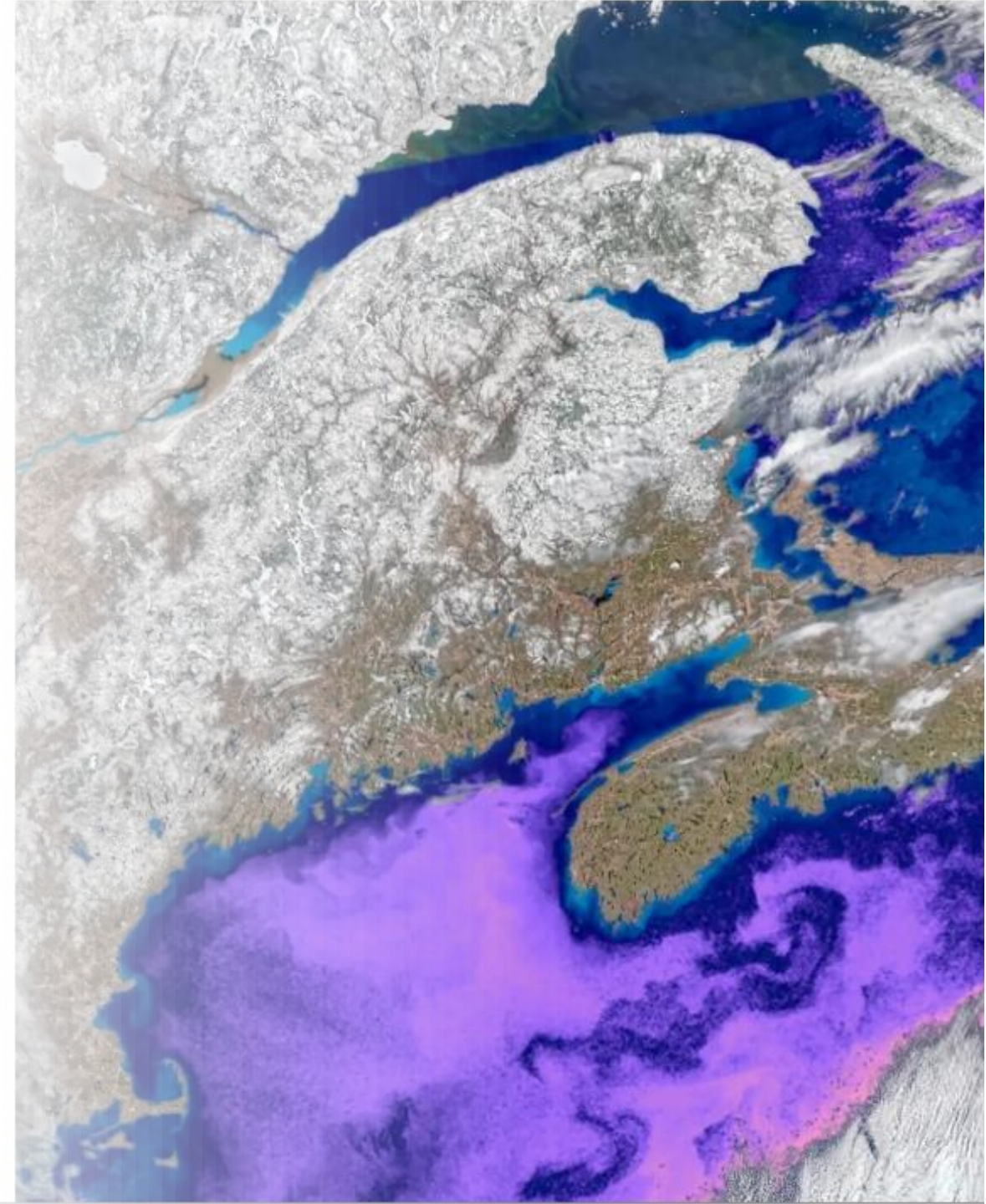




Ivona Cetinić  
Ocean Ecology Lab

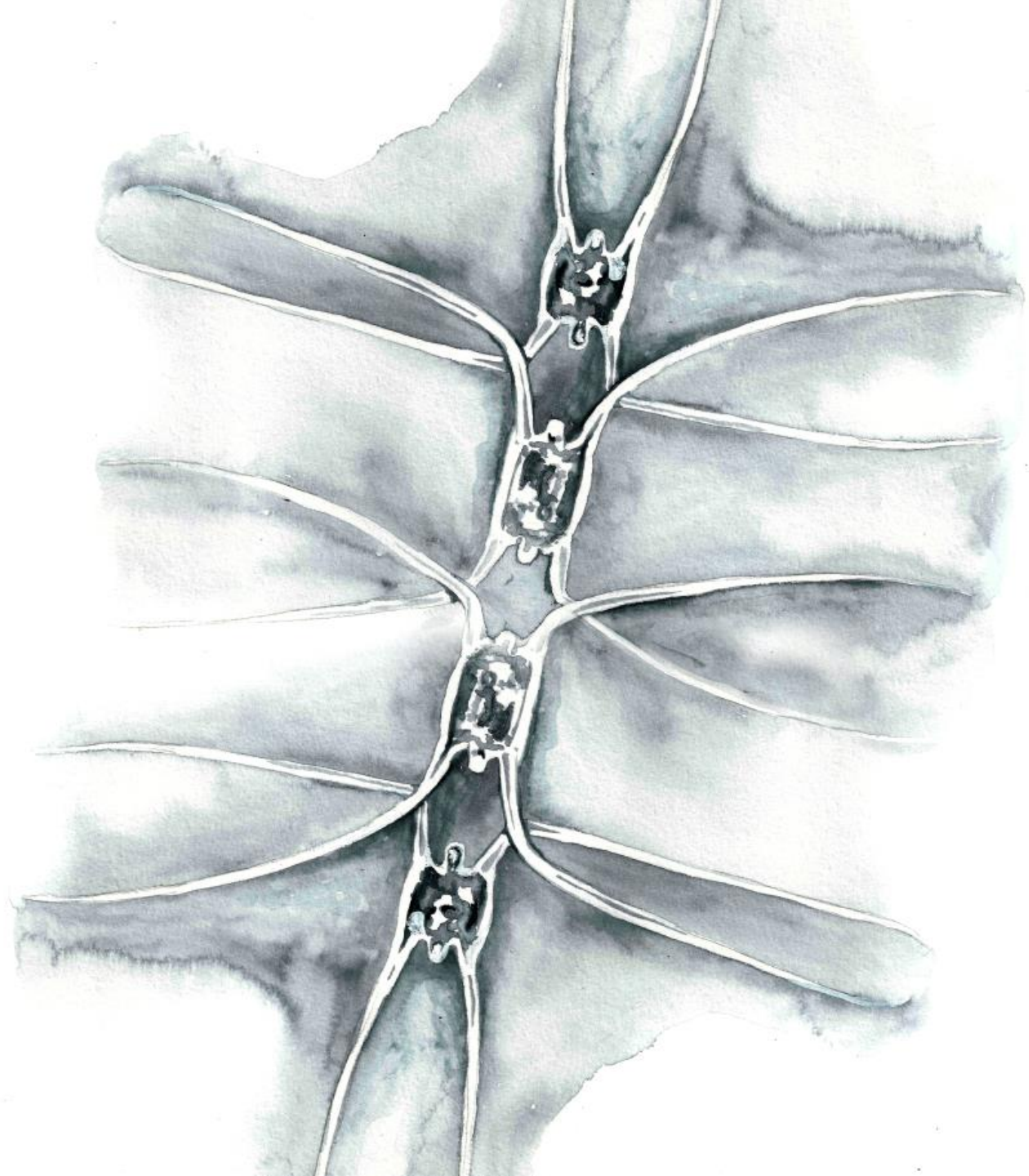
# MOANA

---



AFTER 10 YEARS (OR  
MORE?) OF US BUILDING  
PACE

ALL OF YOU KNOW WHY  
PHYTOPLANKTON IS  
IMPORTANT



# *PHYTOPLANKTON* groupings

- Particle (size, shape, morphology)
- Taxa (Taxonomic approach)
- Chemistry (pigments, minerals, metabolites..)
- Function (role)



# PHYTOPLANKTON

EACH OF THESE DEFINITIONS/TRAITS (OR ALL OF THESE)  
CAN BE USED TO DEVELOP AN ALGORITHM TOO!

- Particle (size, shape, morphology)
- Taxa (Taxonomic approach)
- Chemistry (pigments, minerals, metabolites..)
- Function (role)



