The National Academies of
SCIENCES • ENGINEERING • MEDICINE

U.S. NATIONAL COMMITTEE FOR THE DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

OCEAN-SHOTS
Examples

UNDERSTANDING MARINE ECOSYSTEM DYNAMICS FOR SUSTAINABLE DEVELOPMENT:
The Quest for a 4-D 'Digital' Ocean

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A Simple Statement

The "New Blue Economy" based on data, information, and knowledge, depends on reliable and authoritative models to predict the behavior of marine ecosystems.

Therefore understanding the forces driving their dynamic behavior is an essential component of "NBE" development.

Source: R. Spinrad

Key Points

- We must understand the capacity and resiliency of **ever-changing** Marine Ecosystems;

- Studied from within: long-term, real-time, high-res. 'maps' of all key interactions in **both time & space;**

- Rapid data acquisition, synthesis, modeling, and visualization is essential to guide **evolving experimental designs.**

Realizable Developments

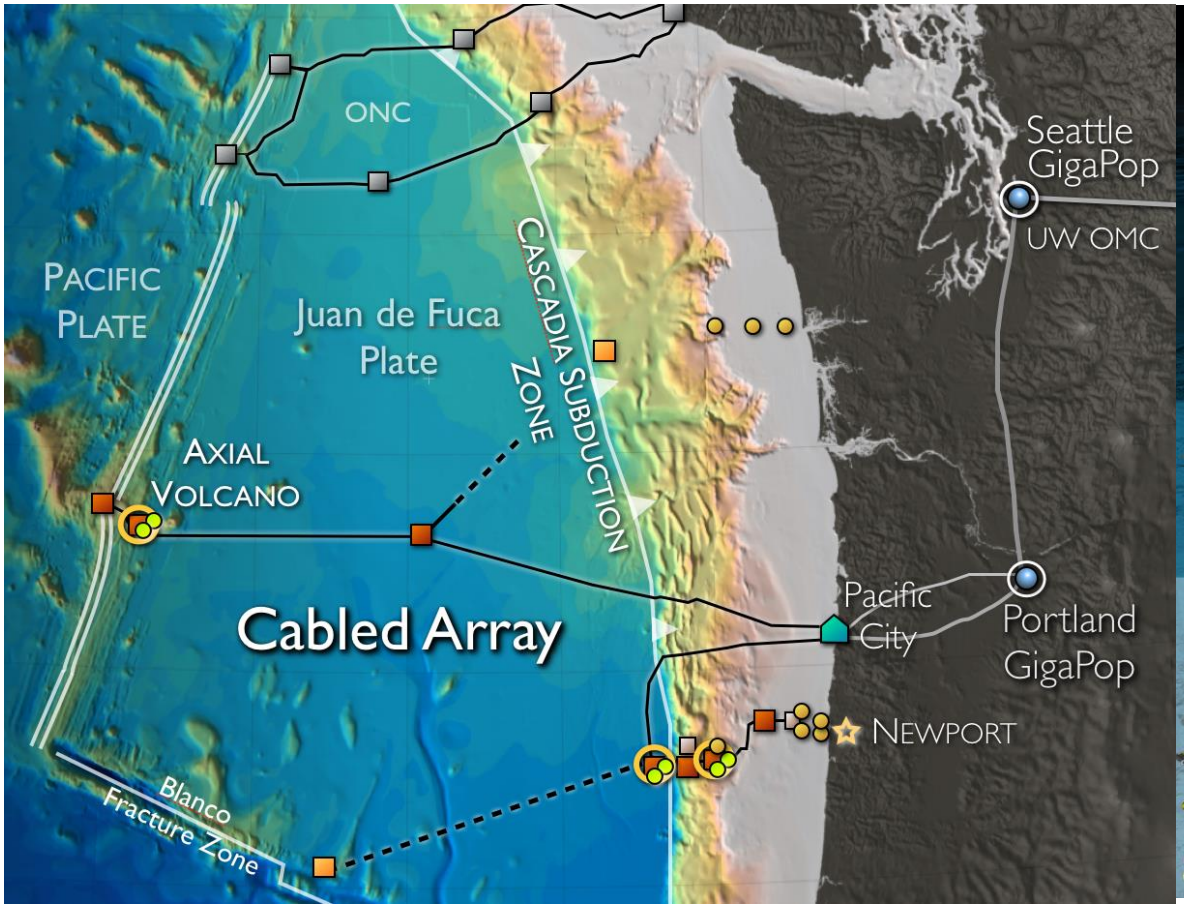
• **SENSOR EVOLUTION** - Aggressive development & adaptation of existing and novel physiochemical, and bio-sensor systems (eg. eDNA & enhanced optical and acoustic Imaging)**.**

