Living Liquid: Design and Evaluation of an Exploratory Visualization Tool for Museum Visitors

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Introduction

Exploratorium's Vision

[The Exploratorium] represents the hope that people will be convinced that the world, including the private world, is understandable.

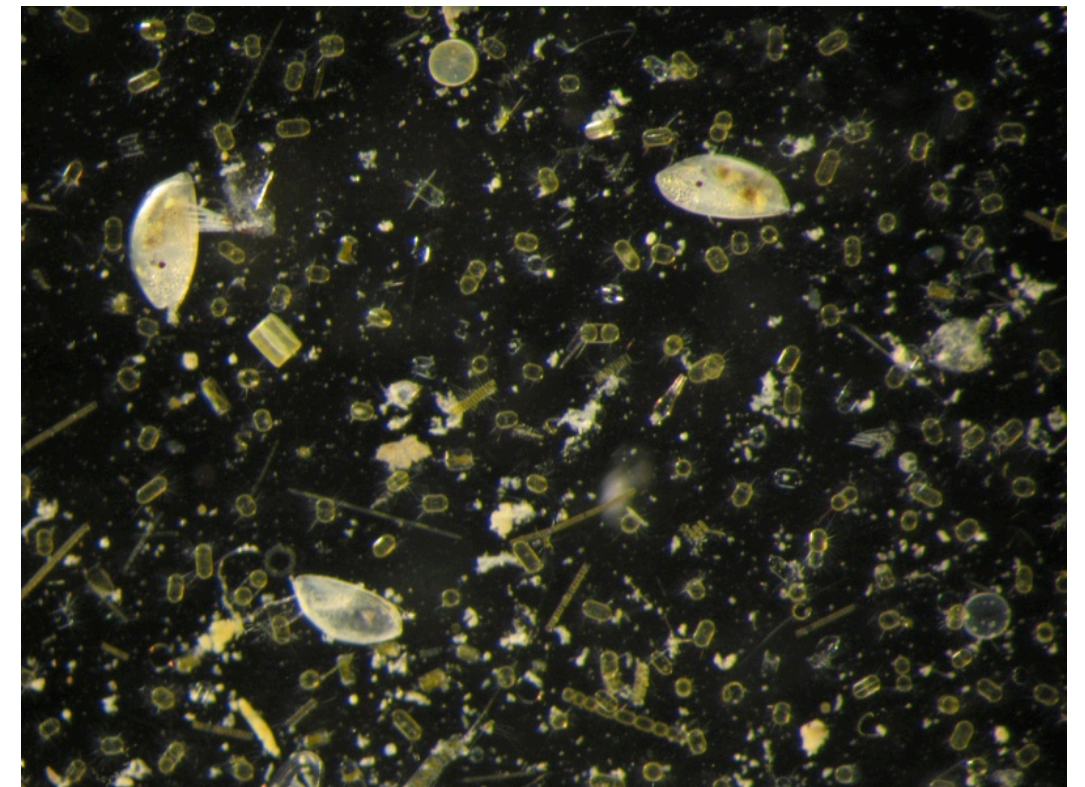– F. Oppenheimer

Introduction

New location opening April 2013

Exhibit Goals

- To engage museum visitors in the exploration of a scientific dataset about plankton

- To support visitors in making sense of data

- To encourage visitors to ask and answer questions about the data

Plankton from the San Francisco Bay

VisWeek 2012
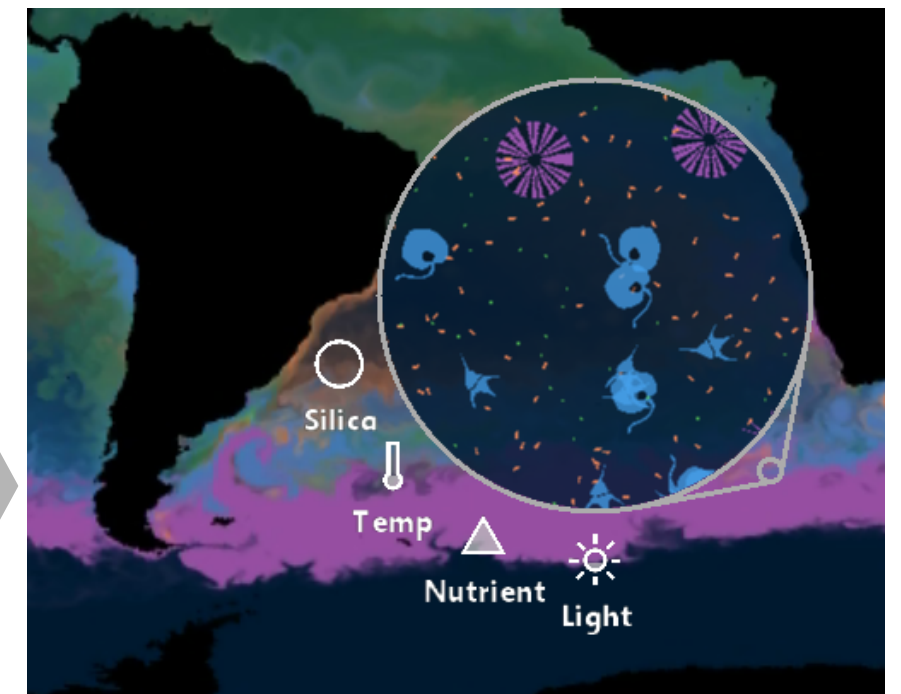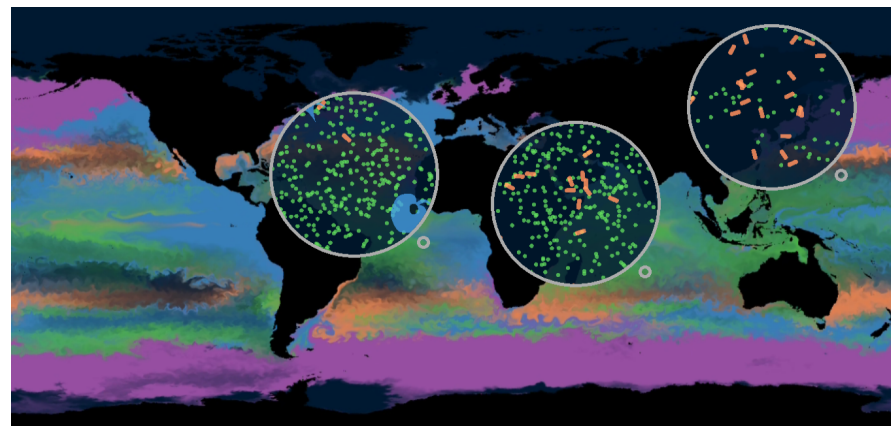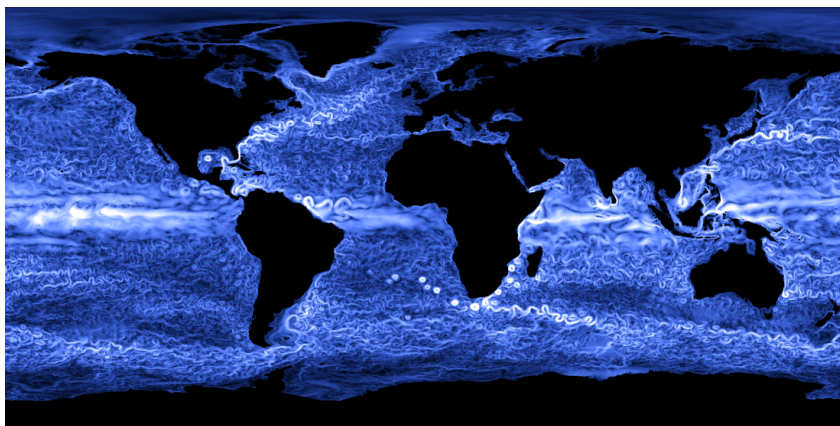SCIVIS · INFOVIS · VAST
BIOVIS · LDAV

Challenges of the Museum Environment

- Free-choice environment
- Varying domain knowledge
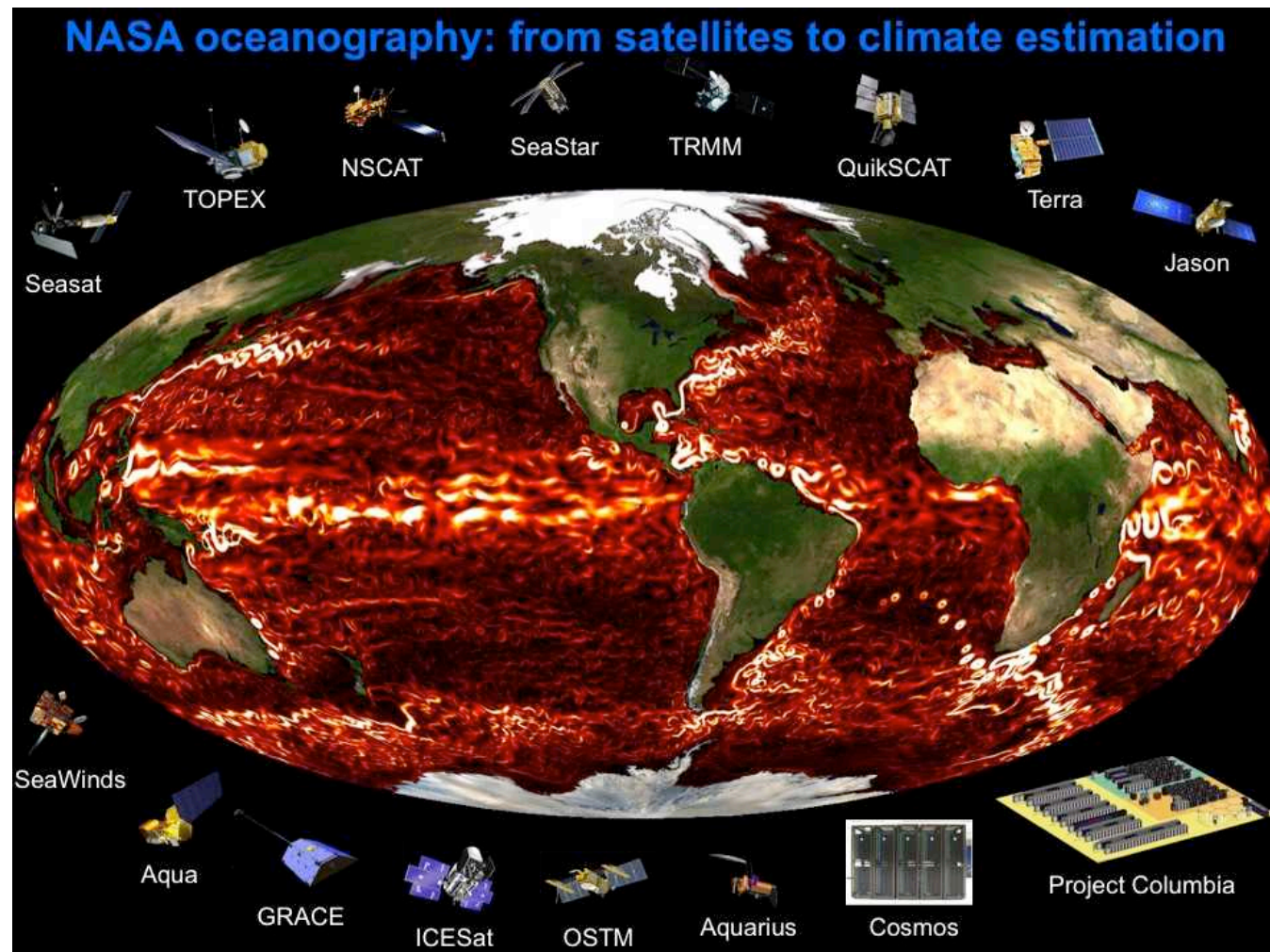- Varying familiarity with visual representations of data

Overview

- Dataset

- 3 prototype iterations and evaluations

- Lessons learned

- Current status of prototype

- Acknowledgements

Dataset

Prototype Iterations

- Prototype 1: What to visualize to initiate exploration?
  - Addresses "free choice" challenge
- Prototype 2: How to visualize the microscopic?
  - Addresses "varying familiarity with visual representations" challenge
- Prototype 3: How to incorporate environmental conditions?
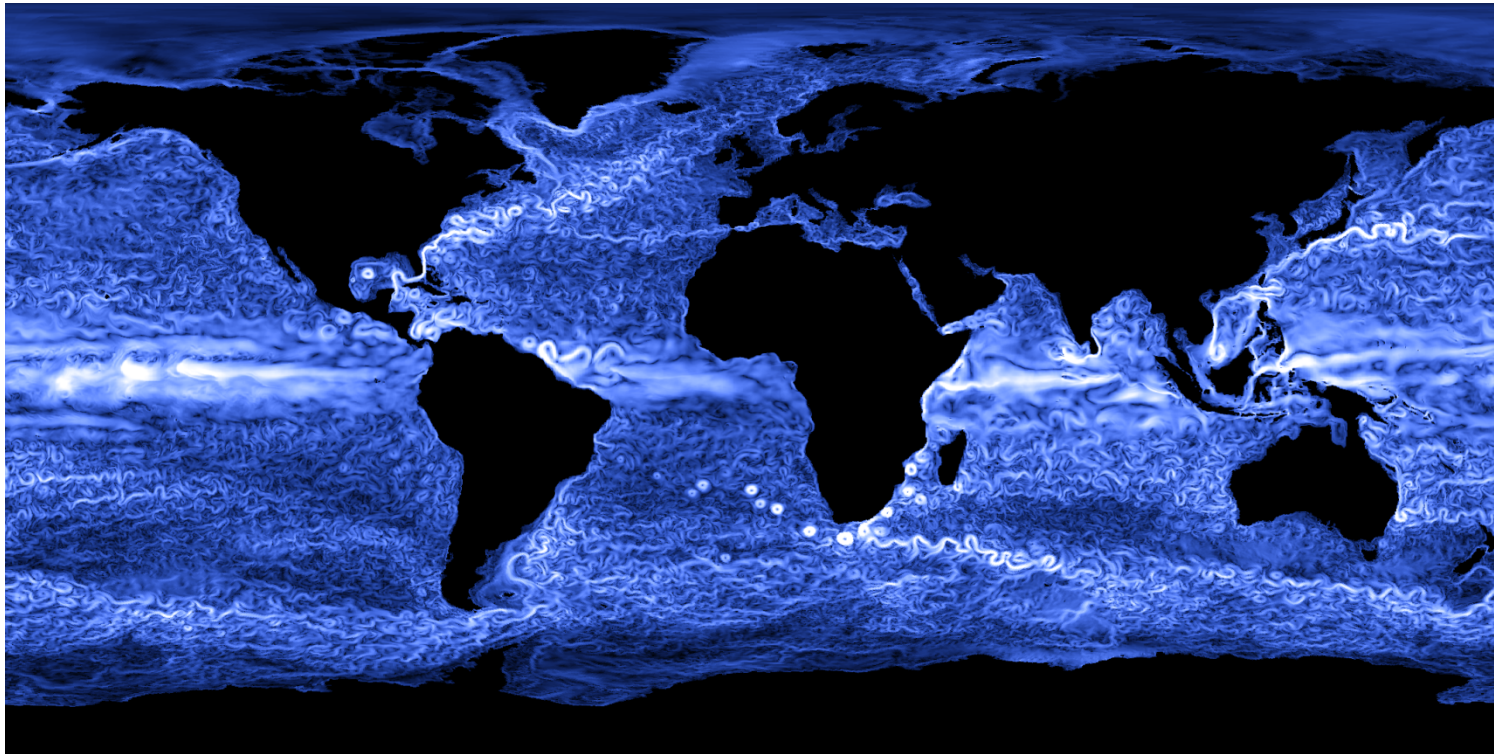 - Addresses "varying domain knowledge" challenge

