4S Fugro Drone

Technical information and first result
Wismar Bay test

Manfred Stender; EOMAP SDB Day; 40.10.2022

Agenda

Our business and motivation for drone operation

Fugro 4S drone and their payload

First results from test flight „Wismar Bay“ (Baltic Sea)

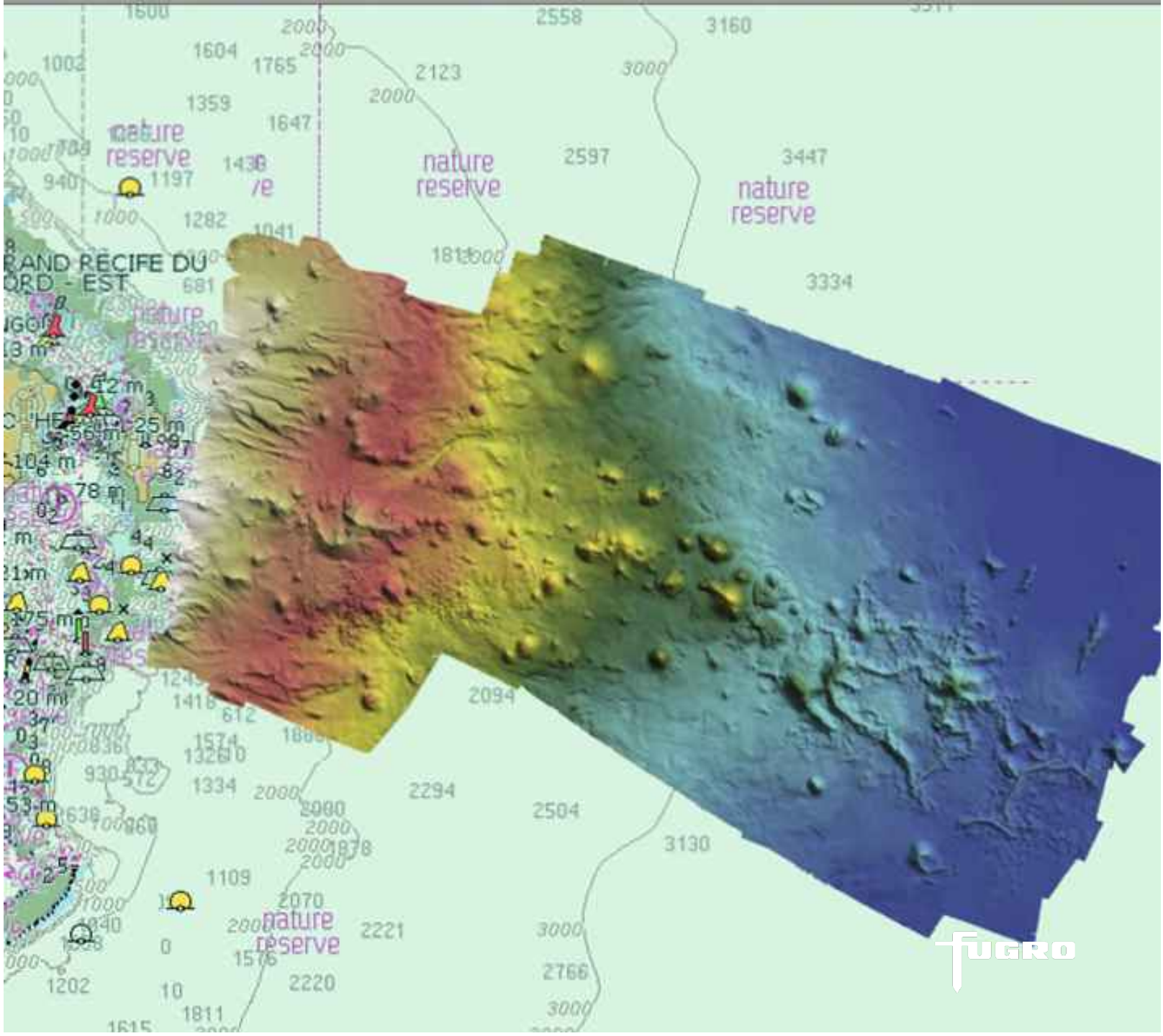
Into the future

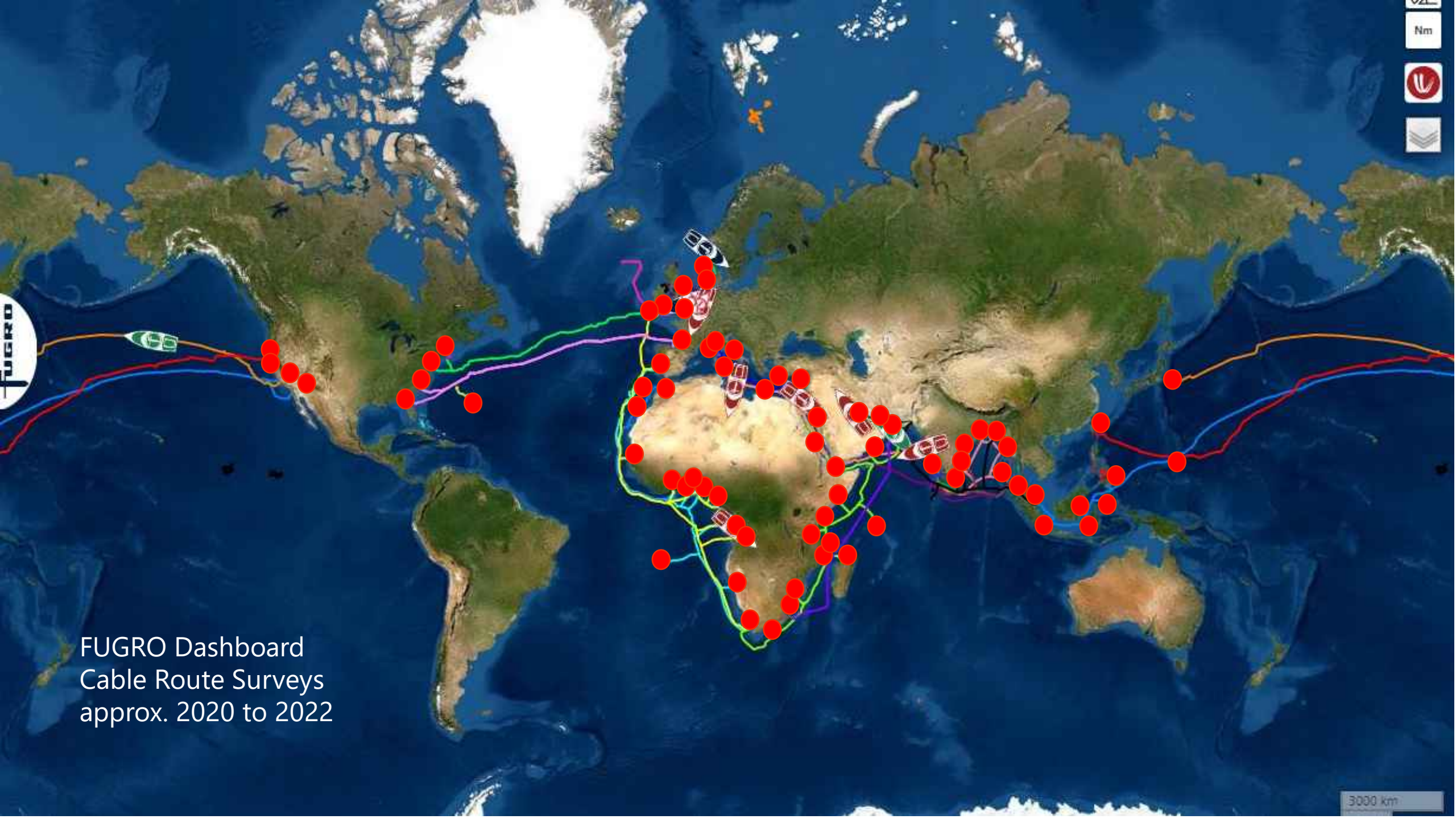
“Excellent Cluster” Hydrography & (telecom) Cable Route Survey

