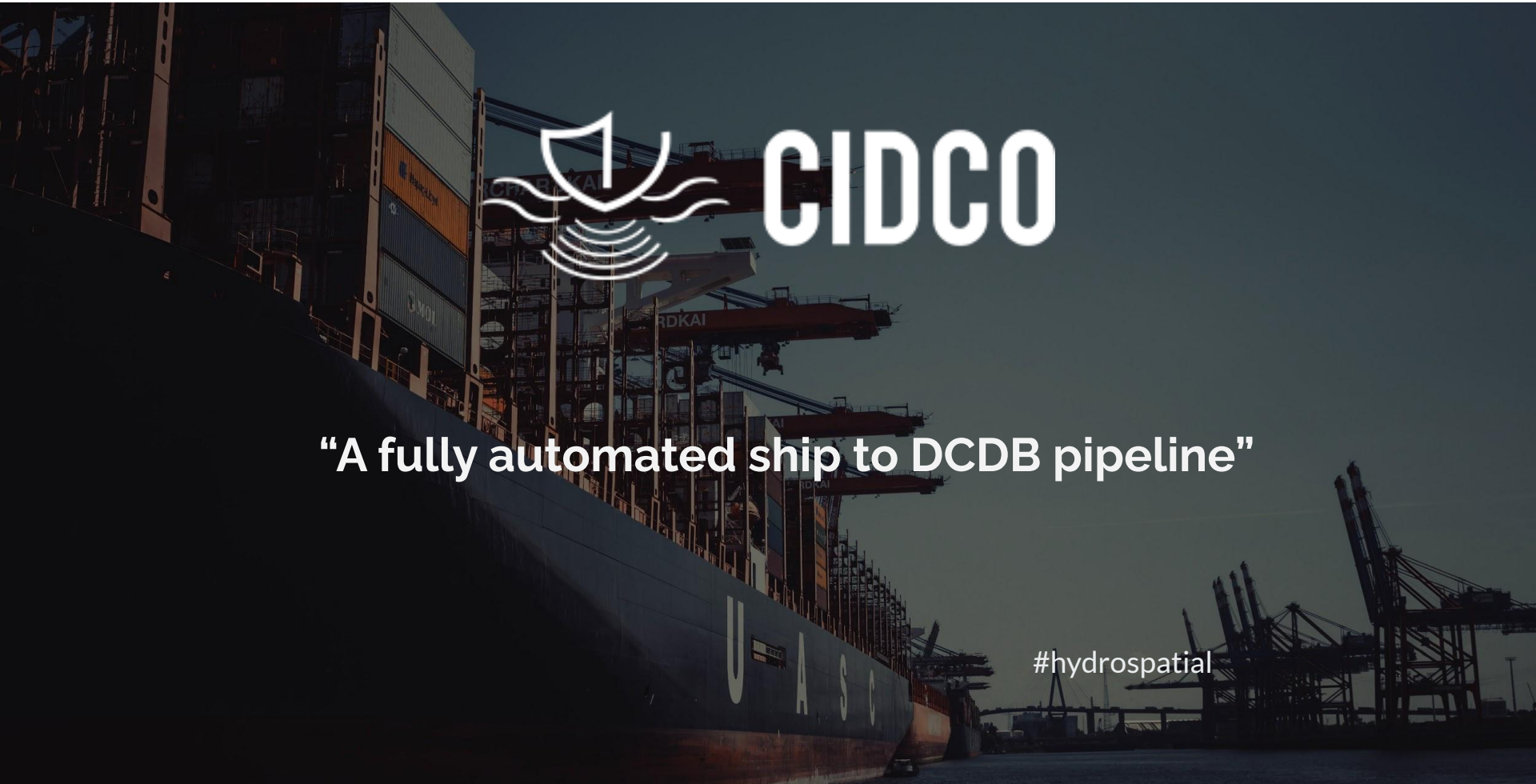
CIDCO

Autonomous Monitoring of the St-Lawrence Seaway Using Trusted Crowdsourced Bathymetry

#hydrospatial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“A fully automated ship to DCDB pipeline”
#hydrospatial

CSB will be a hot topic at the CIDCO symposium April 3,4 and 5th in Rimouski, Canada

For further info, please contact guillaume.morissette@cidco.ca

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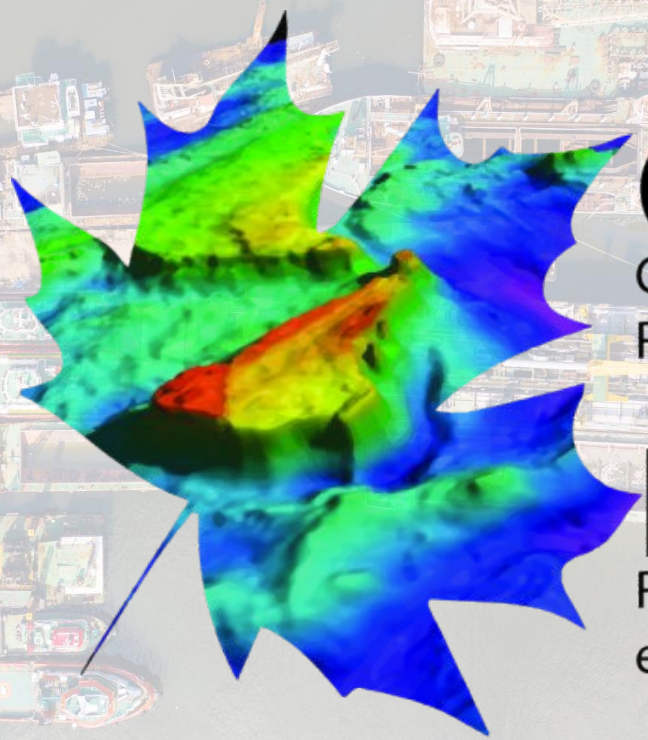
A Pan-Canadian coalition



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With the participation of the Government of Canada

R & D Axes

Enabling MASS technologies

The emergence of next-level autonomous shipping vessels brings about new opportunities in terms of data collection and collaborative data acquisition.

Situational Awareness

Fleets of opportunity vessels can be turned into data-acquisition platforms to build a common map.

Autonomous monitoring

Channel monitoring can be mostly automated using the channel's traffic.

Trusted Crowdsourced Bathymetry

HydroBlock dataloggers can provide intelligent recording capabilities and smart uploading to cloud-based processing infrastructures.

Satellite-derived bathymetry

Implement an early warning system for quick detection of collapsing walls and hydrodynamic scour problems.

