# Terratec Airborne Lidar Bathymetry services using the CZMIL SuperNova

22nd meeting of the IHO MACHC
3rd December 2021 - Charles de Jongh

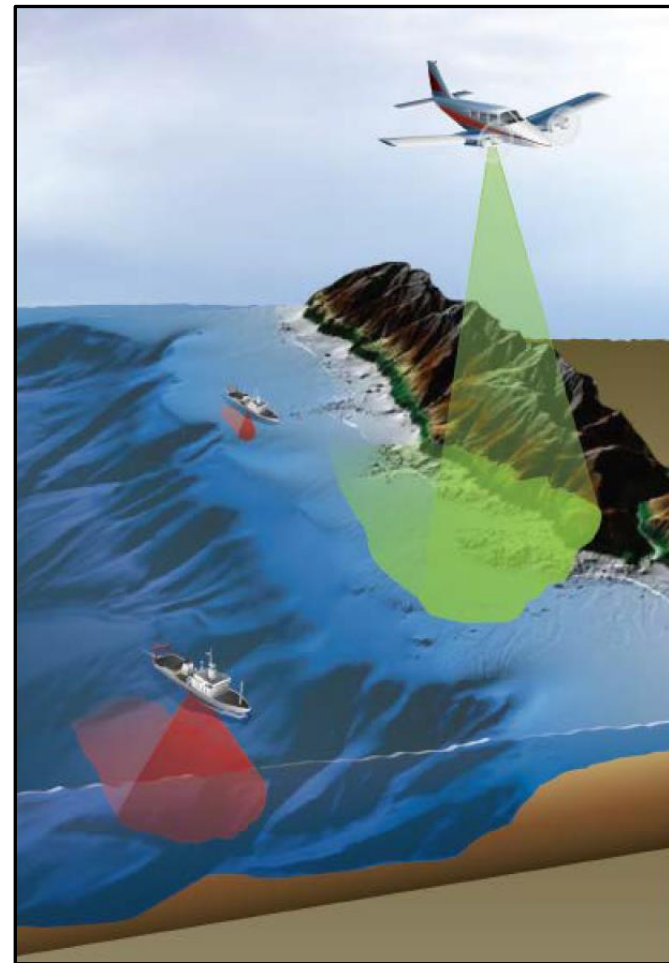# Advantages of Airborne Lidar Bathymetry

- Fast & reliable bathymetric survey method.

- Ability to reach very shallow areas.

- Seamless mapping of land & water in the coastal zone.

- Ability to reach up to 3 times the visible water depth.

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# Terratec's Bathymetric Lidar Sensor

- **CZMIL: Coastal Zone Mapping and Imaging Lidar**. Deep penetrating lidar with powerful laser.

- Original **CZMIL** (2012) & **CZMIL Nova** (2015) developed by US government and Teledyne Optech.

- **CZMIL SuperNova** (2021) is a new generation with many improvements, e.g.:
  - Double point density of CZMIL Nova.
  - Best penetration of deep and turbid waters.
  - Improved accuracy - shallow channels within IHO Special Order.
  - CARIS processing software.

- **Terratec is the first company owning a CZMIL SuperNova.**



Bathymetric lidar : CZMIL SuperNova (+ Applanix POS AV GNSS & IMU built in)

RGB Camera: PhaseOne iXM-RS150F, 150 megapixel, 3cm GSD.

Optional: Hyperspectral Cameras Hyspex VNIR-1800 & SWIR-384 (or other sensors)

# Why the US Government uses the CZMIL

## PROBLEM

Regional coastal elevation data and imagery are required to characterize coastal change and manage sediment as a resource to support navigation, flood risk reduction and ecosystem restoration. The data are also needed to engineer entire coastlines for resilience to acute and long-term coastal hazards.

## SOLUTION

The Joint Airborne LIDAR Bathymetry Technical Center of Expertise (JALBTCX) fielded the Coastal Zone Mapping and Imaging LIDAR (CZMIL) in 2012. This third-generation airborne coastal mapping and charting system, developed by Corps researchers, improves sensor performance in challenging environments, accelerates data delivery, and enables new and better information extraction from collected datasets.

## IMPACT

JALBTCX uses CZMIL to collect nationally consistent, regional coastal data for the NCMP, for Corps and FEMA post-hurricane surveys, and for Naval Oceanographic Office Tactical Nautical Charting Surveys. Within the Corps, CZMIL data support regional sediment management, comprehensive coastal studies, smart planning, coastal asset management, and coastal storm modeling. Outside the Corps, CZMIL data are used to produce NOAA nautical charts, USGS coastal studies, and FEMA flood maps. State and local governments use CZMIL data for numerous coastal zone management applications.
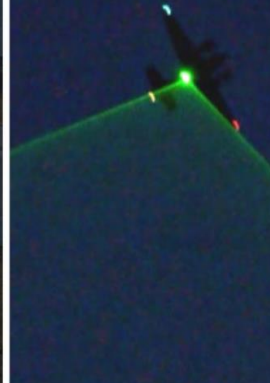
## 44+ THOUSAND
DATA DOWNLOADS