Prototype 1: What to visualize to initiate exploration?
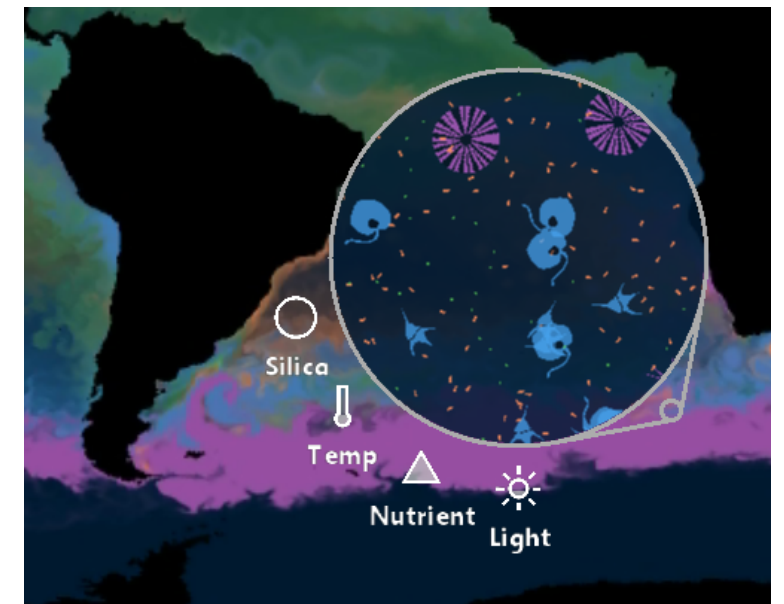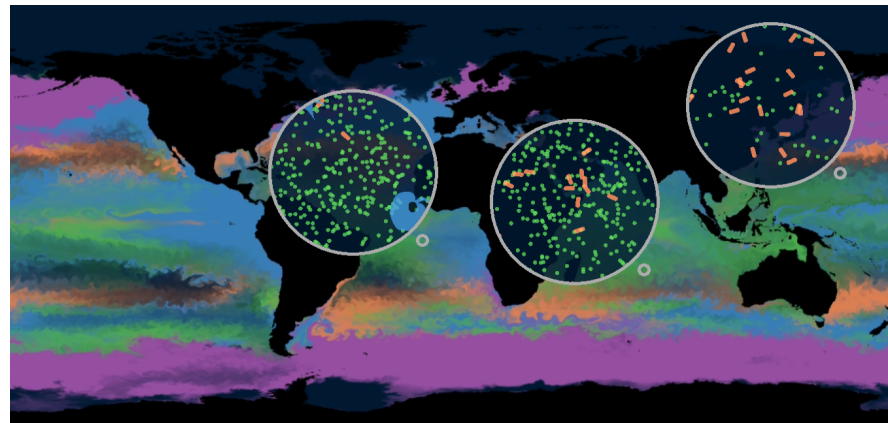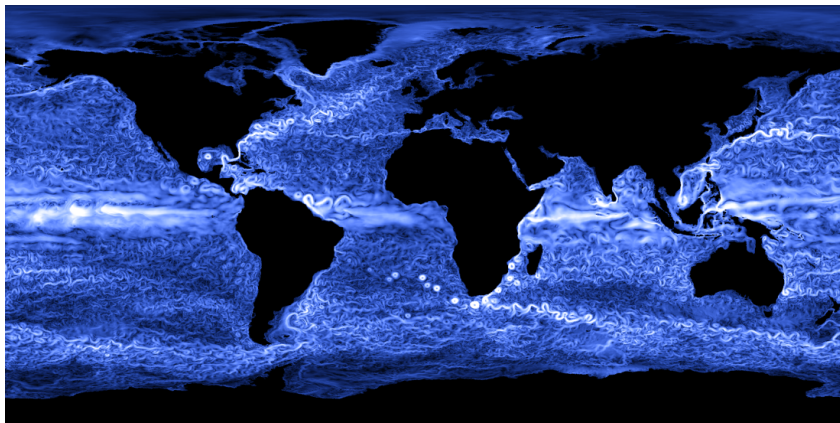
Prototype 1a: ocean currents
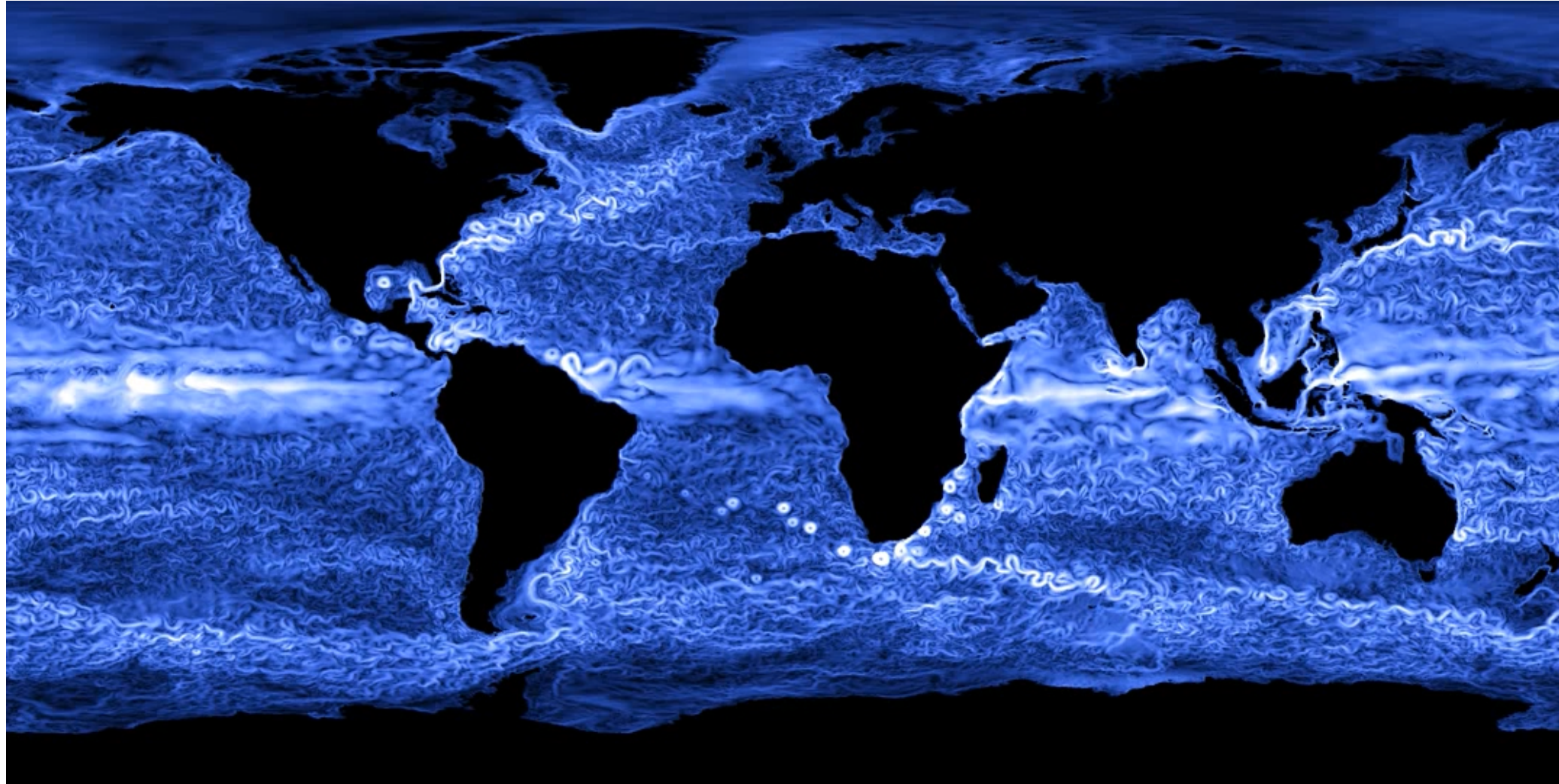
- 3 non-interactive videos
- Looked for:
  - Interest
  - Understandability
  - Exploration

Prototype 1a: Findings
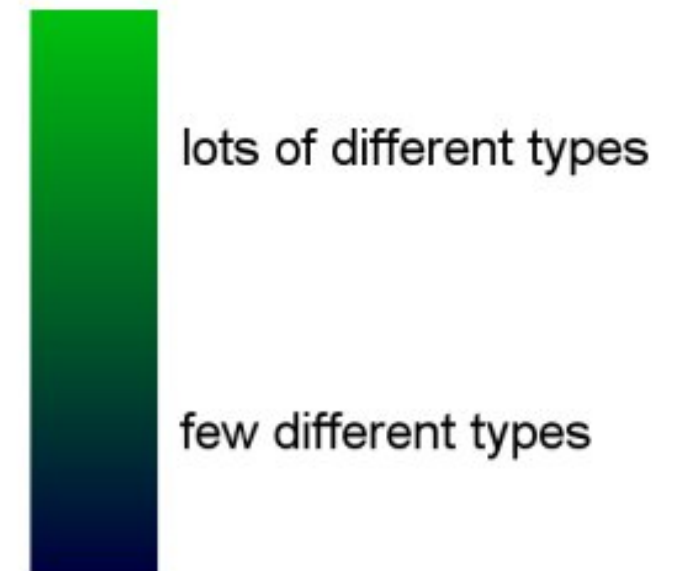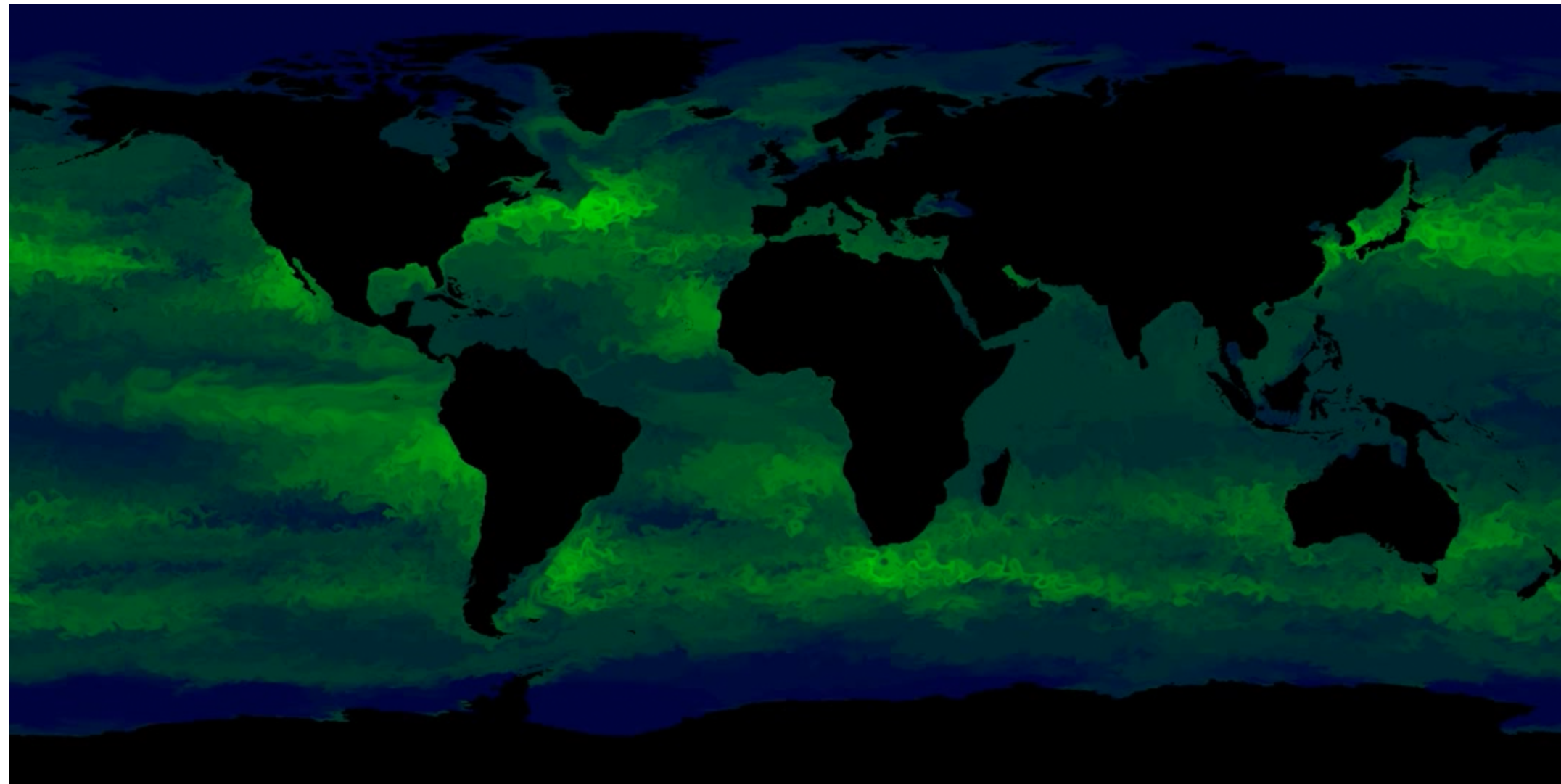

Prototype 1a: ocean currents

Visitor1c: There's one big current in the center (equator) and it's going under the continents.

