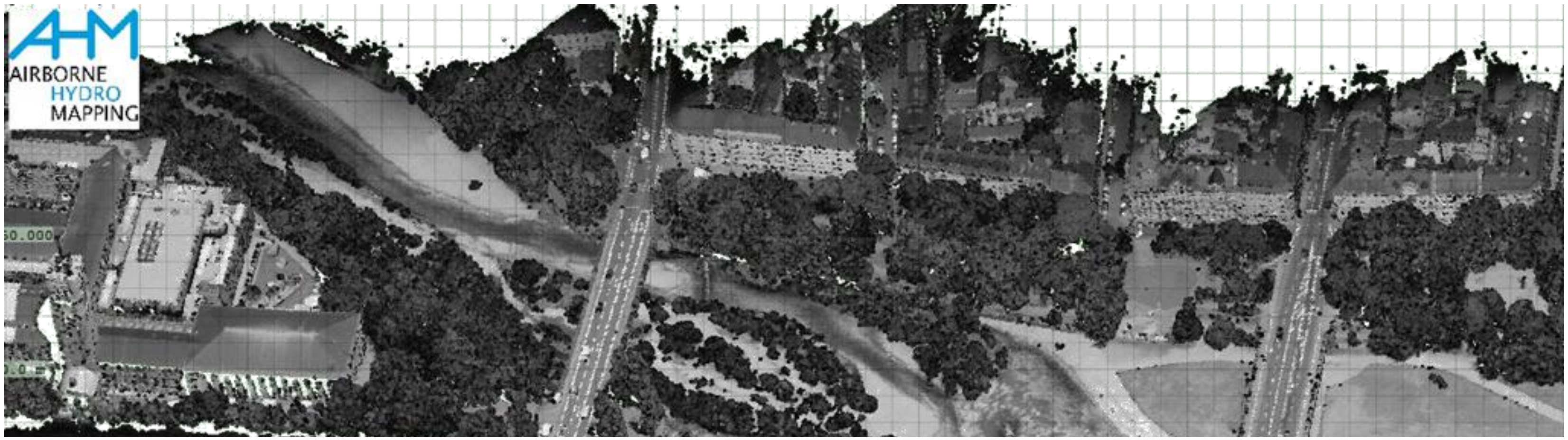


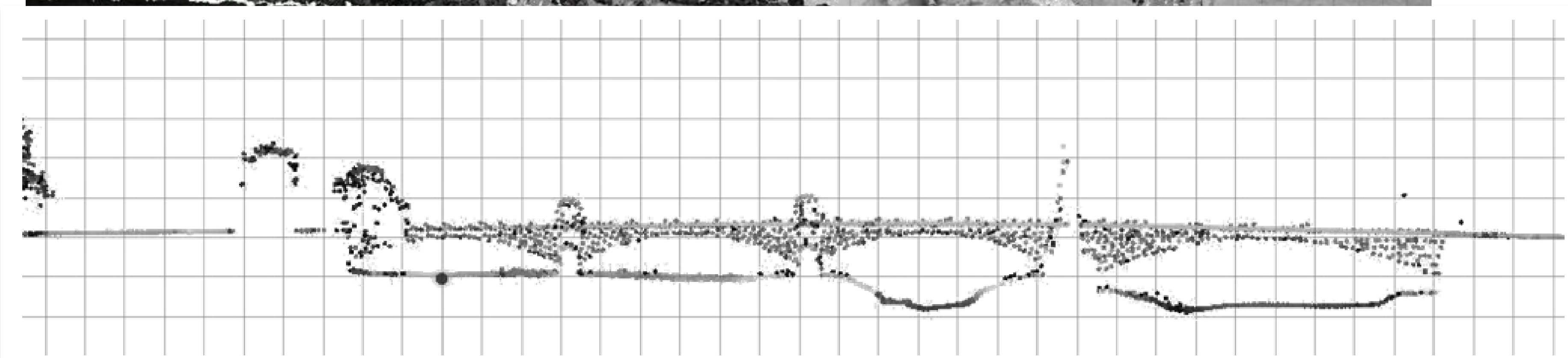
Isar, Midsize river





Isar, Midsize river

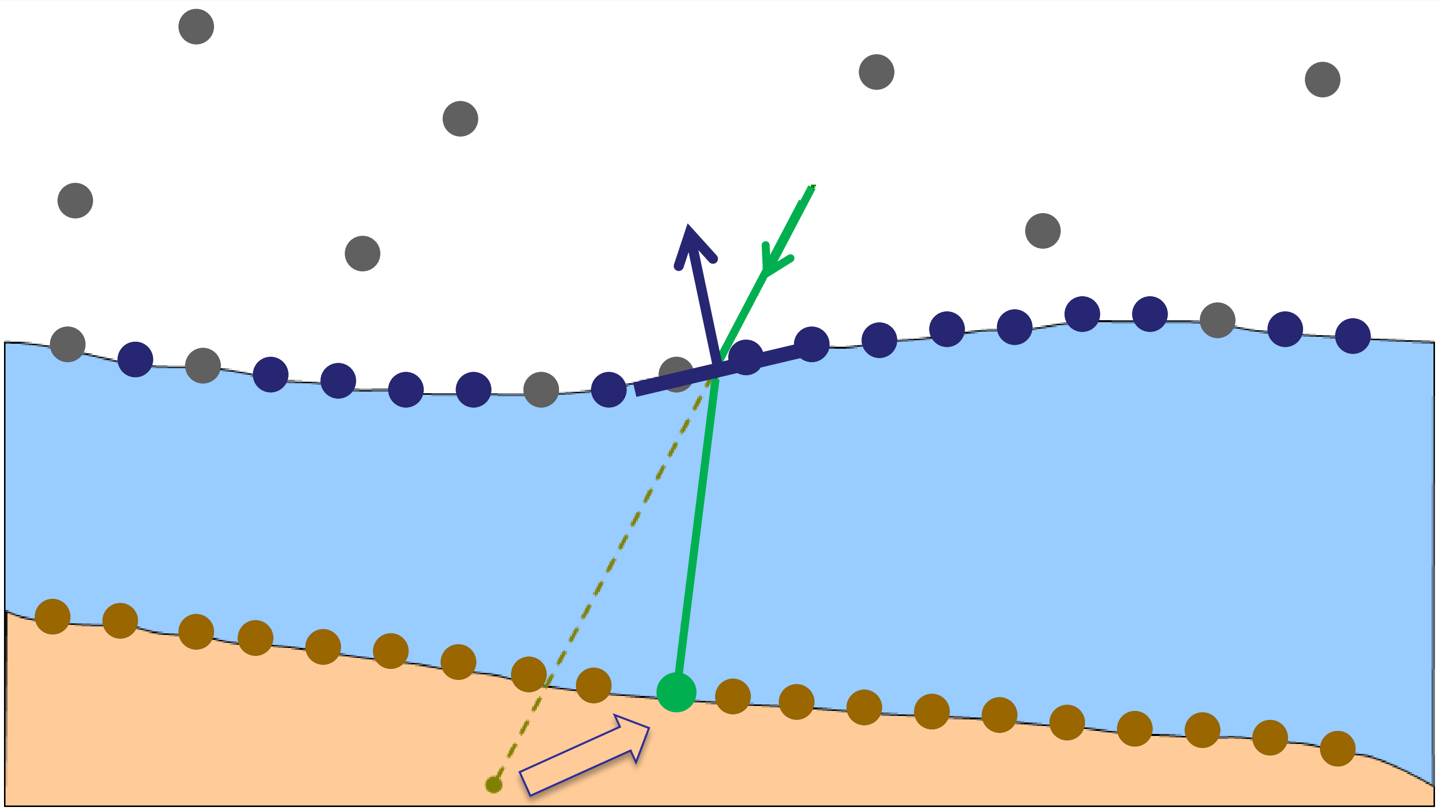




RIEGL Software
Hydrography
Addons

point cloud classification
refraction correction

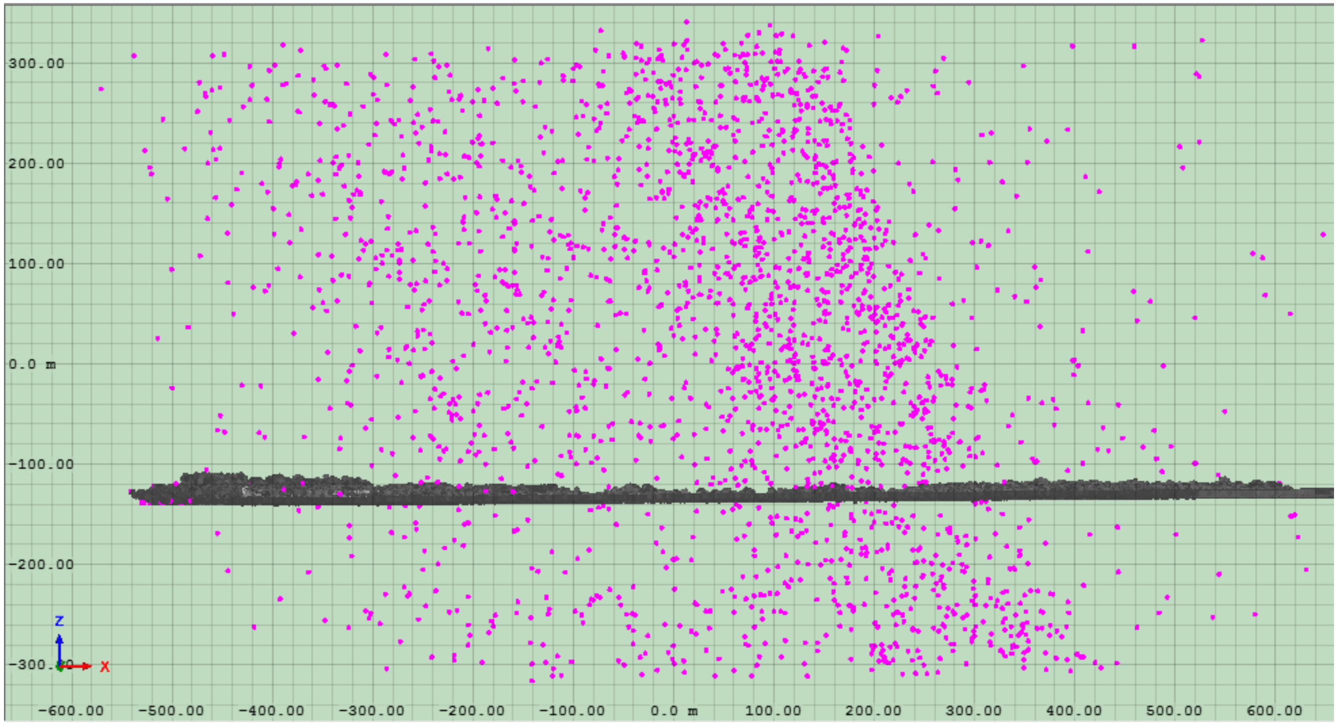
what it's all about…



Post-processing of bathymetric LiDAR data is different to topographic LiDAR data. Additional correction due to different medium (air / water) is needed.

