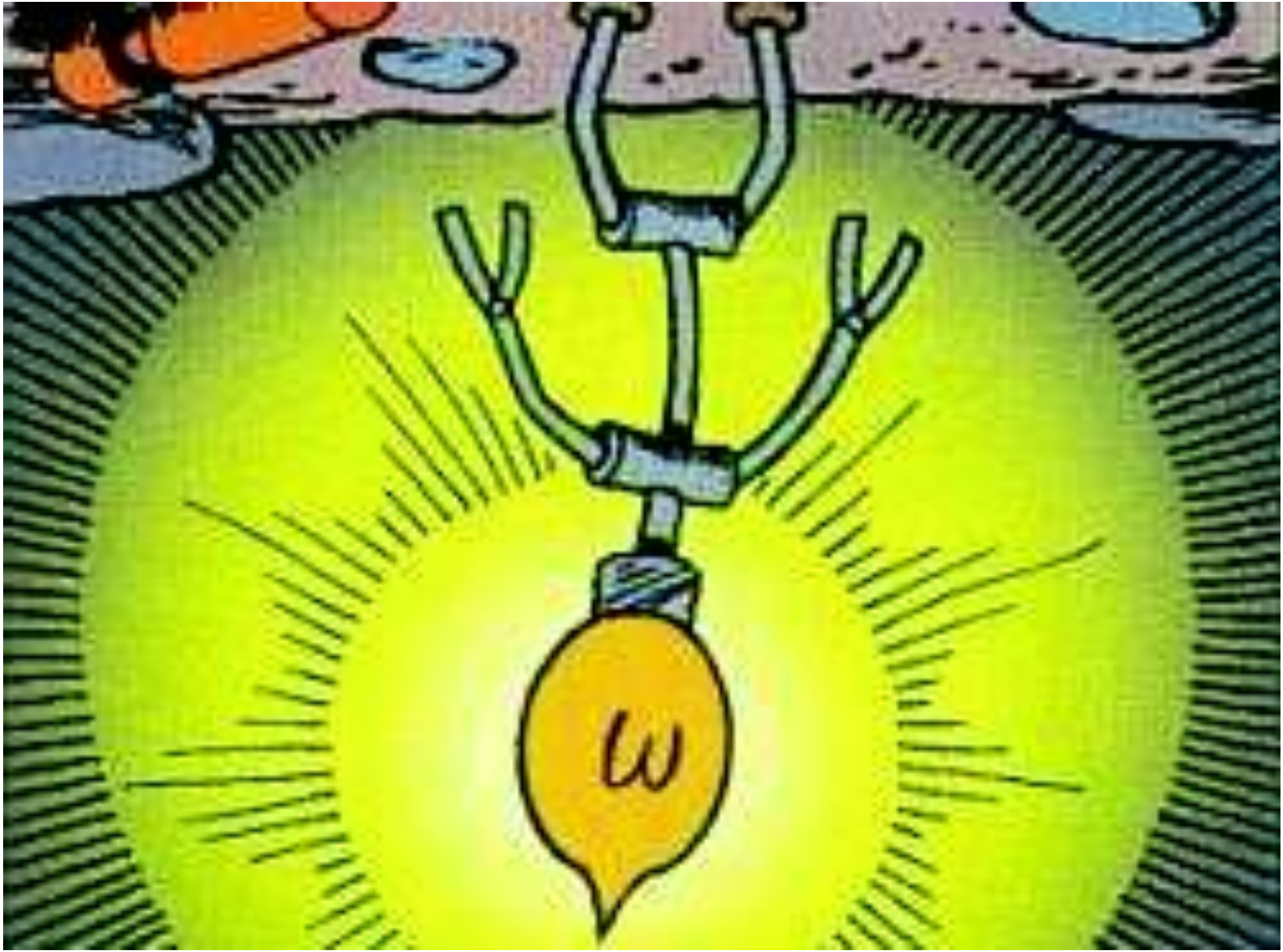
UNMANNED SYSTEMS FOR MARITIME OPERATIONS

- Trends and opportunities

Vegard Evjen Hovstein, Maritime Robotics AS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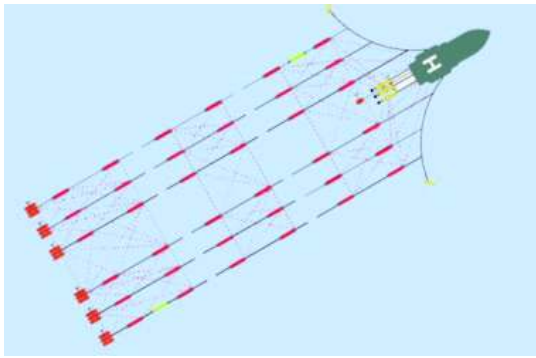
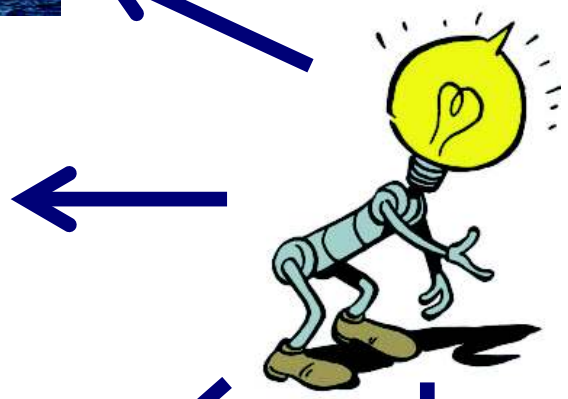
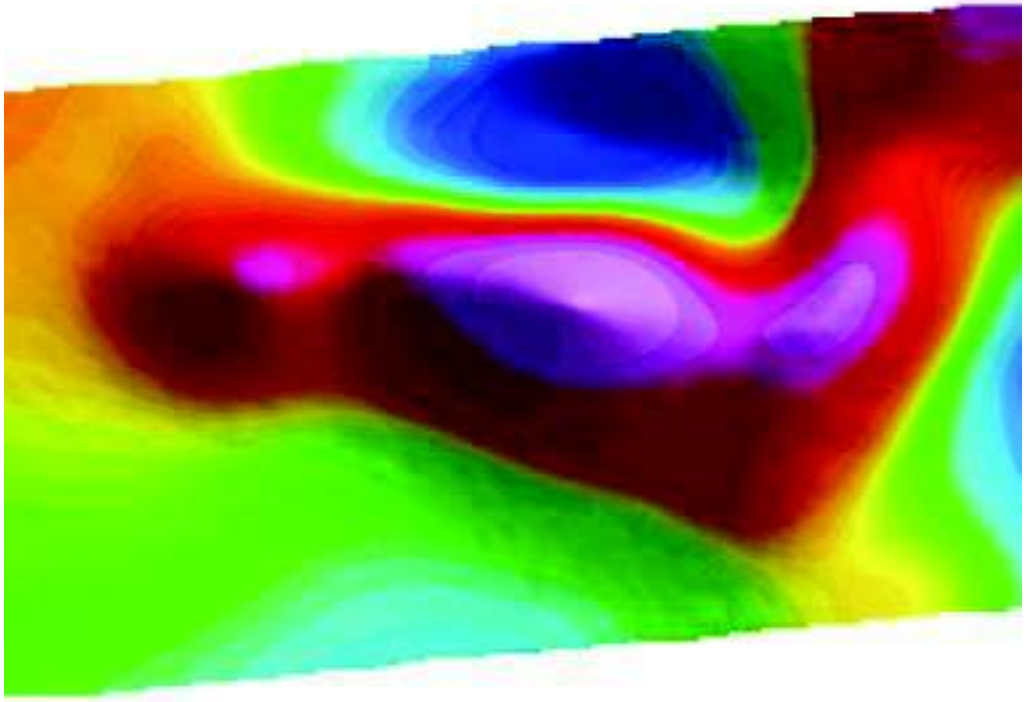
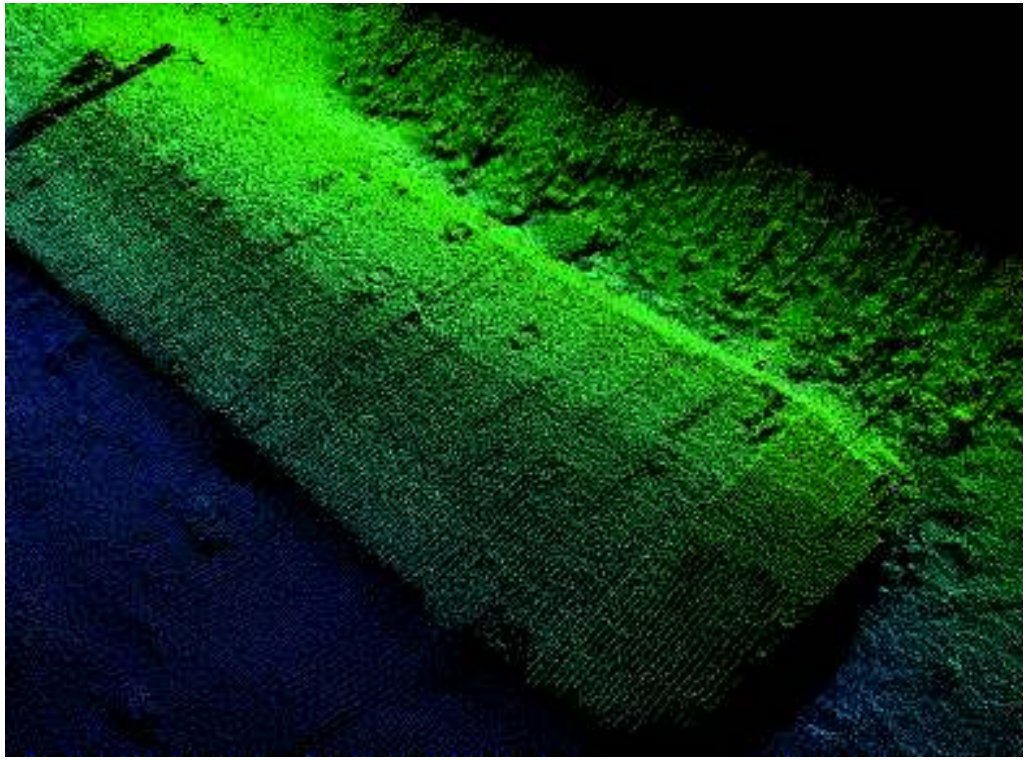
WHERE IS THE MARKET?



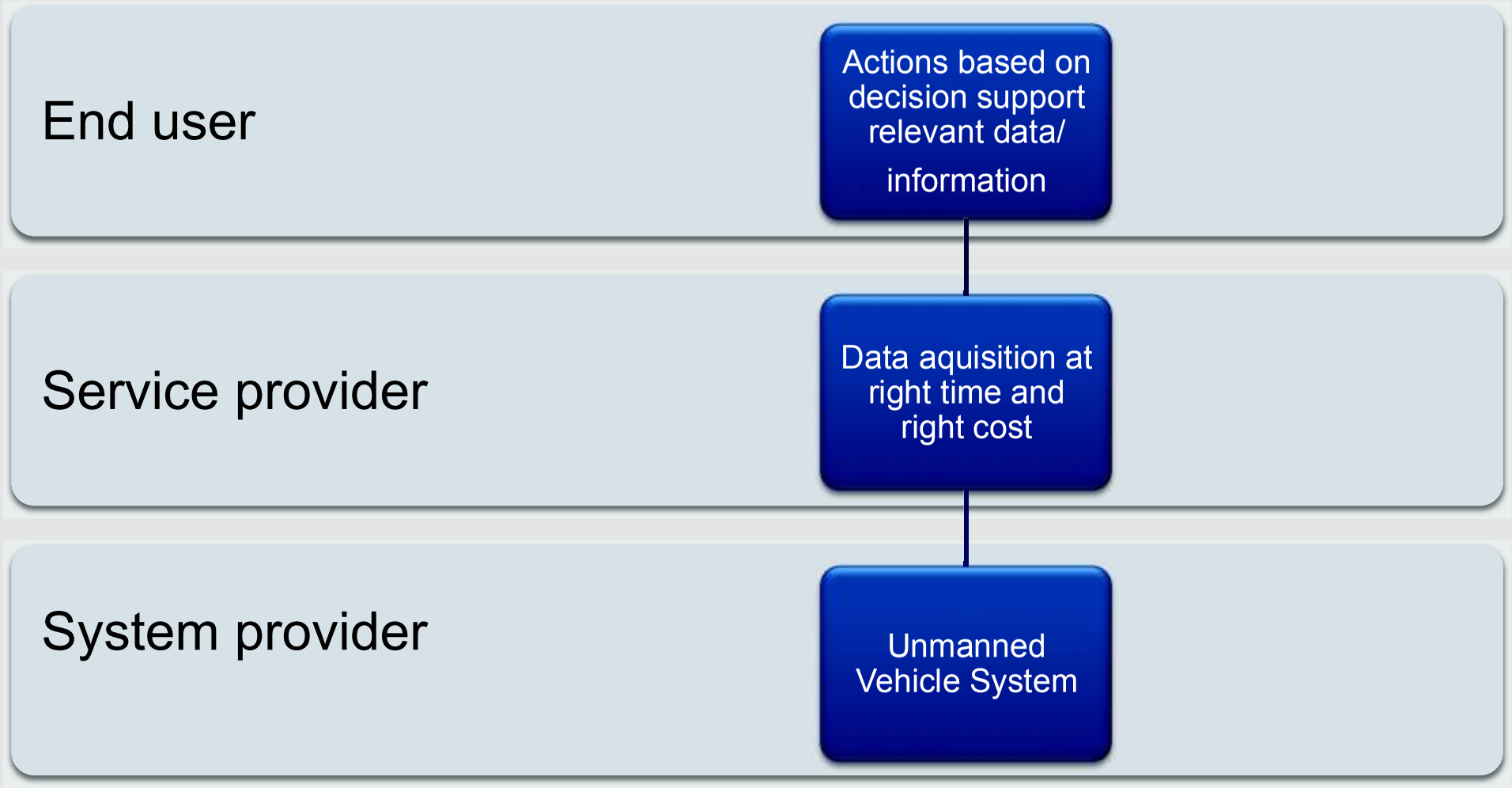


IS THERE A MARKET?





