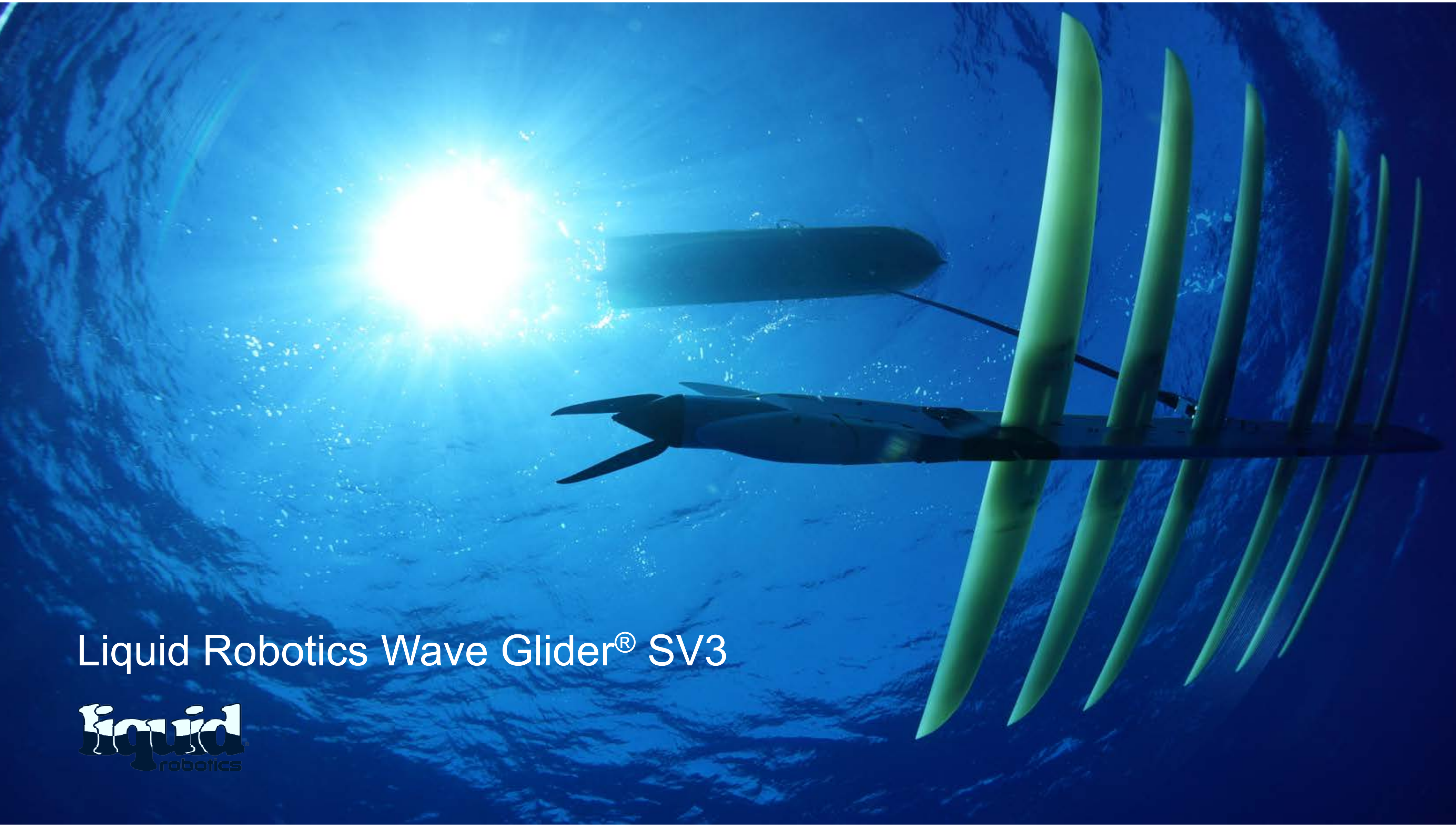
A Demonstration of Autonomous Survey with a Shallow water Multibeam and Near Real-Time Processing

Reducing Risk and Expanding the Operational Window

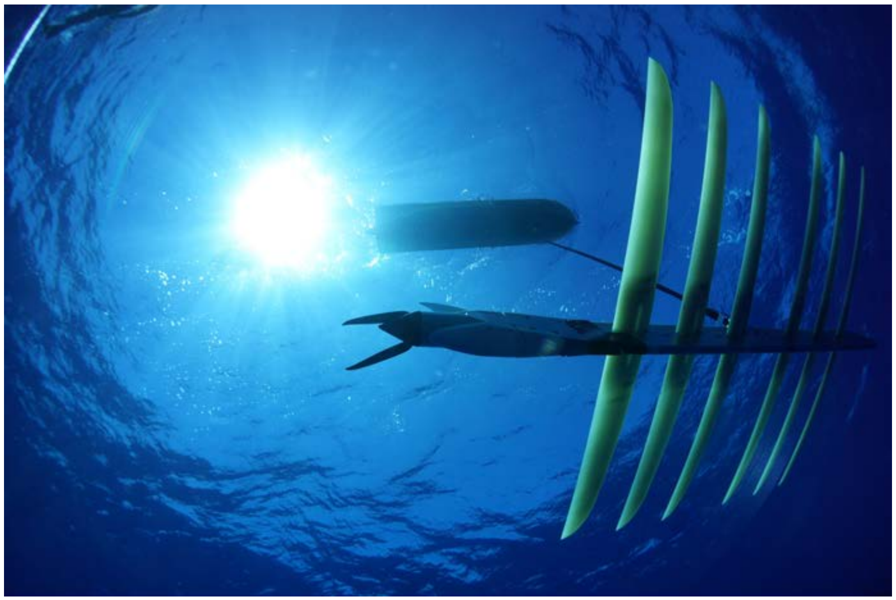
Advantages of Autonomous Operation

- **Safety**
  - No surveyors in the field
  - Reduced vessel count
- **Cost**
  - Lower fuel cost
  - Lower victualling cost
  - Lower personnel cost
- **Efficiency**
  - Fewer surveyors per sonar


Liquid Robotics Wave Glider® SV3

Wave Glider® SV3

World's first wave and solar propelled ocean robot



- No fuel, no manpower, no emissions
- Long duration missions – 1yr.+ at sea
- Onboard computational power for in-situ processing
- Real time communications
- Intelligent Autonomy