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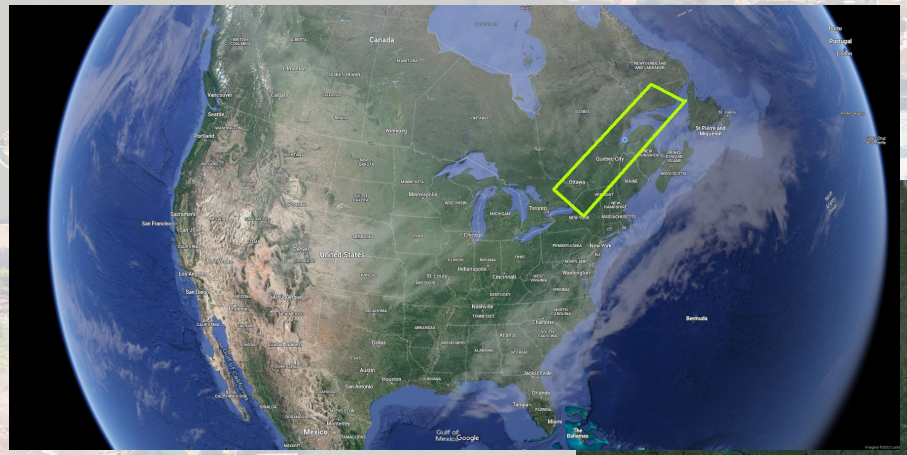
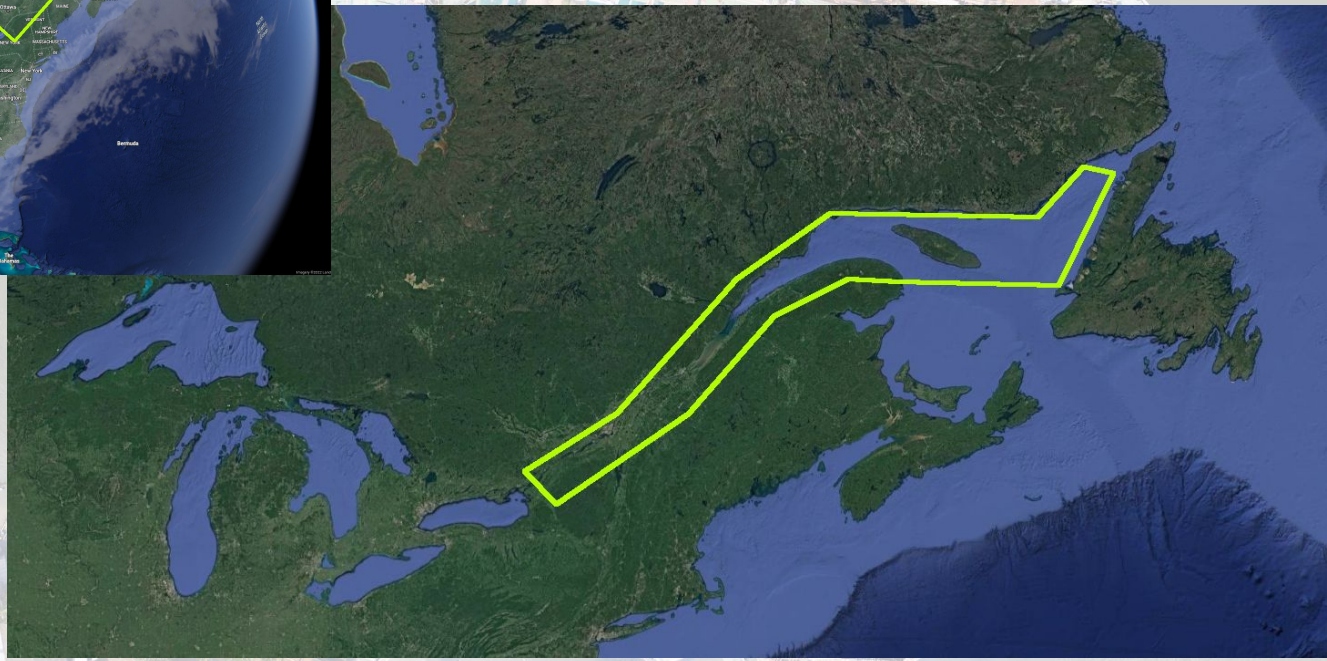
Study Zone: St-Lawrence Seaway





Length: 600 km
Economic impact: $45 billions
Jobs: 238,000

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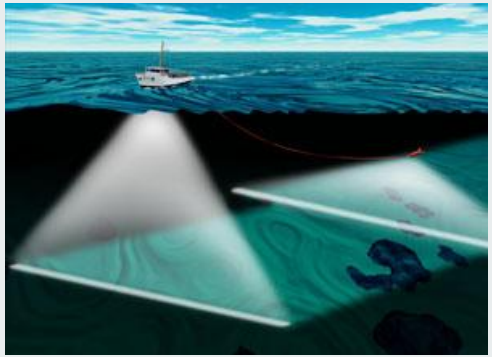
Key Navigation Problems

Man made channel
Requires dredging



Continuously monitoring
600km is hard and costly

Suboptimal situational
awareness

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Trusted CSB
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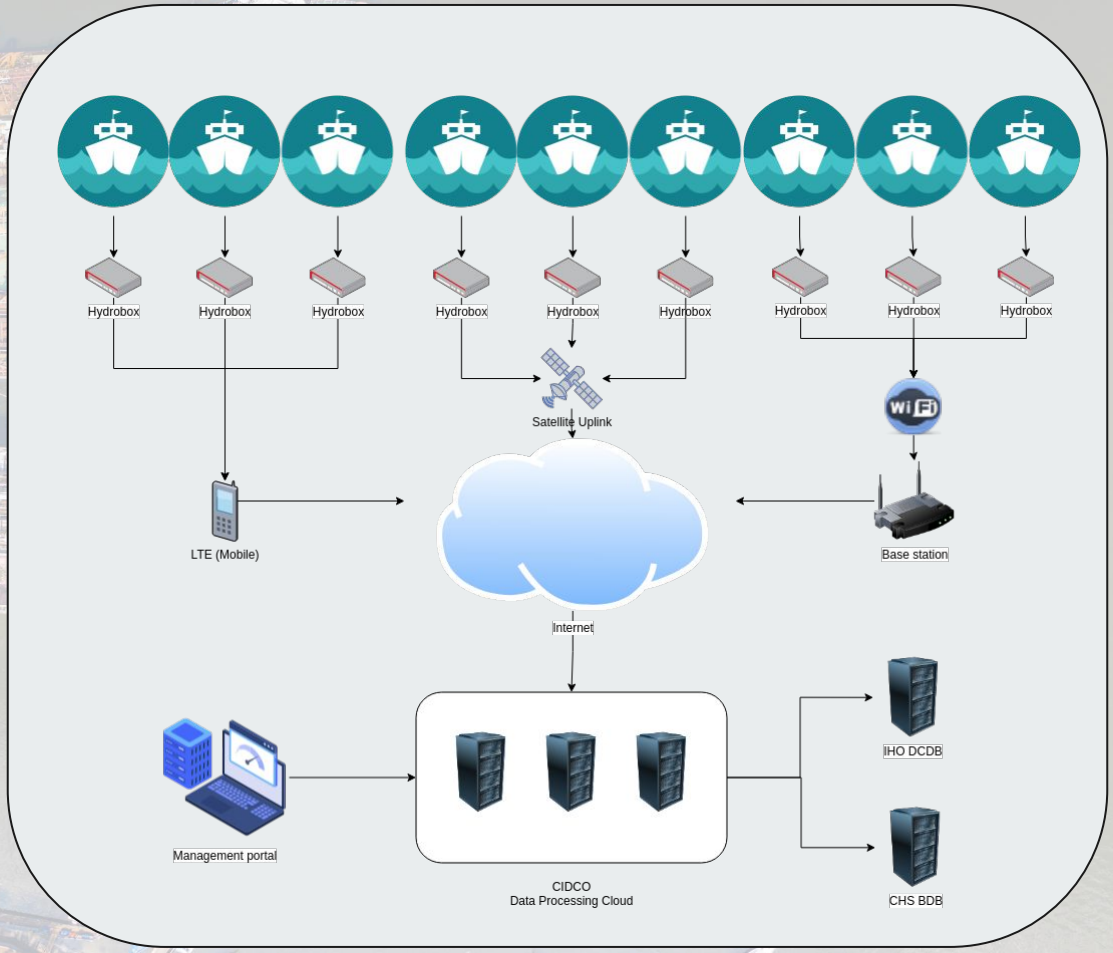
System architecture