Change in → direction → length

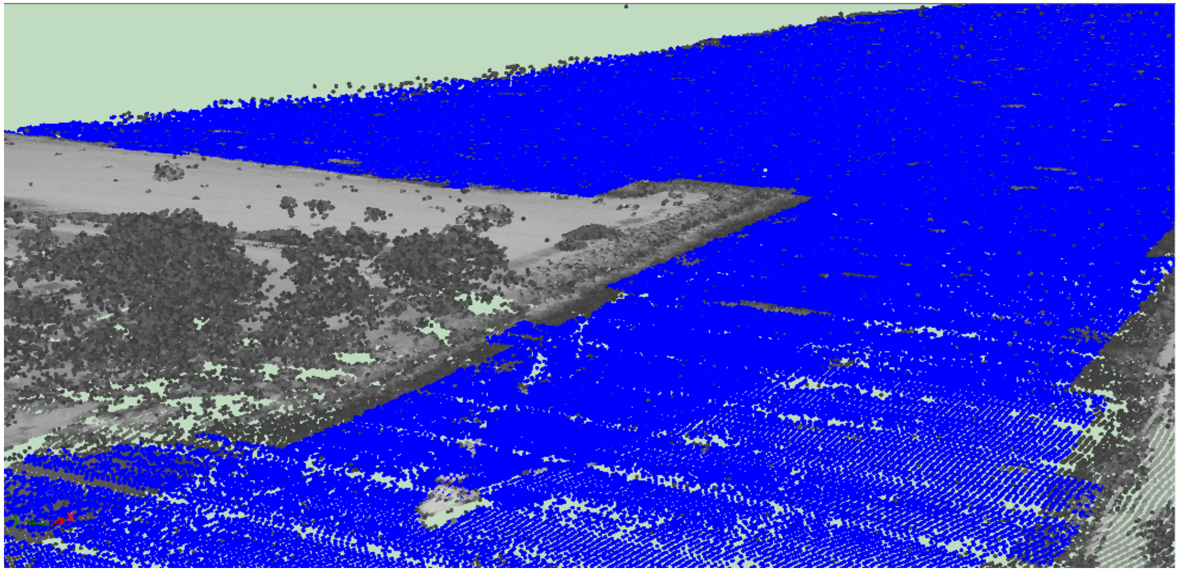
detection of isolated points



analysis based on number of neighboring points

classification of water surface points

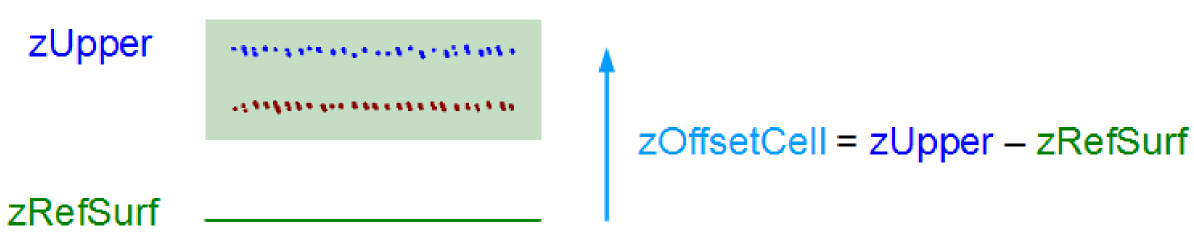
- fully automatic approach
- each scan line (strip) is processed independently
- input: geo-referenced scan line with sufficient quality



classification of water surface points – outline of method (1)