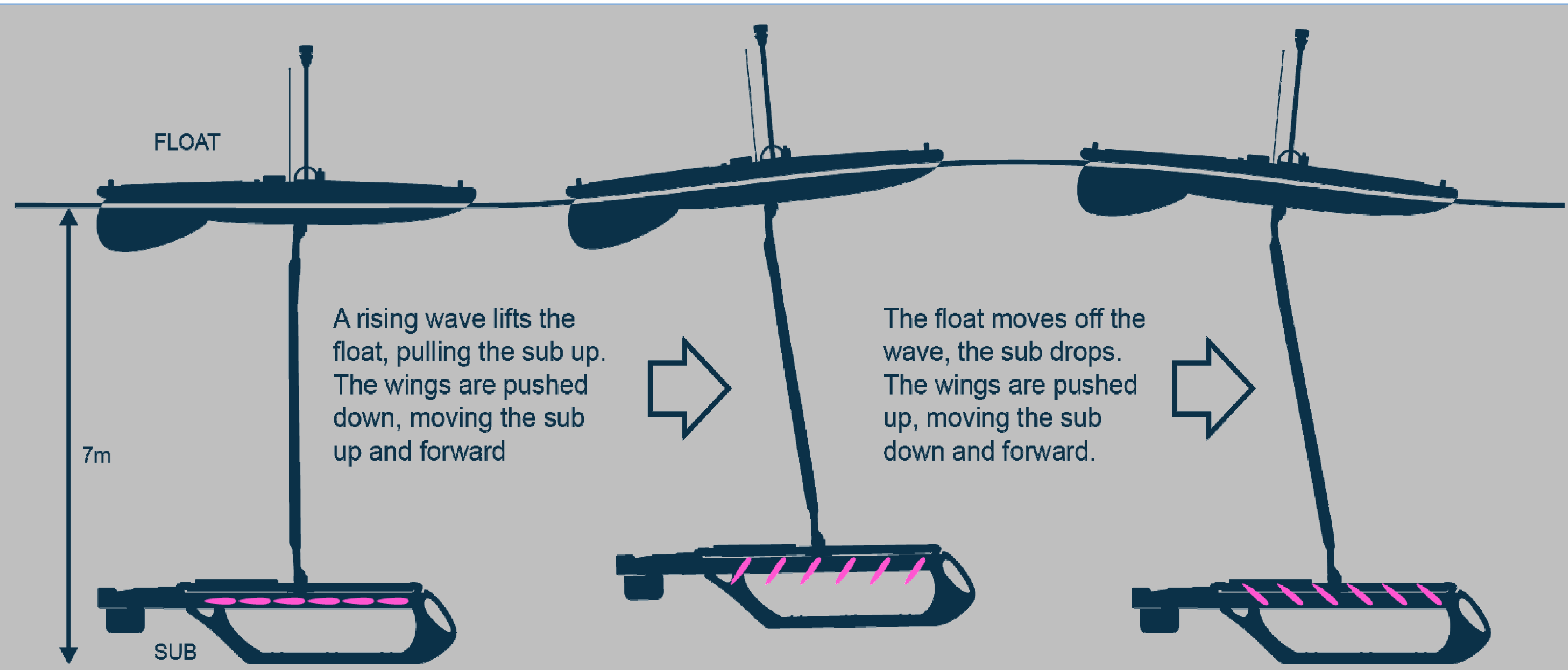
Wave Glider SV3 Core Components

Wave and Solar energy harvesting system

Solar power for computing, communications & sensor payloads

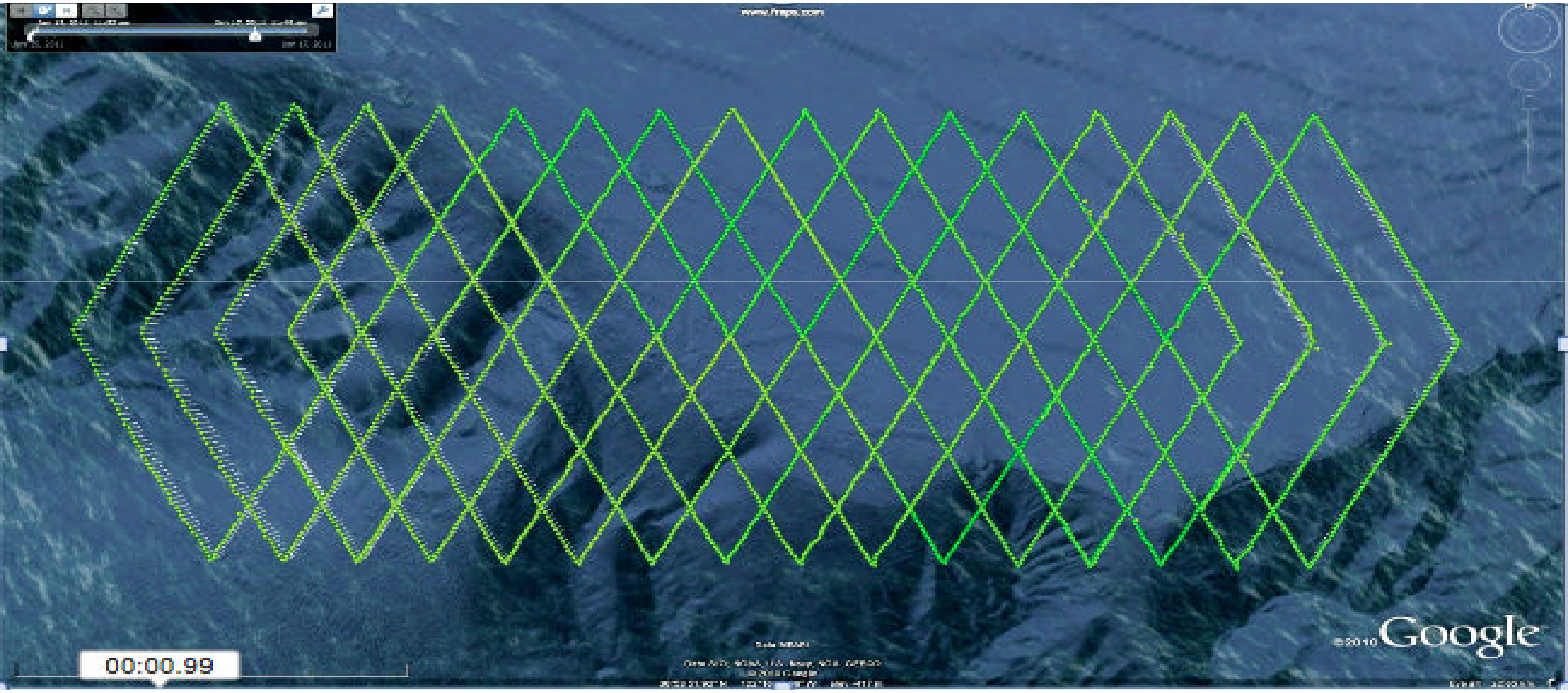
- **Wave Powered Sub**
  Wing system converts wave energy into forward thrust
- **Hydrodynamic Float**
  Modular design for maximum payload & solar collection capacity
- **High speed Umbilical**
  High power connection between the Float and Sub
- **Adaptable Modular Power system (AMPS)**
  Advanced power system with large rechargeable battery capacity
- **Solar Powered Auxiliary Thruster**
  For thrust and burst speed thru doldrums and high currents
- **Computational Power**
  On-board processing power and cloud computing environment

How It Works



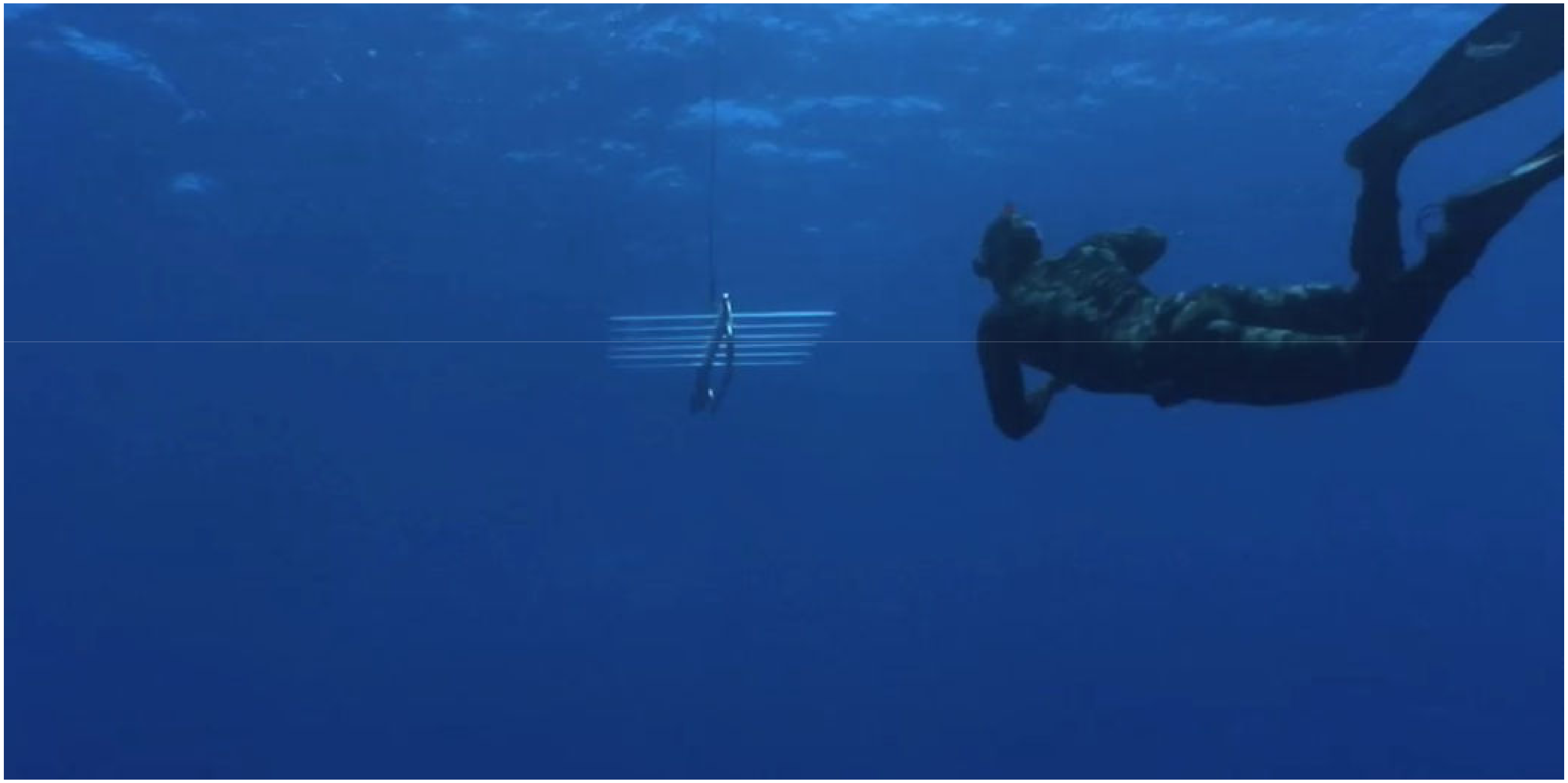
5 U.S. and 14 foreign patents issued. 10 U.S. Provisional applications, 33 foreign applications.

