Panel Members:

Scott Glenn, *Rutgers University (USA)*

Pierre Testor, *Centre National de la Recherche Scientifique - CNRS (France)*

Joaquin Tintore, *Palma de Mallorca (Spain)*

Karen Heywood, *University of East Anglia (UK)*

Alexander Proelss, *Trier University (Germany)*

Glider Challenge: High Resolution for 4D Oceanic Measurements

UNESCO IOC Science Day, 17 June 2015

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

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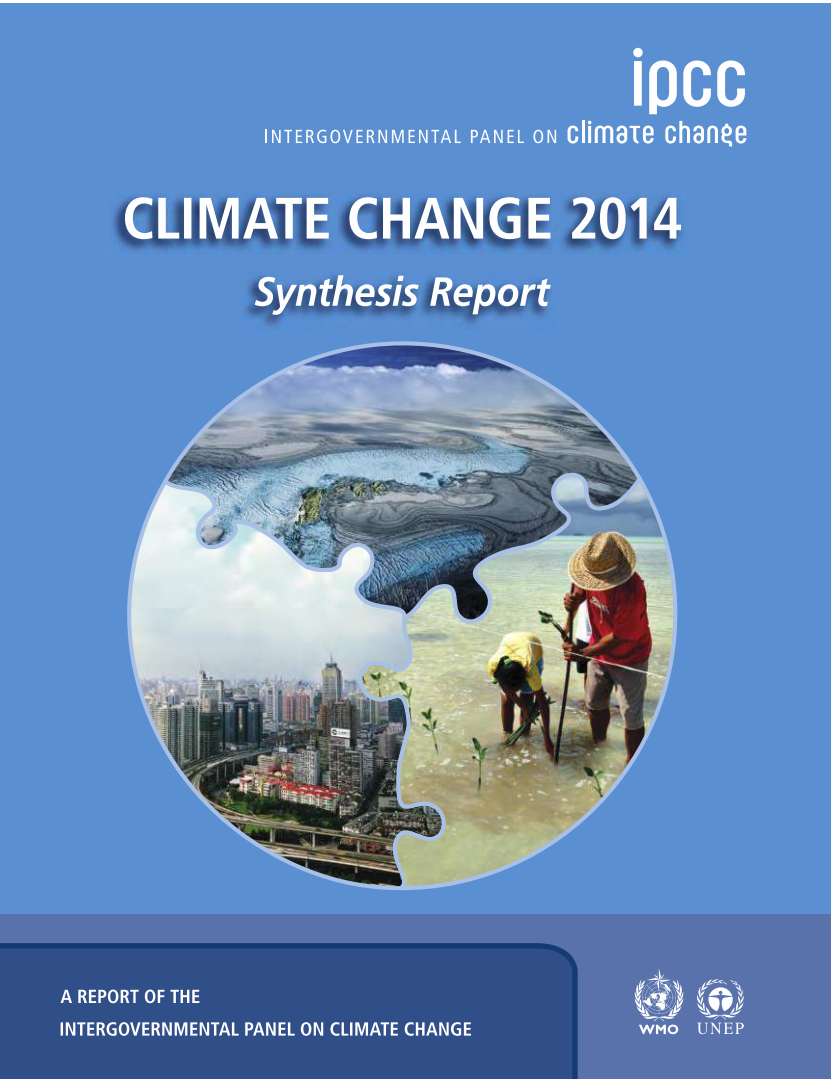
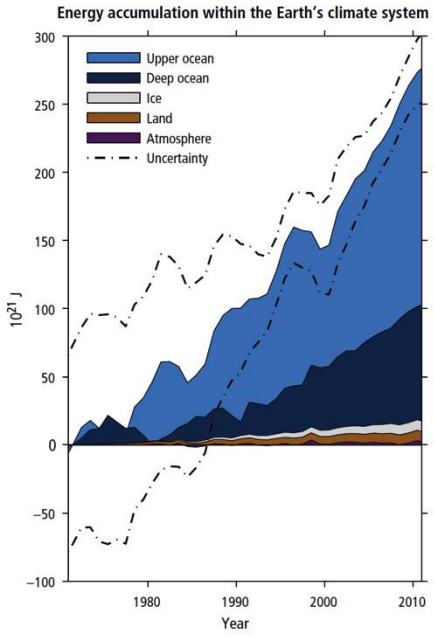
Grand Challenge: Earth is Changing, Population is Growing



IPCC Fifth Assessment Report (AR5)



"Ocean warming dominates the increase in energy stored in the climate system" -- ">90% of the energy accumulated between 1971 and 2010"

2.2 Projected changes in the climate system

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is *very likely* that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise.

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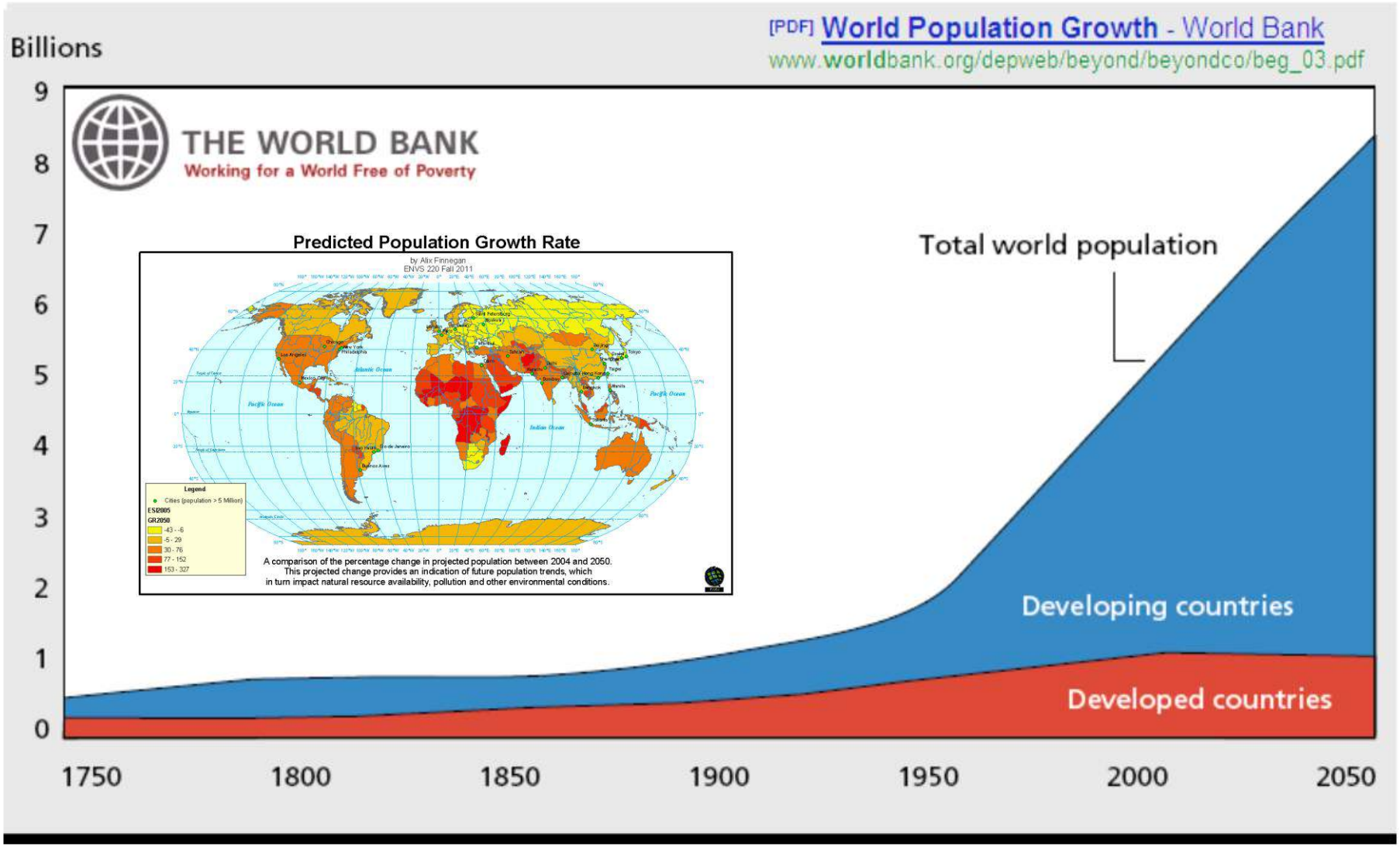
Grand Challenge: Earth is Changing, Population is Growing

Figure 3.1 **World population, 1750–2050**

[PDF] World Population Growth - World Bank
www.worldbank.org/depweb/beyond/beyondco/beg_03.pdf



