

TARA OCEANS

A three year expedition...

- to explore pelagic plankton and coral reef ecosystems in relation to environment
- to popularize science
- to educate

TARA
OCEANS



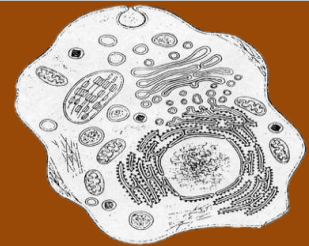
..., archea, eukaryotes -protists, animals, plants.

behavior

Ultrastructure
biominerals

Metabolisms: redox chemistry

1-2% atm. O₂



10-30% O₂

plants

animals

PROTISTS

viruses & prokaryotes

Archéen

Proterozoic

Phanerozoic

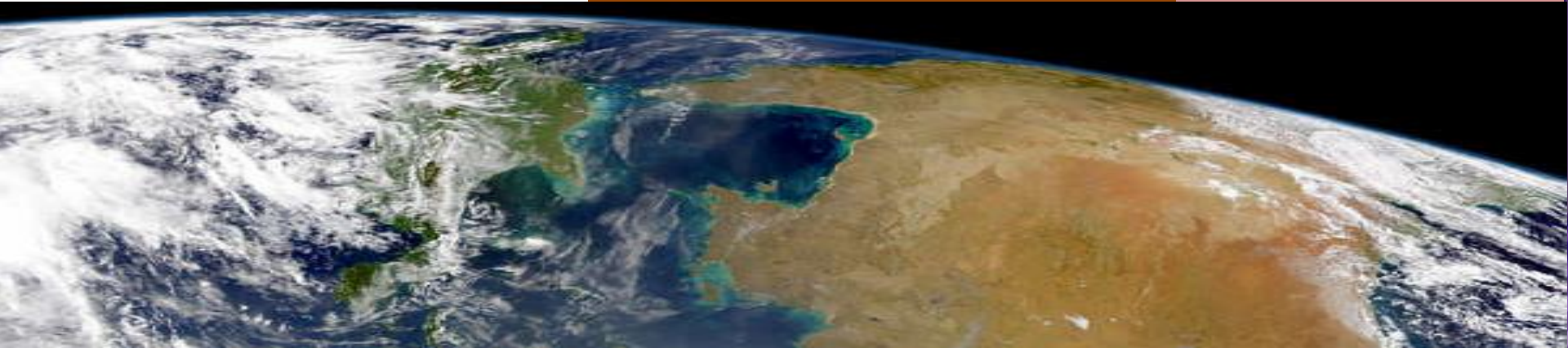
2000

1500

1000

500

0



Plankton Chronicles: Plankton



Movie: C. Sardet

Observatoire Océanologique de Villefranche sur Mer

EMBL



Insight Lectures

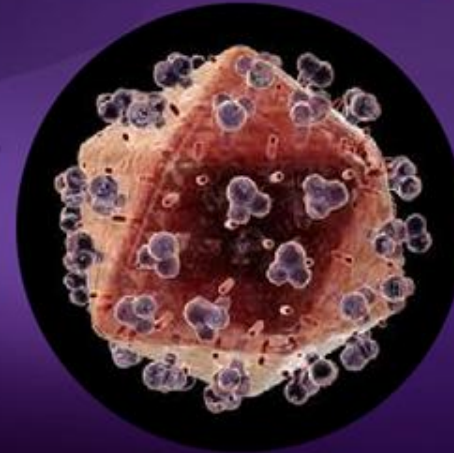
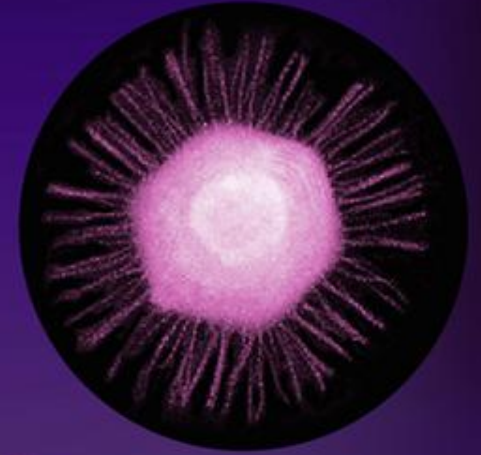
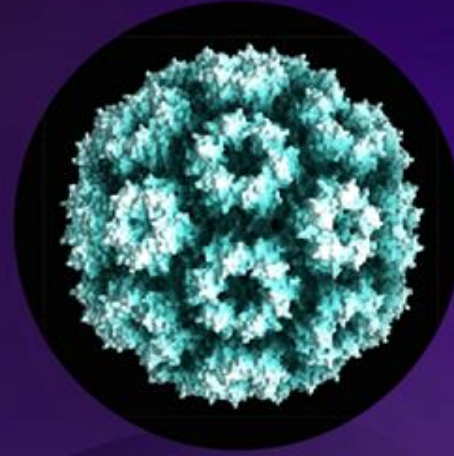
1 Litre of seawater contains:

- 10.000 – 100.000 metazoans
- 1 to 100 million protists
- 1 to 10 billion prokaryotes
(bacteria and archaea)
- 1 to 10 billion viruses

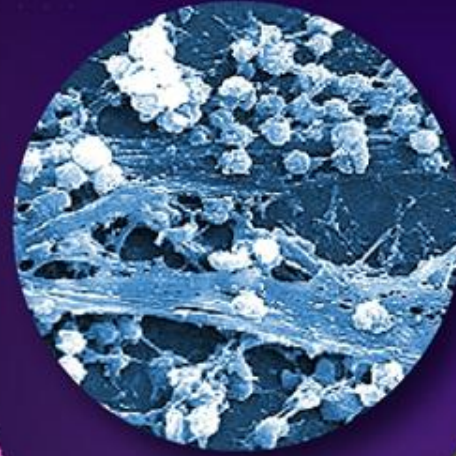
98% of the biomass
in the oceans is unicellular!