Precision Navigation

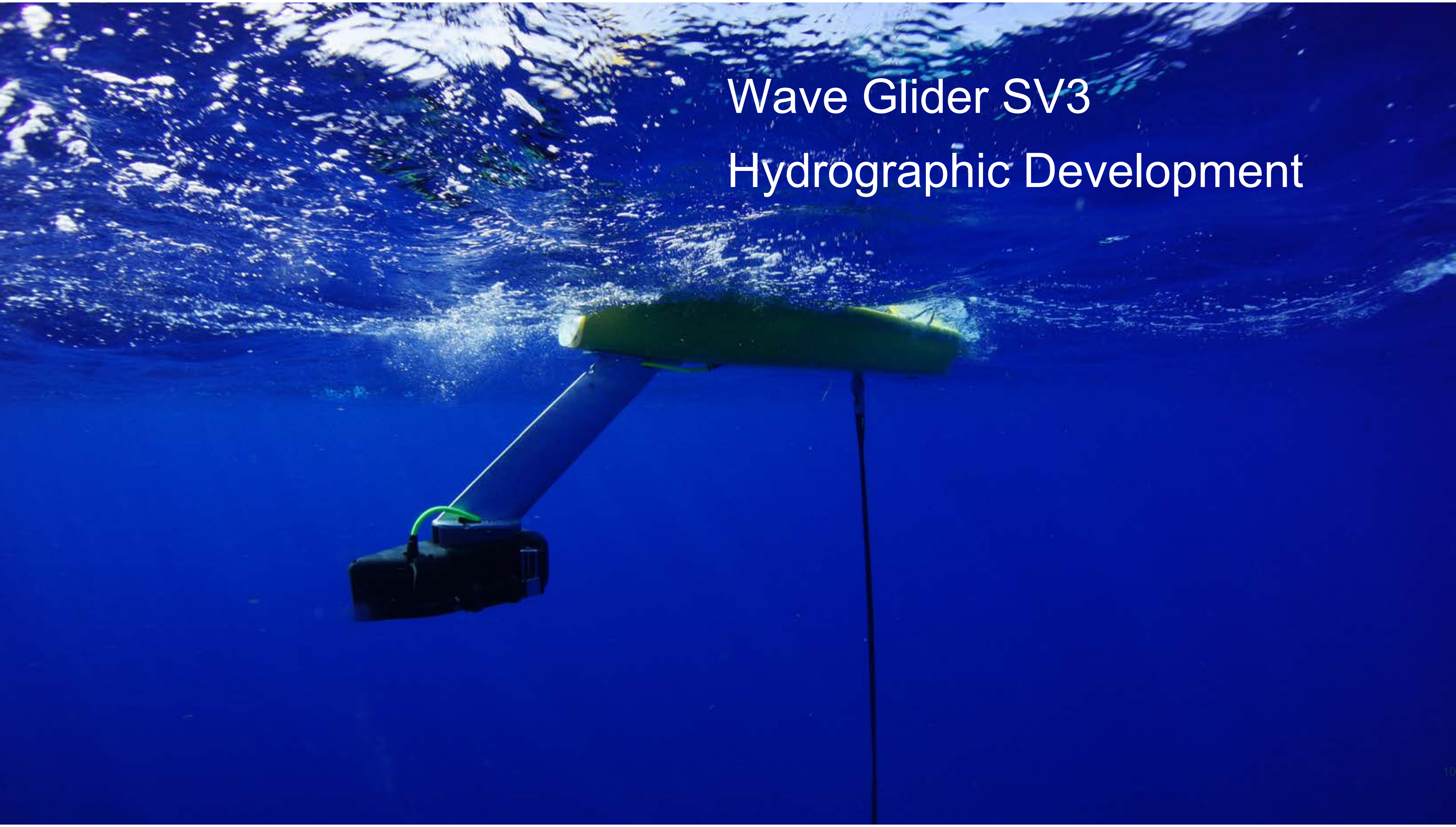


Ease of Launch & Recovery

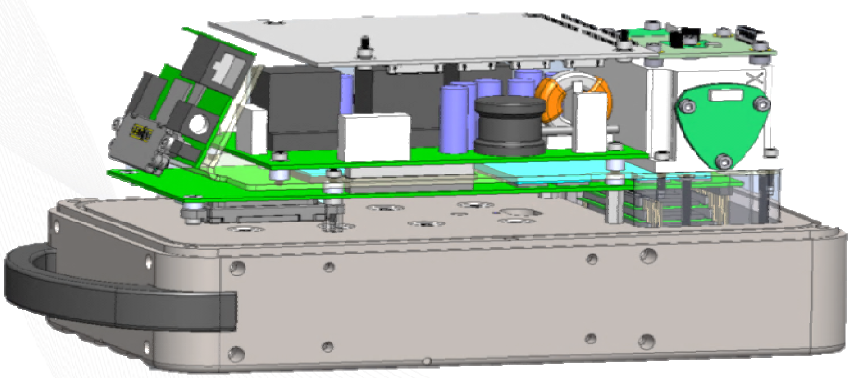
The Wave Glider in Action



Wave Glider SV3
Hydrographic Development

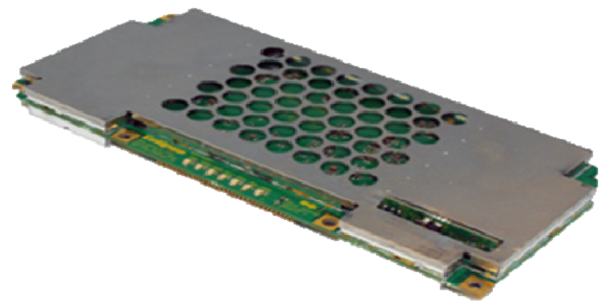


Integrated SVP

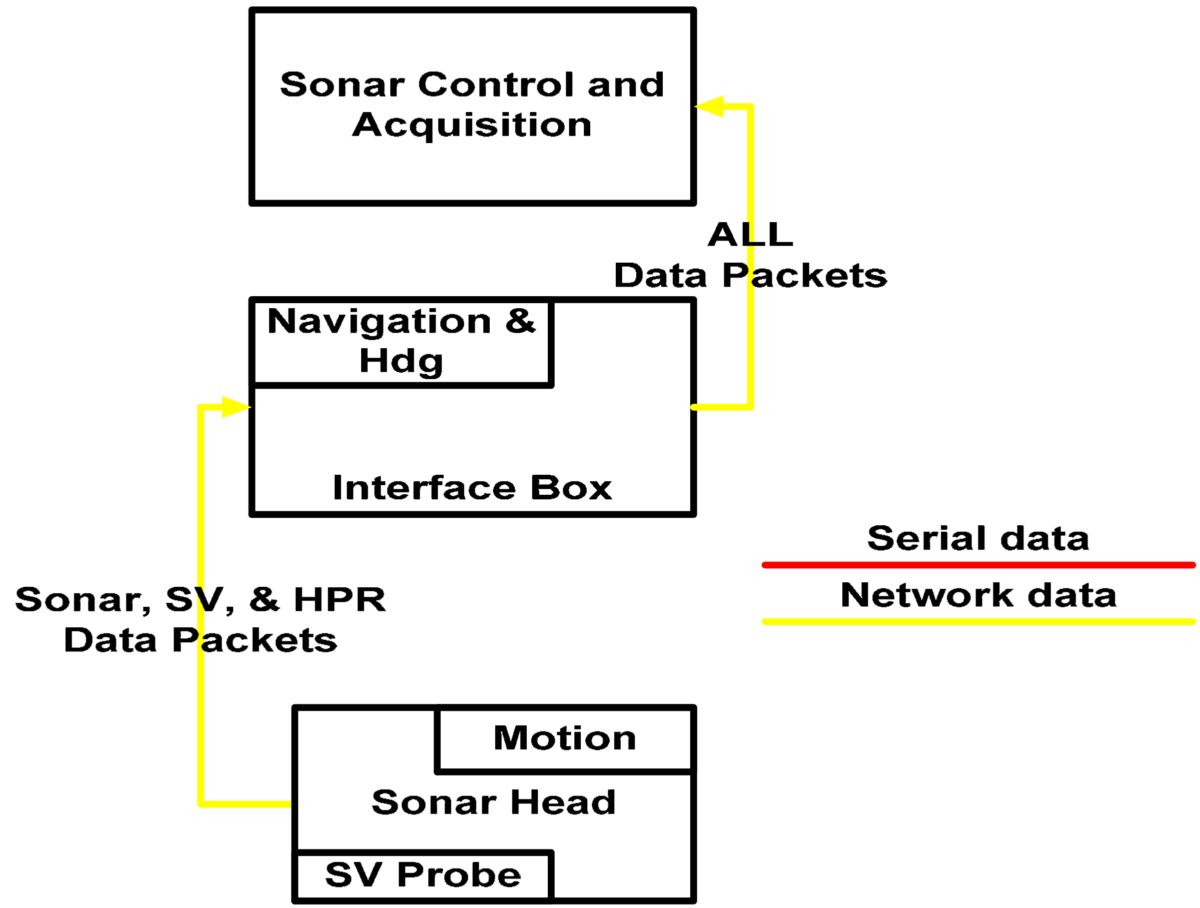


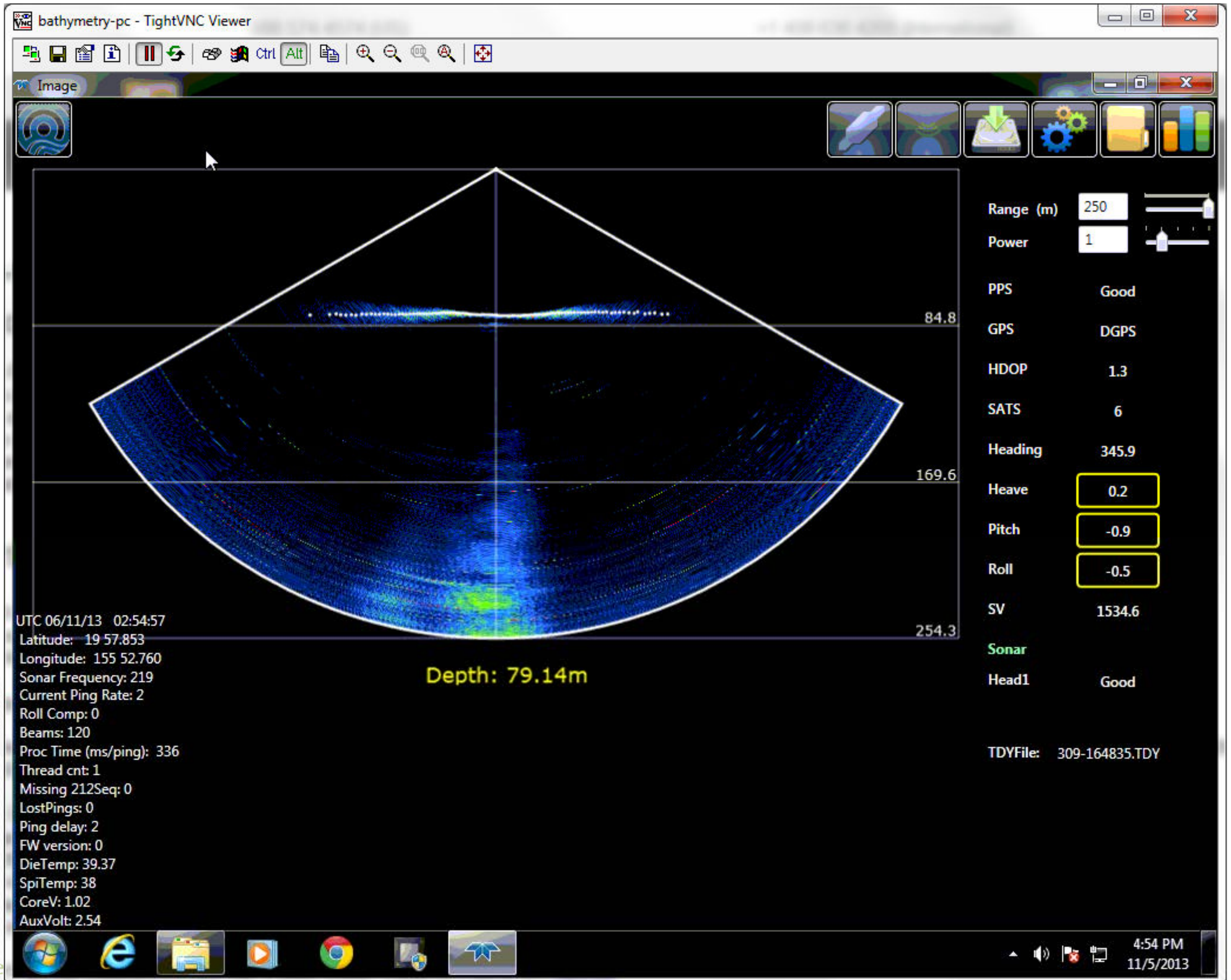
Integrated Motion

Integrated GPS/Heading



MB1 Integrated System





a teledyne marine

presented by

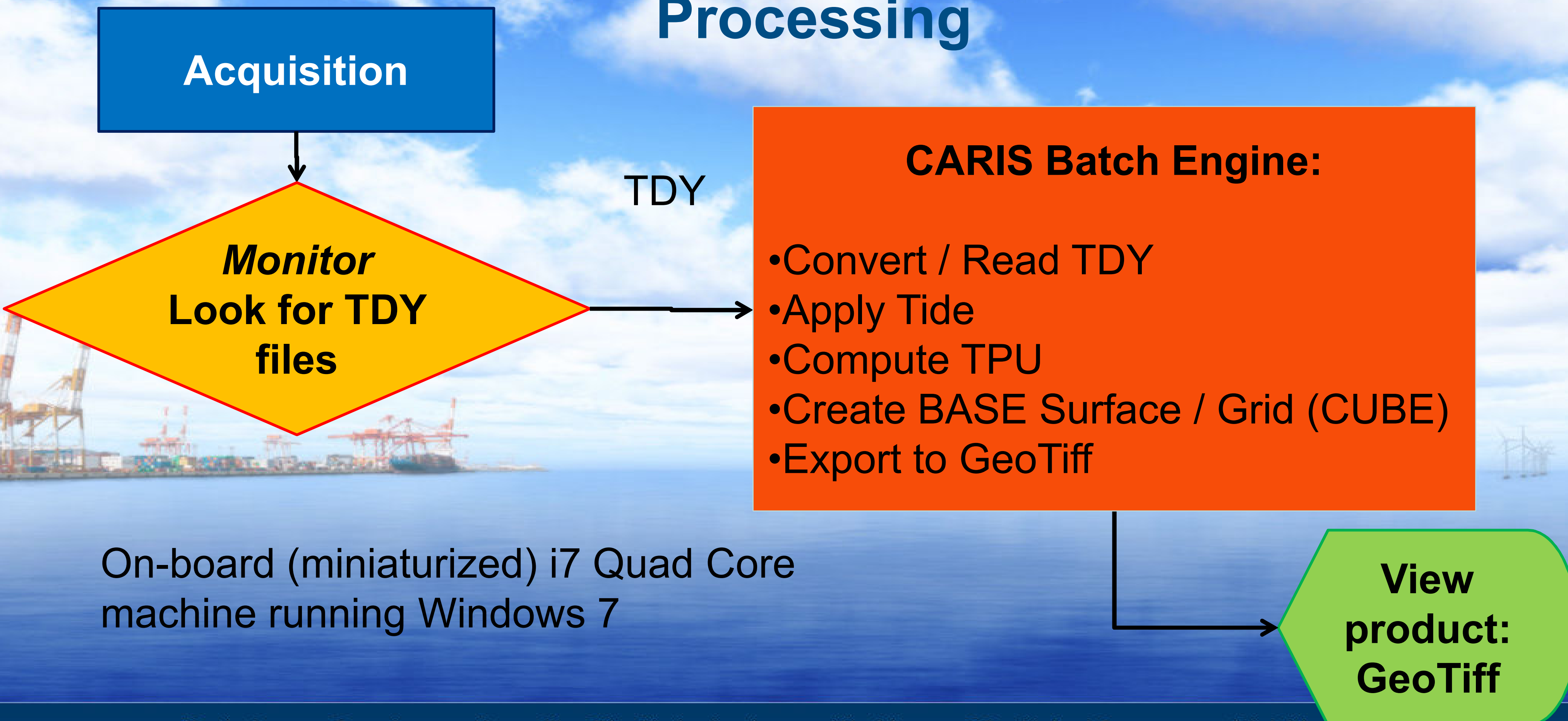
TELEDYNE ODOM HYDROGRAPHIC Everywhereyoulook™