MARKET LEVELS

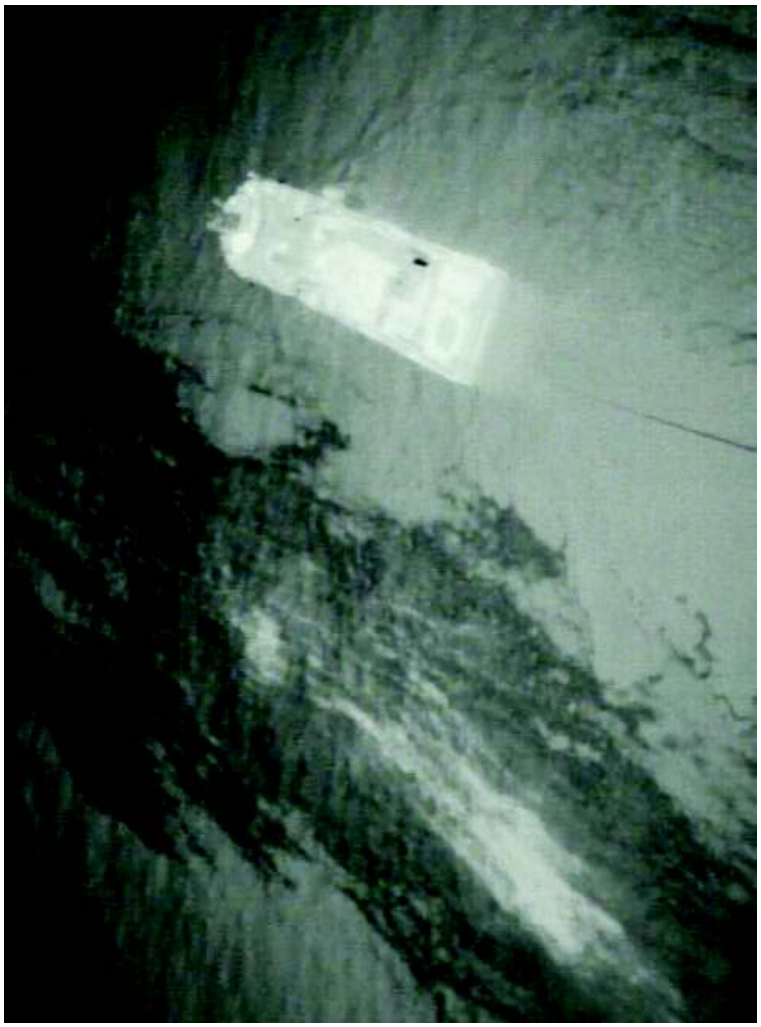


SOME GENERAL VALUE PROPOSITION

- Lower cost
  - Reduced crew costs
  - Less complex systems
  - More accesible and deployable
  - Multivehicle operations
  - Long endurance operations
- Improved HSE
  - No crew onboard
  - Smaller environmental footprint

OCEANEYE

Aerial surveillance system for oil-spill control



MOTIVATION

- An aerial observation system that:
  - Assist and even sometimes replace observations from aircraft or helicopters
  - Be a deployable surface based capacity where aircraft solutions are not an alternative
  - Have a capability for persistent operation for days and weeks

- Deepwater Horizon 2011
  - Never enough aerial surveillance capacity

OceanEye® components

OceanEye® Balloon

OceanEye® Base unit

OceanEye® Sensor unit

OceanEye® Viewer terminal

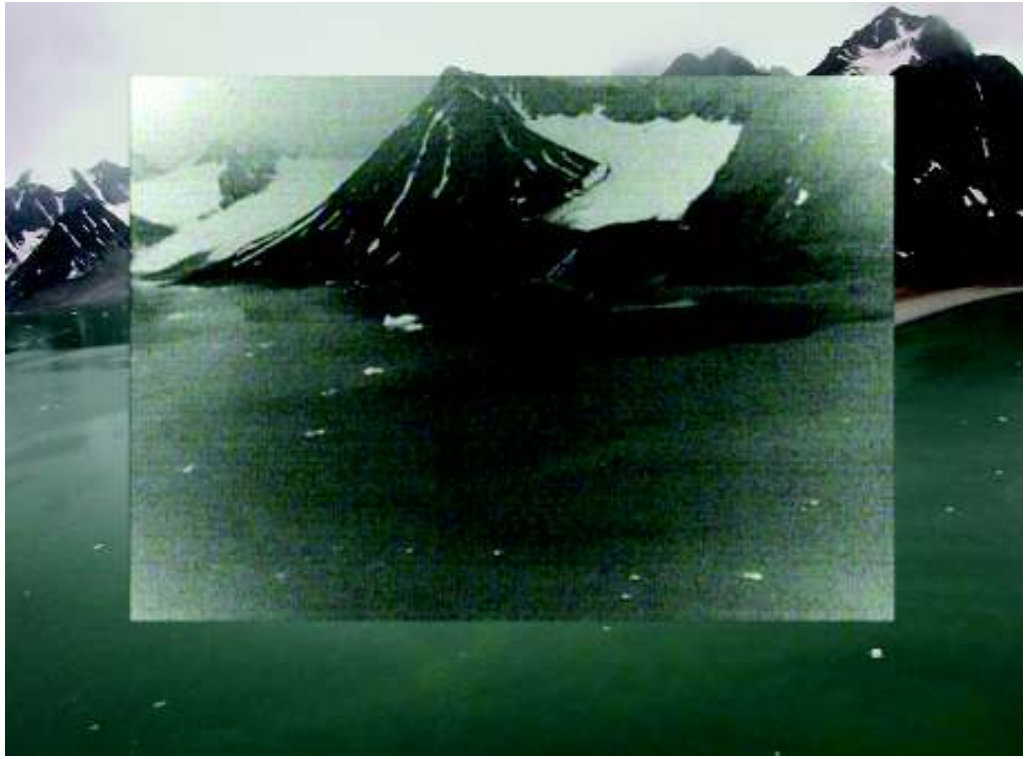
OceanEye® Self-contained and rapidly deployable

Weight: 425 kg / 936 lbs (with all system components packed)

Length x Wide x Height: 1.20 x 0.80 x 1.59 m / 47.3 x 31.5 x 62.6 inches

OverView

- Touch-based Viewer Terminal
  - Daylight camera (EO)
  - Infrared camera (IR)
  - AIS objects overlayed on chart
- Other features
  - Shows sea-level position (Lat,Long) of crosshair
  - Monitors system status



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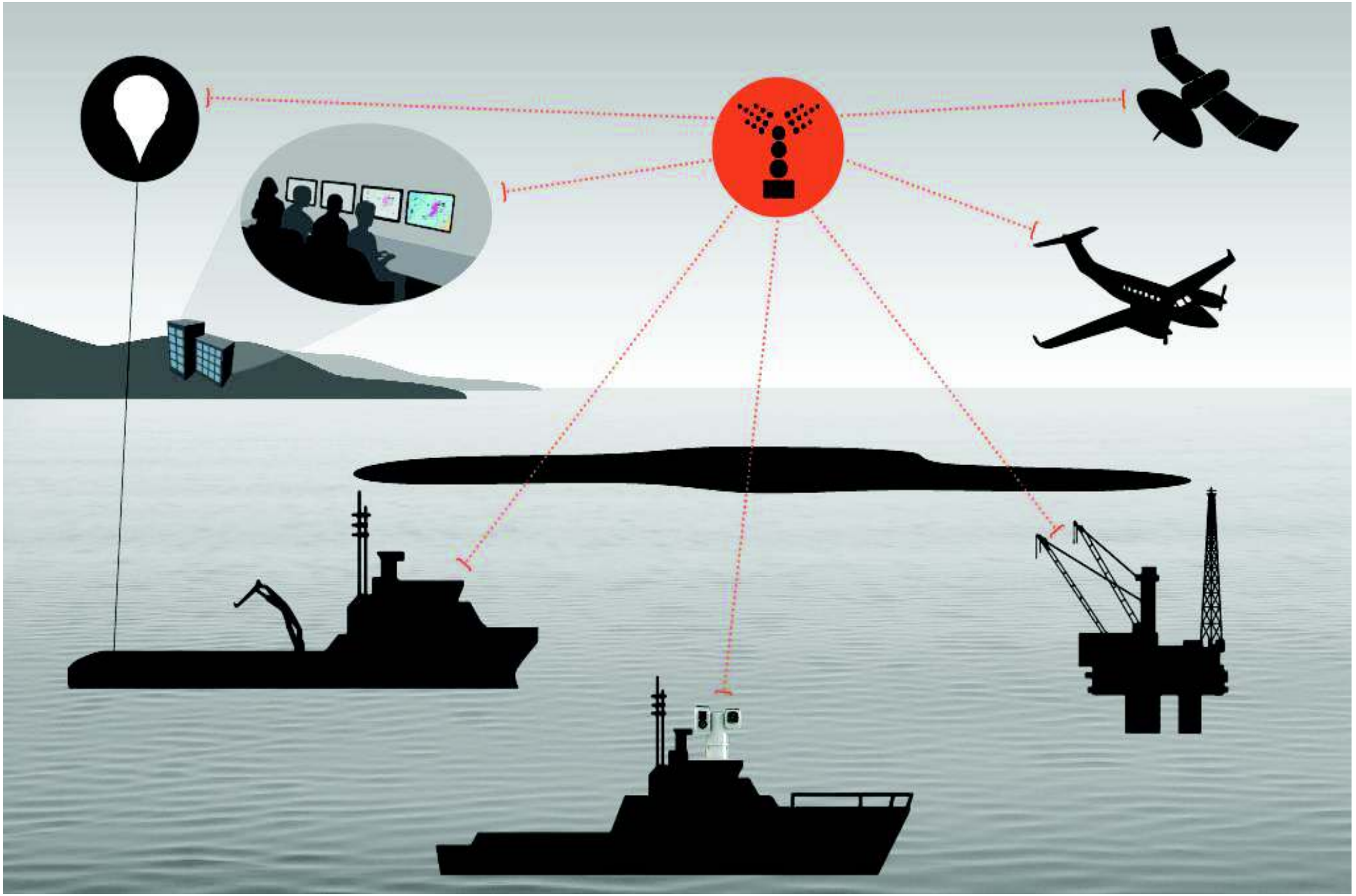
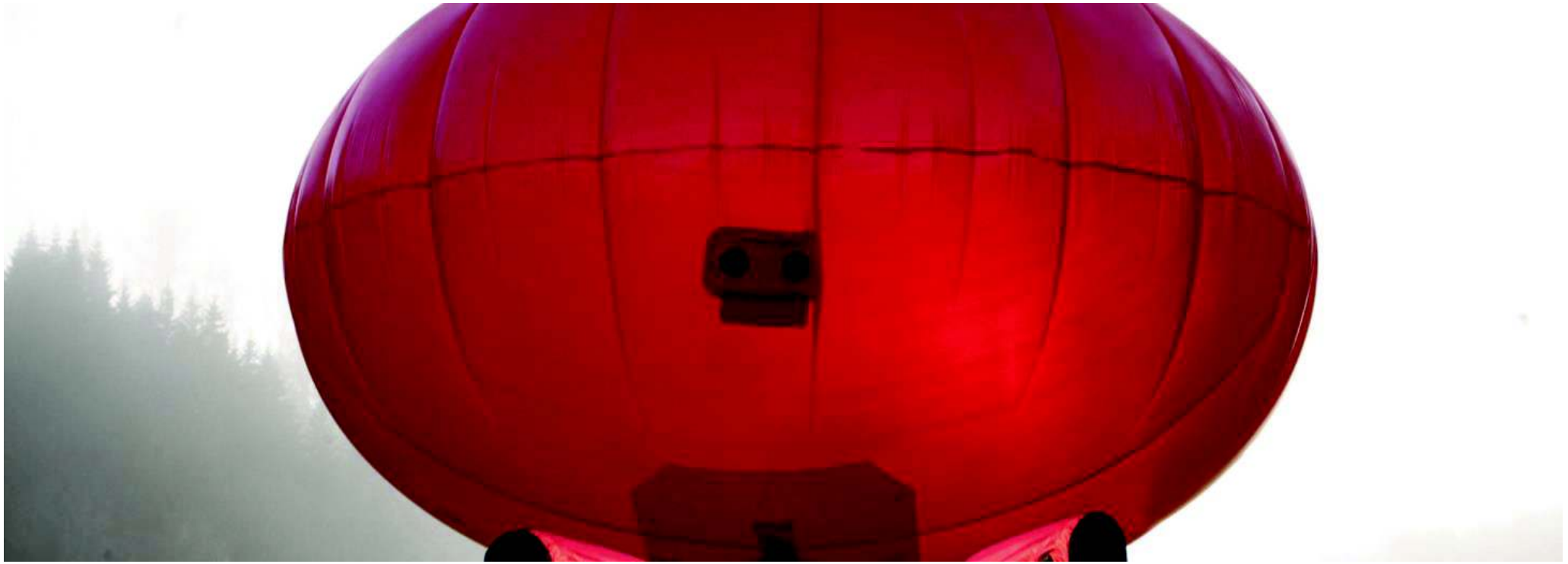
MARITIME
ROBOTICS