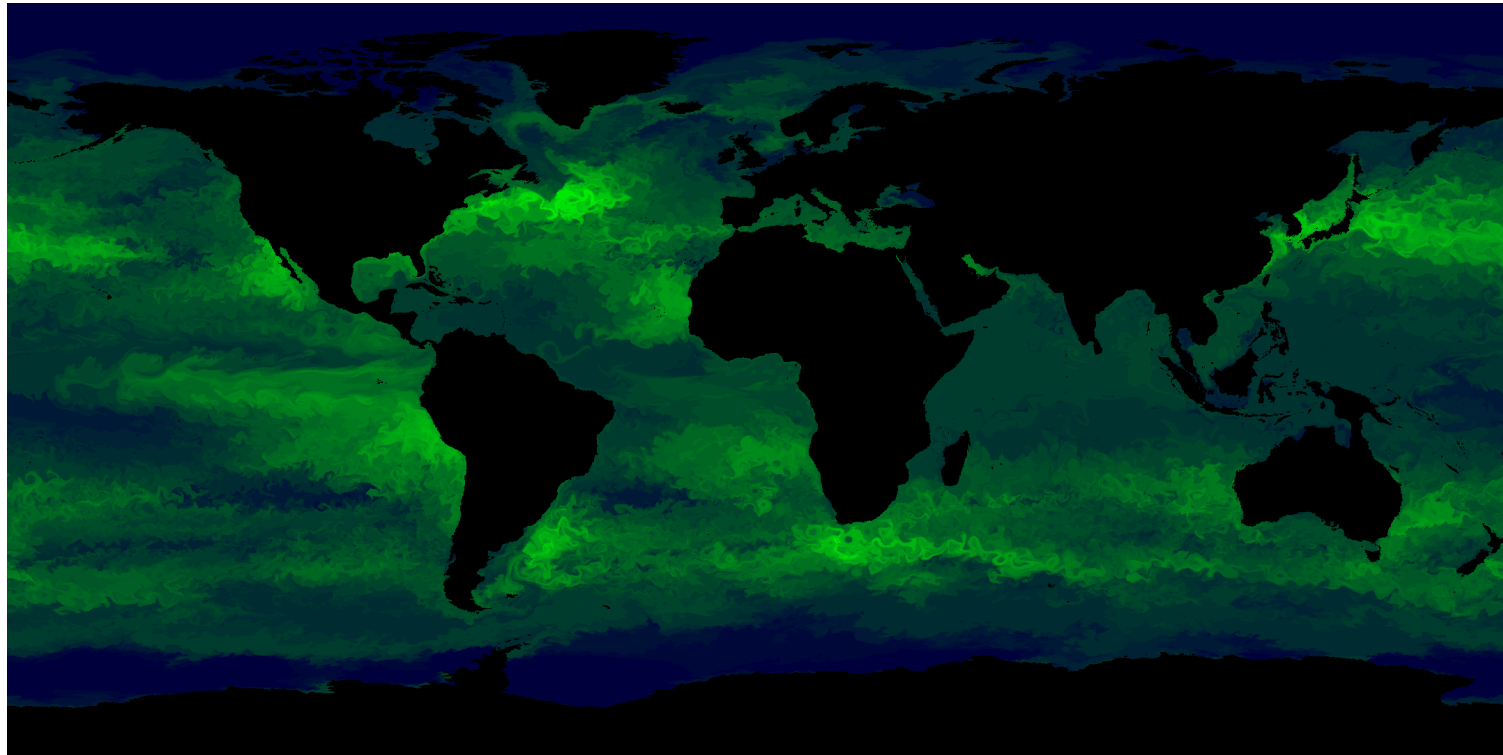Visitor2c: Those little round things. Why do they stay circular, like Cheerios?

Visitor3c: How does sunlight affect the current?

Prototype 1: What to visualize to initiate exploration?

lots of different types

few different types

Prototype 1b: plankton biodiversity
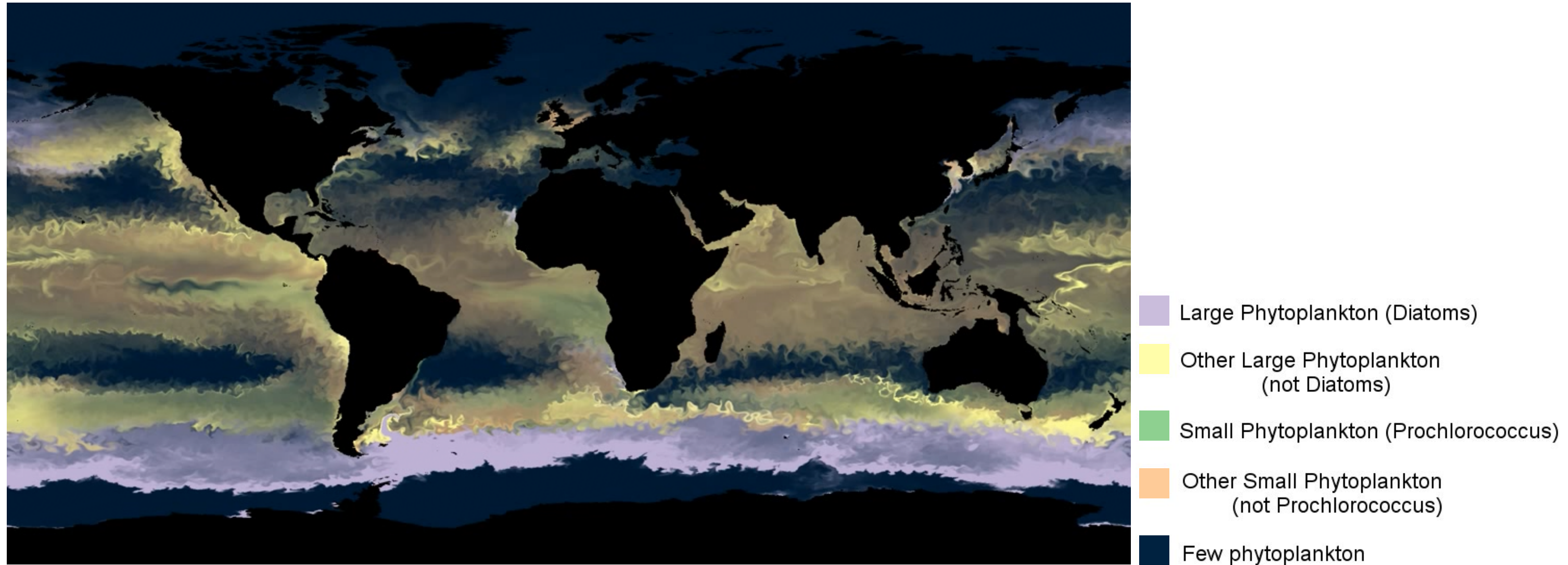
Prototype 1b: Findings

Prototype 1b: plankton biodiversity

Visitor1d: Do they change with the seasons?

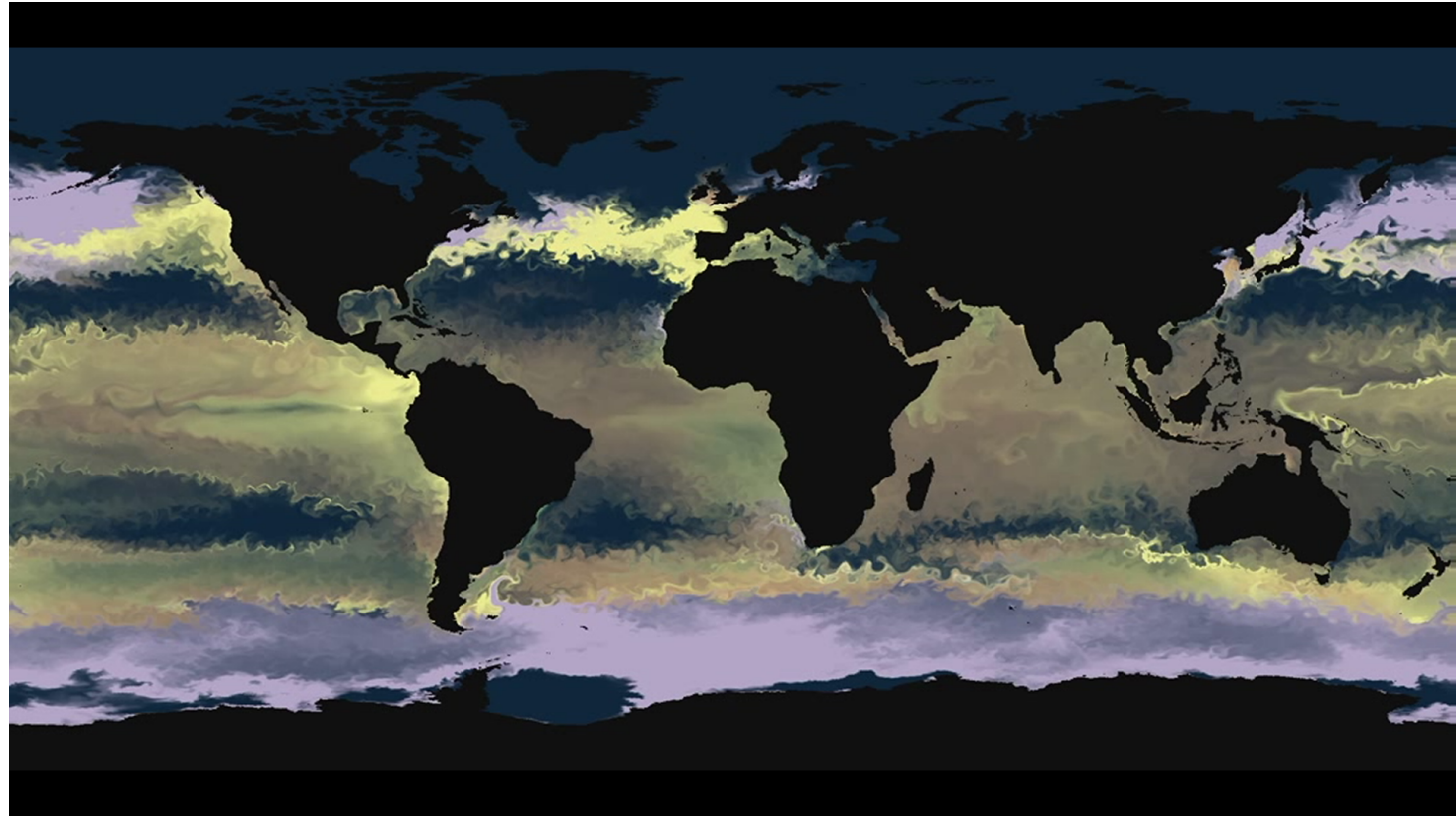Visitor18d: Does temperature affect them?

Visitor20d: Why are there more just north and south of the equator and not on the exact equator?

Prototype 1: What to visualize to initiate exploration?

Prototype 1c: plankton type distribution
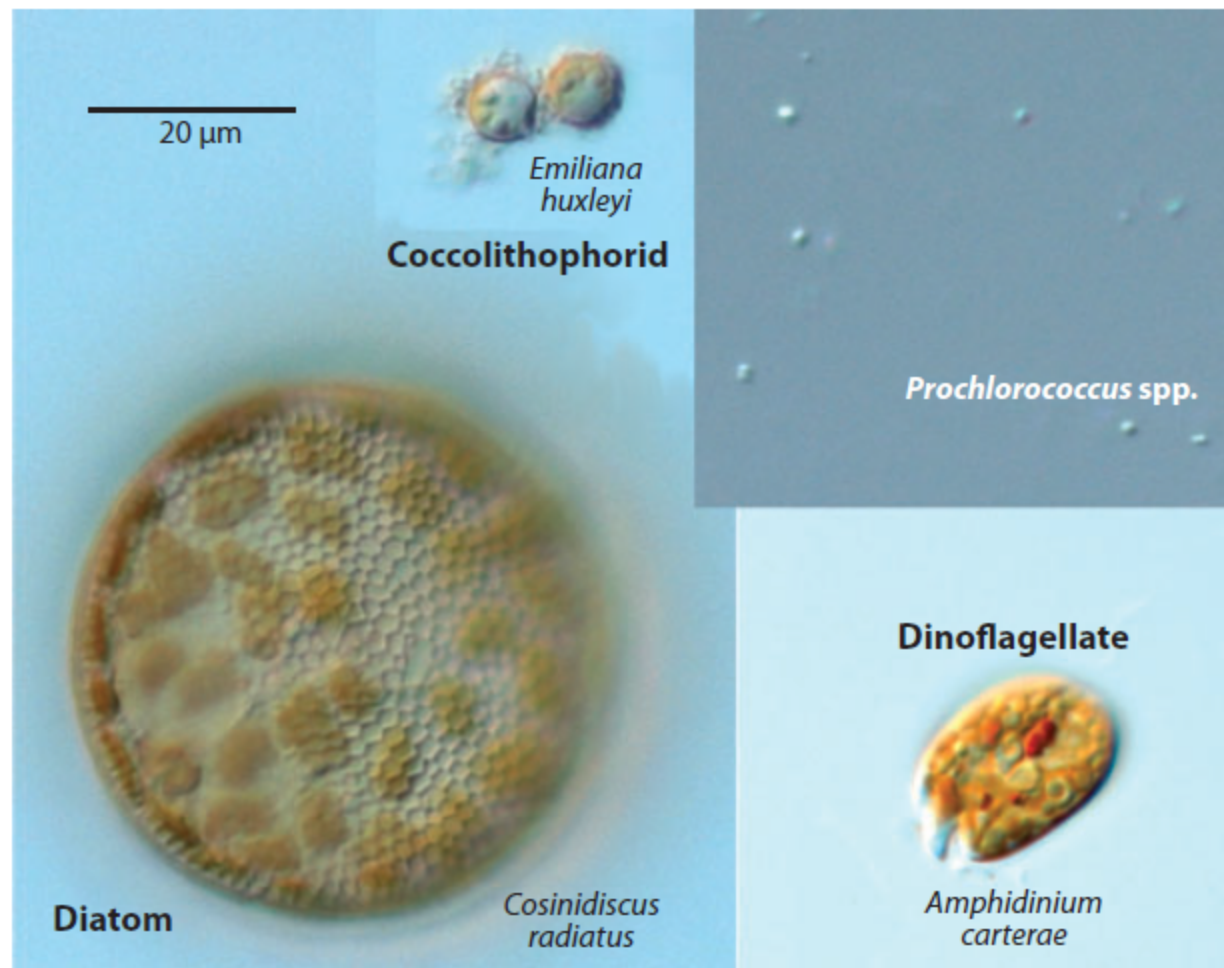
Prototype 1c: Findings

Plankton type distribution

Visitor12t: Are these changes affected by man?