# MOANA

Multiple Ordination ANAlysis

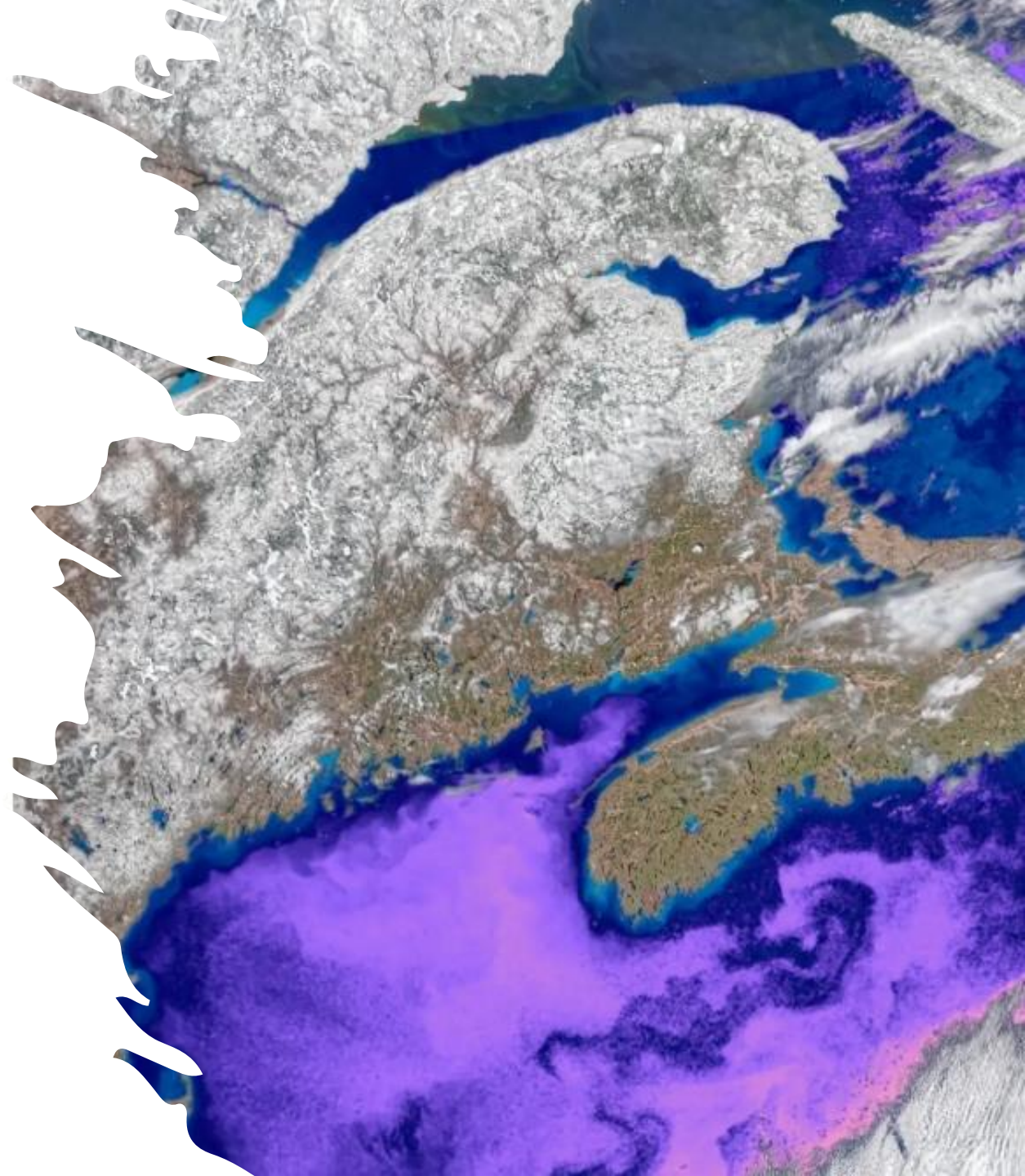
it is named after Moana, a cute kid who lives in Brazil

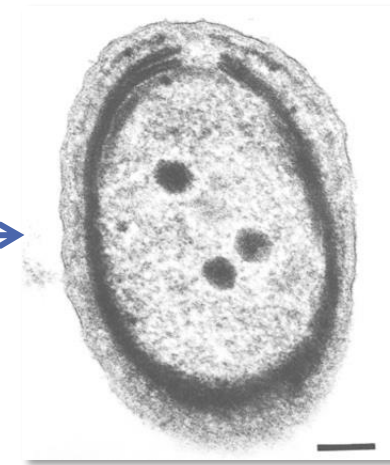
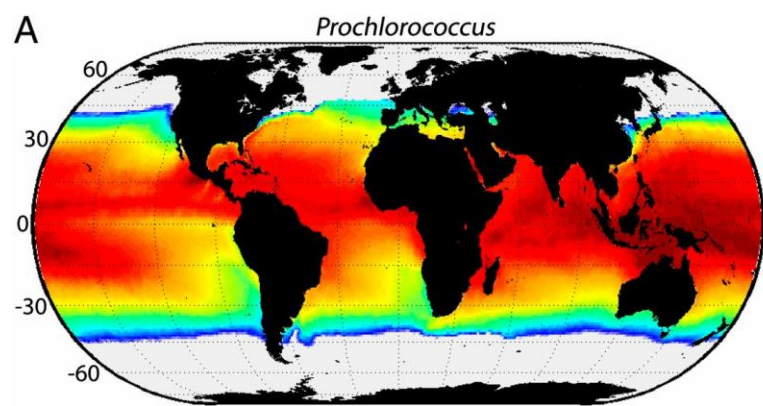
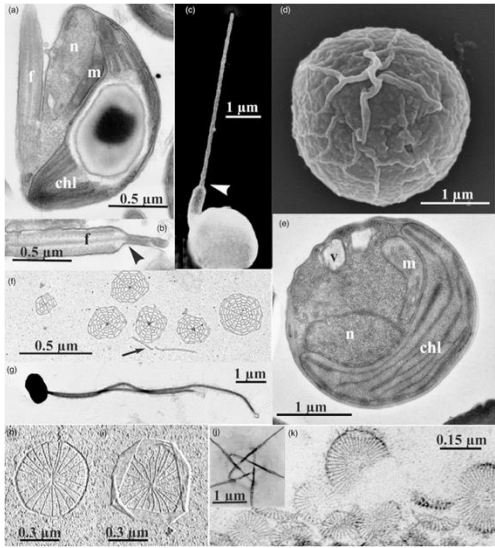
Hyperspectral ocean color + Sea surface temperature algorithm that derives cell counts of three tiny oceanic phytoplankton groups:

*Synechococcus*

*Prochlorococcus*

*Picoeukaryotes*

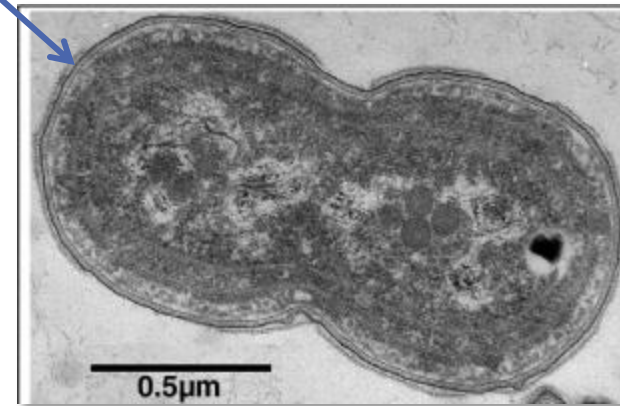
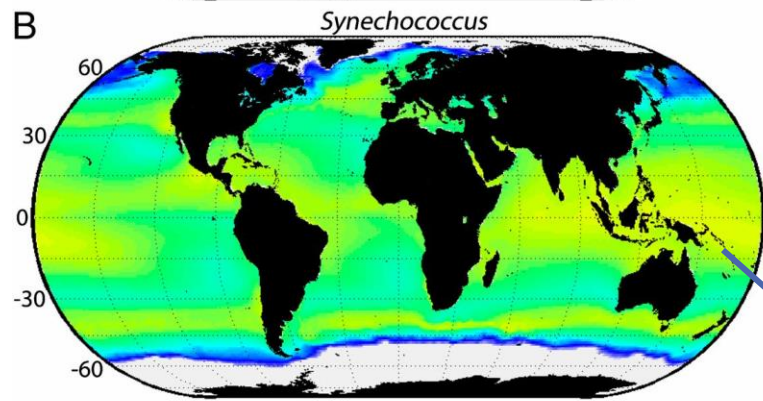




**PROCHLOROCCUS**

SMALLEST AND MOST ABUNDANT.  
(~ 0.7  $\mu\text{m}$ )

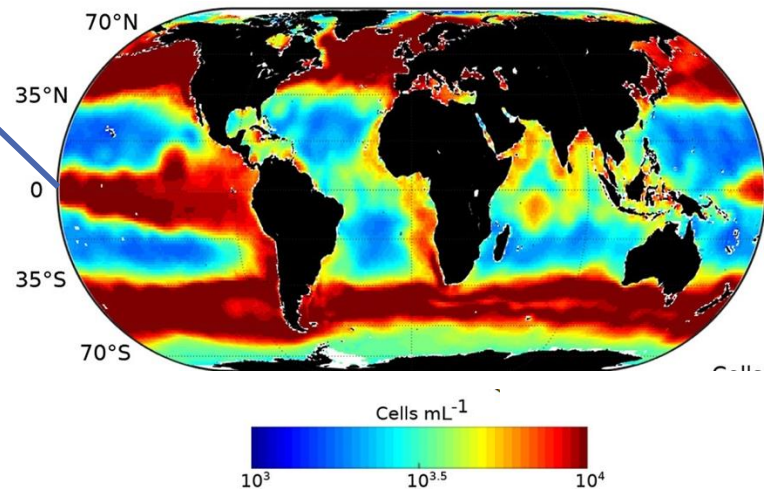
DIAGNOSTIC: VERY SMALL SIZE,  
LACK OF ORANGE FLUORESCENCE,  
DIVINYL CHLOROPHYLL A & B.



**SYNECHOCOCCUS**

(~ 1  $\mu\text{m}$ )

DIAGNOSTIC:  
PHYCOERTHYRIN  
PIGMENT FLUORESCES  
ORANGE (IN CONTRAST  
TO CHLOROPHYLL,  
WHICH FLUORESCES RED.