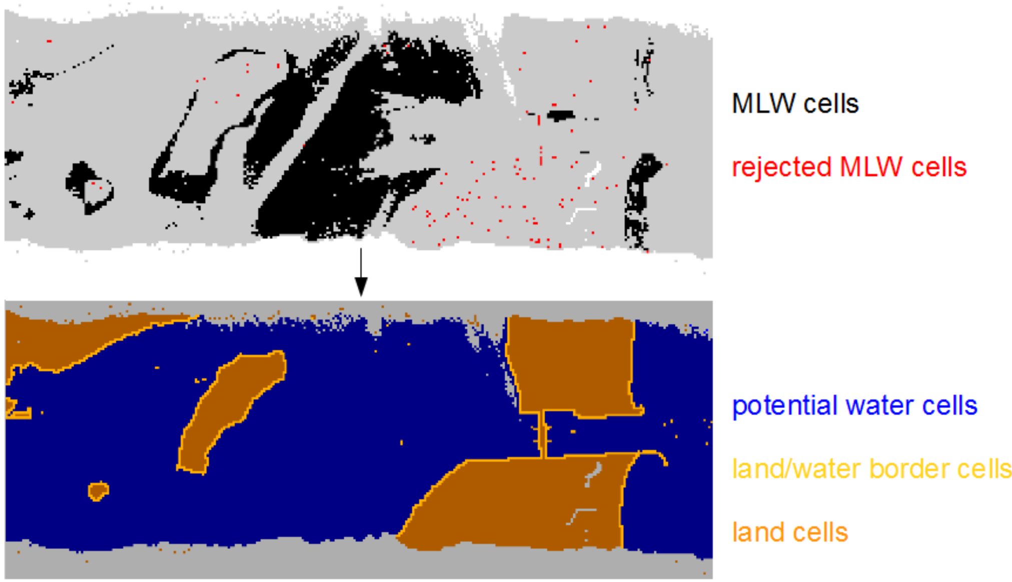
1.) find MLW cells by analyzing point distribution cell by cell

- “**M**ost **L**ikely **W**ater” cell
- contains two well-separable point sets (in z-coordinate direction)
- “upper layer“ is supposed to contain water surface points
- determine z-offset of cell’s “upper layer” w.r.t. reference surface



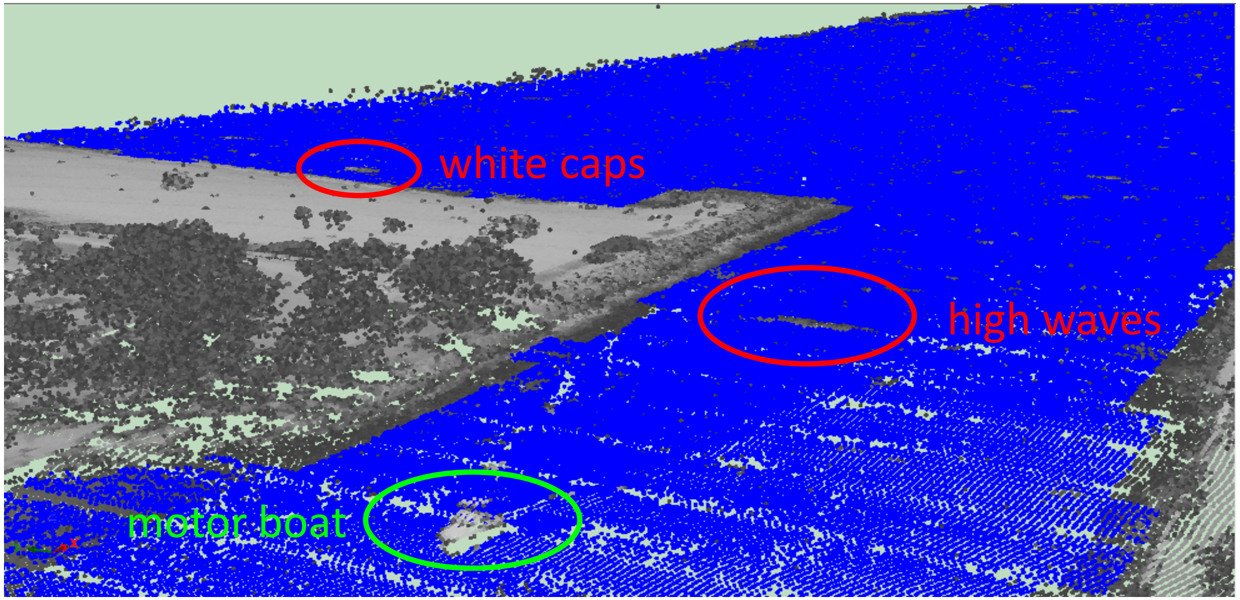
classification of water surface points – outline of method (3)

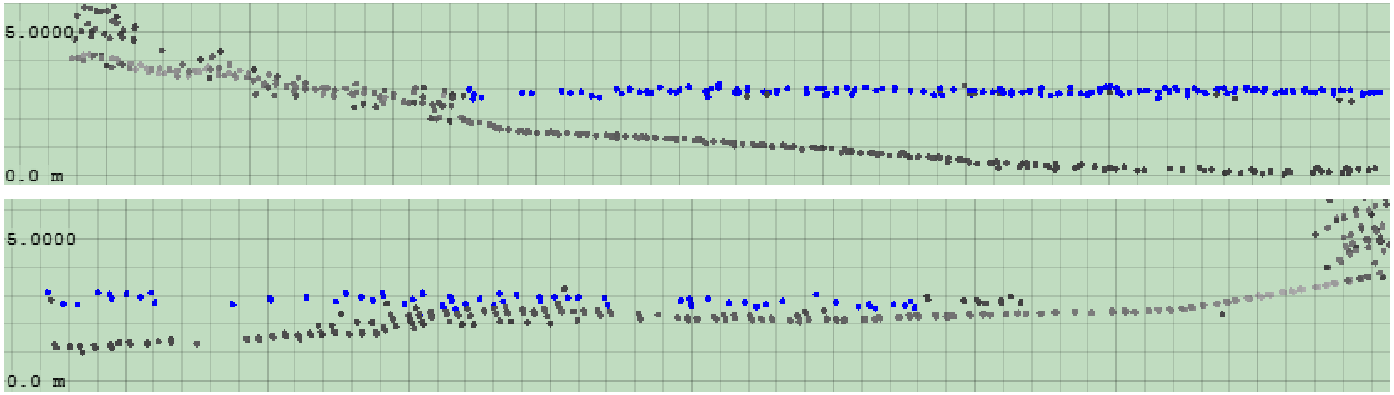
4.) growth algorithm to find further potential water cells starting from MLW cells