- Opportunity Vessels
- Dataloggers with real-time processing capabilities
- Automatic data transmission
- CSB-Cloud processing backend
- CHS/DCDB dissemination



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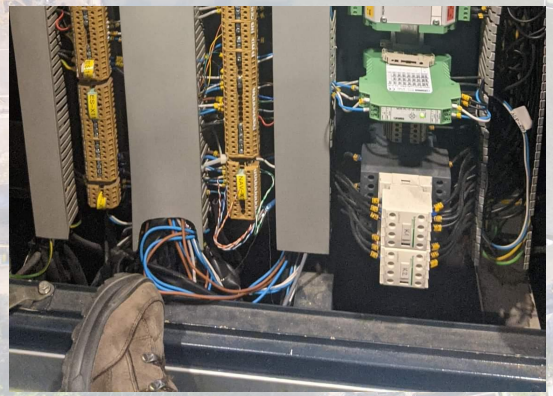
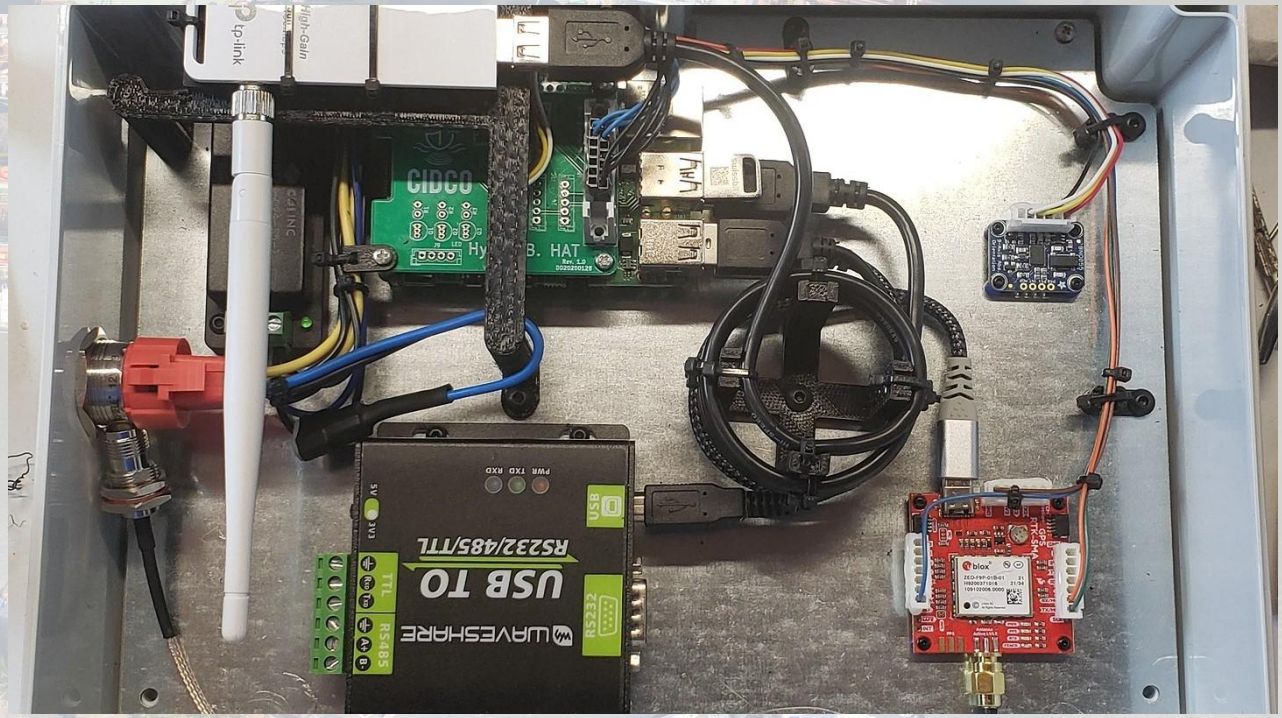
Next-Gen Data loggers: 24/7 data transfers