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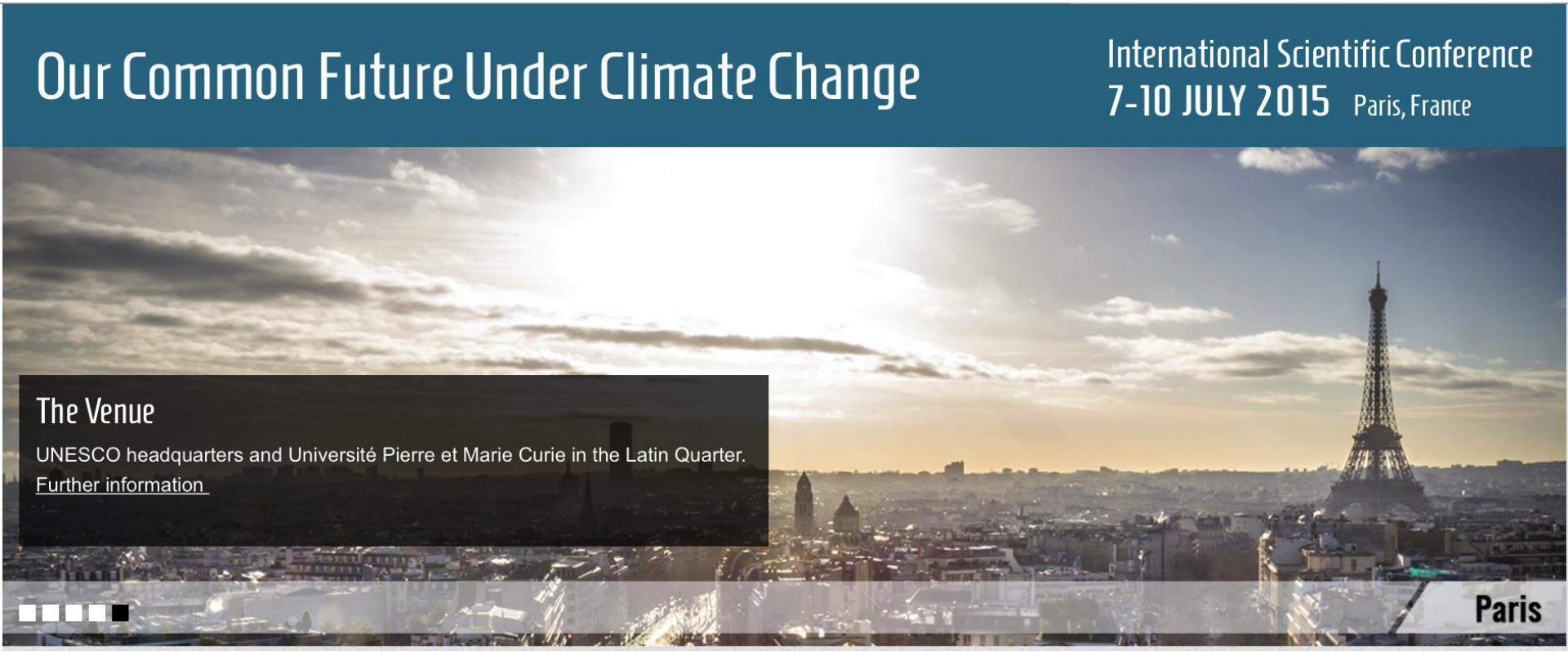
Response: Mitigate and Adapt to a Changing Climate



- Explore pathways for adaptation and mitigation with sustainable development
- Builds on IPCC Fifth Assessment Report (AR5)
- Preparation for 21st UNFCC Conference of the Parties (COP21) climate governance regime based on a low carbon, resilient development model
- Oceans are a key component – absorbed 30% of anthropogenic CO2 and continue to acidify

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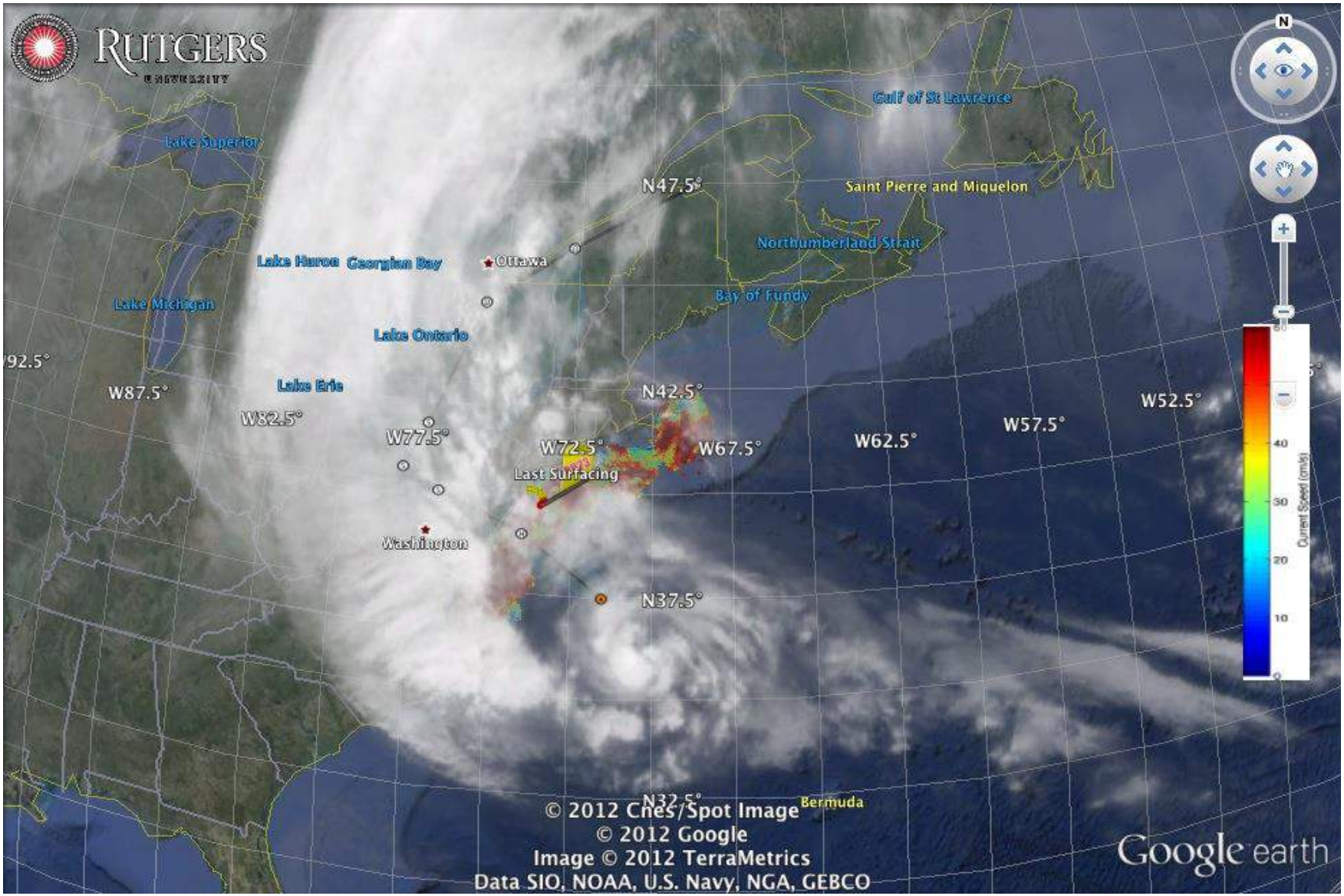
Response: Improve Severe Weather Warnings & Resiliency



