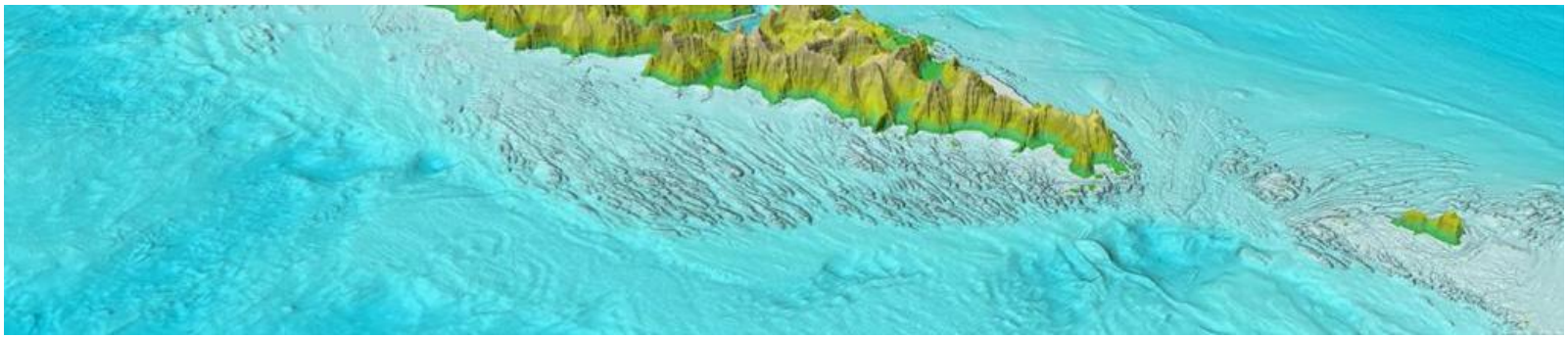
NORWEGIAN MAPPING AUTHORITY

MAREANO – PROGRAM: COLLECTING MARINE KNOWLEDGE

SPATIAL DATA – FOR BENEFIT OF THE SOCIETY

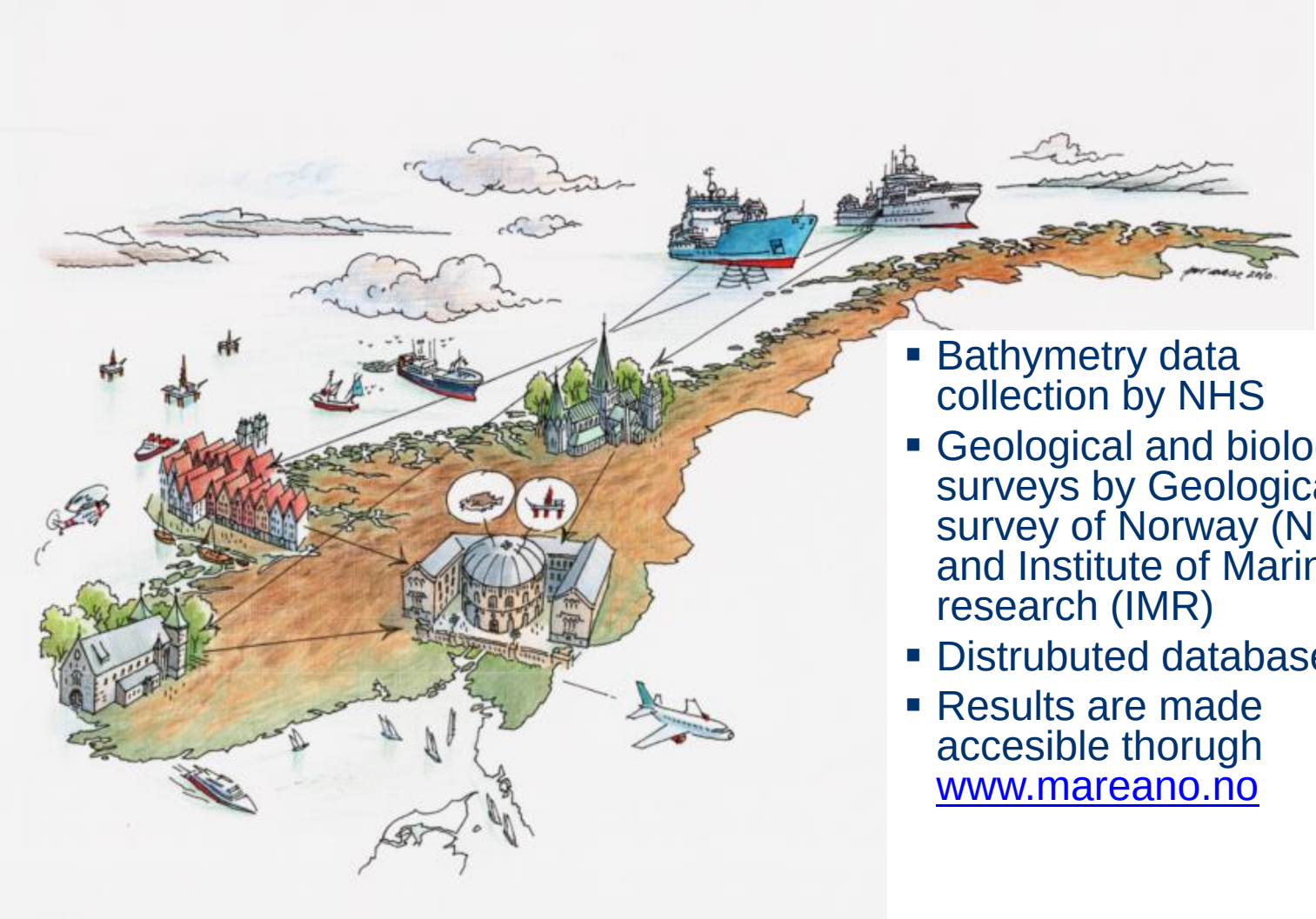


MAREANO – program: Collecting marine knowledge

Hanne Hodnesdal
Norwegian Mapping Authority Hydrographic Service

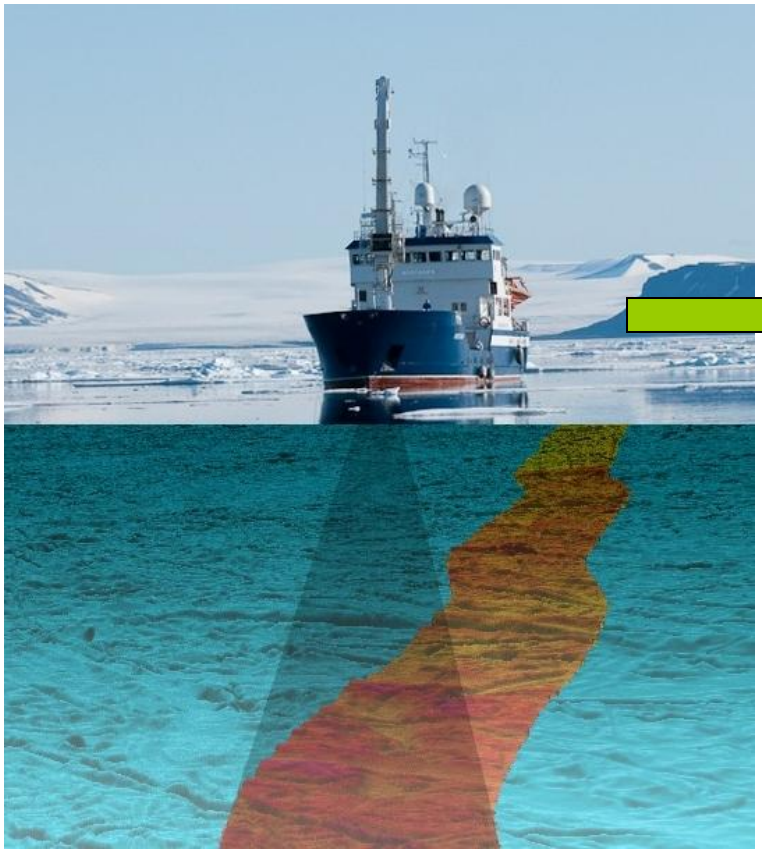
IHO TWLGW
Stavanger 27 April 2010

MAREANO – Dataflow

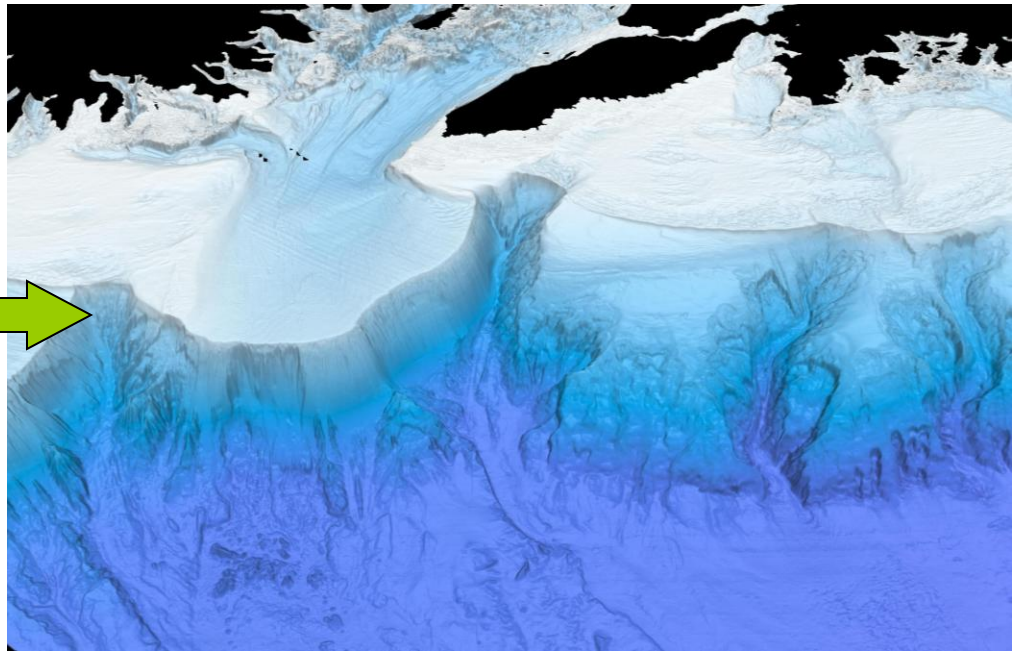


- Bathymetry data collection by NHS
- Geological and biological surveys by Geological survey of Norway (NGU) and Institute of Marine research (IMR)
