

Interoperable and scalable echosounder data processing with Echopype

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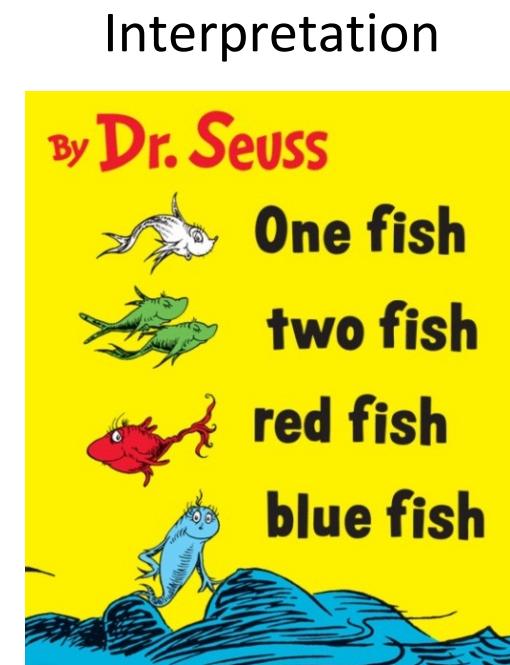
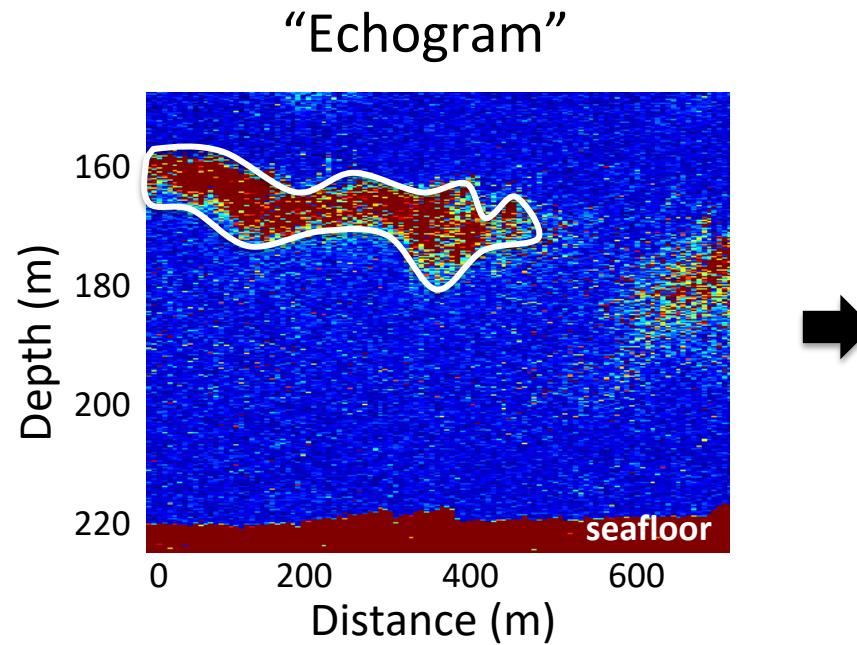
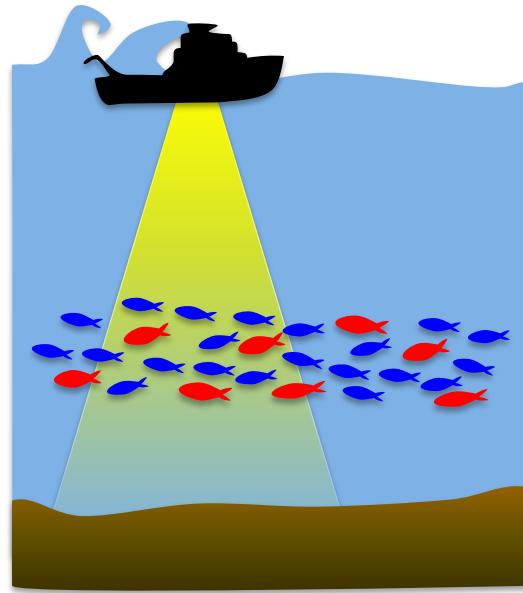