5.) examine potential water cells for water surface points

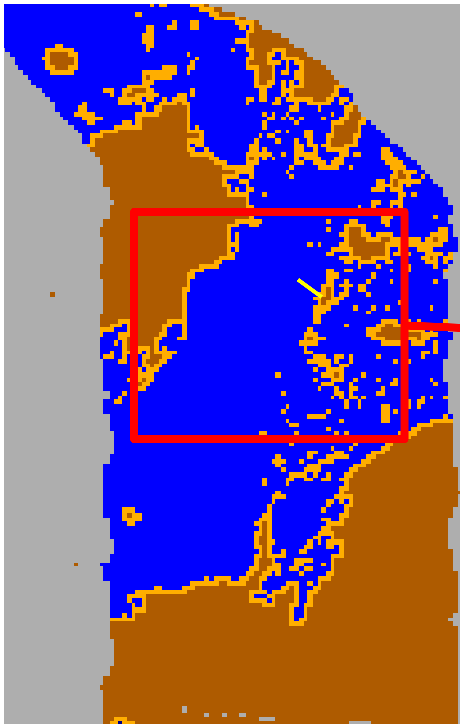
classification of water surface points – examples



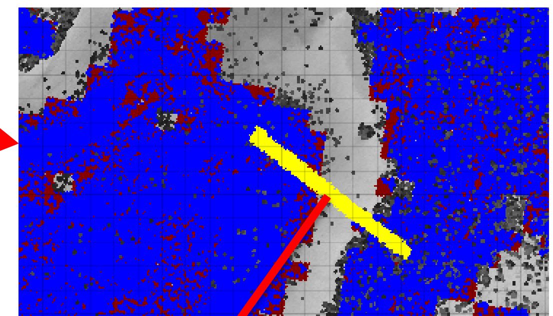


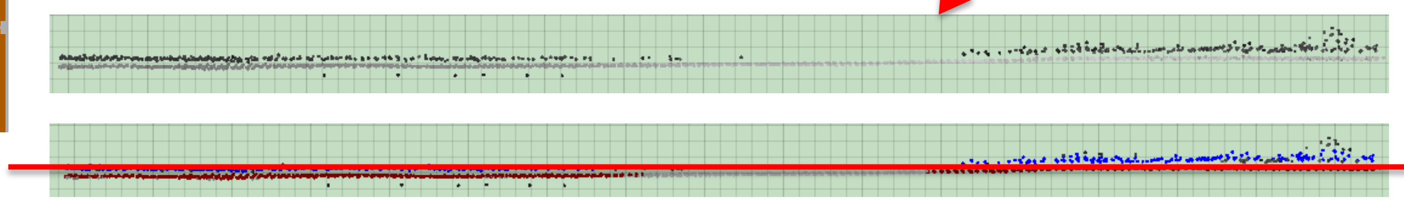
typical profiles crossing coast line

classification of water surface points – examples (2)



Aerial image

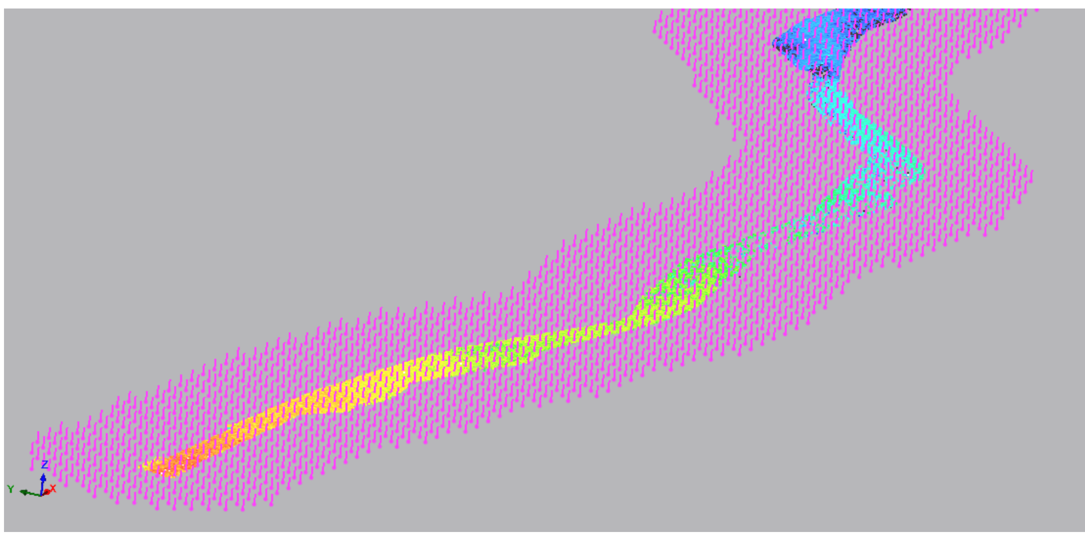


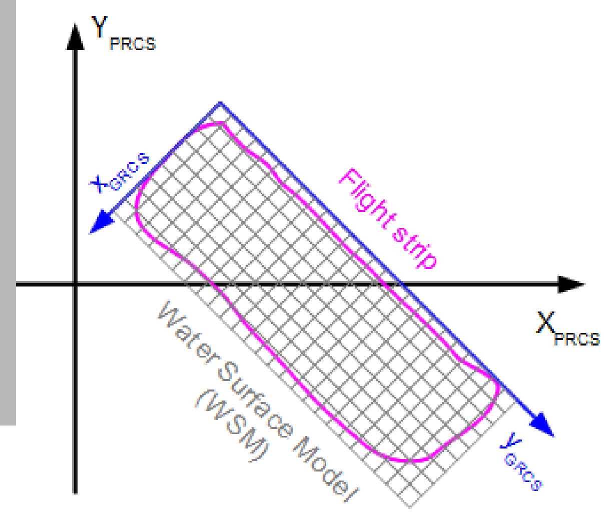


water surface (left) vs. low vegetation (right)

generation of a water surface model (WSM)

- generated for each scan (strip) based on classified water surface points
- WSM is represented by grid model (GRCS) aligned to main flight direction
- WSM cell information: height (z_{GRCS}) and normal vector