- Distrubuted databases
- Results are made accesible thorugh www.mareano.no

From bathymetry surveyes to digital terrain models (DTM)



Bathymetry survey with multibeam echosounder



- Also collected:
  - Backscatter
  - Water coloumn data
  - Gravity

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Depth data from different sources: Defence, gas- and oil industri, other projects, own vessel and purchase of bathymetry surveys

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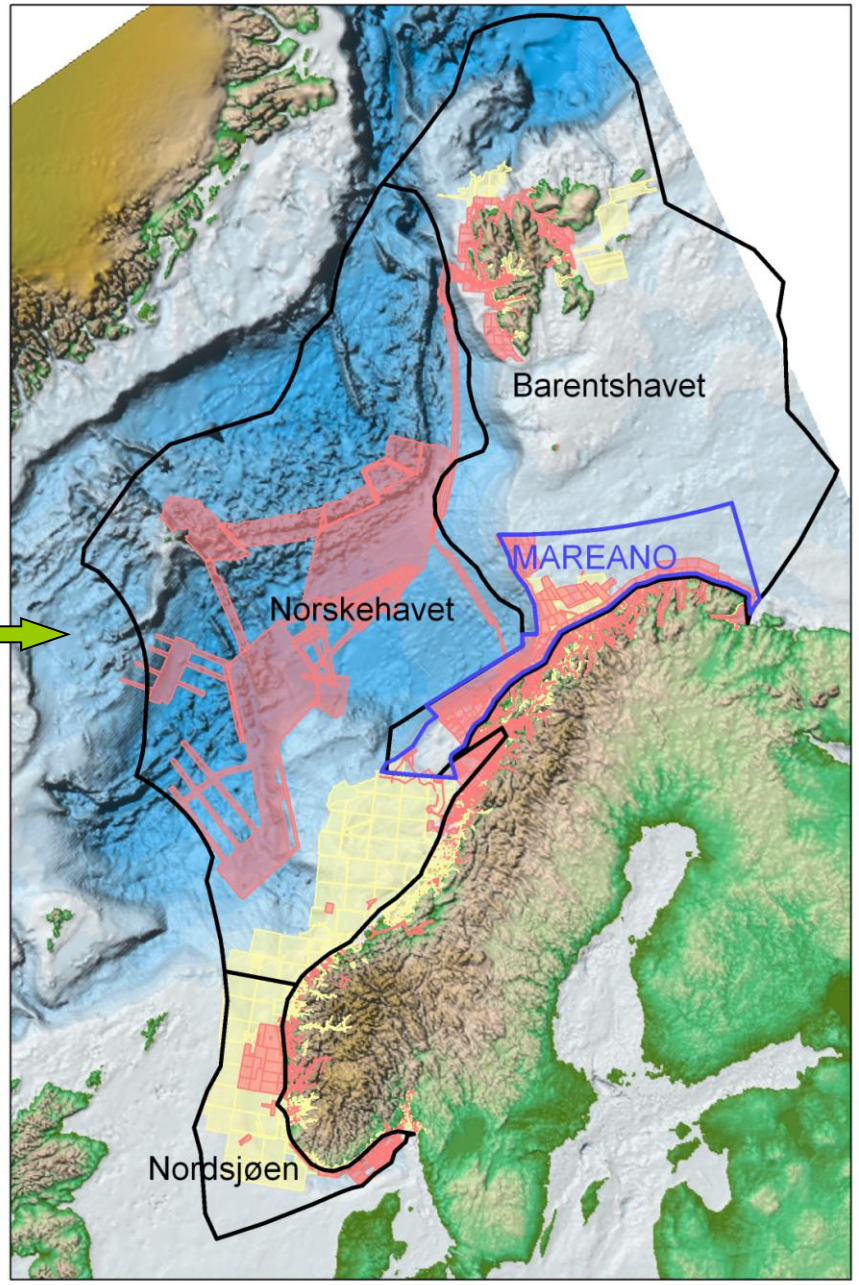
Norwegian sea areas