CARIS Workflow

- Create Vessel File
  - Enter lever arm measurements
  - Supply device model for MB1
  - Build model for Total Propagated Uncertainty
- Create Project
- Raw data conversion
- Apply correctors
  - Load Tide
- Georeference data – Merge Process
- Optionally compute Total Propagated Uncertainty
- Create BASE Surface using CUBE algorithm
- Export to raster format, GeoTiff

On Board

CARIS HIPS & SIPS Automated Processing



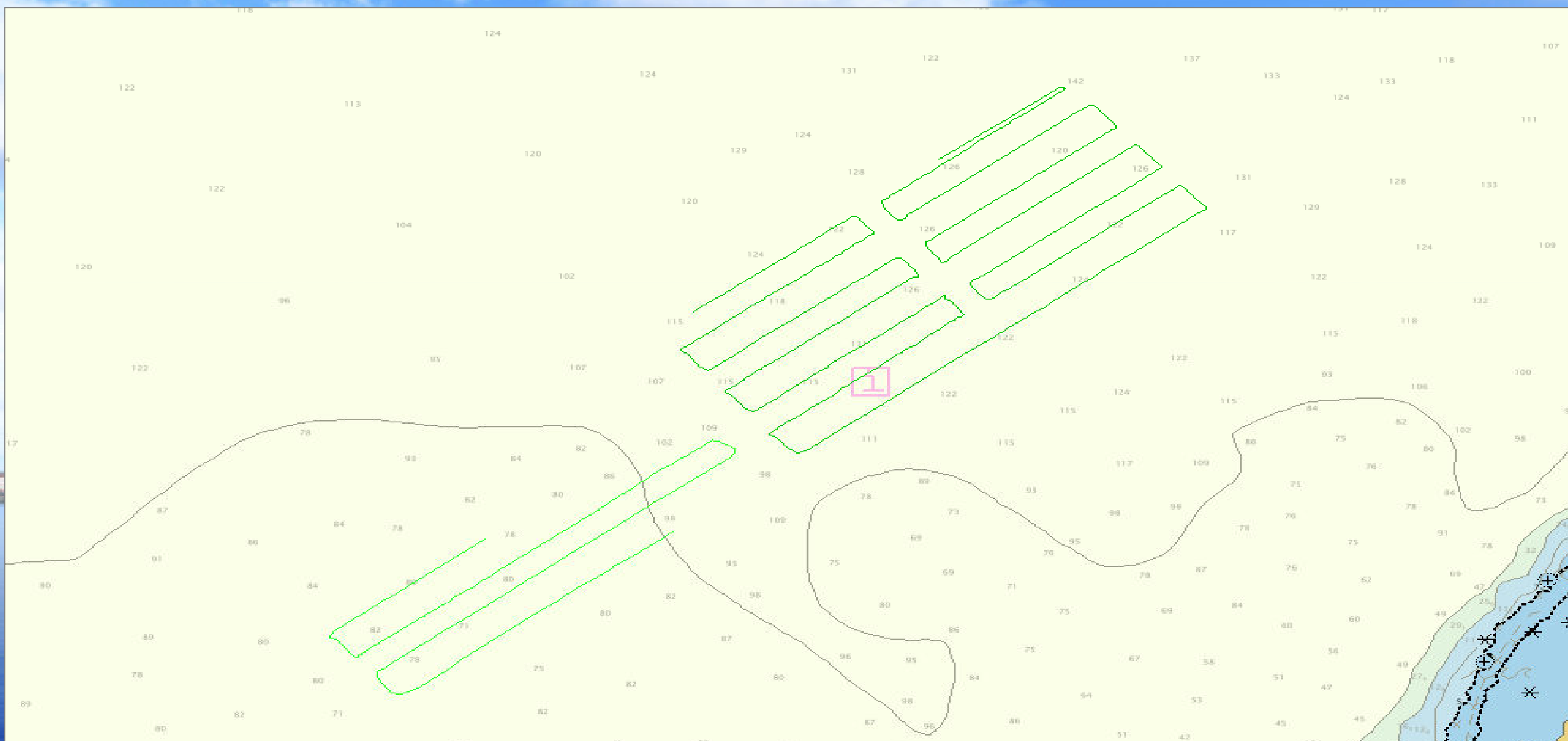
On-board (miniaturized) i7 Quad Core machine running Windows 7

