Liquid Robotics, Inc. (LRI)

Wave Glider Data Collection

WOC-Meopar Smart Ocean/Smart Industries Workshop – Montreal – May 27-29 2014

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Collecting ocean data is difficult & expensive

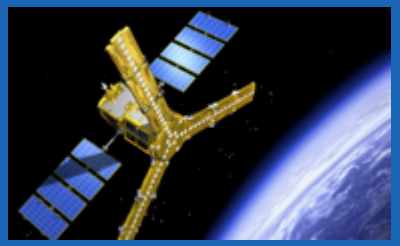
But not for us

And our applications are as big as the ocean.

Markets & Applications

Defense	Anti-Submarine Warfare | Counter-Narcotics | Communications Gateway Marine Domain Awareness | Intelligence, Surveillance & Reconnaissance
Oil & Gas	Seep Detection & Marine Acoustics | Marine Seismic Survey | Subsea Support Meteorology & Oceanography | Security | Geophysics & Magnetics | Hydrographic Survey
Science & Oceanography	Ecosystem & Habitat Monitoring | Weather | Water Quality Management Resource Management | Earthquake & Tsunami Warning | Climate Change

Augmenting today's approaches



Satellites

+ Large coverage
– 'Best guess' from 250mi
– Weather limited

Ships

+ Large coverage
+ Direct tasking
– Human risk to deploy/maintain
– Weather limited

Deep ocean buoys

+ Direct measurement
– Single point
– Human risk to deploy/maintain
– Excellent data gathering tool