Viruses and Giruses: 1-10 billion per litre

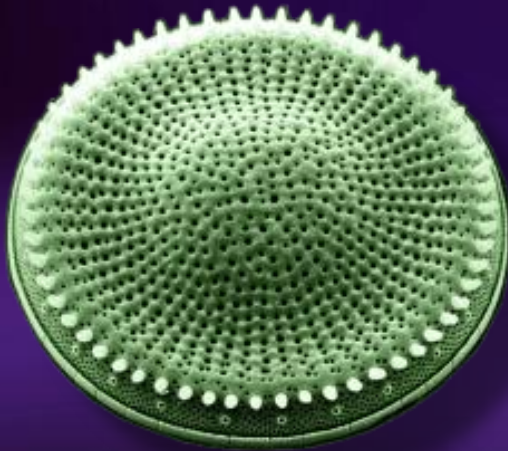


Bacteria/Archaea: 0.1-1 billion per litre

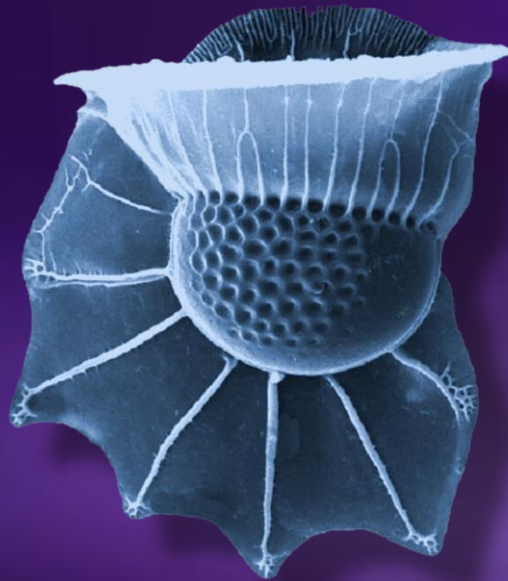


Phytoplankton: 1-100 millions per litre

There are 3 main groups of phytoplankton:



Diatoms



Dinoflagellates

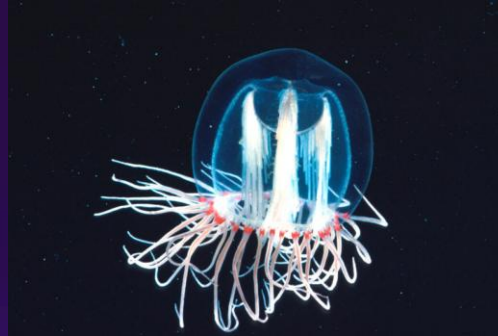


Coccolithophores

Zooplankton: 10.000–100.000 per litre

Zooplankton mostly consists of small animals and their larval stages:

- Sea urchins
- Fish
- Copepods
- Jellyfish
- ...