Hurricane Sandy approaching U.S. East Coast

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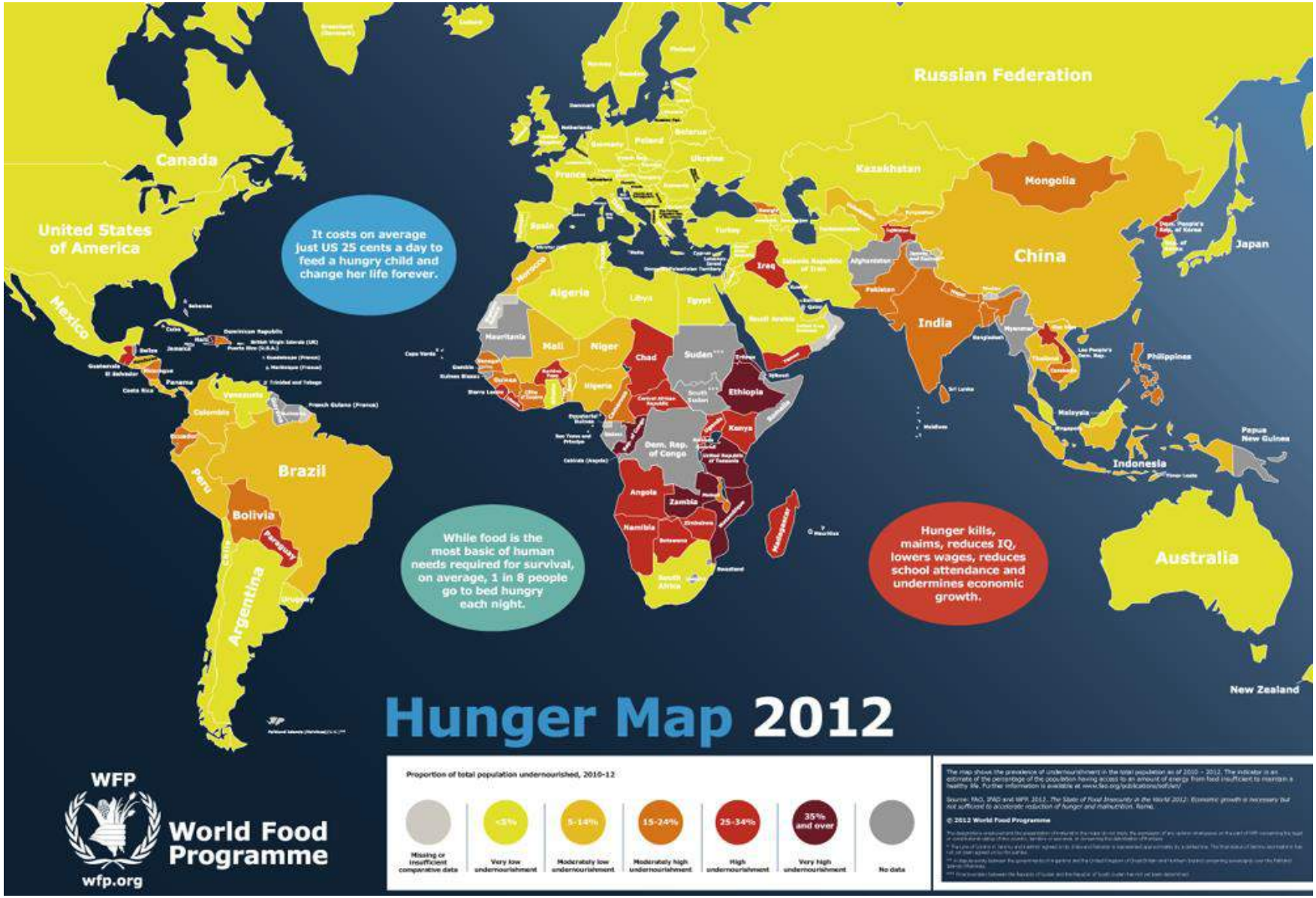
Response: Provide Food, Water and Energy Security



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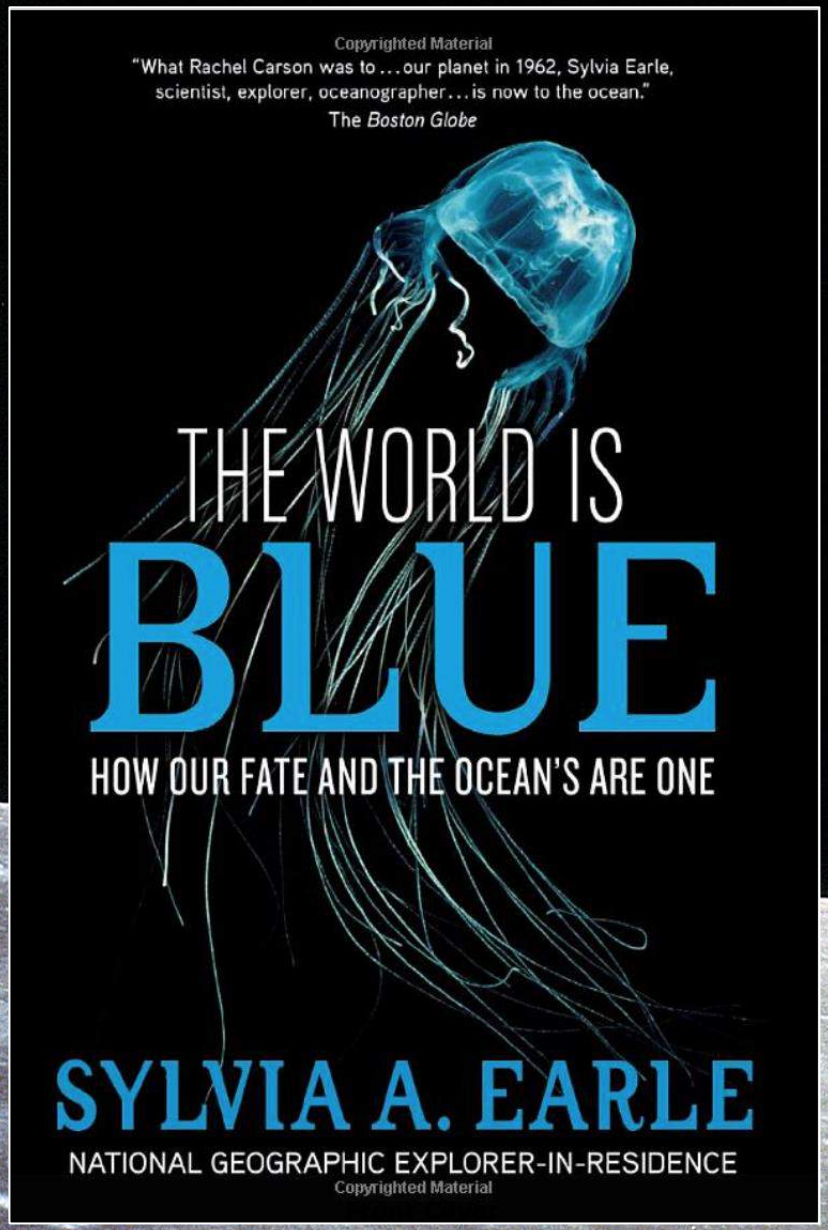

Solutions we must seek will involve the Sea

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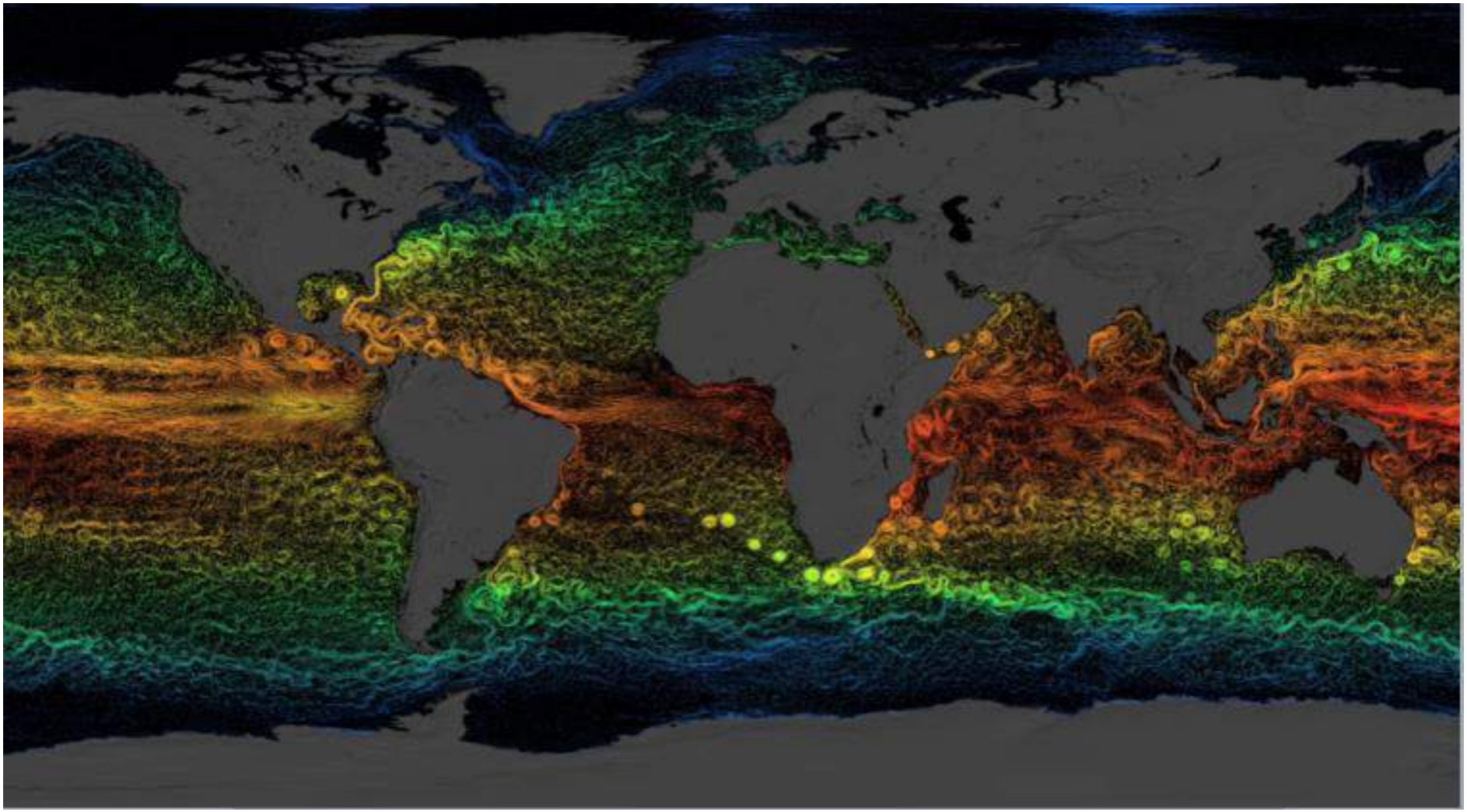
The Ocean is Physically Complex & Biologically Diverse