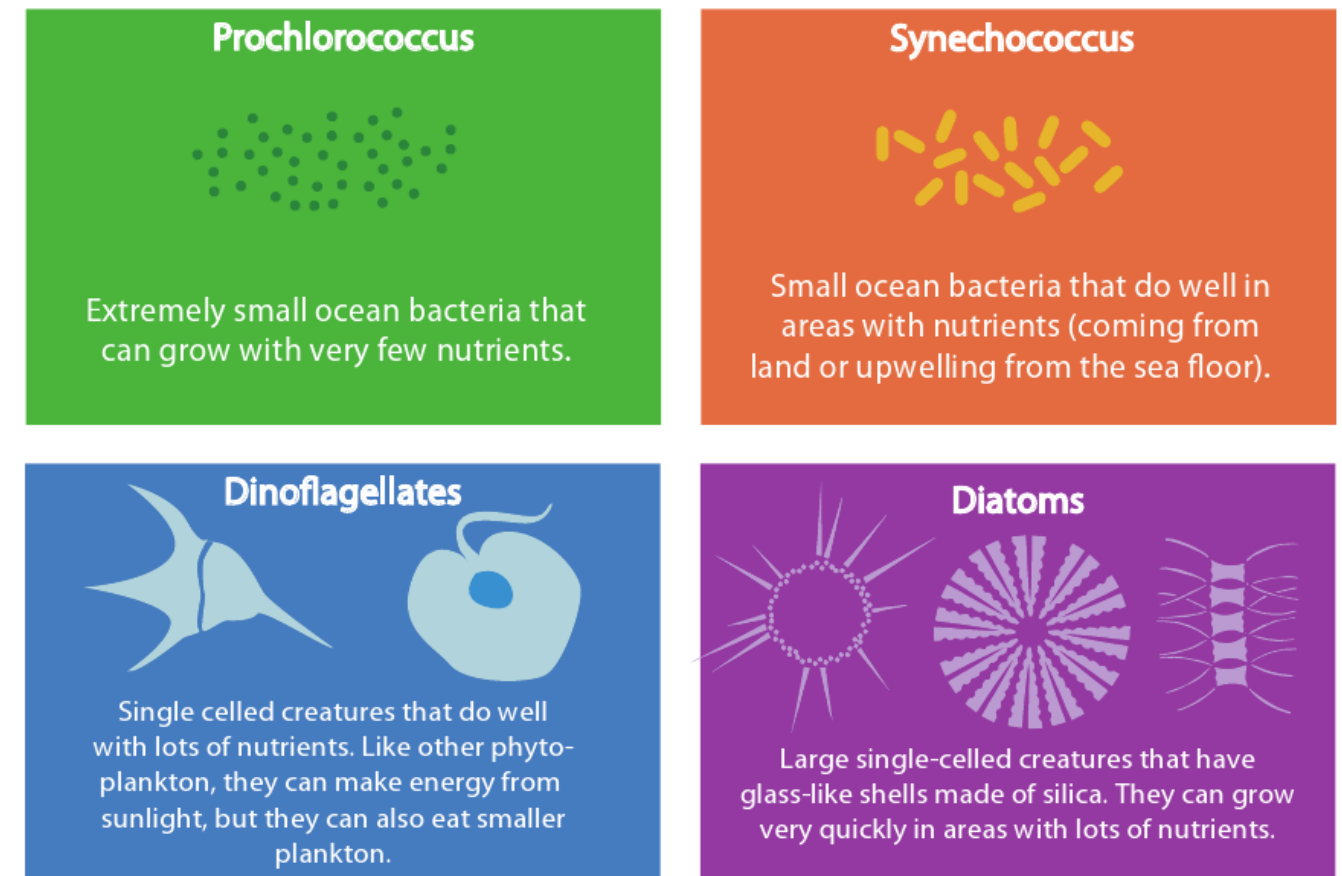Visitor13t: Why are the large ones near the poles? It seems like they get small towards the equator. Why is that?

Visitor10t: But the purple disappears? Are they just dying out or is it just at certain points? [watches] See they come back.

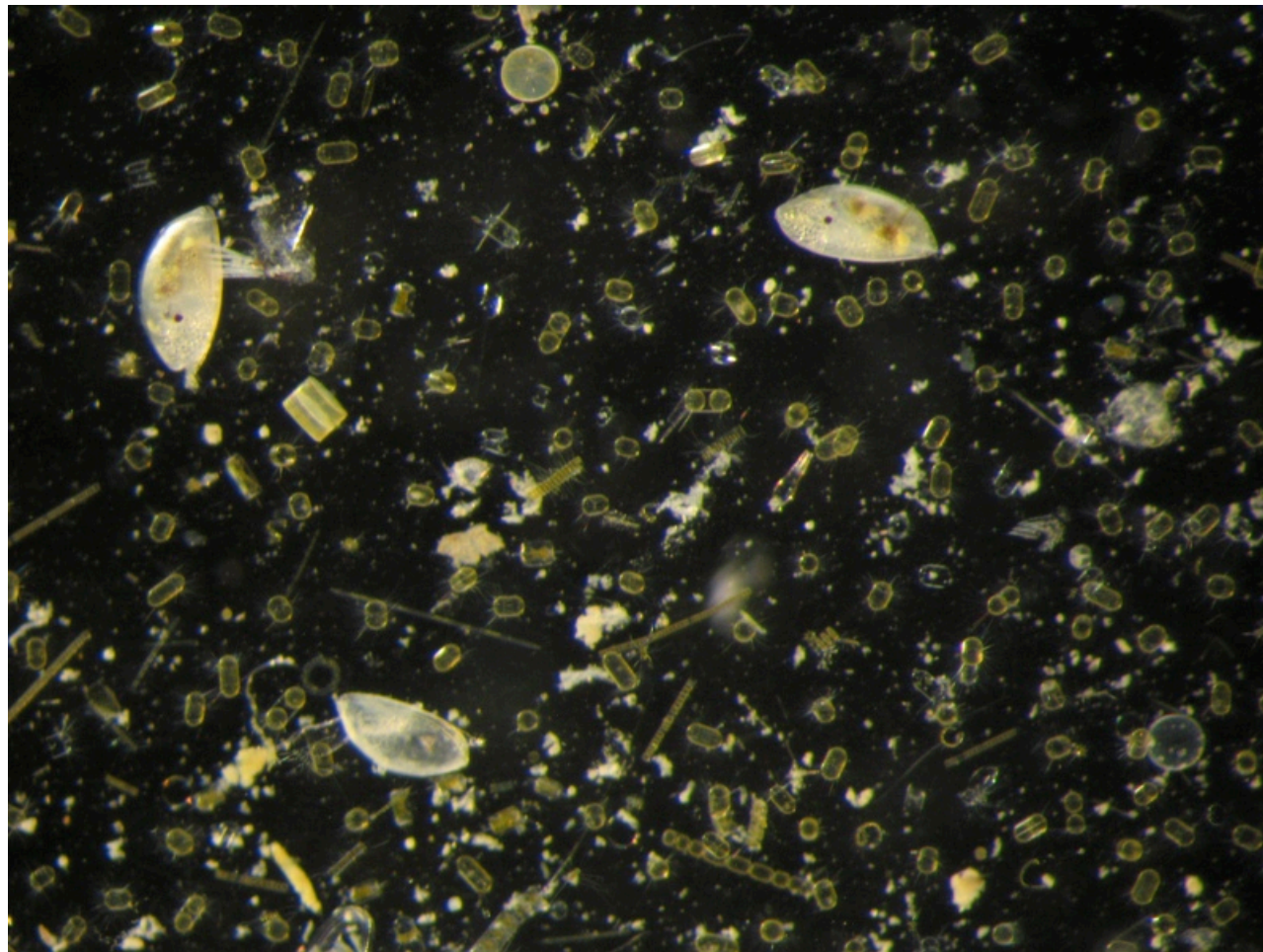# Prototype 2: How to visualize the microscopic?

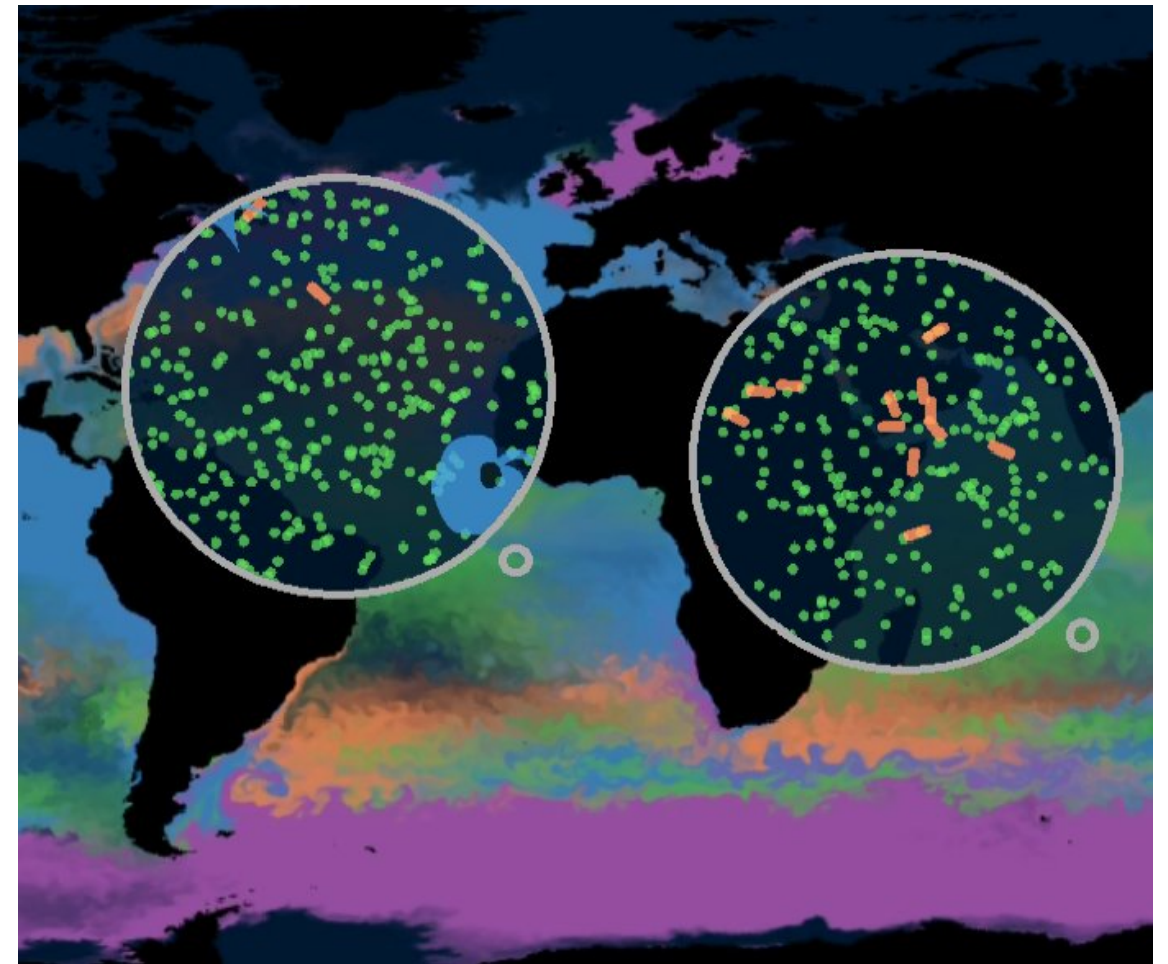Light micrographs (Follows, 2007)

Icons and color legend

Prototype 2: How to visualize the microscopic?
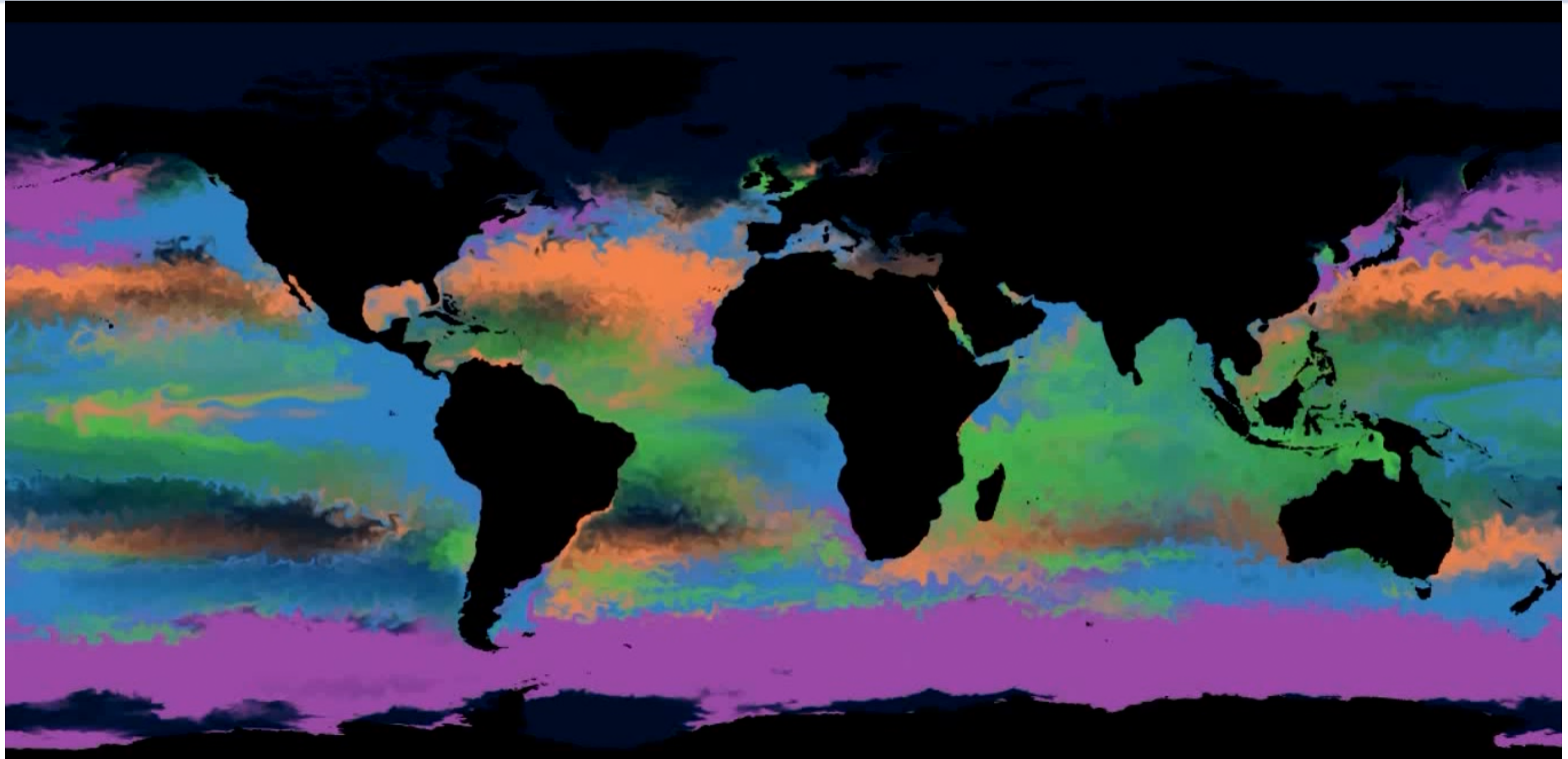

