

A decorative graphic on the left side of the slide. It features several circles in orange, light blue, and dark blue. A central dark blue circle contains the word 'MERIDIAN' in white capital letters and is filled with small, multi-colored numbers. To the right of this central circle is a series of vertical orange bars of varying heights, resembling a sound waveform.

An Atlas of the Changing Soundscape in Canadian Oceans

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Ocean Soundscape Atlas



Concept:

- Web-based interactive application
- 2D and 3D visualization of modeled noise levels

Purpose:

- Facilitate transfer of scientific results from researchers to the public
- Allow managers and policy makers to monitor trends in the ocean acoustic environment
- Ensure timely, effective, and efficient marine environmental management

Traditional Atlas



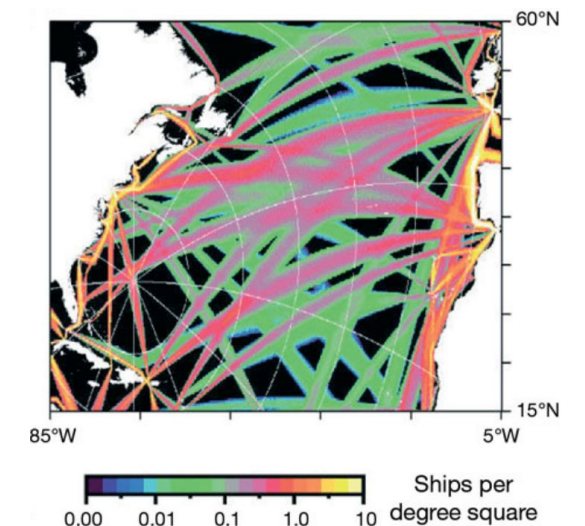
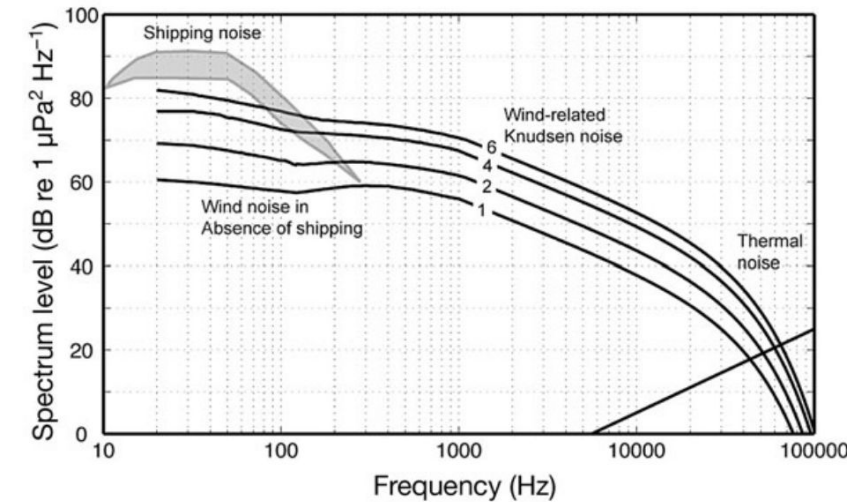
Credit: Wikipedia

Motivation



- Fish and marine mammals use sound for navigation, habitat selection, mating, communication, prey detection, etc
- Marine organisms may be expected to modify their behavior based on natural and anthropogenic background noise.
- Ships are a dominant source of noise at low frequencies.
- Significant increase in the number and size of vessels over the past 50 years.
- Evidence suggests overall increase of ~20 dB from pre-industrial conditions to the present.

Hildebrand, J. A. (2009). "Anthropogenic and natural sources of ambient noise in the ocean," Marine Ecology Progress Series 395, 5-20.



Context



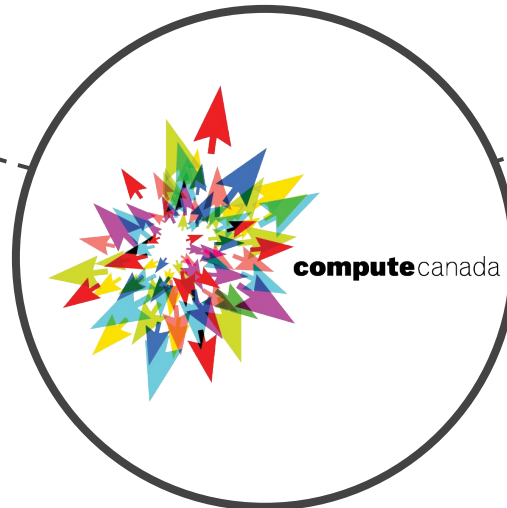
Research groups



Data portals



HP Computing



Soundscape components



Anthropo-phony



Shipping, oil and gas (air-guns, ships, drilling), naval operations (sonars, communications, explosions), fishing (sonars, acoustic deterrent devices), research (air-guns, sonars, telemetry, communication, navigation), construction, icebreaking, recreational boating, ...

Bio-phony



Sounds produced by fish and marine mammals

Credit: Reinhard Dirscherl/Alamy Stock Photo

Geo-phony



Earthquakes, waves, rain, thermal, ...