Echospace

ASA Virtual 2024 | November 19, 2024

uw-echospace.github.io

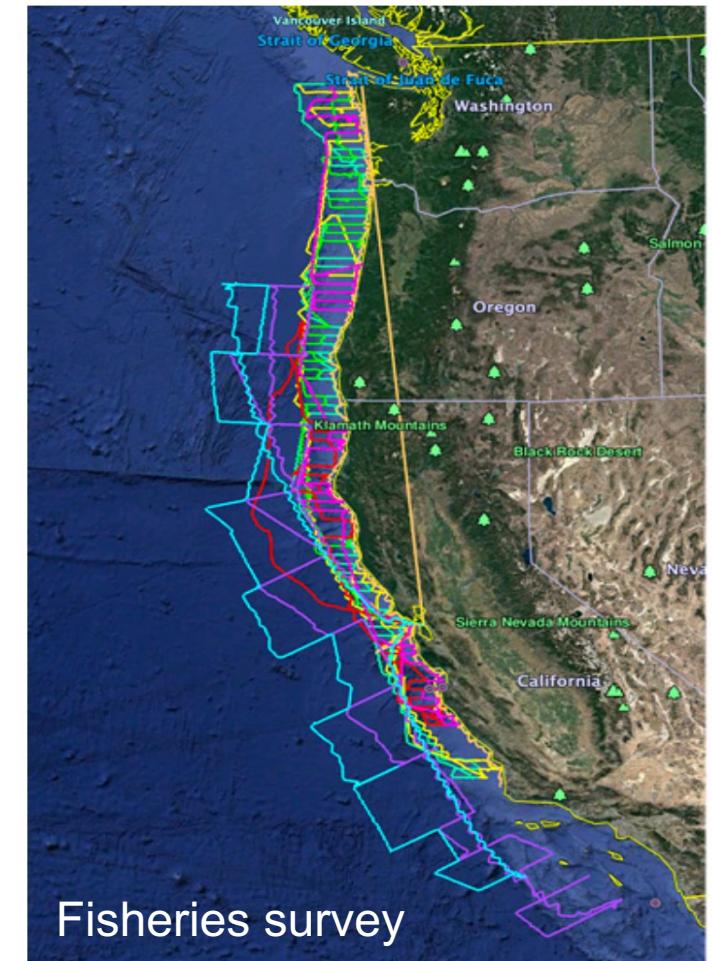
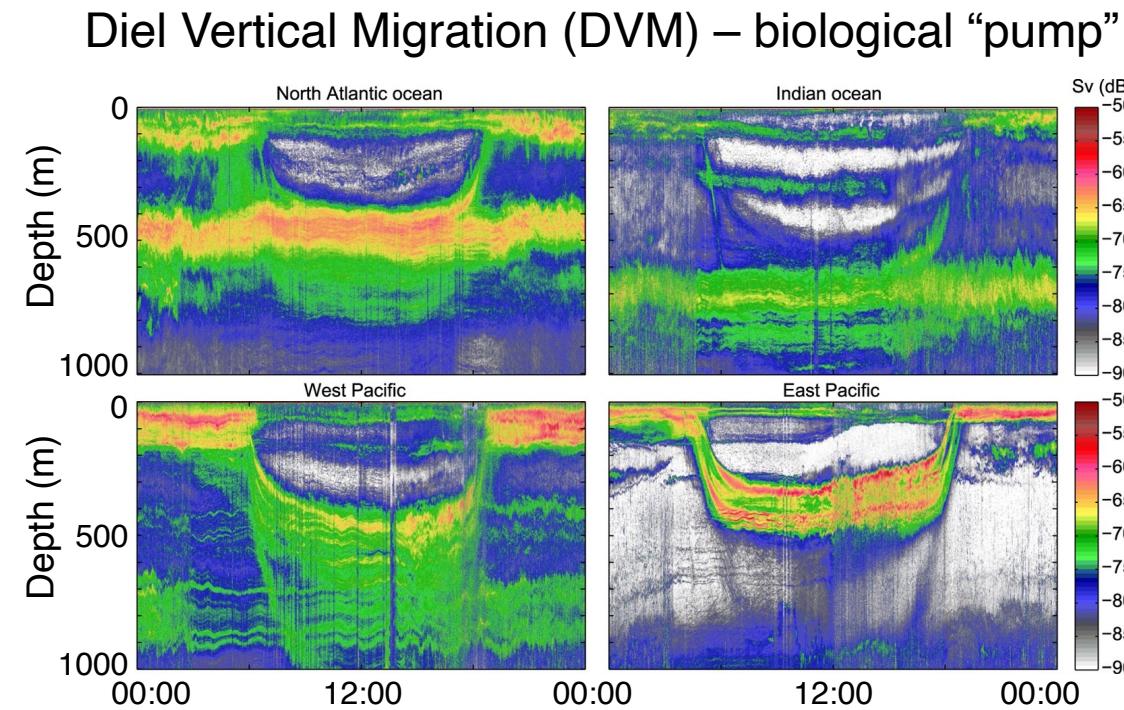
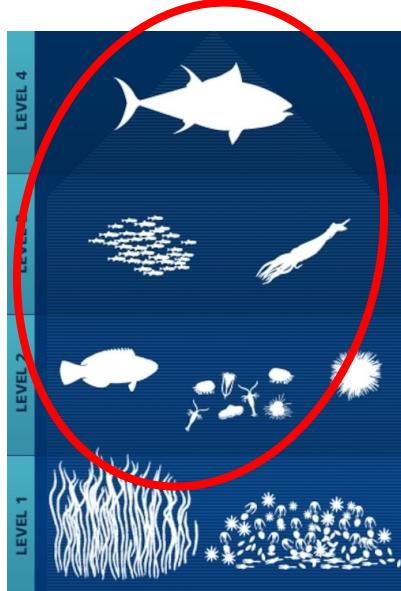
Echosounders “image” the interior of the ocean with sound