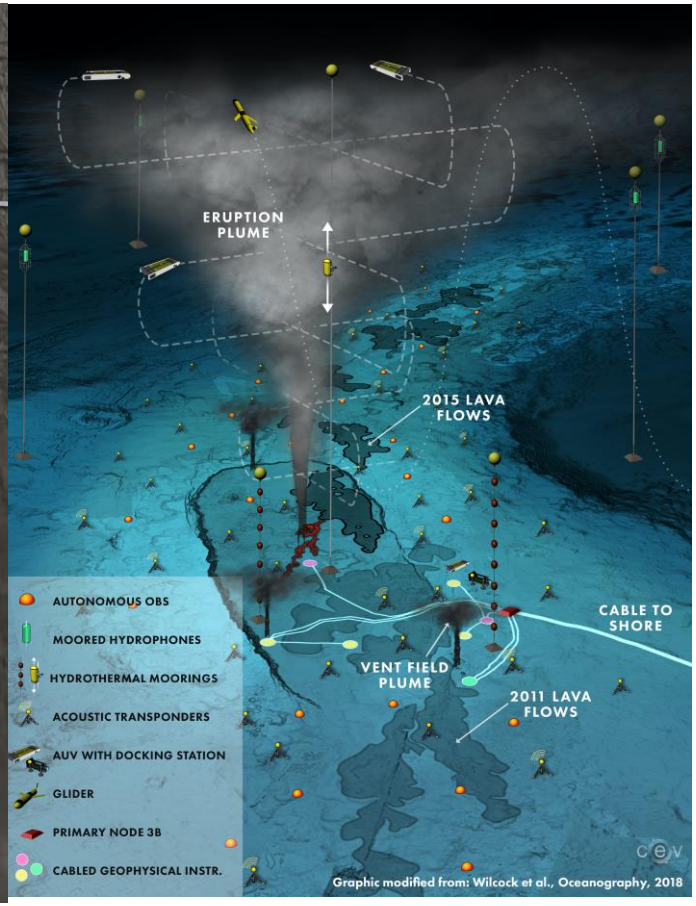
• **MULTI-NODE PLATFORM ENSEMBLES** - Autonomous, Aerial & Submarine => Many tens of variables in Time and Space, transmitted in **Real-time to Open-Access Data Hubs.**

• **COMPUTATIONAL SUPPORT**- Requires immediate fusion of Engineering, Navigation, & Quality Data via integrative Modeling and Visualization to utilize evolving **Digital Twin Ecosystems.**