Global circulation dominated by the Mesoscale

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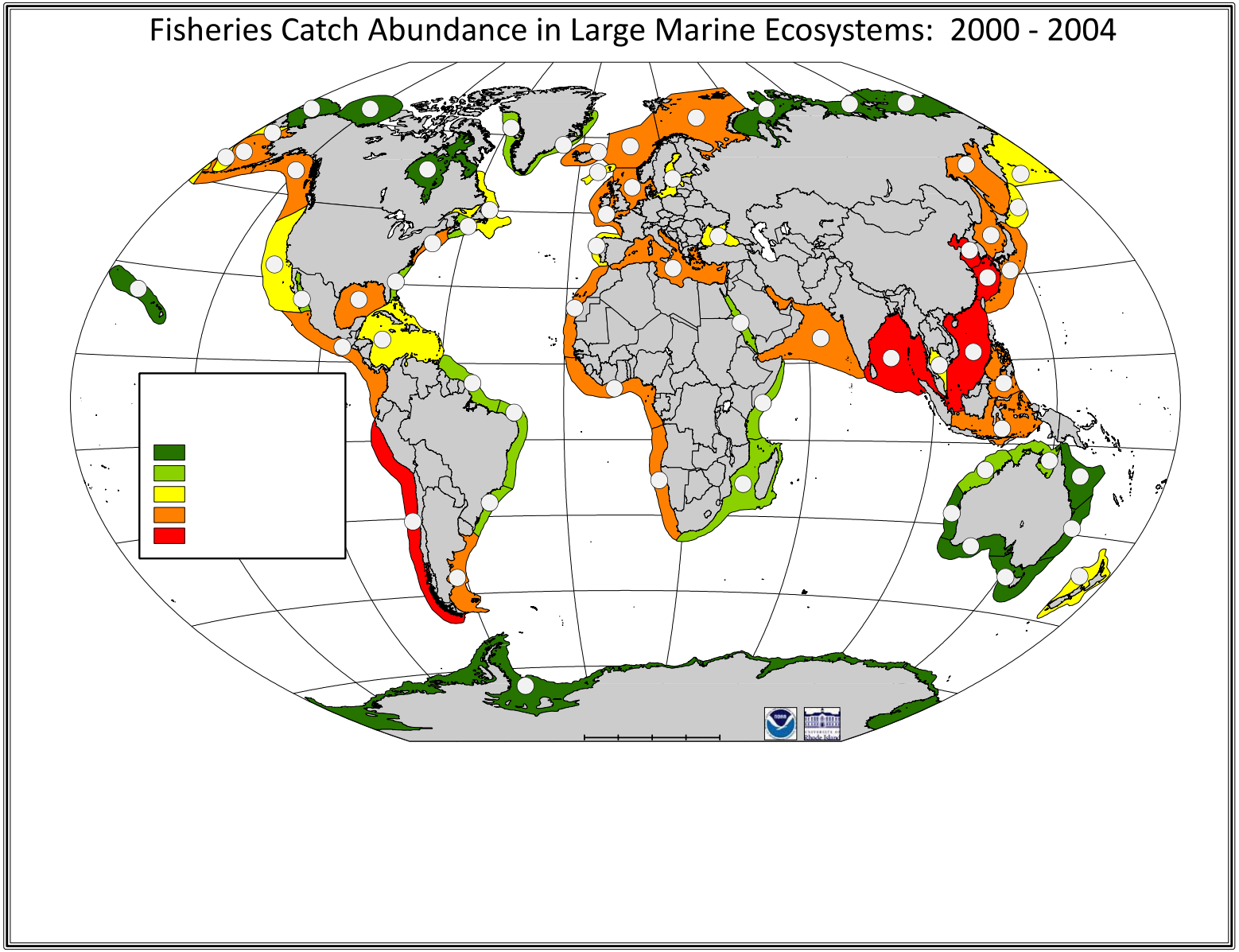
The Ocean is Physically Complex & Biologically Diverse



61 Large Marine Ecosystems

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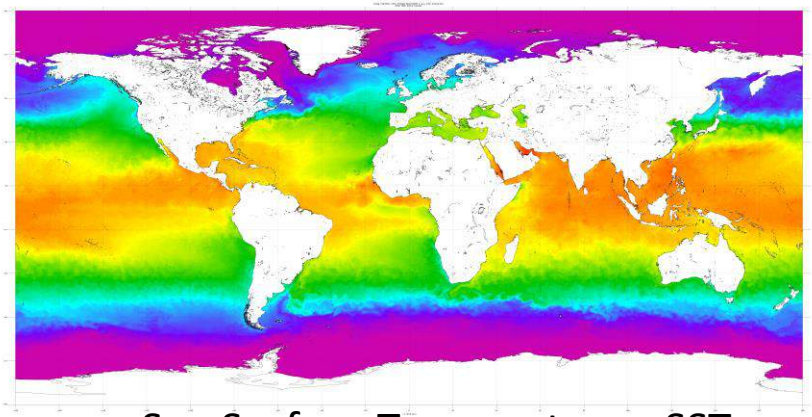
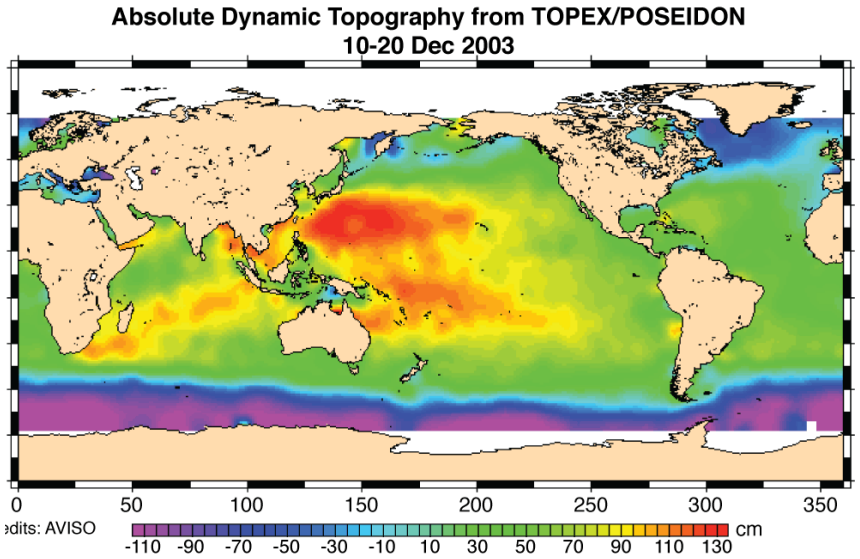
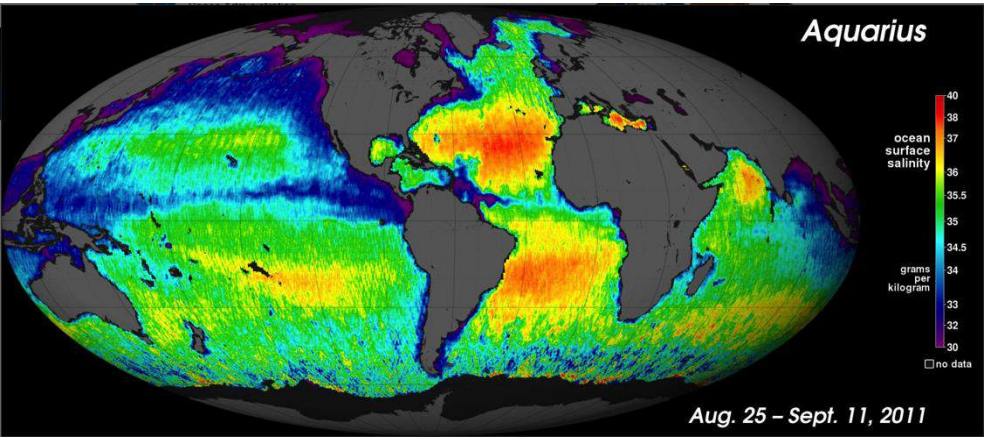
Satellite Revolution: Global coverage of the ocean surface



