Ocean Digital Twins

From Data to Decisions

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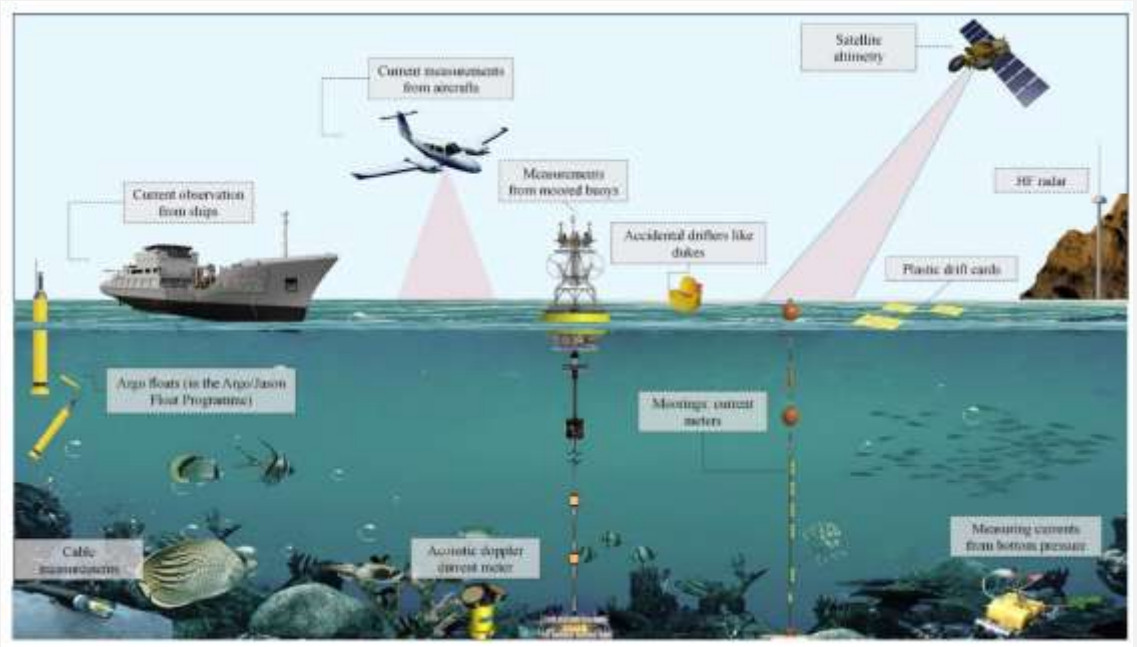
Oceans generate petabytes but decisions still lag.

50+ PB/yr — Marine observation data produced globally each year.

4,000 — Argo floats profiling the subsurface ocean in near-real-time.

200k+ — Vessels broadcasting ais tracks at any given moment.

6 hrs — Typical latency from observation to actionable policy brief.



Credits: Ocean Remote Sensing Techniques and Applications: A Review (Part I) https://www.mdpi.com/2073-4441/14/21/3400

We have the data. What we lack is the synthesis layer that turns it into timely, defensible decisions

An Ocean Digital Twin is its living replica.

THREE QUESTIONS IT ANSWERS

WHAT IS

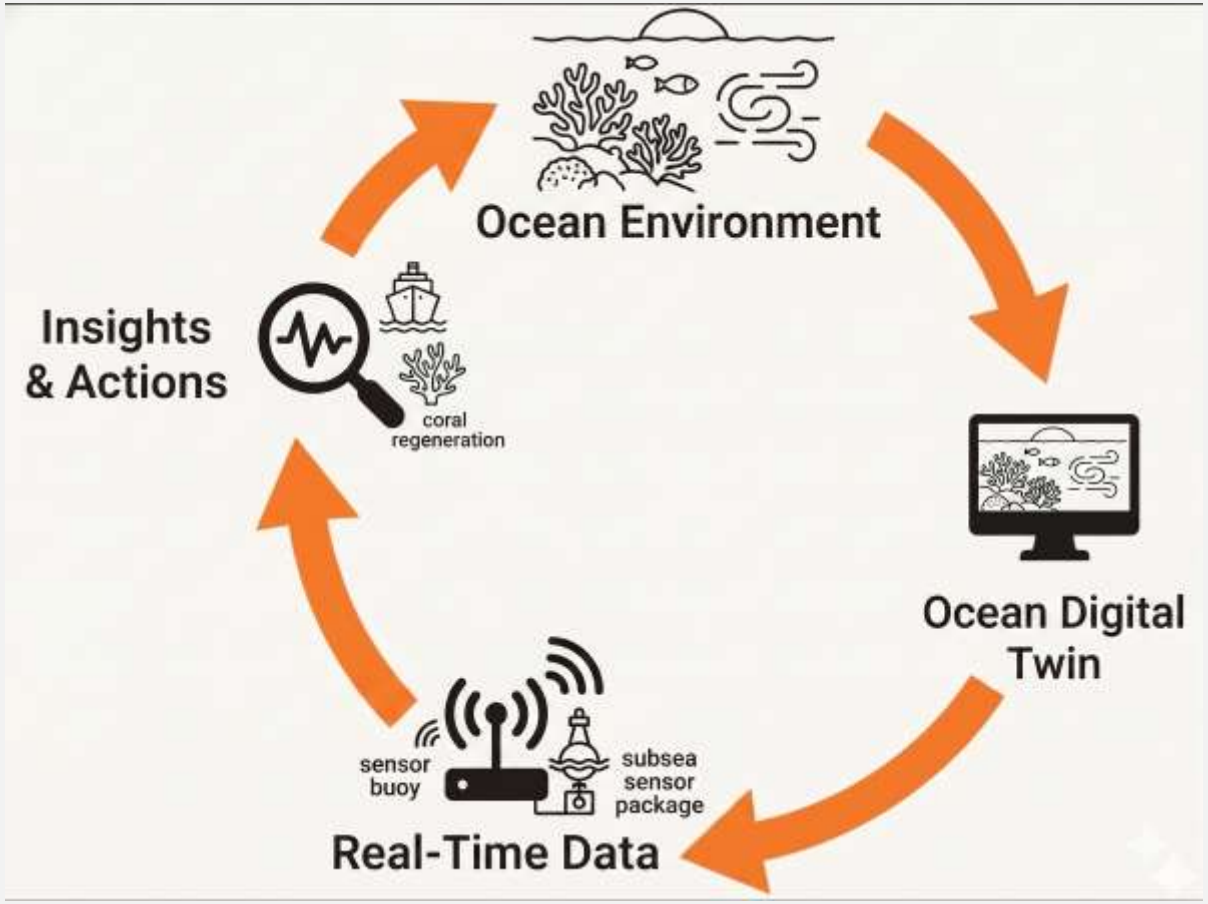
Current state of the ocean, observed and assimilated