Demonstration Survey

- Survey Operation on the west side of Hawaii
- Survey Monitored in St Maarten, Caribbean at the MACHC IHO meeting
- Uplink/downlink by cell phone
- Control for
  - Vehicle
  - Sonar
  - Caris processing

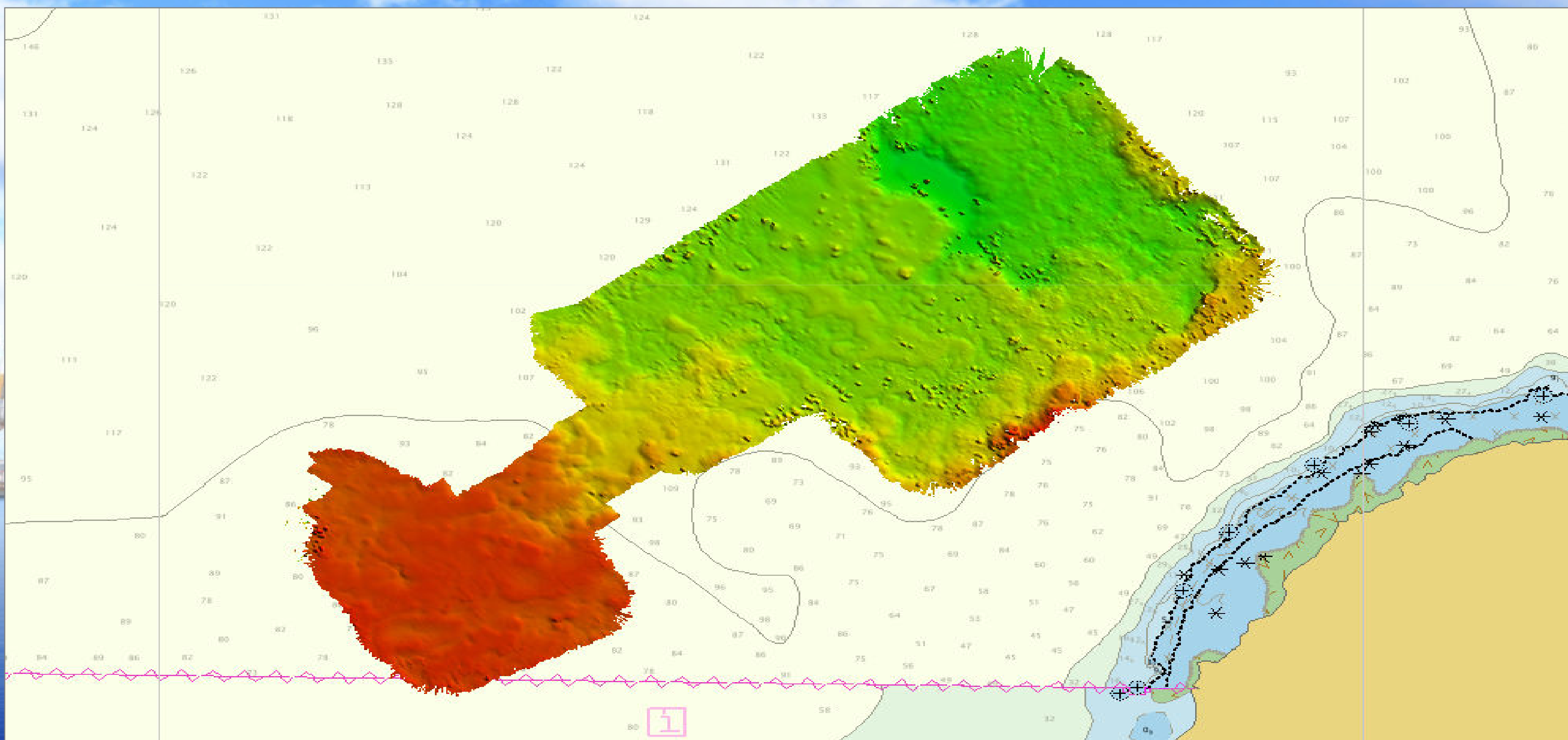
Products and Visualization

Vessel Track



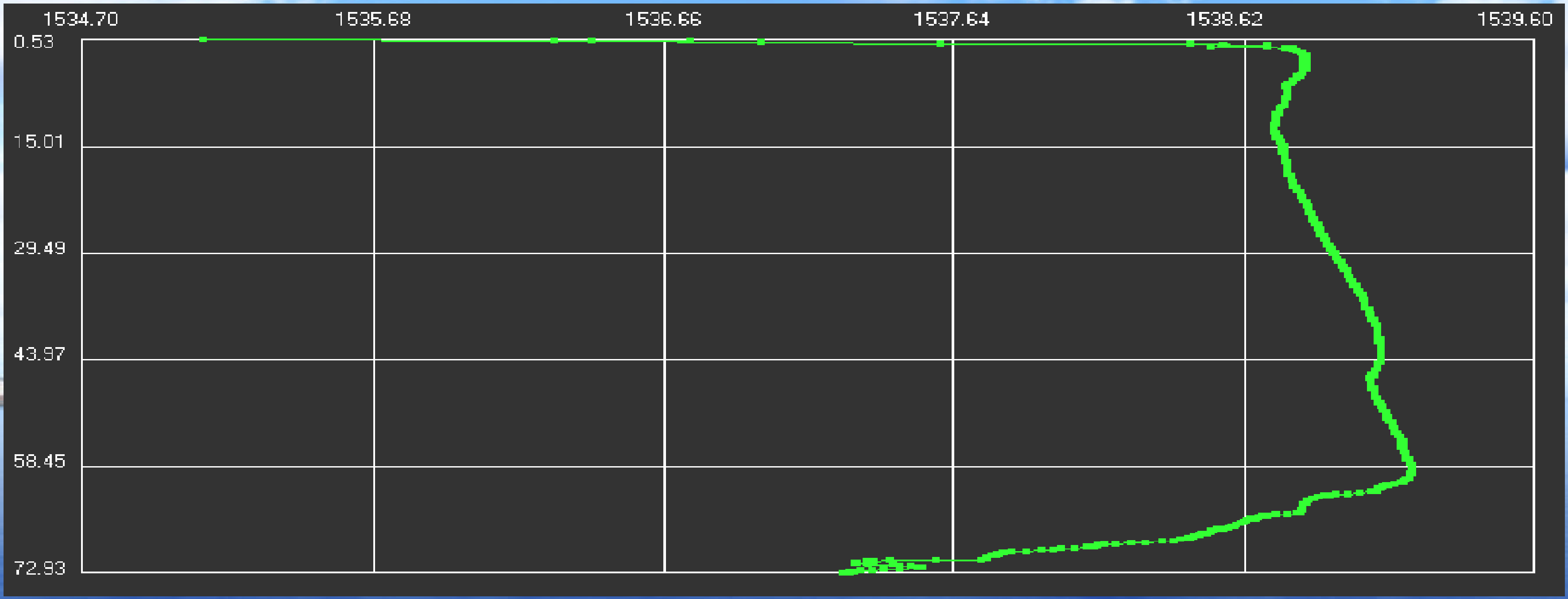