VALUE PROPOSITION

- Lower cost
  - Replaces aircraft or helicopter
  - Less complex systems
  - Requires little training
  - Accesible for the ship itself
  - Very deployable
  - Long endurance operations
- Improved HSE
  - No crew onboard
  - Night operations
  - Harsh weather operations
  - Smaller environmental footprint



THE FOLLOWING COMPANIES HAVE SUPPORTED THE OCEANEYE™ PRODUCT DEVELOPMENT

UNMANNED SURFACE VEHICLE

Bathymetry or seabed mapping

MR USV

- Proven USV technology platform in a projects with different customers/partners:
  - Specto Remote
  - Norwegian Navy
  - Norwegian Armed Forces
  - Current RnD project with the following partners:
    - NOFO
    - Norwegian Meteorological Institute
    - Insitute for Marine Research, Bergen, Norway
- USV PGS
  - Mariner 560 built and delivered in 2011
  - Petroleum Geo-Services (PGS)
    - One of the worlds three largest seismic survey companies
    - RnD platform for application experiments for improved efficiciency in seismic operations
- Patented technology
  - Formation control of multiple USVs
  - EU patent and US patent

Mariner 560

The Mariner 560 Unmanned Surface Vehicle (USV) is a multipurpose unmanned vehicle with hull and superstructure made of polyethylene. The vehicle is based on the successful PolarCirkel workboat that offers a very stable, unsinkable and near maintenance-free hull construction. The vehicle will fit into a standard 20 feet container for easy cargo shipping.

The Mariner 560 is equipped with a large payload room of more than one cubic meter and can be equipped with a variety of surface and sub-surface sensors/payload types such as: EO/IR camera, radars, oceanographic instruments, hydroacoustic positioning systems, echo sounders (single and multibeam) and sonar systems etc. The sub-surface sensors can be mounted through a 300mm moon-pool in the mid area of the craft, and an elevator mechanism for sinking and lowering the sensor under the hull can also be installed.

The Mariner 560 is delivered with an inboard diesel engine with waterjet propulsion. The standard diesel tank of 250 liter gives the Mariner 560 an endurance of more than 50 hours in typical survey speed.

The USV operator monitors the Mariner 560 and its installed payload from the Vehicle Control Station (VCS) which features electronic charts, engine and navigation info. The operator can monitor the surrounding sea areas from AIS and video information. Radar information will also be provided in future upgrades.

Mariner 560

Technical data:

Overall length:	5.85 m
Length hull:	5.60 m
Beam:	2.05 m
Draught:	0.4 m
Height:	2.05 m
Weight, empty:	1 700 kg
Max speed:	>30 knots
Max endurance:	50 hours+ (5 kts)

Engine and propulsion:

Standard engine:	Volvo Penta D3
Propulsion:	Hamilton 241 waterjet
Thrusters:	Bow thruster, proportional

Typical payload: EO/IR camera, radar, CTD, ADCP, HPR systems, echosounder (single/multibeam) and sonars

Modes of operation:

Manual control:	Handheld remote control or from Vehicle Control Station
Automatic control:	Waypoint/trajectory based sailplans controlled from Vehicle Control Station
Dynamic positioning:	Planned release in 2013
Formation control:	Planned release in 2013

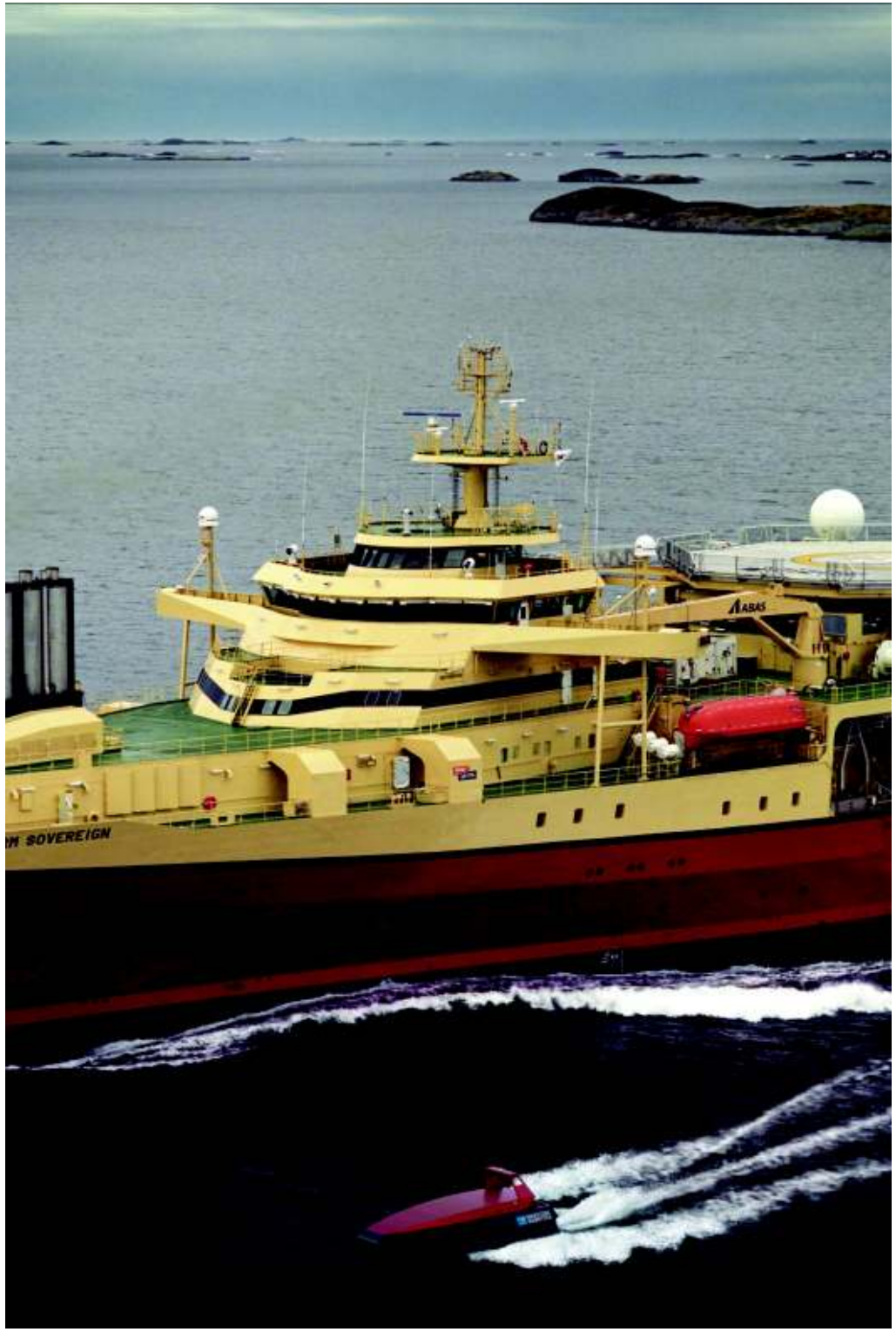
Other:

Typical range:	15 km (with conventional radio link)
Communication:	VHF/UHF radio (standard), GPRS/Iridium (option)

VEHICLE CONTROL STATION

CIVILIAN

- Geophysical surveying
  - Scouting in front of seismic vessel
  - Positioning and communication (hydroacoustic) with towed equipment and subsea equipment
  - CTD/ADCP profiling
- Environmental monitoring
  - Oil-spill concentration sensor
  - Algae control/ Chemical sensors
- Subsea suppport
  - ROV/AUV support (Positioning and Com)
  - HPR positioning
- Security related
  - Harbour patrol
  - Coastal/perimeter surveillance



MILITARY

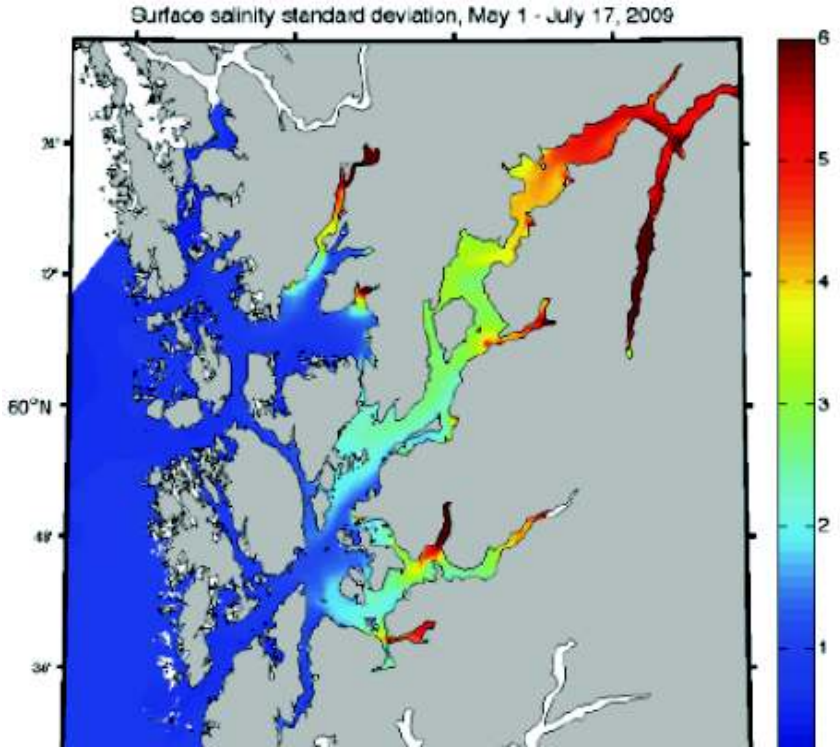
- Target training
  - Norwegian Navy technology trials
  - MR developed and demonstrated:
    - Target drone system
    - Miss-distance sensor system
  - Project canceled due to budget cuts