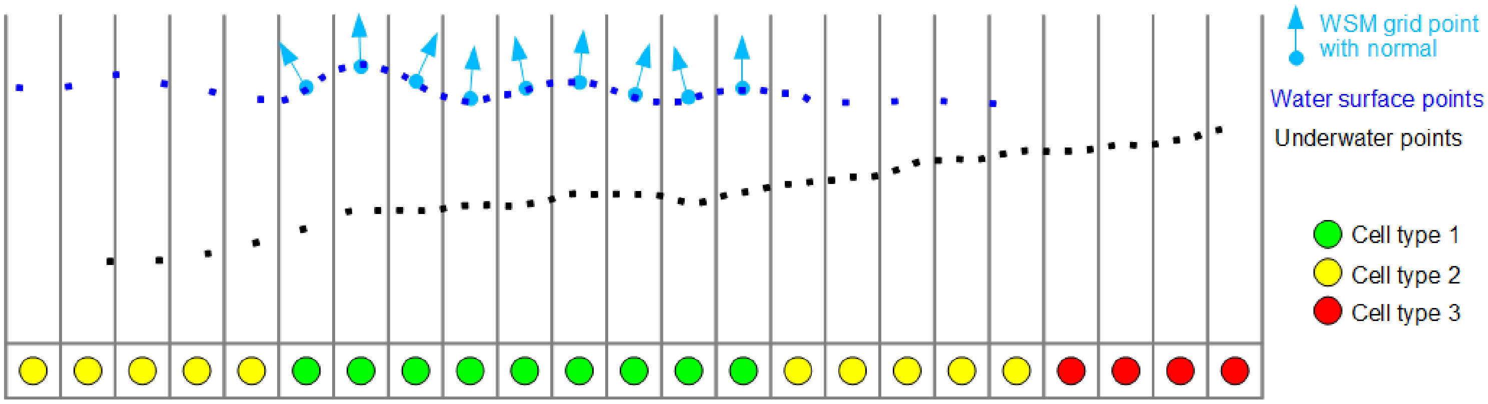




generation of WSM – outline of the method

step 1: consider only cells with sufficiently high point density

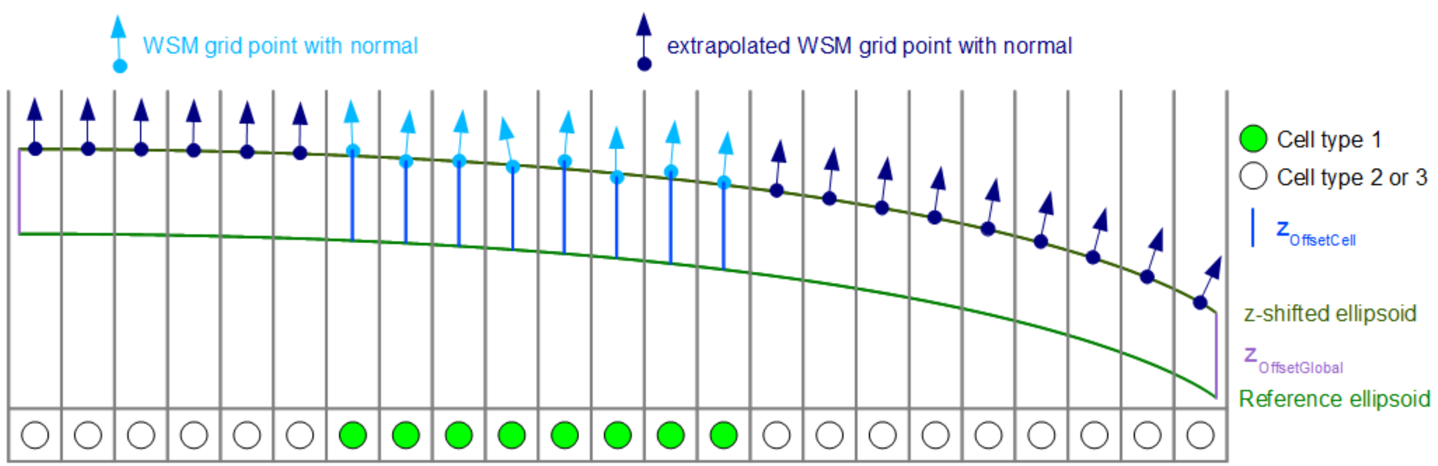
- if cell information meets criteria for cell type 1
  - store WSM parameters
- otherwise: cell type 2 or cell type 3



generation of WSM – extrapolation "ocean"

step 2: derive extrapolated WSM for remaining cells – mode "ocean"

assumption: water surface is more or less at the same level (cell of type 1)

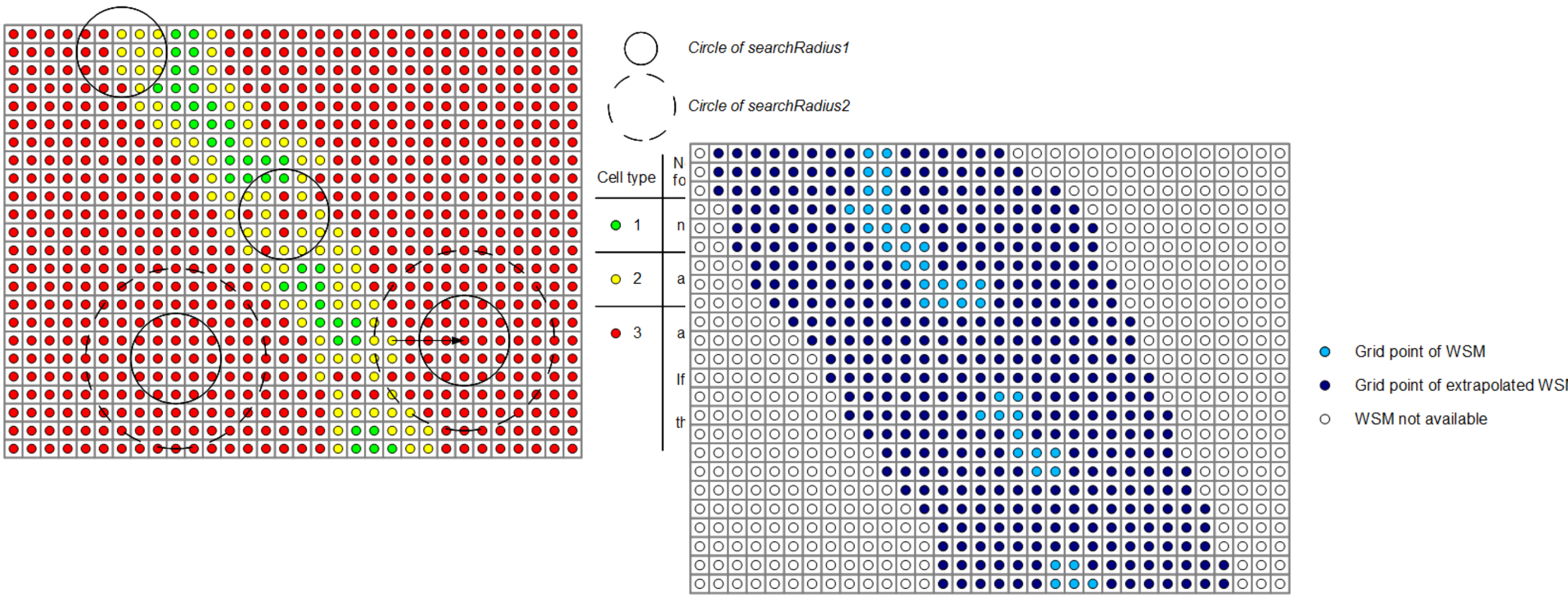


generation of WSM – extrapolation “river”

step 2: derive extrapolated WSM for remaining cells – mode “river”

Due to slope: use individual z-offsets instead of a global one.