**PICOEUKARYOTES**

EUKARYOTIC ORGANISMS

3.0  $\mu\text{m}$  OR LESS IN SIZE

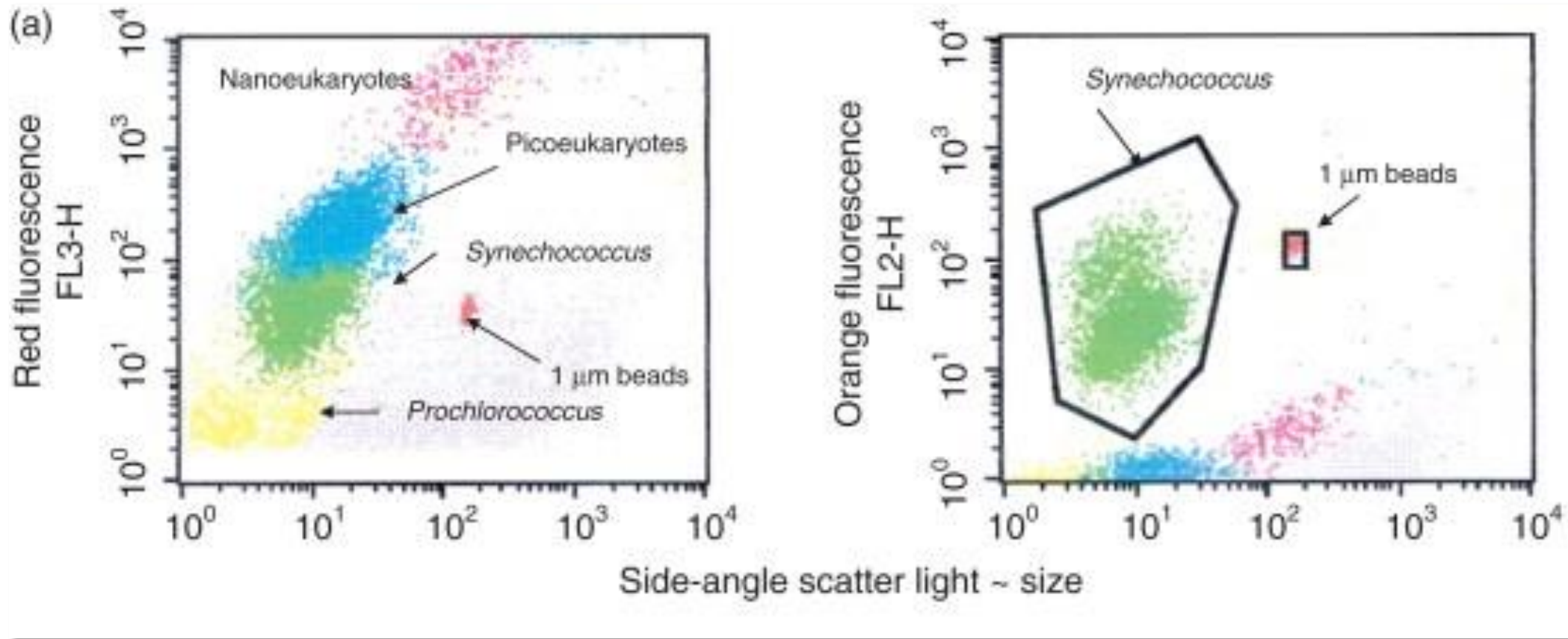
IT CAN BE ANYTHING

(TAXONOMIC & PIGMENT  
WISE)

SMALL BUT ACTS AS BIG  
PLANKTON



# FLOW CYTOMETRY



# *THEORETICAL BASE OF THE ALGORITHM*

Different sizes but TINY



• Particle (size, shape, morphology)

• Taxa (Taxonomic approach)



DIFFERENT PIGMENTS

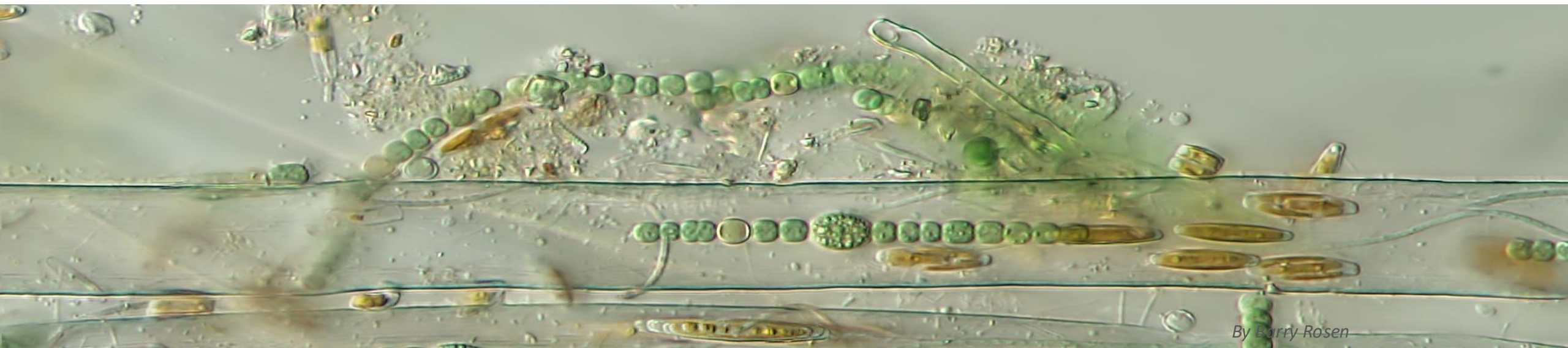


• Chemistry (pigments, minerals, metabolites..)

TEMPERATURE RANGE



• Function (role)



# Radiometric approach for the detection of picophytoplankton assemblages across oceanic fronts

PRISCILA KIENTECA LANGE<sup>1,2\*</sup>, P. JEREMY WERDELL<sup>1</sup>, ZACHARY K. ERICKSON<sup>1,3</sup>, GIORGIO DALL'OLMO<sup>4</sup>, ROBERT J. W. BREWIN<sup>5</sup>, MIKHAIL V. ZUBKOV<sup>6</sup>, GLEN A. TARRAN<sup>4</sup>, HEATHER A. BOUMAN<sup>7</sup>, WAYNE H. SLADE<sup>8</sup>, SUSANNE E. CRAIG<sup>1,2</sup>, NICOLE J. POULTON<sup>9</sup>, ASTRID BRACHER<sup>10,11</sup>, MICHAEL W. LOMAS<sup>9</sup>, IVONA CETINIĆ<sup>1,2</sup>

<sup>1</sup>*Ocean Ecology Laboratory, NASA Goddard Space Flight Center, USA*

<sup>2</sup>*Universities Space Research Association, USA*

<sup>3</sup>*NASA Postdoctoral Program Fellow, NASA Goddard Space Flight Center, USA*

<sup>4</sup>*National Centre for Earth Observation, Plymouth Marine Laboratory, United Kingdom*

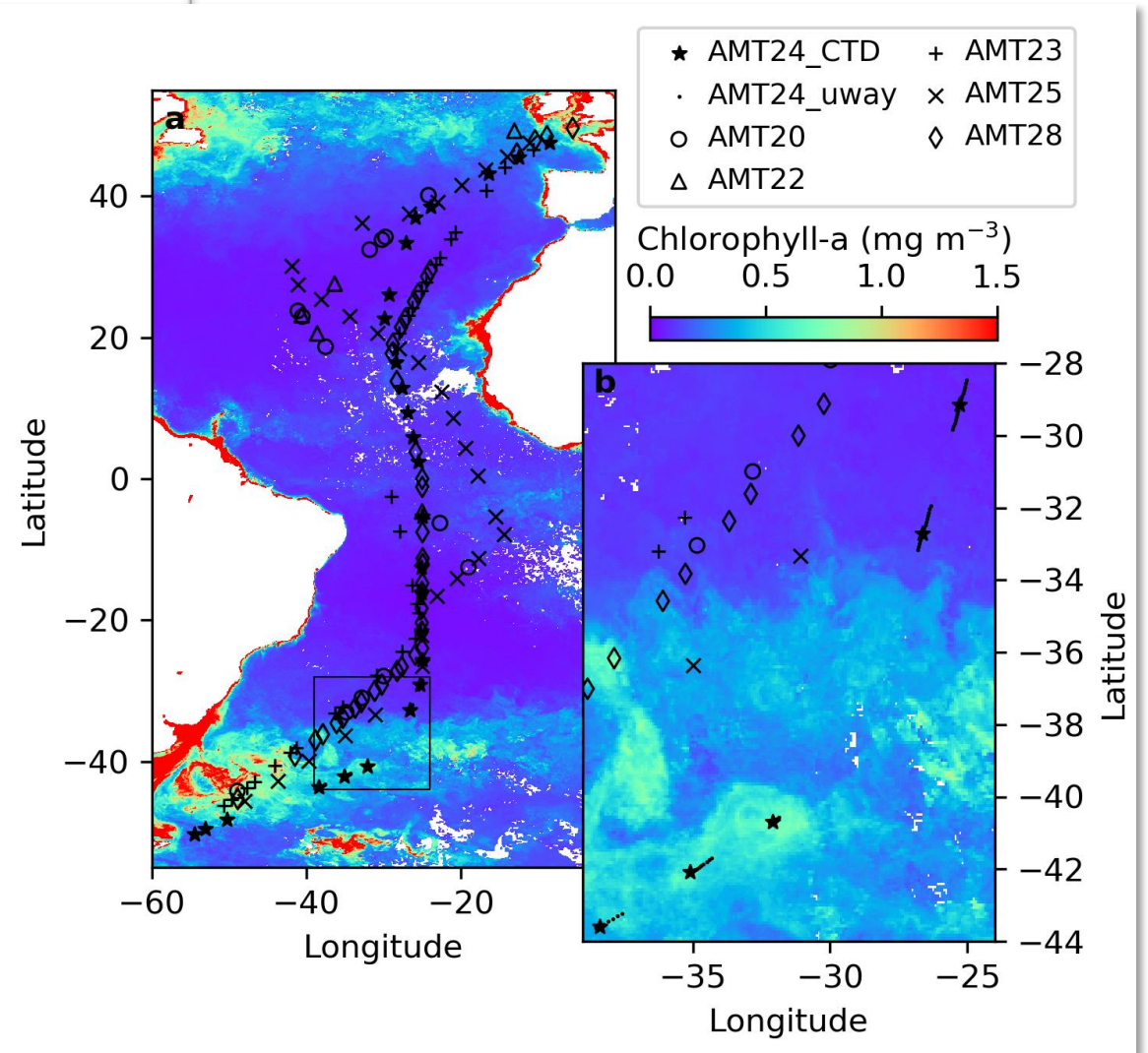
<sup>5</sup>*College of Life and Environmental Sciences, University of Exeter, United Kingdom*