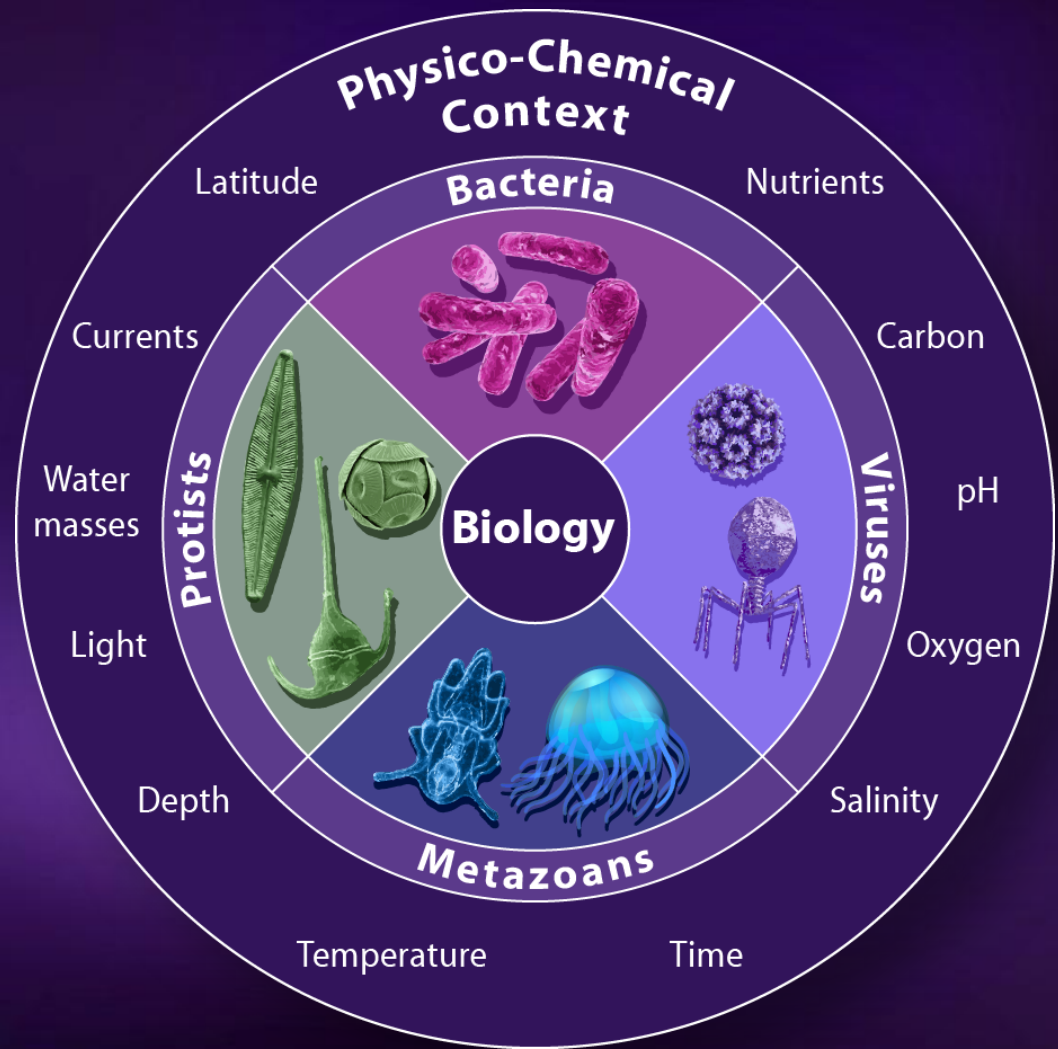


Zooplankton predate on phytoplankton and protists

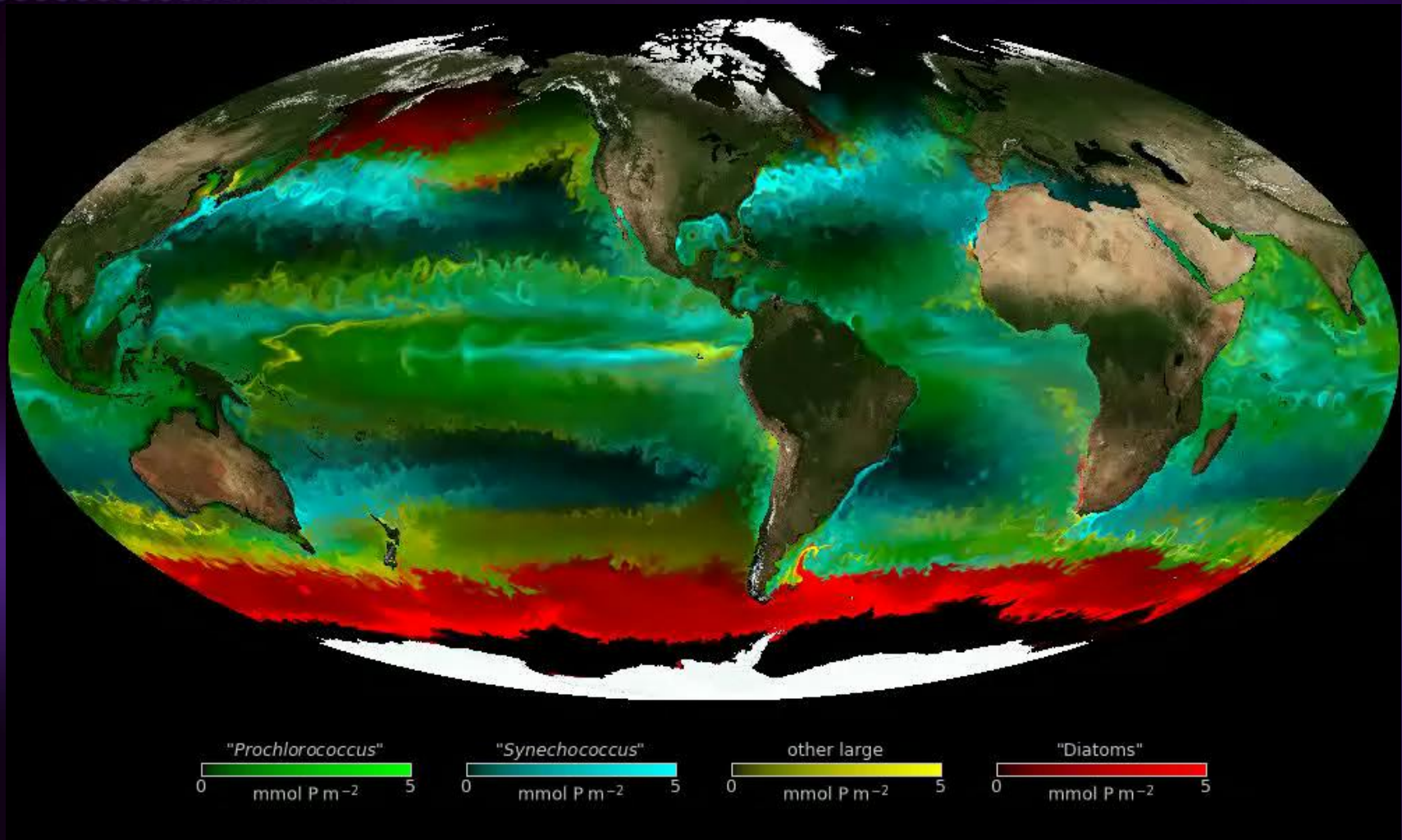
TARA OCEANS: The Challenge

How does the plankton composition change with the environment?

Can we predict how it will change with global warming?