Fire-and-forget

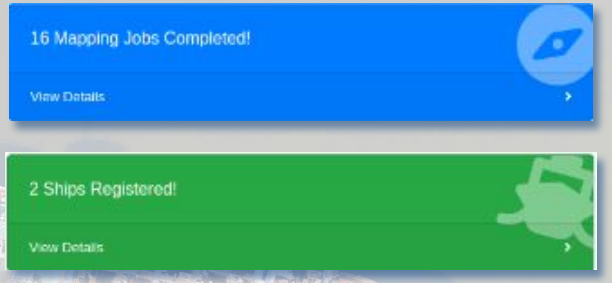
Zero client interaction

Multi-channel automatic uploads



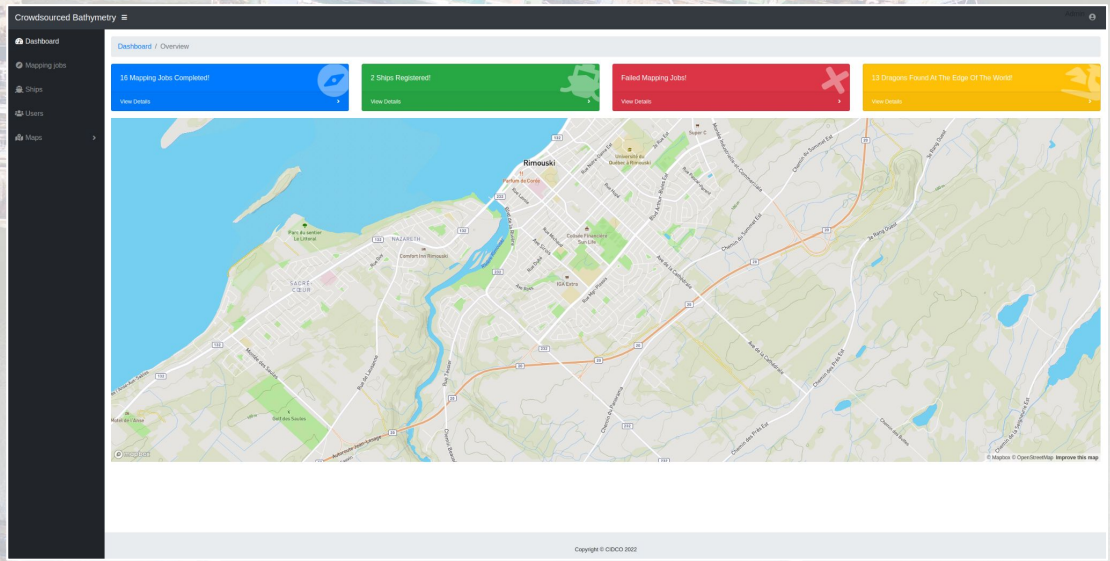


Automated Data Processing



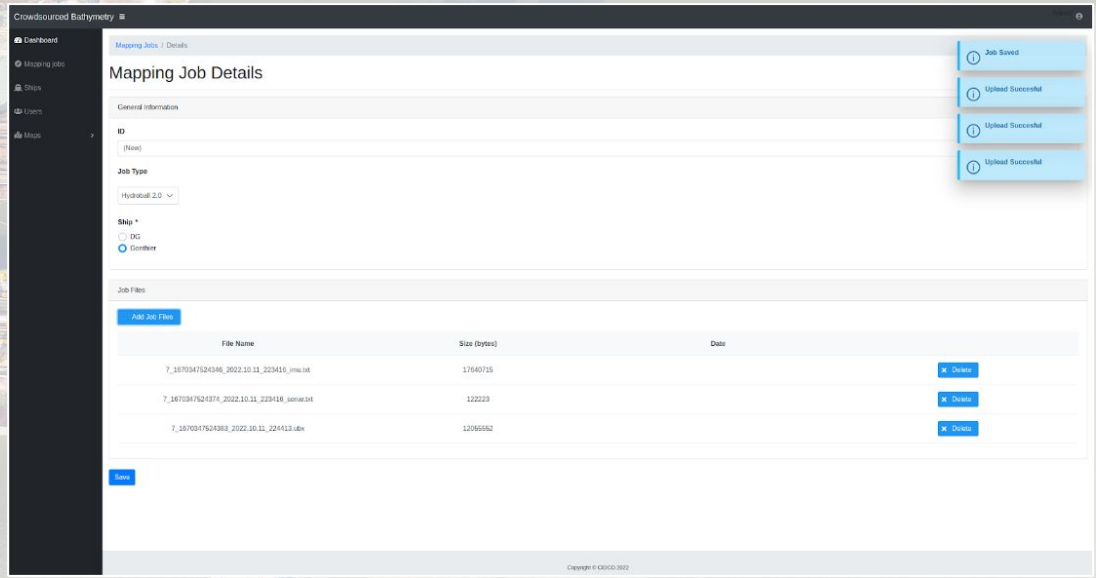
Scalable cloud-based bathymetric data processing platform

- Ingests and parallelises data processing jobs
  - Georeferencing
  - Attitude & Motion compensation
  - PPP GNSS position enhancement
  - De-noising
  - Parallelize and distribute processing



Automated Data Processing

- *A 1h data bucket takes 90 seconds to process*
- *Processed data pushed to clients' GDBMS*
- *Streamable to DCDB in GeoJSON*



id	ellipsoidalHeight	latitude	longitude	sdEllipsoidalHeight	sdLatitude	sdLongitude	timestamp	job_id
1803	17.07360056694597	50.1895921020344	-66.41440862119522	0.0488	0.0277	0.0215	2022-10-11 23:42:44.792000	7
1804	17.16553436871618	50.189592433775026	-66.41440859358971	0.0485	0.0274	0.0213	2022-10-11 23:42:53.663000	7
1805	17.14688776805997	50.189592673091894	-66.4144090487811	0.0466	0.0269	0.0208	2022-10-11 23:42:55.373000	7
1806	17.145888967439532	50.18959237226412	-66.41440941812239	0.0481	0.0271	0.0211	2022-10-11 23:42:57.123000	7
1807	17.122513368725777	50.18959197586995	-66.41440945370744	0.0481	0.0271	0.0211	2022-10-11 23:42:58.849000	7
1808	17.131564767099917	50.18959203435318	-66.41441055357424	0.0485	0.0275	0.0213	2022-10-11 23:43:07.664000	7
1809	17.13487616740167	50.18959182627537	-66.41441086230387	0.0486	0.0275	0.0214	2022-10-11 23:43:09.375000	7
1810	17.09341896791011	50.18959205673694	-66.41441120772728	0.0487	0.0276	0.0214	2022-10-11 23:43:11.057000	7