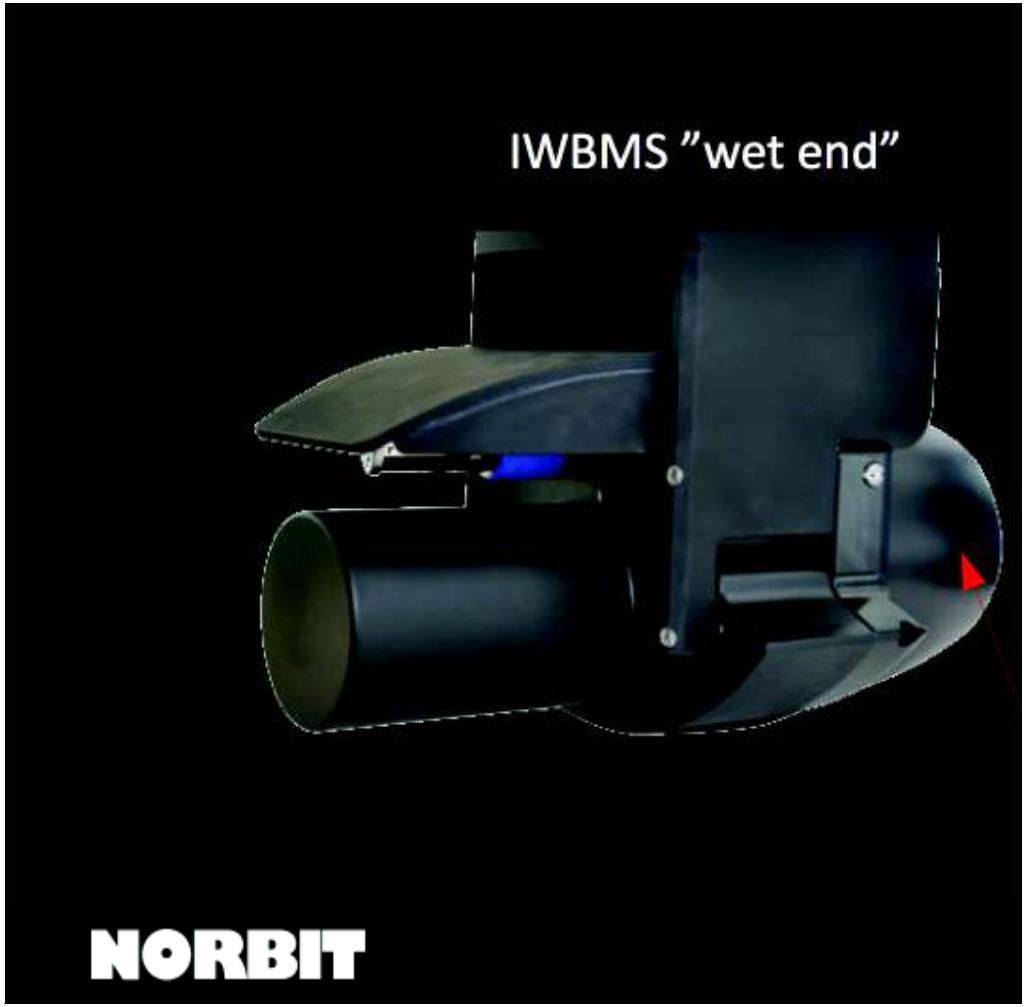
- Other military applications:
  - Mine countermeasures
  - Anti-submarine
  - Patrolling/Scouting/Surveillance
  - And more…

OCEANOGRAPHY AND ENVIRONMENTAL MONITORING

- Oceanography
  - Project partners
    - Institute for Marine Research, Bergen
    - Meteorological Institute, Bergen
  - MetOcean sensor packagerat
    - CTD (conductivity, temperature, density)
    - ADCP (acoustic doppler current profiler)
    - Weather station
    - Wave-measurement sensor

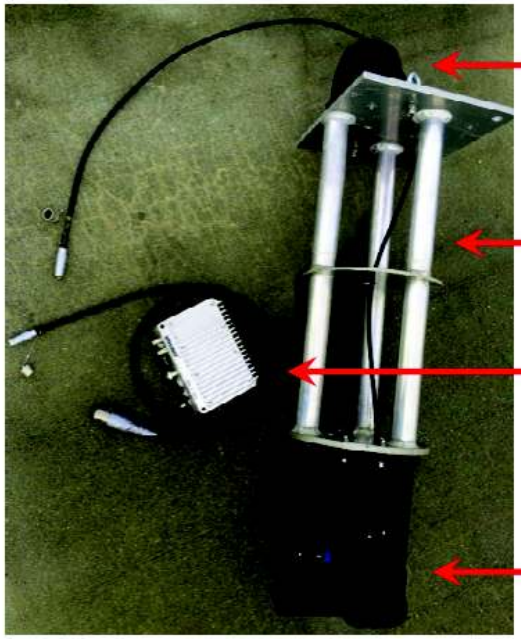
- Environmental monitoring/oil-spill
  - Project partner
    - Norwegian Clean Seas Association for Operating Companies (NOFO)
  - Sensors:
    - Fluorometer/oil-concentration sensor
    - OceanEye moored balloon system

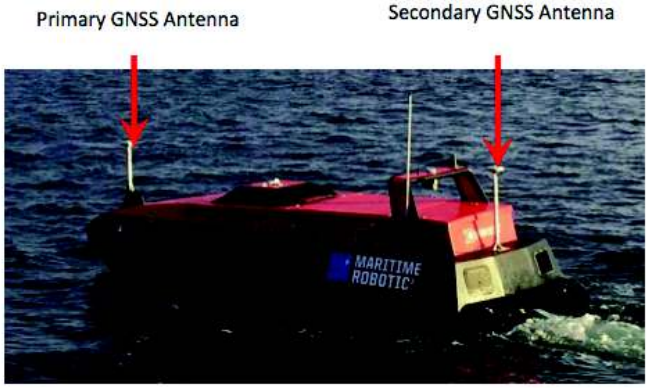




NCEI PROJECT 323836
Seabed mapping with unmanned surface vehicles

INTEGRATION OF USV AND SENSOR



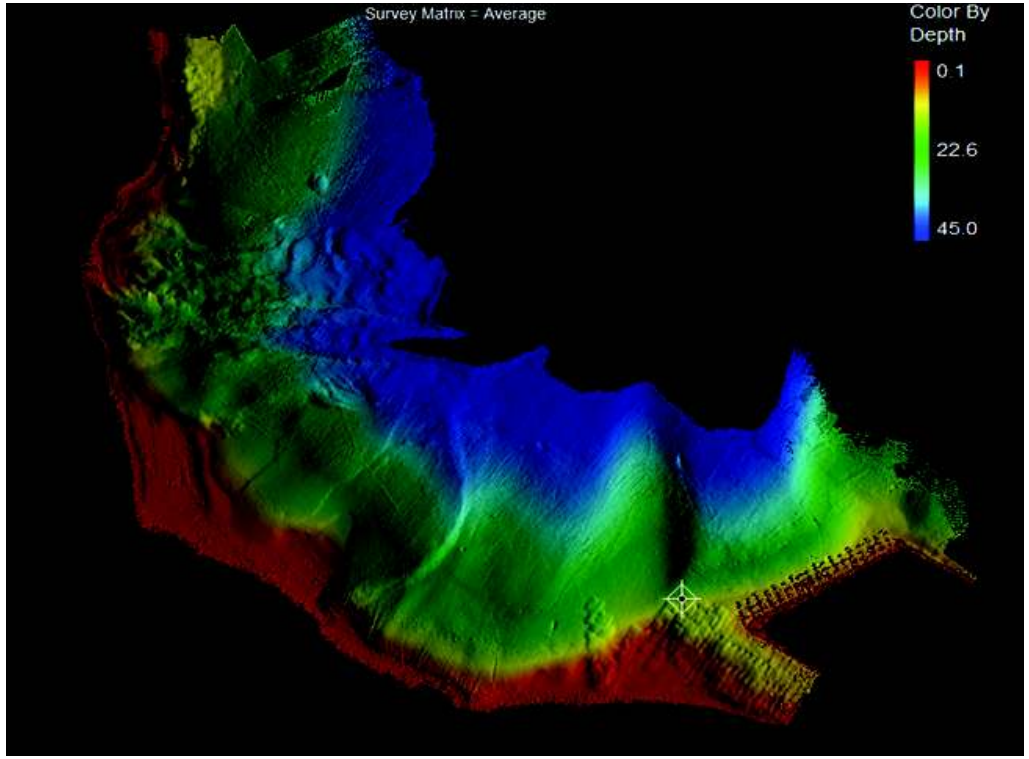


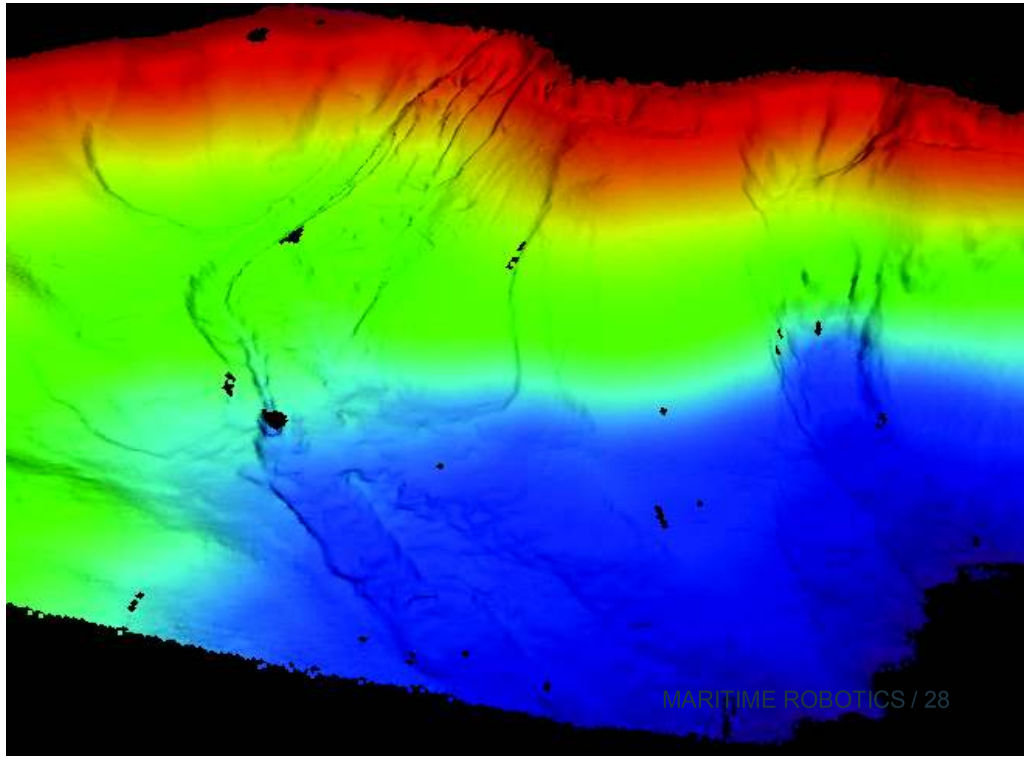
MARITIME ROBOTICS

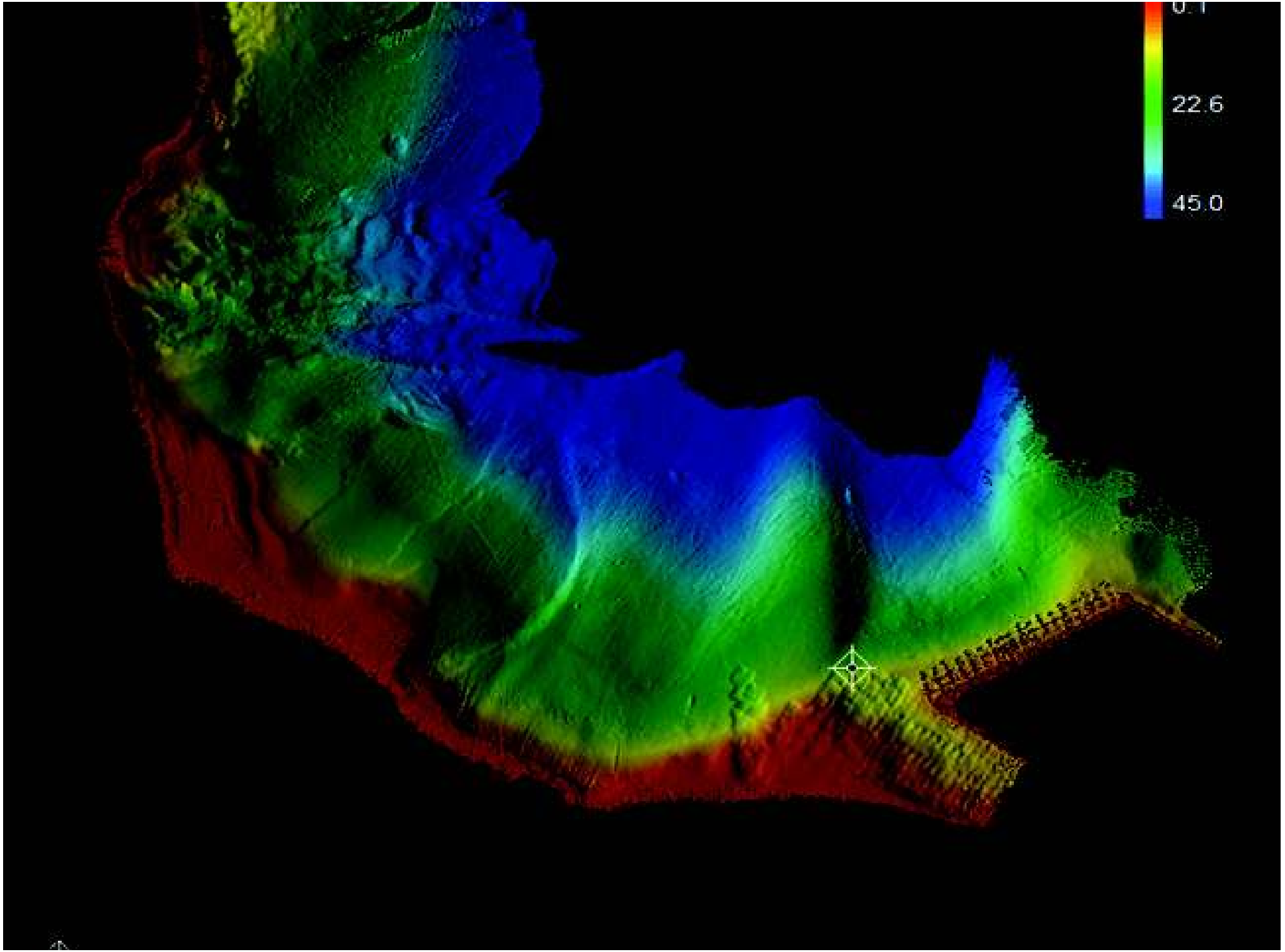
TEST SURVEY TRONDHEIMSFJORD WINTER 2014

- Project perfomed by
  - Seahorse Geomatics, US (Survey mngment)
  - Maritime Robotics (USV)
  - NORBIT Subsea (Multibeam echosounder)