## SAVES
## $18 THOUSAND & 12 DAYS
### PER MILE OF SHORELINE
COMPARED WITH TRADITIONAL SURVEY TECHNIQUES

## COASTAL ZONE MAPPING & IMAGING LIDAR

Priority coastal areas for the Corps, such as surf zone and turbid waters, present challenges for current LIDAR sensors. Advances in processing bathymetric LIDAR signals and fusion of these signals with ancillary sensor data, such as hyperspectral imagery, have revealed opportunities for more progressive environmental applications of the data. The Coastal Zone Mapping and Imaging LIDAR (CZMIL) is an ongoing sensor development effort within the Corps' National Coastal Mapping Program (NCMP). The program produces high-quality, high-resolution information products from airborne LIDAR bathymetry, topography and accompanying Red-Green-Blue and hyperspectral imagery data around the U.S. coasts on a recurring basis. New information products have been developed for the Corps and the Nation by further analyzing and fusing CZMIL's LIDAR and imagery data streams. The current product suite includes: LIDAR point clouds, digital elevation models, laser reflectance images, air photo and hyperspectral image mosaics, a shoreline vector, and elevation shoreline and beach volume change. Products currently in development are beach and dune geomorphology metrics, dune vegetation and submerged aquatic vegetation metrics, coastal structure metrics, and water quality parameters.
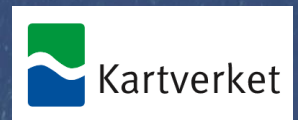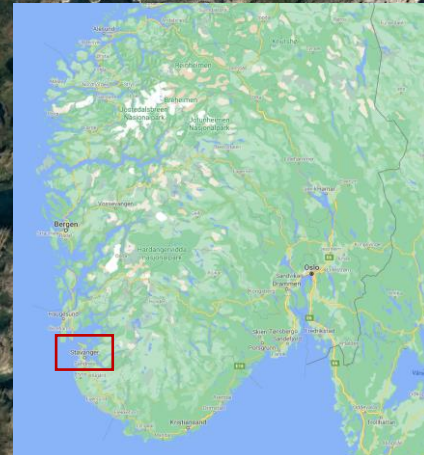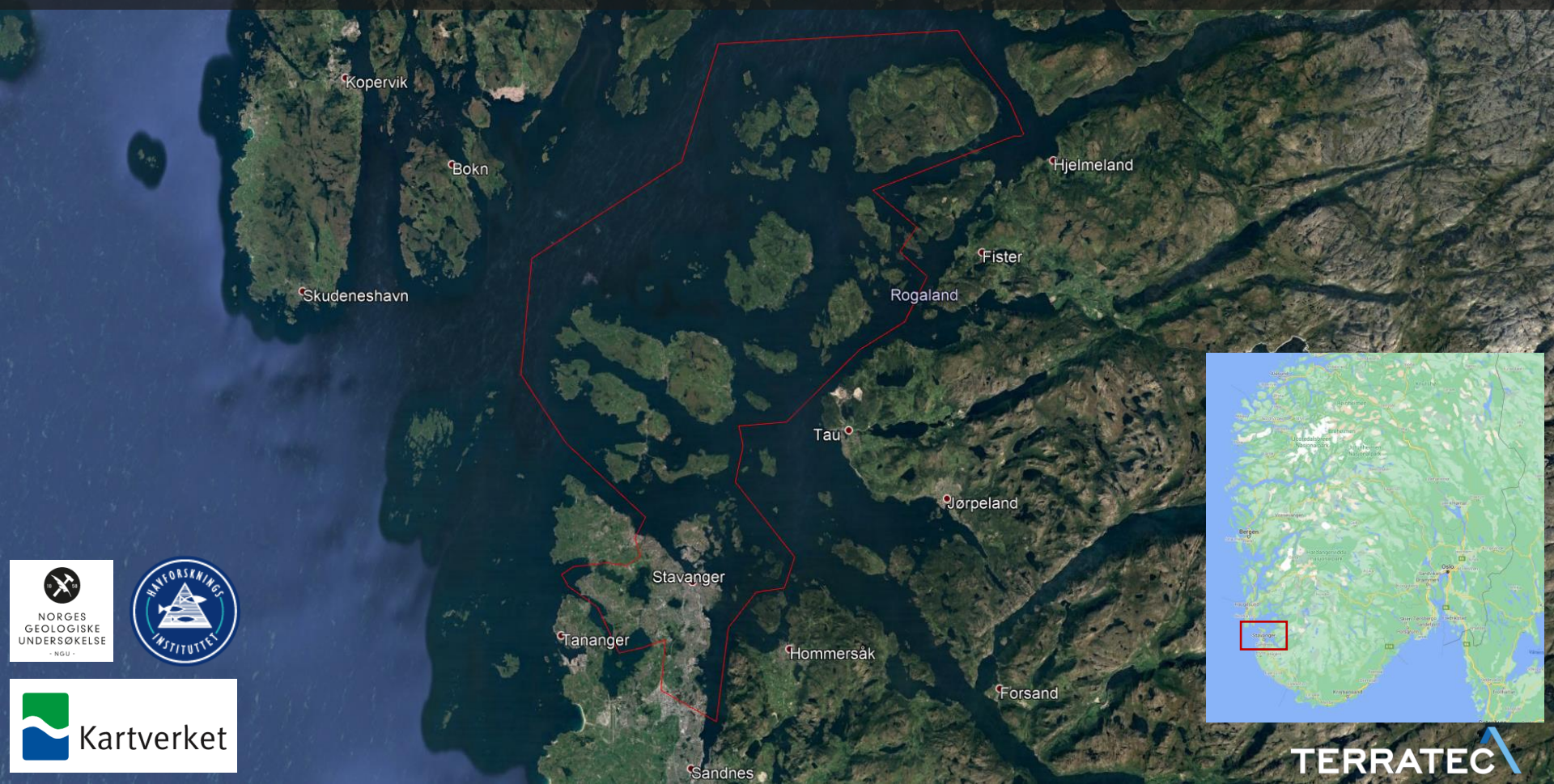
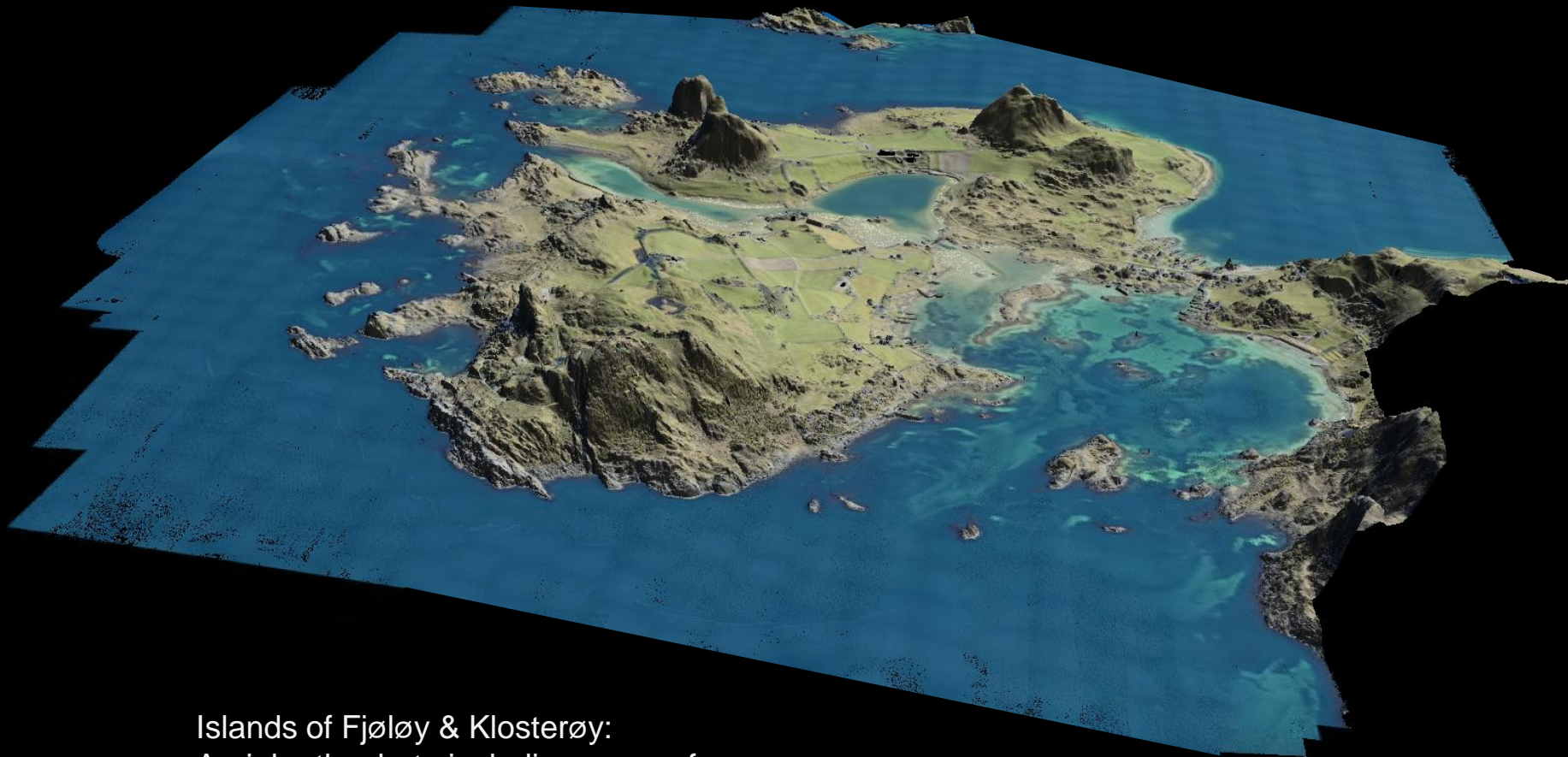# Terratec Use Case: Survey around Stavanger, Norway
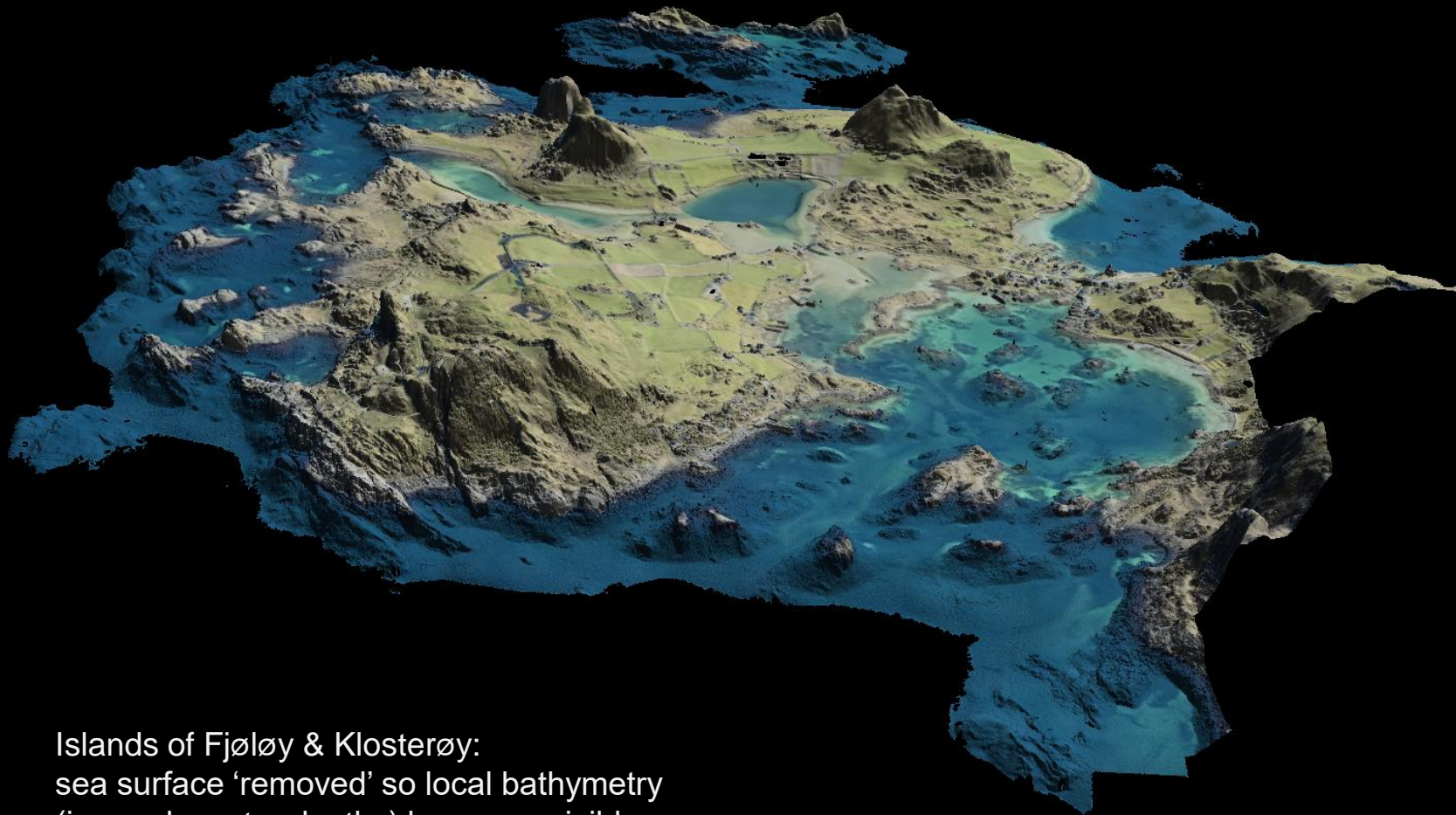## Project: Marine Base Maps for the Coastal Zone
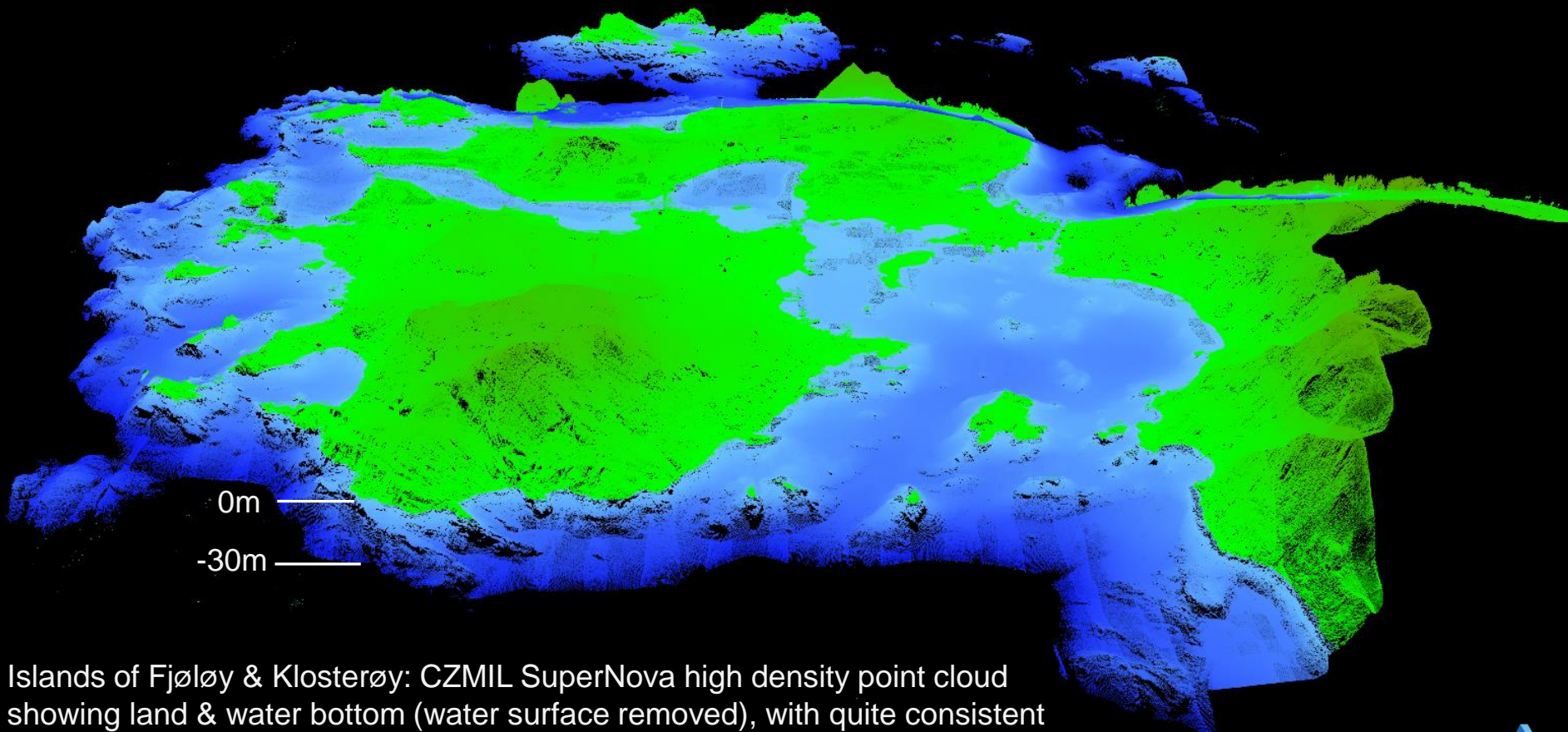
0m