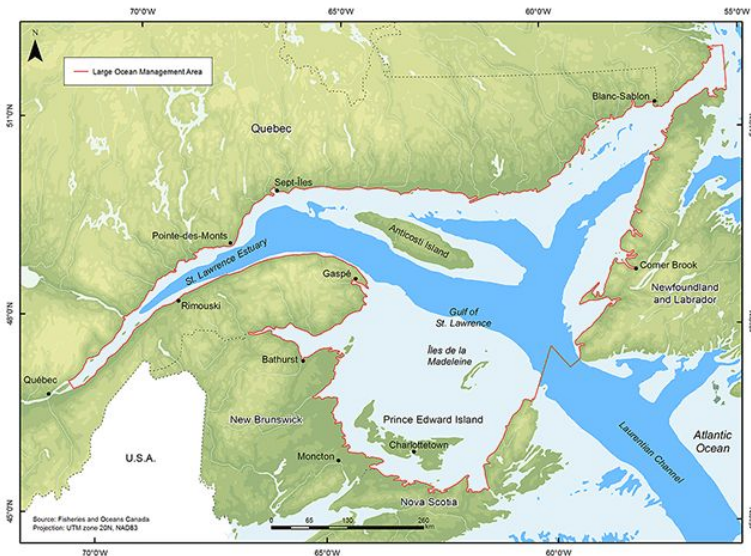
First prototype



- Estuary and Gulf of St. Lawrence
- 2013 and 2018
- Noise sources:
 - Shipping
 - Waves and rain



- North Atlantic Blue Whale (endangered)
- a few hundred individuals
- A and B calls, 15-19 Hz
- D call, 30-100 Hz



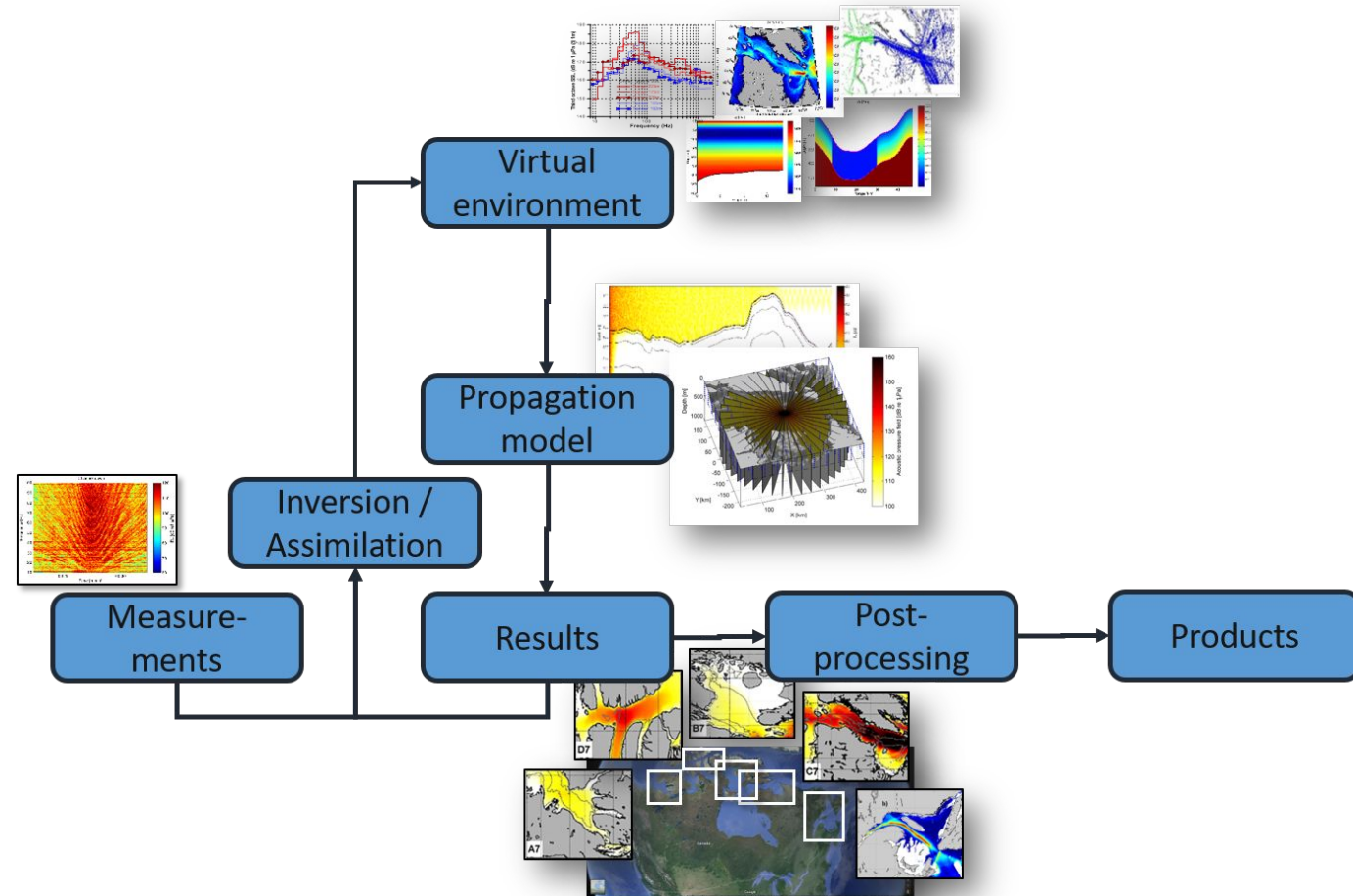
Shipping noise modeling



Key ingredients:

- AIS vessel tracking data
- Realistic ship source levels
- Accurate modeling of sound propagation
 - Bathymetry
 - Seafloor acoustic properties
 - Water properties (temp, salinity, etc)
 - Numerical solution of wave equation
- Validated by measurements

[Aulanier, Simard et al. Proc. Mtgs. Acoust. 27, 070006 \(2016\)](#)



Environmental noise modeling



Modeled data:

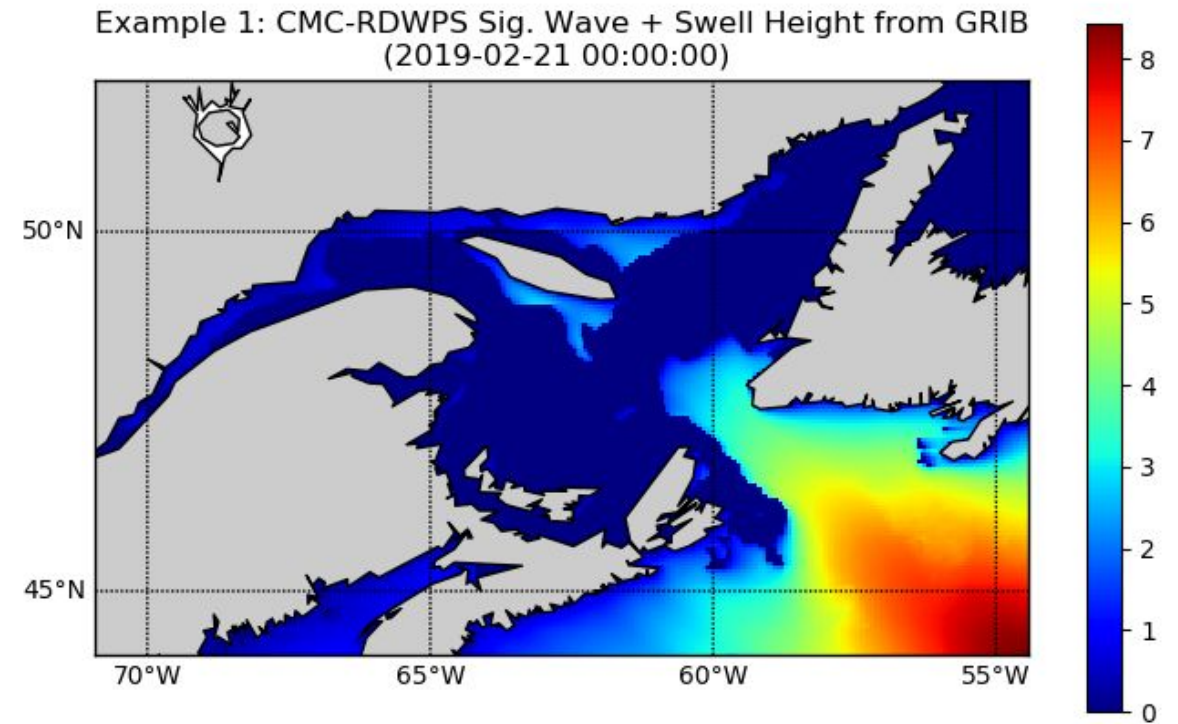
- Significant height of combined wind waves and swell
- Mean wave direction
- Mean wave period

Data sources:

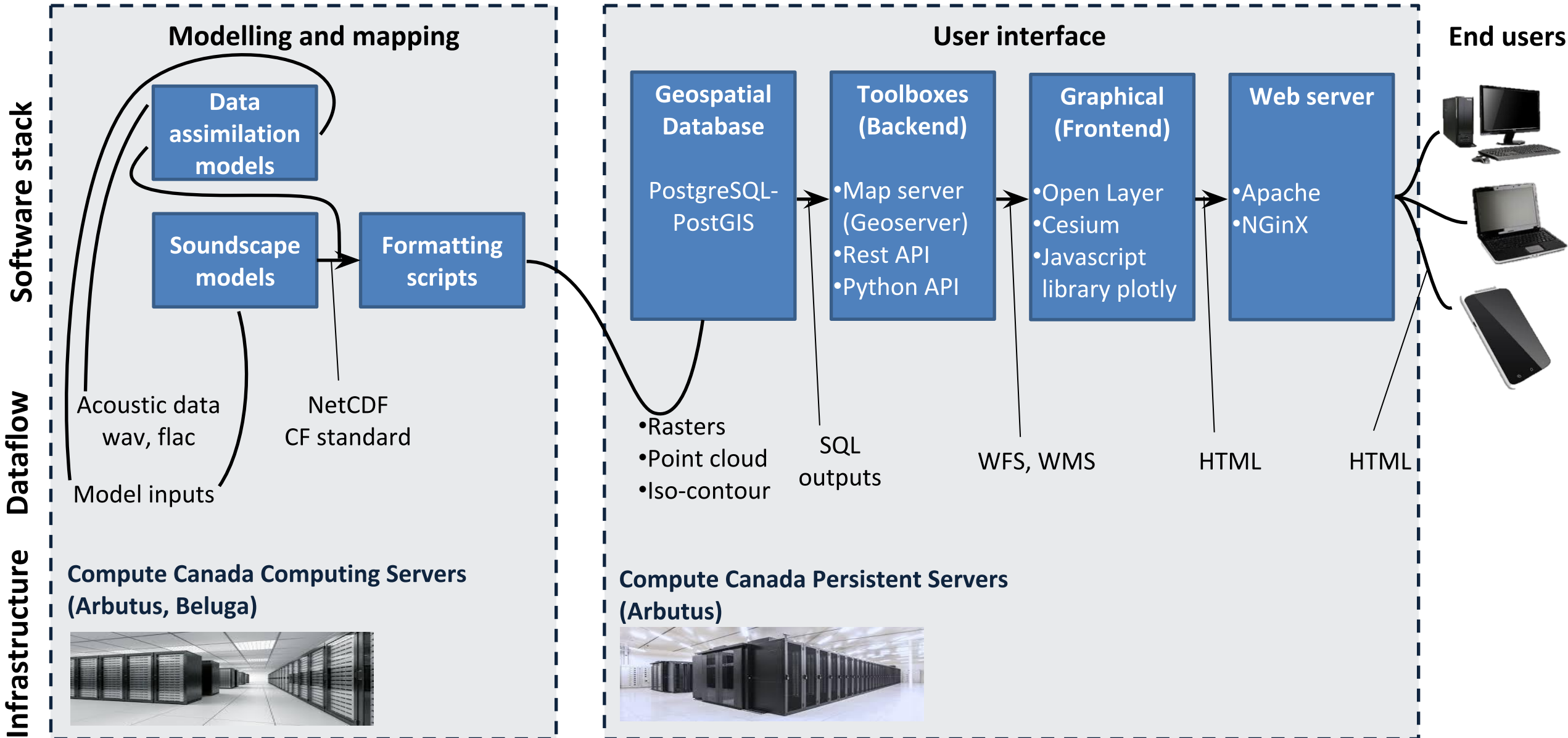
- ECMWF ERA 5
- NOAA Wavewatch III
- Env. Can. RDWPS

Open-source Python package:

- Automatic retrieval of relevant environmental data
- Interpolation of retrieved data
- Calculation of source sound level and transmission loss