- Main results:
  - Stable high quality data aquisition
  - Especially suitable for shallow water operations
  - Good potential for further development of commercial concept



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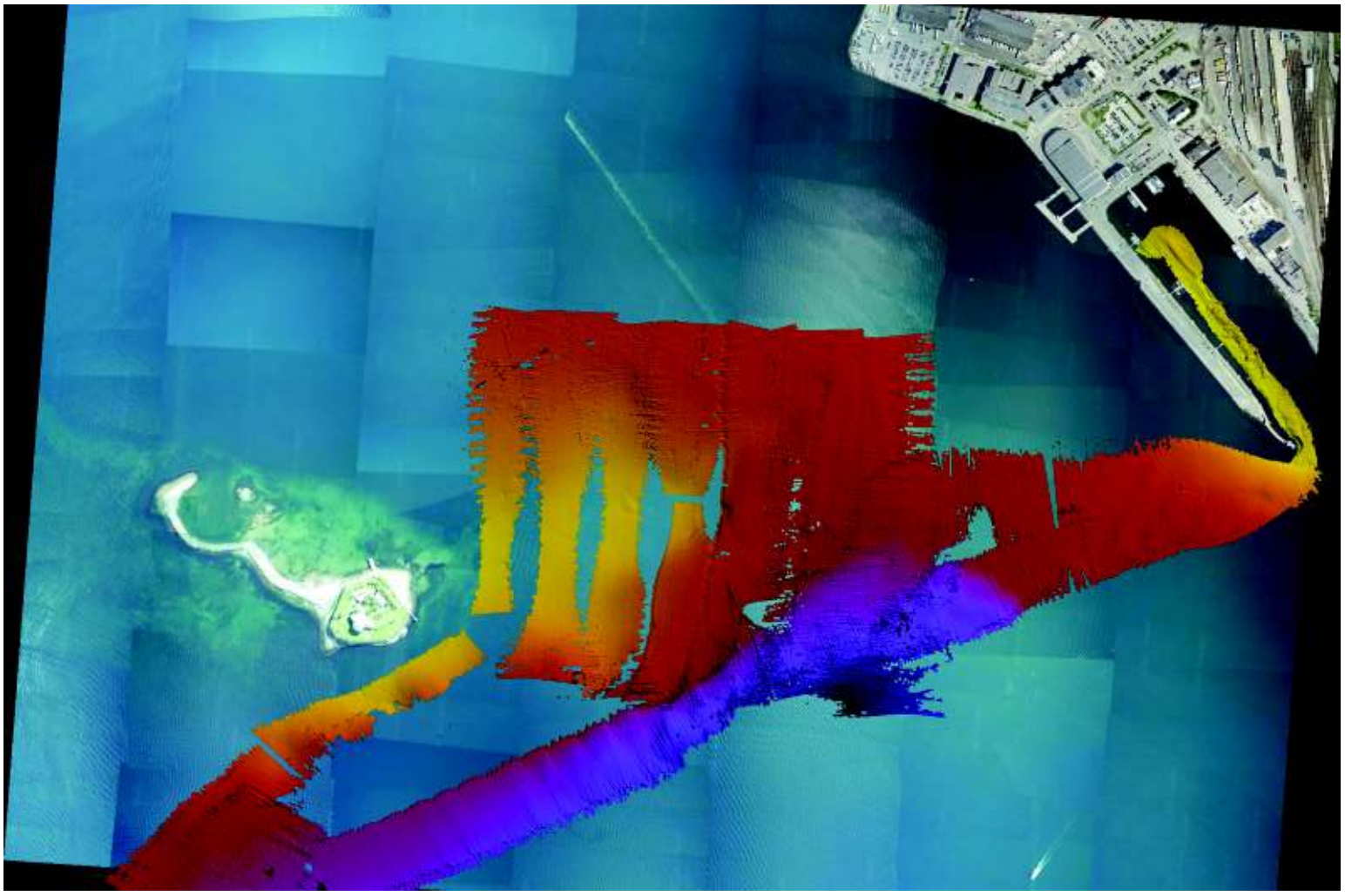
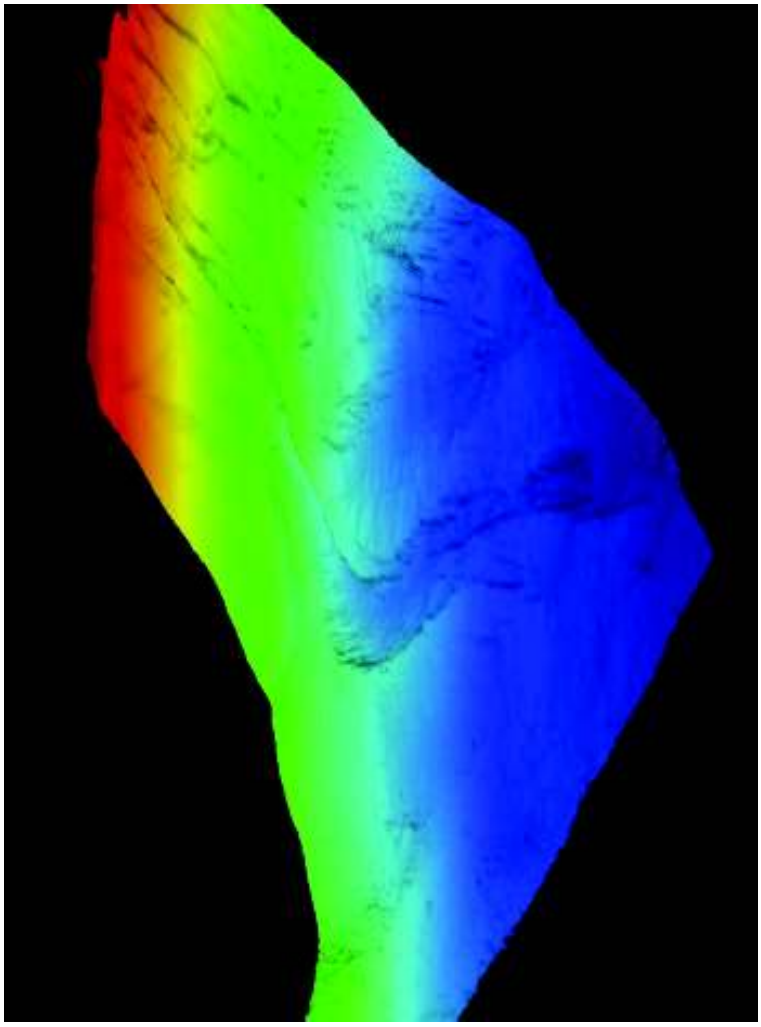
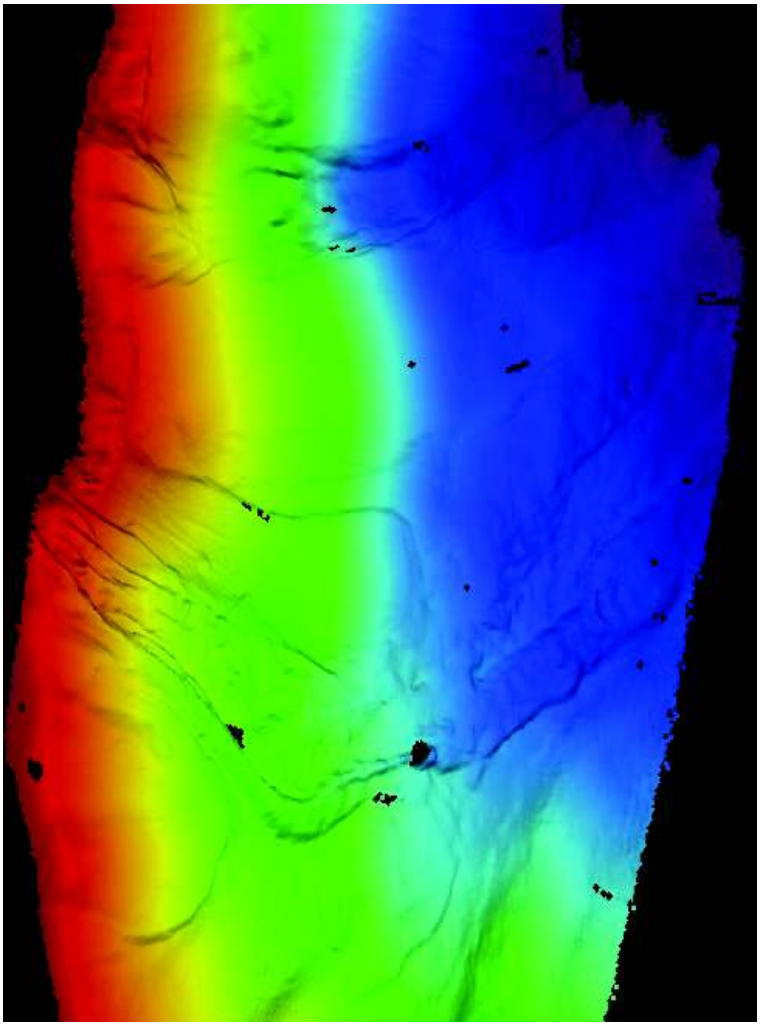
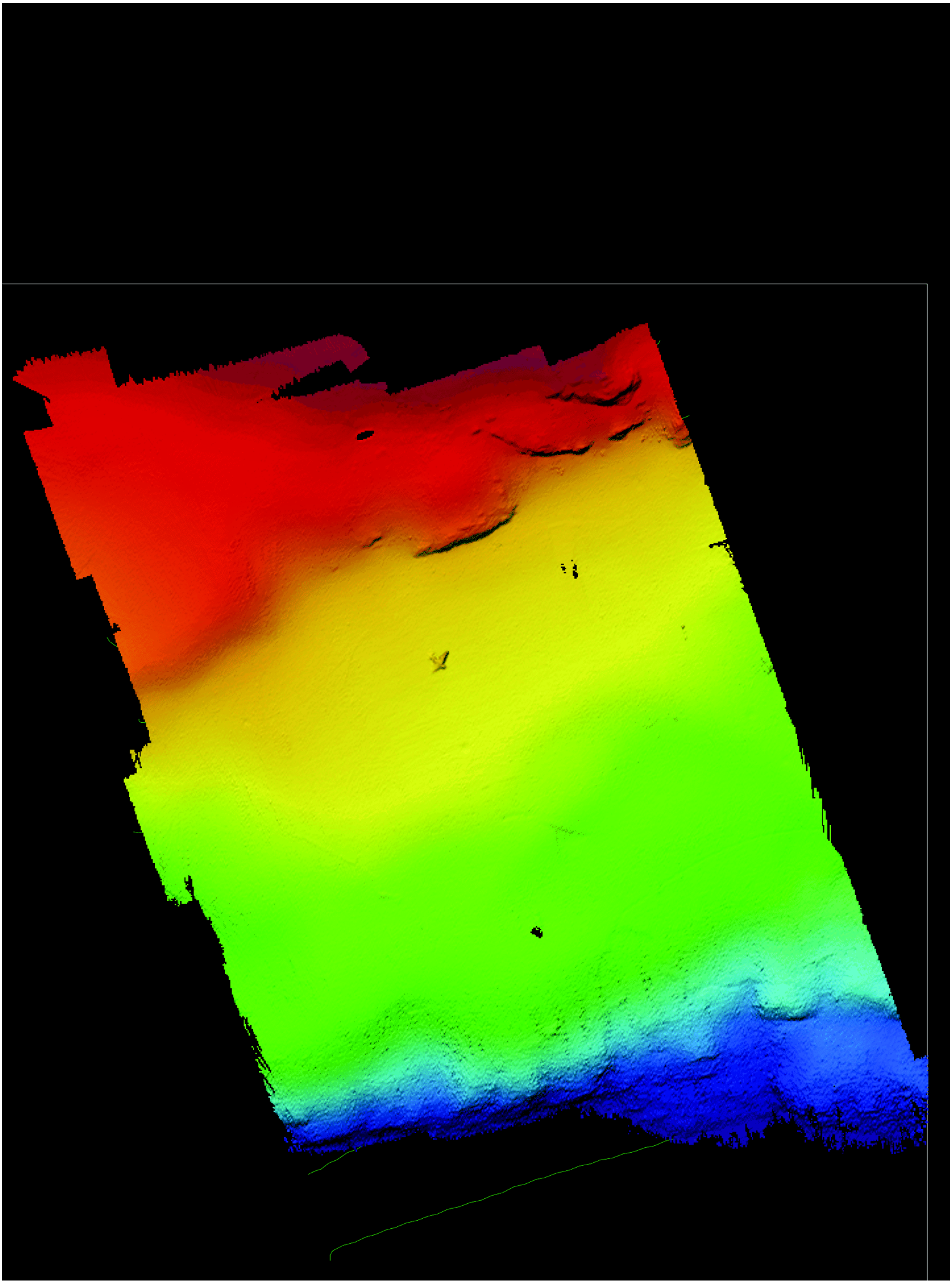
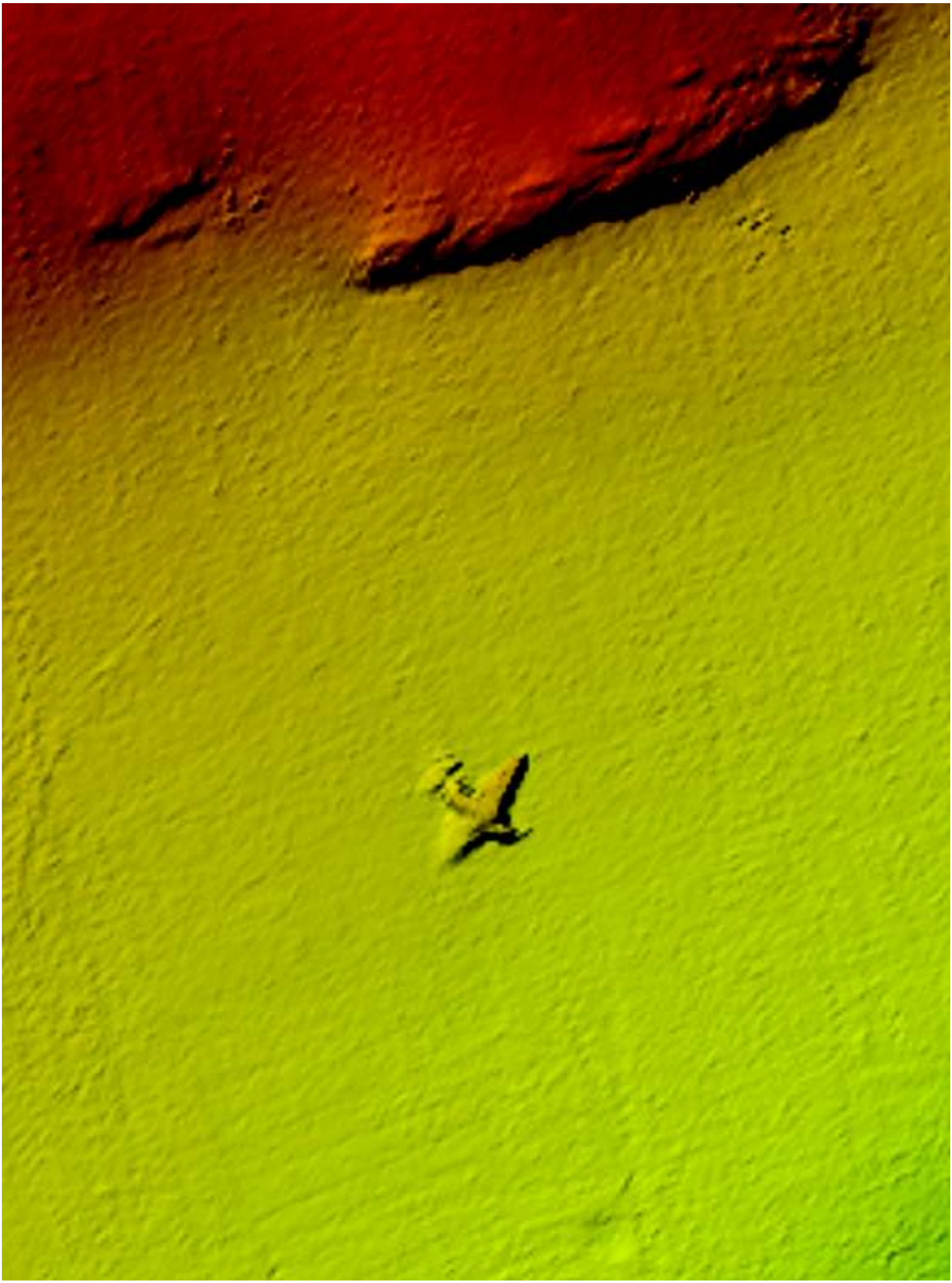