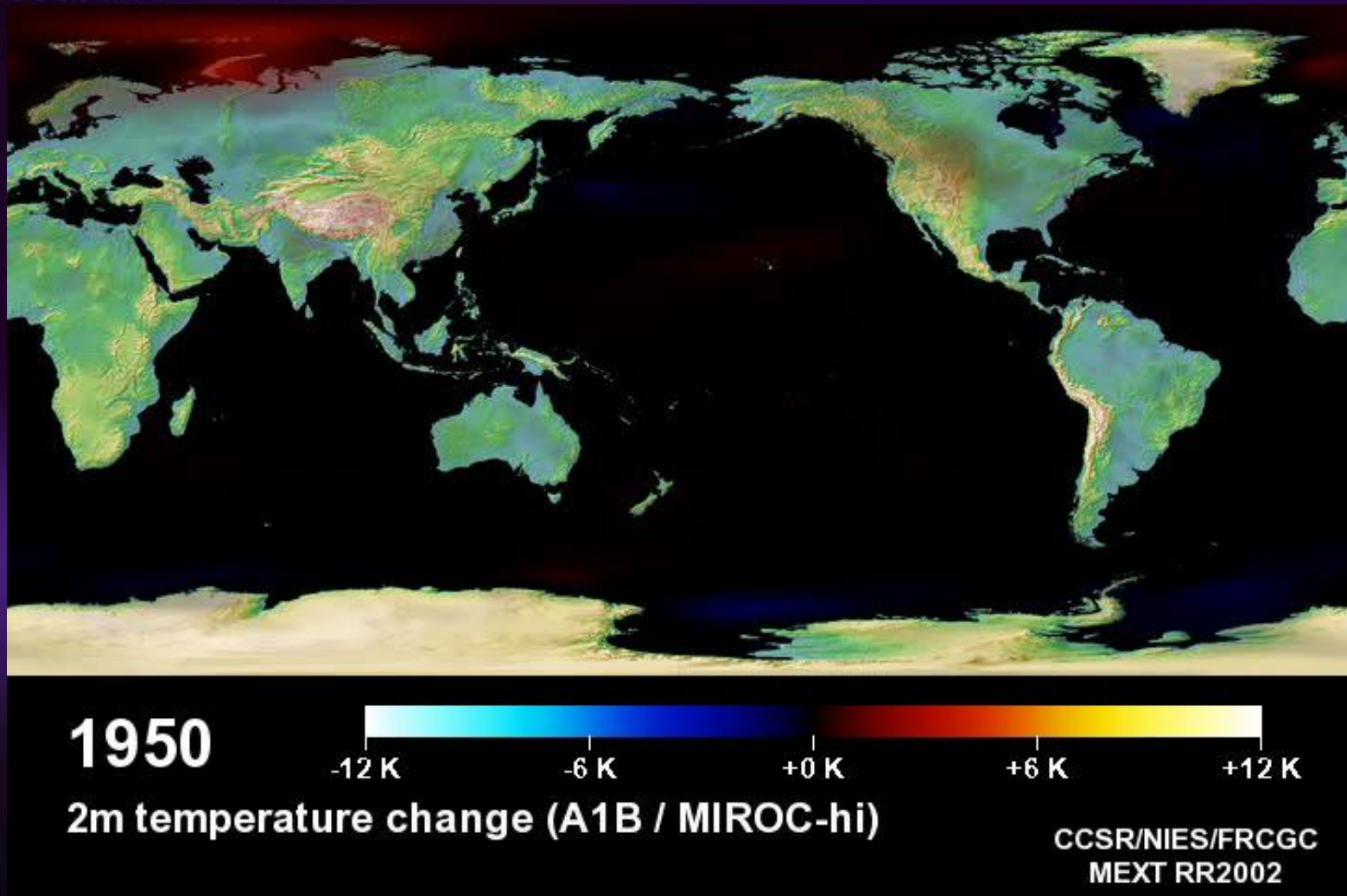
Prediction: Global species distribution



Movie: Mick Follows, MIT



Prediction: Global warming

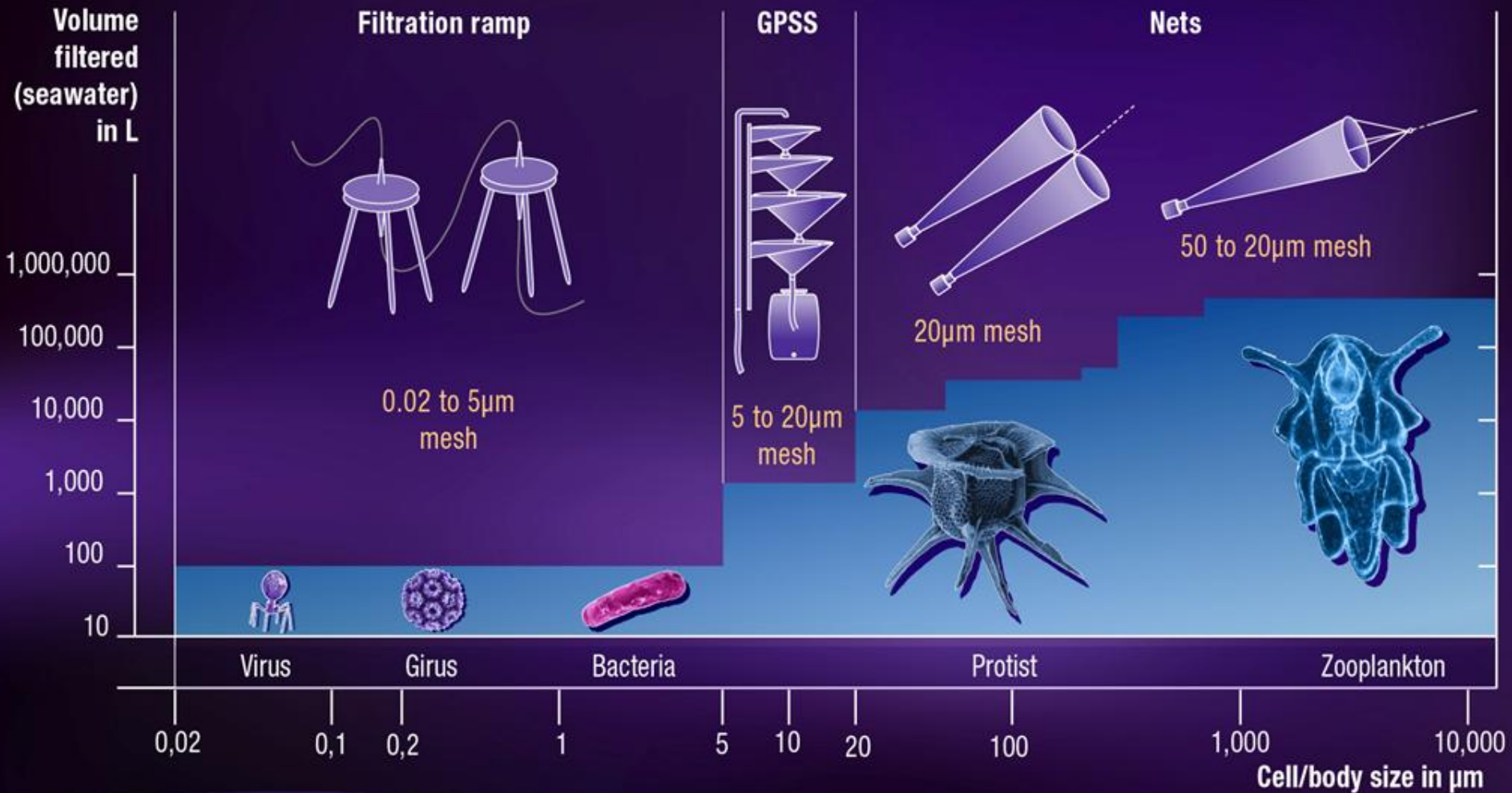


TARA Oceans: Driven by...