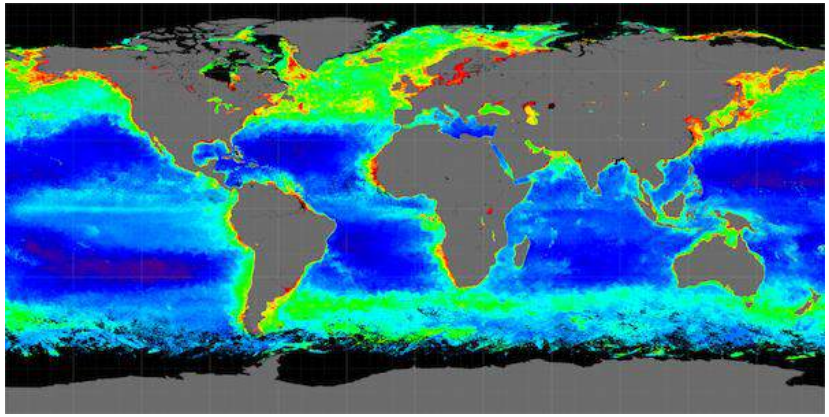
Sea Surface Temperature - SST



Sea Surface Height - SSH



Sea Surface Salinity - SSS



Near Surface Chlorophyll

Below the surface requires in-water observations

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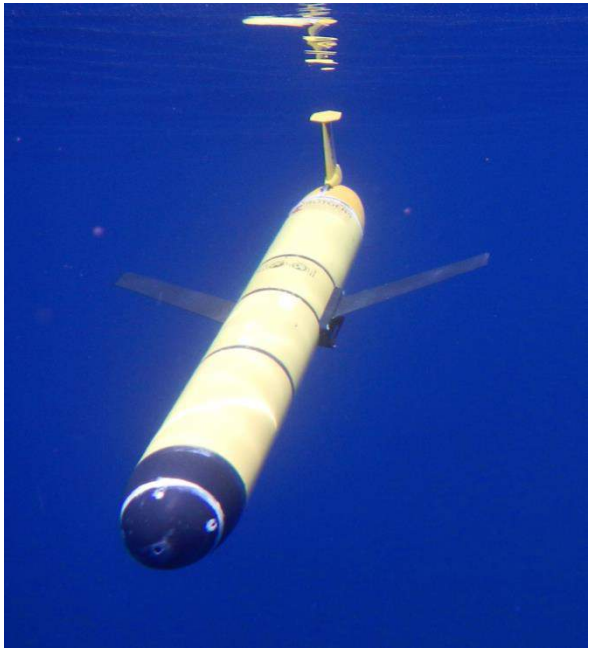
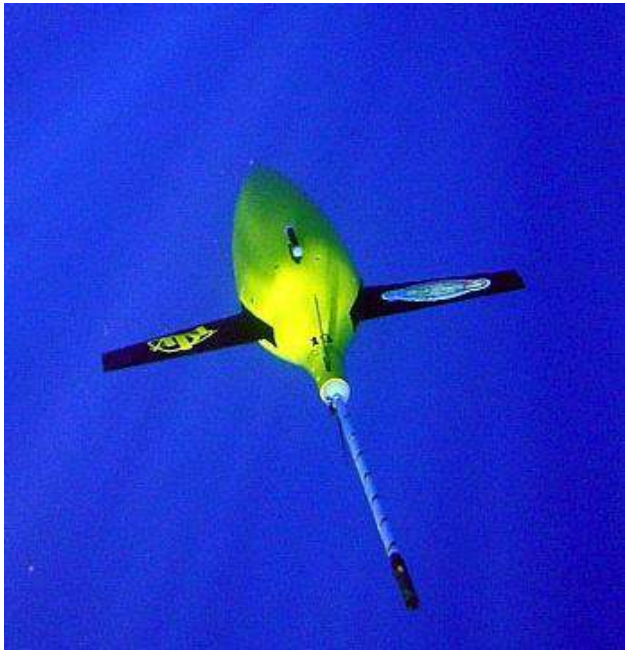
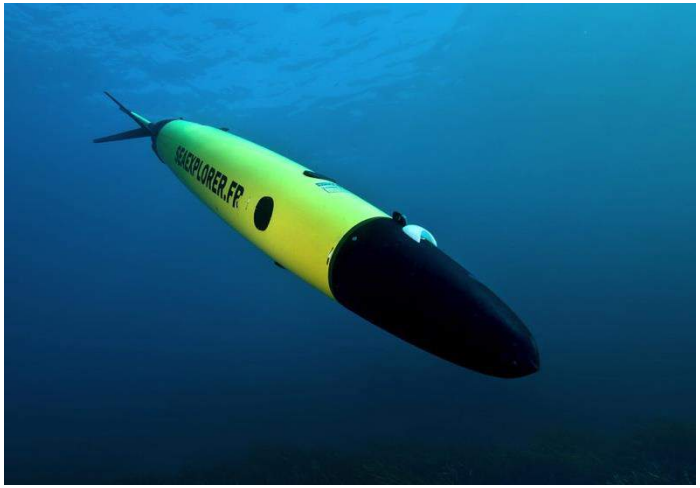
Robotics Revolution: Commercially Available Gliders



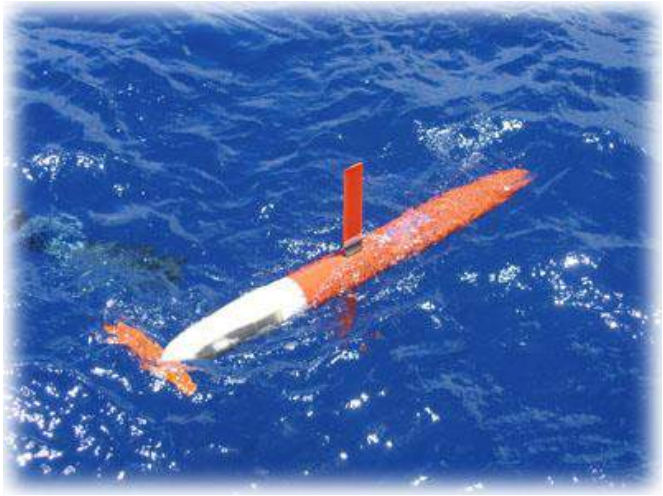
Slocum Glider



Seaglider

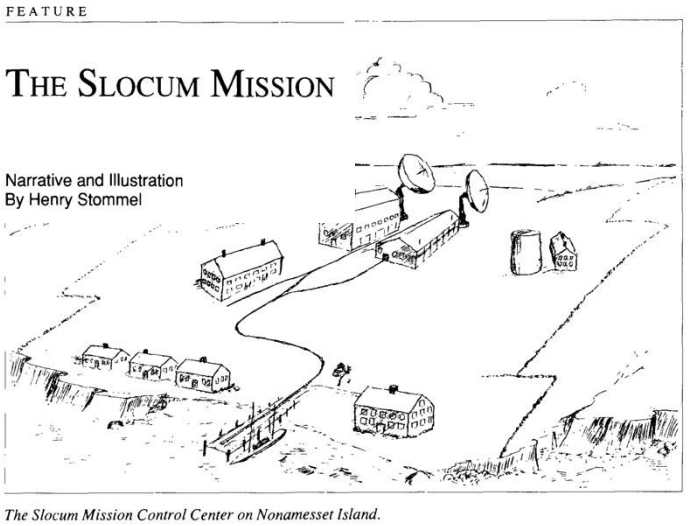


Seaexplorer Glider



Spray Glider

Underwater Gliders have Evolved Rapidly


FEATURE

THE SLOCUM MISSION

Narrative and Illustration
By Henry Stommel

The Slocum Mission Control Center on Nonamesset Island.