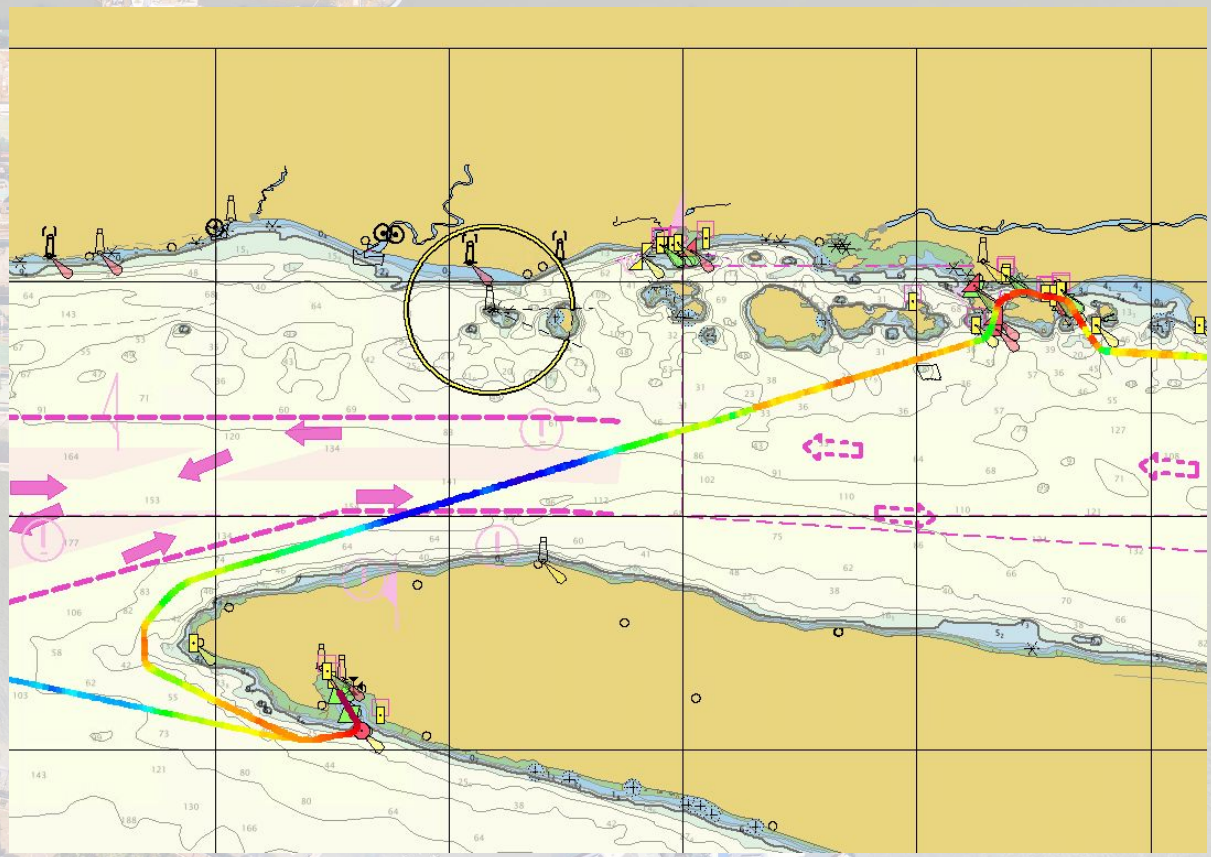
A continuous surveying loop

90+ days of continuous survey

24/7 automatic data transfers

5398 data products to date

Data processing examples



Data processed by the Canadian Hydrographic Service

IHO CATZOC B Order
Standard deviation: 0.5m