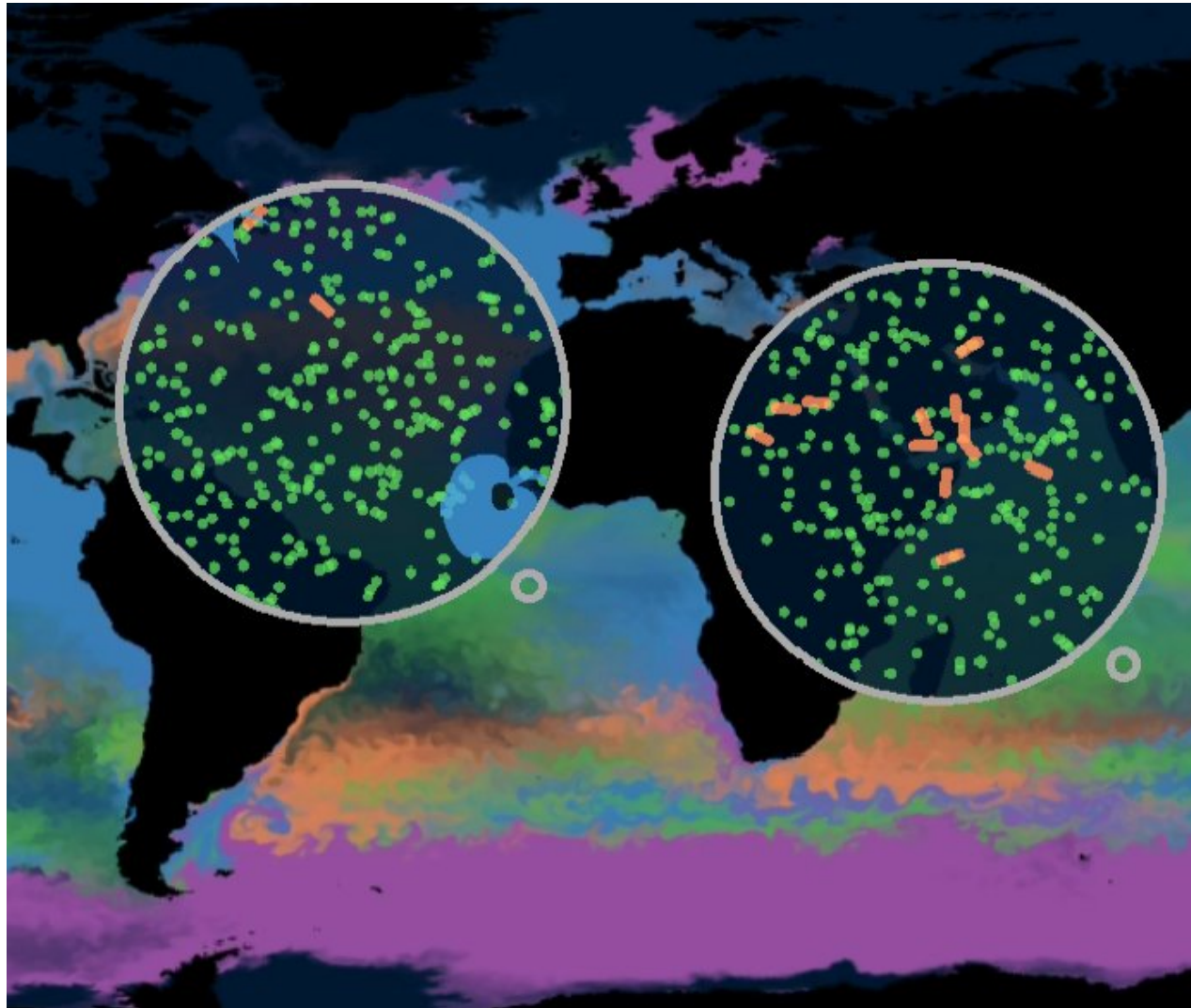Plankton from the San Francisco Bay

Circle viewers

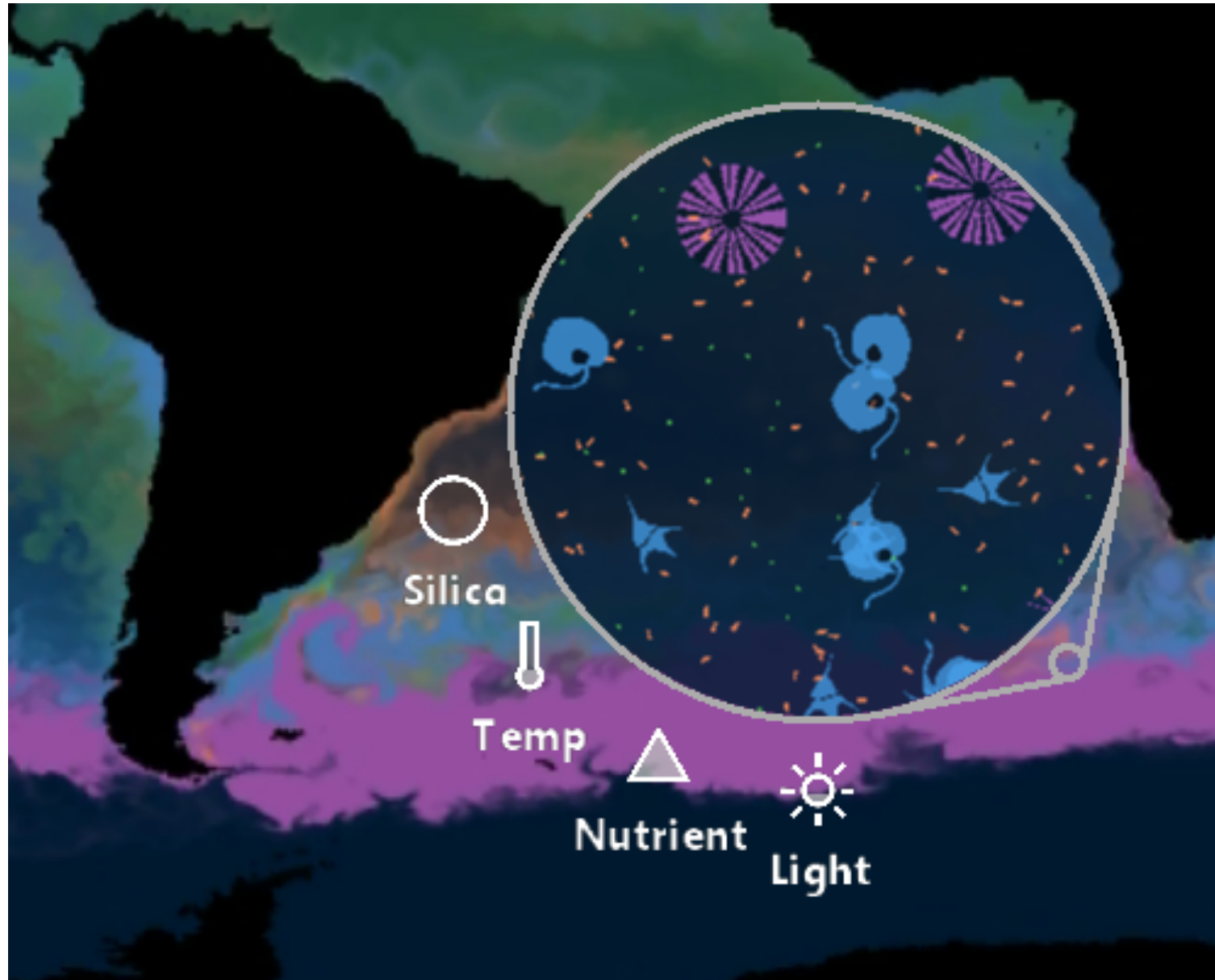# Prototype 2: How to visualize the microscopic?

Prototype 2: Findings

Visitor1: Shows more detailed representation of plankton.

Visitor3: Different kinds in one: green, orange and blue.

Visitor6: Obviously a magnification of the smaller circle [the touchpoint].

Prototype 3: How to add environmental conditions?

- Icon "fills up" if the location is abundant in the resource
- Looked for visitor mentions of:
  - Environmental conditions
  - Global patterns
  - Correlations between plankton and environment
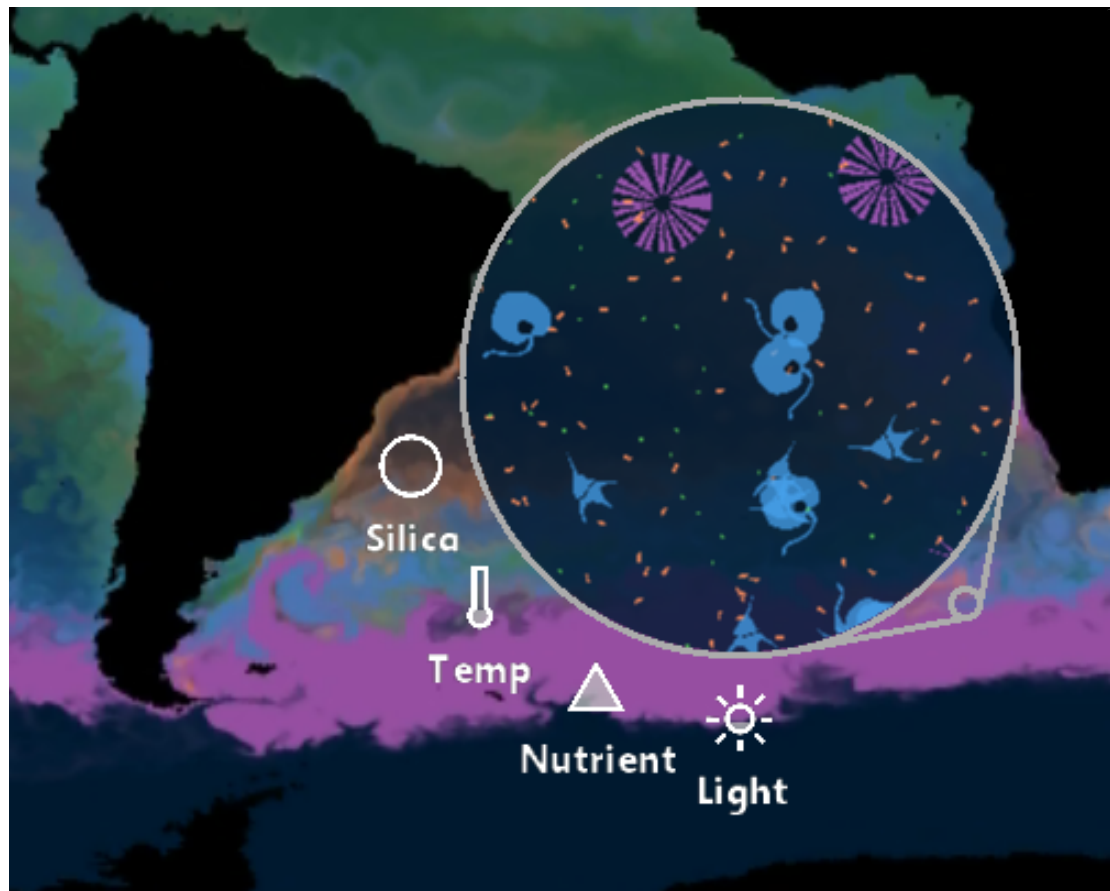
Prototype 3: Findings

Environmental Factor Mentioned by Visitors
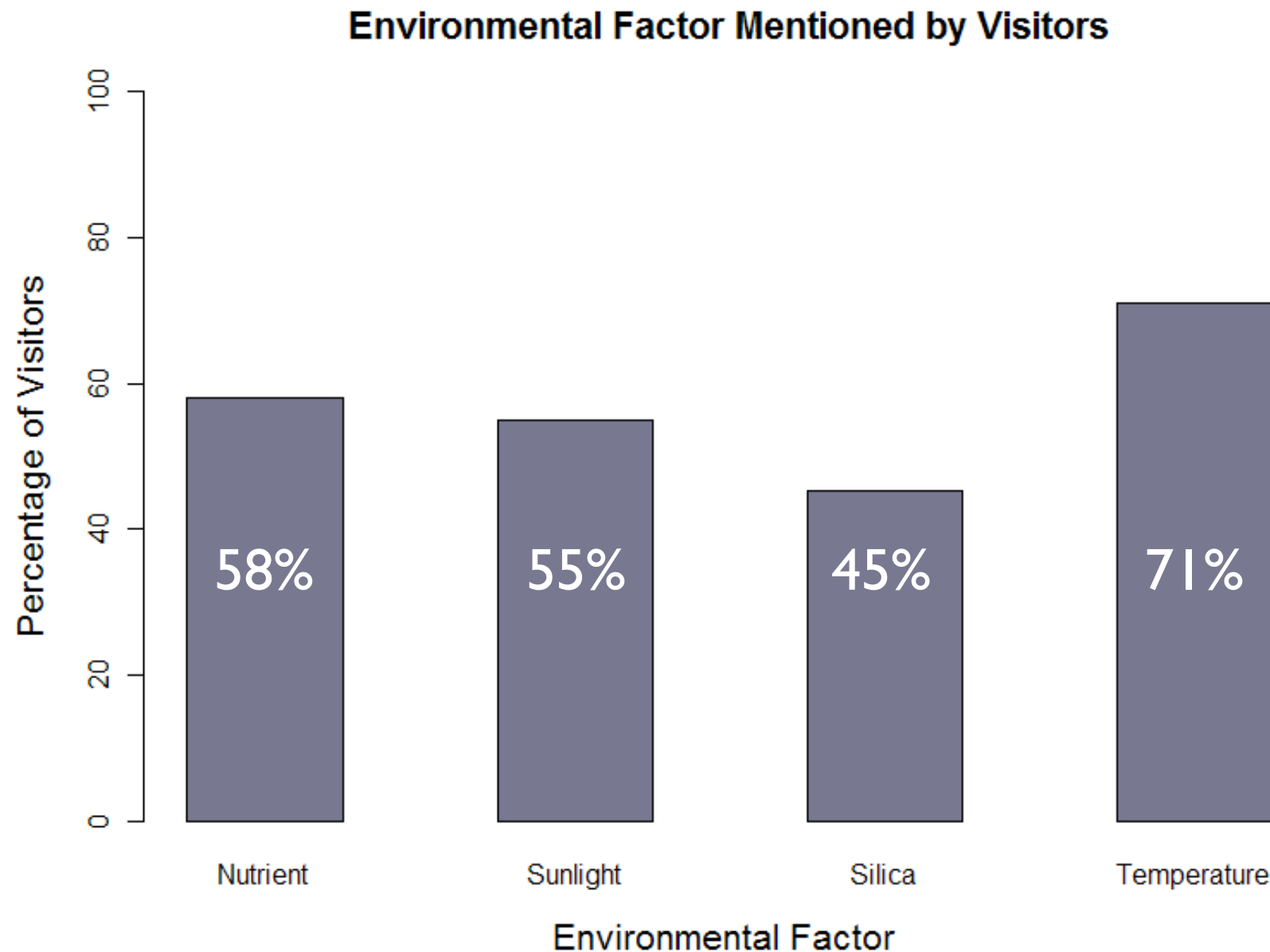
- 28/31 (87%) talked about at least one environmental factor

N = 31 dyads

Mdn = 3 factors

Min = 0

Max = 4

Prototype 3: Findings

- Only 52% of visitors correlated plankton type with environmental factors

Dyad88: Lot of nitrogen means diatoms.
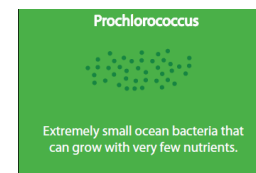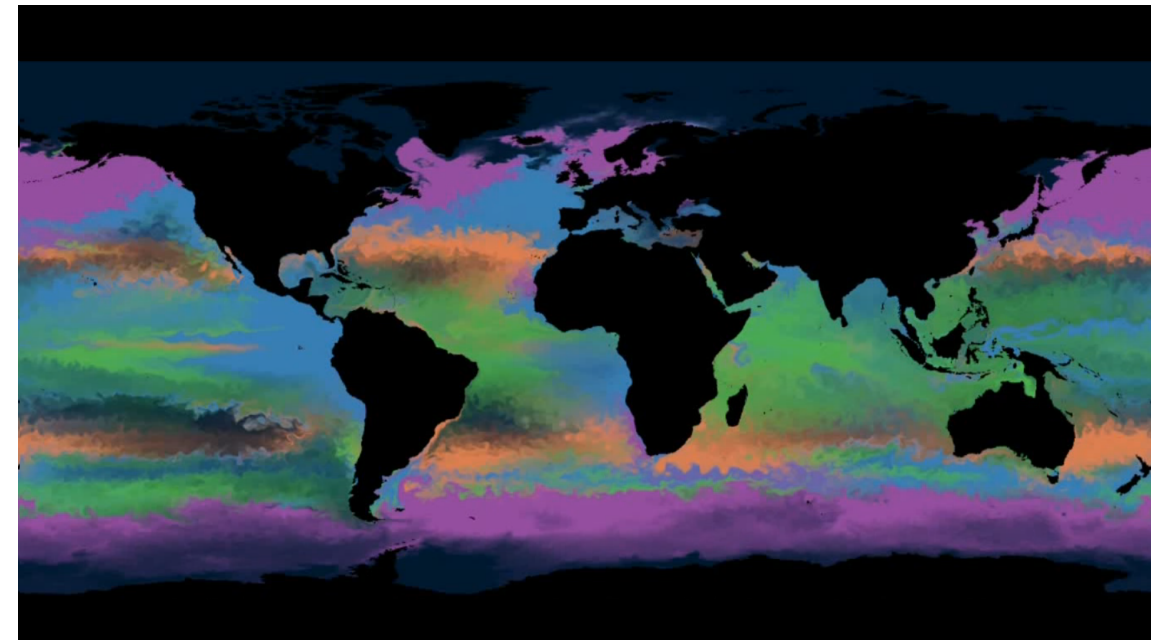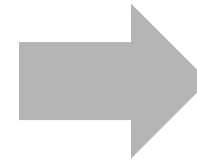
Dyad86: No plankton live in cold places, could that be true? No, 'cause look here, there's a ton in Alaska.