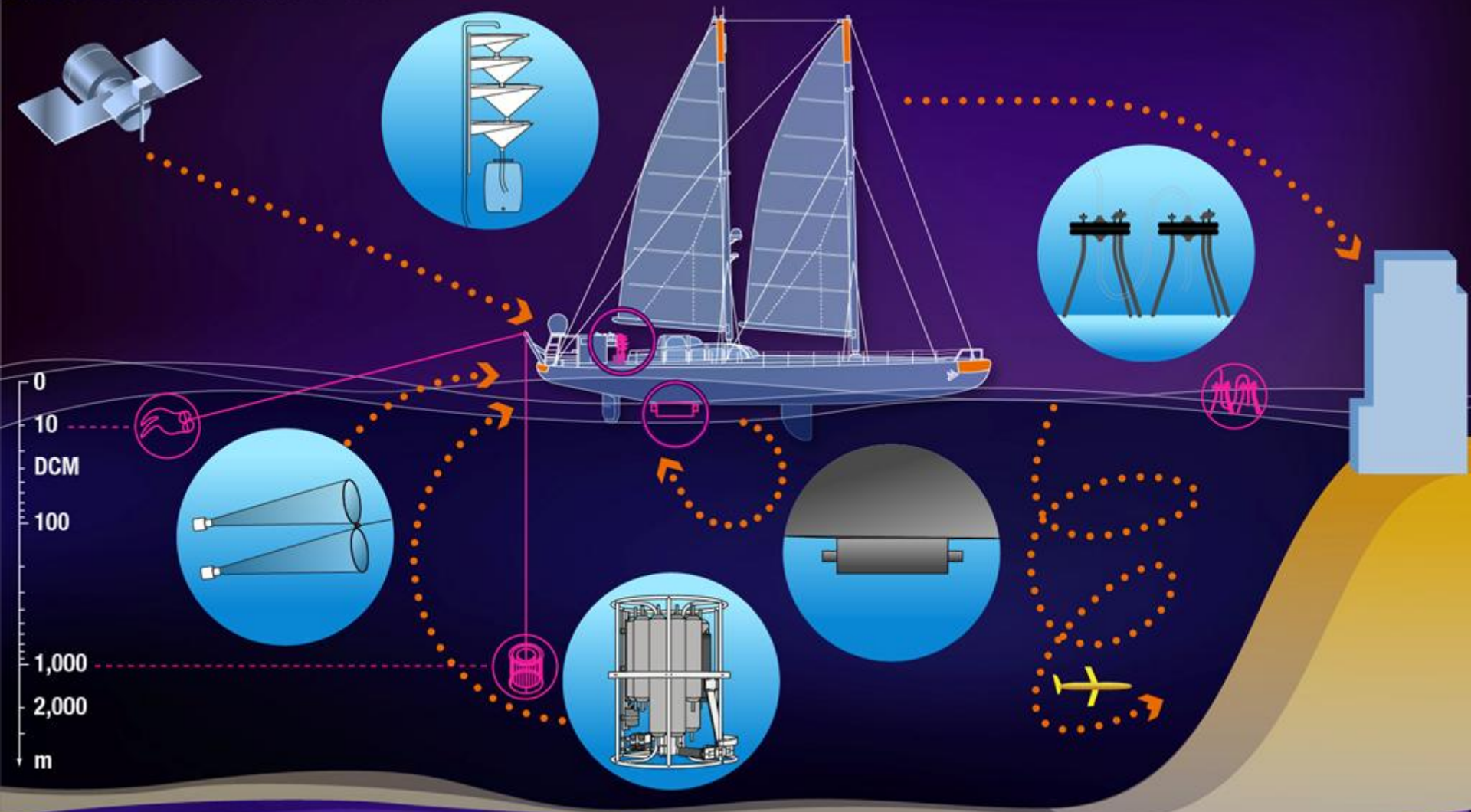


...an interdisciplinary and multicultural team

TARA Oceans: sampling overview

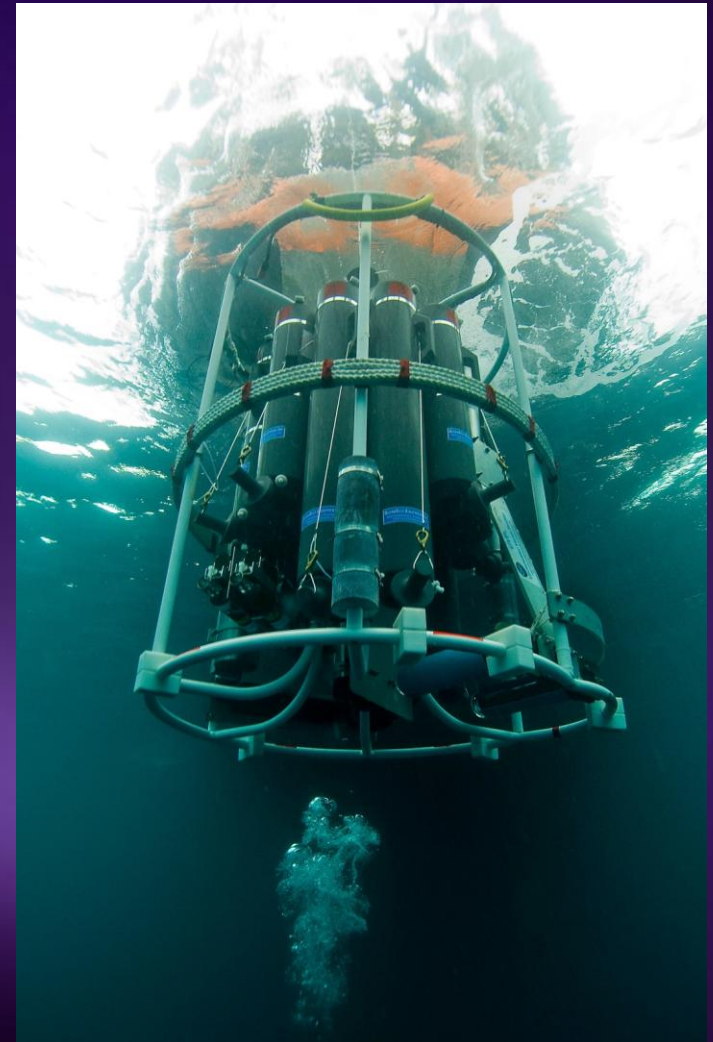


TARA Oceans: data and sample collection



CTD Rosette for TARA

1. Sample collection
 - 10 Niskin bottles (96 L)
2. Characterize water masses
 - Pressure
 - Temperature x 2
 - Conductivity x 2
 - Oxygen
3. Biological parameters
 - Beam attenuation (660nm)
 - FChl
 - FCDOM
 - Back scatter (470 nm)
 - Nitrates