One Example

Oceanic Ecology of Mid-Ocean Ridge Eruptions

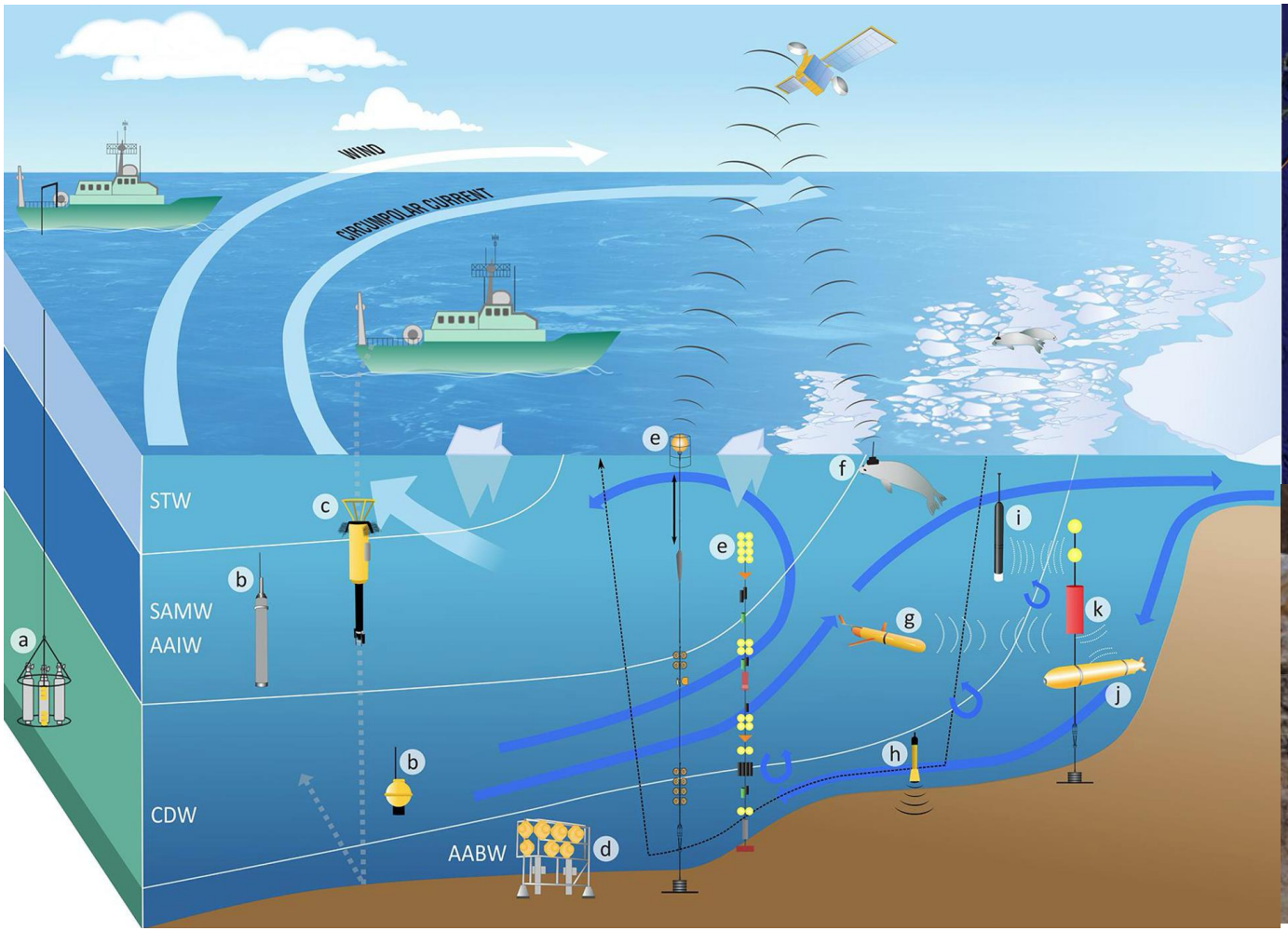


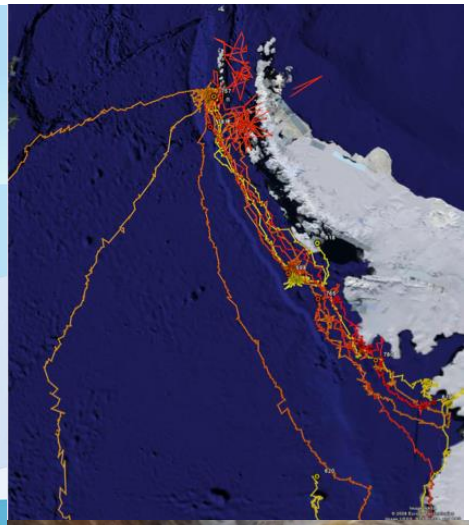


Global, Subsurface, Transient, Powerful….Forecasting & Access Difficult

Second Example:

Antarctic Ecology



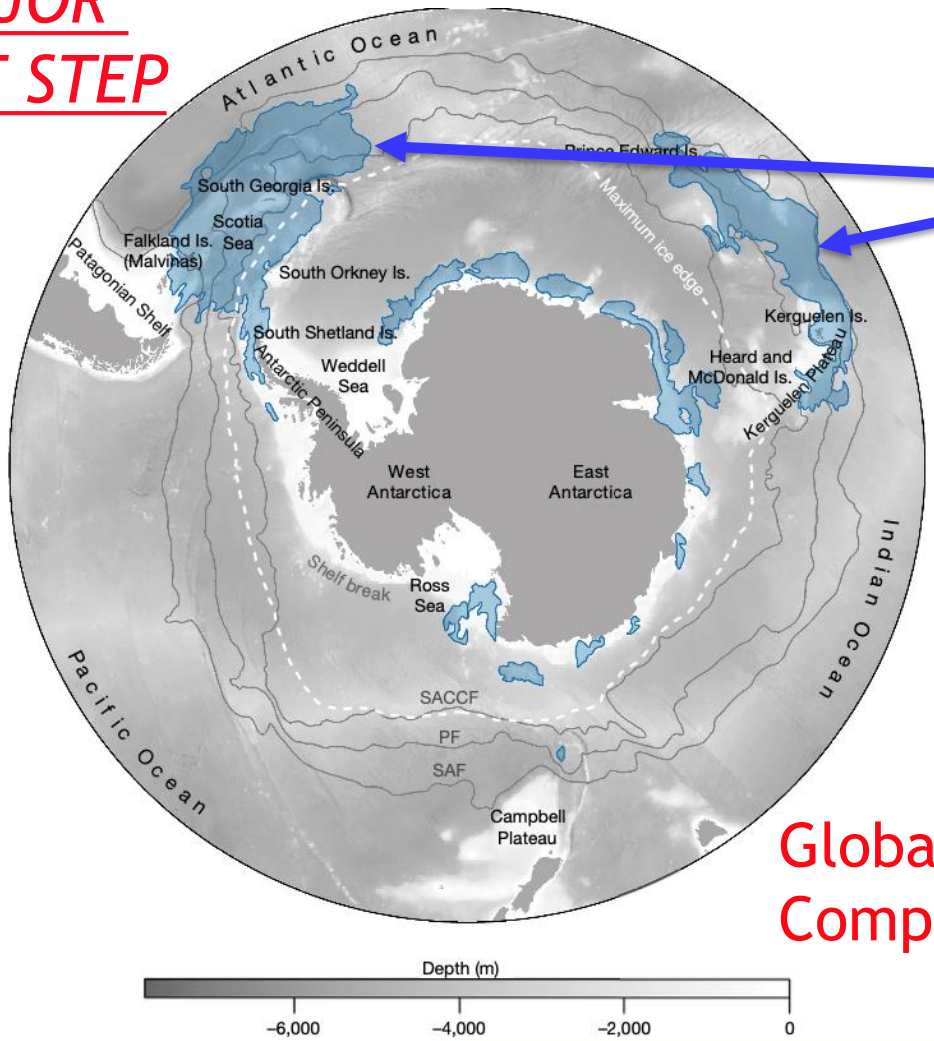


Globally Significant, Highly Complex, Remote, Access Difficult

Second Example:

Antarctic Ecology

A MAJOR FIRST STEP



"Areas of Ecological Significance" (in blue)

"AES's" Defined using 4,060 tracks of 17 birds and mammal species (Hindell et al., 2020)