- Large areas (2.1 mill km^2)
- Only partly covered by MBE data (pink areas show MBE data in NHS database)
- Bathymetry data collection is expencive ecpecially in shallow waters
- It is important to use data from other sources: Defence, oil- and gas industry etc.



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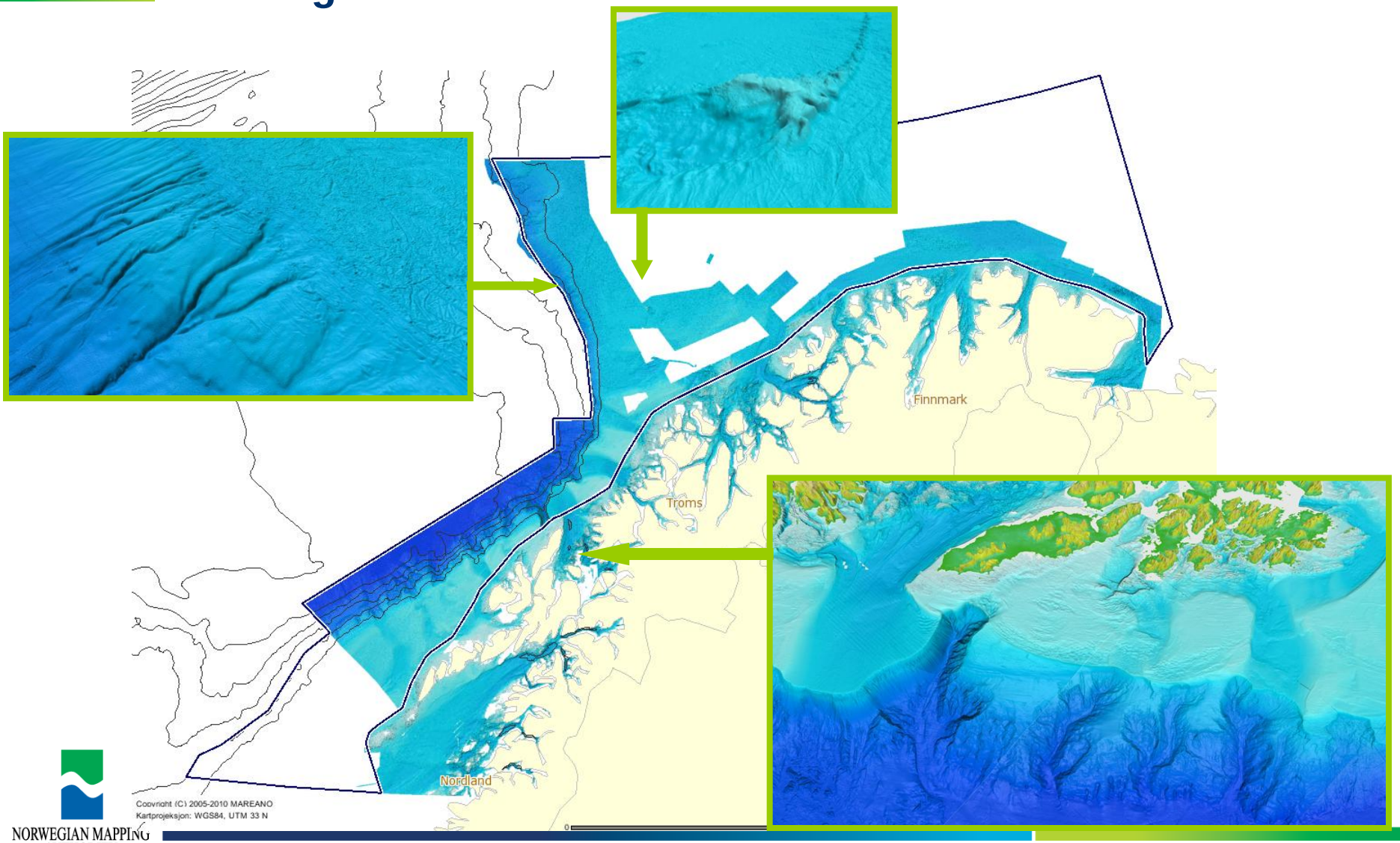
Coverage – detailed DTM