CSB Added-Value: SDB Calibration Data

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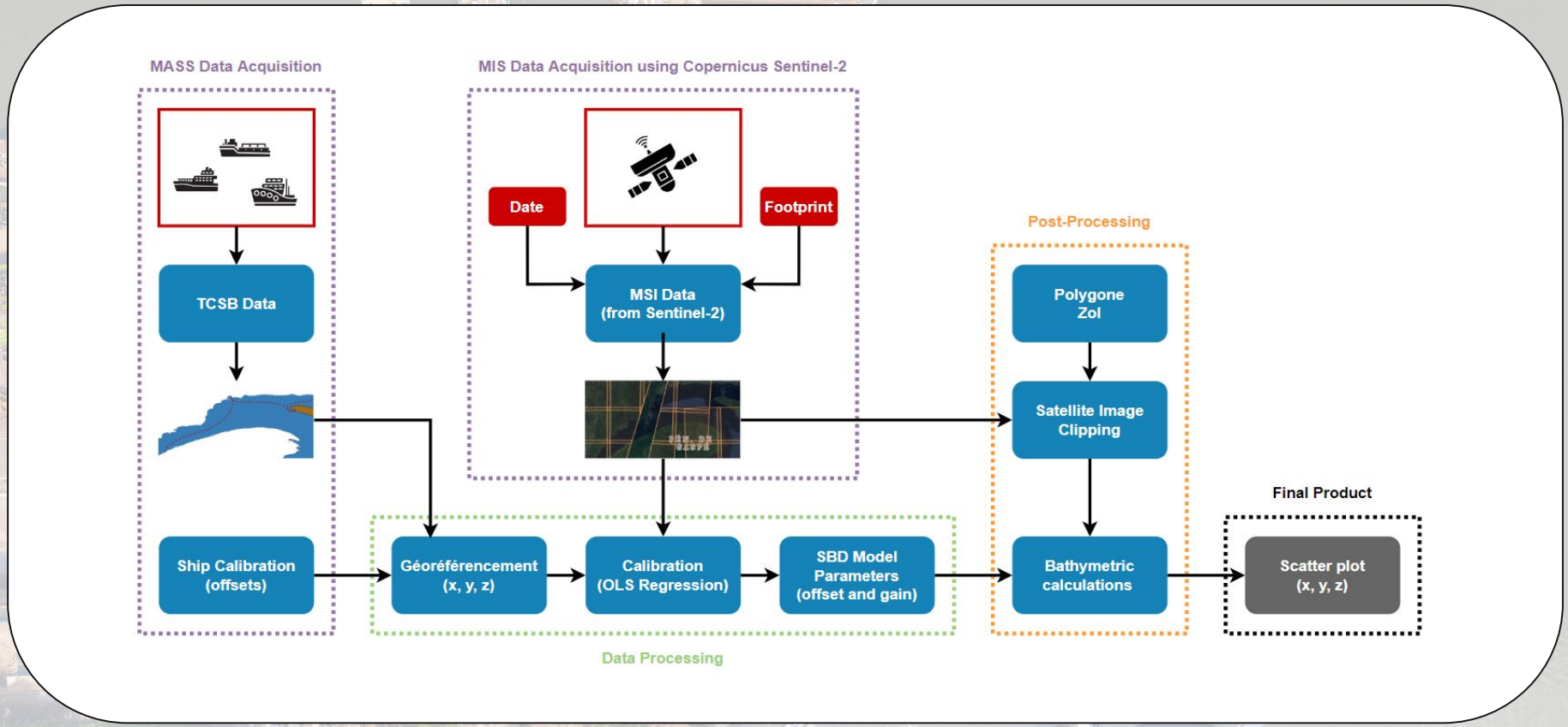
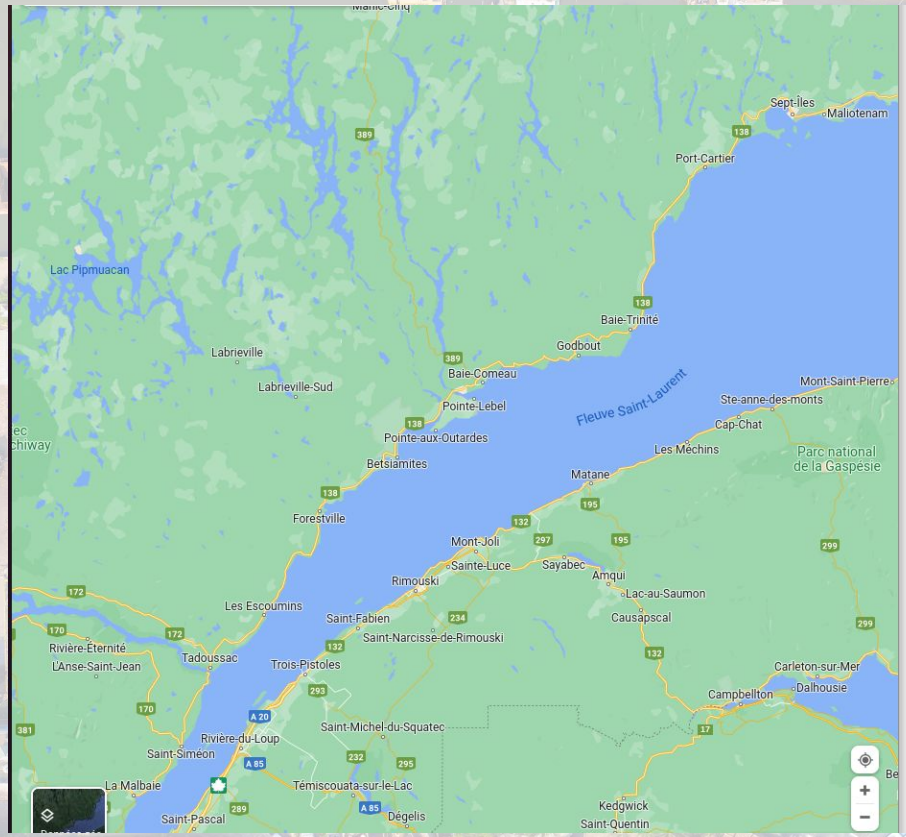
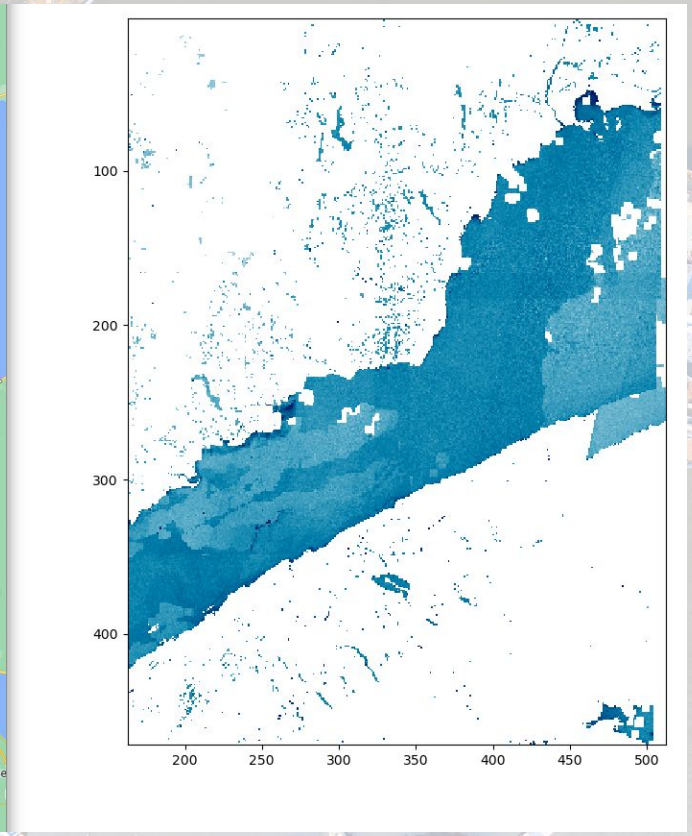
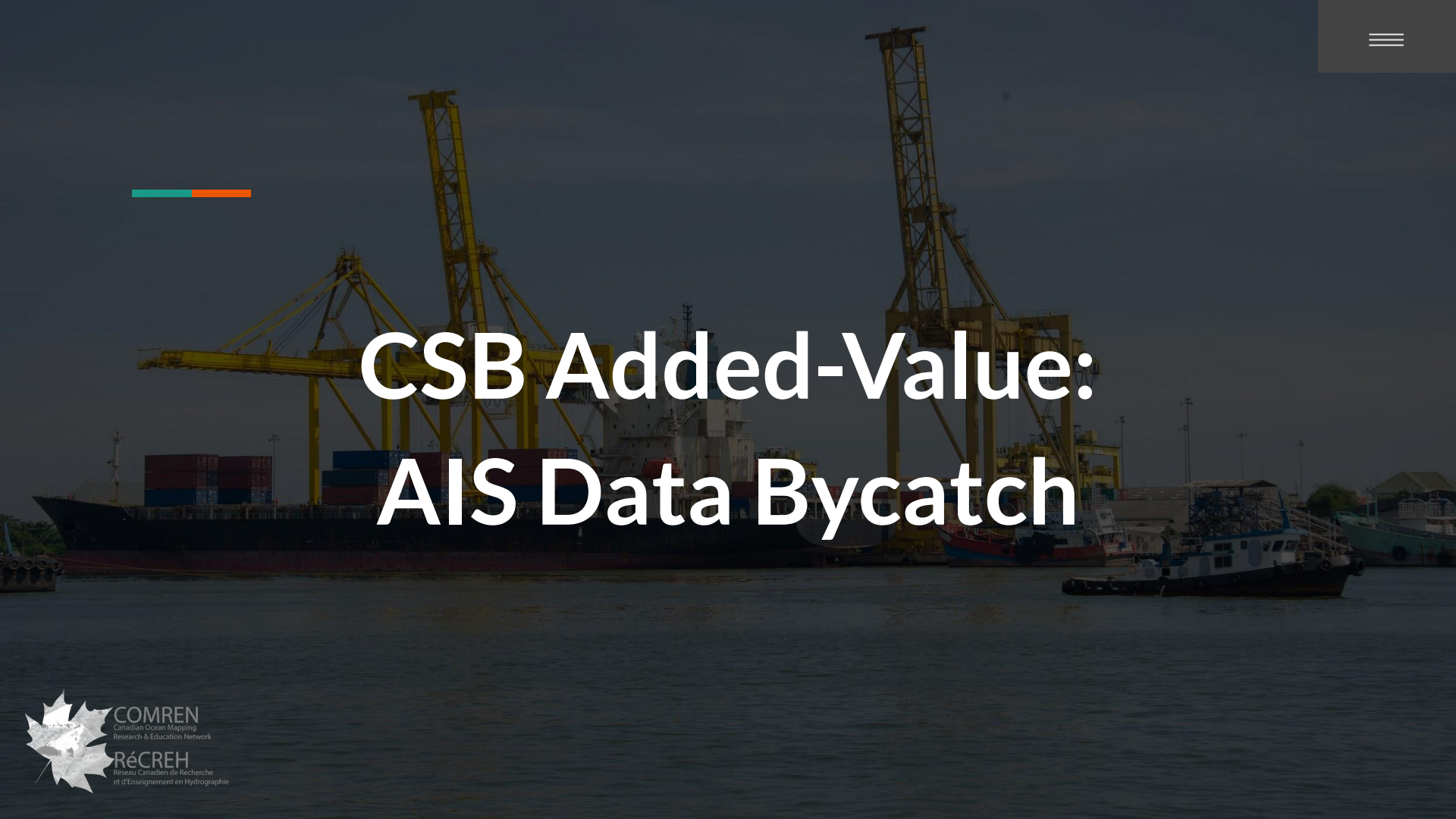
CIDCO's data processing workflow (Sentinel 2)