-30m

Islands of Fjøløy & Klosterøy: CZMIL SuperNova high density point cloud showing land & water bottom (water surface removed), with quite consistent depths up to 30 meters (deeper is classified)

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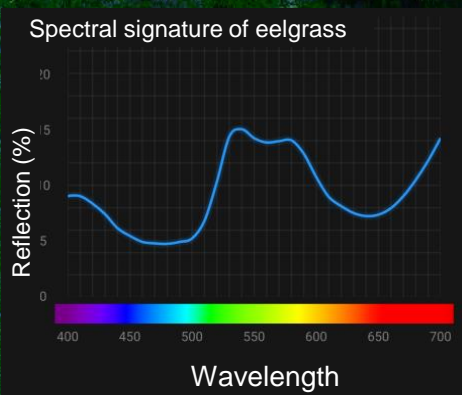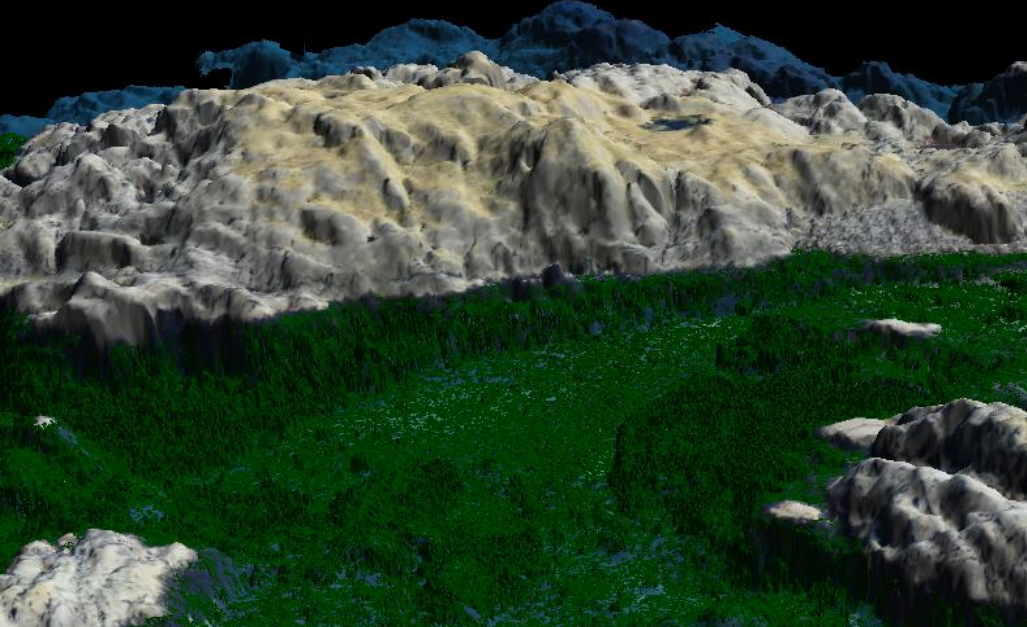Islands of Fjøløy & Klosterøy:
Aerial orthophoto including sea surface