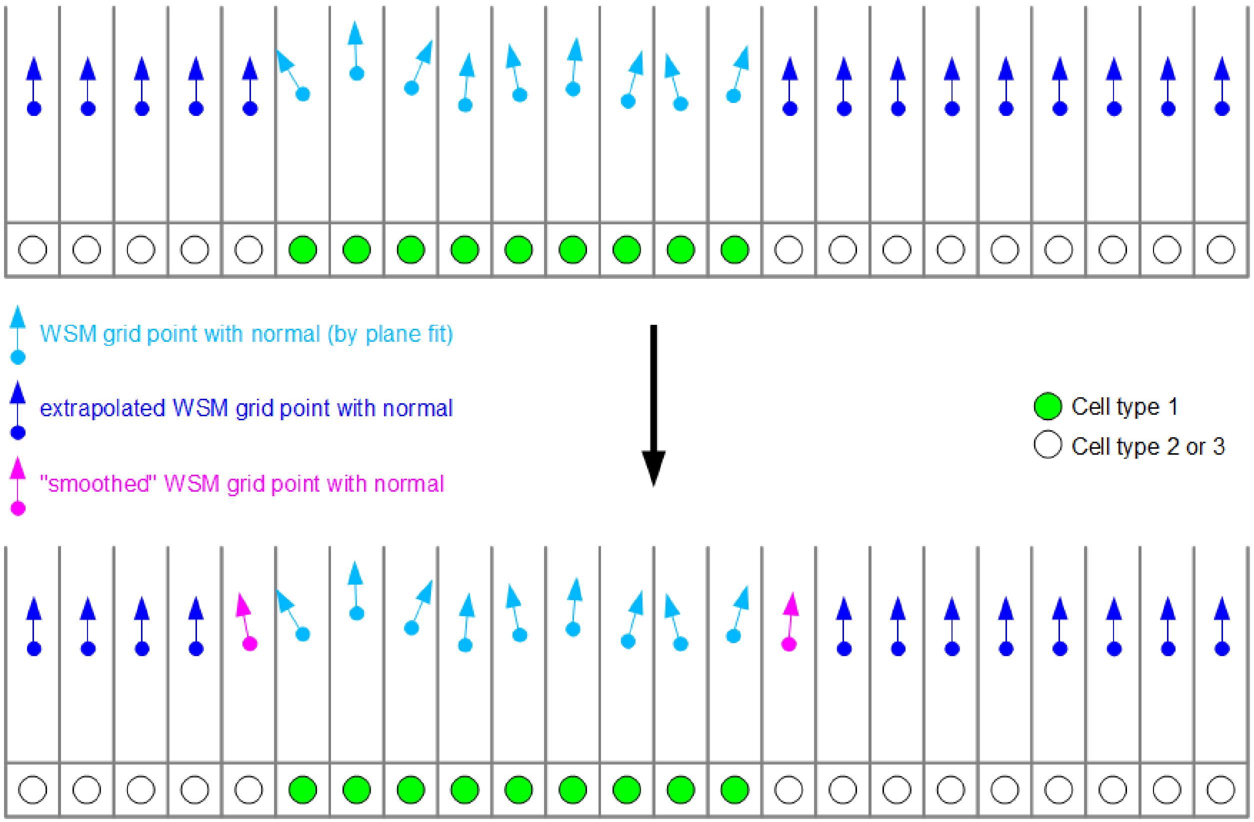
Note: extrapolation is only done within buffer zone around water surface points



generation of WSM – complete the model

step 3: Complete the WSM

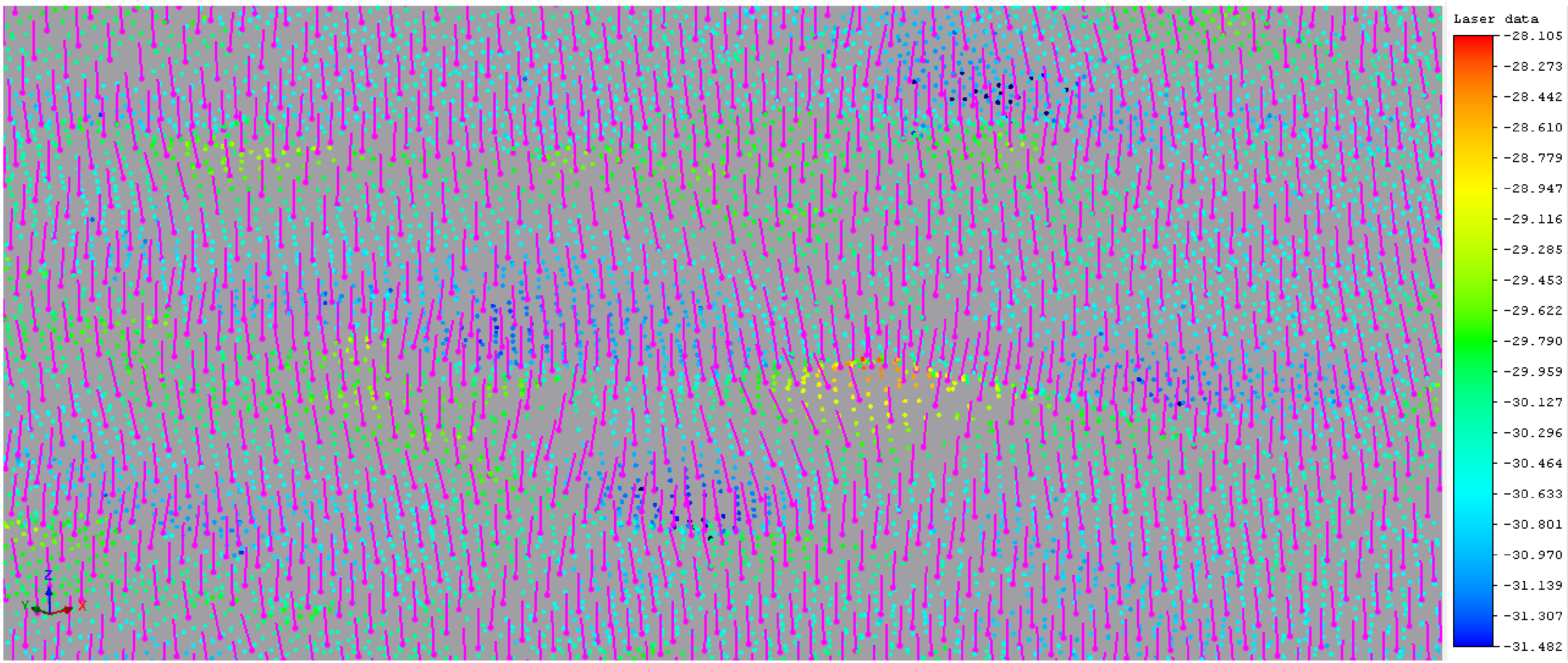
smoothen extrapolated WSM at transitions to type-1 cells



generation of WSM – results (1)