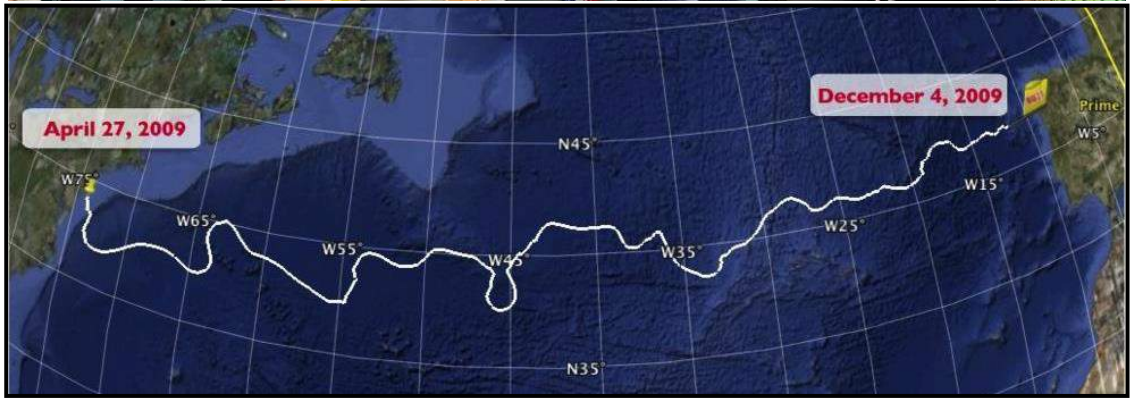
Each Slocum reports into Mission Control via satellite about six times a day.

1989

Science Fiction Article

1999

First Slocum deployed at Sea



2009

First Glider crosses an Ocean Basin

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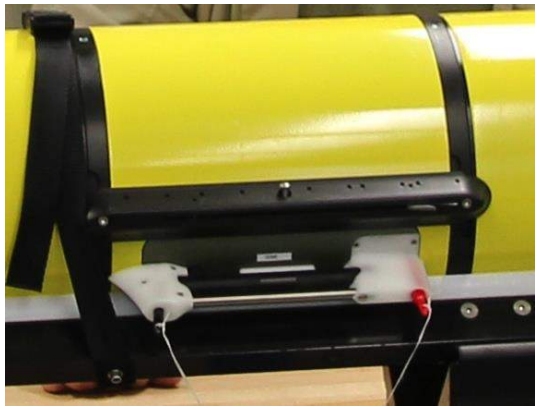
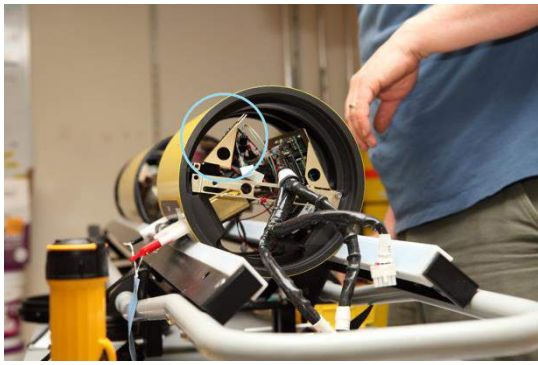
Gliders can carry a wide variety of sensors

Acoustic Modem
ADCP/DVL
Altimeter
Bathyphotometer (bioluminescence)
Beam Attenuation Meter
Echo Sounder
Optical Backscatter
Optical Attenuation
Oxygen
Conductivity, Temperature, Depth
Fish Tracking
Fluorometer
Hydrocarbon
Hydrophones
Nitrates
PAR sensor
Radiometer
Scattering Attenuation Meter
Spectrophotometer (red tide detection)
Turbulence
Wave Accelerometer



Internal Payload Bay

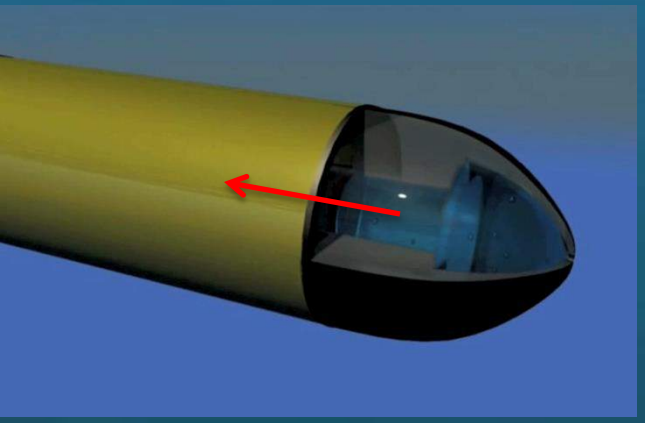


Internal

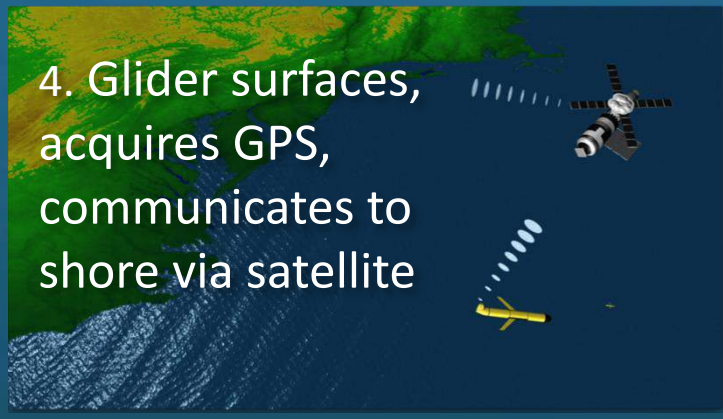
External Payload Area

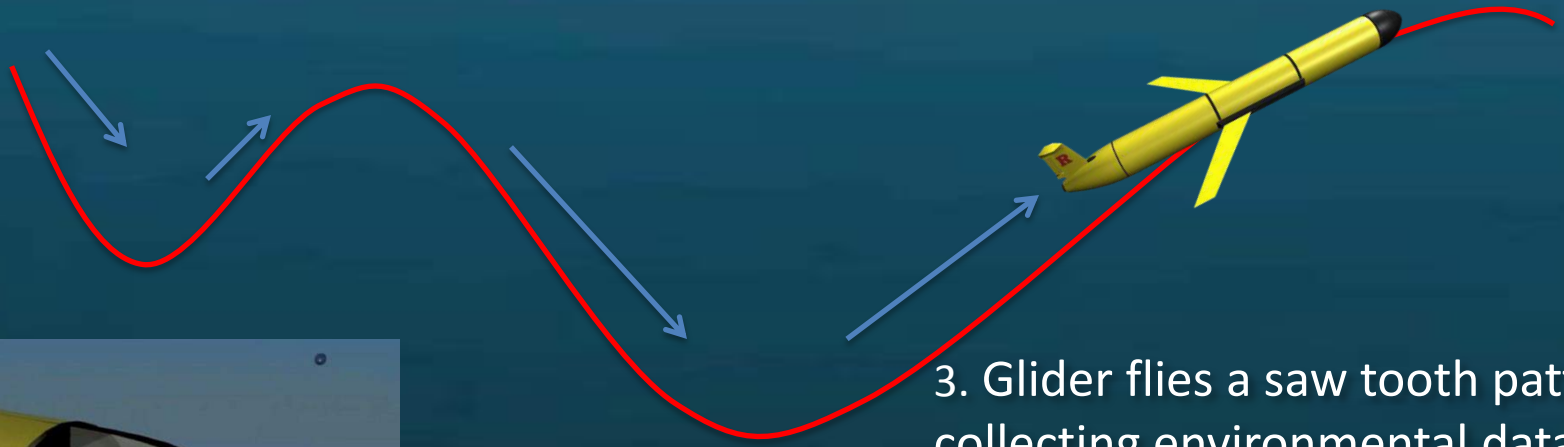
External Mounted

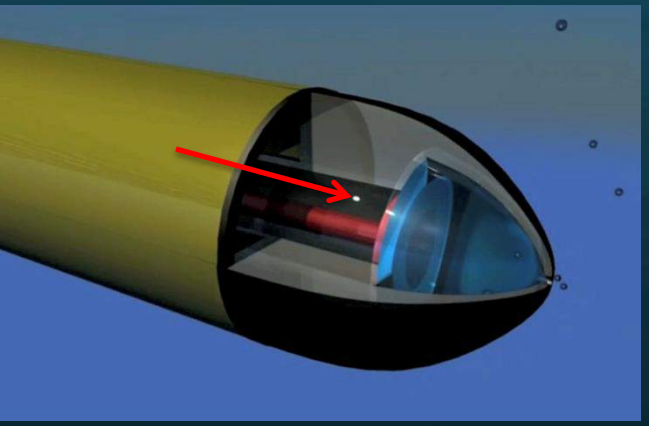
How an underwater Glider works…



1. At surface, pump/diaphragm decreases volume, Glider descends

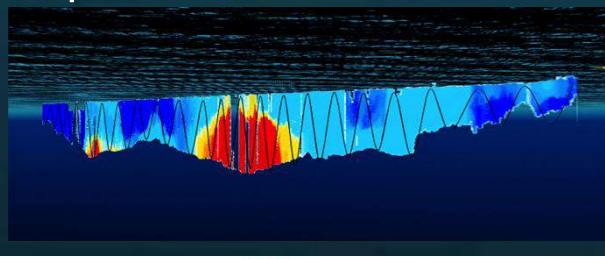






2. At depth pump/diaphragm increases volume, Glider ascends

3. Glider flies a saw tooth pattern, collecting environmental data along it's path



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Mobile Subsurface Profile Observation Capabilities