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Islands of Fjøløy & Klosterøy:
sea surface 'removed' so local bathymetry
(i.e. underwater depths) becomes visible

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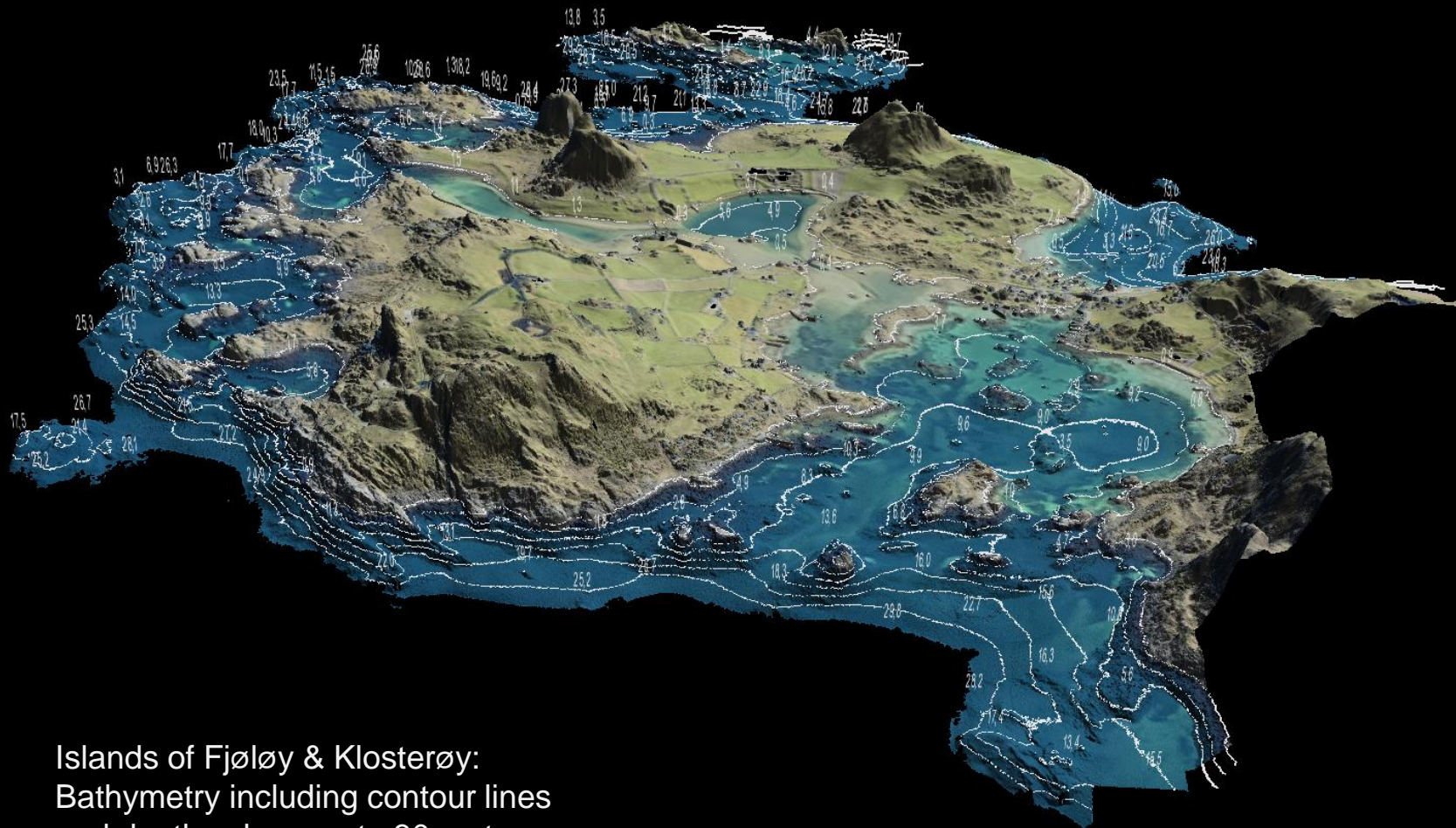
Islands of Fjøløy & Klosterøy:
Bathymetry including contour lines
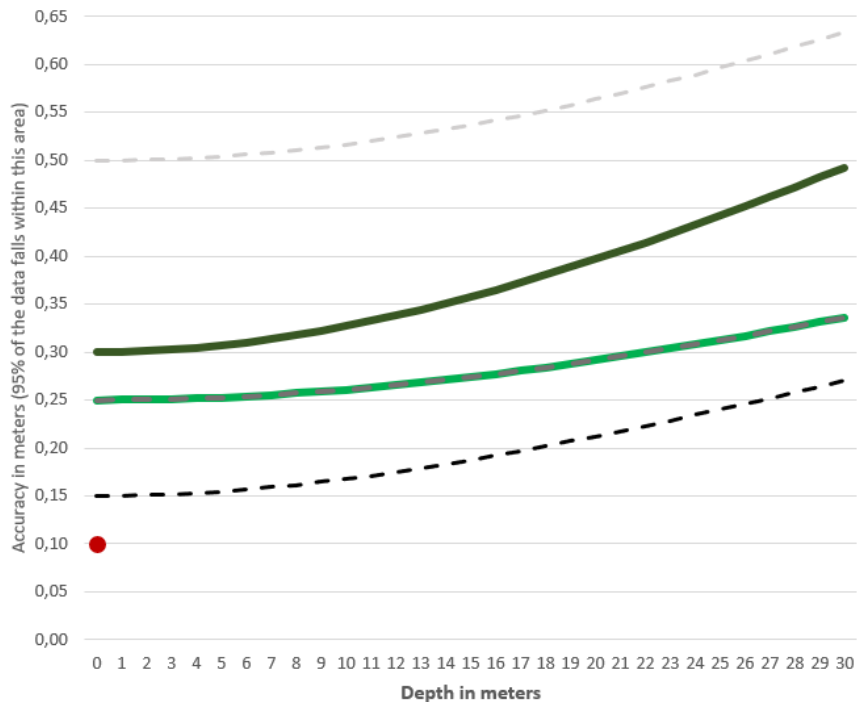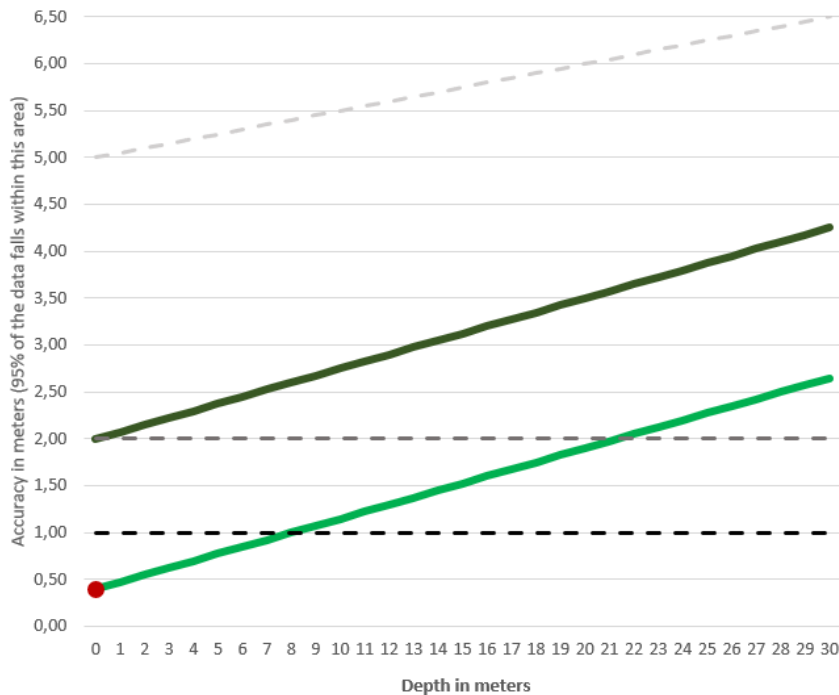and depth values up to 30 meters