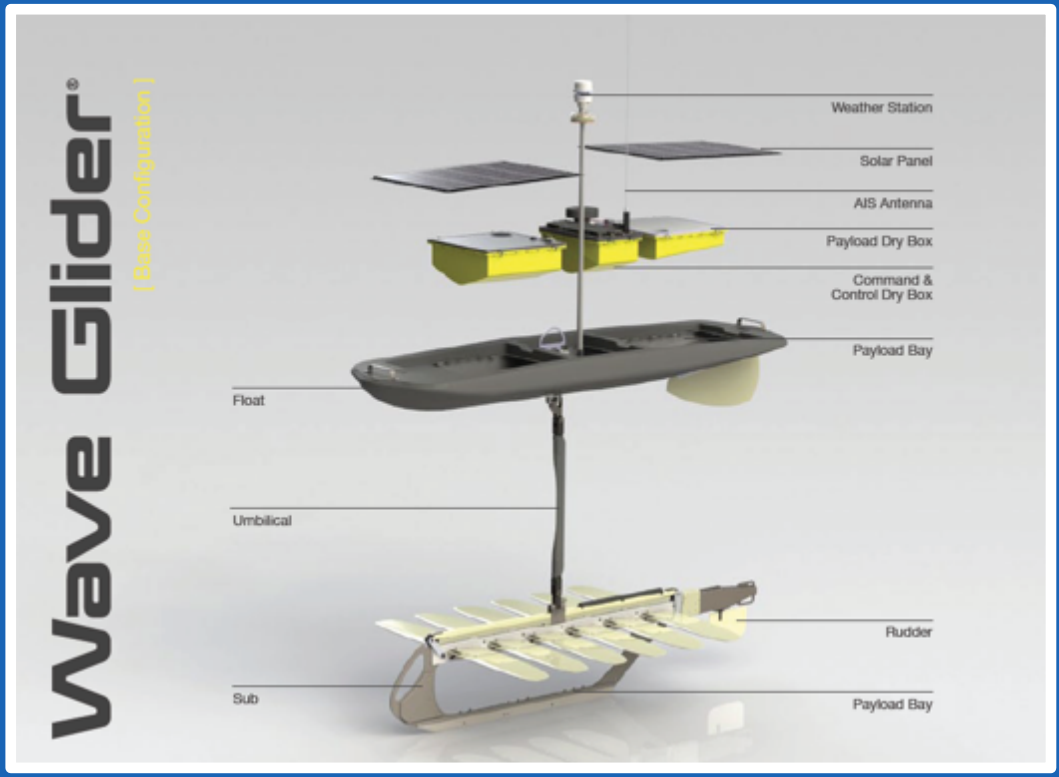
Wave Gliders

+ Large coverage
+ Direct measurement
+ Direct tasking
+ **Low day rate**

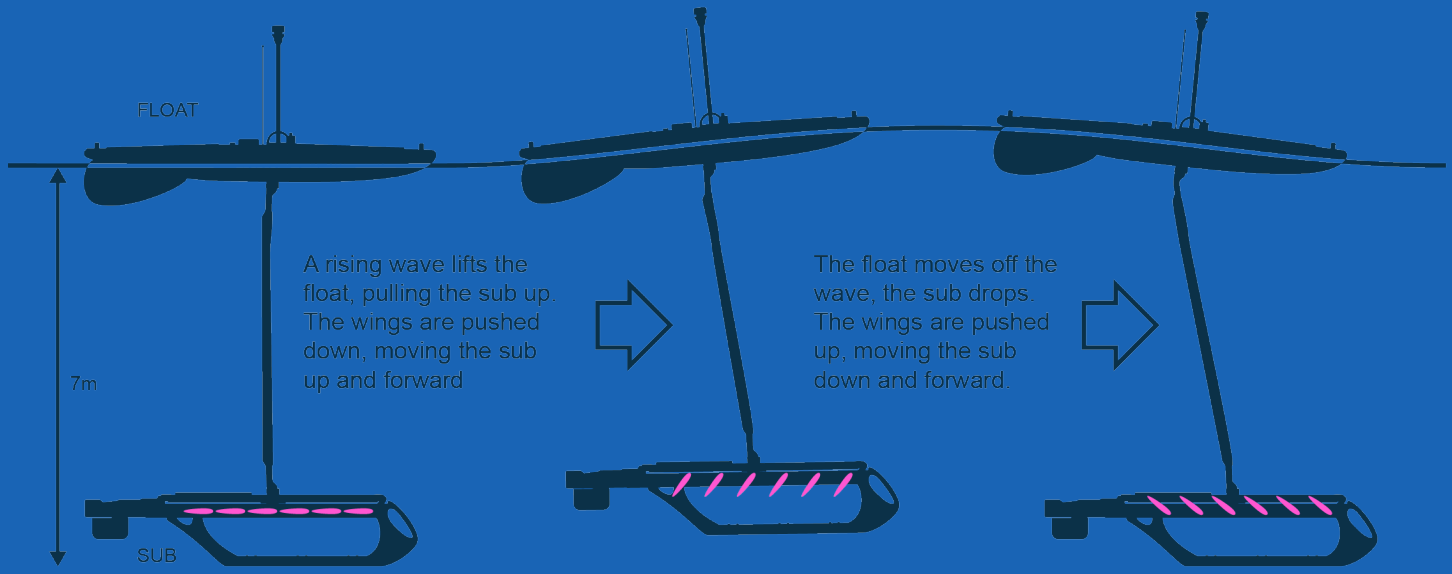
System Architecture

Float
- Solar Panels
- Navigation
- Communications
- Payloads

Sub
- Wave Powered
- Forward Thrust
- Rudder Control
- Payloads

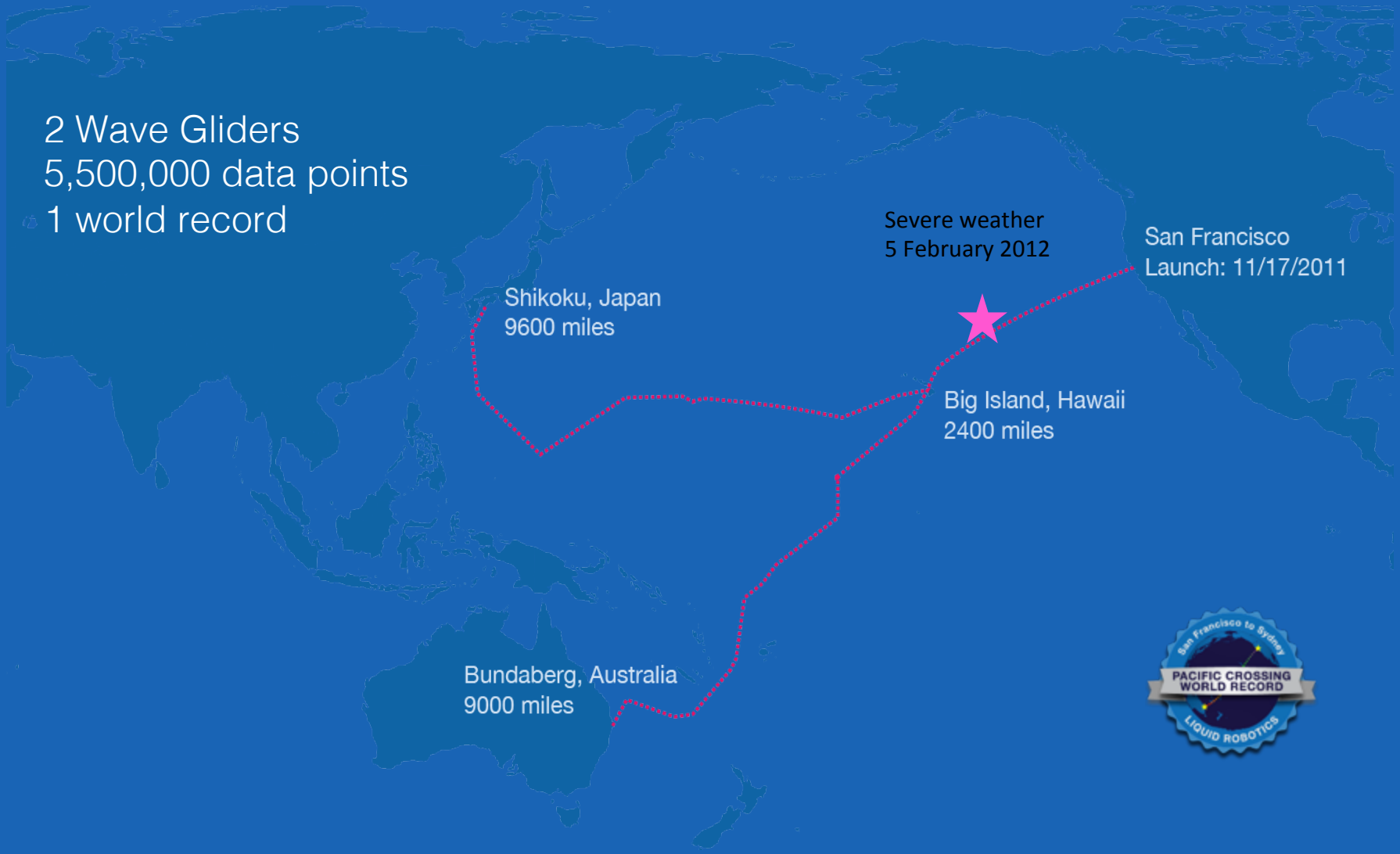


How It Works



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

PacX CHALLENGE



Launch of a Wave Glider

Available Sensors for METOC and ocean data gathering & analysis

Surface Sensors

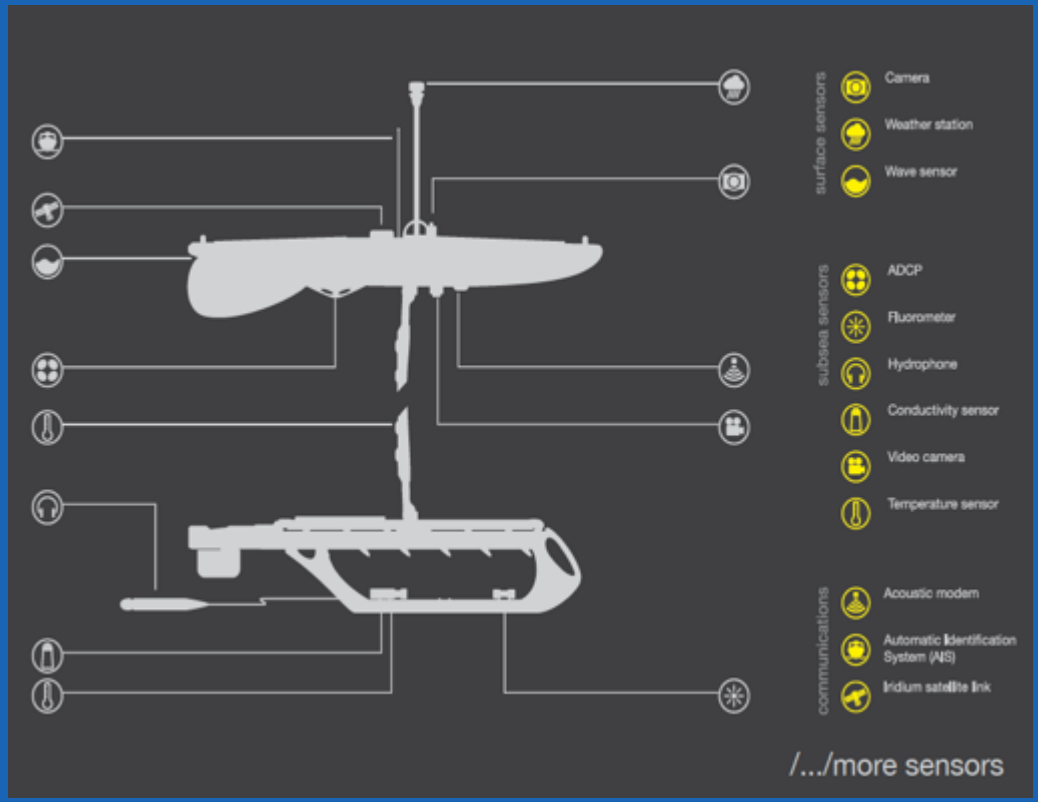
- Camera
- Weather Station
- Wave Sensor

Subsea Sensors

- ADCP
- Fluorometer
- Hydrophone
- CTD
- Echosounder

Communications

- Acoustic Modem
- Automatic Identification System (AIS)