worldwide

IFREMER MAYOBS13-2

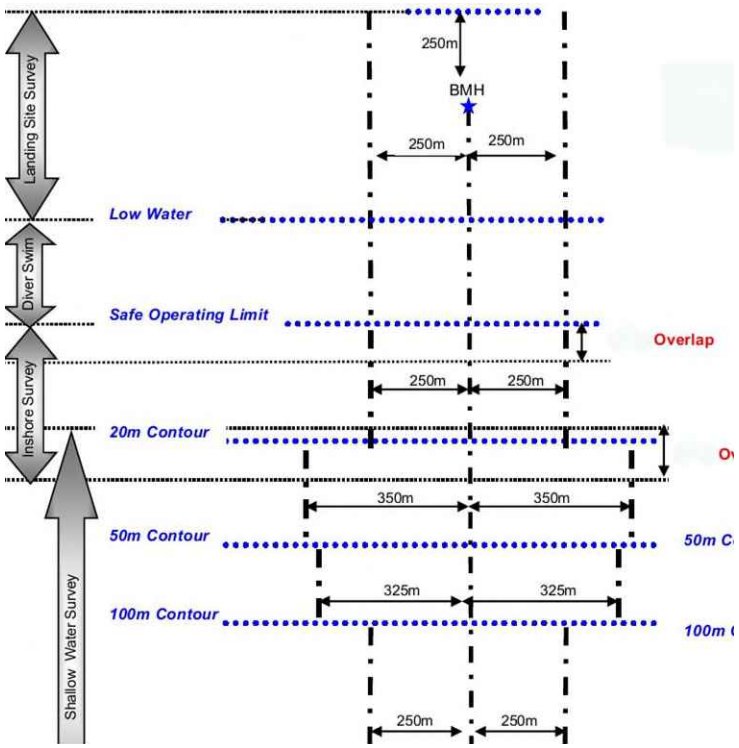
Courtesy of IFREMER




FUGRO Dashboard
Cable Route Surveys
approx. 2020 to 2022

From BMH to Deeper Waters

clients requirements, our tools



Bathymetry / Topographie

Surface Geology

Sub-surface Geology

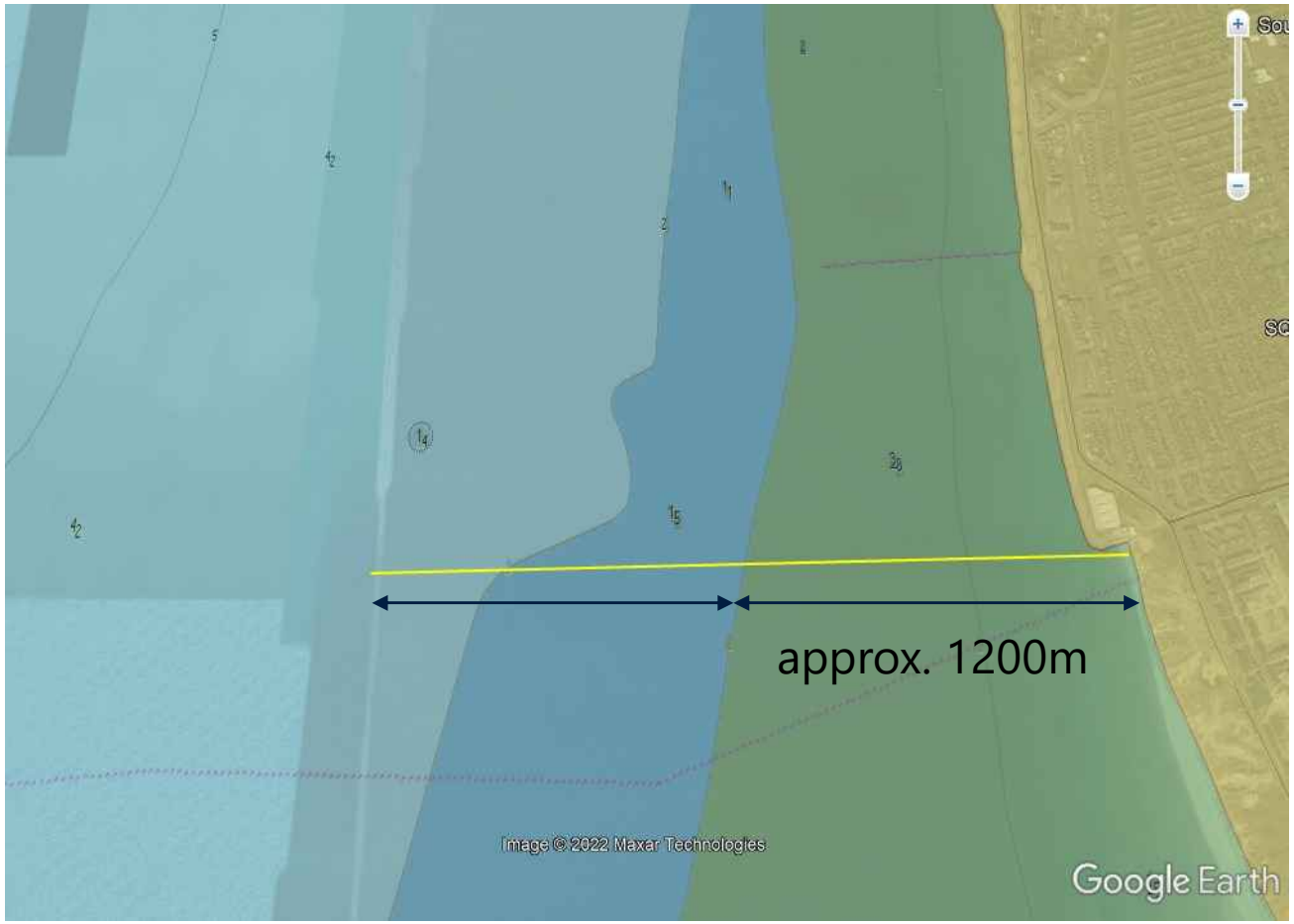
Object Detection

Landing site surprises

Vacation feeling or high-risk experiences with security guards

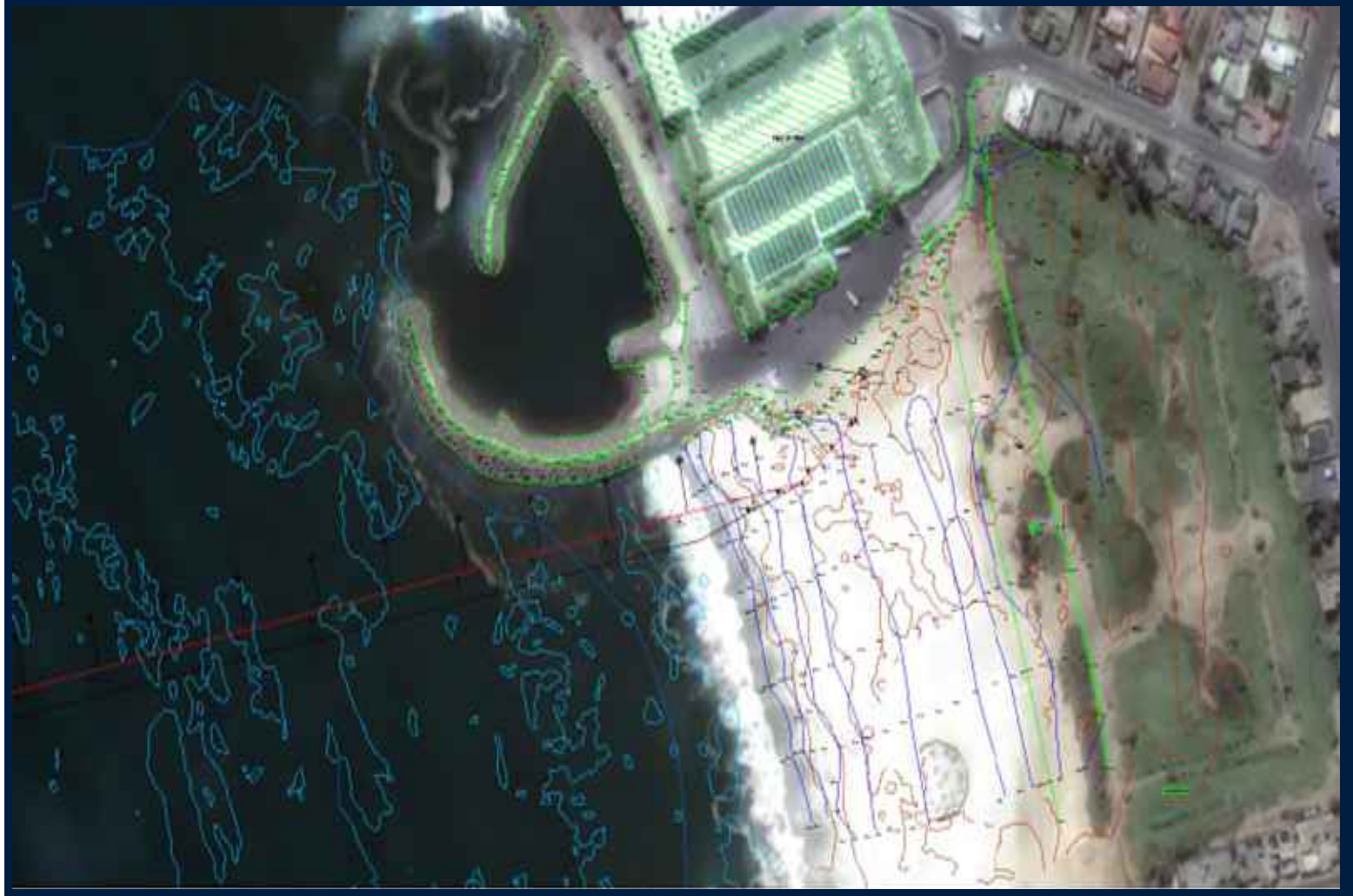
Long distances to walk

Time constrains due to tidal regime



Data derived from satellite images

DTM determination and SDB to fill gaps

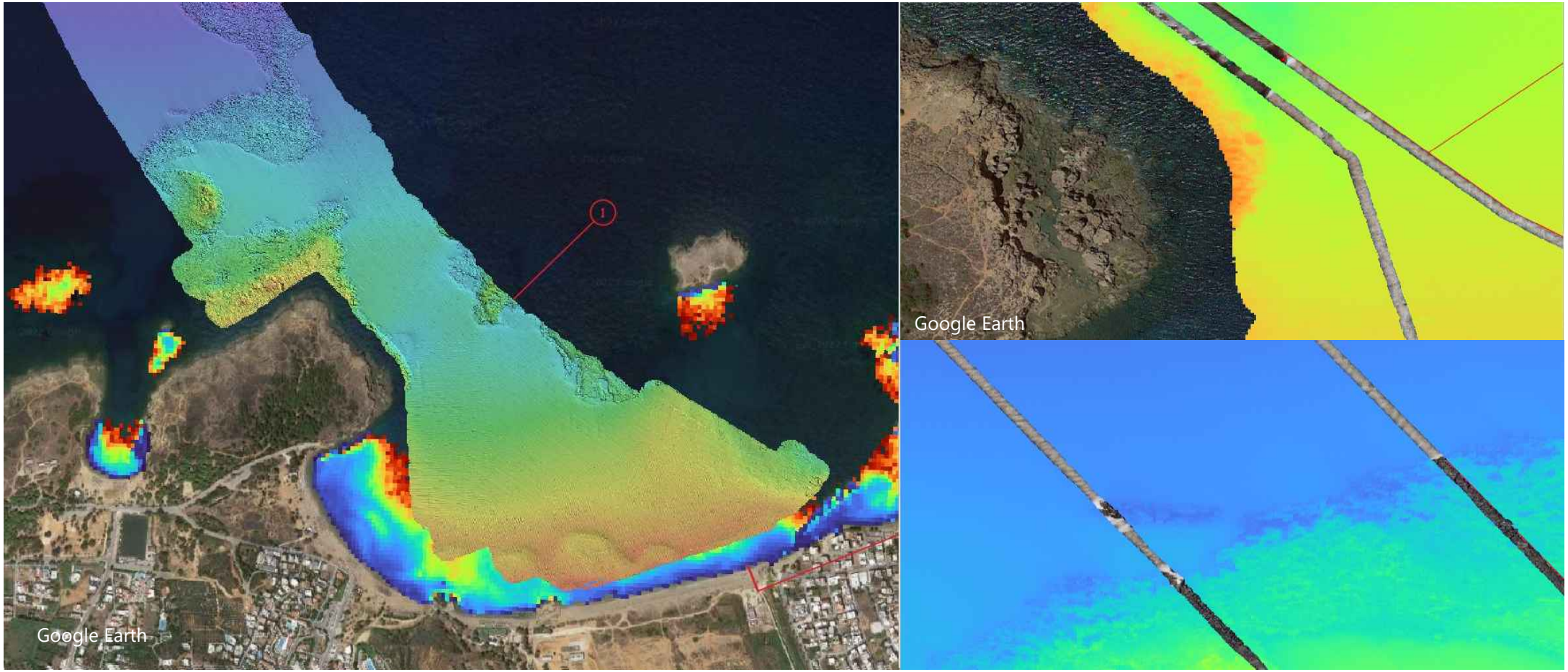


SDB to fill shallow water gaps

DTM determination based on commercial SAT image (resolution 0.5m)

Satellite Derived Bathymetry

Still some gaps open and information missing



Crosscheck with SAT images

No SDB, but still valuable information in SAT images

Multi Sensor Results

Dealing with Resolutions

MBES (15m flight height)

- Grid resolution >20cm

SSS (15m flight height)

- Grid resolution >10cm

Video (3m flight height)

- Pixel size >>1cm

SDB (free images)

- Sentinel-2 10m (!)