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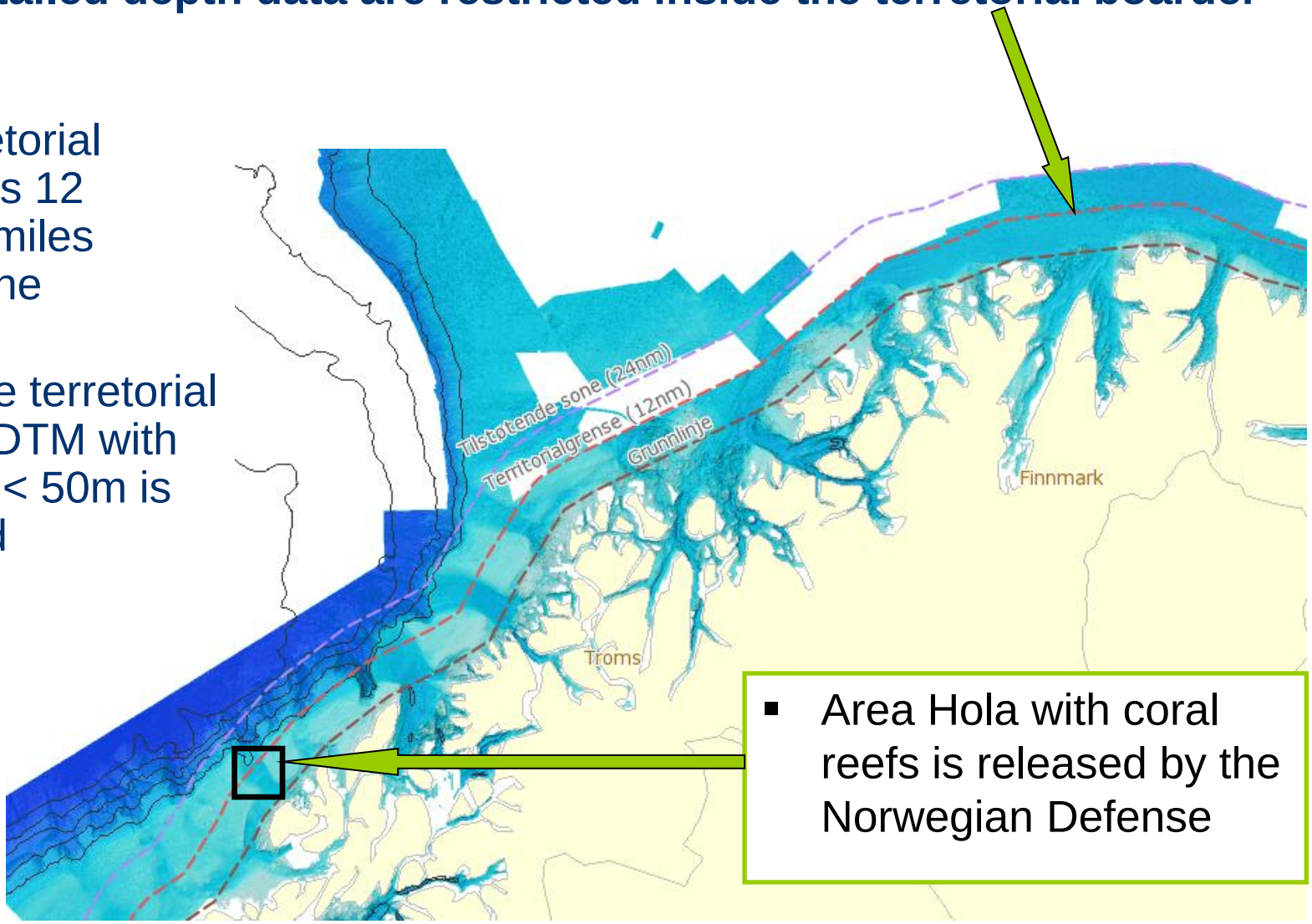
Detailed depth data are restricted inside the terretorial boarder

- The terretorial boarder is 12 nautical miles outside the baseline
- Inside the terretorial boarder DTM with grid size < 50m is restricted