Technical structure



Risk maps

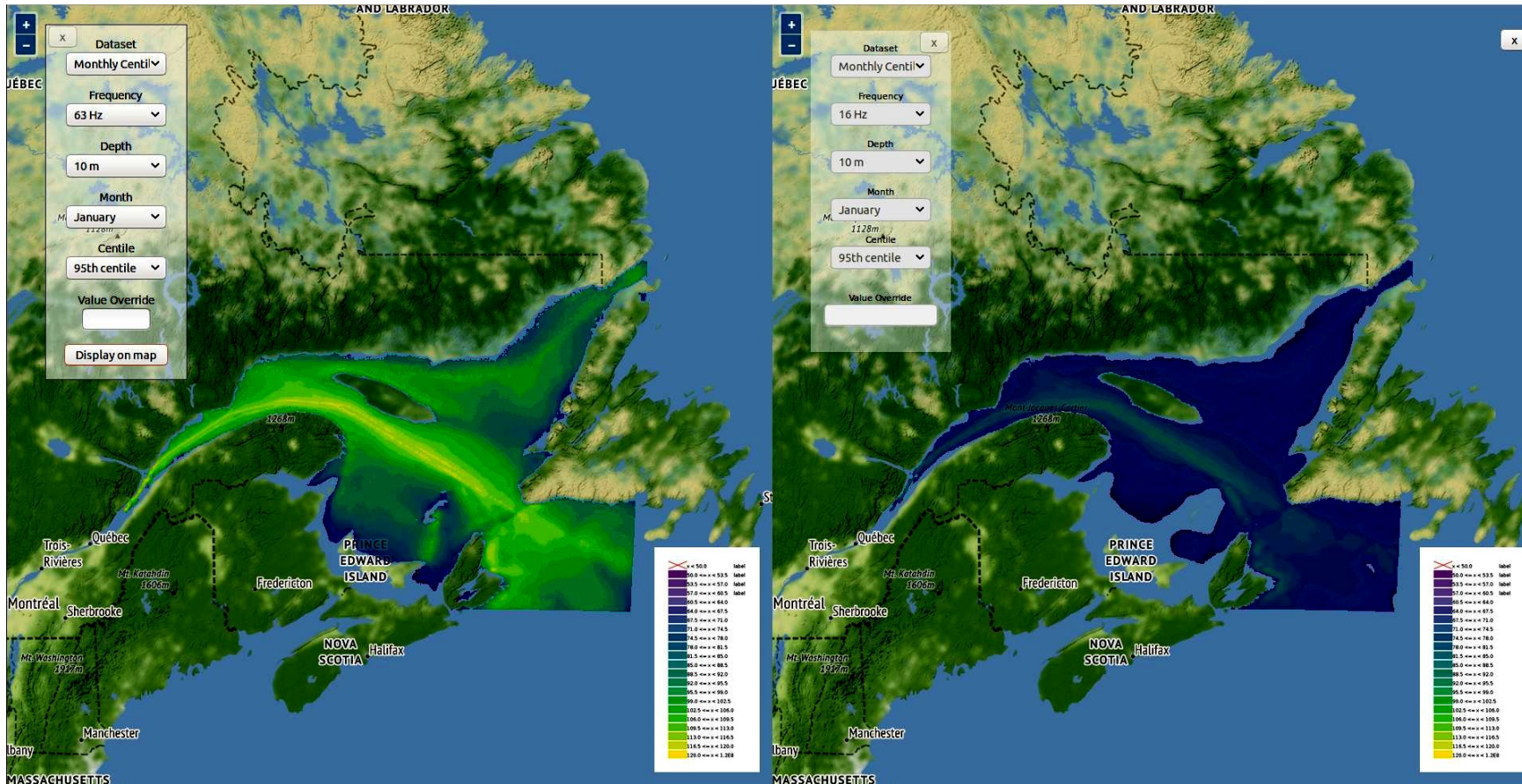


Risk to exceed 90 dB at 63 Hz and 150 m in July 2013

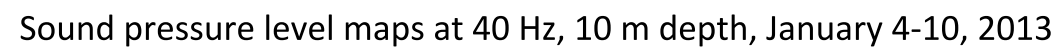


Risk to exceed 90 dB at 40 Hz and 100 m in January 2013

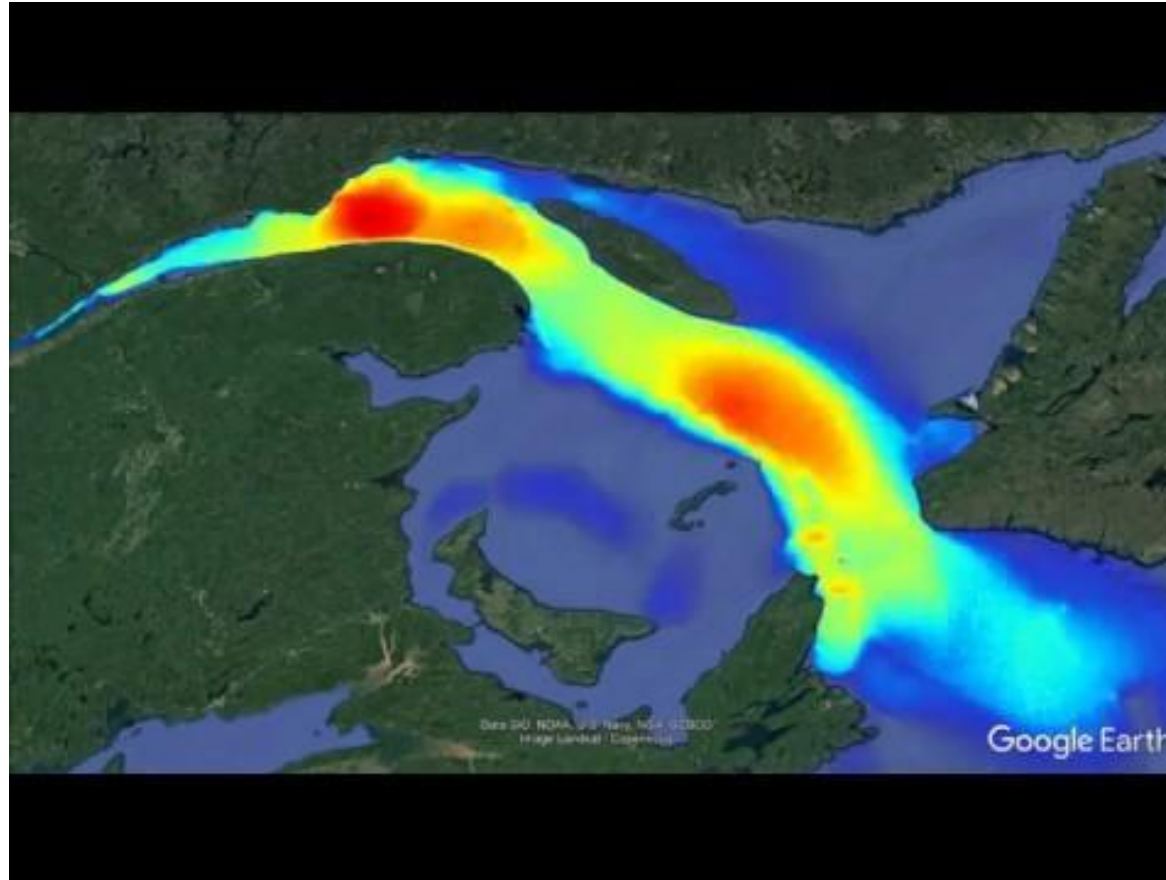
Percentile maps



Comparison between the 95th percentile of January 2013 shipping noise levels at 63 Hz (left) and 16 Hz (right)