SDB (commercial images)

- WorldView2 2m (!)

SDB (drone)

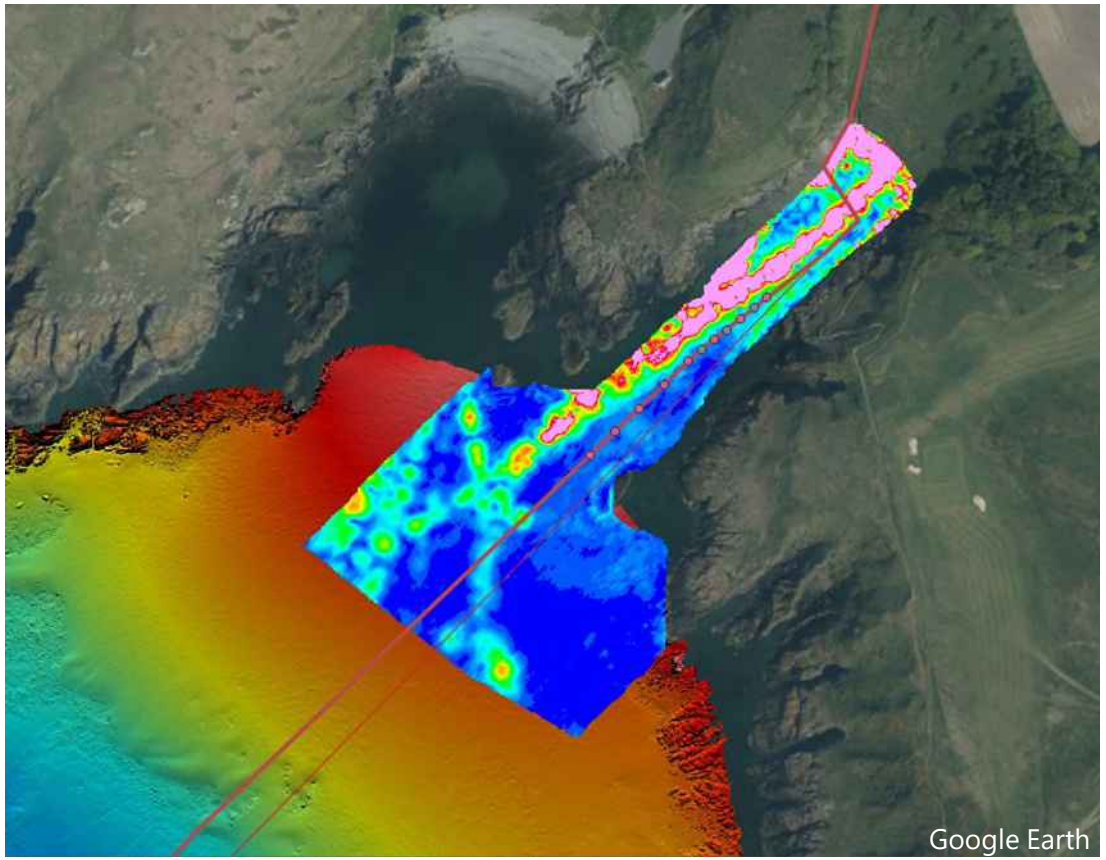
- expected 5-10 cm

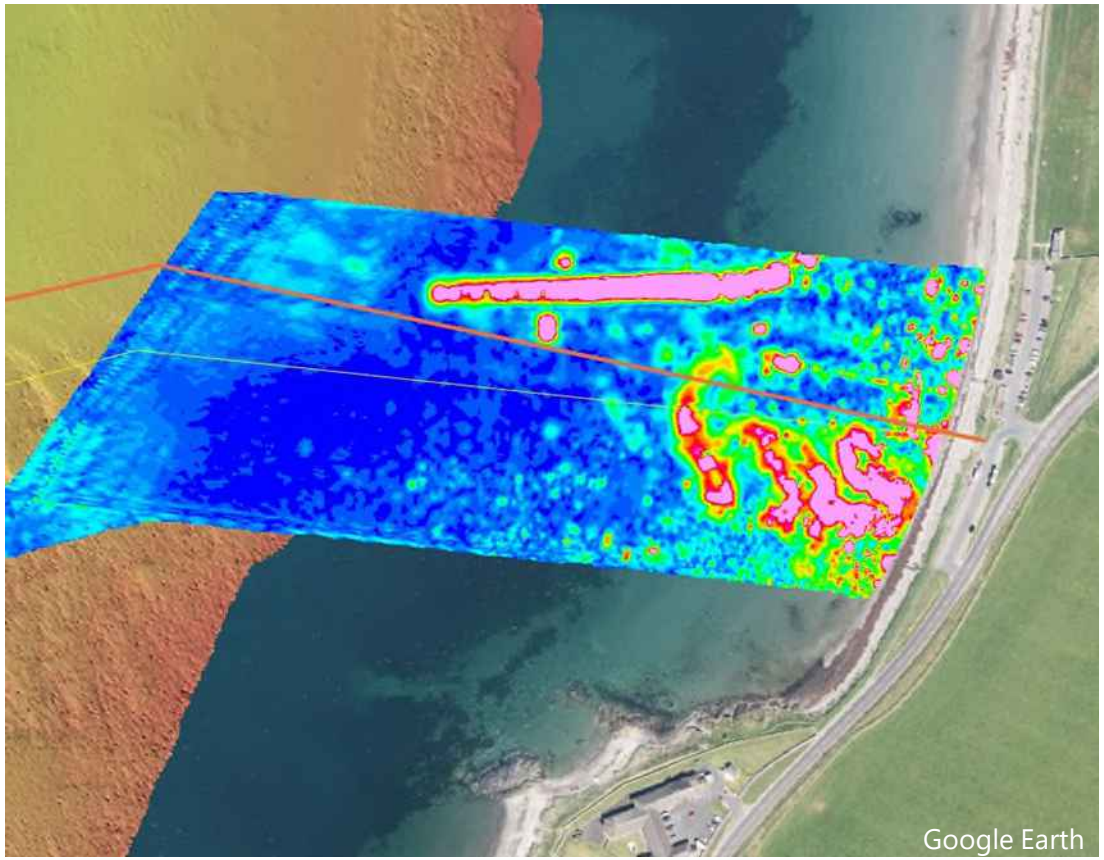
Already: Photogrammetry by Drone

From onshore extended to nearshore by multispectral

Already: Magnetometer Survey by Drone

Another application suitable for drones at beach and nearshore





Fugro 4S Drohne

Combined topographic and bathymetric / benthic survey platform


DJI 1000S


2 GNSS Receivers


DSLR (RGB) camera


Multispectral camera

Drone and sensor payload

technical information

Drone modell DJI 1000S include DJI flight controller

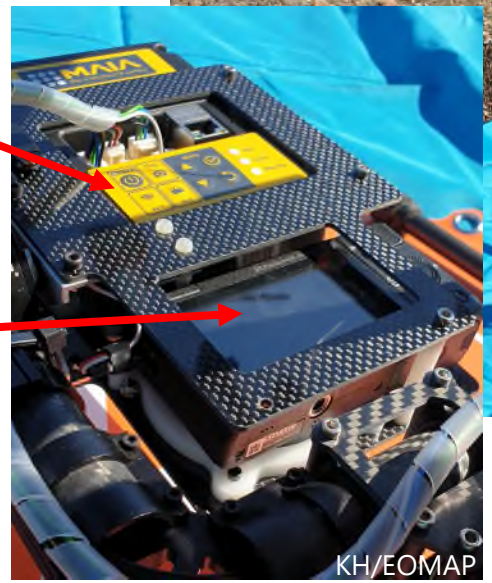
Sensor suite:

2 antenna GNSS positioning and heading system

MAIA multispectral camera for SDB or environmental survey

SONY 5000 DSLR camera for photogrammetric top / shallow water survey

Total TOW: approx. 11kg

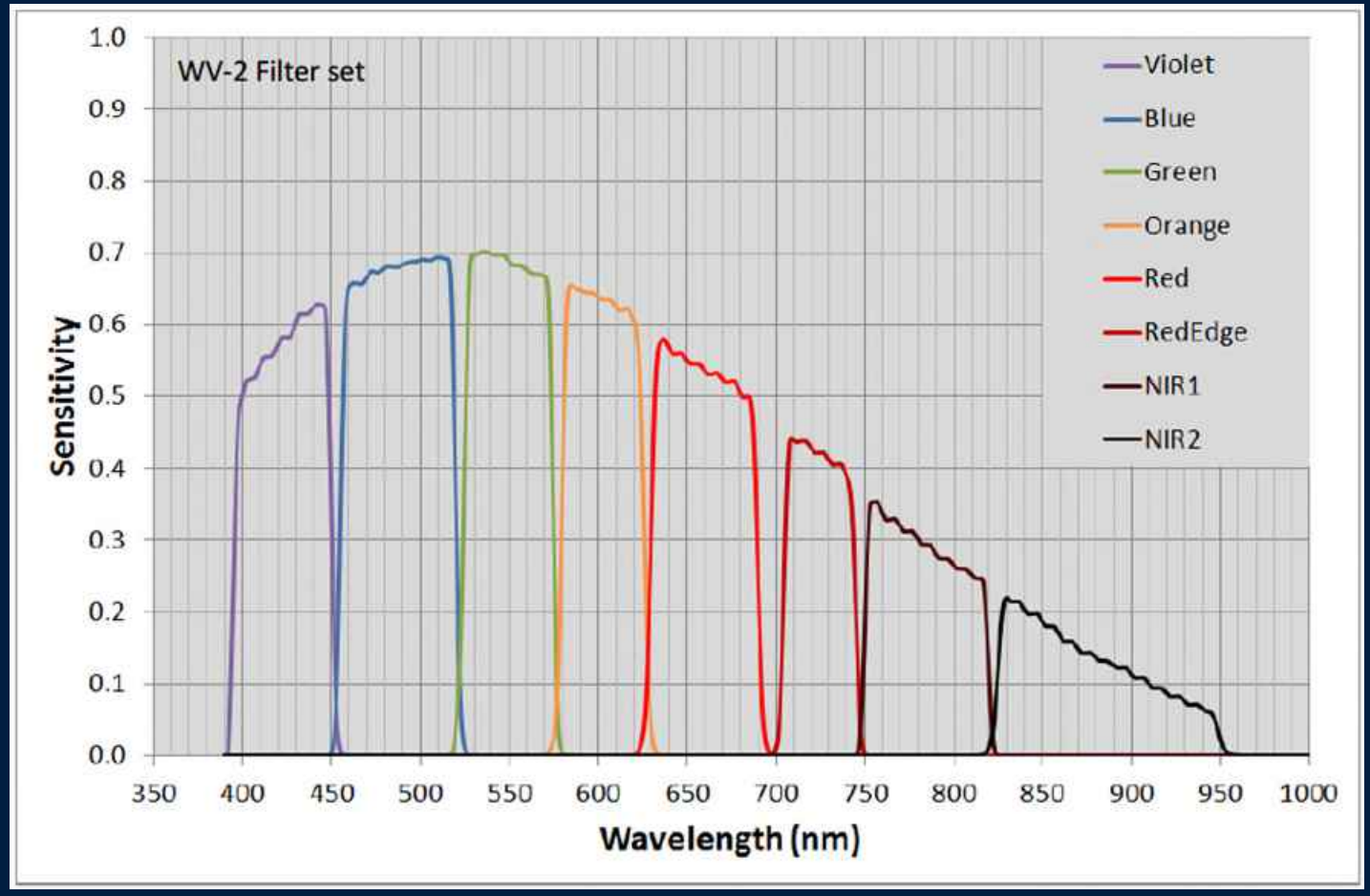


EOPTIS SRL „MAIA“

Sensitivity of the MAIA MS camera optical band with World View 2 filter set

The imaging sensors features *1.2Mpix resolution*, *high-sensitivity* and *global shutter* technology, allowing the **simultaneous acquisition of images** free from motion artifacts at a frame rate up to *5Hz*.