Products and Visualization

BASE Surface and GeoTiff Export



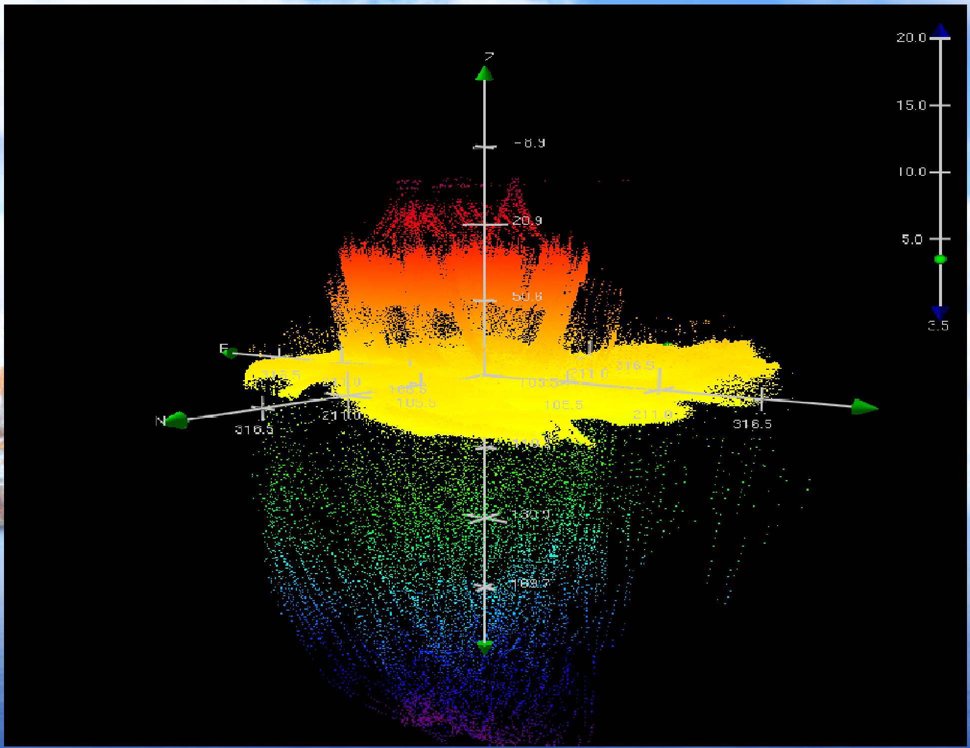
Further Processing

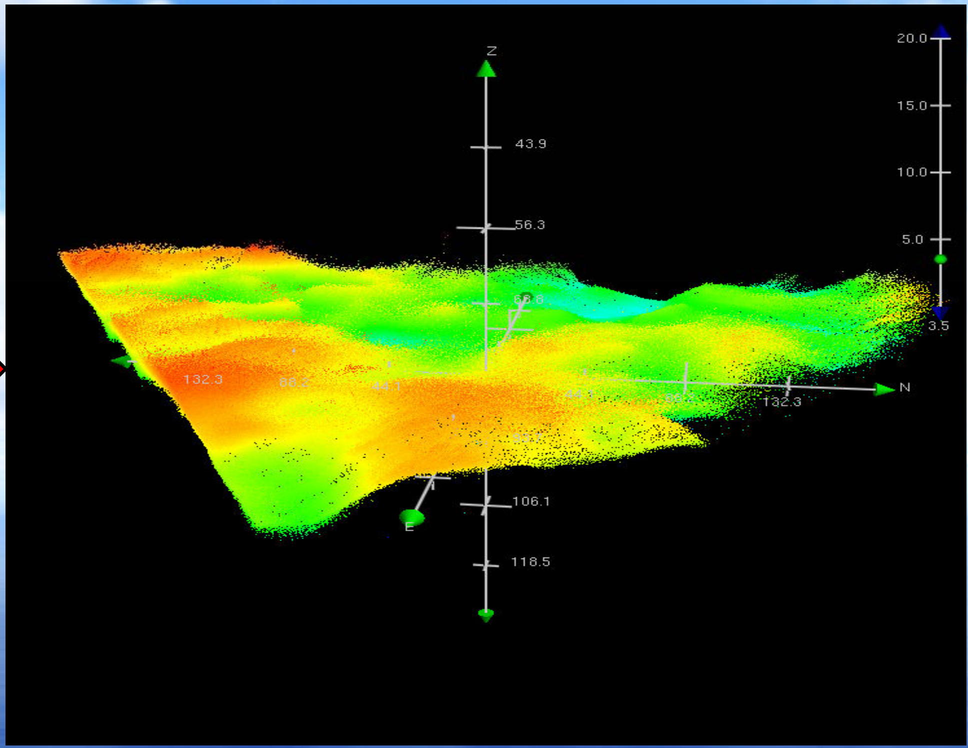
- **Sound Velocity Correction**
- **Load observed Tides**



Further Processing

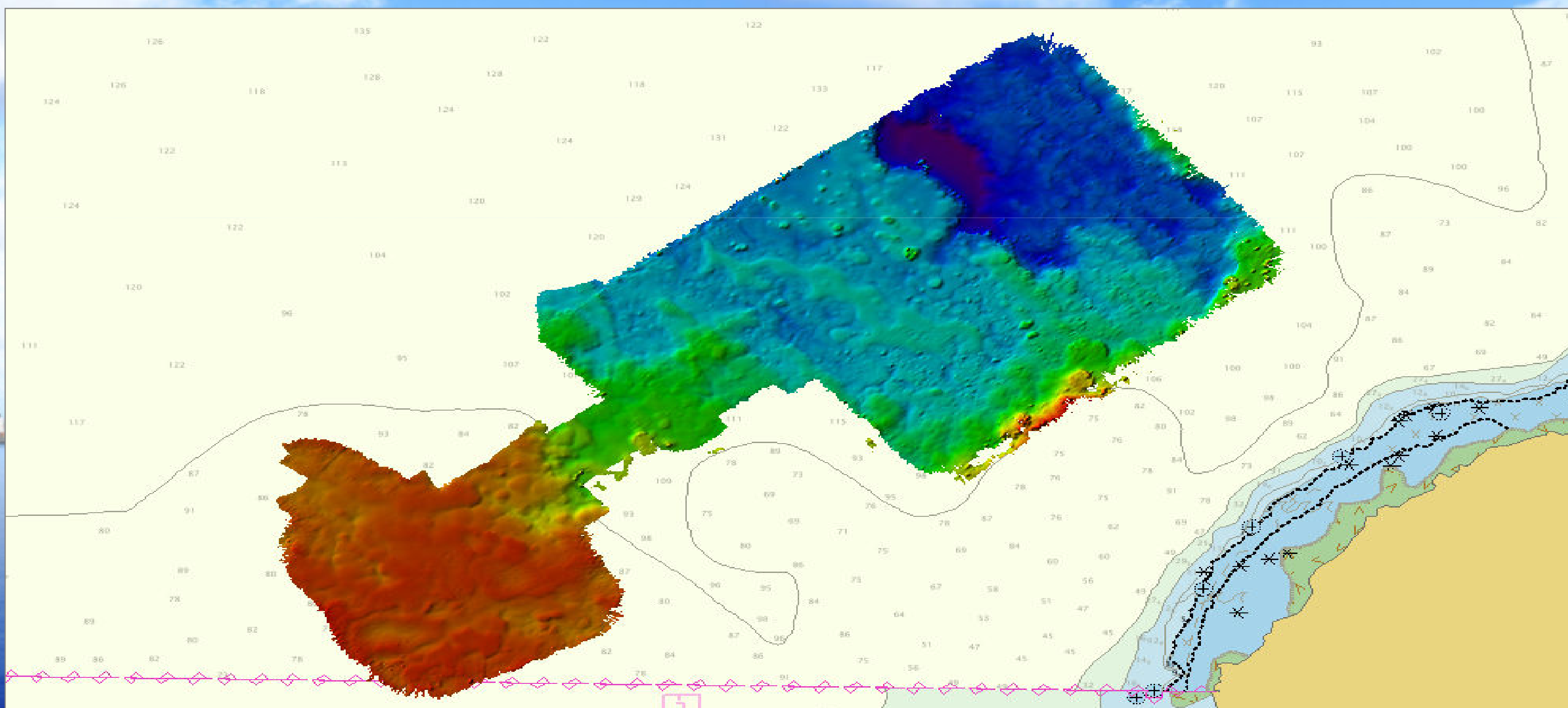
- Swath and/or TPU filters
- Area-based editing