Drifters

Gliders

Ships

Increasing Control, Capacity & Cost

Decreasing Endurance & Risk Tolerance

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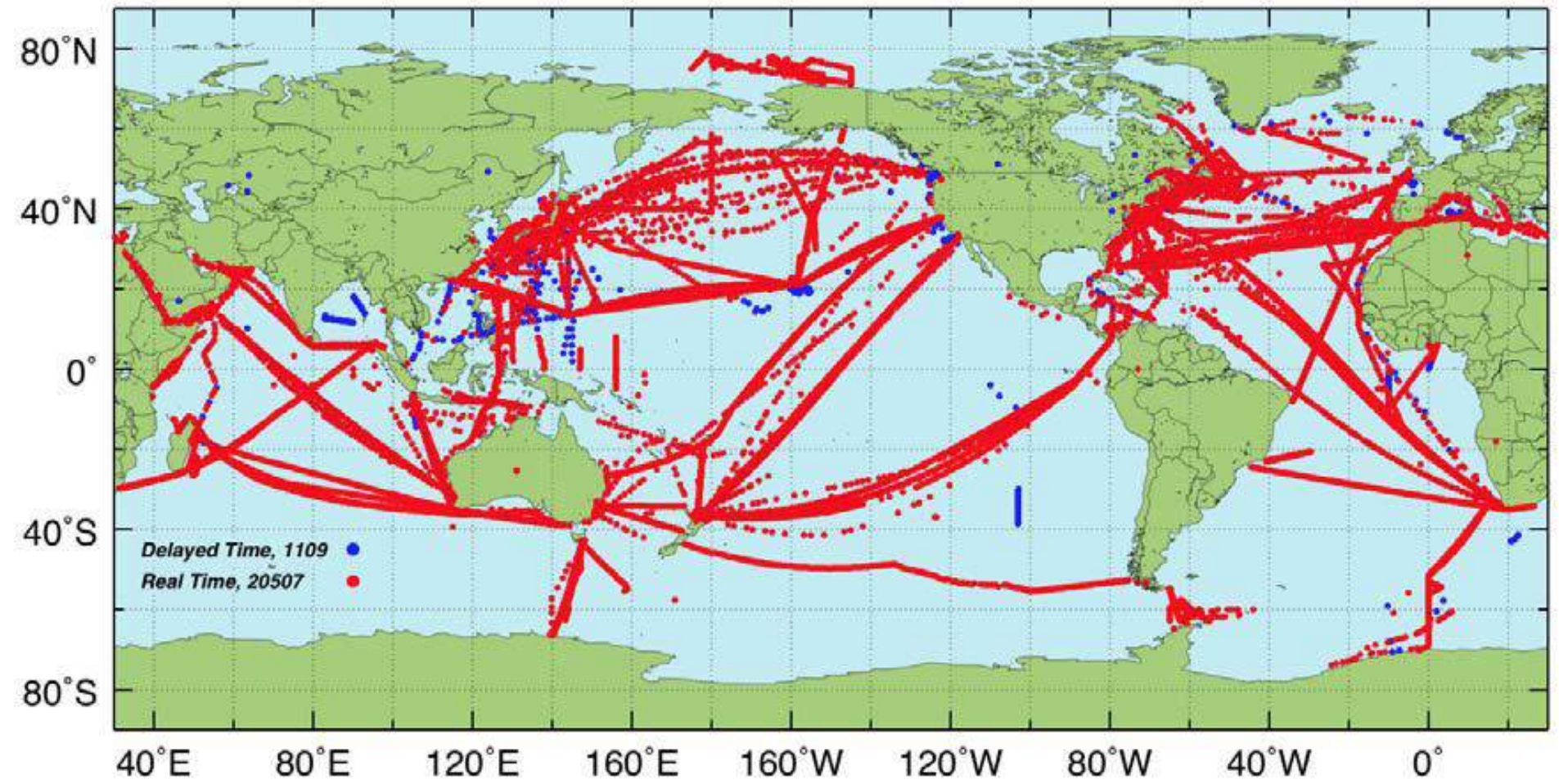
Sustained Subsurface Profile Observations by Ships of Opportunity



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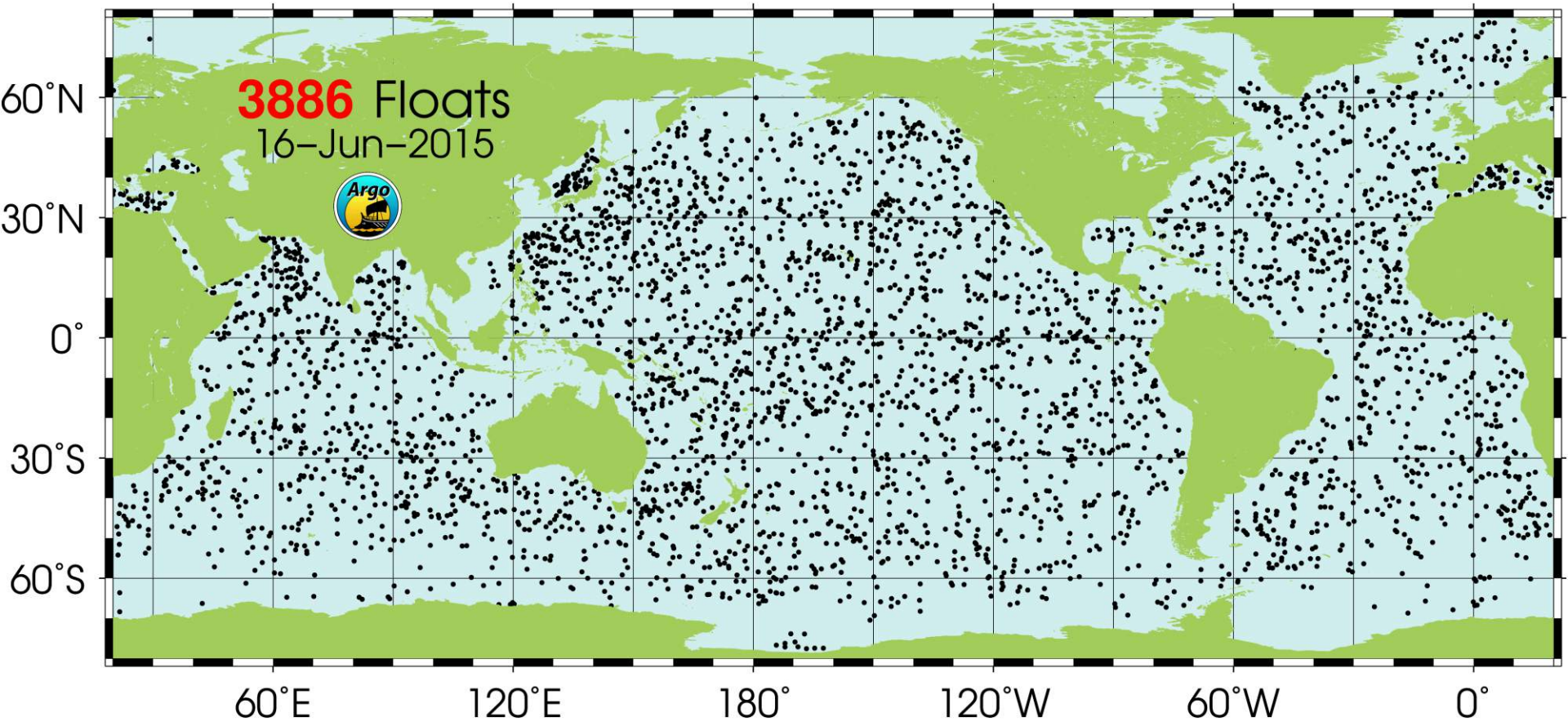
Sustained Subsurface Profile Observations by Argo Drifters