# Mapping of Marine Vegetation



Spectral signature of eelgrass

Reflection (%)

400 450 500 550 600 650 700

Wavelength

Eelgrass

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# CZMIL SuperNova Accuracies compared to IHO Orders (S-44 edition 6)

# CZMIL SuperNova: object detection

- The CZMIL SuperNova has a short laser pulse width & the fastest photon digitizer on the market (2,500,000,000 samples per second), which results in more precise depth measurements and excellent object detection possibilities.



Nova waveform sample rate (1 GSPS)

Supernova waveform sample rate > 2x CZMIL Nova (> 2 GSPS)



Long laser pulse width

Short laser pulse width

**Water**

**Bottom**

Object return

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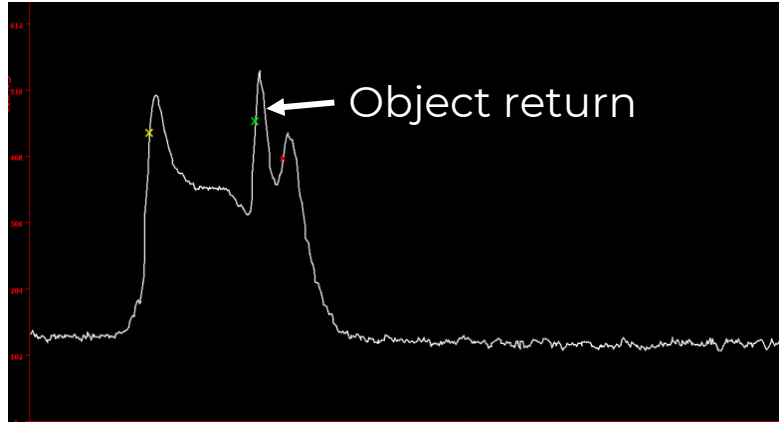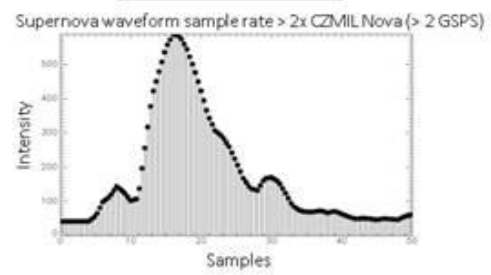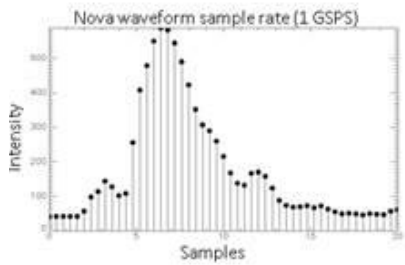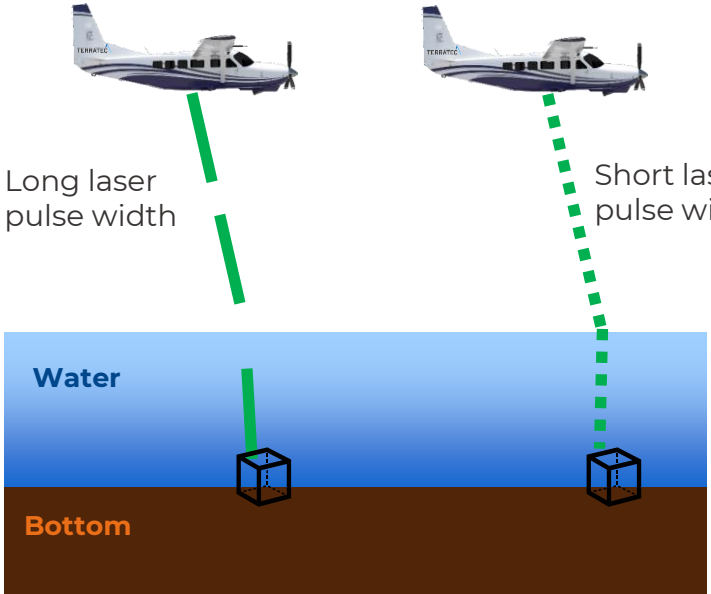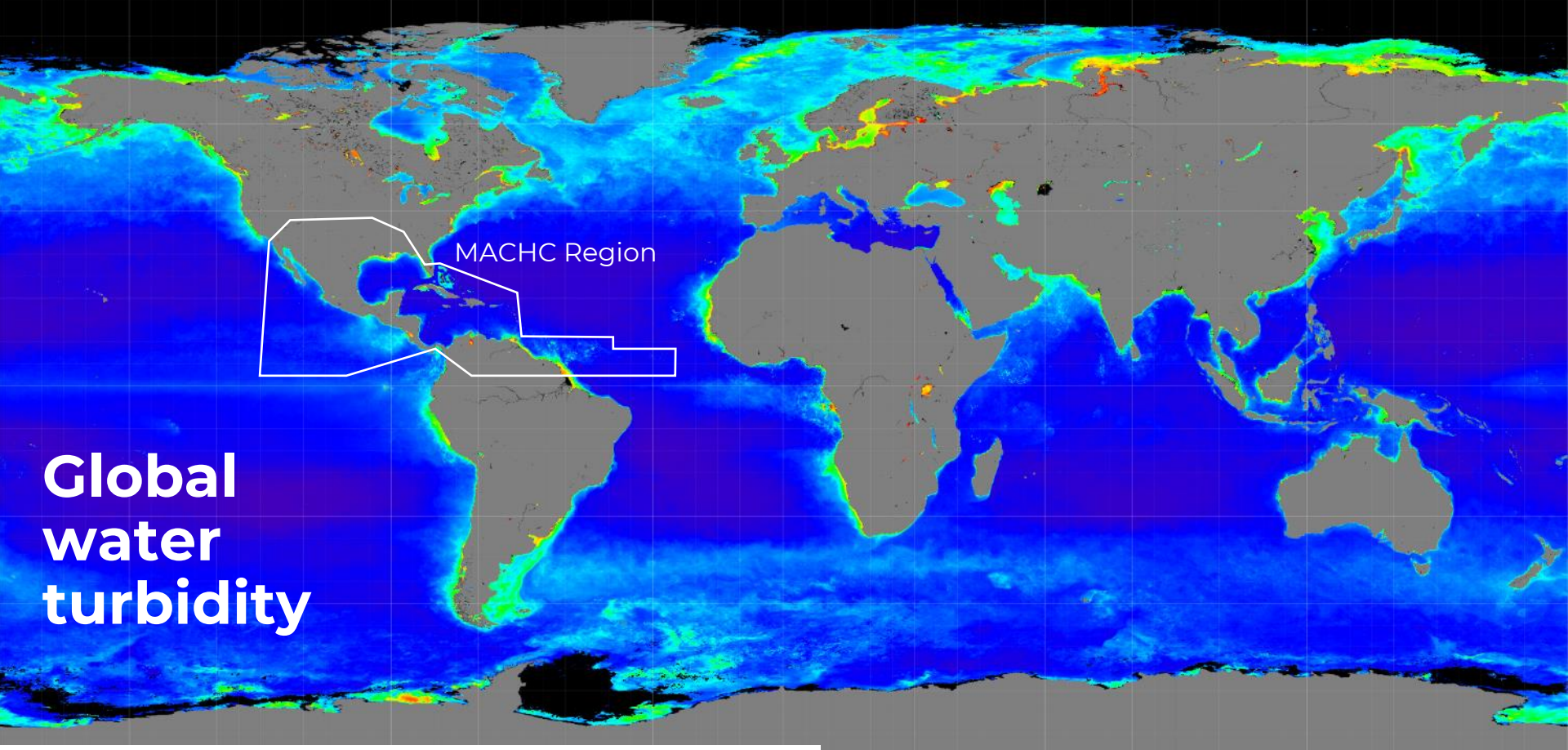
Global water turbidity

MACHC Region

Diffuse Attenuation Coefficient at 532nm (m⁻¹)

Based on NASA Aqua-MODIS space satellite derived diffuse attenuation coefficients (K_d) at 490nm and recalculated at 532nm (https://oceancolor.gsfc.nasa.gov/atbd/kd_490/ )