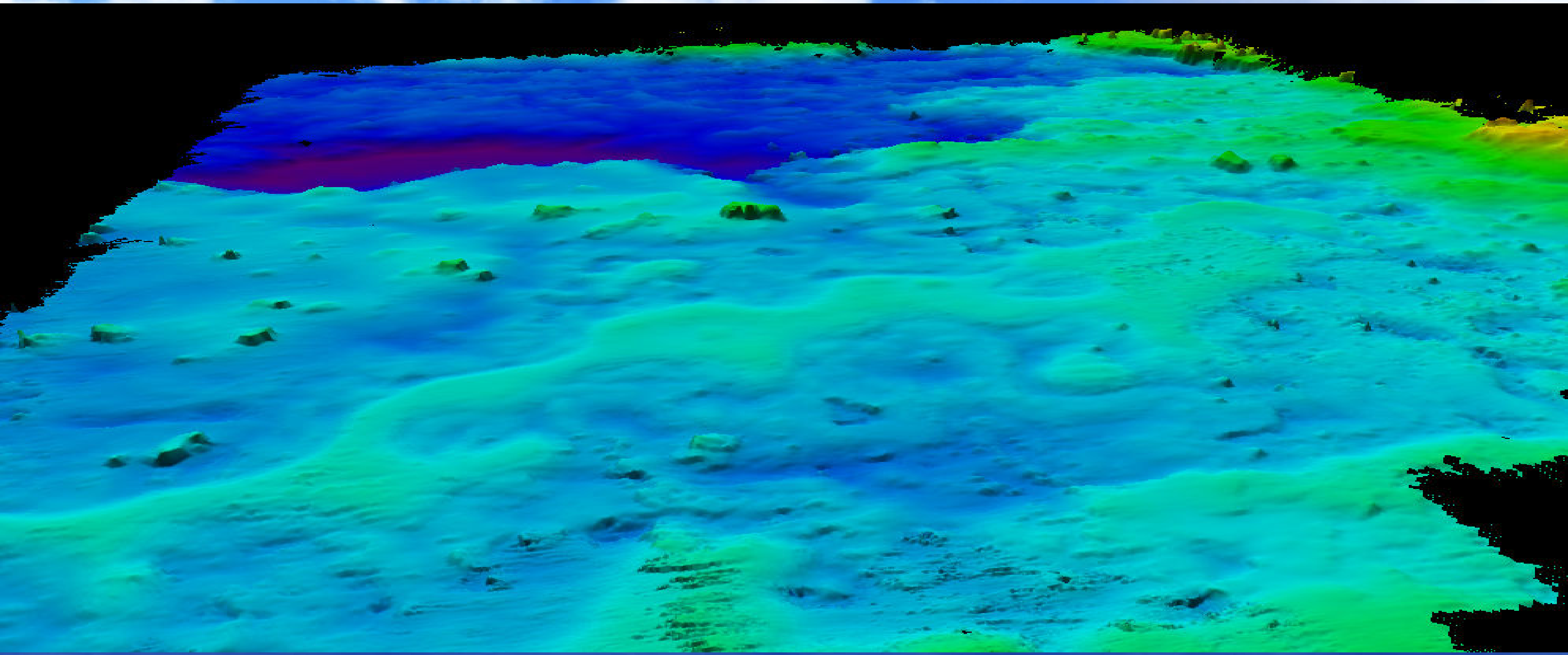


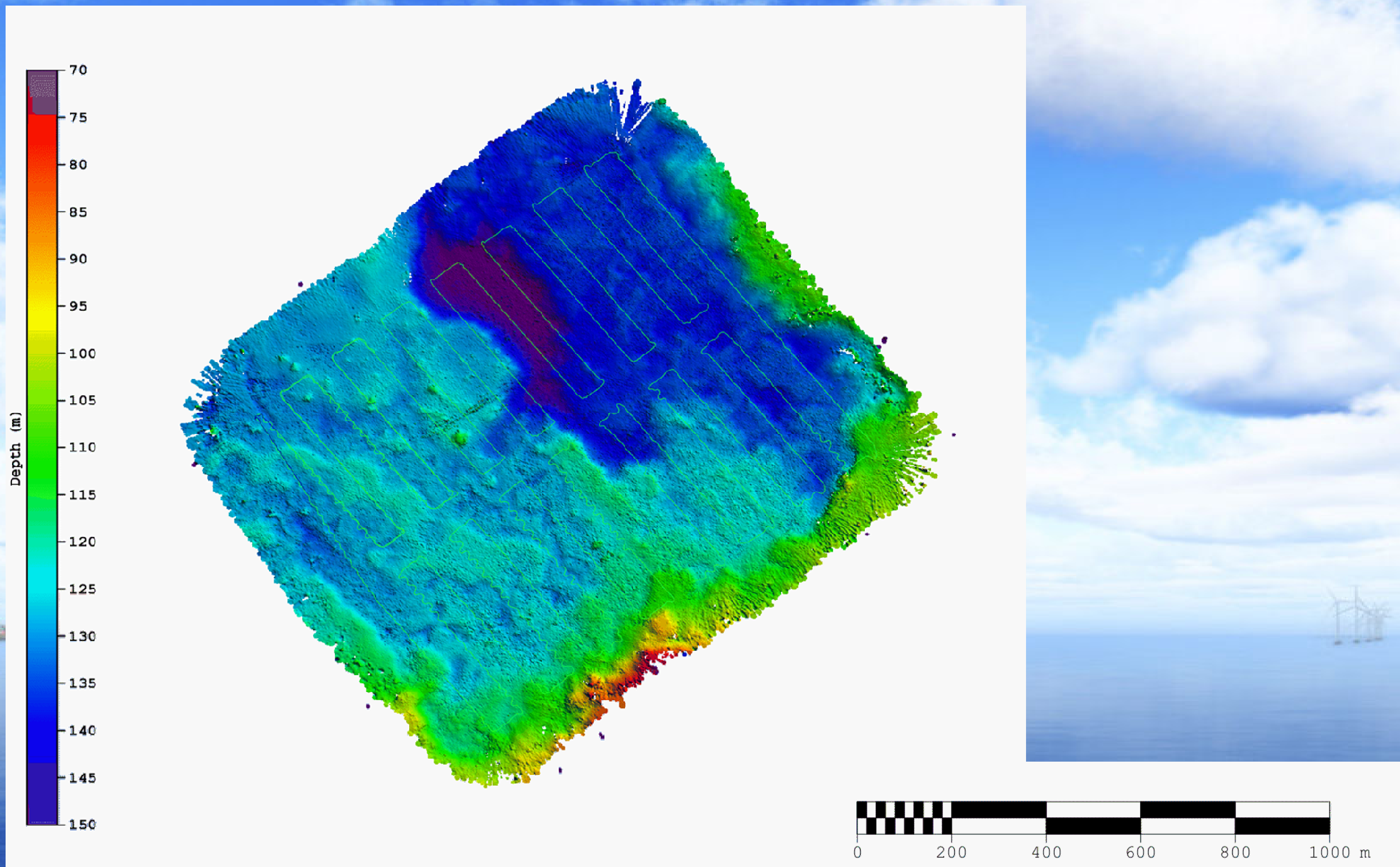
Final BASE Surface

– All post processing corrections applied
– Ping edited



Final Products

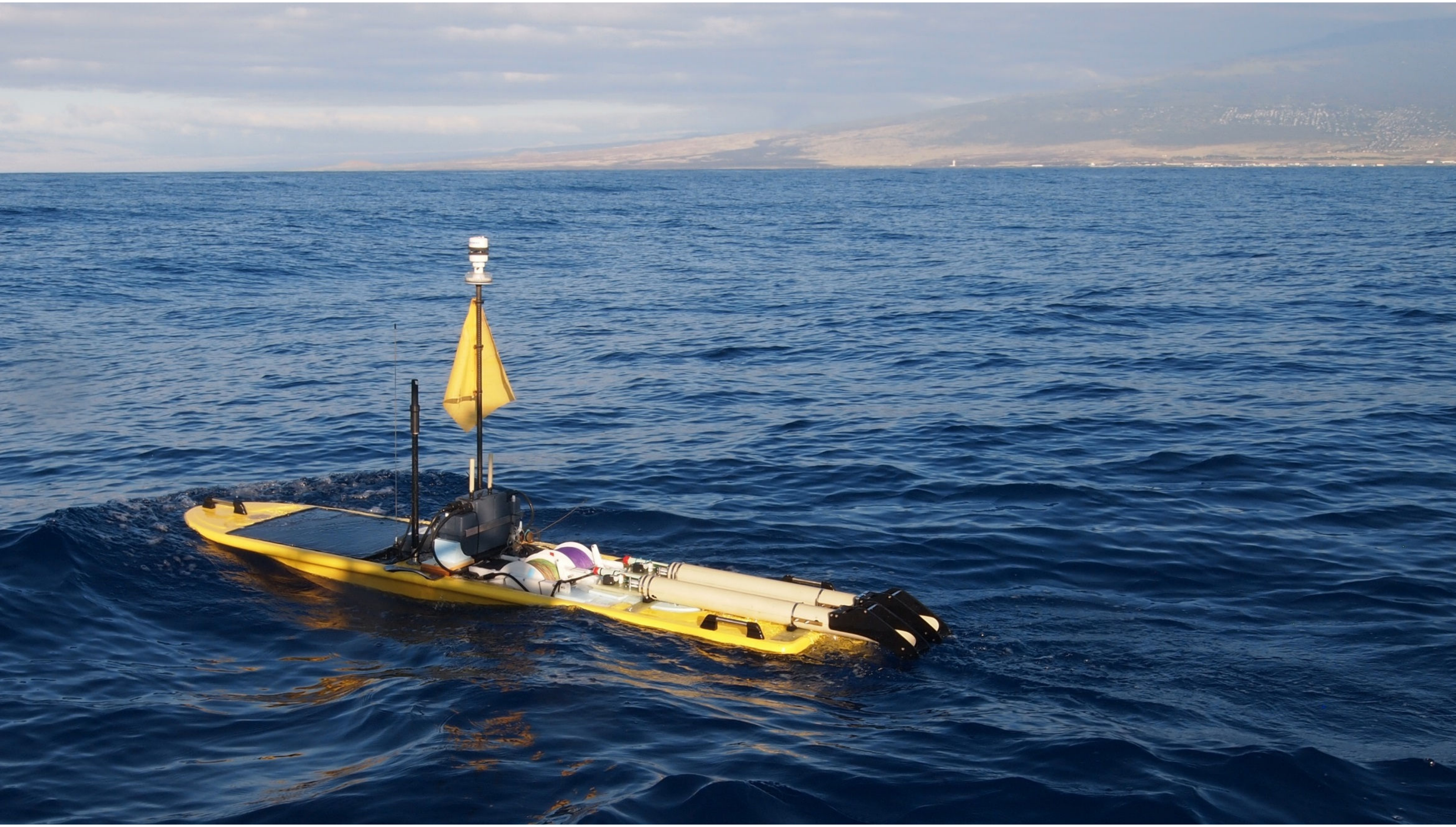


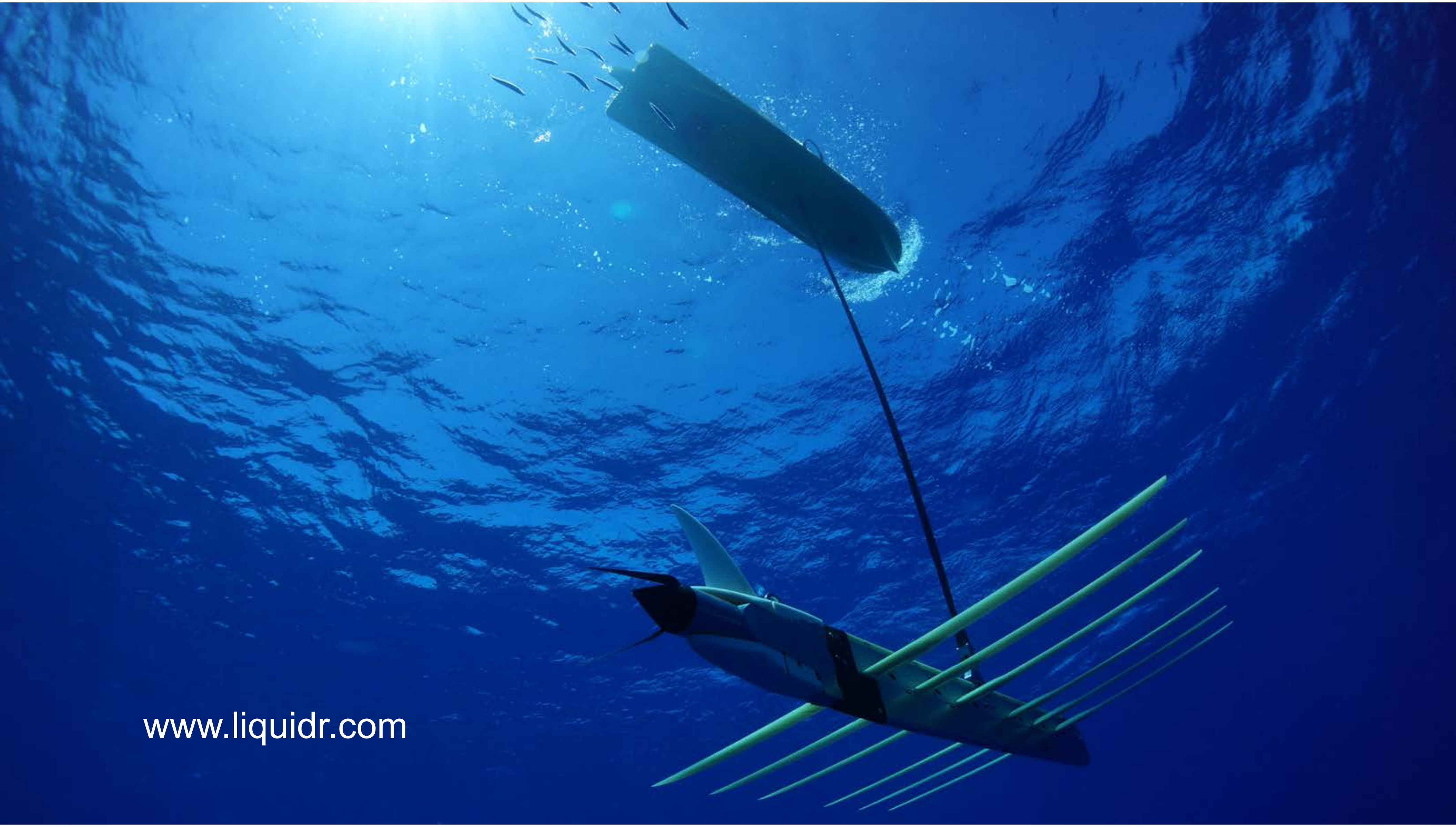

Depth (m)
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
0
200
400
600
800
1000 m

Conclusions

- Autonomous Hydrographic Survey has been Demonstrated.
- The hydrographic survey can be adequately operated from shore.