 - Particles >100 μ m
 - Zooplankton > 500 μ m



TaraOceans figures

60 000 miles over 2.5 Years

*** 153 Stations**

27 000 biological samples

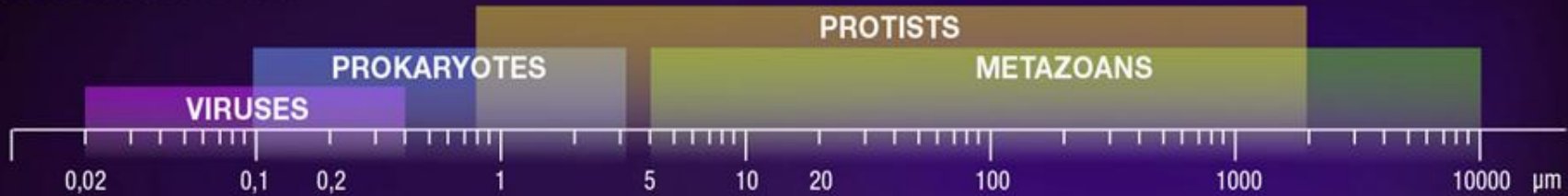
**48% molecular - 52%
morphology**

- 455 CTD profiles
- 1800 nutrient samples
- 825 carbonate chemistry
- 1500 pigments (HPLC)

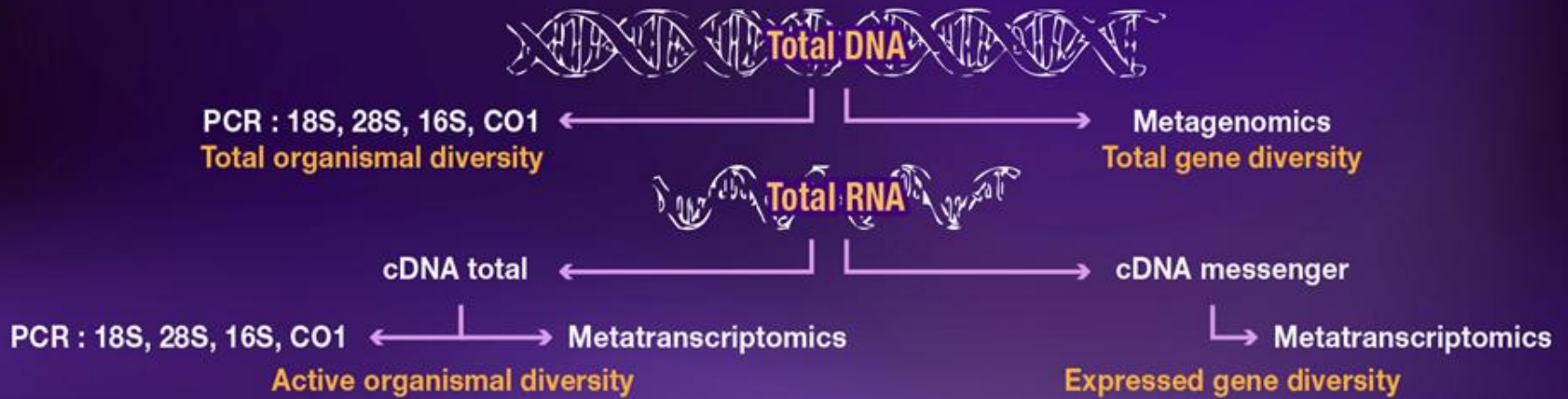


DATA ANALYSIS

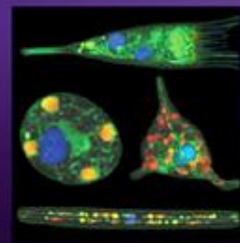
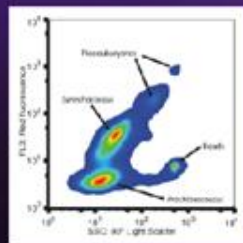
Cell / body size in μm