Clear water  0.06  0.07  0.1  0.2  0.4  0.8  1.5  Turbid water

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# Survey Preparation: CZMIL SuperNova depths that can be reached
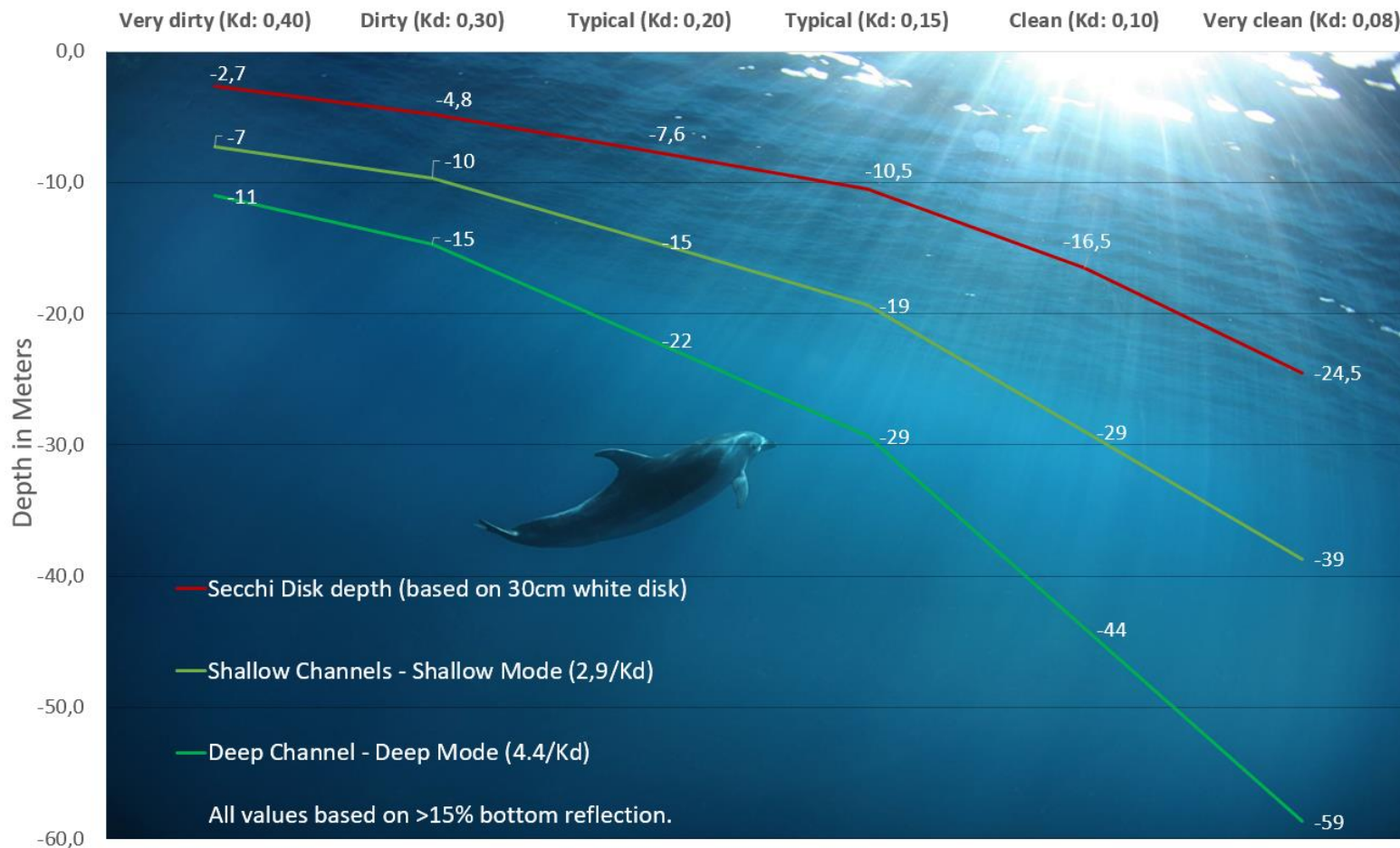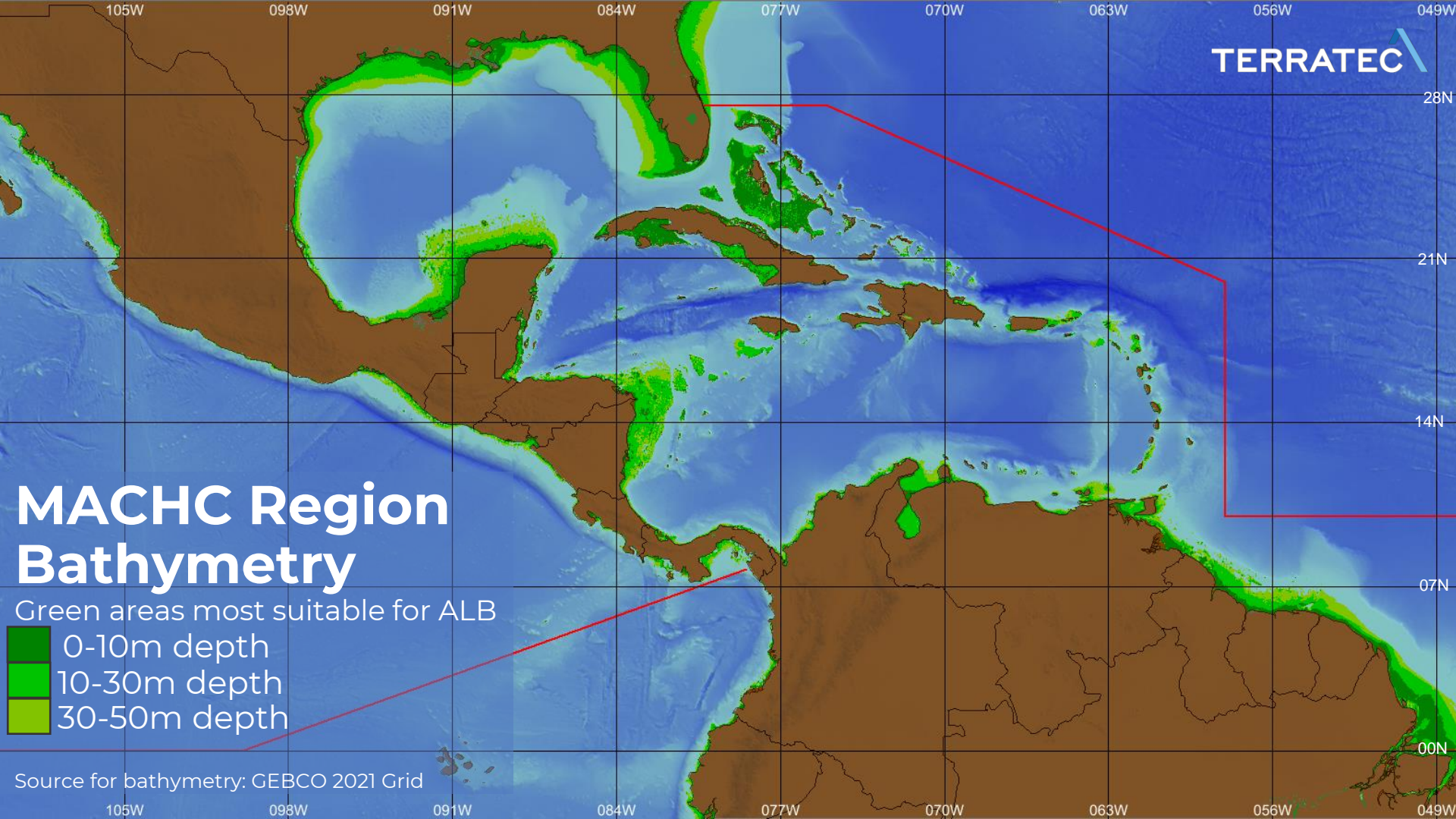
**MACHC Region Bathymetry**

Green areas most suitable for ALB

- 0-10m depth
- 10-30m depth
- 30-50m depth

Source for bathymetry: GEBCO 2021 Grid

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# Terratec Conclusion

- With airborne bathymetric lidar large areas can be surveyed accurately & efficiently.

- With the CZMIL SuperNova Terratec has a top-notch bathymetric lidar system, delivering very good results.

- Terratec is looking forward to use this sensor to survey more waters and is ready to provide its services!

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