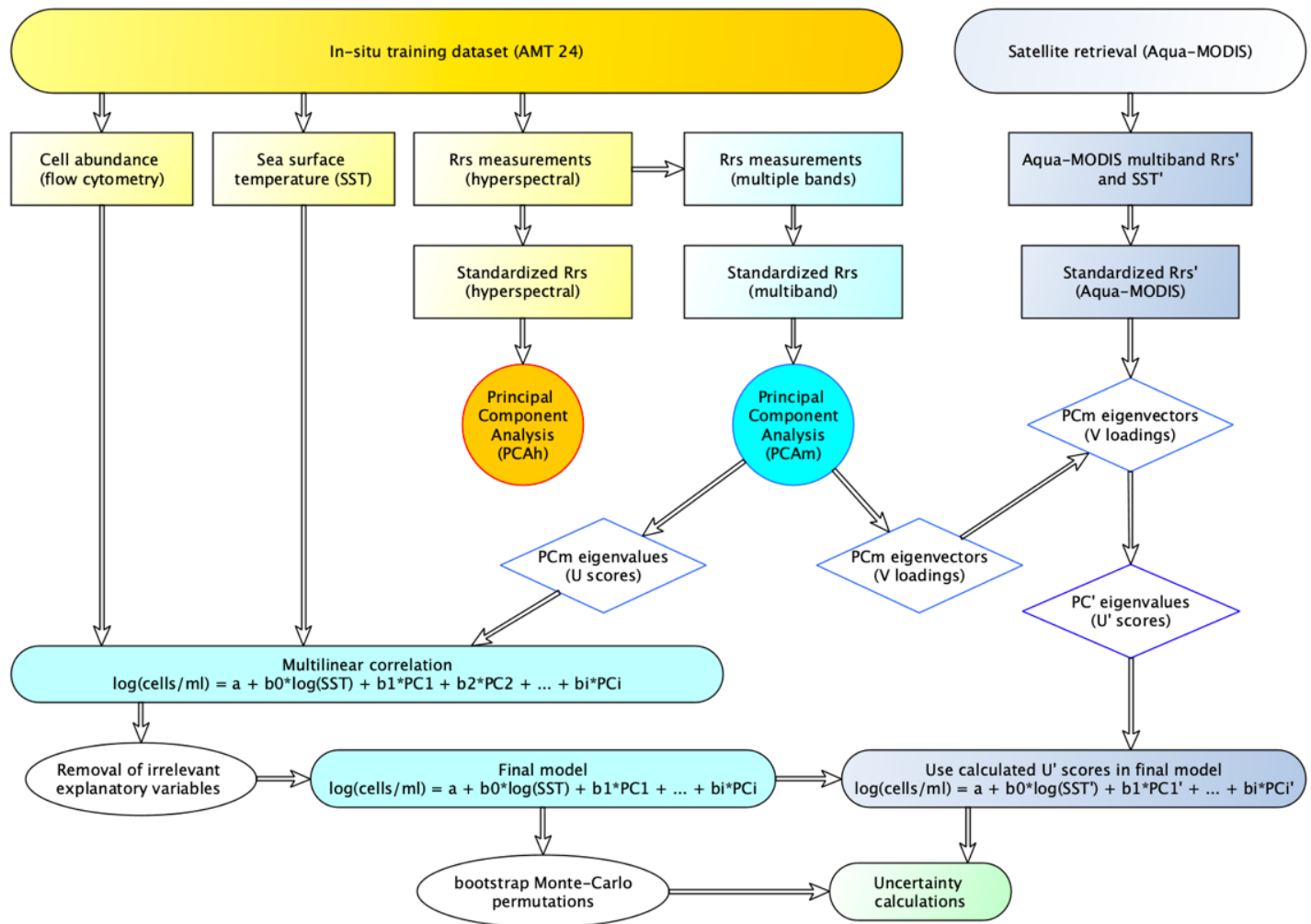
<sup>6</sup>*Scottish Association for Marine Science, Scotland*

<sup>7</sup>*Department of Earth Sciences, University of Oxford, United Kingdom*

<sup>8</sup>*Sequoia Scientific, USA*

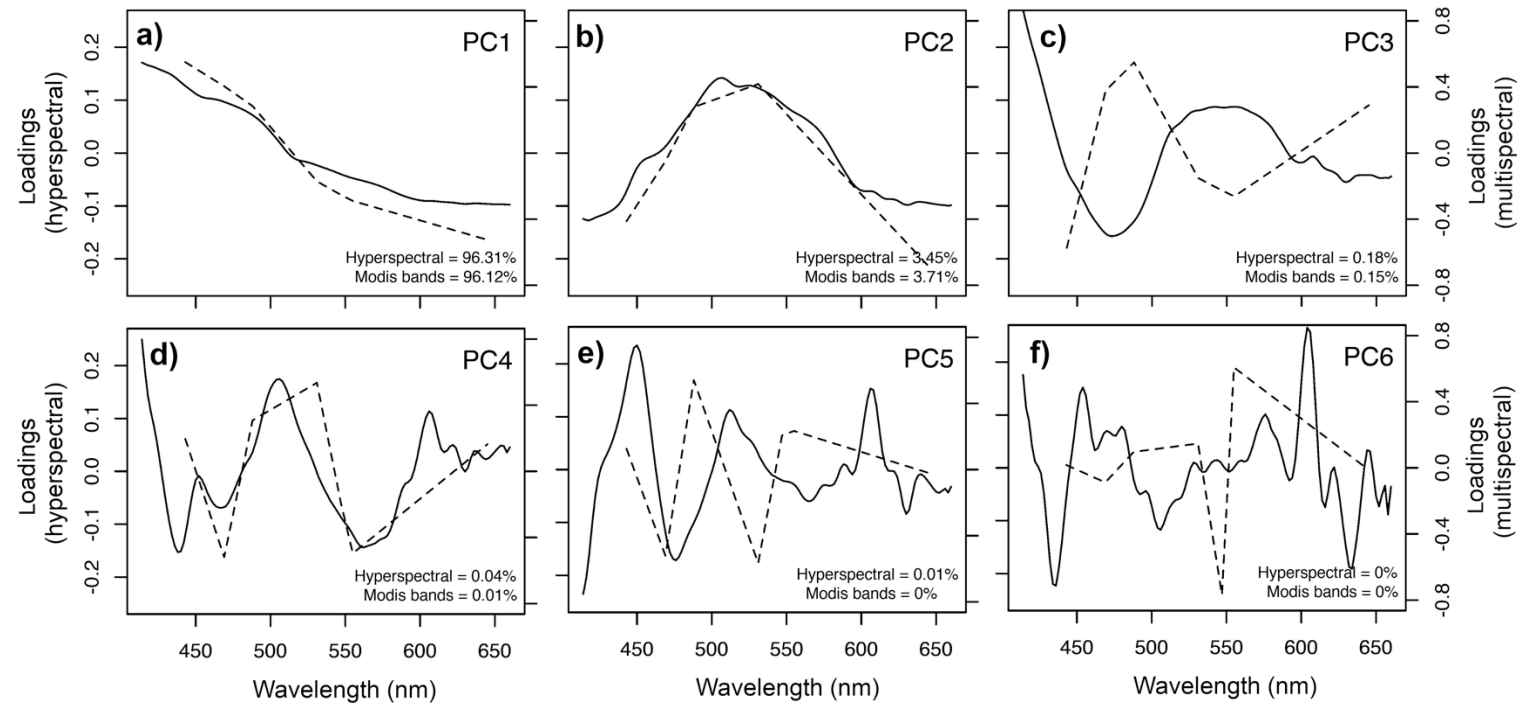
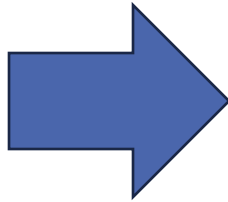
<sup>9</sup>*Birelow Laboratory for Ocean Sciences, USA*