- Echosounders: high-frequency active acoustic (sonar) systems
- Echogram: images formed by echoes
- Interpretation of echoes: scatterer identity, number, etc.

Echosounders are the workhorse of observing marine life

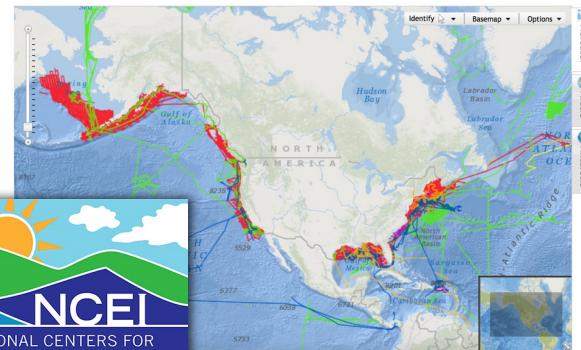
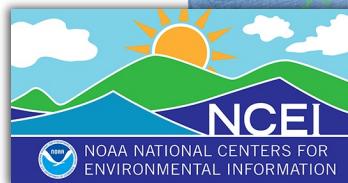
- Particularly useful for observing fish and zooplankton
- Large-scale, long-term observation
- Marine ecosystem monitoring and fisheries management



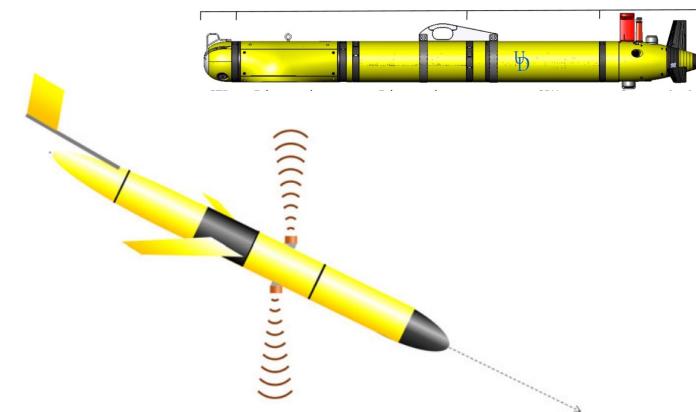
We've become very good at collecting echosounder data