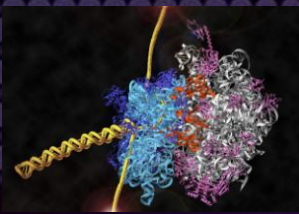
High Throughput Sequencing



High Throughput Imaging

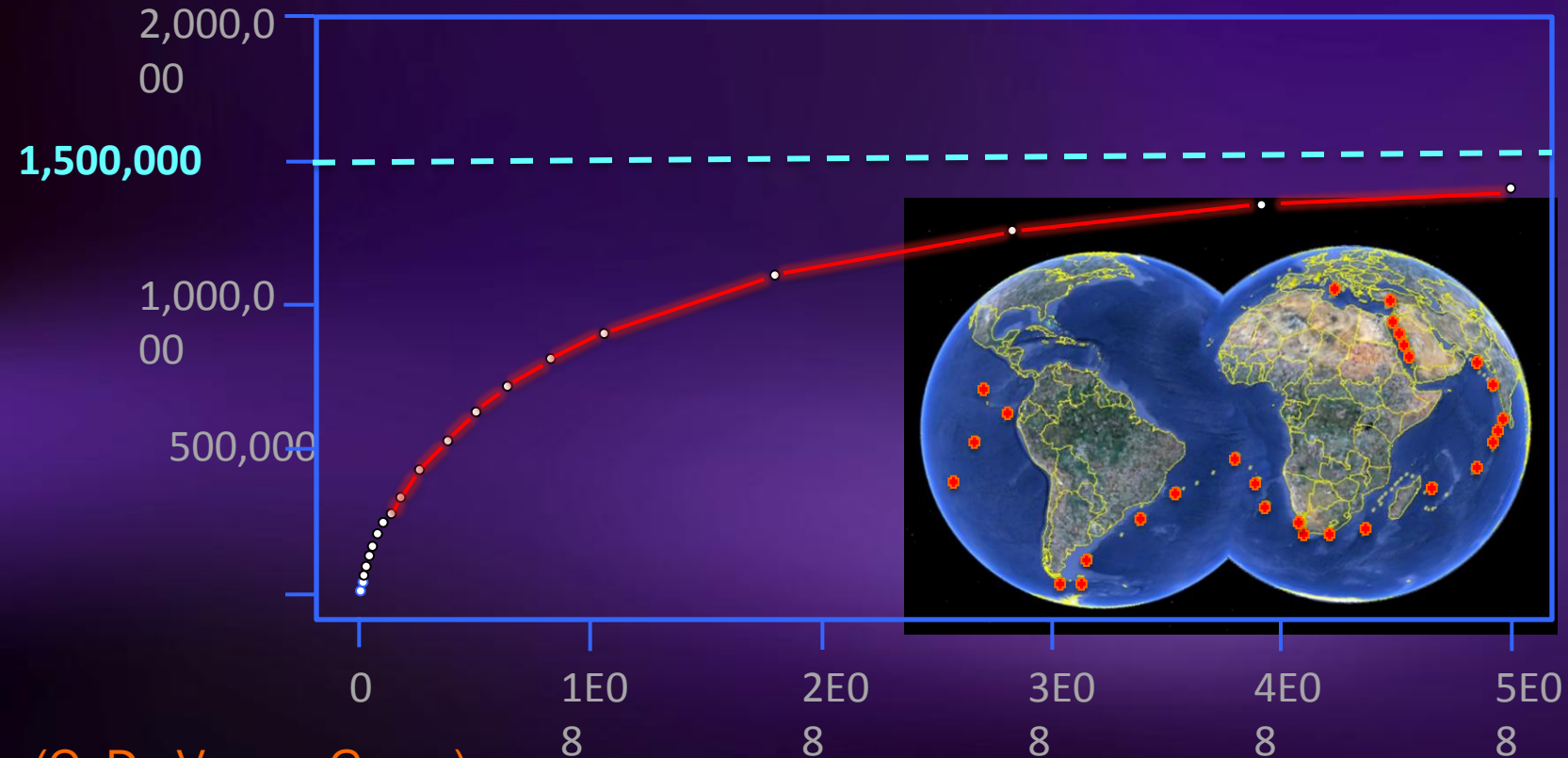


Preliminary analysis of Eukaryotic metabarcodes from 35 stations



Ribo-species
(OTU-97%)

~1,5 million protist + animal taxa in photic oceanic plankton



(C. De Vargas Group)

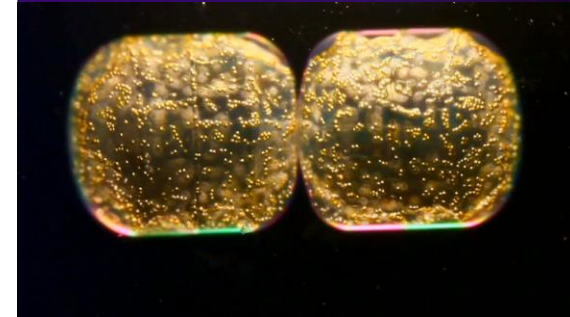
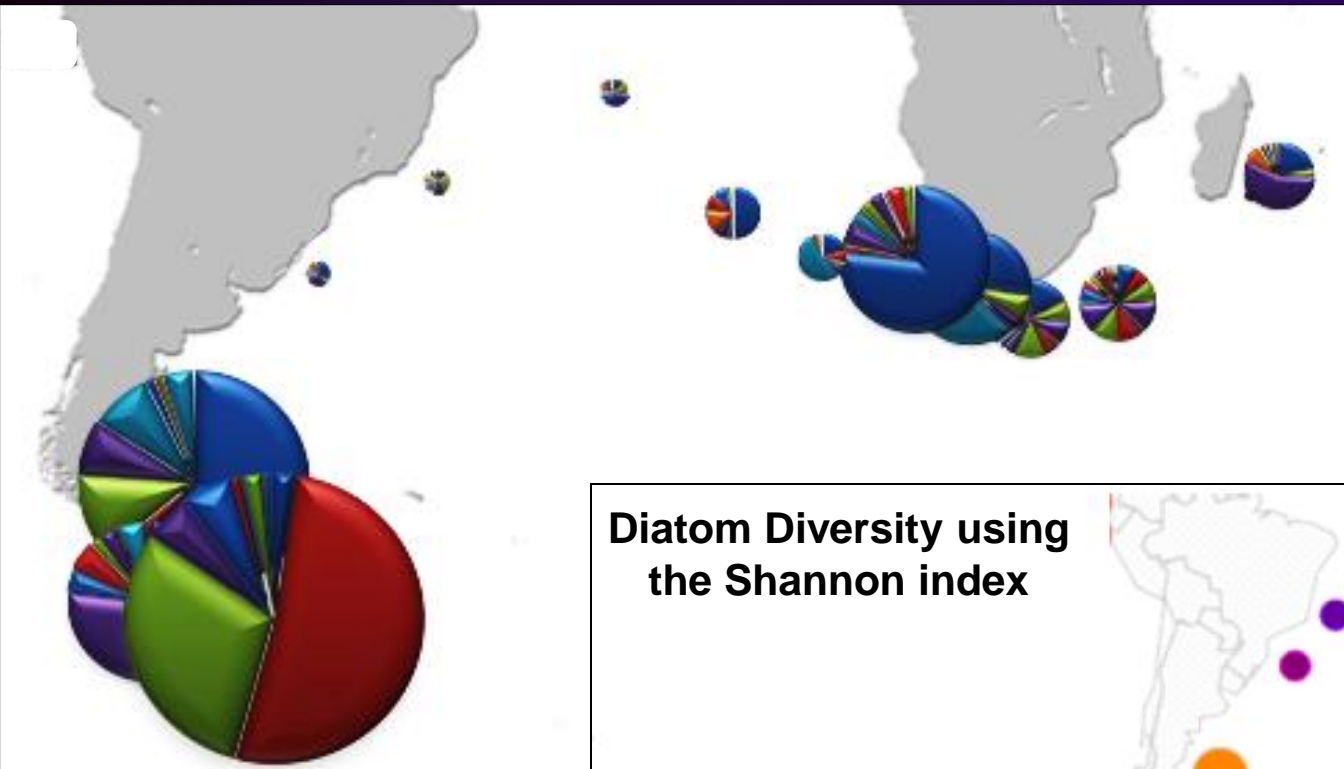
Number of rDNA reads illumina sequencing of V9 18s PCR barcodes