Dyad39: Ok so it shows you the green areas, and here (very close to Antarctica land mass) there's none. Too many nutrients.

Lessons Learned

- Emphasize relevant content even when it's less attention-grabbing
  - Initial attractor screen needs to be plankton-related
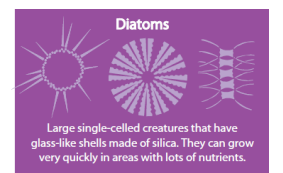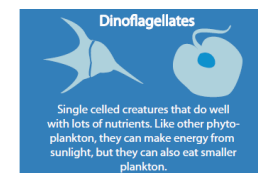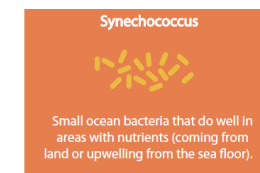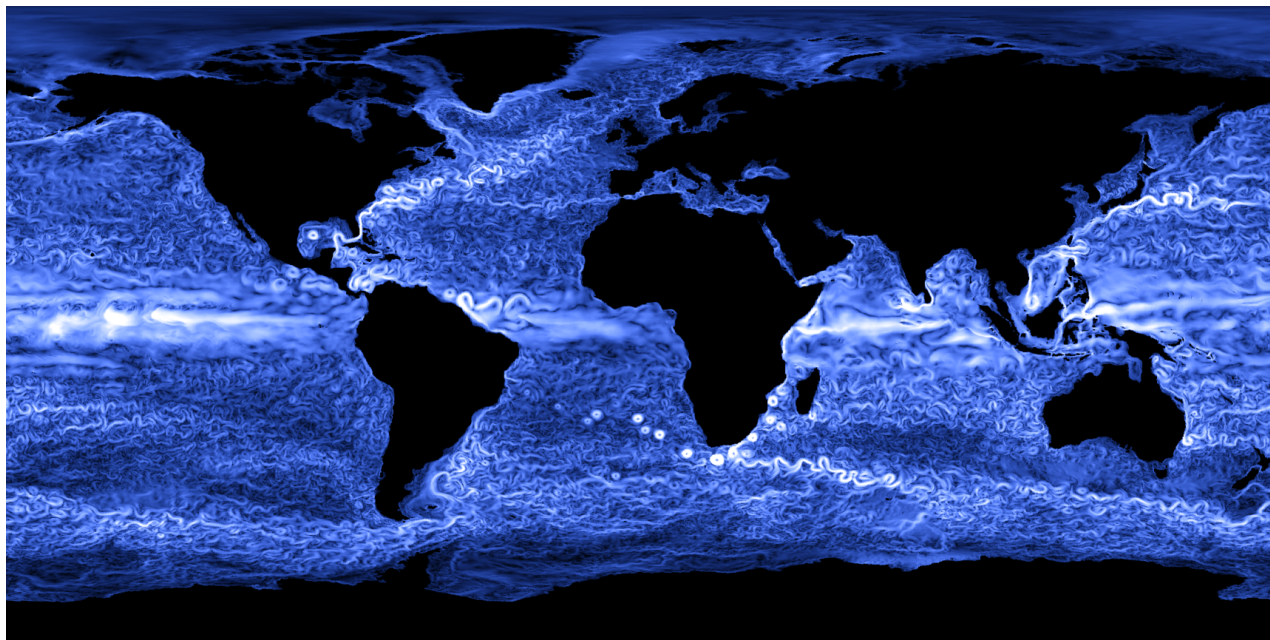
Lessons Learned

- Assess and support visitor interpretation of visual encodings
  - Visitors are able to associate plankton types between the global map and the circle viewer using color-coding and a touch-to-zoom metaphor
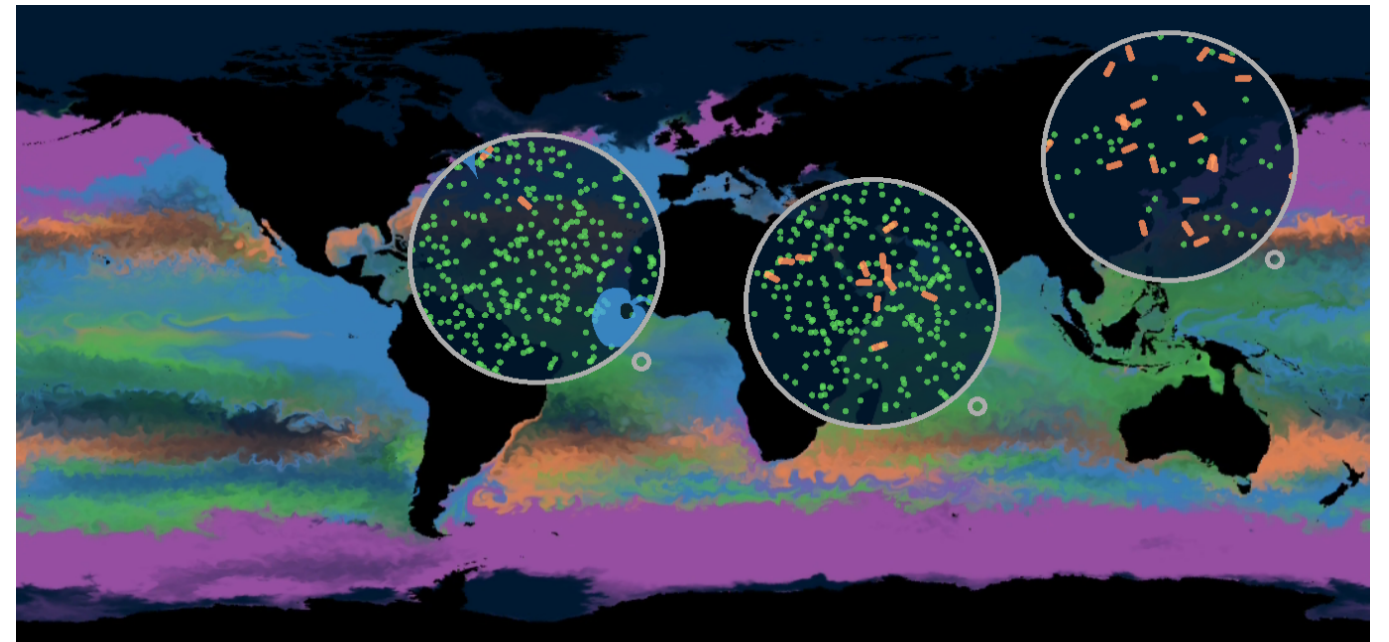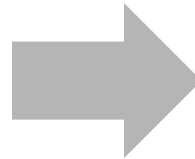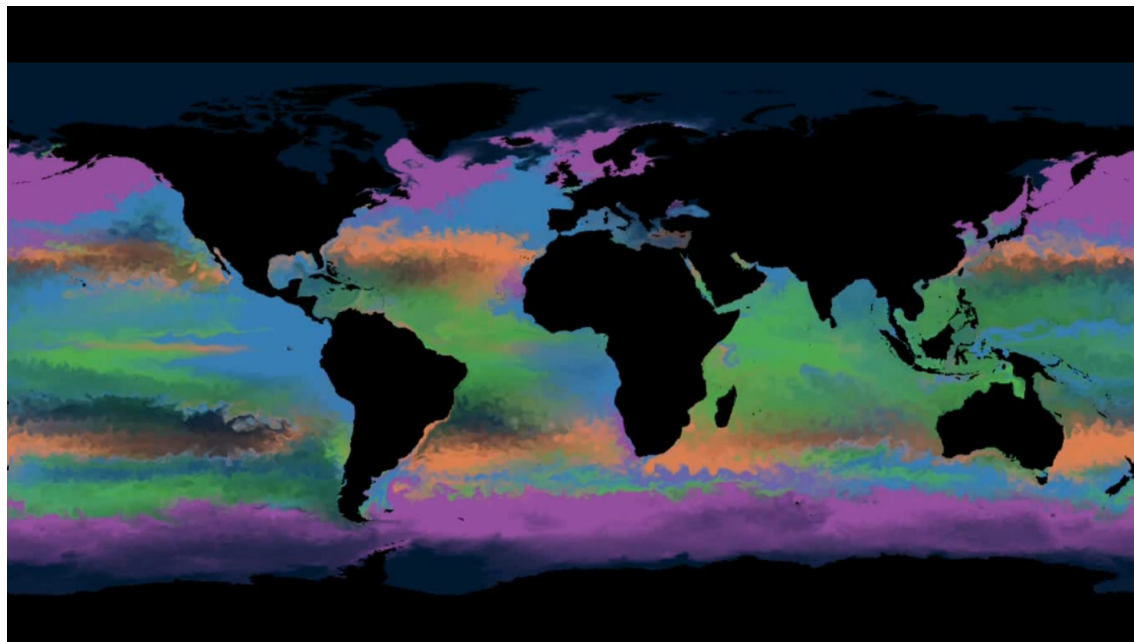
Lessons Learned

- Layer the accessibility of complex data
  - Need another interaction level that clarifies the relationships between plankton and environmental factors
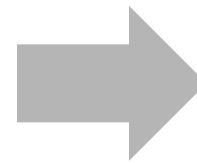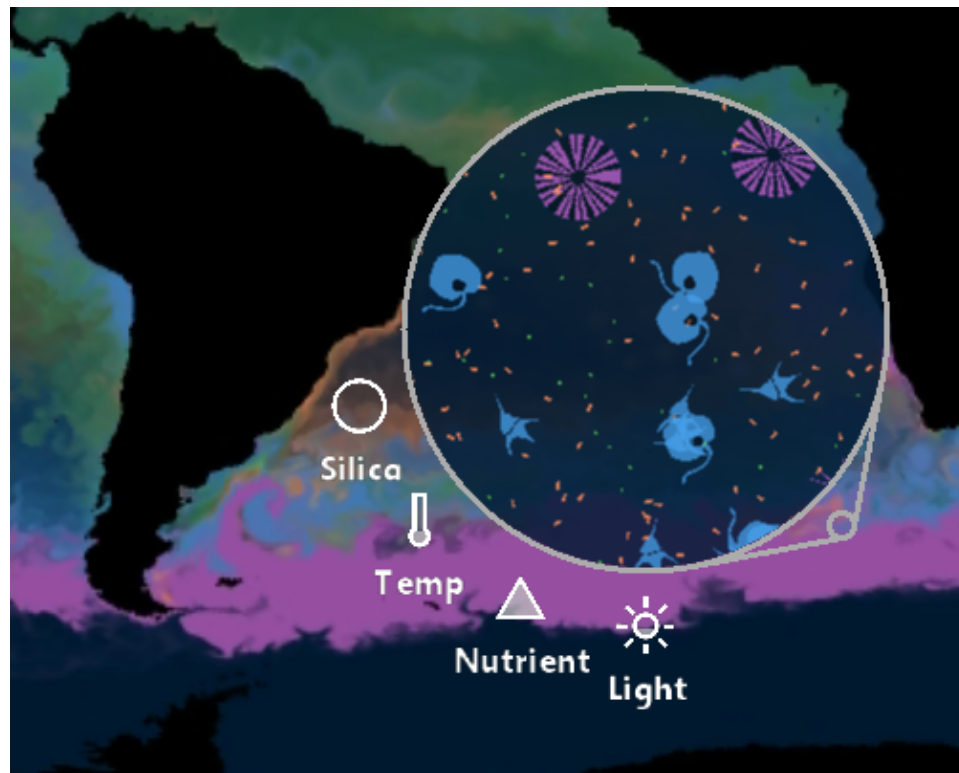
Current status of prototype
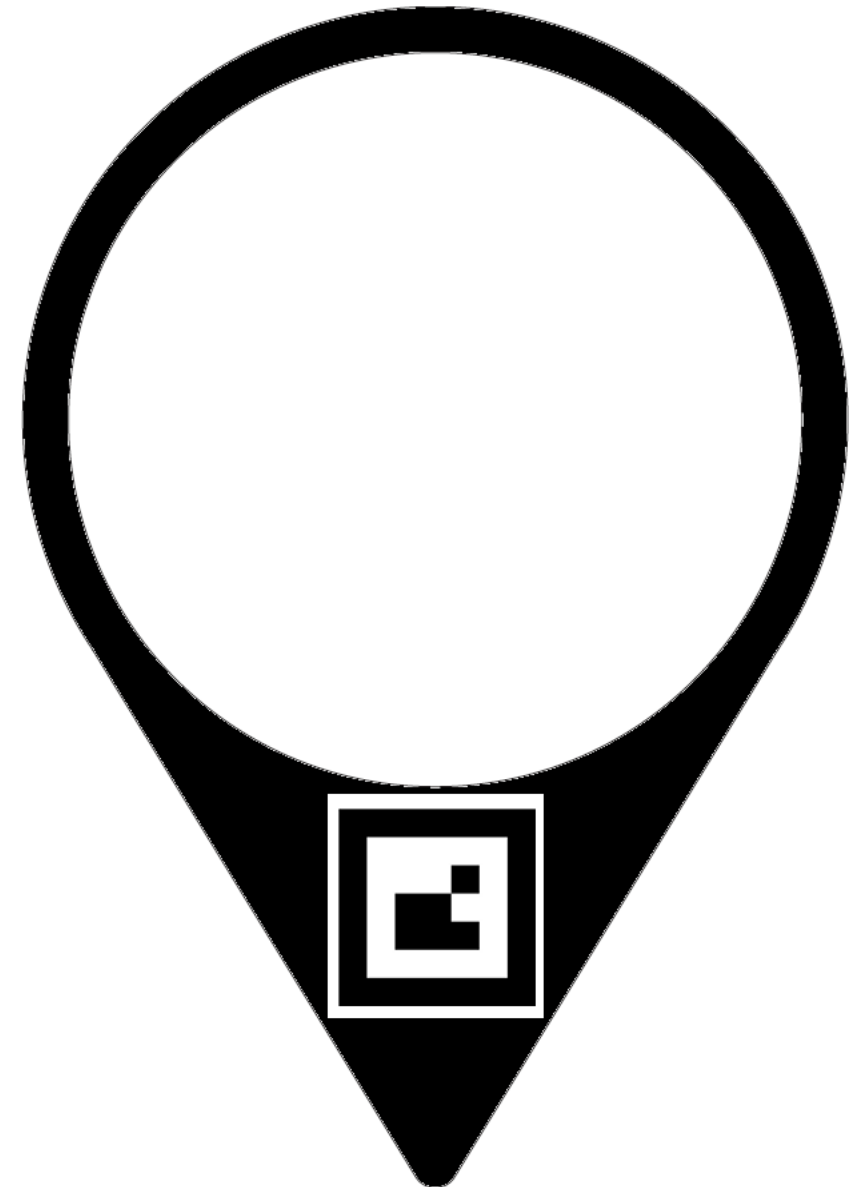
Current status of prototype
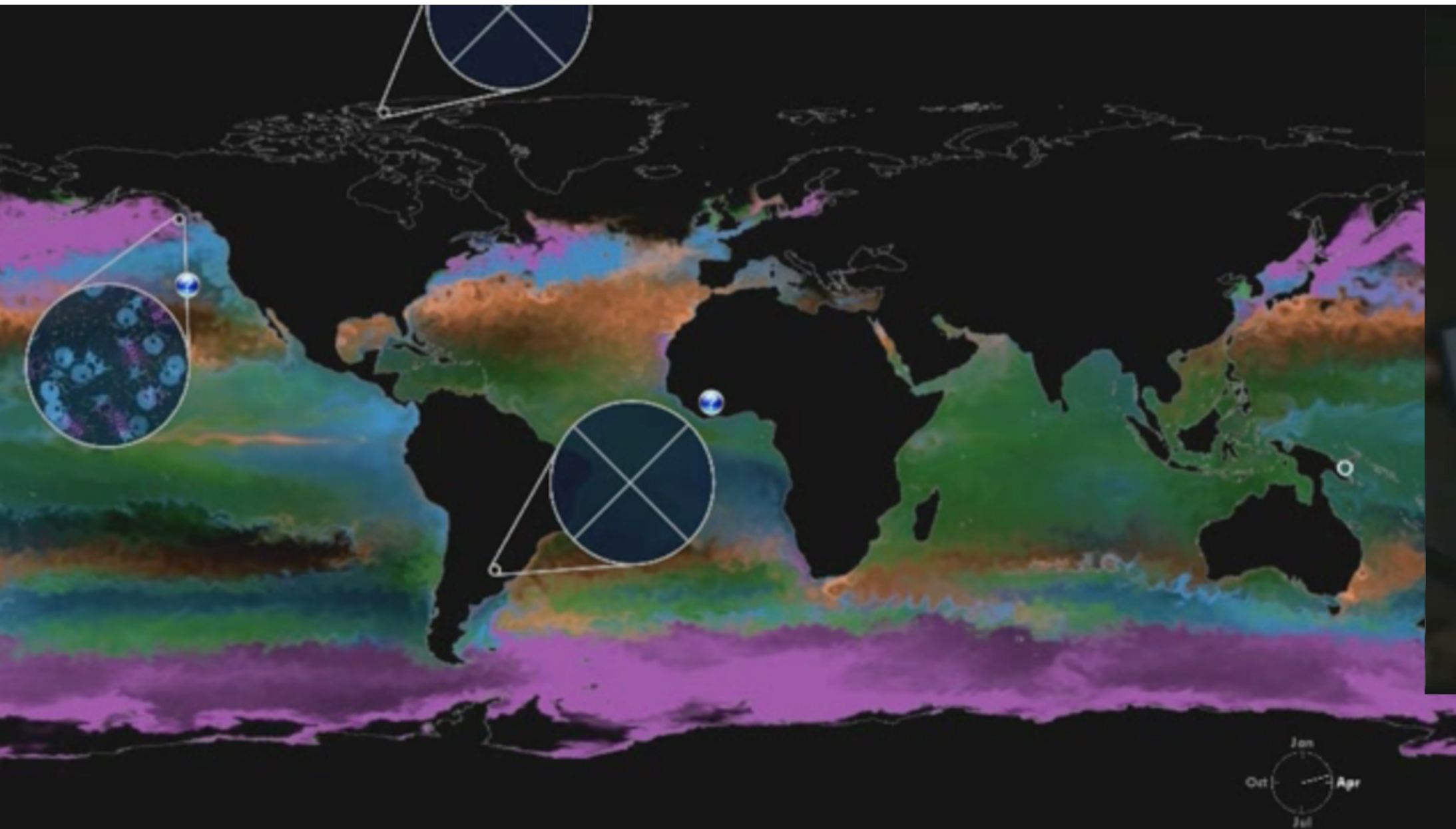
Acknowledgements