- Area Hola with coral reefs is released by the Norwegian Defense

Coral reefs in Hola
DTM with 5m grid

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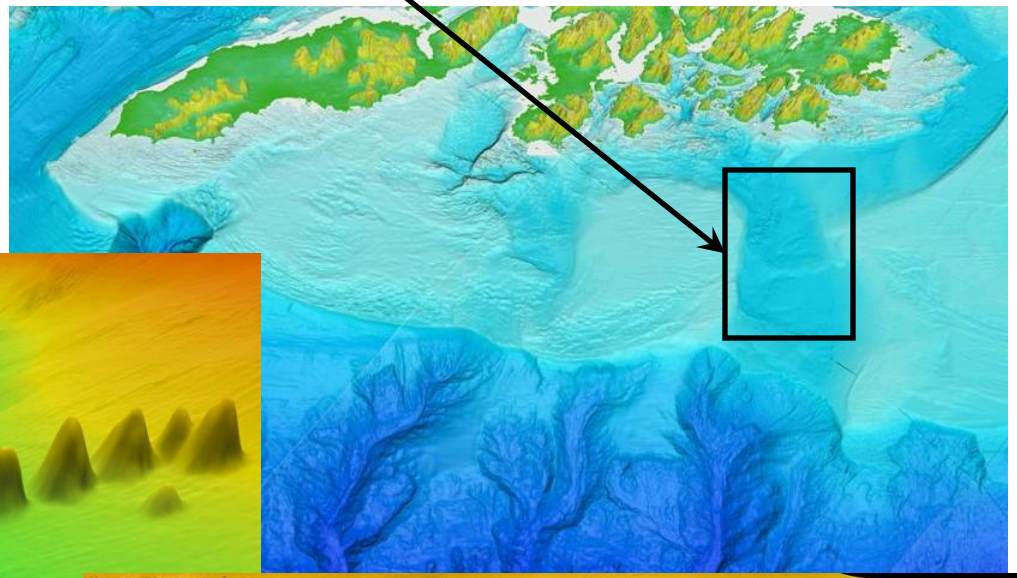
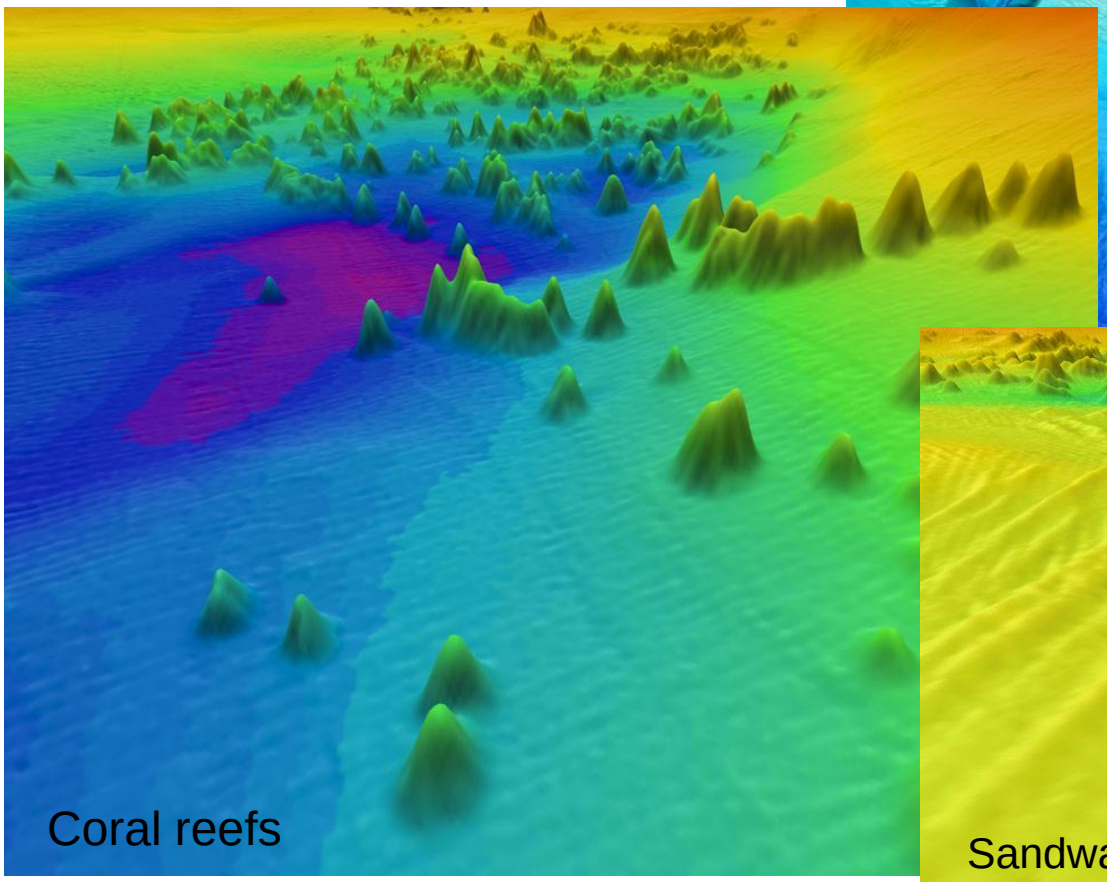
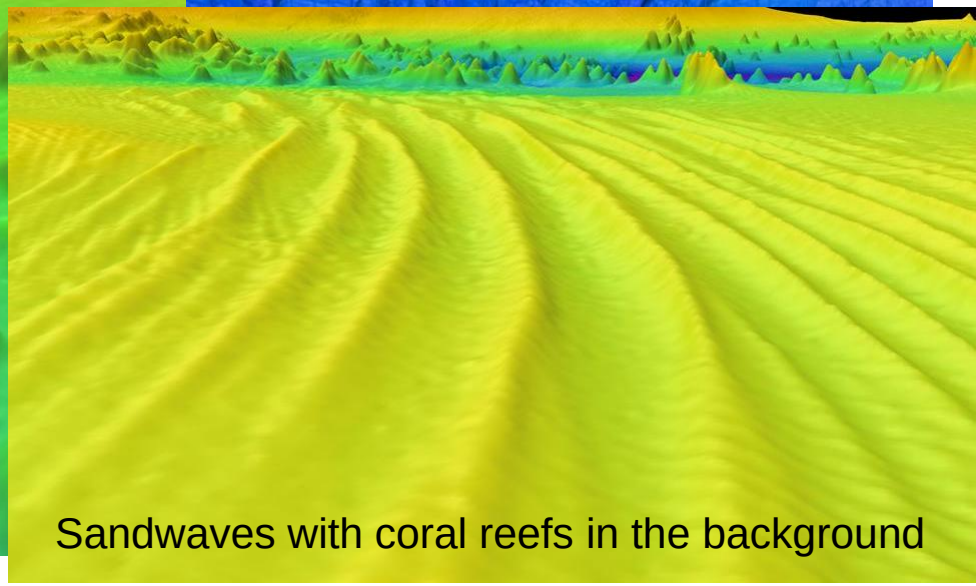