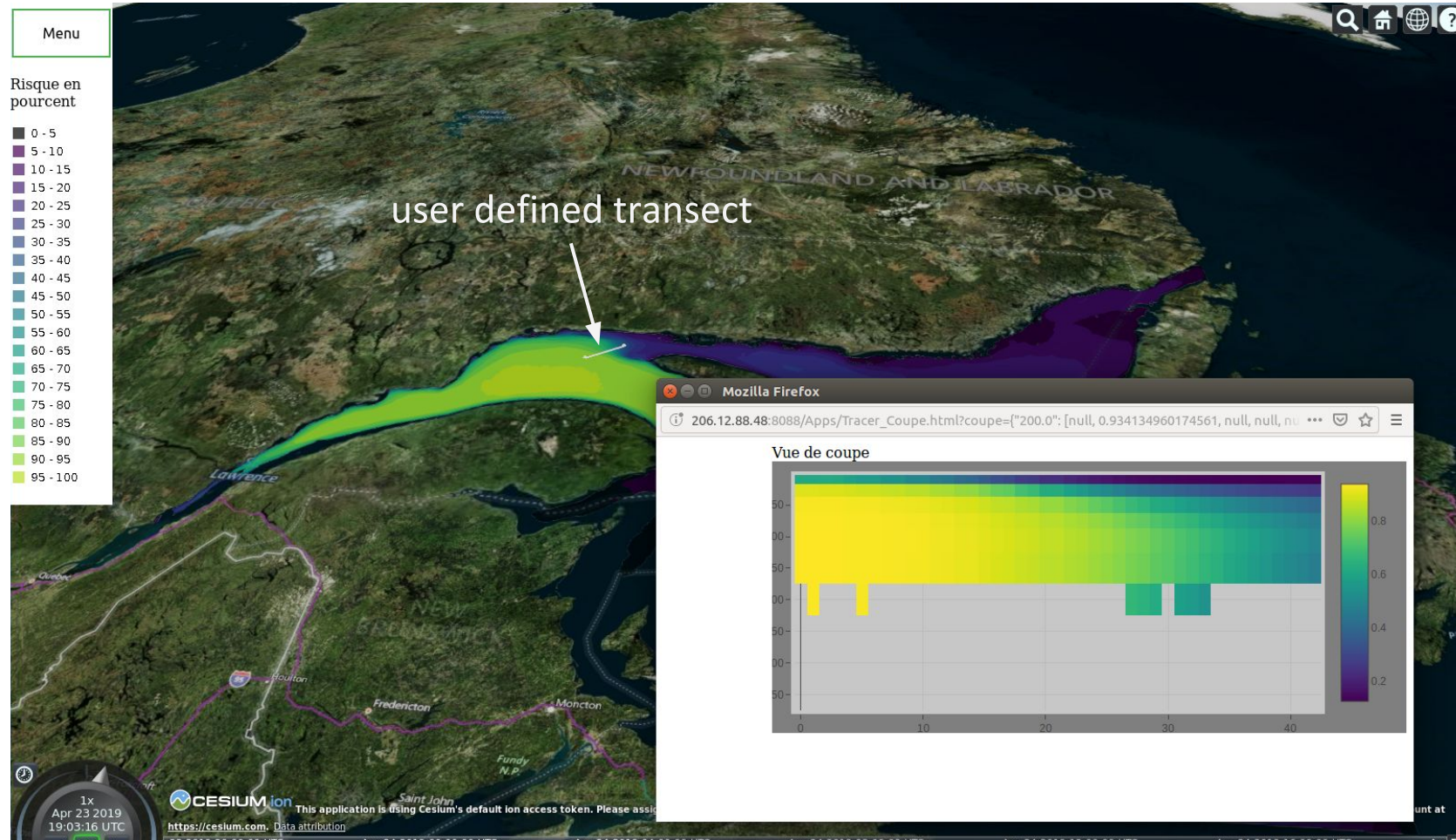
OceanPredict'19, May 6-10, 2019, Halifax, NS, Canada



Daily risk maps to exceed 85 dB at 40 Hz, at 10m depth, from January 1st to February 23rd, 2013