- Darwin Project: Mick Follows, Stephanie Dutkiewicz, Oliver Jahn
- Exploratorium: Eric Socolofsky, Lisa Sindorf, Sarah Kimmerle, Mandy Ice
- Supported by:
  - NSF grants DRL-1011084 and CCF-0811422
  - Department of Energy grants DE-FC02-06ER25777 and DE-FC02-12ER26072, program manager Lucy Nowell
  - Gordon and Betty Moore Foundation

Current status of prototype
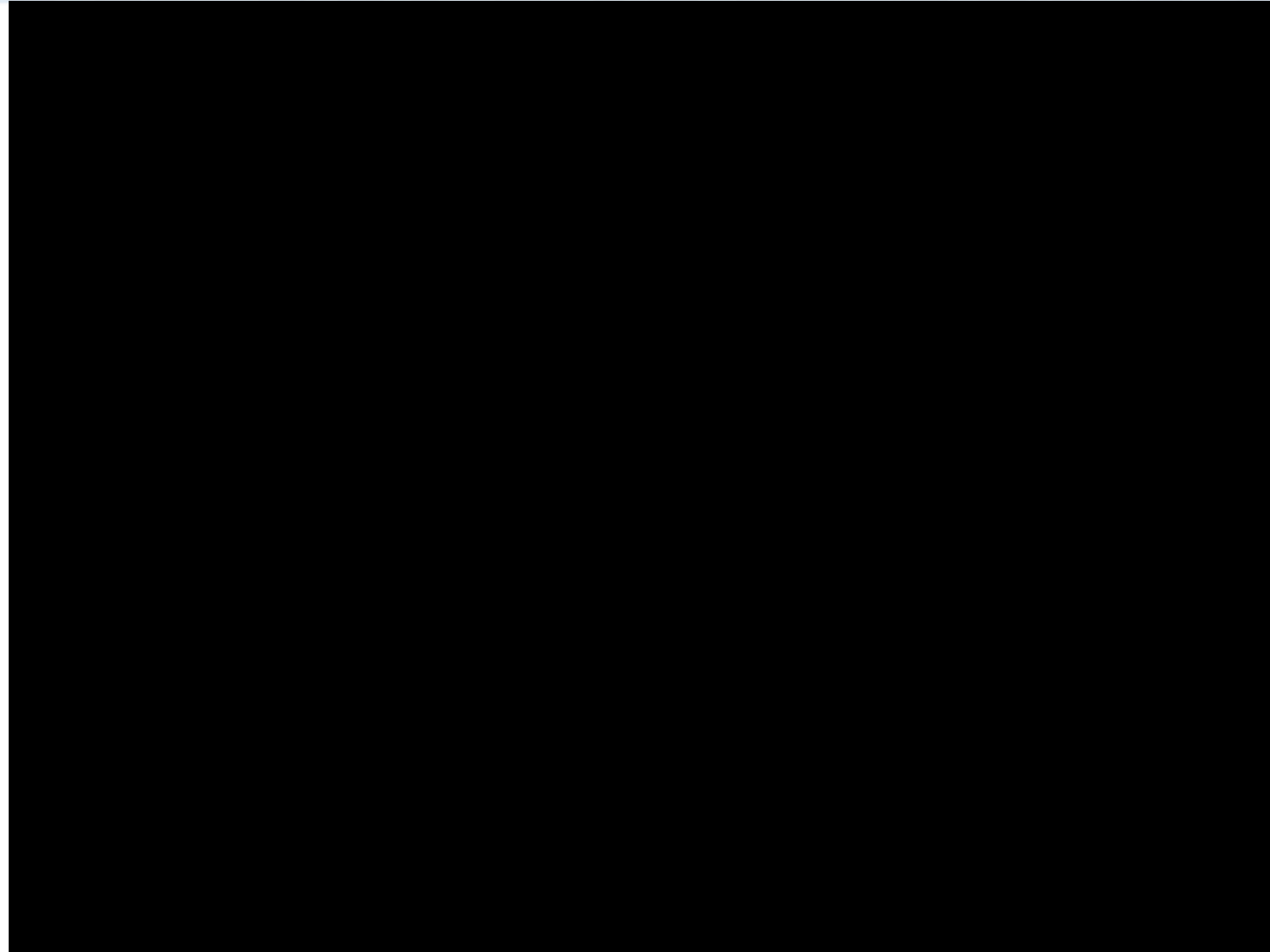
Current status of prototype
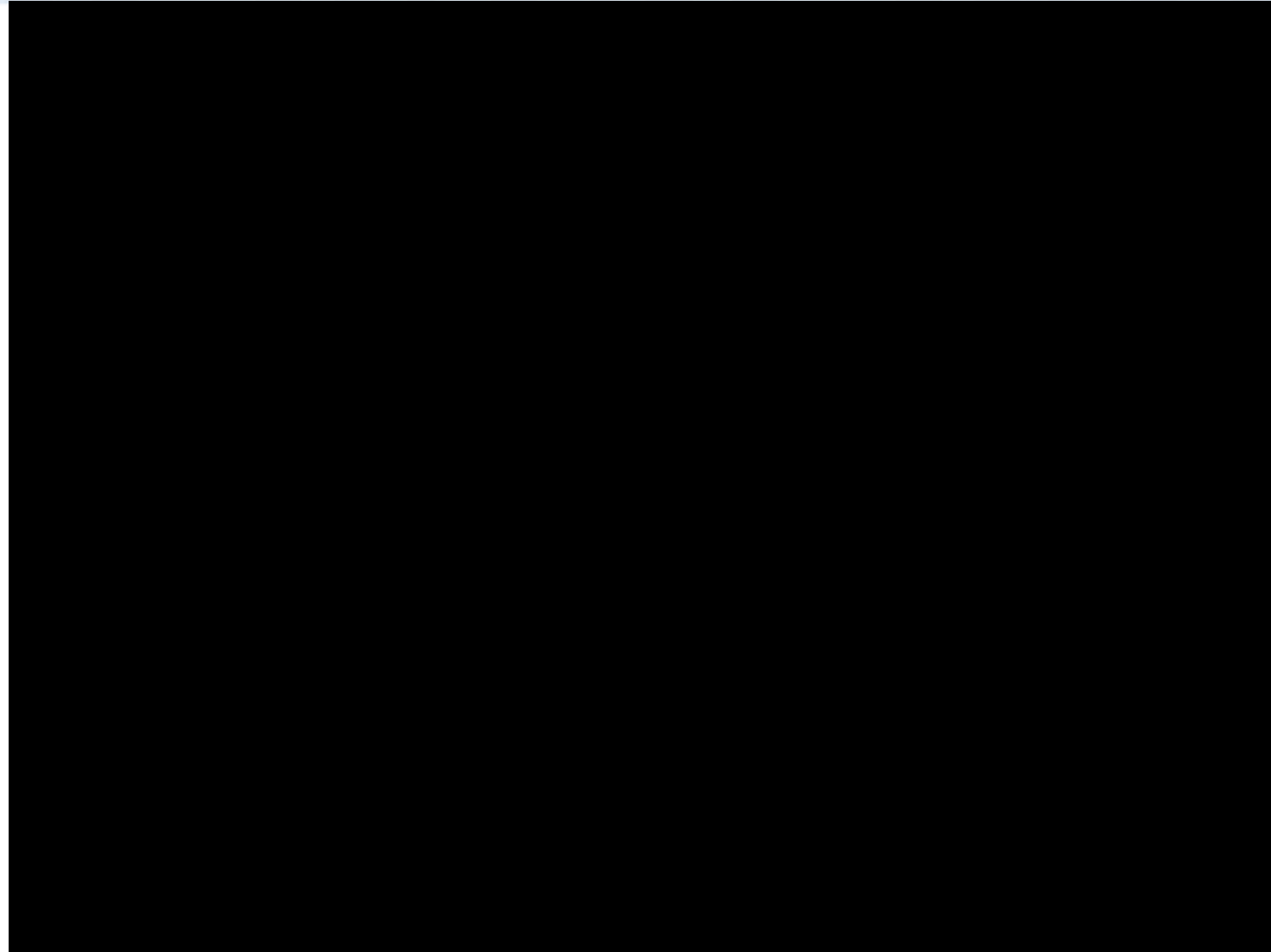
modeling the marine ecosystem

light

many (100+) phytoplankton

zooplankton

nutrients

PO4
NO3
Si
Fe

grazing rates

randomly assigned growth rates

detritus

some sinks out to depths

the darwin project

http://darwinproject.mit.edu

(slide courtesy S. Dutkiewicz)

Initial Biomass of 100 phytoplankton types

log10 (biomass)