Interfaced to an *external GPS* to trigger the acquisition start and to get the position of the camera at the time of shot. The geo-tagged images are thus stored in an **internal solid state non-volatile memory**.



GNSS positioning bar

Precisse heading and positioning by two antenna, GNSS raw data recording and postprocessing

H-MSL (m)	Easting (m)	Northing (m)	SDHoriz (m)	SDHeight (m)
83.076	653338.286	5981398.264	0.165	0.203
83.074	653334.304	5981403.211	0.164	0.200
82.988	653330.355	5981408.226	0.164	0.200
82.950	653326.360	5981413.254	0.164	0.199
82.946	653322.291	5981418.306	0.164	0.199
82.993	653318.210	5981423.349	0.164	0.199
82.986	653314.131	5981428.529	0.164	0.199
83.049	653310.053	5981433.720	0.164	0.199
83.100	653305.937	5981438.912	0.164	0.199
83.107	653301.867	5981444.182	0.164	0.199
83.119	653297.783	5981449.456	0.164	0.199
82.985	653293.688	5981454.702	0.164	0.199
82.964	653289.524	5981459.970	0.164	0.199
83.043	653285.356	5981465.266	0.164	0.199
82.992	653281.173	5981470.534	0.164	0.199
83.065	653276.997	5981475.827	0.164	0.199
83.056	653273.141	5981480.556	0.164	0.199
83.030	653269.554	5981484.924	0.164	0.199
82.976	653266.032	5981489.361	0.164	0.199
83.067	653262.521	5981493.831	0.164	0.199
83.033	653259.122	5981498.238	0.164	0.199
83.041	653255.704	5981502.602	0.164	0.200
83.088	653252.273	5981507.020	0.165	0.202
83.298	653249.192	5981509.817	0.165	0.202
83.398	653248.946	5981508.008	0.166	0.205
84.041	653251.729	5981503.796	0.166	0.205
83.966	653254.997	5981499.785	0.166	0.205
83.351	653258.334	5981495.515	0.166	0.206
83.031	653261.976	5981490.657	0.166	0.206
82.533	653265.711	5981485.836	0.166	0.207
81.849	653277.310	5981471.310	0.166	0.208
81.808	653281.192	5981466.541	0.166	0.206
81.879	653284.980	5981461.711	0.166	0.206

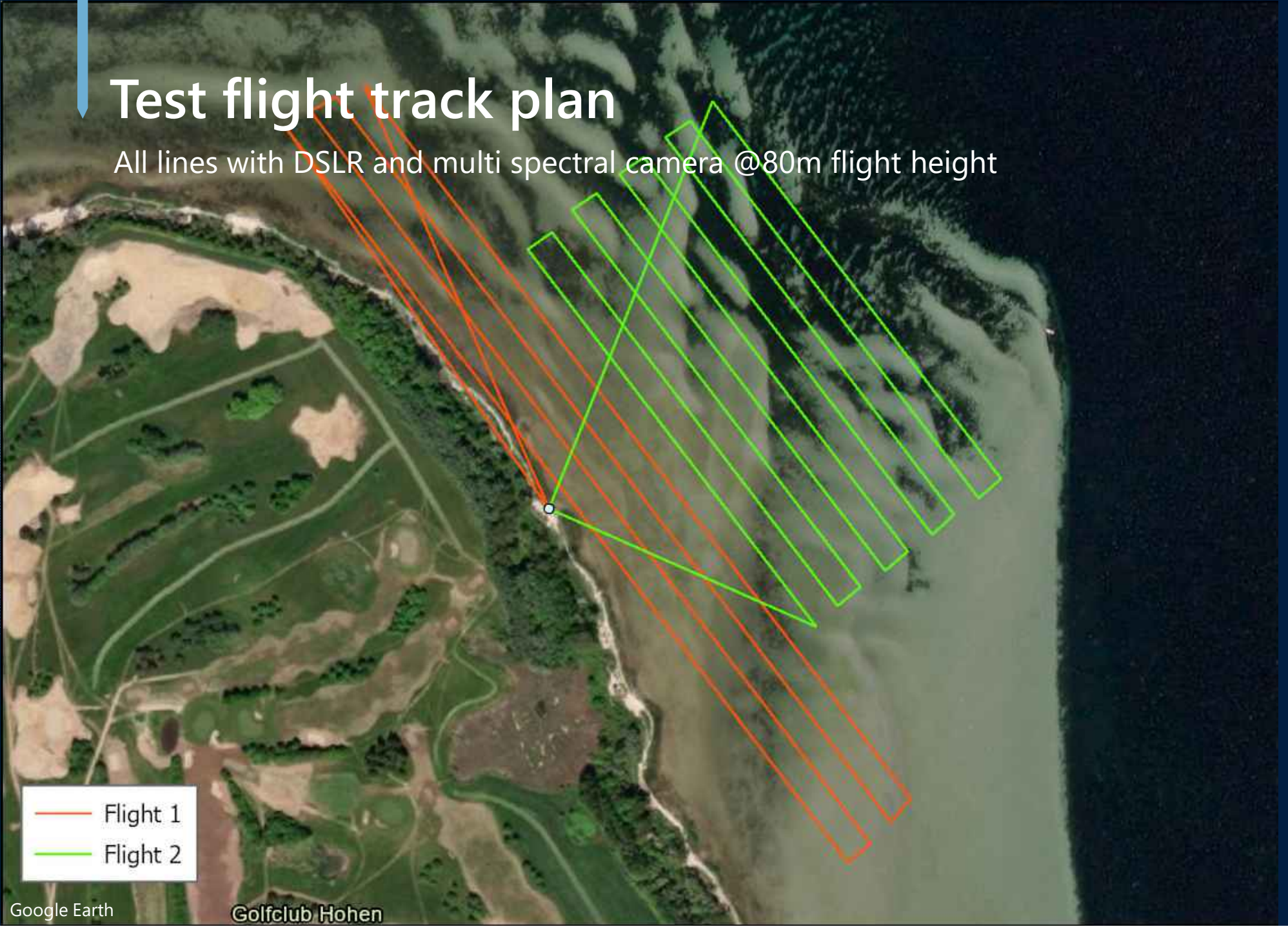
Test flight area Wismar Bay

Baltic Sea

Google Maps / Earth

Test flight track plan

All lines with DSLR and multi spectral camera @80m flight height



All lines with DSLR and multi spectral camera @70m flight height

Two flights @ approx. 12min each

Total about 5,5km of lines and >1200 images each camera system

Flown week 34/22, data evaluation still in progress, e.g. MS camera under the EU 4S project scope