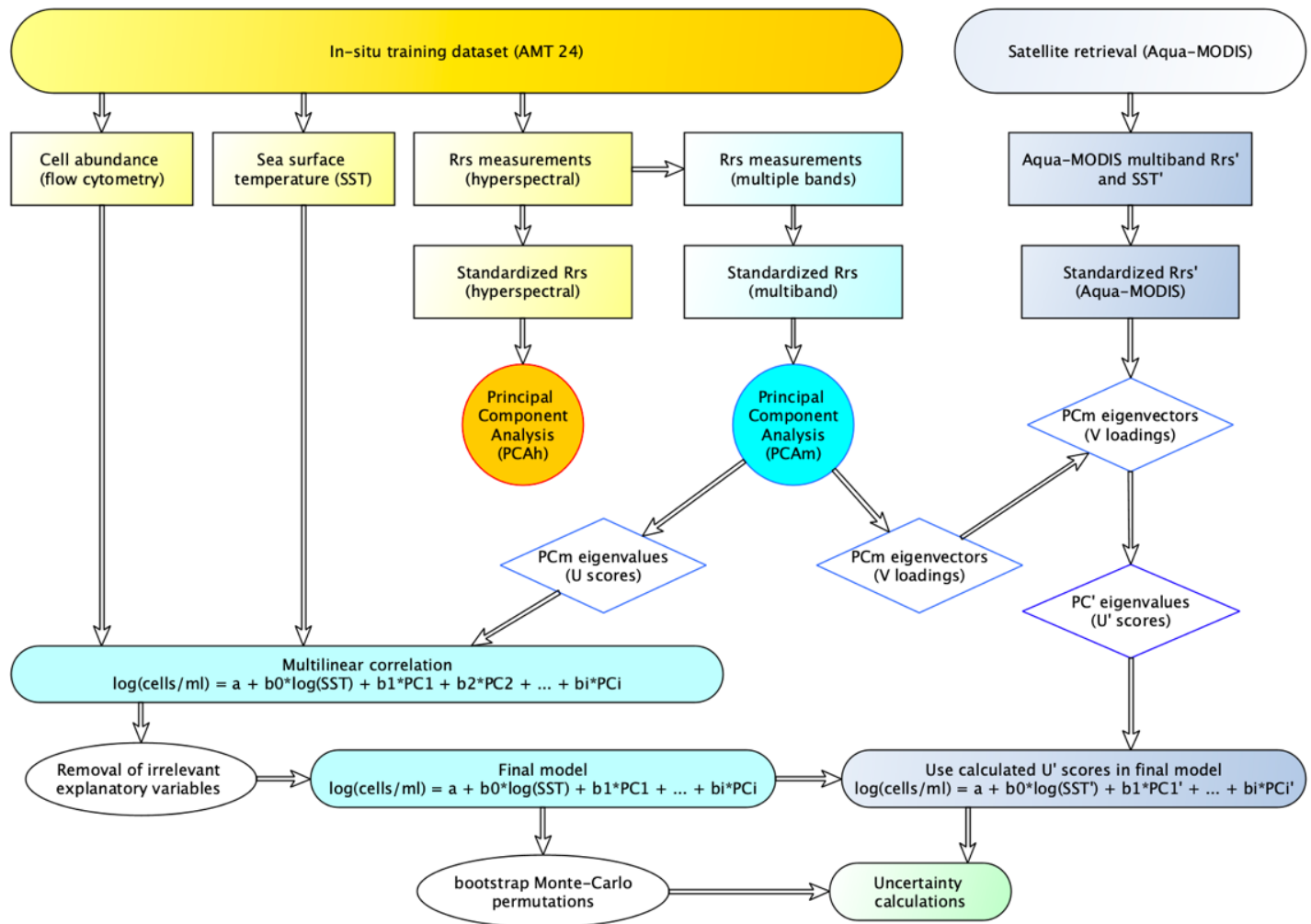


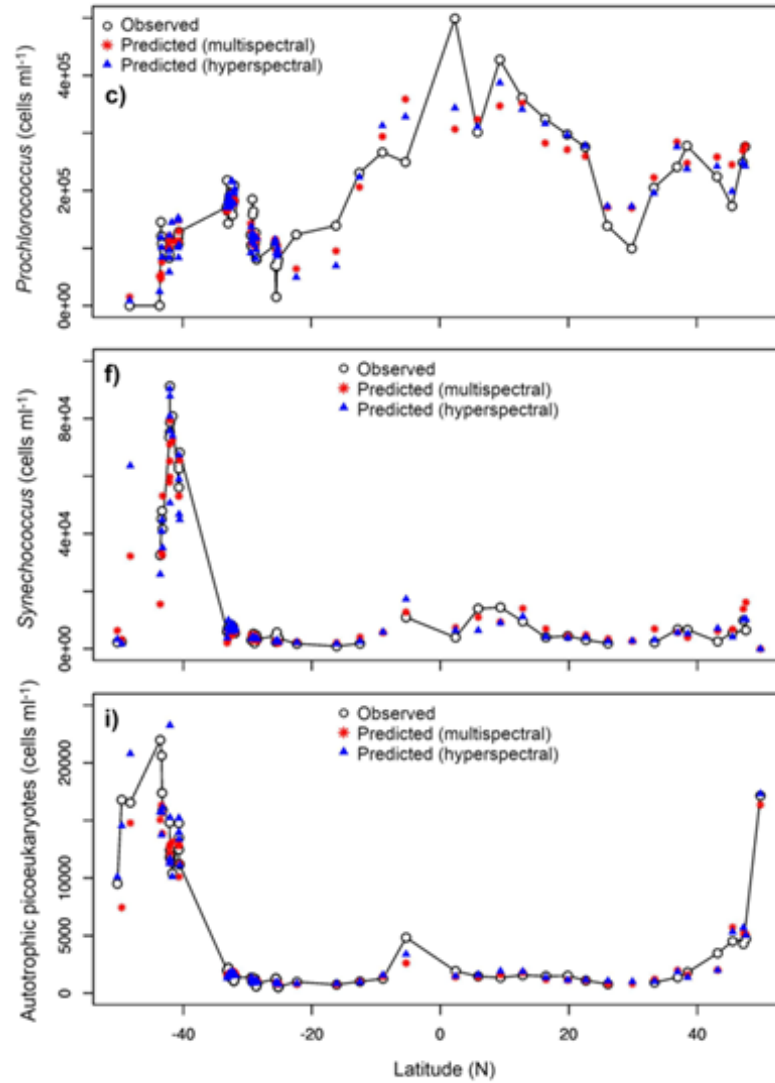
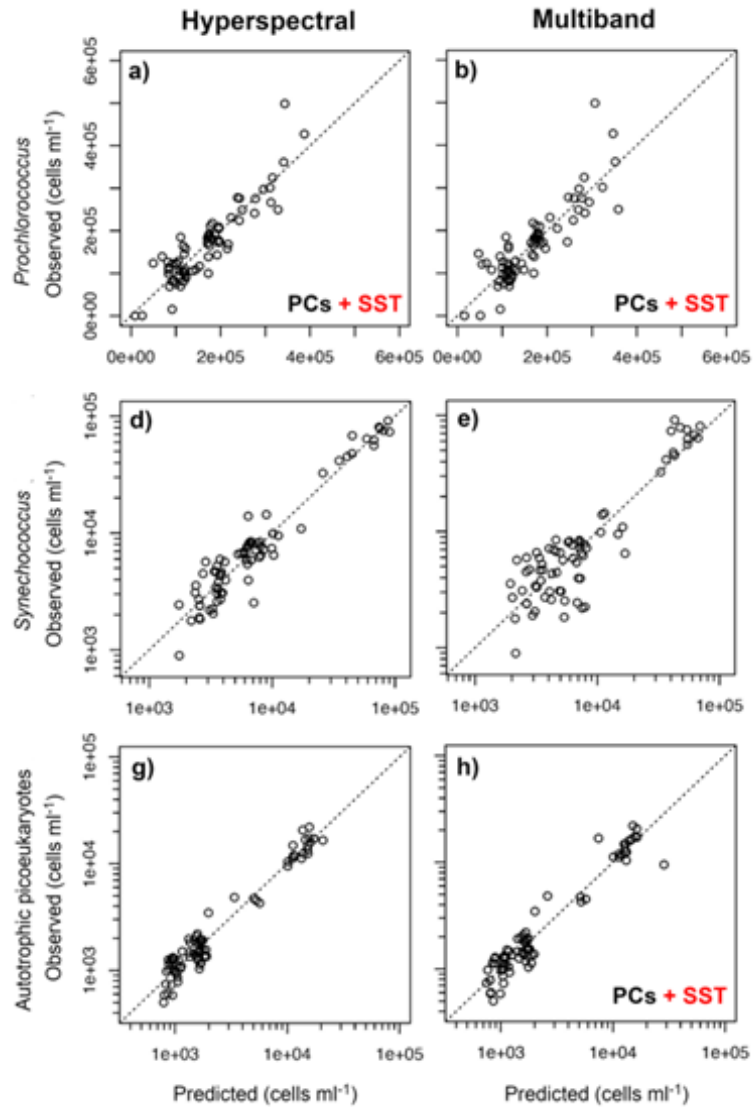
# Principal component analysis of Rrs

Rrs (420-660)



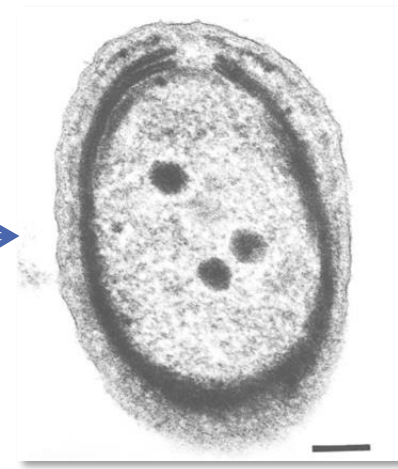
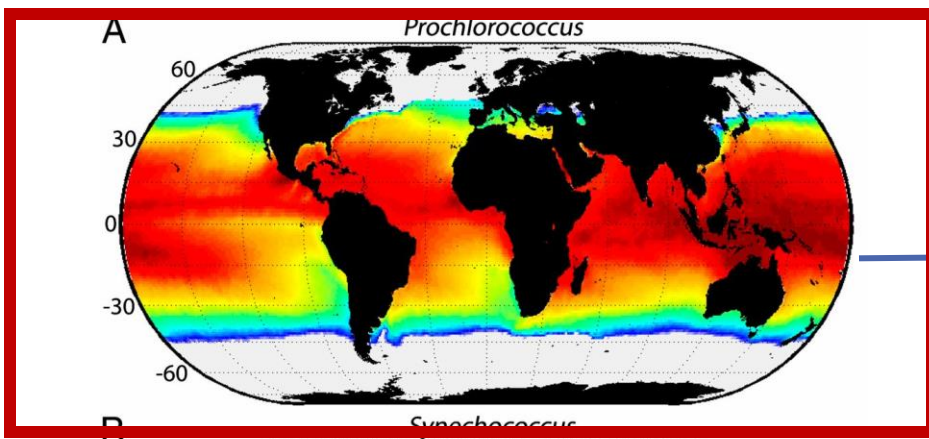
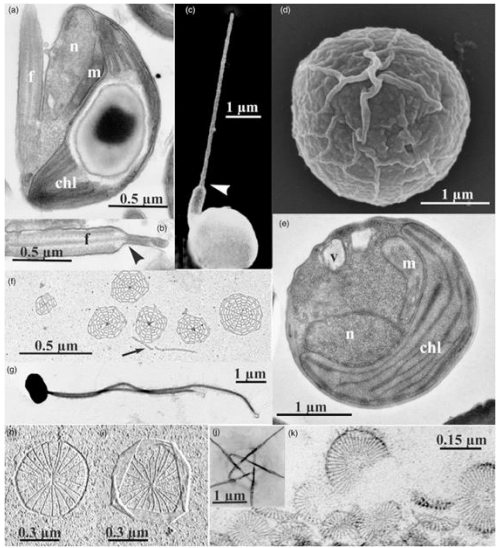
(PCA will isolate spectral trends in data, and bring forth the wiggles – usually associated with dominant things in the water, such as specific pigments)