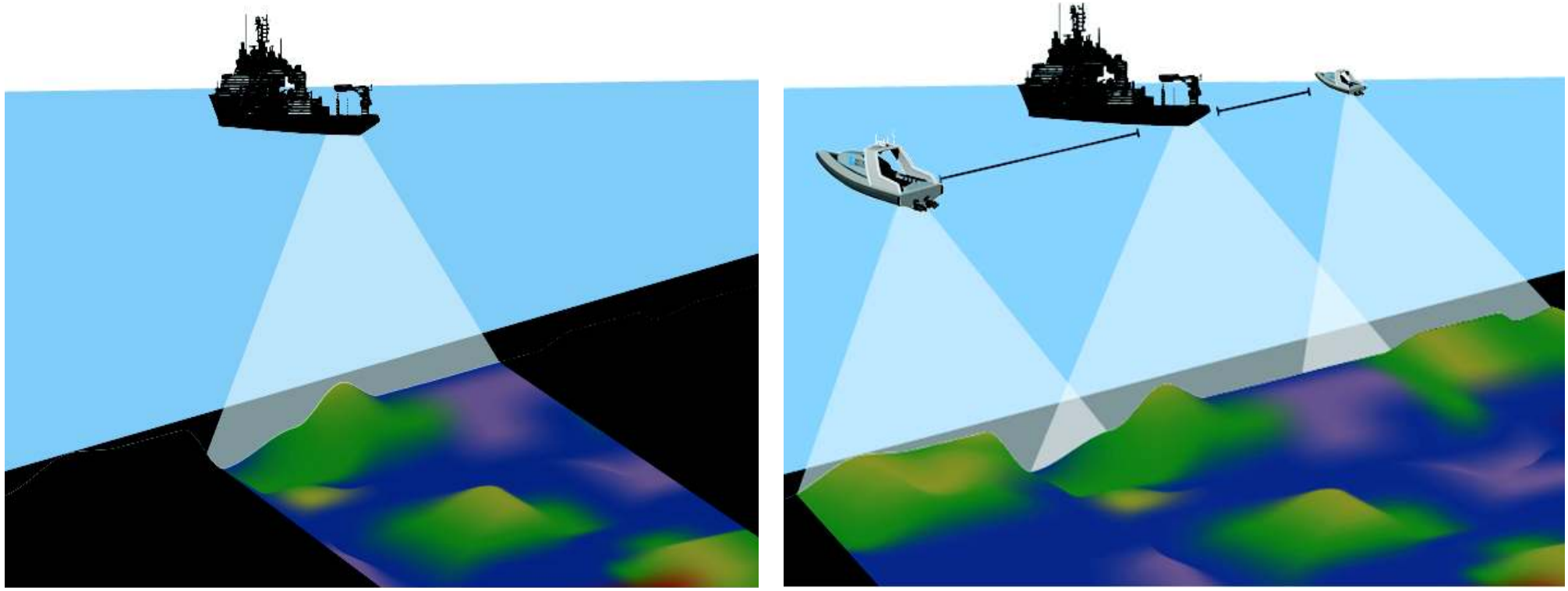








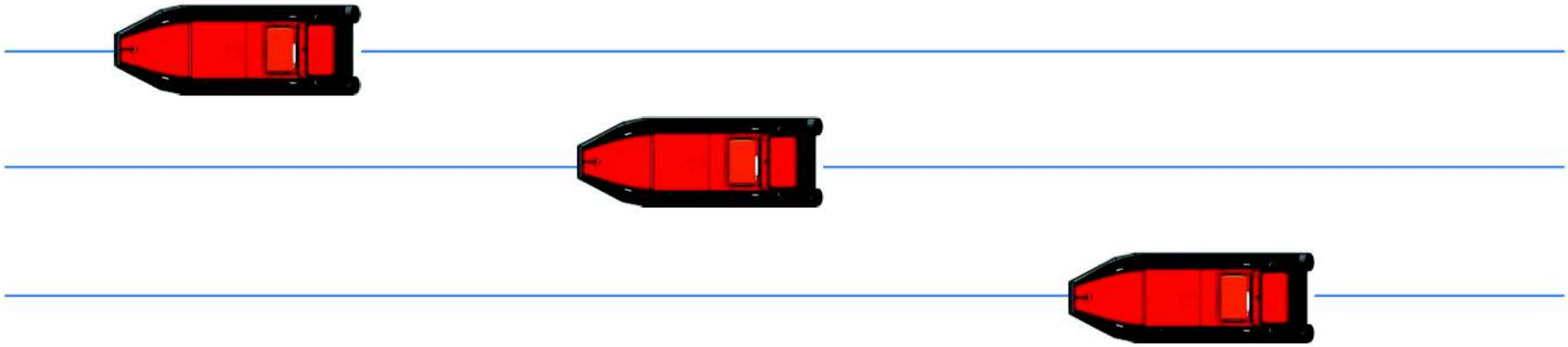
CASE STUDY – SEABED MAPPING



The capability of the main survey vessel has been augmented with a fleet of USVs, thus saving both time and money

VALUE PROPOSITION

- Lower cost
  - Mother ship can be aided by small USV
  - Potential for multivehicle operations
  - Long endurance missions
- Improved HSE
  - No crew onboard
  - Shallow water operations
  - Night operations
  - Smaller environmental footprint