- Iridium Satellite Link



Example of METOC sensor payloads fully integrated and tested

Airmar Weather Station PB200

Turner Designs – C3 Fluorometer

Teledyne RDI Instruments- ADCP

Seabird – Glider Platform
CTD + DO

WetLabs ECO Puck

Datawell – Mose-G Wave Sensor

AIS

Sonardyne – Acoustic Modem

MetOcean Measurement & Forecasting

Challenge

- Accurate modeling and forecasting of weather, currents and ocean conditions relies on timely, widespread and dense observational inputs
- Satellites provide good wide-area atmospheric measurements but have limited ability to infer key subsurface ocean temperatures or currents
- Deep ocean buoys can sense these factors, but their coverage is sparse
  - Separated by 1,000 miles or more
  - Cost $ millions to set and maintain
  - 50% are down at any given time

Improving Hurricane Tracking & Forecasting -

Challenge

Improve accuracy and reliability of hurricane & tropical storm guidance, tracking & forecasts

Solution

- Wave Gliders equipped with weather sensors for measurement at the oceans' surface
- Incorporate air/sea data from within the hurricane to improve intensity forecasting

Results

- Navigated, collected data and communicated through 5 hurricanes and 3 cyclones (highest was Cat 4)

"The unmanned Wave Glider can give us that real-time ground truth and can also give us a closer look at the dynamics of air-sea interactions in a storm environment safely."

- Alan Leonardi, deputy director, Atlantic Oceanographic and Meteorological Laboratory (AOML).