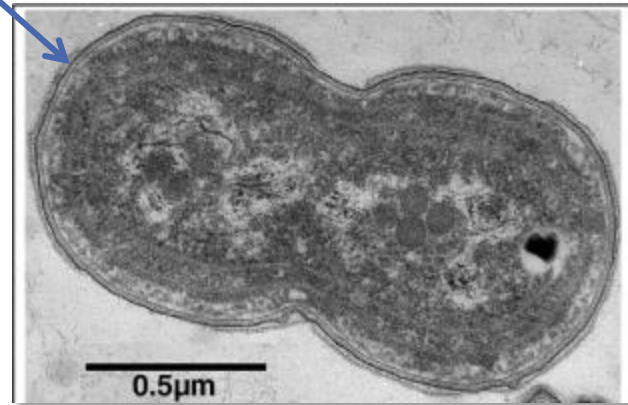
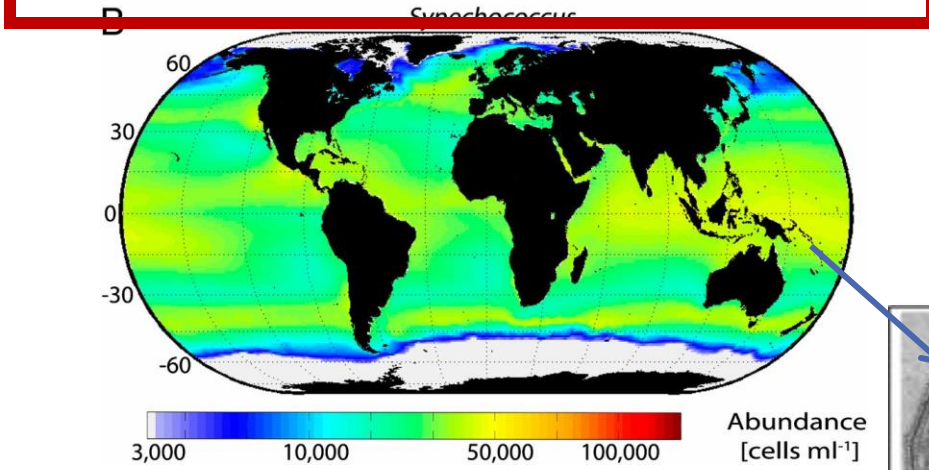


# Using field data:

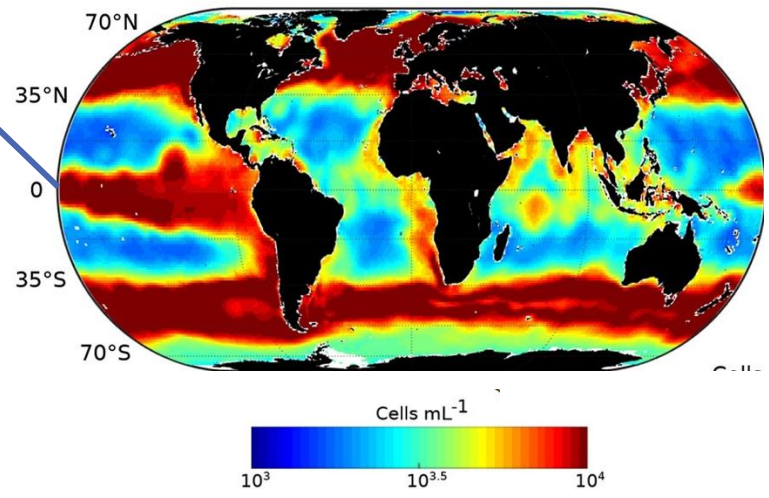
- Hyperspectral outperforms multispectral
- Addition of Sea Surface Temperature improves retrievals of Prochlorococcus



**PROCHLOROCCUS**  
 SMALLEST AND MOST ABUNDANT.  
 (~ 0.7  $\mu\text{M}$ )  
 DIAGNOSTIC: VERY SMALL SIZE,  
 LACK OF ORANGE FLUORESCENCE,  
 DIVINYL CHLOROPHYLL A & B.



**SYNECHOCOCCUS**  
 (~ 1  $\mu\text{M}$ )  
 DIAGNOSTIC:  
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 PIGMENT FLUORESCES  
 ORANGE (IN CONTRAST  
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 WHICH FLUORESCES RED.



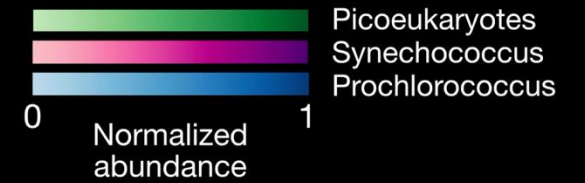
**PICOEUKARYOTES**  
 EUKARYOTIC ORGANISMS  
 3.0  $\mu\text{M}$  OR LESS IN SIZE  
 IT CAN BE ANYTHING  
 (TAXONOMIC & PIGMENT  
 WISE)

**SMALL BUT ACTS AS BIG  
 PLANKTON**



How  
does  
it  
work  
with  
PACE  
data?

RELATIVE DOMINANCE  
OF INDIVIDUAL  
PLANKTON GROUPS

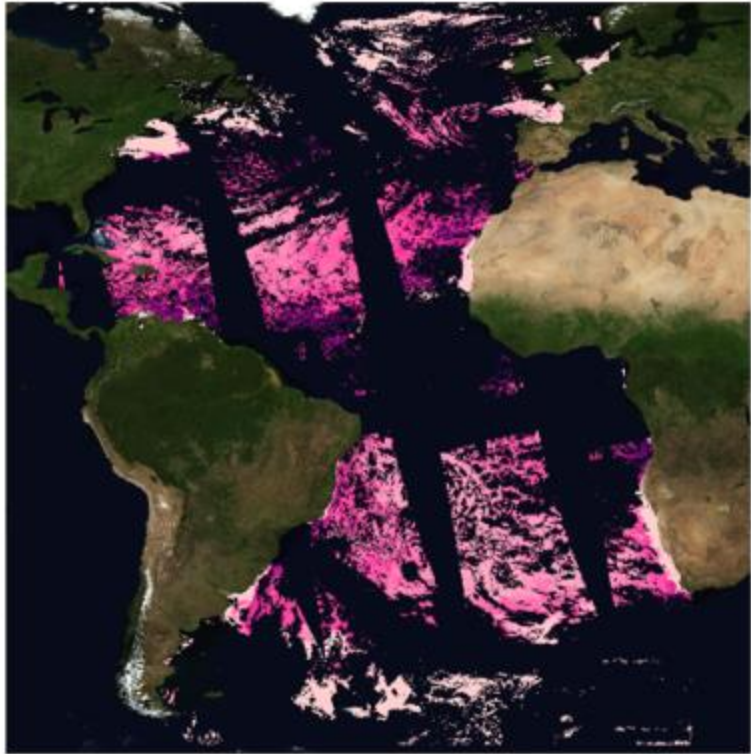


Mar 2024

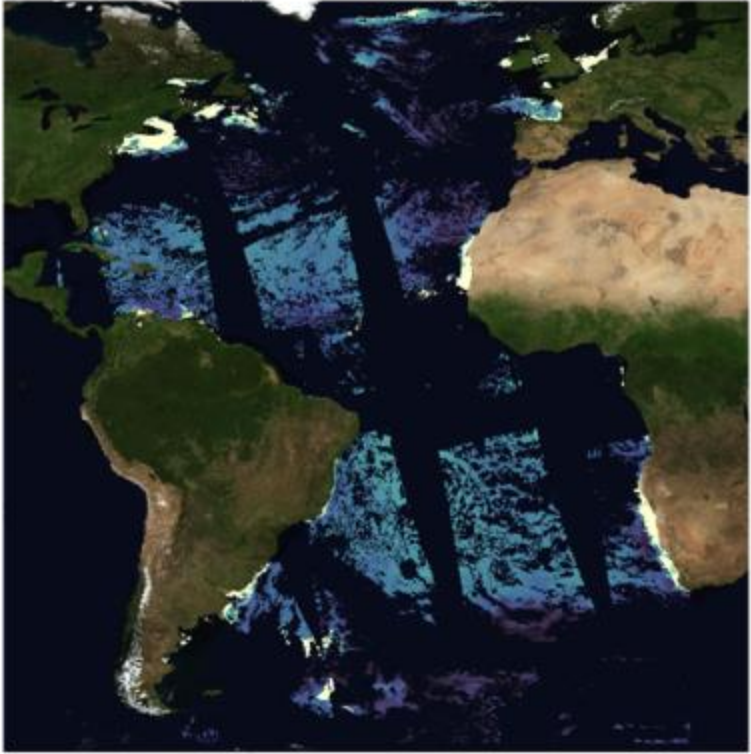
MOANA algorithm PACE - OCI

# Moana L3, 0.01°, Feb 10, 2025

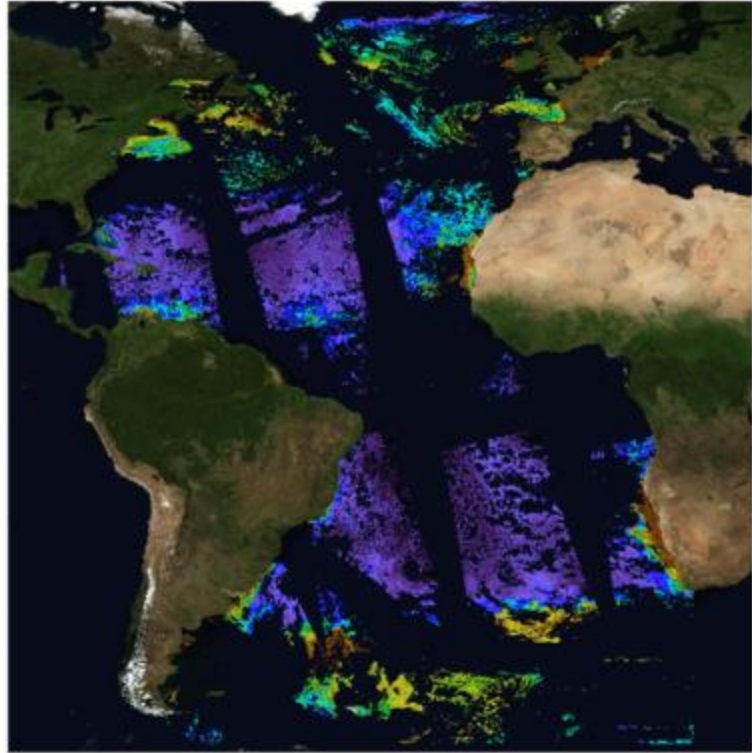
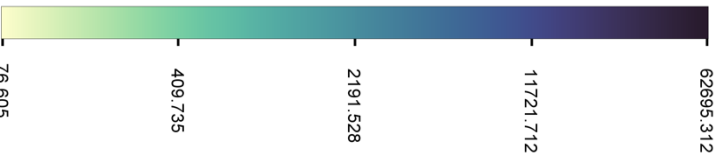
524,288 pixels daily  
~50% valid