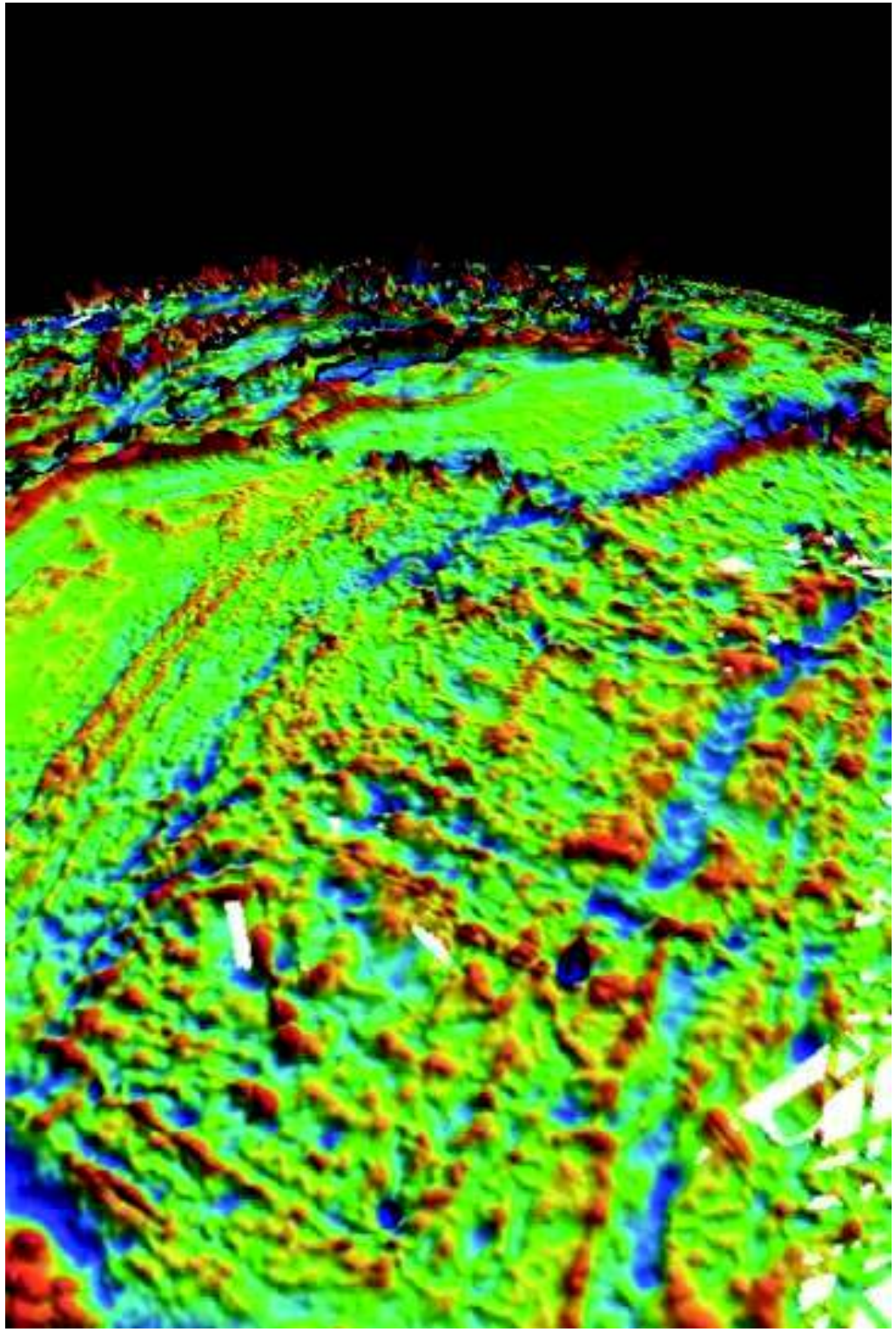


UNMANNED AIRCRAFT SYSTEM

Geological mapping of the earth

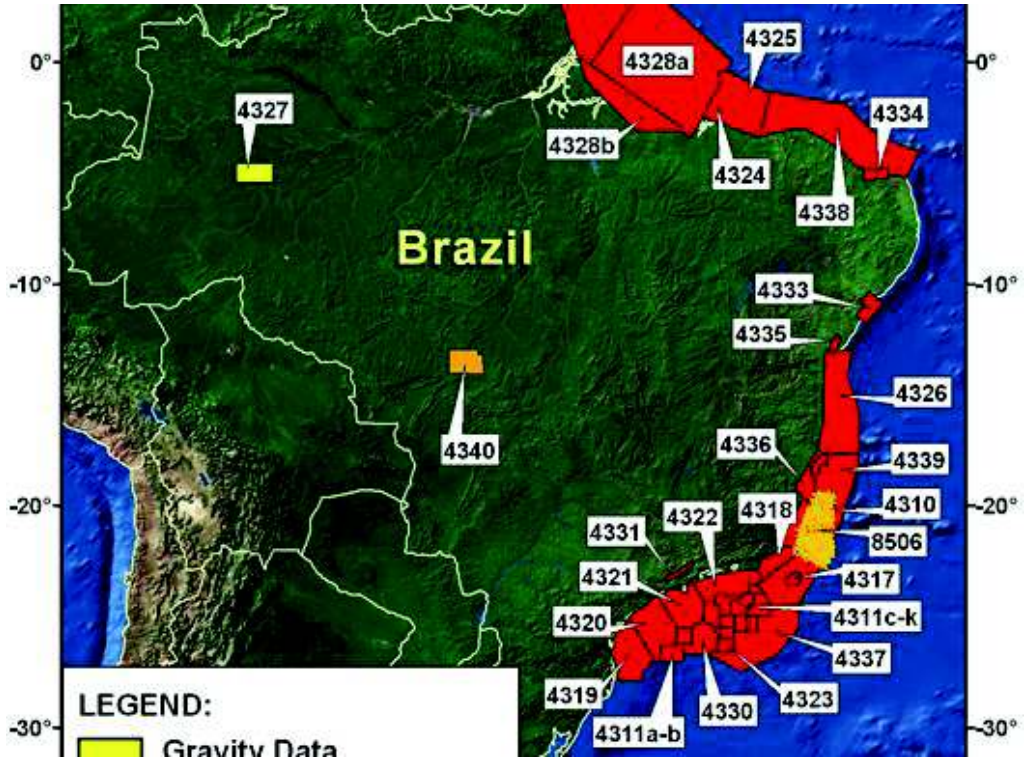
BACKGROUND

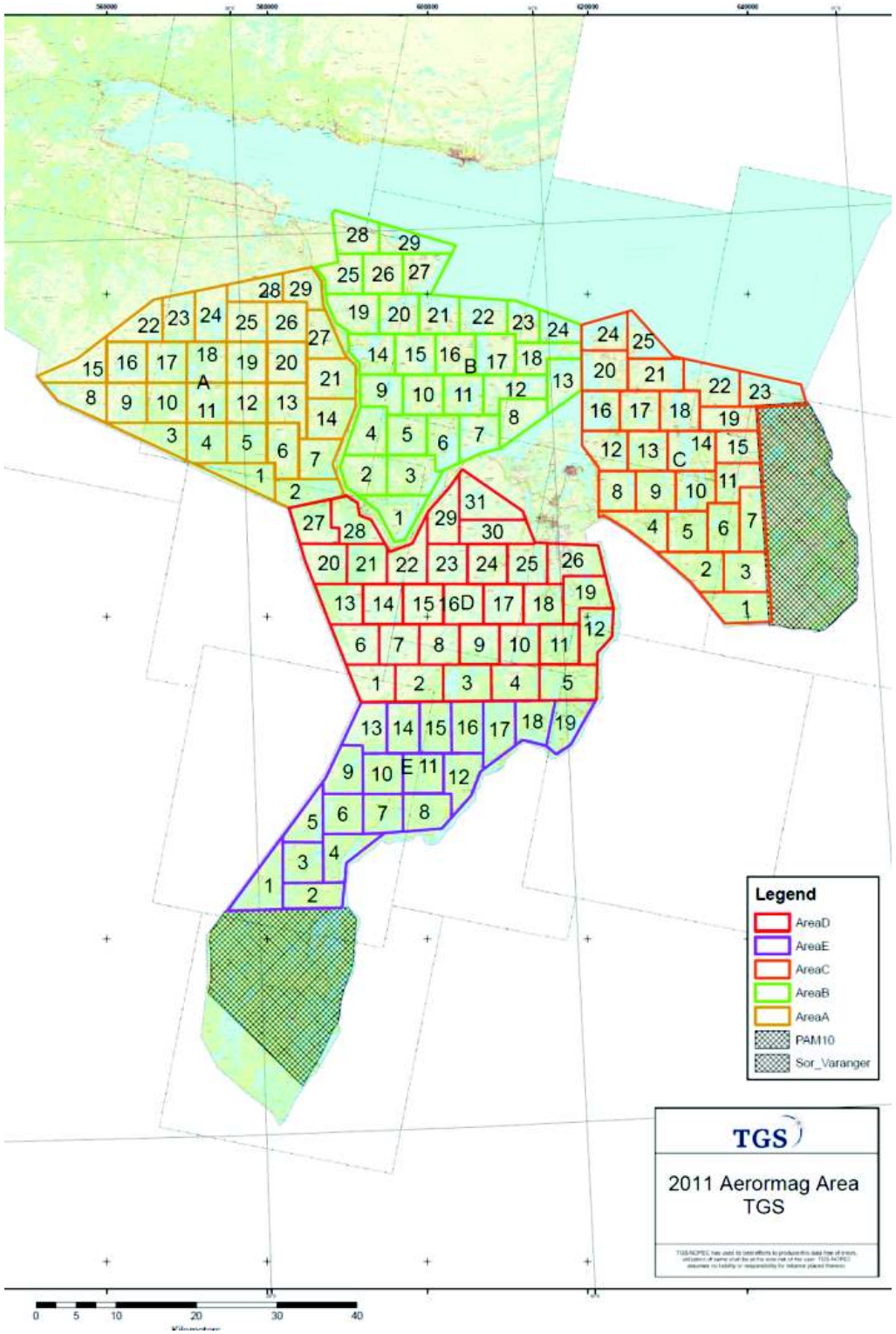
- An **aeromagnetic survey** is a common type of geophysical survey carried out using a magnetometer aboard an aircraft.
- The onboard magnetometer measures the magnetic strength at a point in space
- The principle is similar to a magnetic survey carried out with a hand-held magnetometer, but allows much larger areas of the Earth's surface to be covered quickly for regional reconnaissance.
- The aircraft typically flies in a grid-like pattern with height and line spacing determining the resolution of the data (and cost of the survey per unit area).



CIVILIAN MARKETS

- Surveying with airborne magnetometers has markets where there is a need to know the mineral content of the earth. Such as:
  - Mineral exploration
    - Magnetometric surveys can define magnetic anomalies which represent a mineral ore
    - Direct measurements of Iron, magnetite, hematite, kimberlite etc -> indirect indication for gold, diamonds etc.
  - Oil and gas exploration
    - Magnetic surveying can give additional information about the underlying geology and in some environments evidence of leakage from traps. Magnetometers are also used in oil exploration to show locations of geologic features that would make drilling impractical, and other features that give geophysicists a more complete picture.