FUGRO

Drone mobilisation

Unpacking, sensor installation and preparation, last check,


NL/Fugro

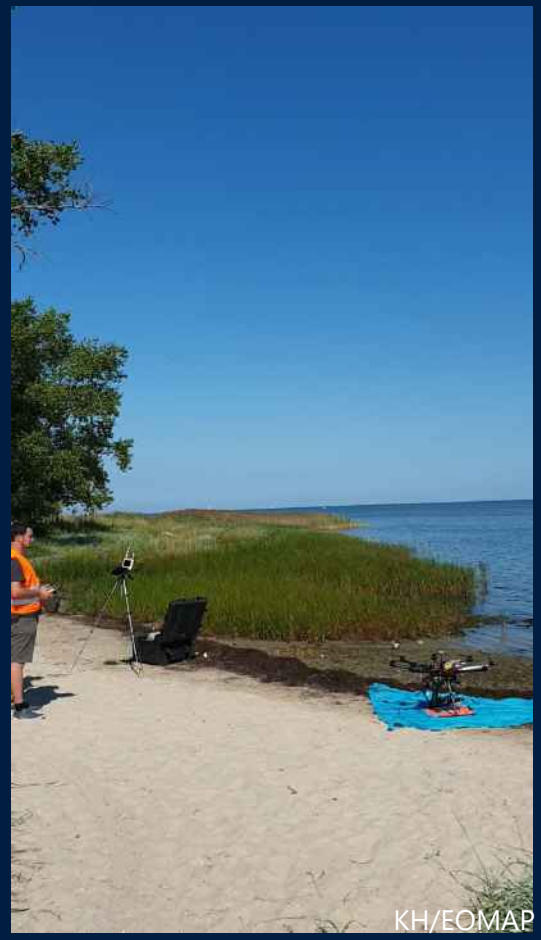

MS/Fugro


KH/EOMAP

Drone ready for tack-off

Ground control and communication check, security at site


MS/Fugro


KH/EOMAP

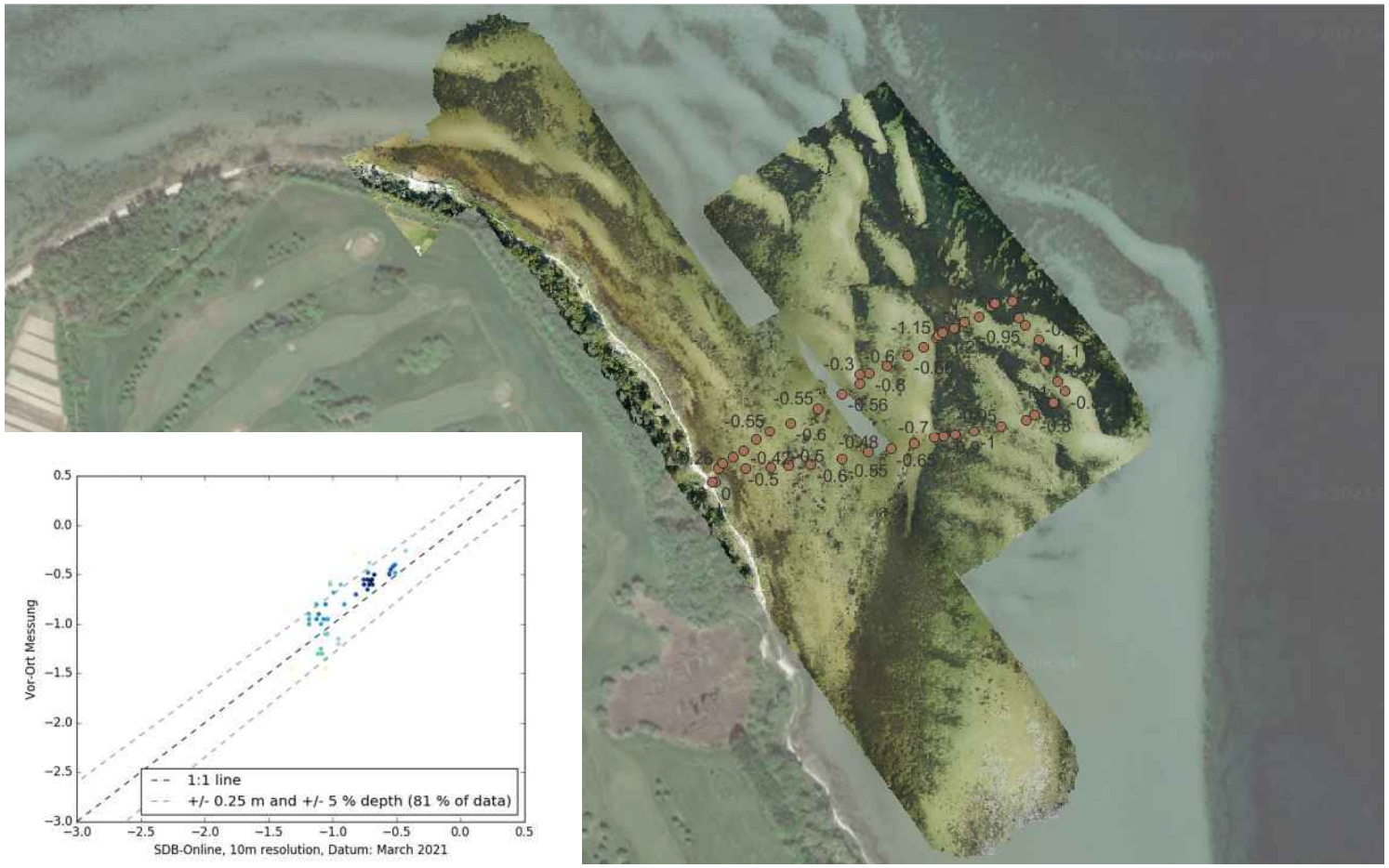

KH/EOMAP

Intermediate results and findings

Orthomosaic created out of approx. 1200 RGB images

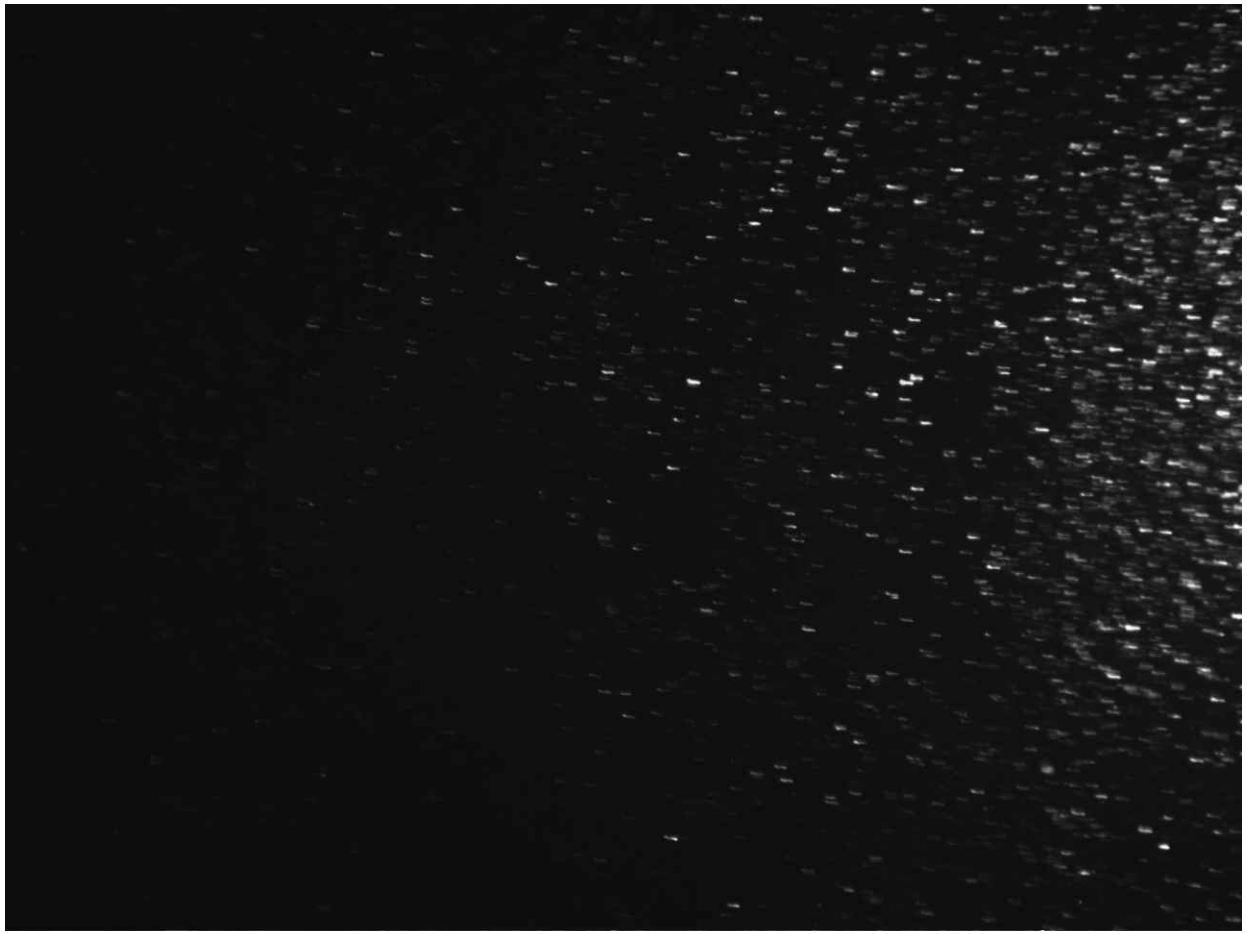
Control Point Survey

Handheld Hydrography, comparison with SDB (Sentinel-2)



Misalignment of MAIA bands

Correction need to improve resolution



SDB WITHOUT „S“

DRONE BASED BATHYMETRY

Challenge 1: Method

Inversion of the Radiative Transfer Equation (RTE) for MAIA 8-band drone sensor.

Spectral databases were created to allow for reflectance inputs of 80m flight records, matching the spectral response functions and respecting different recording geometries of the MAIA sensor.

Seafloor bottom albedo was defined by the drone records.

No on-site information were collected or used to run the RTE inversion process.

SDB WITHOUT „S“

DRONE BASED BATHYMETRY

Challenge 2: Big data

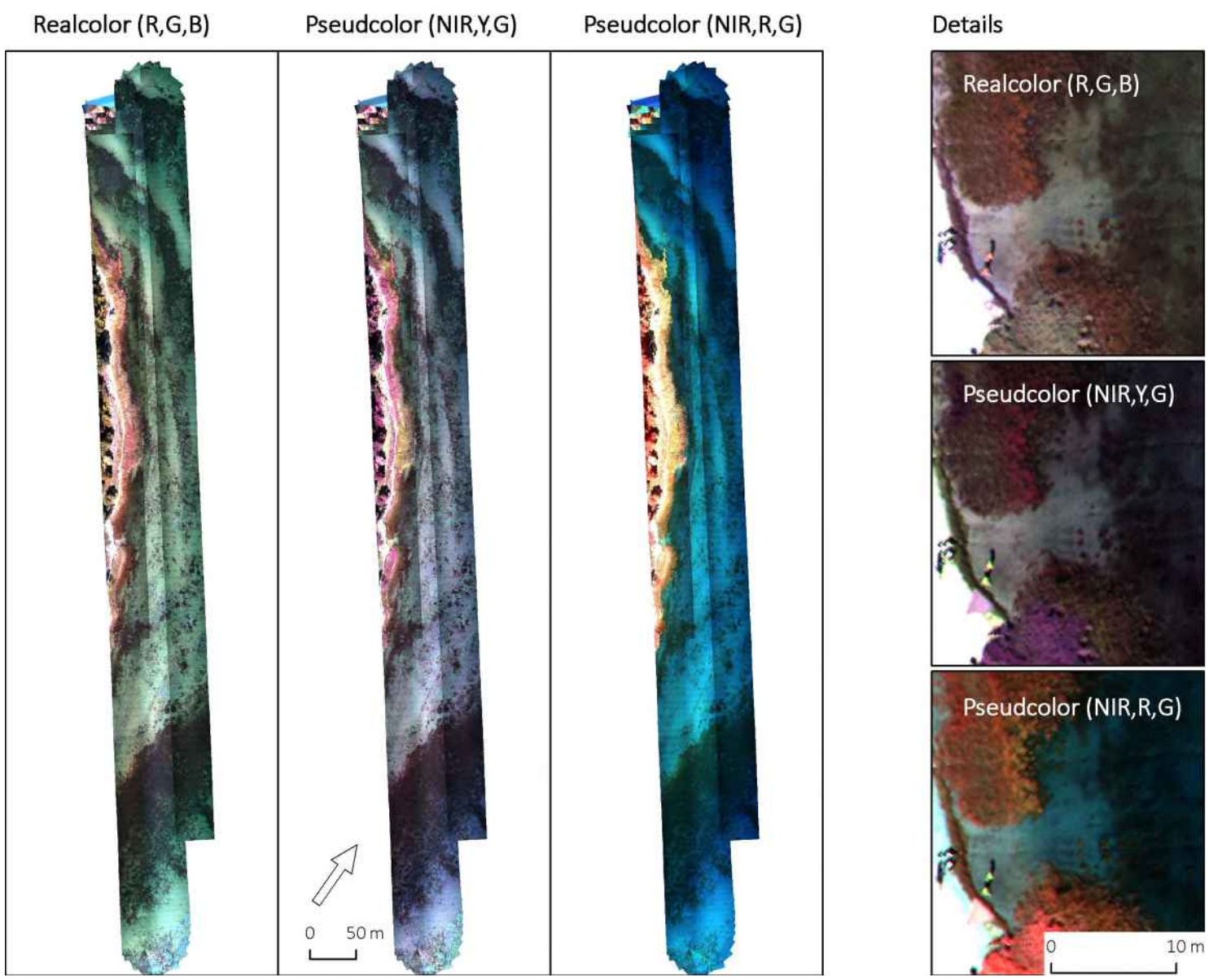
Massive amounts of multispectral, high bit depth, extremely high res data are collected by the drone records.