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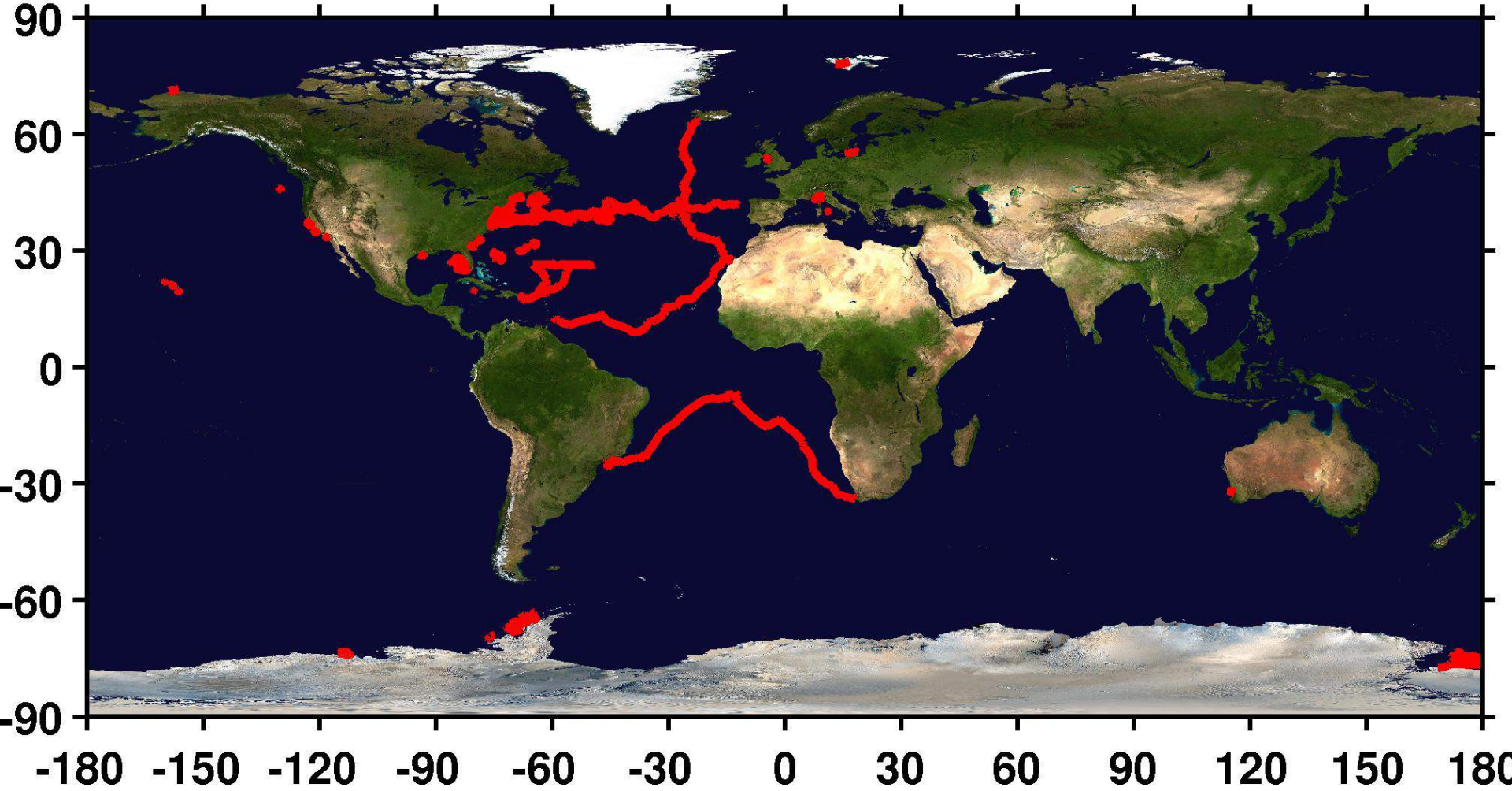
Sustained Subsurface Profile Observations by Gliders - 1 Center

394 deployments - 170065.54km flown - 8093 days



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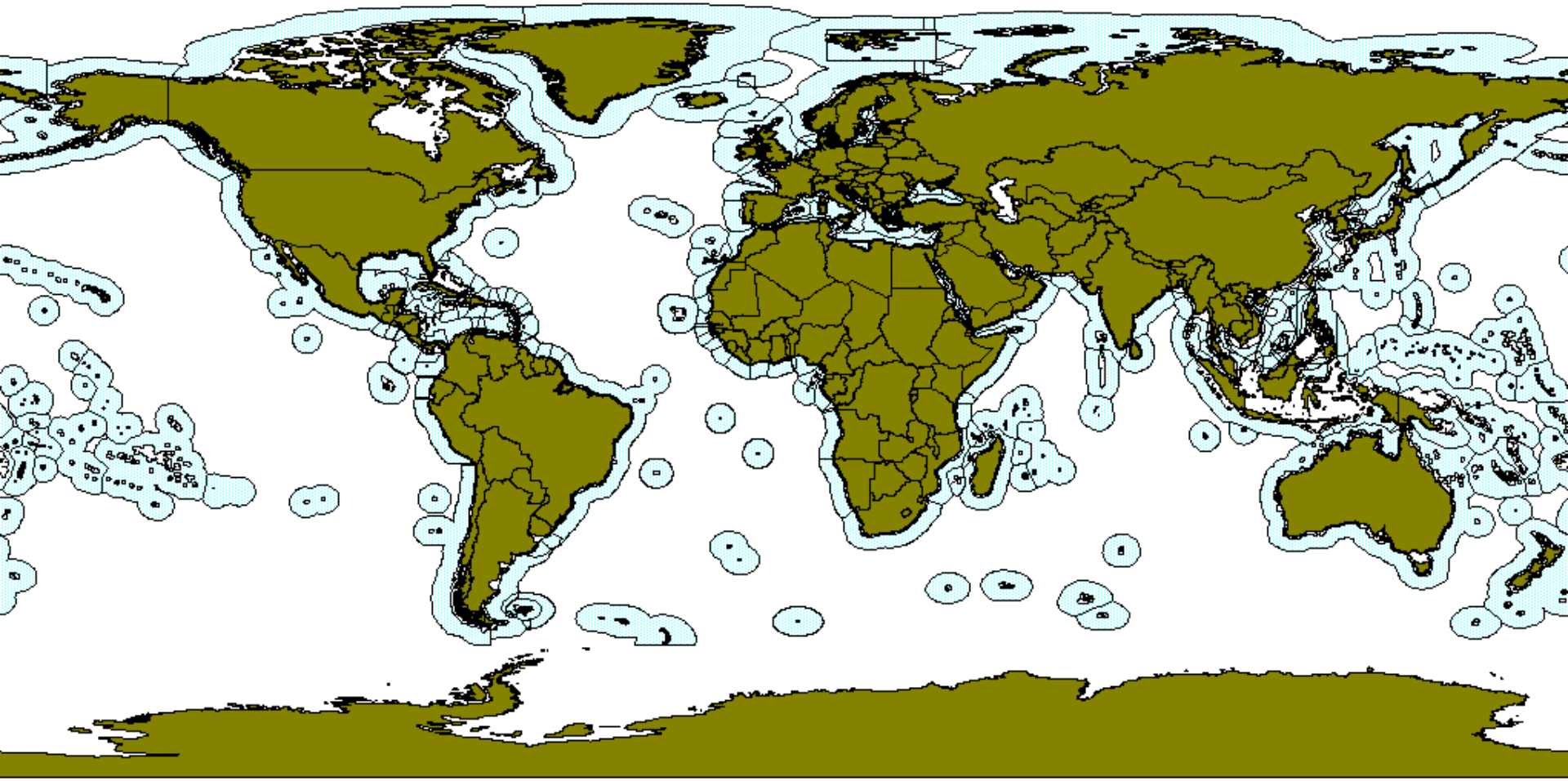
Large Marine Ecosystems & Exclusive Economic Zones



Gliders can fill the sustained coastal ocean profile sampling gap

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Glider Challenge:
High Resolution for 4D Oceanic Measurements

Panel Presentations:

- **Pierre Testor** – Building an international glider community and using gliders to resolve mesoscale and smaller features
- **Joaquin Tintore** – Gliders as a sustained component of integrated observing and forecast systems
- **Karen Heywood** – Gliders in remote and extreme environments
- **Alexandar Proelss** – Legal aspects of glider operations

Discussion Points:

- Where are the greatest needs for sustained 4-D oceanic measurements?
- What are the barriers to progress?
- What can we do together as an international community?
- How can the IOC help?