Science – Climate Change – NOAA PMEL – Arctic Data

Challenge

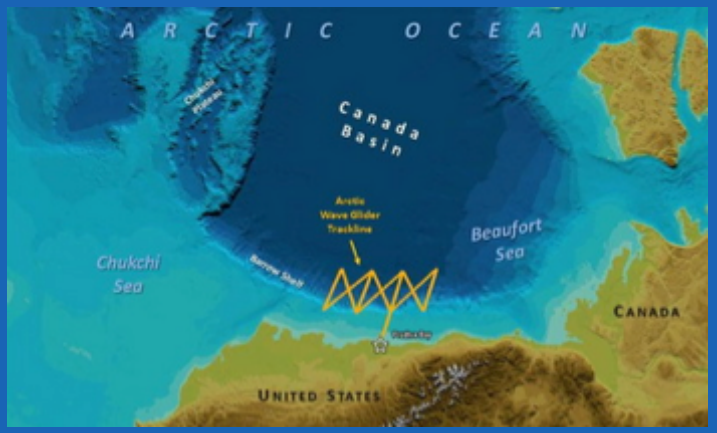
- Climate change driving interest in the Arctic
- Insufficient observational data to model sea ice behavior

Solution

- Two Wave Gliders collect temperature data in the Beaufort Sea for 55 days during the summer of 2011

Results

- Unprecedented quantity of data to support Arctic modeling
- Wave Glider proven effective in harsh ocean environments



"The Wave Glider gives us a unique tool to bring down the costs of observations and sample regions of the ocean that are rarely or never visited by research vessels."

— Christian Meinig, Lead Engineer

Solutions & Services

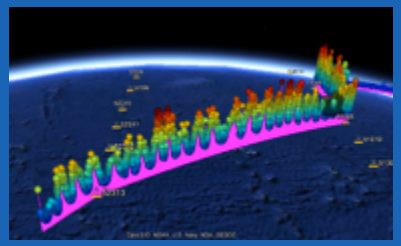
Products

Standard and custom configurations

Vehicle-as-a-Service

Customer defined missions

Data delivered by LRI



Data-as-a-Service

On-demand data

Data by type, date, density, location

Price per observation or by data set

Professional Services

Engineering

Piloting

Maintenance

Training

Launch & Recovery

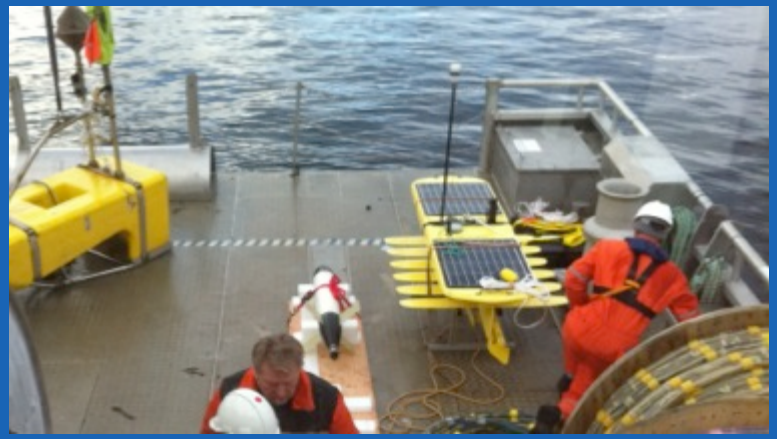
Liquid Robotics Oil & Gas

Joint venture with Schlumberger

Exclusive worldwide partner

Offshore exploration, production and marine operations

Leading oilfield services provider ($40B+)



OTHER SENSORS BEING VALIDATED FOR APPLICATIONS FOR

- HYDROGRAPHY/COASTAL MAPPING
- SURVEILLANCE
- CHEMICAL DETECTION (POLYCARBONS, CO2, etc.)
- GEOLOGICAL (Benthic topography, sedimentation)

Questions?

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