Parallelizing, cloud computation and ML methods have been applied to improve speed performance of the workflow. This in an ongoing activity.

DRONE MULTISPECTRAL RECORD

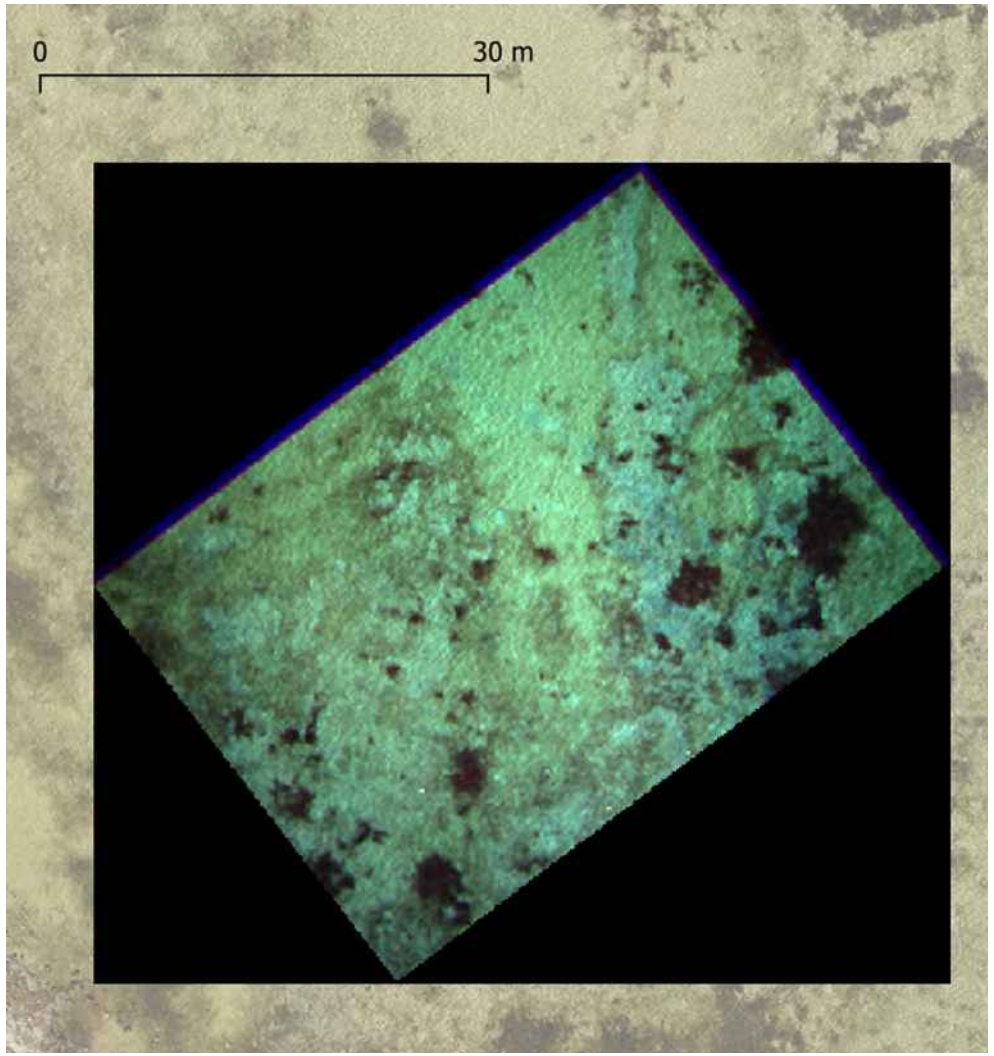
WISMAR, GERMANY

- **8 band multispectral (blue to NIR)**
- **Spatial resolution of 3 cm**
- **Approx. 1500 single tiles**
- **Records in Aug 2021, coastal shallow waters of the German Baltic, near Wismar**