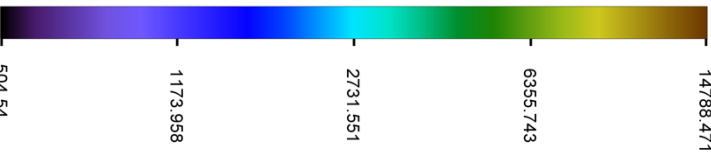
prococcus\_moana (cells ml<sup>-1</sup>)



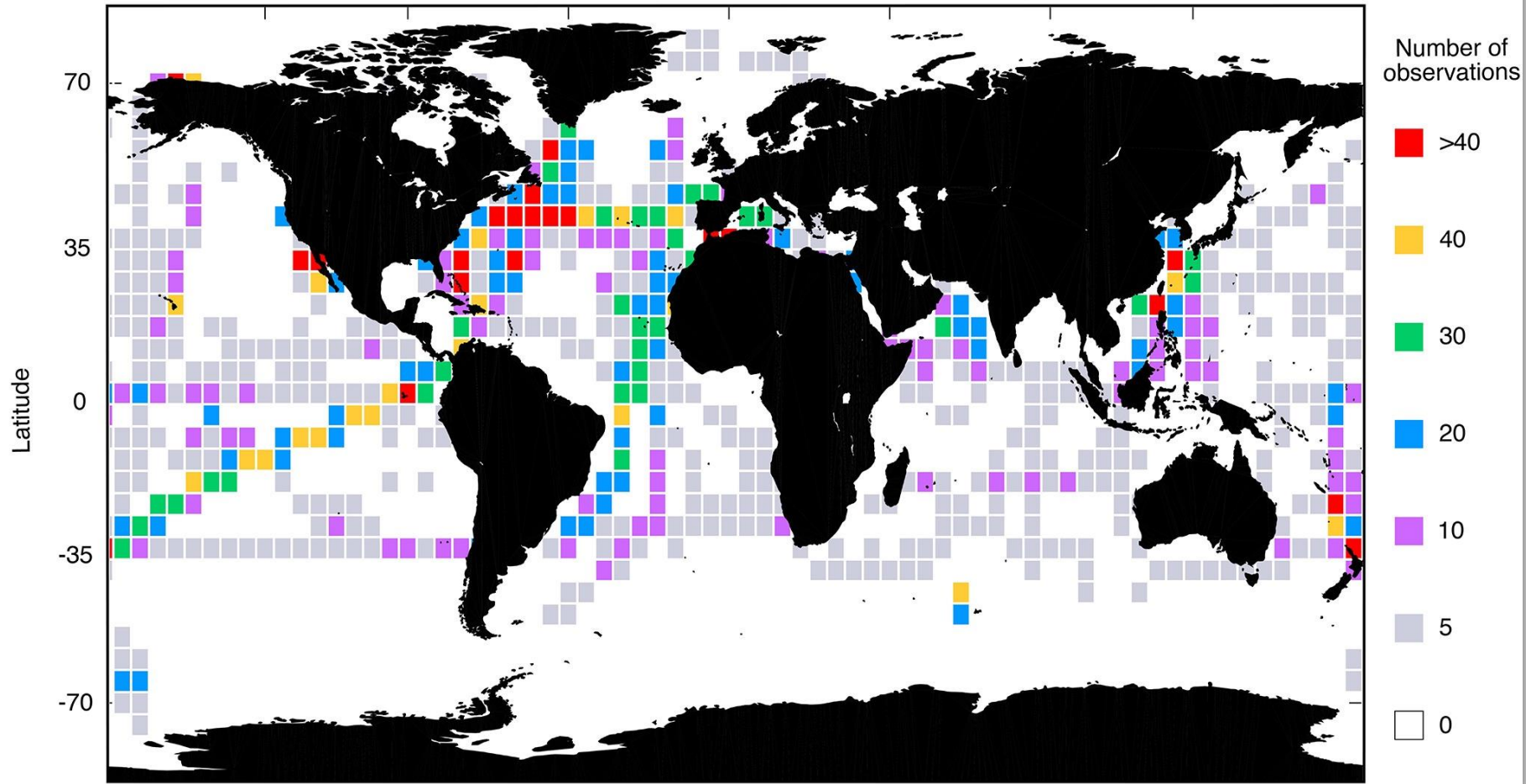
syncoccus\_moana (cells ml<sup>-1</sup>)



picoeuk\_moana (cells ml<sup>-1</sup>)



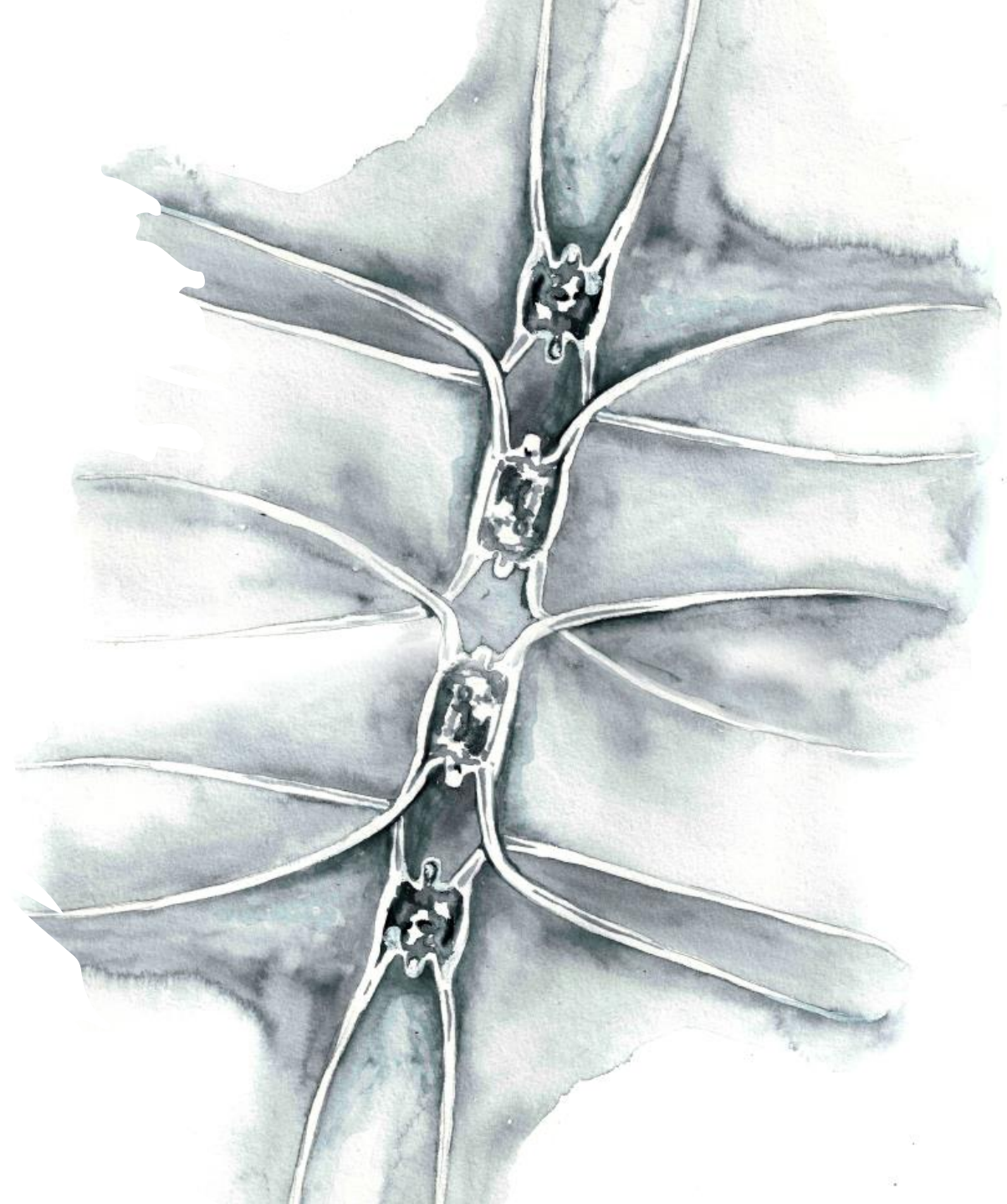
(a)