Satellite-derived bathymetry examples







CSB Added-Value: AIS Data Bycatch

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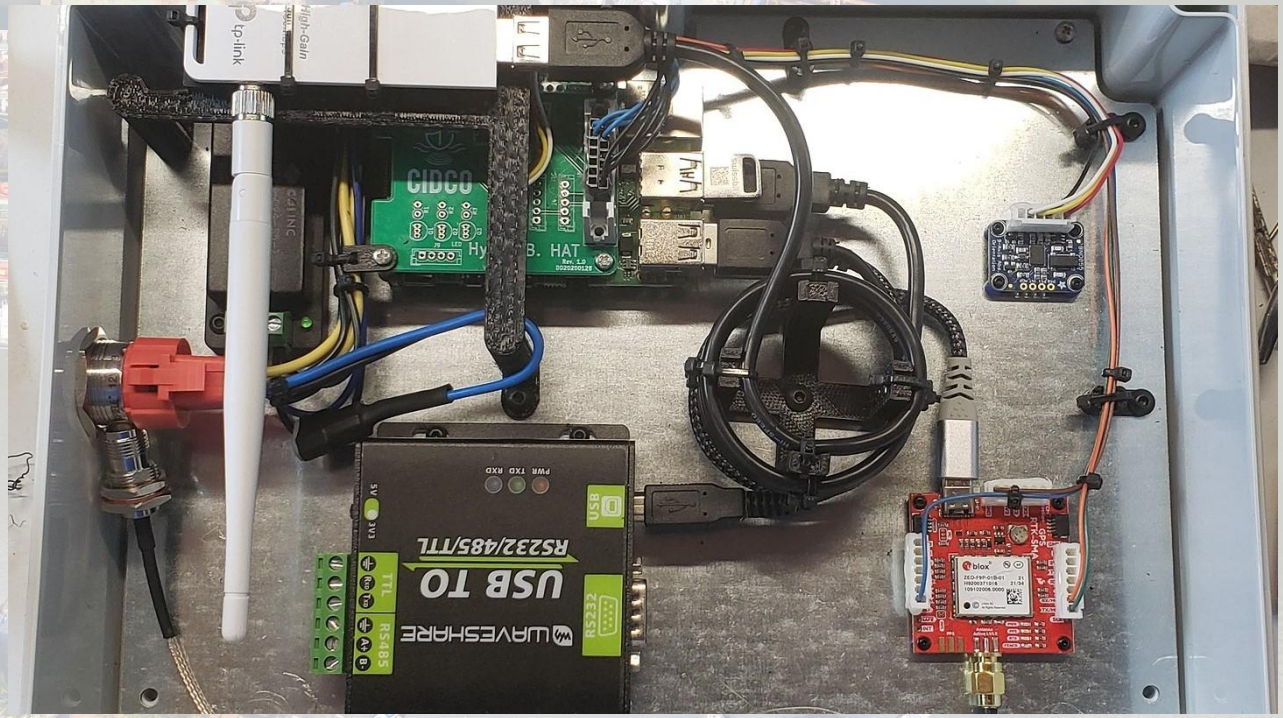
Next-Gen Data loggers: 24/7 data transfers

Dataloggers log data (!)

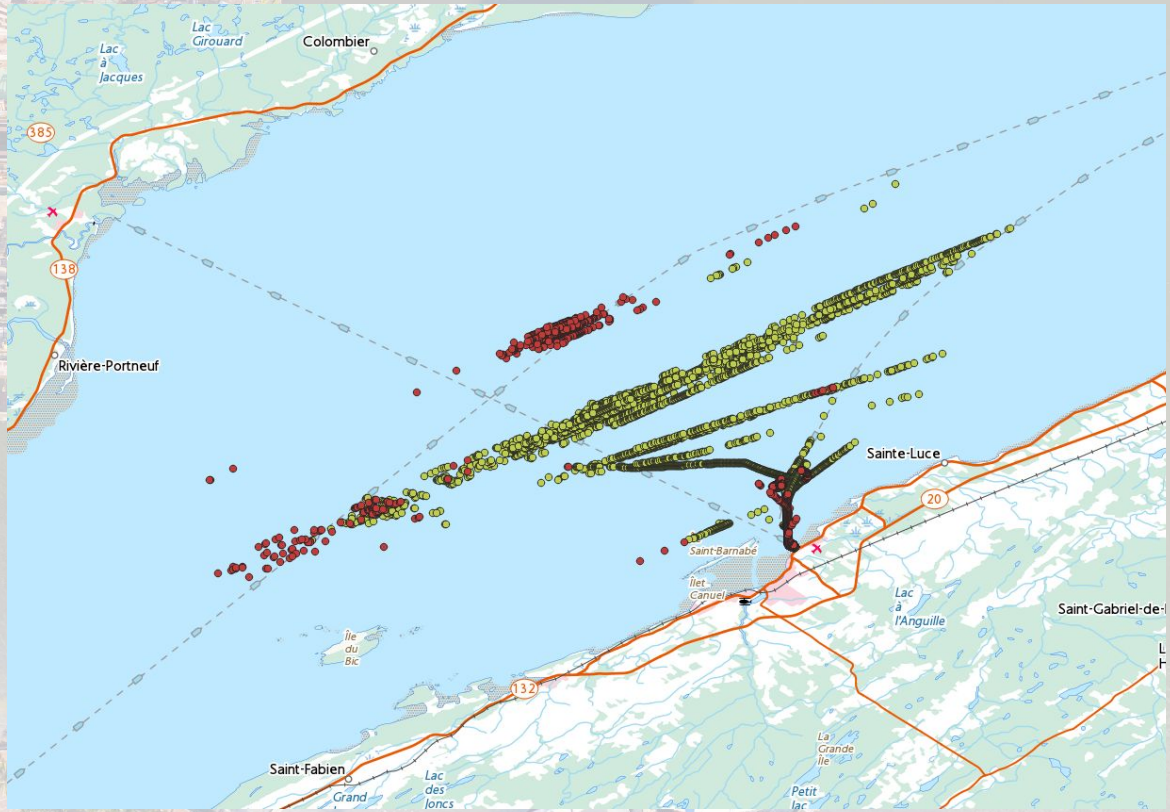
- AIS data can be harvested either directly from NMEA data streams, or intercepted off the air using cheap 20$ SDR receivers.
- AIS data can be leveraged to provide situational awareness about surrounding ships, and AtoN stations
- Continuous data transfer capabilities can be leveraged to spread this information
- AI can sift through this data very quickly to generate insights to mariners and other marine environment stakeholders.



Using AI to detect anomalous ship behavior

AI can be used to spot anomalous behaviors in complex spatial patterns using:

- Ship information and trajectory
- Ship position
- Ship course
- Ship speed



Using AI to detect anomalous ship behavior

These alerts feed an early warning system to bring stakeholders's attention to exceptional situations.

For example, boats with anomalously high speeds or exceptional navigation courses are easily detected on this marina map.

Challenges

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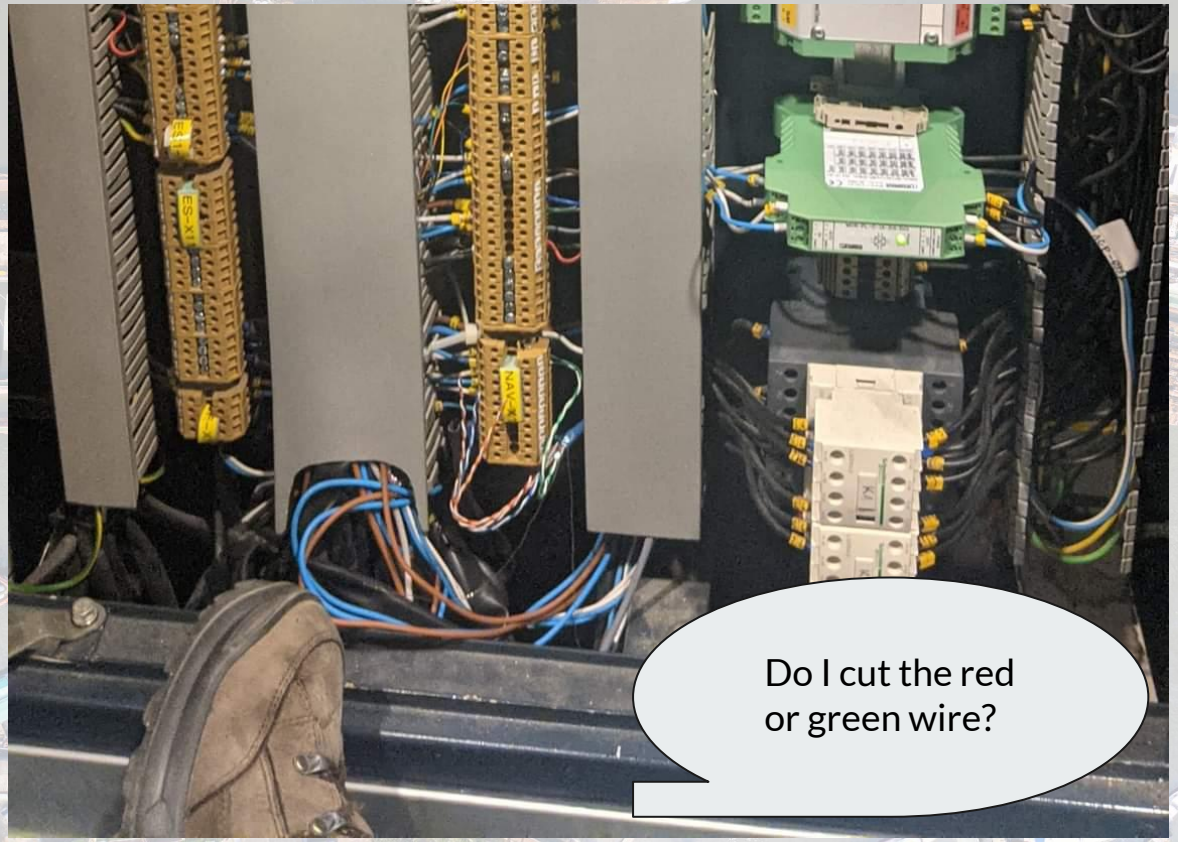
Universal User-friendly Installs And Unicorns Live in the Same World