- Survey control and oversight is similar to survey launch operations.
- Capacity can be quickly and economically scaled.
- Manpower, operational cost, and risk are significantly reduced.

Back up slides

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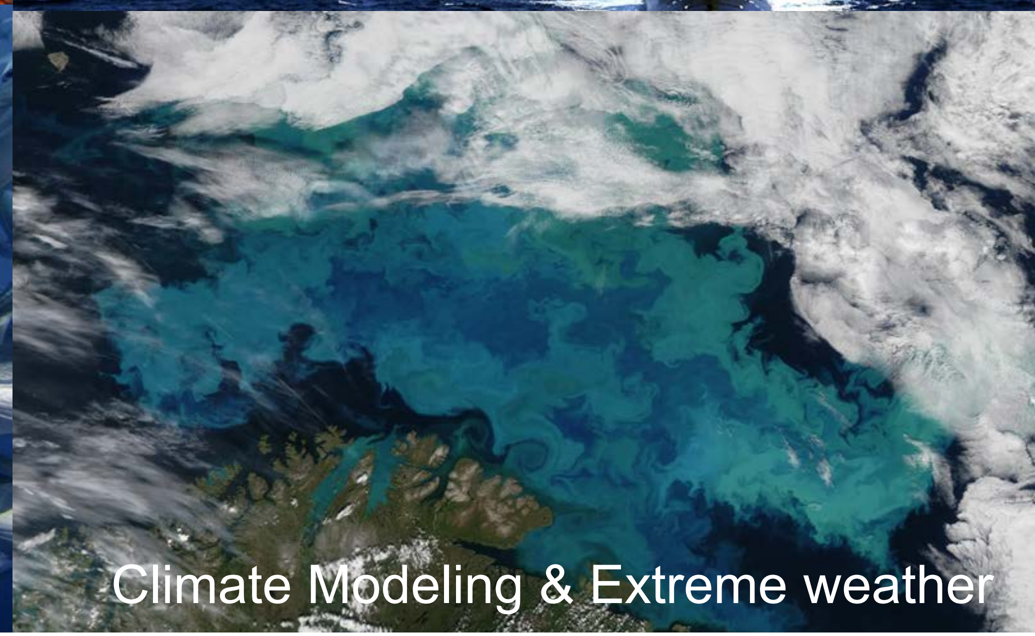
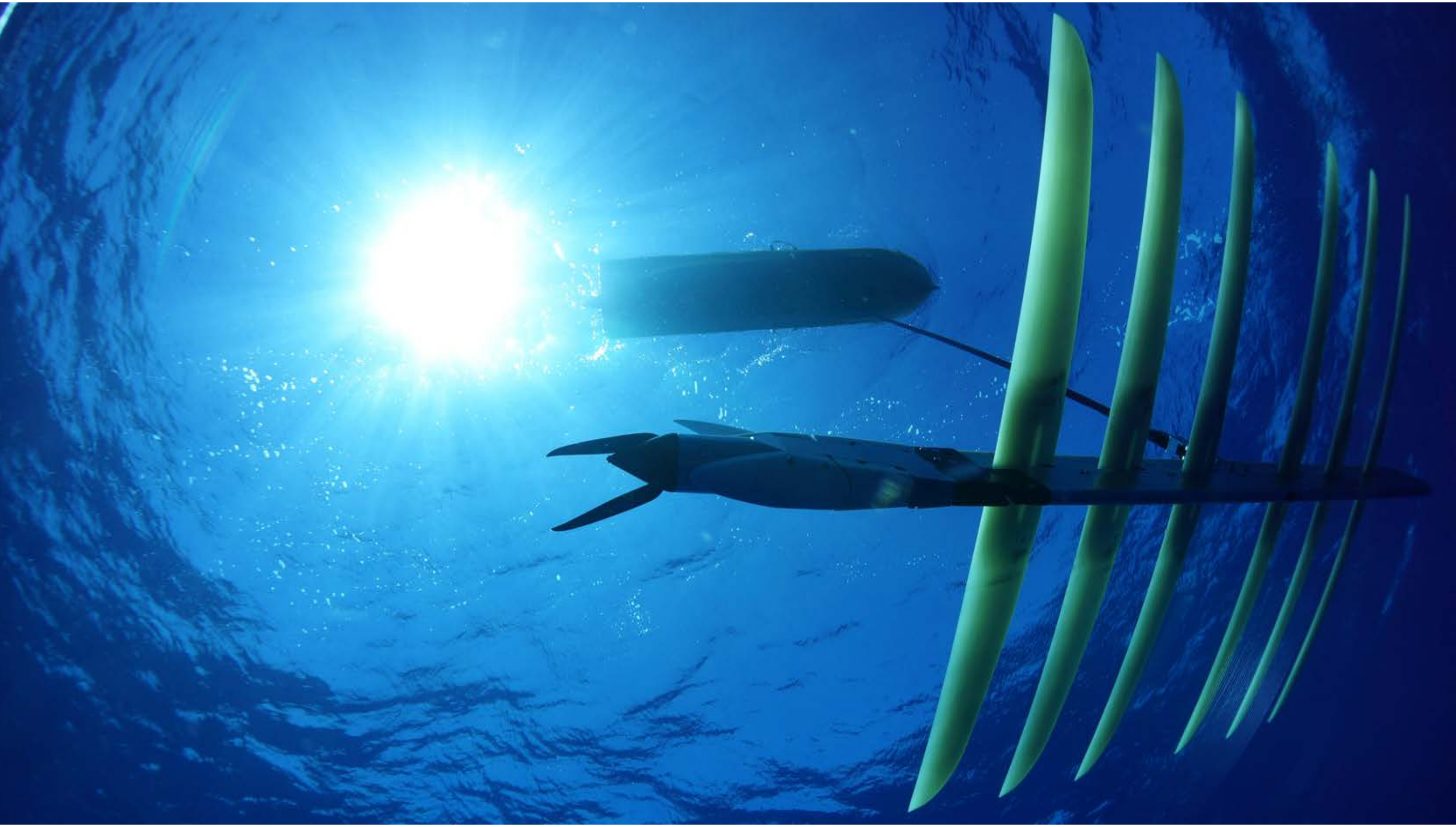
Environmental Monitoring

Maritime Security

Fish & Shark Tracking

Climate Modeling & Extreme weather



How It Works