- Flexible deployments with many ocean observing platforms

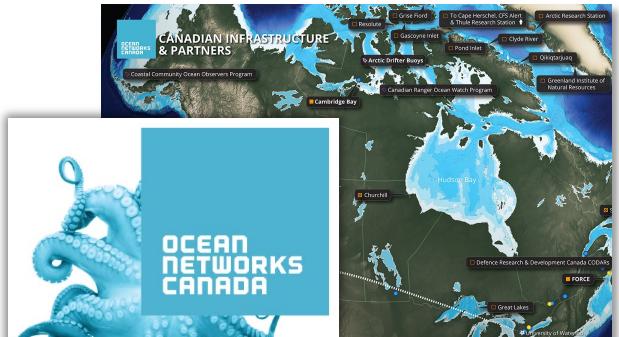
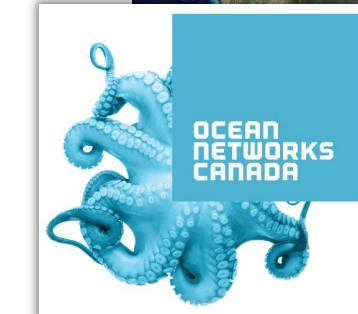
Ships



Moorings



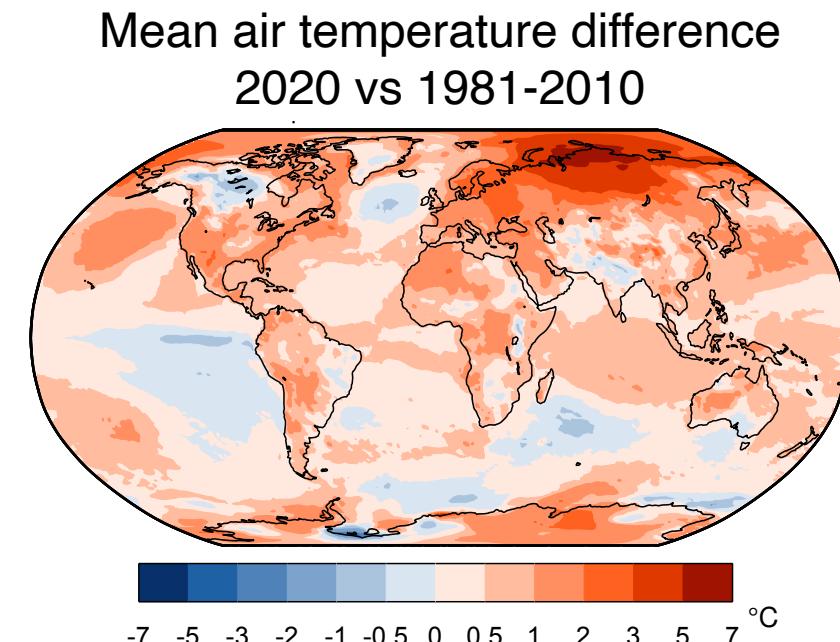
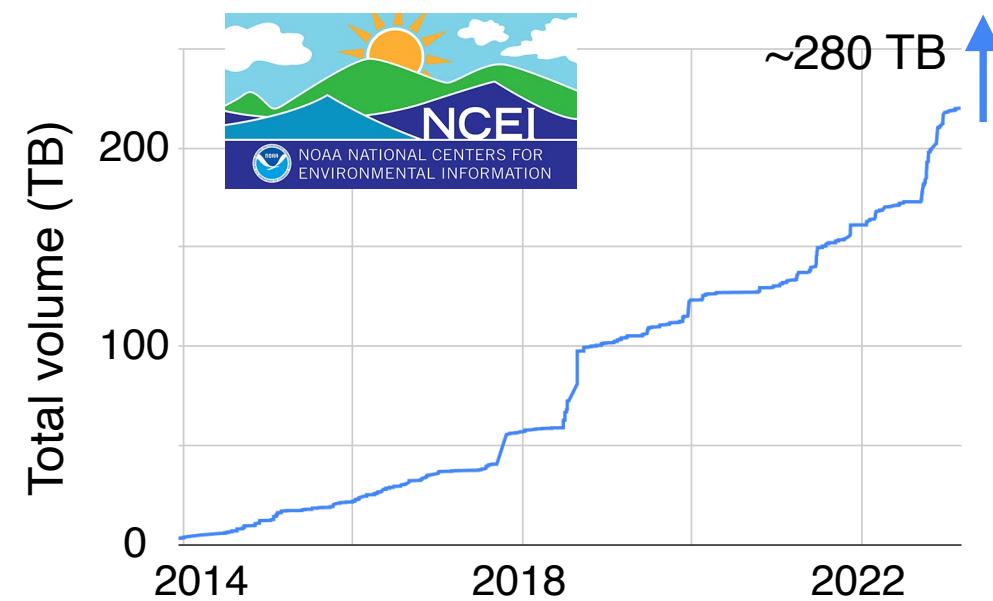
Autonomous surface & underwater vehicles