WHAT NEXT

Short-range forecasts for surge, bloom, drift, traffic

WHAT IF

Counterfactuals for policy, planning, and crisis response



> Not a dashboard. Not a GIS layer. A continuously updated simulation that fuses satellite, sensor, and model data and lets anyone ask what is, what next, and what if.

The Data Backbone | Sensing layers that feed the twin

SOURCE	VARIABLES	RESOLUTION	LATENCY	ACCESS
Public satellites	SST, ocean color, SSH, winds, SAR	0.3 km – 10 km	min – hrs	Open
Commercial sats	Optical, SAR, RF	< 1 m – 5 m	~daily	Paid
Argo floats	T / S profiles, BGC	0–2000 m · ~3°	10-day cycle	Open
Drifters	SST, currents, pressure	~5° × 5°	1-min	Open
Buoys & tide gauges	Waves, winds, sea level	Point	NRT	Open
Gliders / AUVs	T, S, O_2, chlorophyll	Meters vertical	hrs (Iridium)	DAC
HF radar	Surface currents	1–6 km · hourly	min	Open
Bathymetry	Seafloor depth	~500 m (GEBCO)	static	Open

Data becomes decisions through a real-time pipeline.

01 · OBSERVE

Multi-source ingest

Satellites · ARGO · buoys · gliders · AIS · ship reports

02 · ASSIMILATE

Federated data layer

Cloud · HPC · common standards (OGC)

03 · SIMULATE

Physics + AI models

Numerical ocean models accelerated by ML emulators

04 · SERVE

Decision interface

APIs · dashboards · alerts · scenario tools

LATENCY TARGET

Minutes

ACCELERATOR

AI emulators

OUTPUT

A single source of truth

Use Case 01: Disaster Resilience

Storm surges can be forecast before they hit shore.

01 Surge modeling at neighborhood resolution

Twins couple cyclone tracks with bathymetry, tides, and river discharge to predict flood extent street-by-street.

02 Scenario planning for infrastructure

Sea-level rise × cyclone intensity simulations inform where to harden — and where to retreat.

03 Near-real-time early warning

Continuous twin output feeds SMS alerts, evacuation triggers, and emergency response dashboards.

Use Case 02: Ecosystem Management

Algal blooms can be predicted before fisheries collapse.

01 Bloom forecasting

Fuse chlorophyll, SST, and nutrient flux to predict HABs days in advance.

02 Sustainable fisheries

Real-time stock models set quotas that track reality, not last year's data.

03 MPA monitoring

Continuous biodiversity metrics turn conservation from audit to operations.

Use Case 03: Cross Border Coordination

Oceans ignore borders coordination cannot.

01 Shared situational awareness

A Bay of Bengal twin gives every riparian state the same operational picture.

02 Transboundary spatial planning

Harmonized data for migratory stocks, Federa.

03 Joint enforcement & response

Coordinated action on pollution drift, illegal fishing, and emergency SAR.

Takeaways

Unified ocean intelligence

Today's ocean datasets are large but siloed across institutions, sensors, and national boundaries — fragmenting decisions. The first step is fusing them into a single interoperable system.

A two-way living digital twin

Beyond petabytes of data, the future is a Living Digital Twin of the Ocean with bidirectional flow between sensing, modeling, and action.

Shared predictive action

Unified intelligence enables faster disaster preparedness, stronger ecosystem protection, optimized blue-economy choices, and improved cross-border collaboration.

The future of ocean governance is predictive.

EARTHSENSE

Accomplishments

Winner of **IndiaAI Climate Impact Award**
Winner of **FITT Incubation Award**
Part of **NVIDIA Inception** Program
Winner of **ANRF-IBM** hackathon
100 most innovative AI companies by IndiaAI

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Co-Founder & CEO

Ph.D. IIT-Delhi
SERB-OVDF Fellow University of Alberta (2023-2024)
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ESTIC top 100 innovators
Highest Novelty in AI Award IGARSS 2024

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