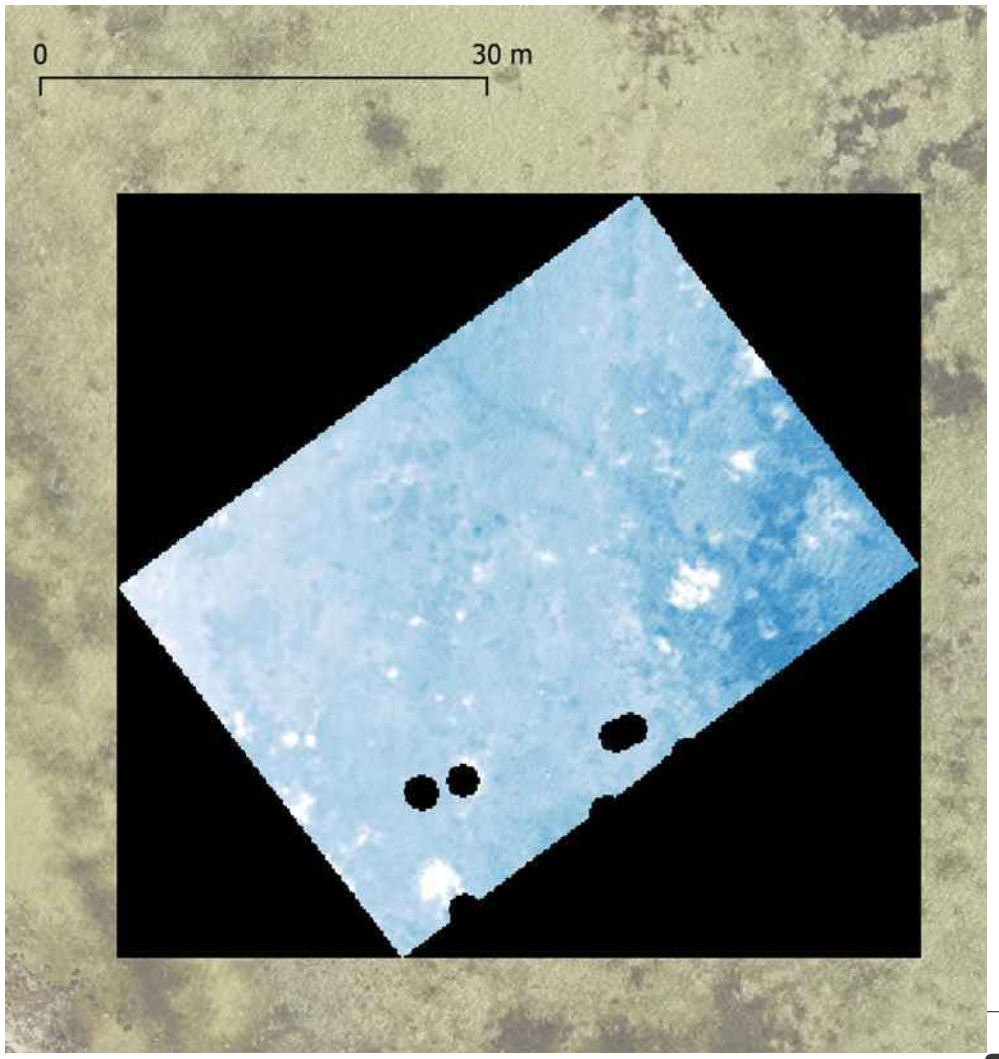


DRONE-DERIVED BATHYMETRY – FIRST RESULTS

SINGLE MULTISPECTRAL IMAGE



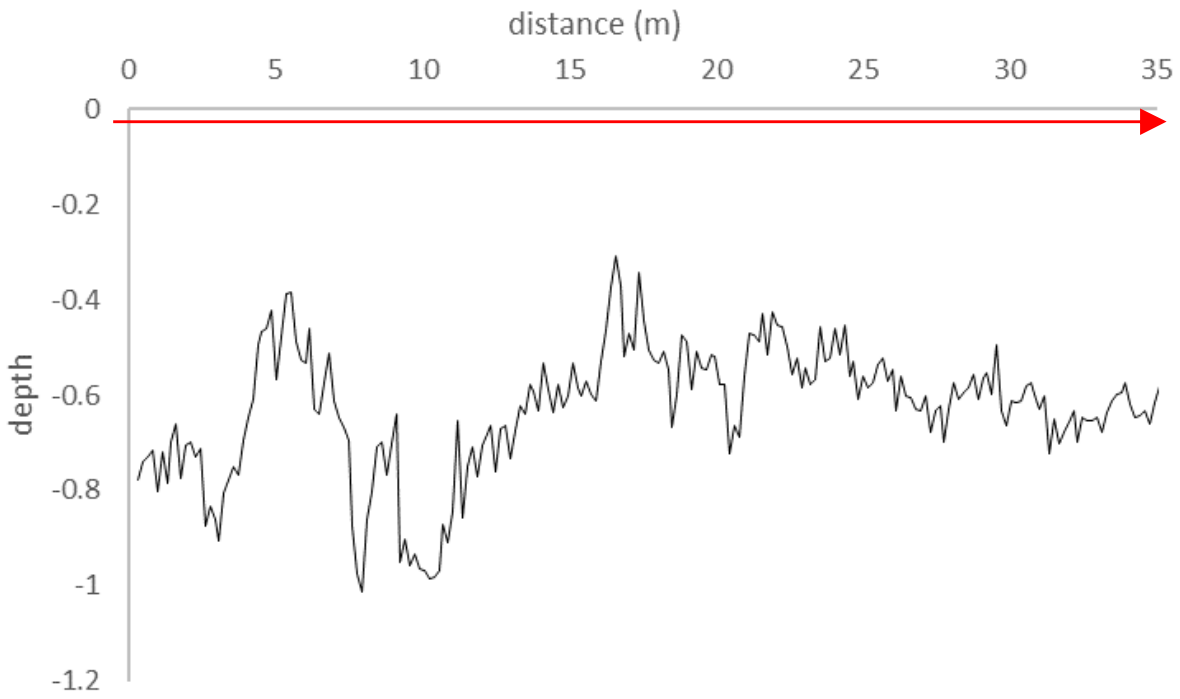
BATHYMETRY



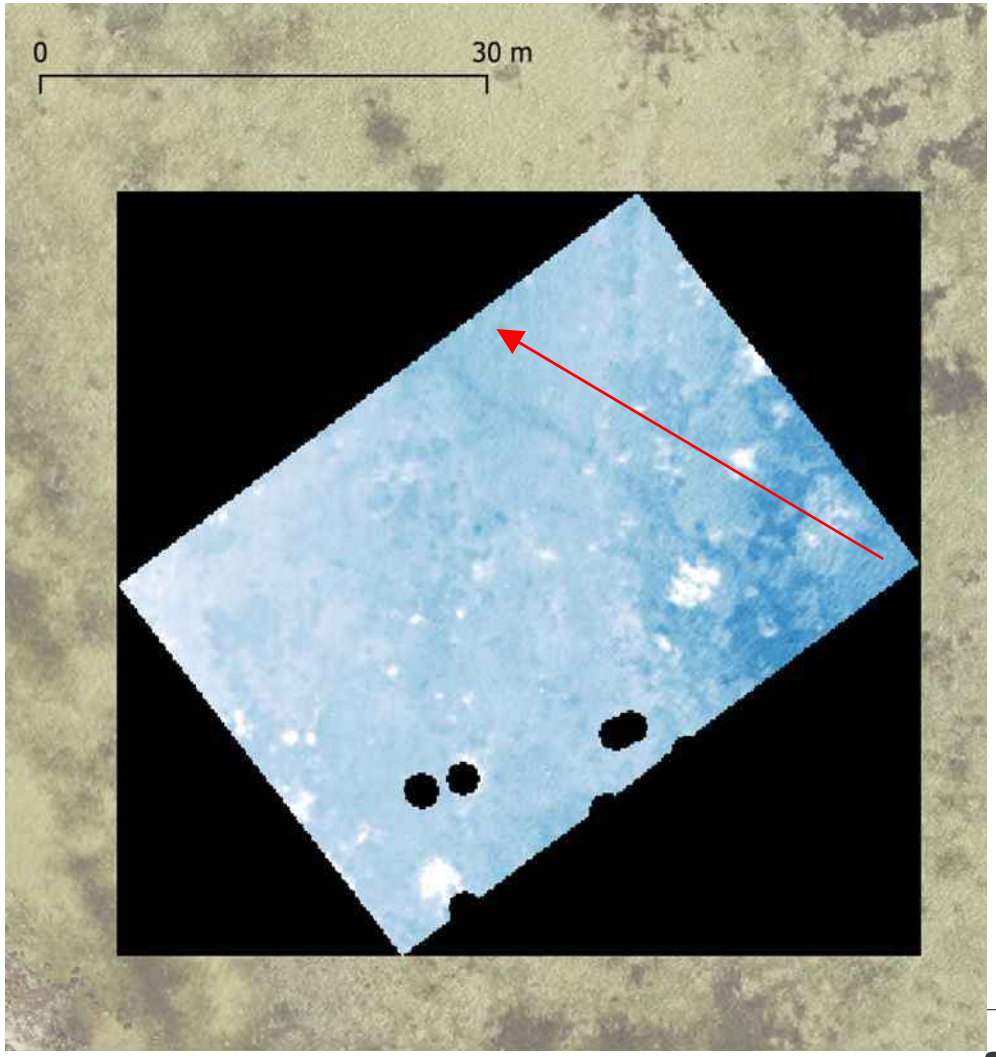
EOMAP

DRONE-DERIVED BATHYMETRY – FIRST RESULTS

SINGLE MULTISPECTRAL IMAGE



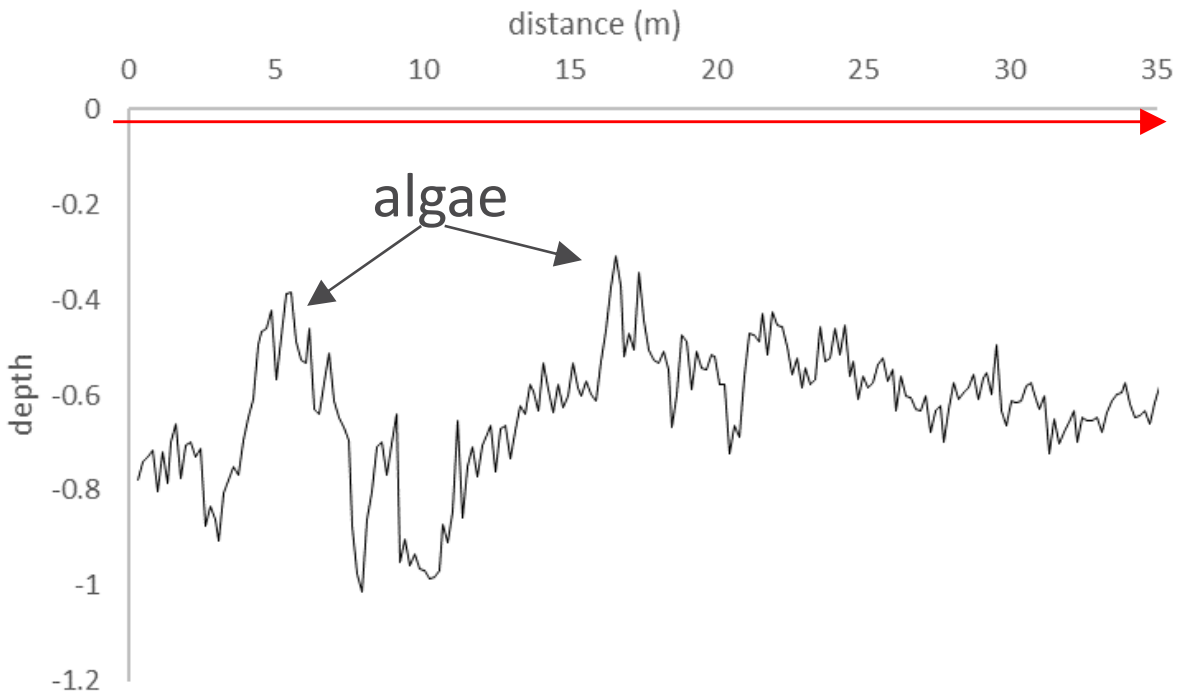
BATHYMETRY



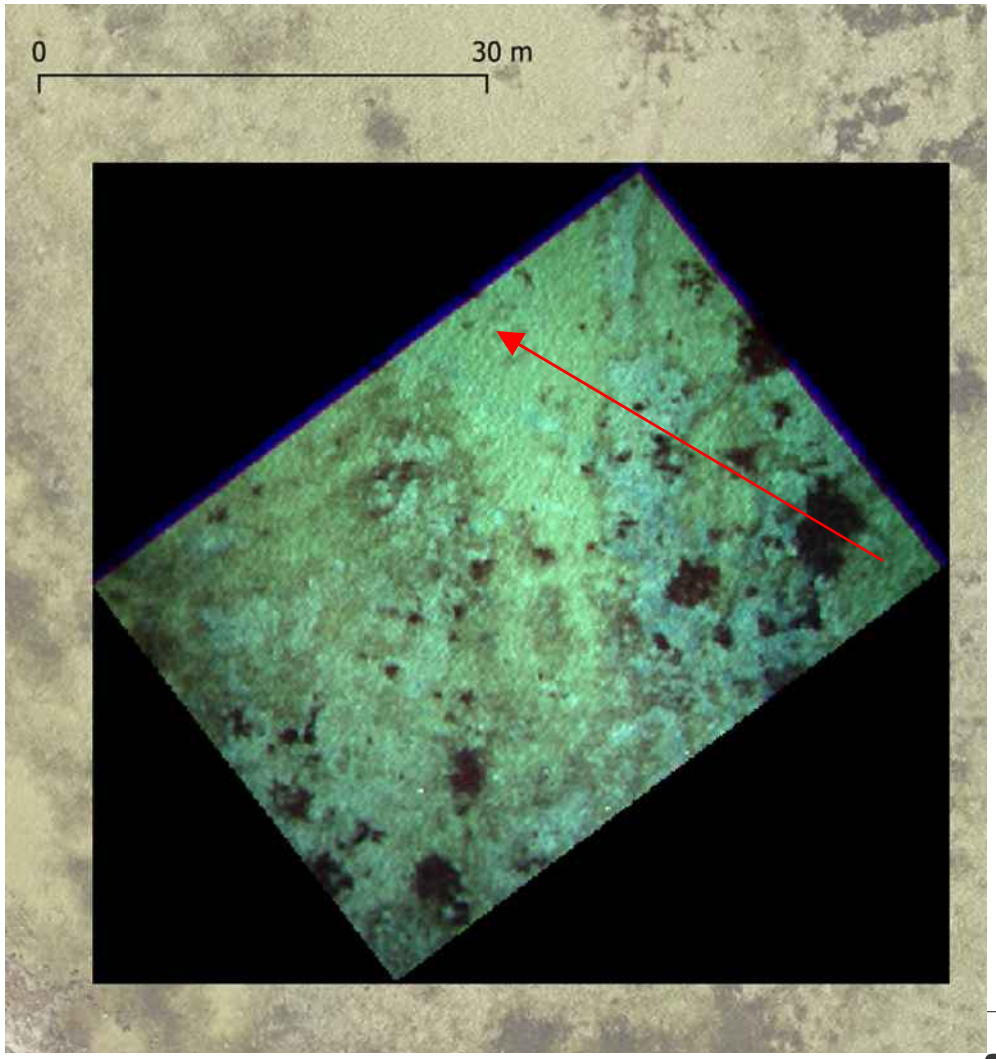
EOMAP

DRONE-DERIVED BATHYMETRY – FIRST RESULTS

SINGLE MULTISPECTRAL IMAGE



BATHYMETRY

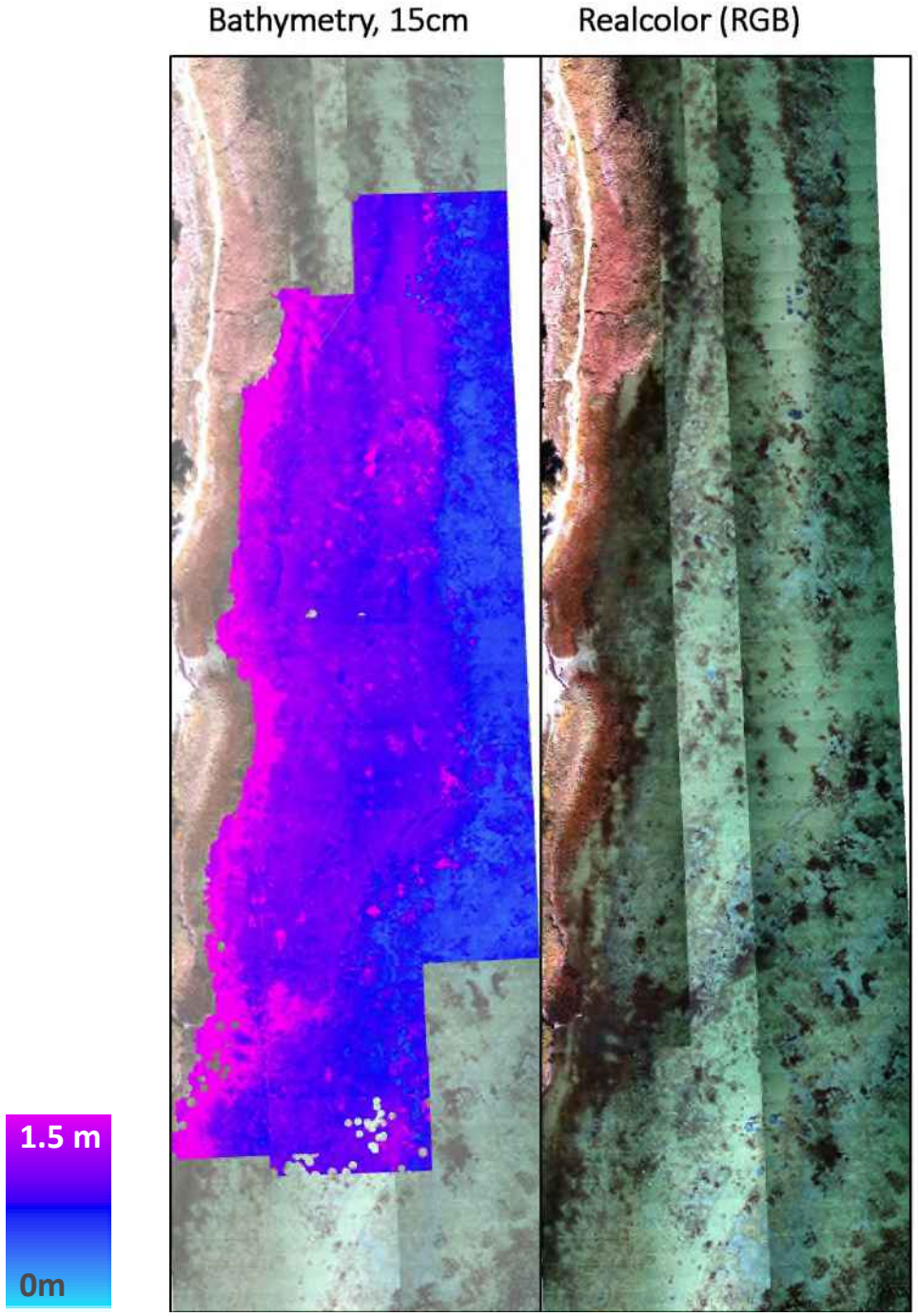


EOMAP

DRONE-DERIVED BATHYMETRY

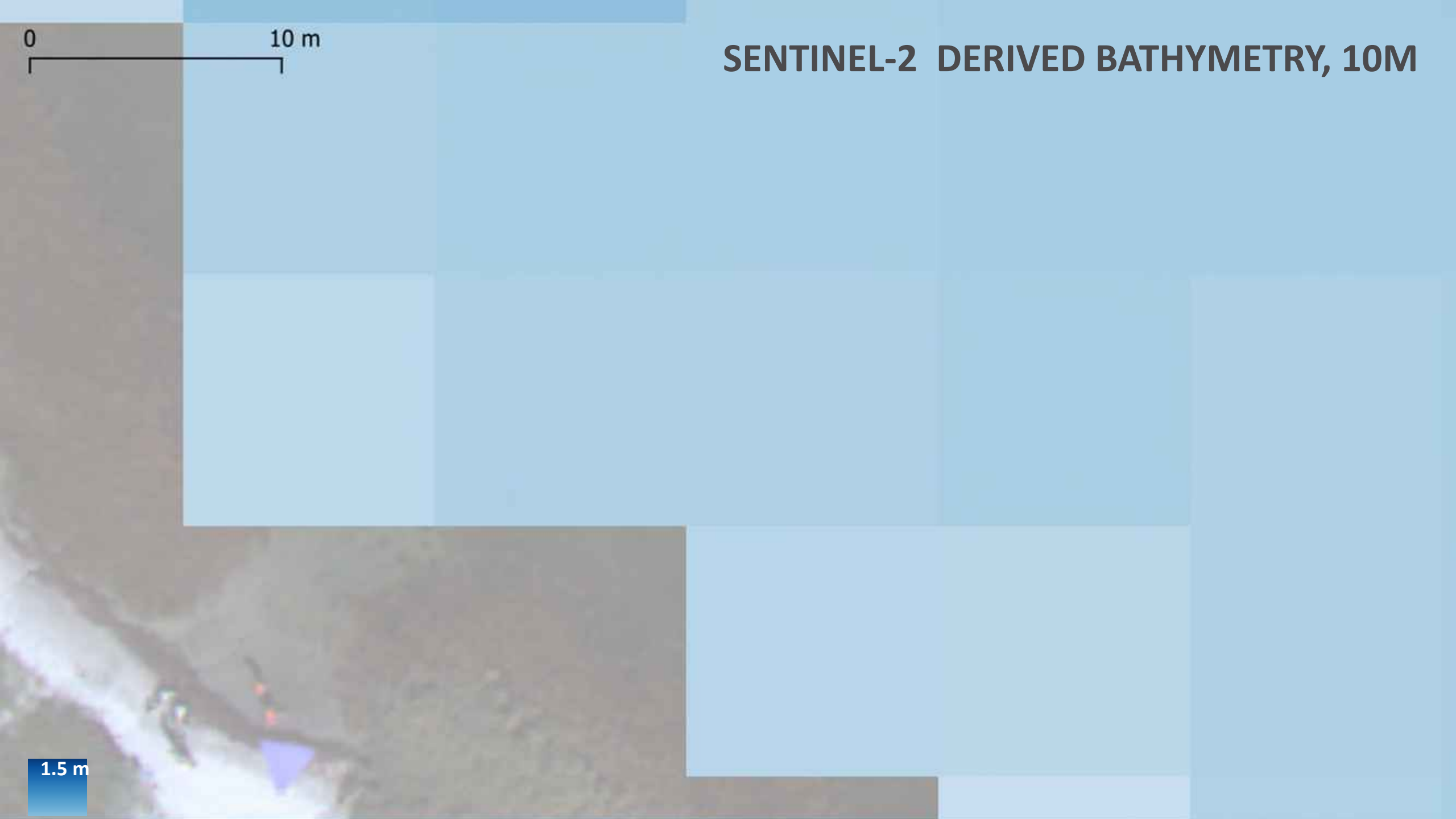
PRELIMINARY RESULTS

- **Based on RTE inversion**
- **Bathymetry surface of 15 cm (3cm native resolution is possible)**
- **The very high resolution results in new challenges: geo-positioning, spectral band-matching, minimizing water surface effects, shadow effects**