Opportunities from the echosounder data deluge

- Significant growth of data volume over the past decade
- Derive large-scale patterns and trends in time and space?
- Understand marine ecosystems response to climate change?

Software ← Today
+
Models / methods



Echostack is an integral part of the scientific Python ecosystem



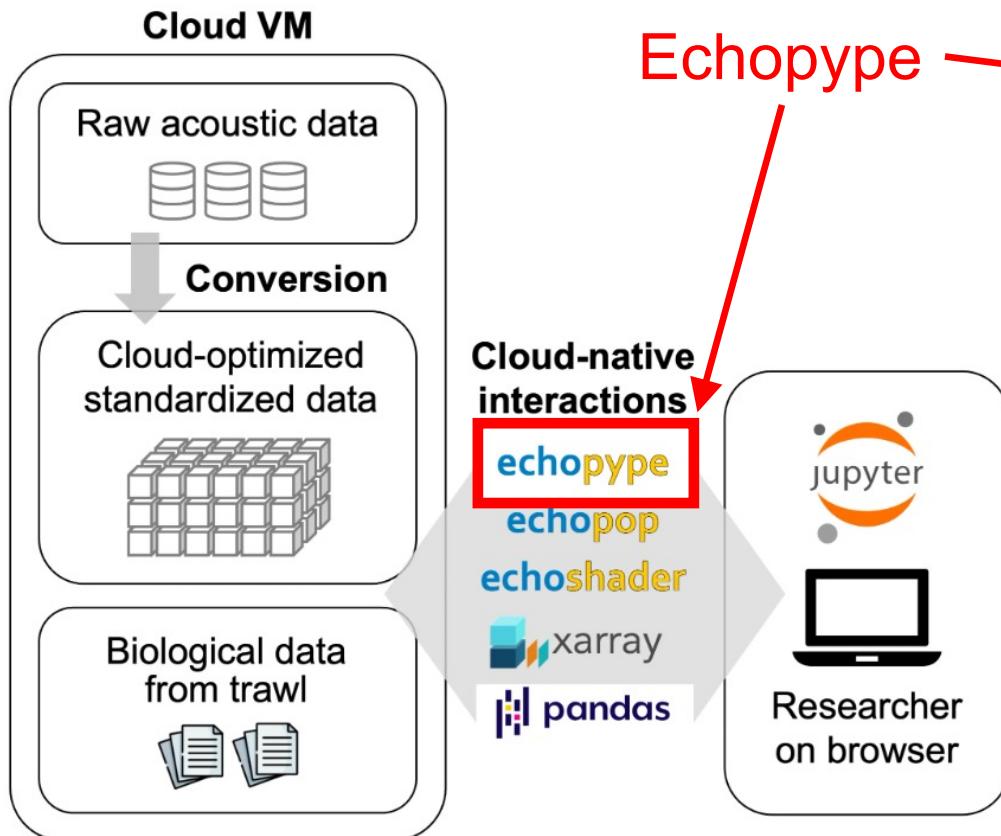
[SciPy 2024 talk](#)