(slide courtesy S. Dutkiewicz)
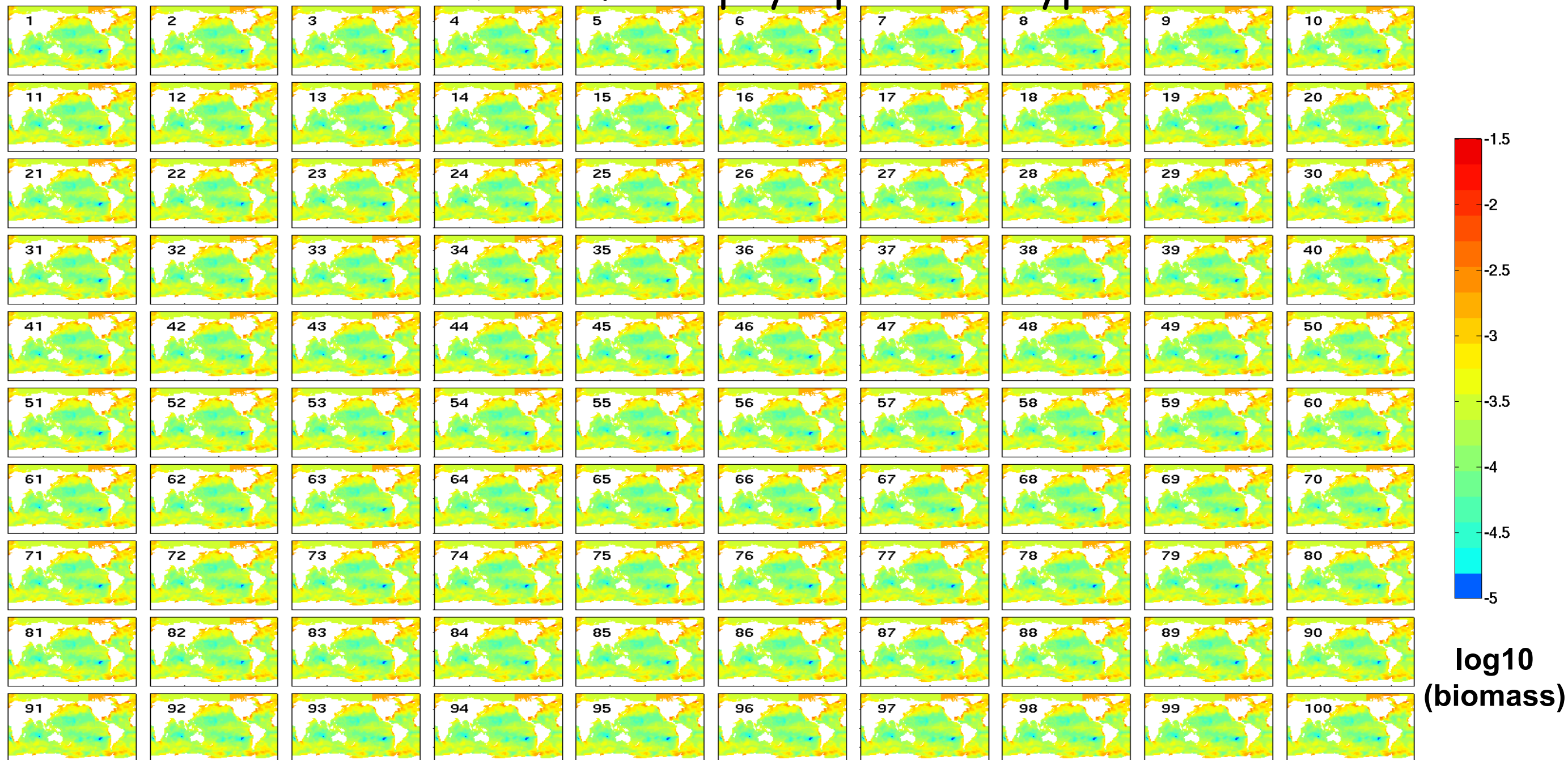
Annual Biomass after 10 years simulation

log10 (biomass)

(slide courtesy S. Dutkiewicz)
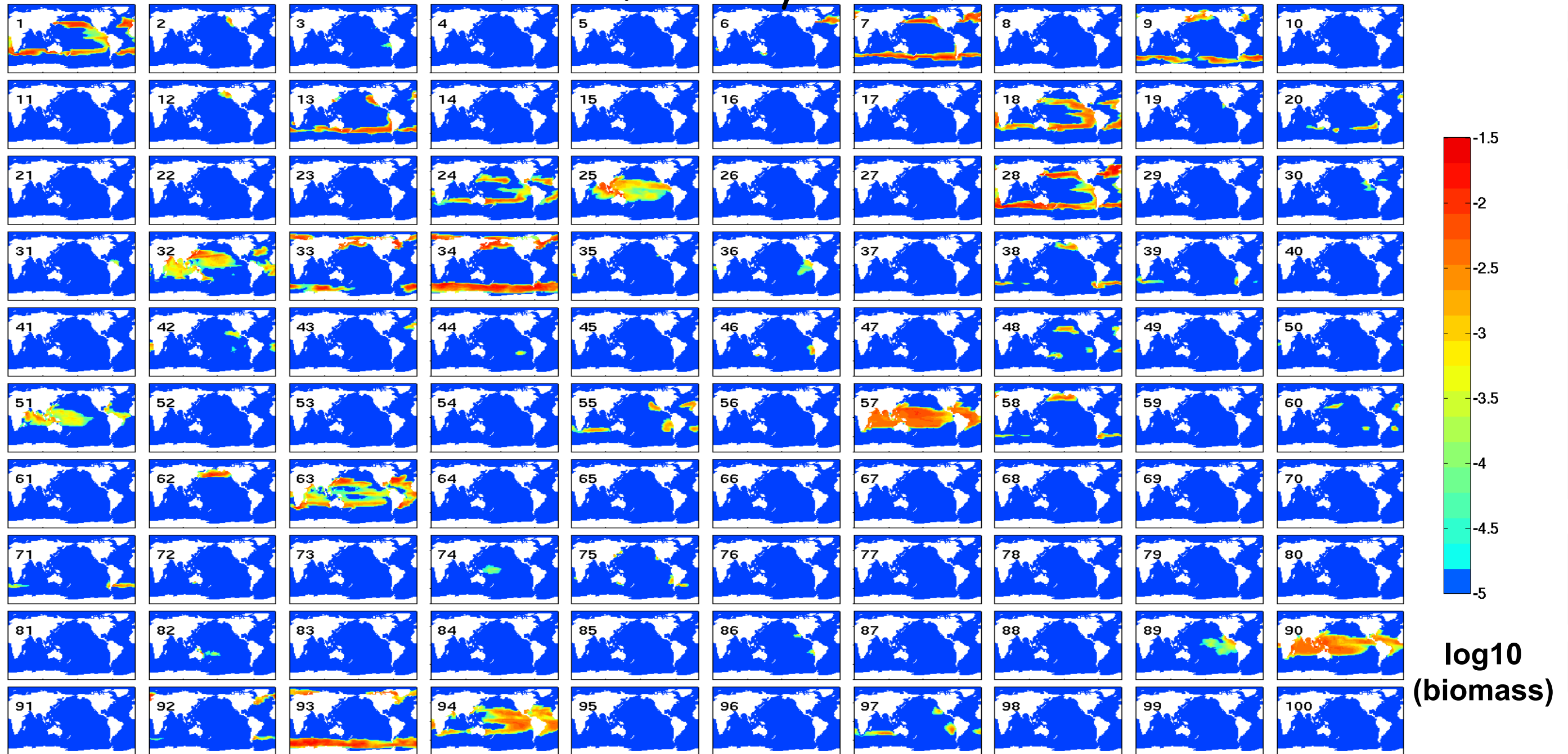
Simulation validation (AMT-13)
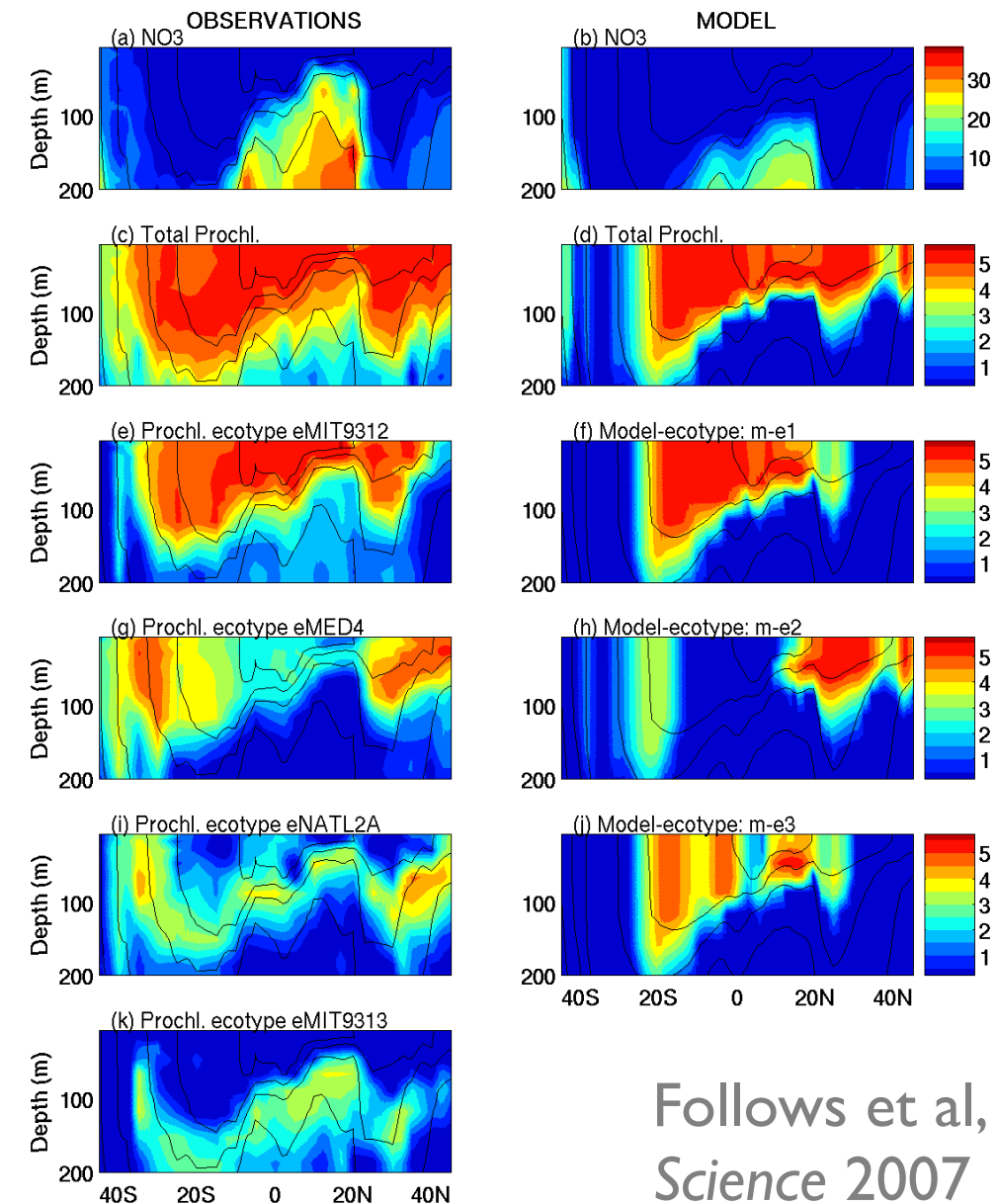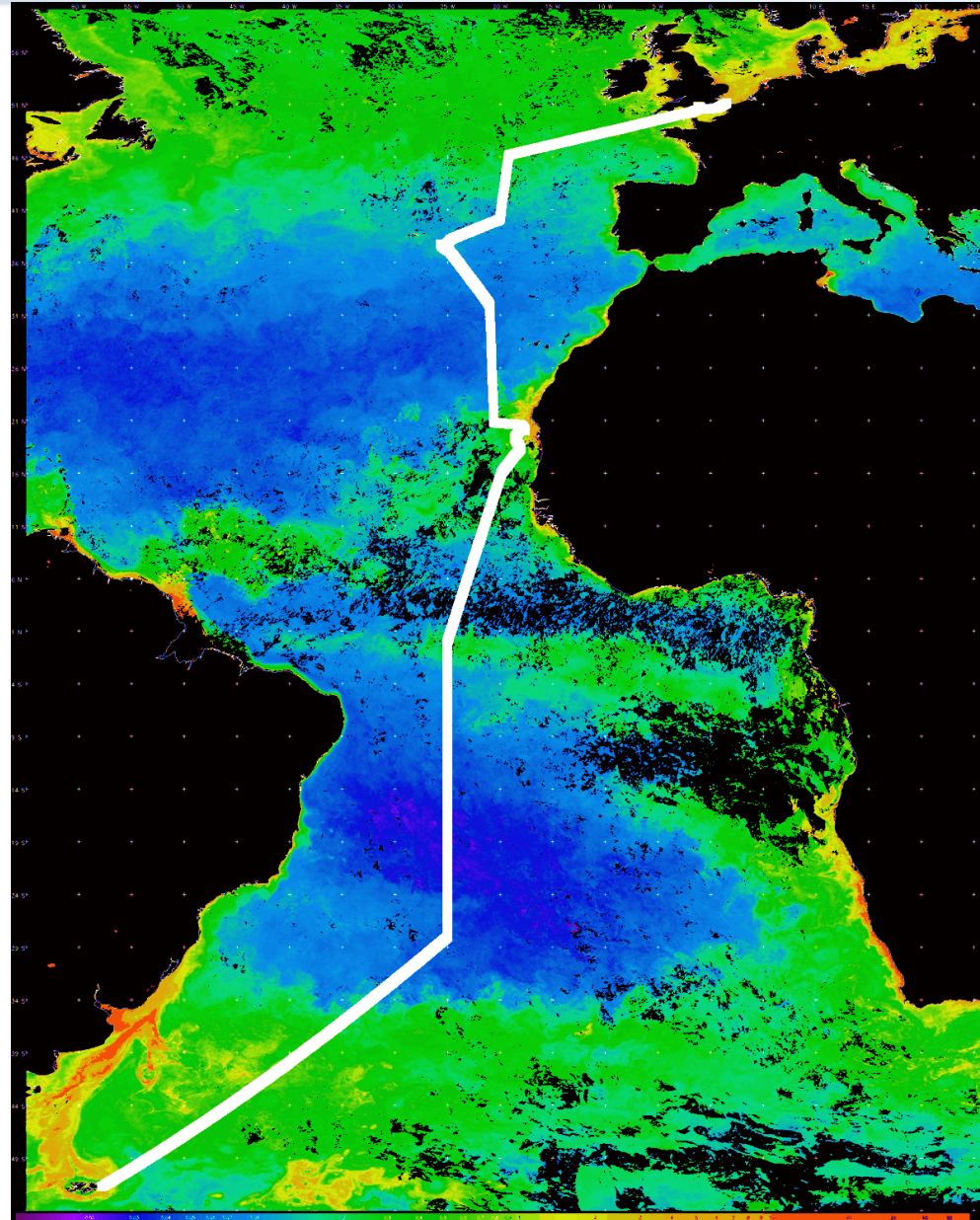
Follows et al,
Science 2007

Evaluation Methods

- Think-aloud protocol
- Interviews

pattern: Type

type : Dinoflagelletes

type: Diatom

type : Prochlorococcus

Let this fade. Each of these is a different color… let's watch it go.

It's January. In October, look--oops, you stopped the clock! So, it's a lot of diatoms (near Antarctic), dinoflagellates (far off W coast of Australia). In the Arctic, not much! There's a lot of this and that (pointing to pro- and dinoflagellates on label).

Ok, let the clock go. Let's see where it's lots of nutrients. Like here (Pacific, near Chile) it has big and small ones.

env variable: Nutrient

pattern: Abundance

It's January--oops, you stopped it! Look. Now the Antarctic has a lot. Lots of nutrients there. The purple places have purple stuff! … Here (Near Madagascar) it's low in nutrients.

type : Diatom

pattern: Environment

Ok, let it go, wait until April. Um, is October winter? Well it depends where you are. Ok it's very rich there (Just south of Greenland).

Let's see how the colors change. Remember at Monterey Bay-- (gets distracted) watch, it's getting yellow (=orange). It's blooming in the Arctic summer. Look at this current (near Galapagos), weird.

type : Synechococcus

env variable : Light

Let's see if it's rich all year (looking at Antarctic). Let's watch. It gets rich here (North of Canada) in July. And January it's not. Why is it empty? It's under ice. Here (Indian Ocean) it's orange. A little light, lots of nutrients, low temperature, low silica. This is high, no silica. Look, these need few nutrients. But at the equator it's green. You'd think there would be more nutrients there. But it's the arctic that's the super-rich place. That's why birds and seals migrate there. The arctic sea has the richest places. Look how rich it is here!

env variable : Silica

env variable : Temperature

pattern: Correlation