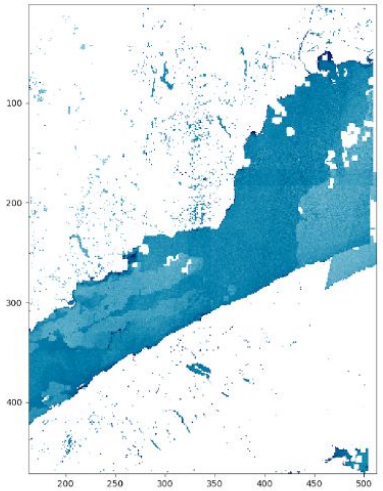


Customer Support is Very Costly. Build a remote support channel.

Be Robust By Design: Because Everything Fails at Some Point.

Satellite-derived bathymetry: Natural Allies

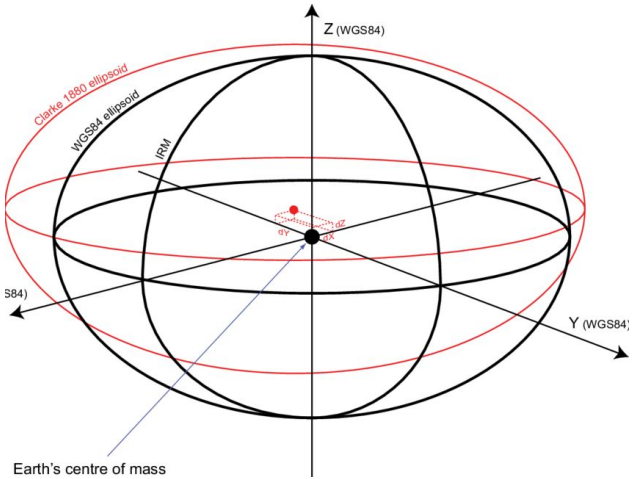
SDB empirical models require ground-truthing data. CSB outputs are SDB inputs, and as such, they constitute natural allies to promote the adoption of CSB.



Quantifiable Uncertainty: Ellipsoid Referenced Surveys

Using ellipsoid referenced surveying removes tremendous headaches:

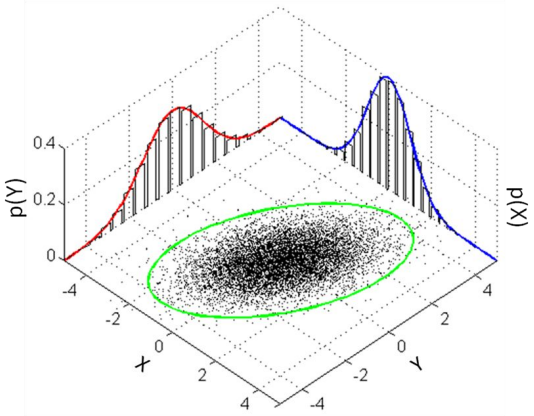
- Dynamic drafts, especially with cargo ships and small vessels
- Heave measurements can be unnecessarily painful
- Tide data



Quantifiable Uncertainty: Total Propagated Uncertainty Model

There is tremendous value in taking the time to develop a ***total propagated uncertainty (TPU) model*** for easy computation of standard deviations on the outputs (longitude, latitude, depth) based on the known standard deviations on the input measurements (GNSS longitude, GNSS latitude, GNSS height, IMU heading, IMU pitch, IMU roll, depth at sonar transducer).

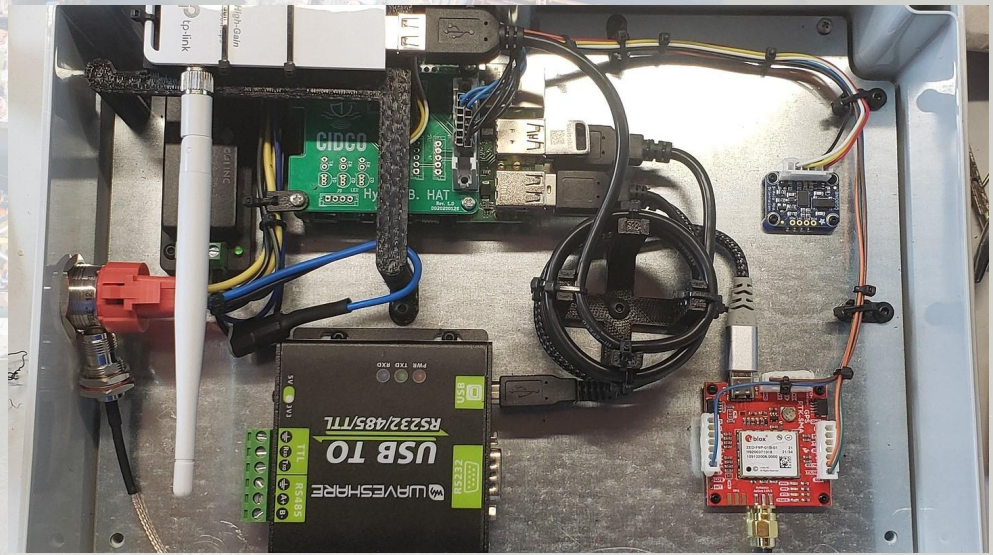
Total Propagated Error=$J \boldsymbol{\Sigma} J^T$



Quantifiable Uncertainty: A Key Decision Making Tool

Knowing the uncertainty on the bathymetry **solves the problem of determining if CSB is suitable or not for a given purpose.**

Giving stakeholders a quantifiable metric to drive their decision to use the data is **fundamental key to CSB adoption**.



Thank you

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