See details in : <https://doi.org/10.25080/WXRH8633>

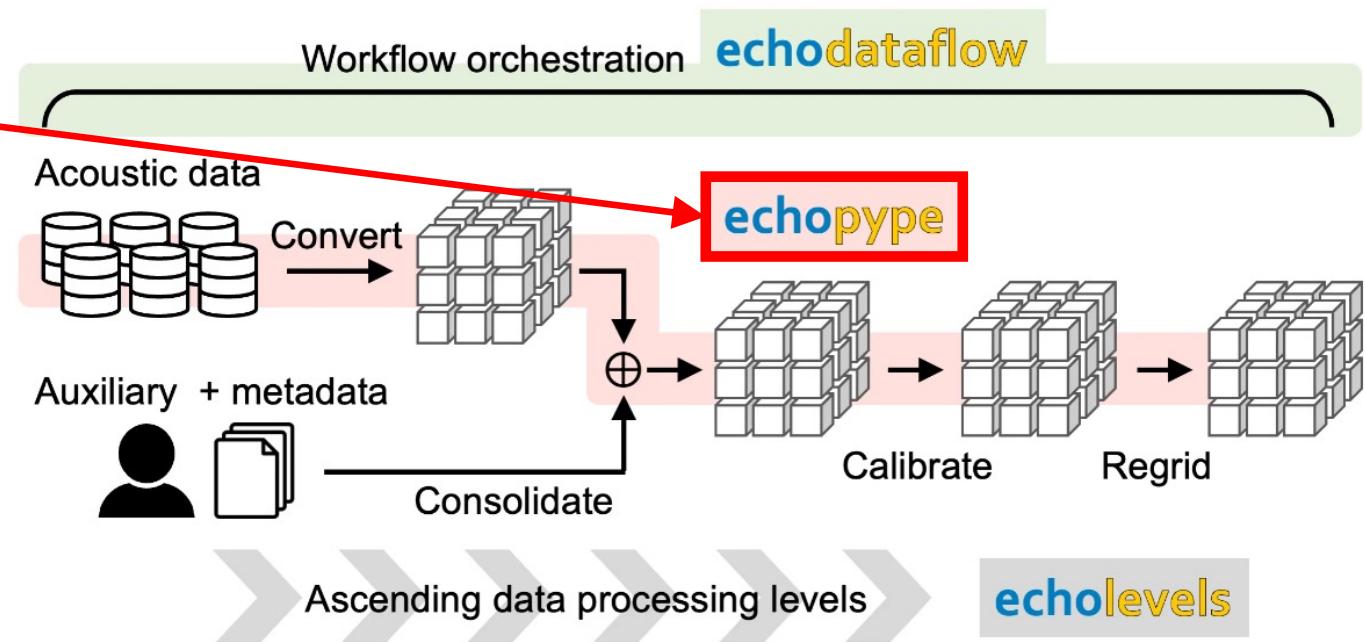
Core dependencies	Package	Usage	Specific dependencies
 fsspec  netCDF  Zarr  dask  xarray  pandas	echotype	Data conversion, aggregation and computation	
	echoregions	Interface between analysis masks and echogram	 regionmask
	echopop	Incorporate trawl data for biological estimates	
	echoshader	Interactive visualization with large datasets	 HoloViz
	echodataflow	Orchestrate workflow on local or cloud platforms	 PREFECT  Pydantic
	echolevels	Proposed data processing levels specifications	

Use case examples

- Day-to-day research use
 - Ourselves and other researchers



- Mass production of analysis-ready, cloud-optimized (ARCO) data
 - Adoption: NOAA NCEI and NSF OOI



- A ship-to-cloud ML pipeline: see [SciPy video](#)

Echopype example: watch zooplankton response to a solar eclipse

- Echopype
 - Platform-agnostic
 - Standardized data to interoperable format
 - Scalable computation
- Example data
 - Ocean Observatories Initiative (OOI)
 - Echosounder on Regional Cabled Array
- Links
 - Paper: <https://doi.org/10.1093/icesjms/fsae133>
 - Code repository:
<https://github.com/OSOceanAcoustics/echopype>
 - Example notebooks:
<https://github.com/OSOceanAcoustics/echopype-examples>



Cabled echosounder
offshore Oregon, US

We are continuing to build...

- Lessons learned
 - Instrument data is messy
 - Scaling is not trivial: 100 MB vs 100 GB/TB
 - Software needs constant maintenance
 - Communication is key to community and organization buy-in
 - Open-source software needs funding!



- Goal: Catalyze community-wide collaborations and workflow transformation



uw-echospace.github.io

Reach out if interested!



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Butala



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Tuguinay



Emilio
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Brandy
Lucca



Dingrei
Lei



Julia
Clemons



Alicia
Billings



Rebecca
Thomas



Beth
Phillips



Dezhang
Chu

THANK YOU!

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OCEAN
EXPLORATION