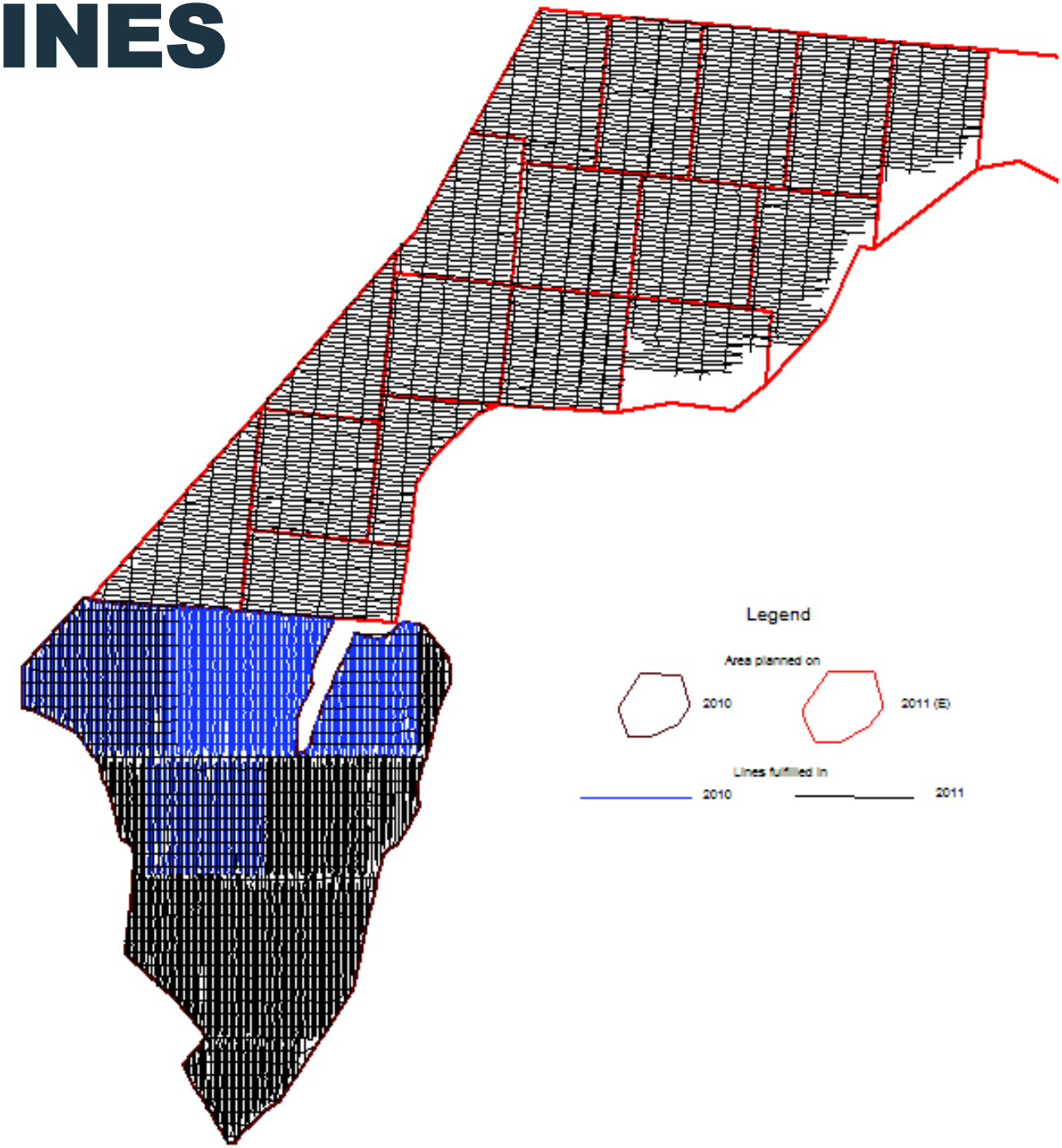




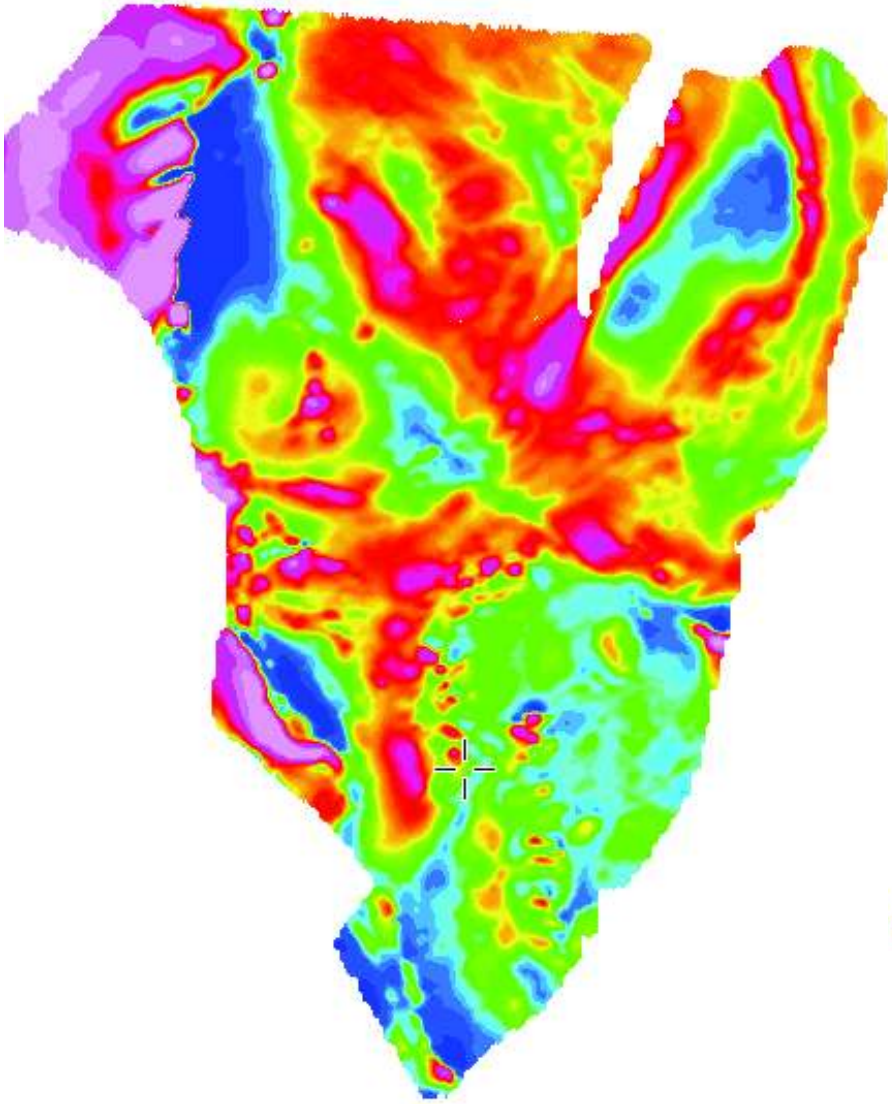
REFERENCE KIMBERLITT SURVEY 2010-2011

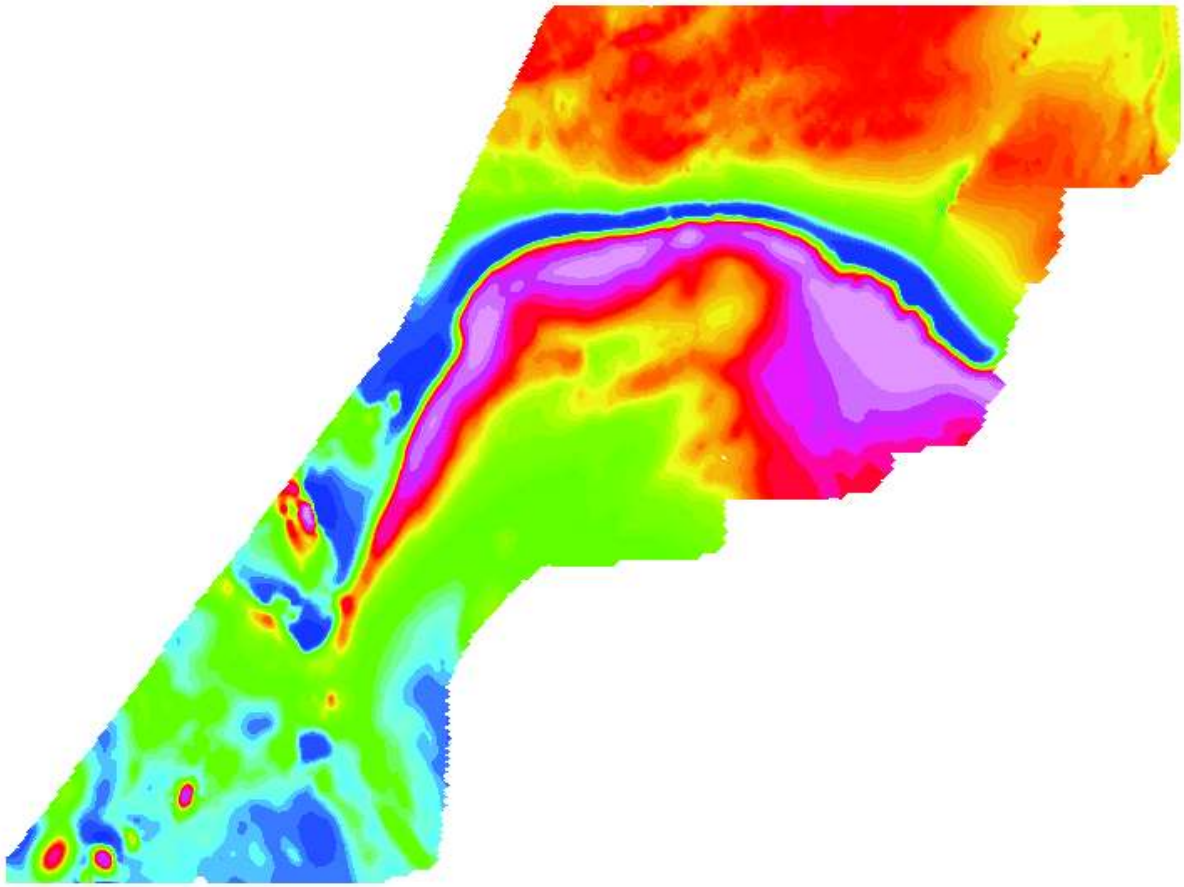
- East-Finmark, Norhern Norway
- Project-leader: TGS NOPEC ASA
- Results:
  - Customer claimed that the data provided was of very high resolution and good quality
  - Good anomaly mapping allows concentrated drilling / soil sampling
  - Client very pleased with data quality
  - Very positive feedback from the civil aviation authorities (CAA) involved in the project. (Norway, Finland and Russia)

SURVEY LINES



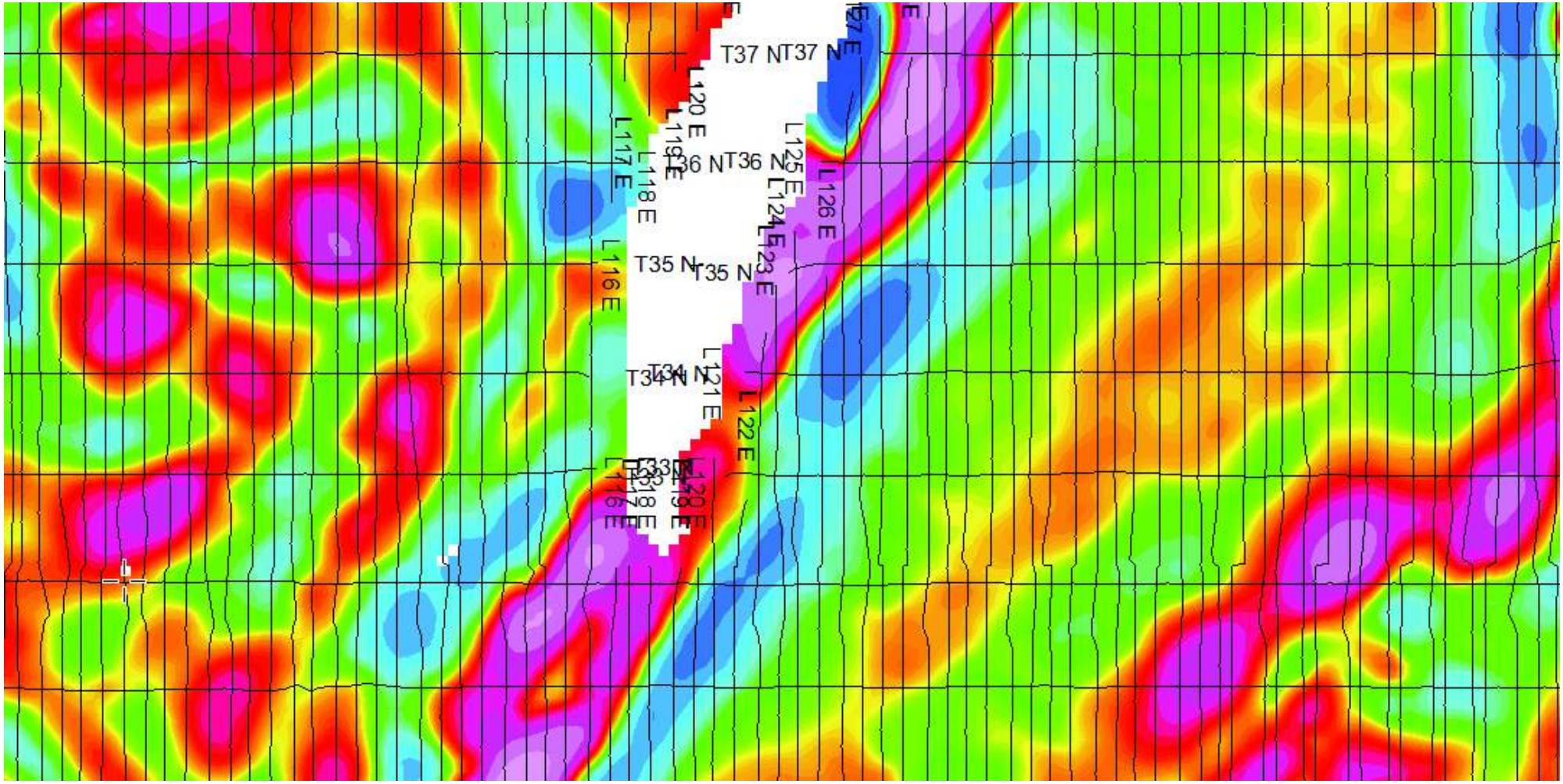
DATA EXAMPLES





MARITIME ROBOTICS

DATA EXAMPLES



MARITIME ROBOTICS

VALUE PROPOSITION

- Lower cost
  - Lower cost than manned aircraft or helicopter
  - Potential for multivehicle operations
  - Long endurance missions
  - Better data quality by being able to fly lower (<100m) and with lower speed
- Improved HSE
  - Better data quality by being able to fly lower (<100m) and with lower speed
  - No crew onboard
  - Night operations
  - Smaller environmental footprint

SOME THOUGHTS…

AERIAL AND SURFACE UNMANNED VEHICLE SYSTEMS

- Trends
  - Automatic umanned vehicles are booming
  - Real autonomous vehicles are still a research area
  - Legislations are maturing but is still among the greatest barrier for surface and aerial robotics
- Opportunities
  - A focus on operational performance more than on technology level (Service level)
  - Small niche players focusing on cost effective, flexible and safe data aquisition (with unmanned vehicles)

RND CHALLENGES

SEEN FROM OUR PERSPECTIVE

- Legislations
  - A formal and psychological barrier
  - Include regulating agencies in RnD projects
- Concepts of operation
  - Crew qualification and training
  - Crew set-up for long endurance operations
- ”Sense-and-avoid”
  - What is required??
  - What can we provide??
- Communication
  - Communication is the main barrier for long distance operation (availability, robustness and/or price)
- Environmental adaption
  - Robust propulsion systems
  - Robot surfaces (icing, fouling)

THANK YOU FOR YOUR ATTENTION

MARITIME ROBOTICS

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