Coral reefs



Sandwaves with coral reefs in the background

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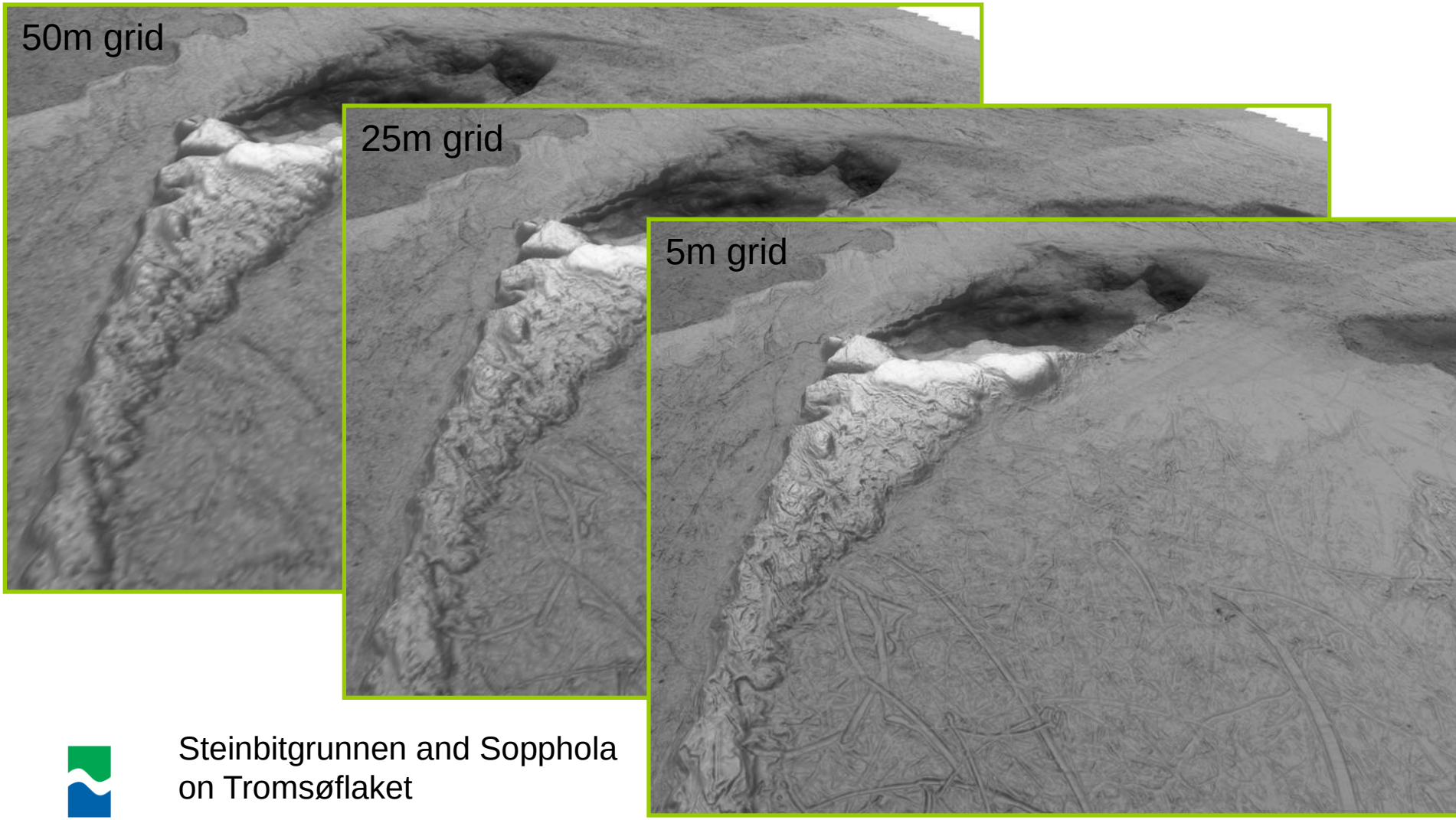
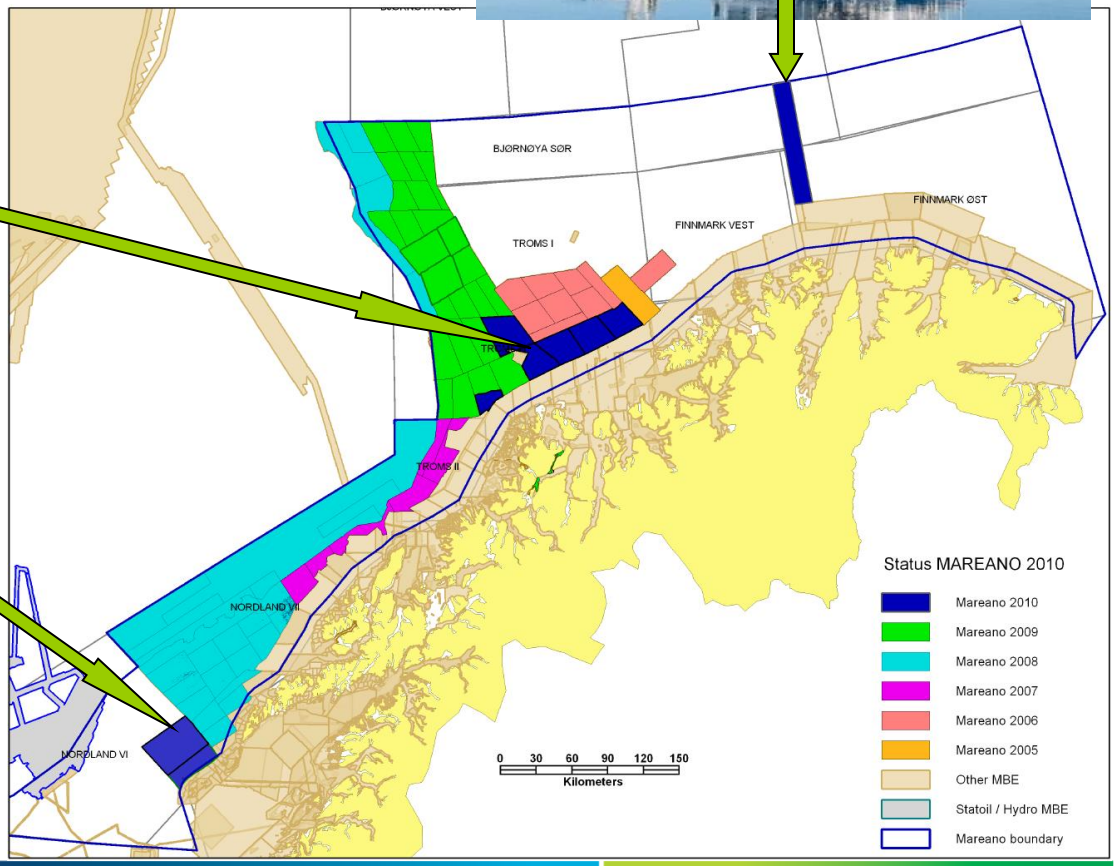
Digital terrain models with 50m, 25m og 5m resolution



Steinbitgrunnen and Sopphola on Tromsøflaket

The MAREANO survey this year starts 29 April 2010



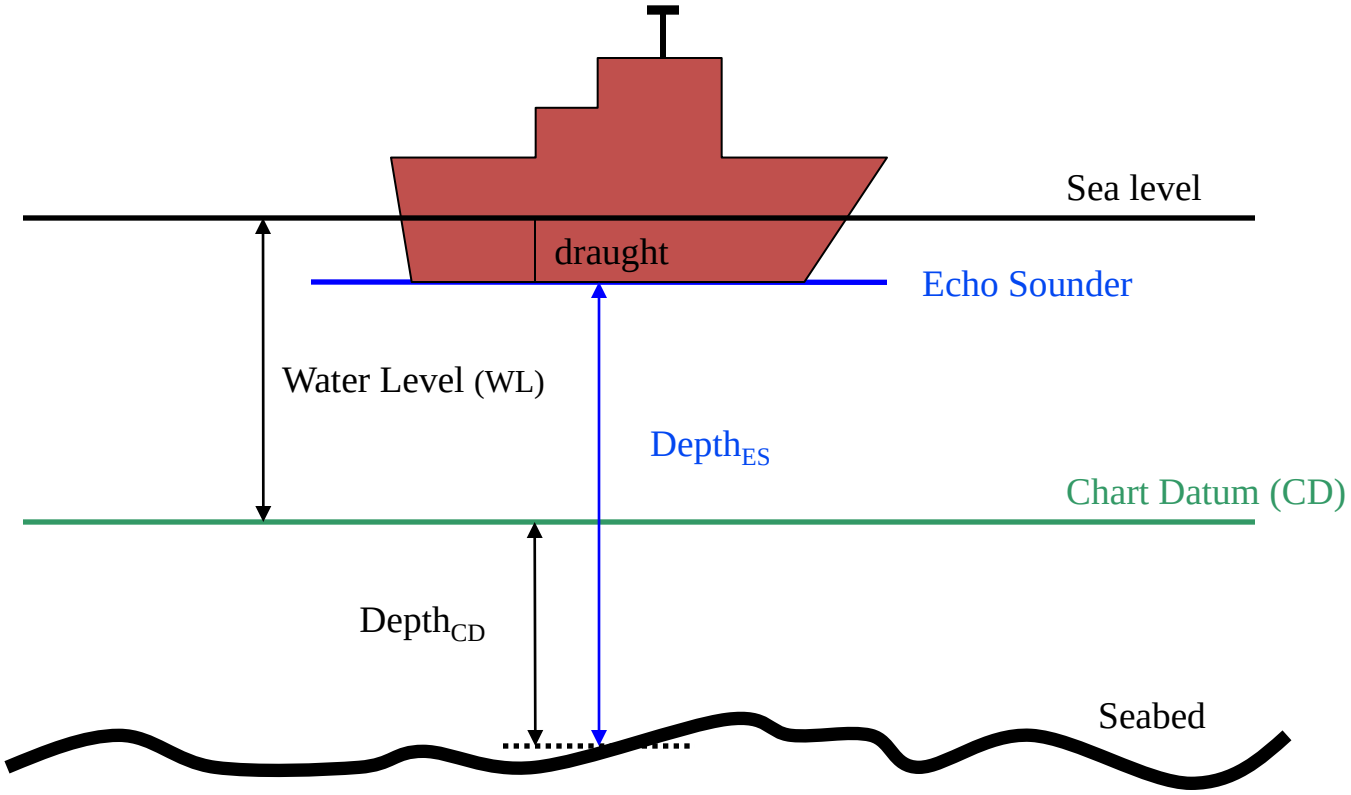
- Later in 2010 we will survey in an area outside Lofoten
- We have also received data from Statoil measured in 2003