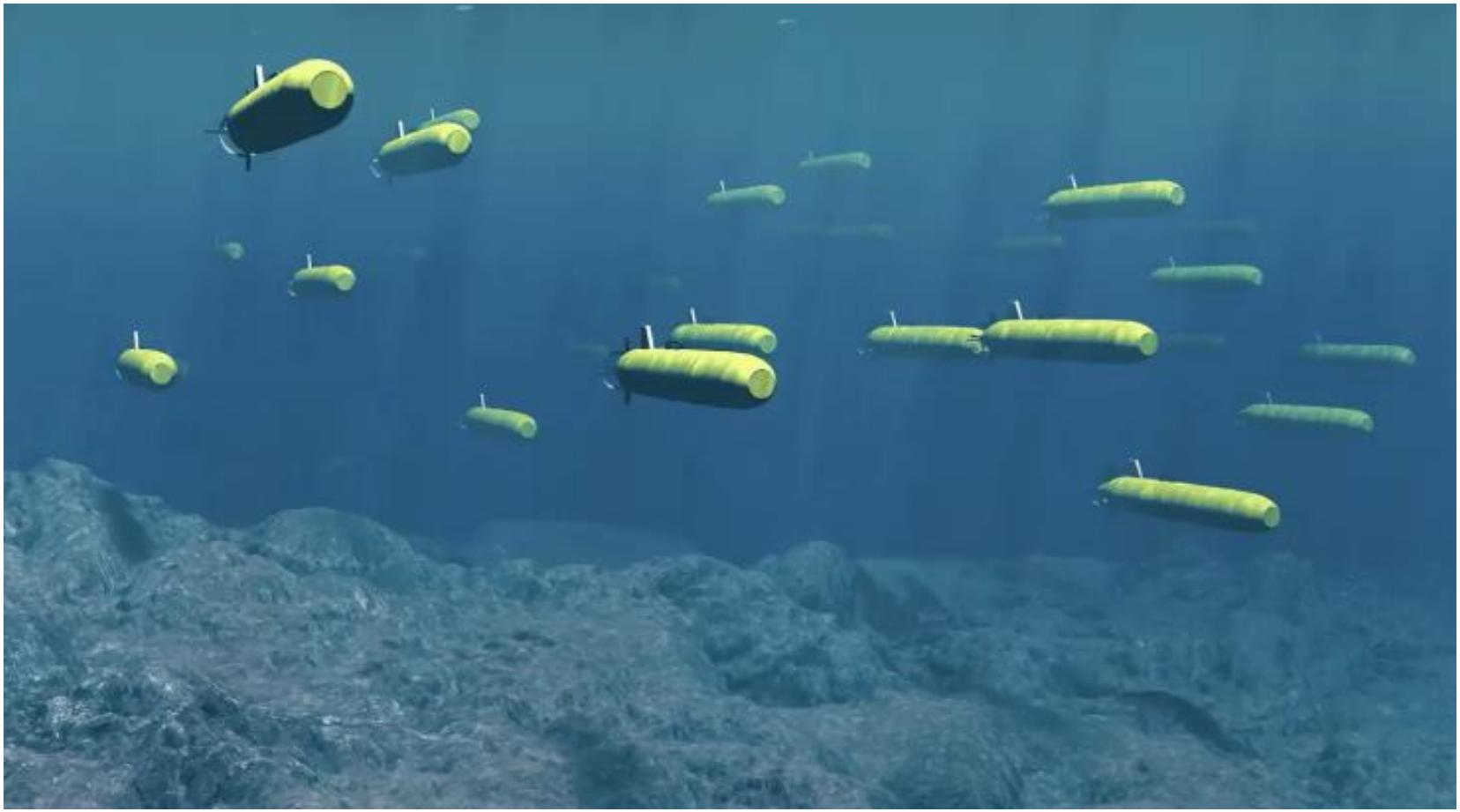
Globally Significant, Highly Complex,Remote, Access Difficult

Third Example
Coral Reefs World Wide

Novel Approaches:
eDNA, Enhanced
Optical, Acoustic
imaging,
& Satellite mapping.

Need for Real-time Science, and International Partnerships

Third Example
Coral Reefs World Wide



Finding Critical Thresholds w/ Swarms of Highly-capable AUV's

CRITERIA for Submission

(after R. Spinrad slide)

- **RELEVANT**: Topic represents a key area of potential scientific advancement related to the ten Ocean Decade Challenges
- **VISIONARY/INSPIRATIONAL**: potential for disruptive or transformational impact
- **REALIZABLE**: connections to existing strengths
- **ENGAGING**: Trans-, inter- and multi-disciplinary … sectors outside of traditional ocean sciences.
- **LEVERAGING**: international participation and collaboration.
- **CAPACITY BUILDING/STRENGTHENING**: developing world, next generation
- **JUST/DIVERSE/EQUITABLE/INCLUSIVE**: build community …involves local or indigenous experts and knowledge.

Ocean Decade Challenges

"Challenges will evolve over the life of the Decade.


Address land and sea-based sources of pollutants and contaminants.


Protect, monitor, manage and restore ecosystems under multiple stressors


Optimise the role of the ocean to sustainably feed the world's population.


Contribute to equitable and sustainable development of the ocean economy.


Understand the ocean-climate nexus, build resilience and improve predictions and forecasts.


Expand multi-hazard warning systems and mainstream community preparedness and resilience.


Ensure a sustainable ocean observing system that delivers timely data and across all ocean basins.


Develop a comprehensive digital representation of the ocean.


Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology.


Identify and overcome barriers to the behaviour change that is required for a step change in humanity's relationship with the ocean.

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Decade Outcomes

Describe the 'ocean we want' at the end of the Decade.

1. A **clean ocean** where sources of pollution are identified, reduced or removed.
2. A **healthy and resilient ocean** where marine ecosystems are understood and managed.
3. A **productive ocean** supporting sustainable food supply and a sustainable ocean economy.
4. A **predicted ocean** where society understands and can respond to changing ocean conditions.
5. A **safe ocean** where life and livelihoods are protected from ocean-related hazards.
6. An **accessible ocean** with open and equitable access to data, information, and technology and innovation.
7. An **inspiring and engaging ocean** where society understands and values the ocean in relation to human wellbeing and sustainable development.