WSM in case of high waves (ocean mode):

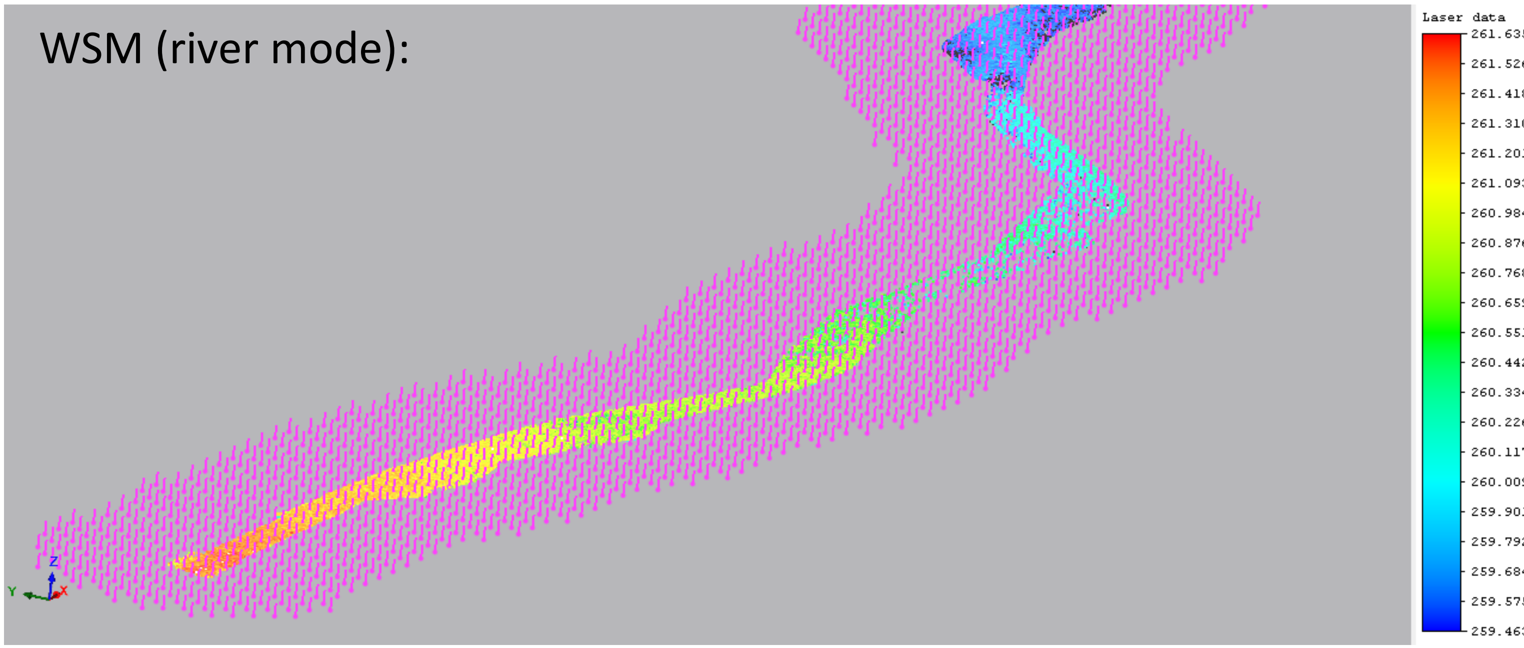
elevation



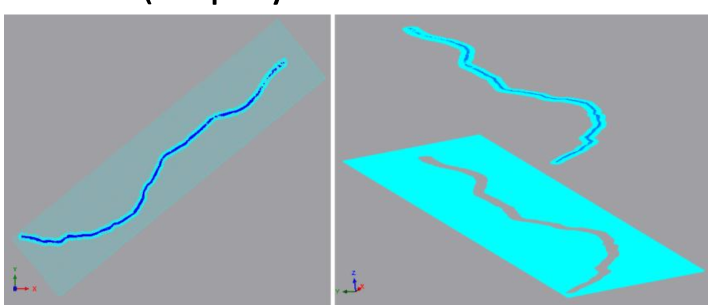
WSM (displayed as normal vector field) and water surface points (z-color-coded)

generation of WSM – results (2)

WSM (river mode):