Alternative methods for seabed mapping

- Seabed mapping with water level data from a tide gauge
  - We use this method close to the coast
- Seabed Mapping using the ellipsoid as vertical reference
  - We use this method for offshore areas

We will look at the two methods in more detail…

Seabed mapping with water level data



$$Depth_{CD} = Depth_{ES} + draught - WL_{CD}$$

Water level at the time of seabed mapping must be removed from the depth data

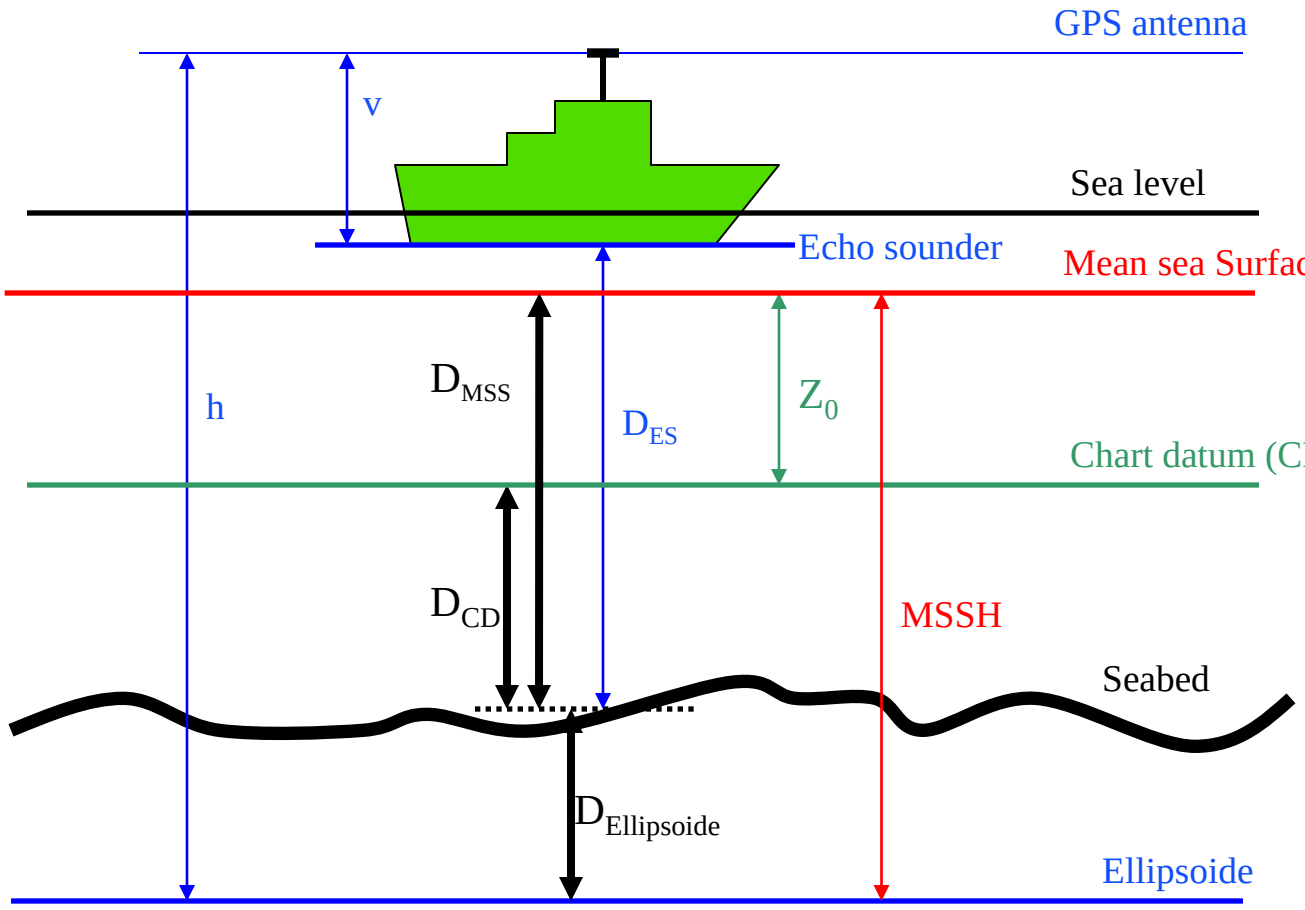
Methods to obtain water level data:

- Permanent tide gauge
  - possibly combined with tide zone
- Temporary tide gauge
  - associated with a permanent tide gauge to get the relation to mean sea level
- Predicted tide
  - possibly combined with air pressure

Alternative method:

- Use GPS to measure water level with ellipsoid as reference

Using Ellipsoid as Vertical Reference for Seabed Mapping



$D_{Ellipsoide}=h-D_{ES}-v$

$D_{MSS}=MSSH-D_{Ellip.}$

$D_{CD}= D_{MSS} - Z_0$

What we need to use the ellipsoid as vertical reference for seabed mapping

Mandatory:

- Vertical position of high quality
- The position of the GPS-receiver must be known in the vessel coordinate system
- The motion of the vessel must be known (attitude data: heave, roll, pitch and heading)

Not mandatory:

- If we want to convert to *mean sea level* we must know the difference between mean sea level and the ellipsoid.
  - MSS (Mean Sea Surface) models can be used.
- If we want to convert to *Chart Datum* (CD) we must know the difference between Chart Datum and mean sea level .
  - Along the Norwegian coast the Chart Datum is equal to LAT (lowest astronomical tide) with a few exceptions. Tide models can be used to estimate LAT offshore

Advantages and disadvantages of using ellipsoid as vertical reference for seabed mapping

- Advantages
  - Water level measurements are not needed
  - Do not have to consider different tidal zones
  - Knowledge of the draught is not needed
  - Less possibility of mismatch in overlapping survey areas by using a consistent reference
  - GPS also measures medium frequency waves not measured by the heave sensor nor the tide gauge
  - ...
- Disadvantages
  - High quality vertical position is needed
  - The position of the GPS-antenna relative to the echo sounder must be known
  - Confusing: The ellipsoidal depth will not represent the true ocean depth
  - MSS and LAT-models must be known to convert to mean sea level and and chart datum
  - MSS- and LAT-models are continuously improving (version control is necessary)
  - ...