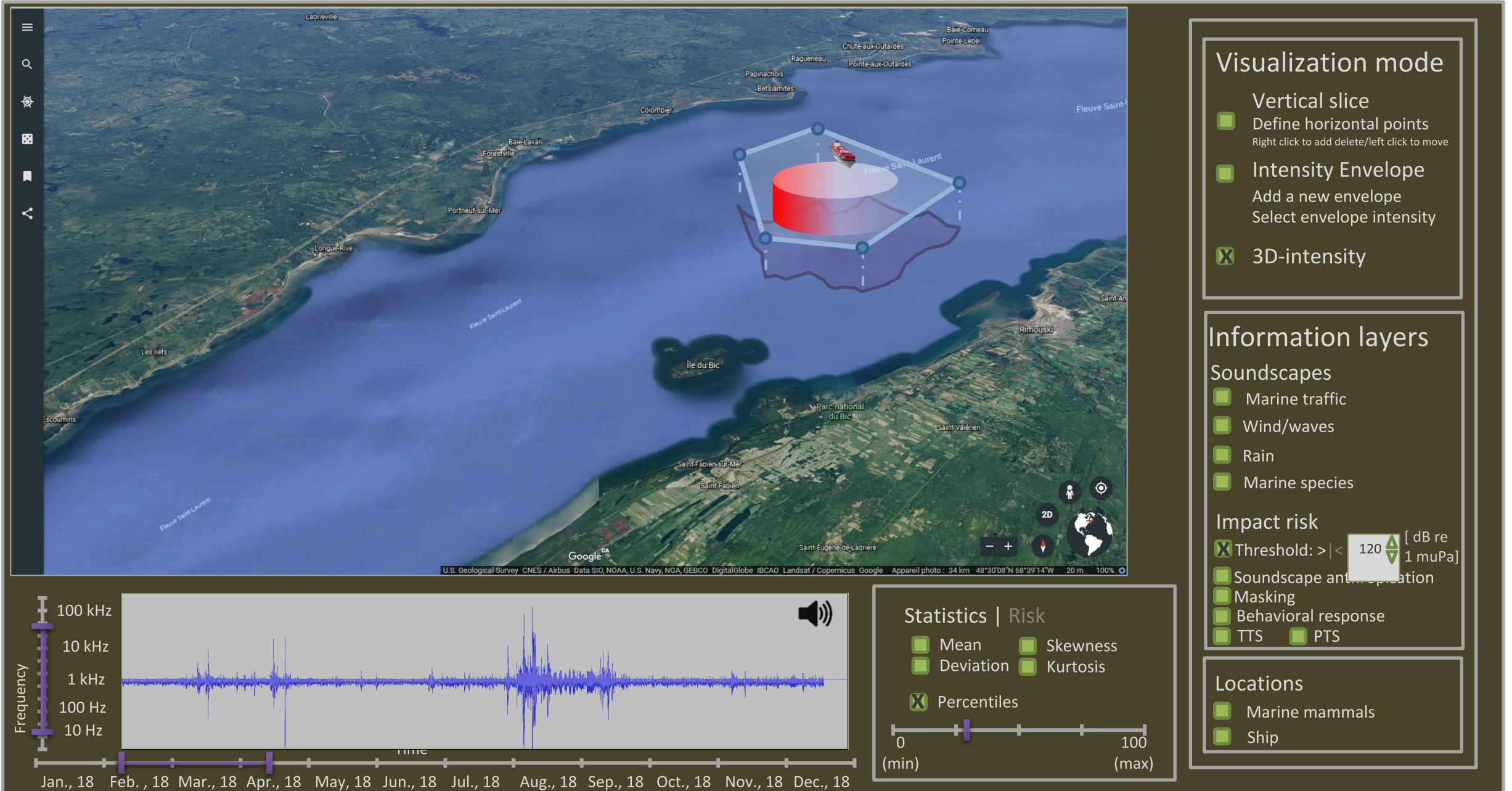
OceanPredict'19, May 6-10, 2019, Halifax, NS, Canada