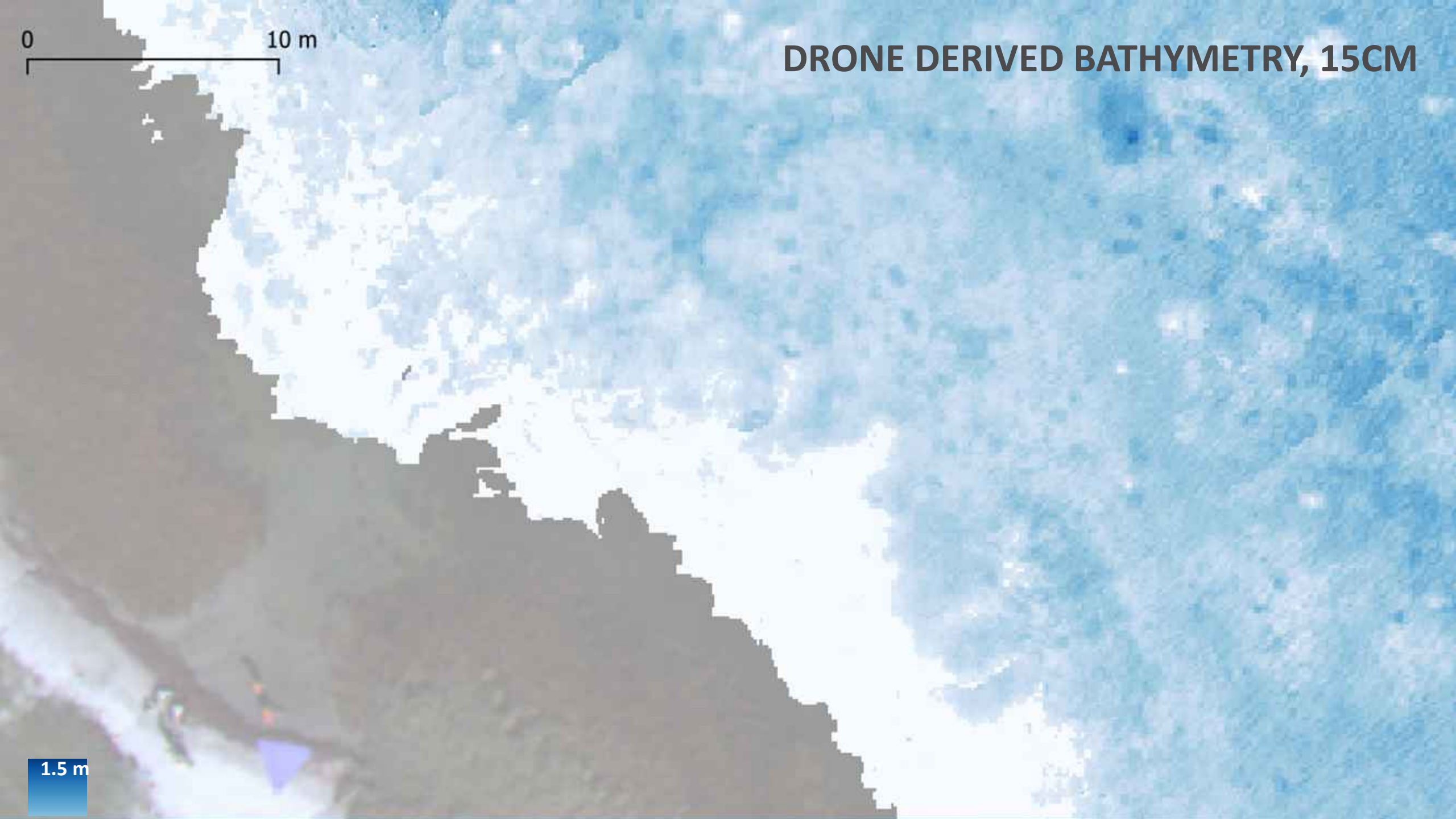


SENTINEL-2 (REALCOLOR IMAGE), 10M RESOLUTION


0
10 m
DRONE (MAIA SENSOR), 0.15M RESOLUTION



SENTINEL-2 DERIVED BATHYMETRY, 10M


0
10 m
DRONE DERIVED BATHYMETRY, 15CM
1.5 m

NEXT STEP

DRONE BASED BATHYMETRY

1. Increasing processing speed
2. Refining geopositioning
3. Testing on multiple sites and across different scenario
4. Enabling integration of on-site measurements
5. ….

Into the future

Improvement of positioning and/or sensor alignment

Development of a solid workflow for „DDB“
Introduction of „DDB“ service to client
Development of other product (envi) workflow
Introduction of environmental survey capability to client

Investigate fuel cell for longer flight time
Development of a flying Subbottom Profiler

FUGRO

Unlocking **Insights**
from **Geo-data**