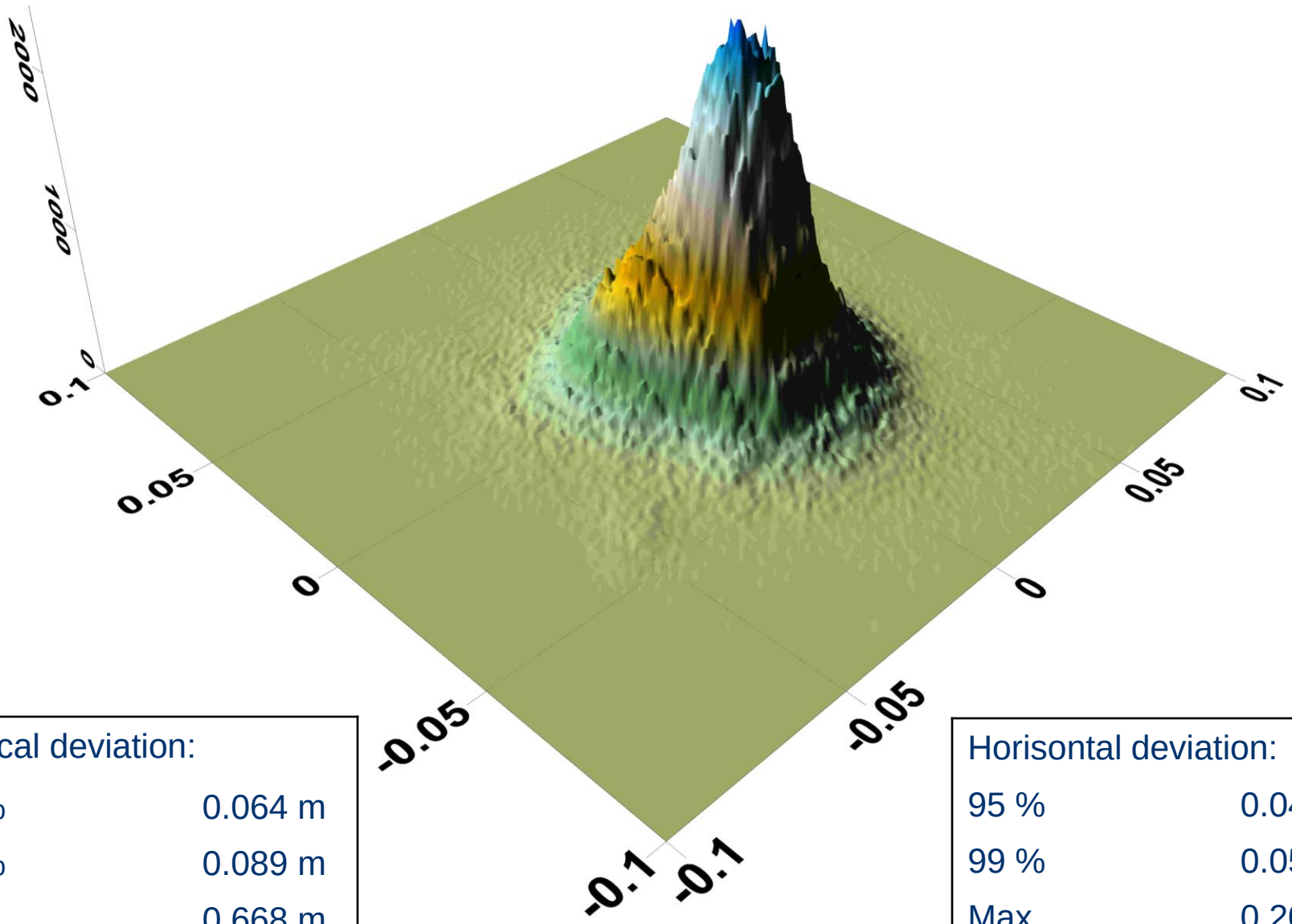
Prerequisites for utilizing GPS heights

- Basic requirement:
  - Stable positioning with a vertical accuracy of 10 cm (95%)
- This requires:
  - High quality software – So far only post processing with the TerraPos software has shown the required quality (RTK may be used for nearshore applications)
  - Data processing with TerraPos requires GPS data to be logged continuously – not depending on start and stop of survey lines
  - The vessel coordinates of all essential sensors must be well determined

What is TerraPos?

- **PPP – Precise Point Positioning**
  - One single GNSS receiver
  - Utilize precise GNSS orbit and clock data (e.g from IGS)
  - High end dual frequency GNSS receiver is required to eliminate the main part of the ionospheric refraction
  - Positioning accuracy cm – dm
- **Corrections**
  - Ionospheric and tropospheric delay
  - Tide and loading effects (solid earth tide, ocean loading, polar motion)
  - Antenna phase center, yaw effects etc.
- **Limitations**
  - Long continuous data (preferably >6 hours)
  - Post processing (precise orbit data must be available)

TerraPos horisontal accuracy



Vertical deviation:	
95 %	0.064 m
99 %	0.089 m
Max	0.668 m

Horisontal deviation:	
95 %	0.048 m
99 %	0.058 m
Max	0.205 m

Conclusions: Seabed mapping with the ellipsoid as vertical reference

- To use the ellipsoid as vertical reference for seabed mapping is today a relevant method since the GPS-height has become quite accurate: 6.4 cm 95%

- *Offshore* it is favourable to use the ellipsoid as reference:
  1. Difficult to get good water level data offshore
  2. There are good MSS-models covering these areas (although poorer for high latitude and areas with sea ice)
  3. It does not matter that the LAT-surface is of less quality offshore since the requirements for depth accuracy in navigational charts are weak offshore

- NHS can still not use the ellipsoid as reference *close to the coast*:
  1. MSS-models are of poor quality
  2. The requirements for depth accuracy in navigational charts are stringent

- It is attractive in the future to use the ellipsoid close to the coast as well, and NHS have project with object to improve MSS-models in this area. It will also be important to reduce other contributions to the error budget

Questions?