Vertical slice

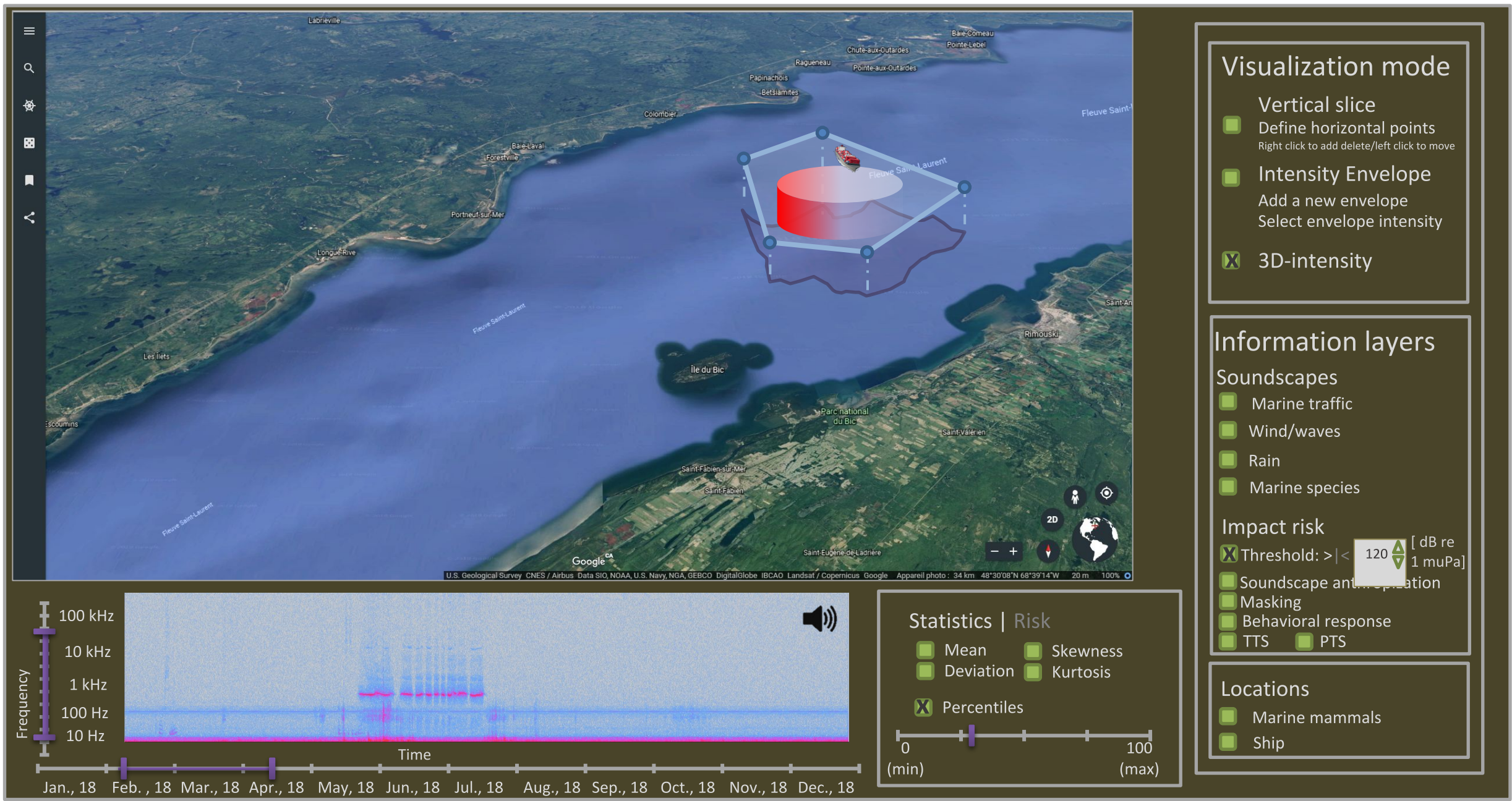


OceanPredict'19, May 6-10, 2019, Halifax, NS, Canada

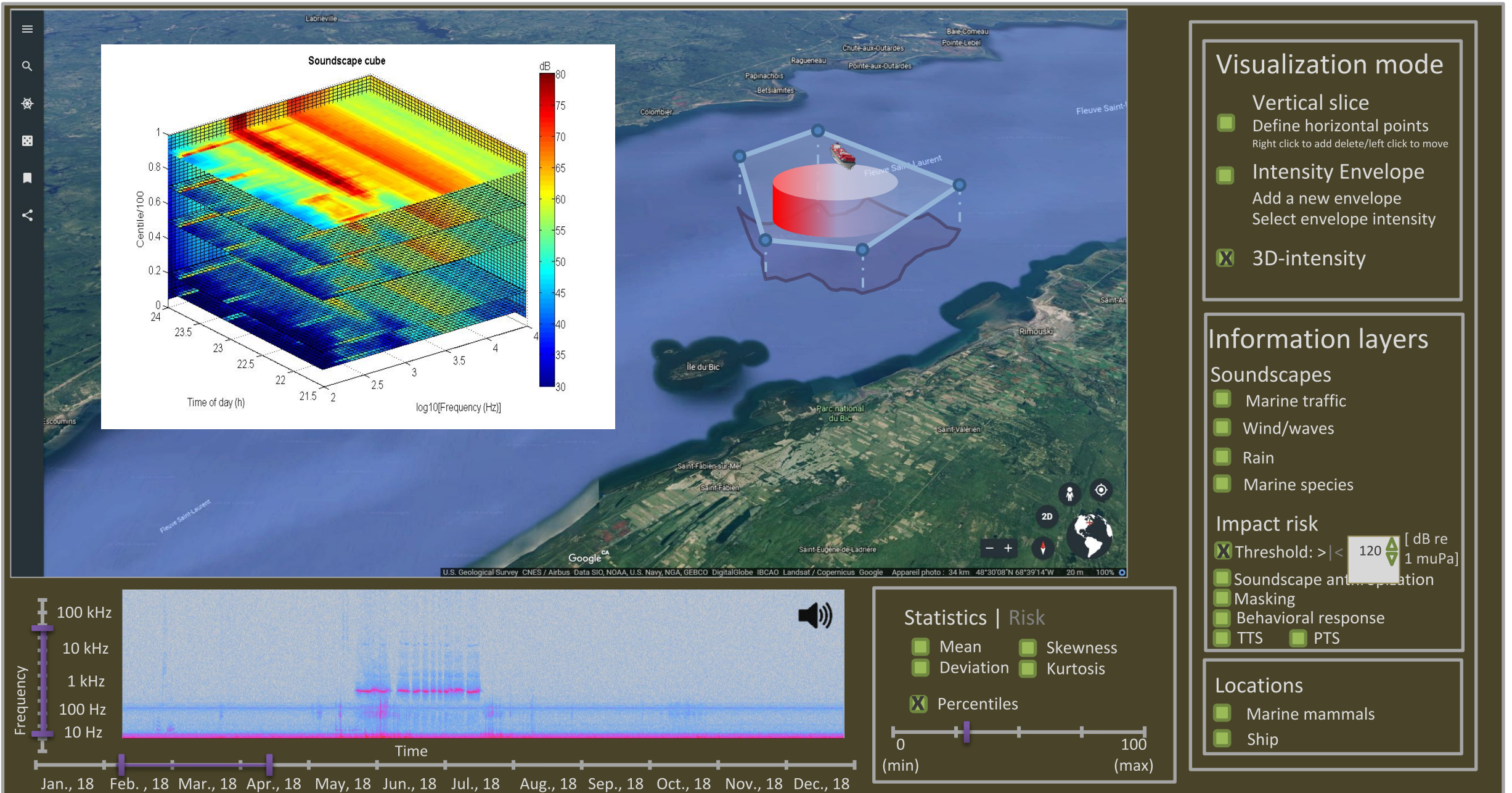
Envisioned interface



Envisioned interface



Envisioned interface



Conclusion



- MERIDIAN is developing an web-based, interactive application for visualizing modeled underwater noise in Canadian waters
- We call it the "Ocean Soundscape Atlas"
- The first prototype of the Atlas will focus on the Estuary and Gulf of St. Lawrence and include noise due to shipping and waves and rain.
- We envision that the Atlas will contribute to increased ocean literacy and ensure timely, effective, and efficient marine environmental management

Acknowledgements



Funders



Partners





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