EMBL



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Overview of Diatom Abundance and Diversity



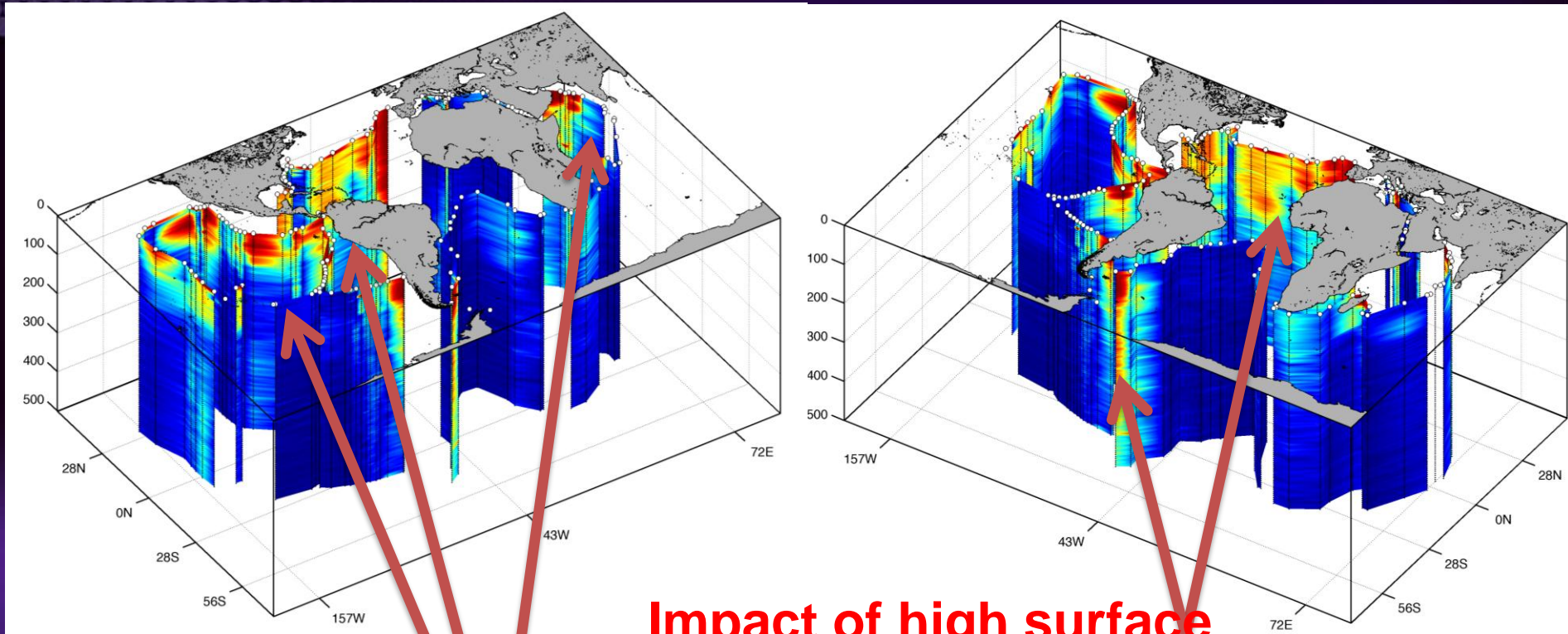
Diatom Diversity using the Shannon index



The diatom community changes radically at the Agulhas choke point.



Ecosystem structure and carbon export



Impact of high surface production on the vertical flux

Impact of OMZ on carbon export to the deep sea



Particulate flux
($>200\mu\text{m mg C m}^{-2} \text{ j}^{-1}$)



Conclusions

- Global and local estimation of ocean viral, bacterial and Eukaryotic diversity
- Environment, depth and latitude constraints on ecosystems
- Data to feed predictive models of ecosystems response to environmental changes
- Estimate the contribution of living matter to CO₂ sequestration



Sampling in EEZ and international waters

- Freedom of sampling for scientific and monitoring investigations (knowledge, decision making)
- Scientific data should be made publicly available
- International agreements are needed to govern the commercial use of scientific data
- Mass exploitation of high productivity and diversity zones should be constrained by international agreements



Acknowledgements



Thank you!



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Noan LeBescot



Insight Lectures