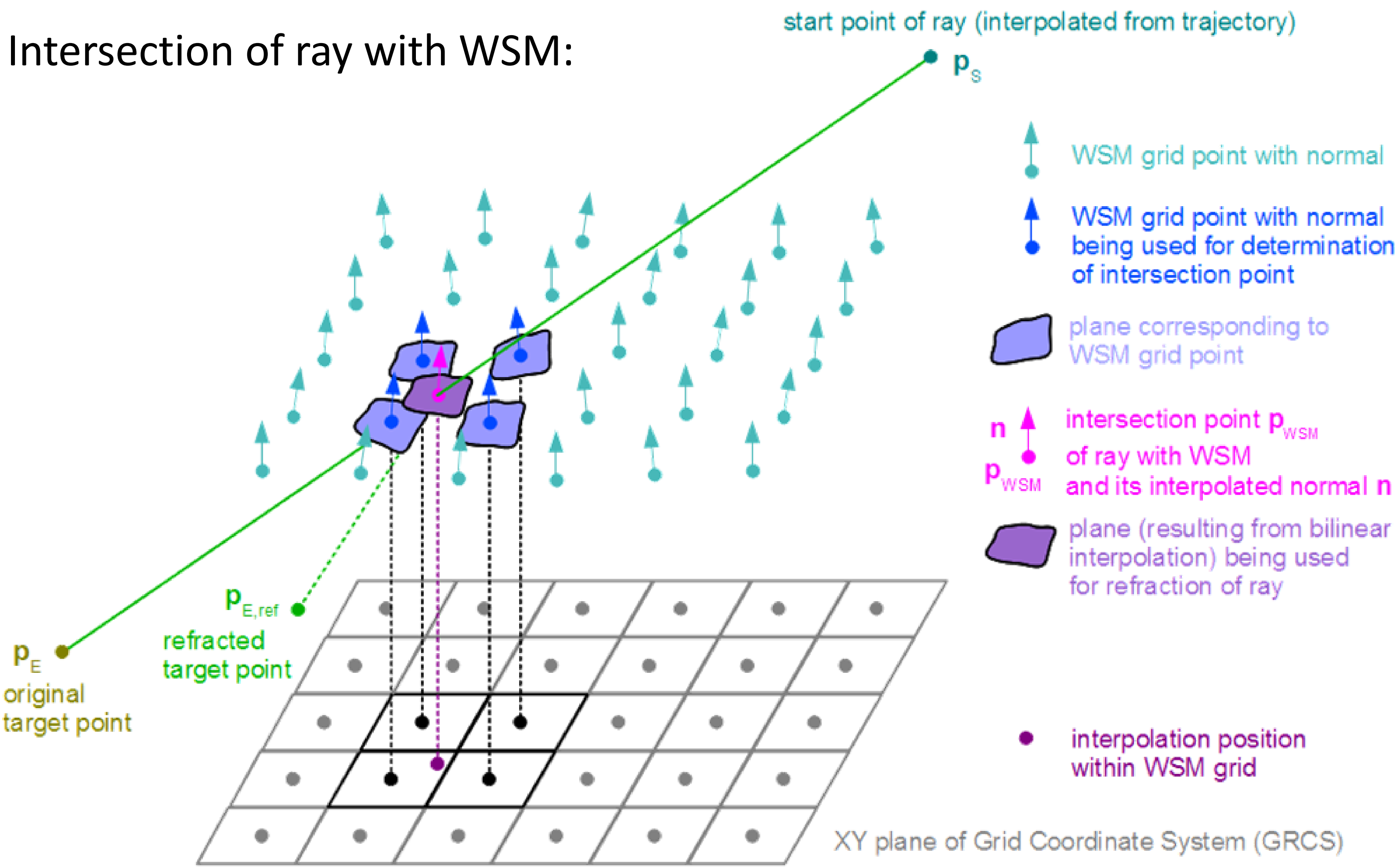
WSM (displayed as normal vector field) and water surface points (z-color-coded)



note: WSM is only available in vicinity of water surface points; elsewhere: no-data values

refraction correction (1)

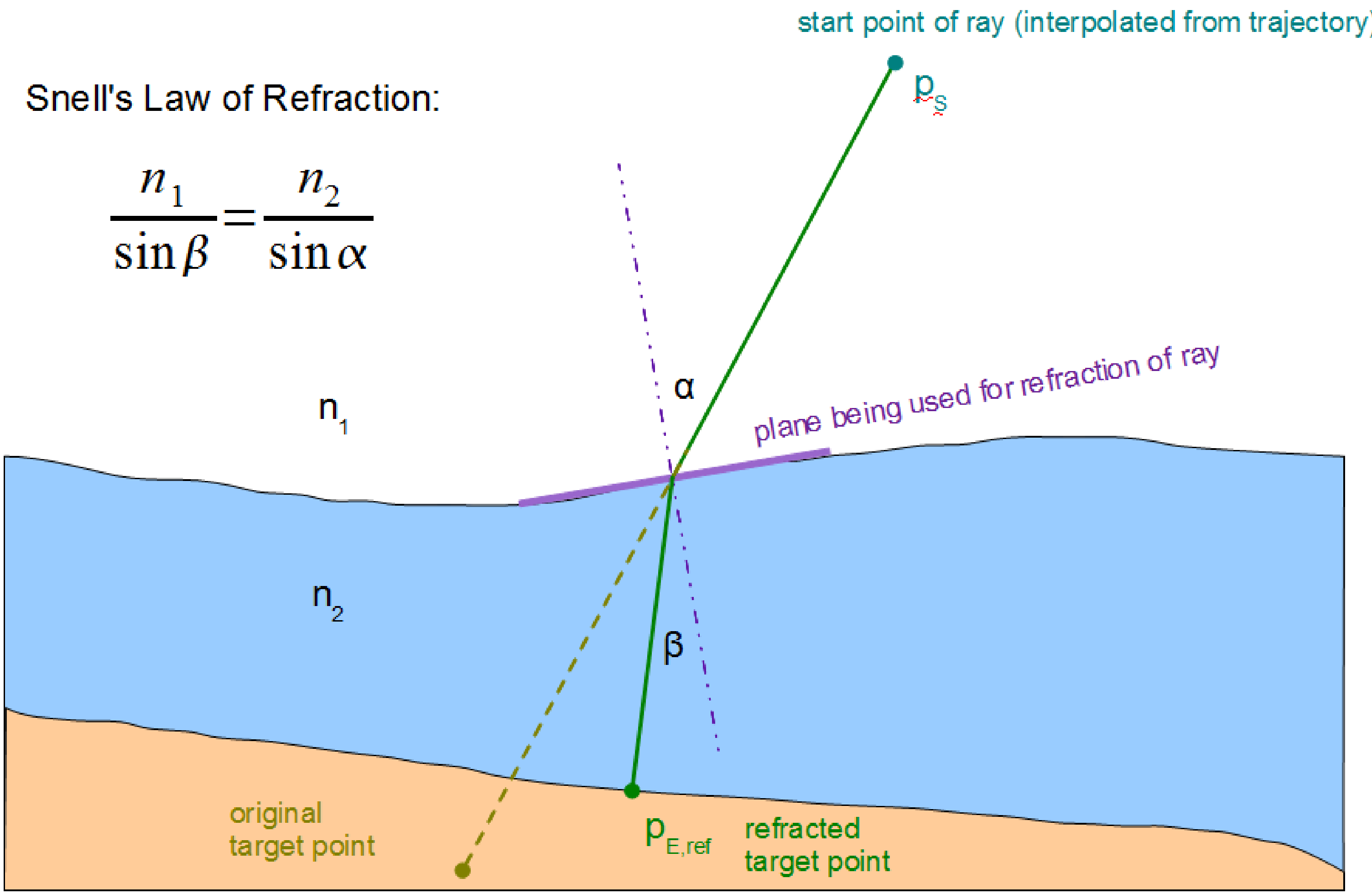
Intersection of ray with WSM:



refraction correction (2)

Snell's Law of Refraction:

$$\frac{n_1}{\sin\beta} = \frac{n_2}{\sin\alpha}$$



conclusion

- *RIEGL* VQ-820-G topo-bathy laser scanner successfully employed for a great variety of applications
- quality of water surface model is essential for quality of bathy-pointcloud
- *RIEGL* provides a fully-automated turnkey solution for point classification and refraction correction
- *RIEGL* software workflow offers interfaces for custom-specific point classification or WSM

RIEGL

www.riegl.com

***RIEGL* Laser Measurement Systems GmbH**

Riedenburgstraße 48

3580 Horn, Austria

Phone +43 2982 4211

office@riegl.com

Innovation in 3D