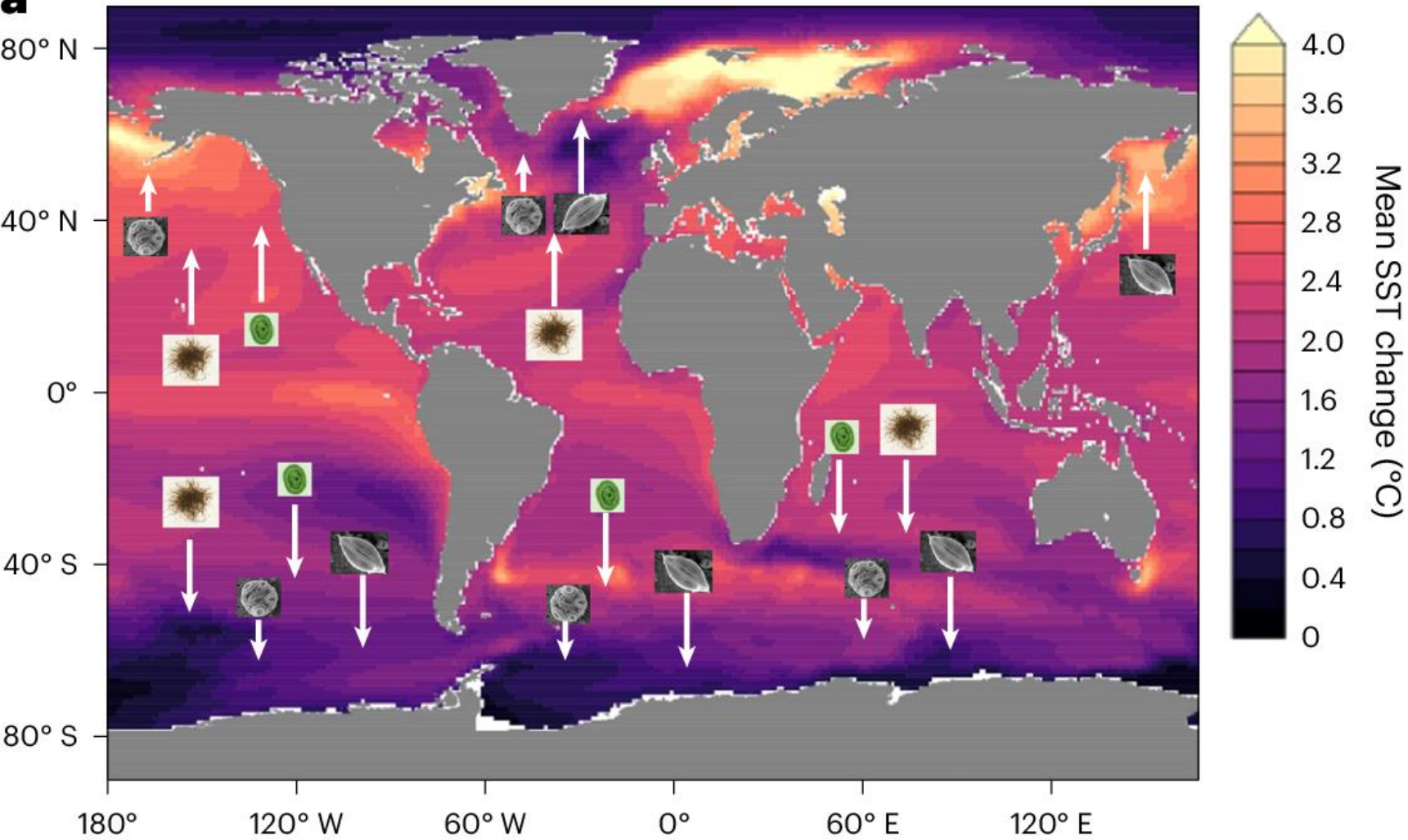


WE HAVE MORE  
THAN THAT IN  
1 DAY OF PACE  
DATA.  
(524,288 pixels  
daily)

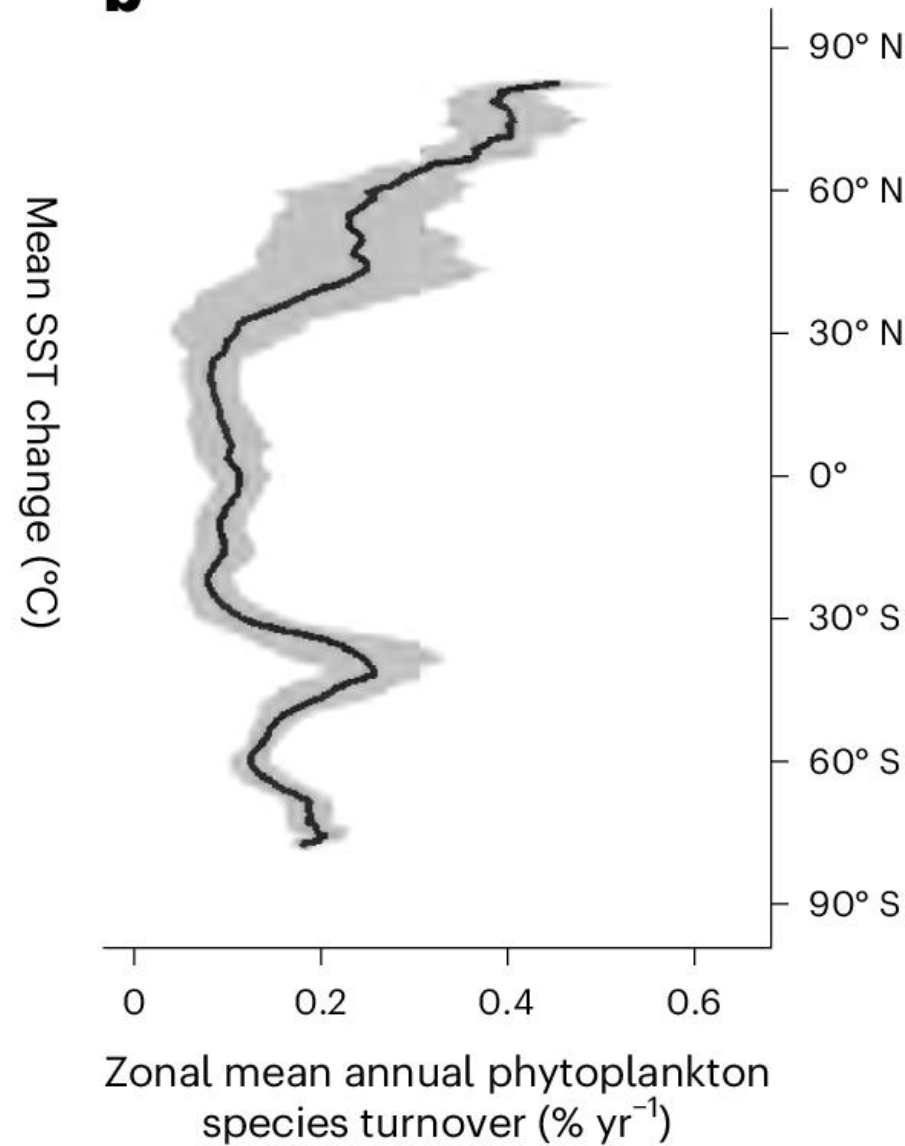
DATASET COMPRISES 41,912 IN SITU OBSERVATIONS OF *PROCHLOROCOCCUS*, 44,949 OF *SYNECHOCOCCUS*, AND 22,184 OF PICOEUKARYOTES.

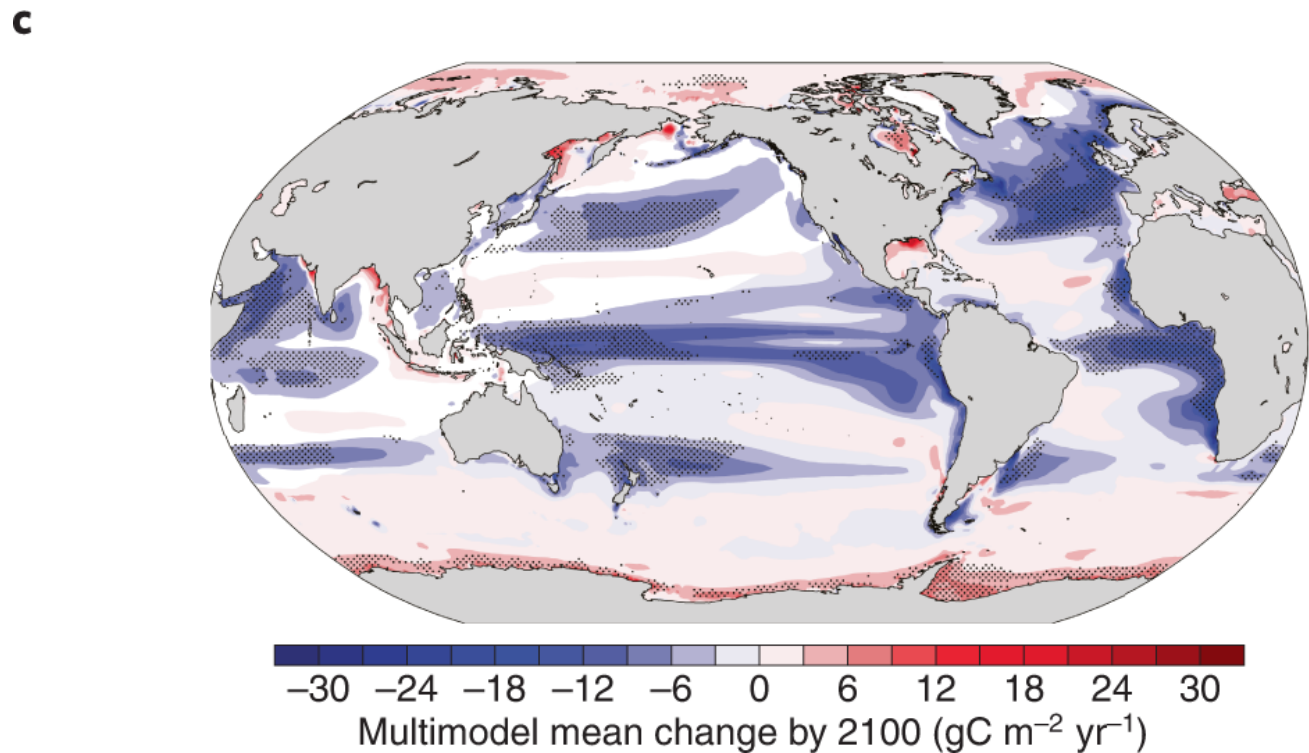
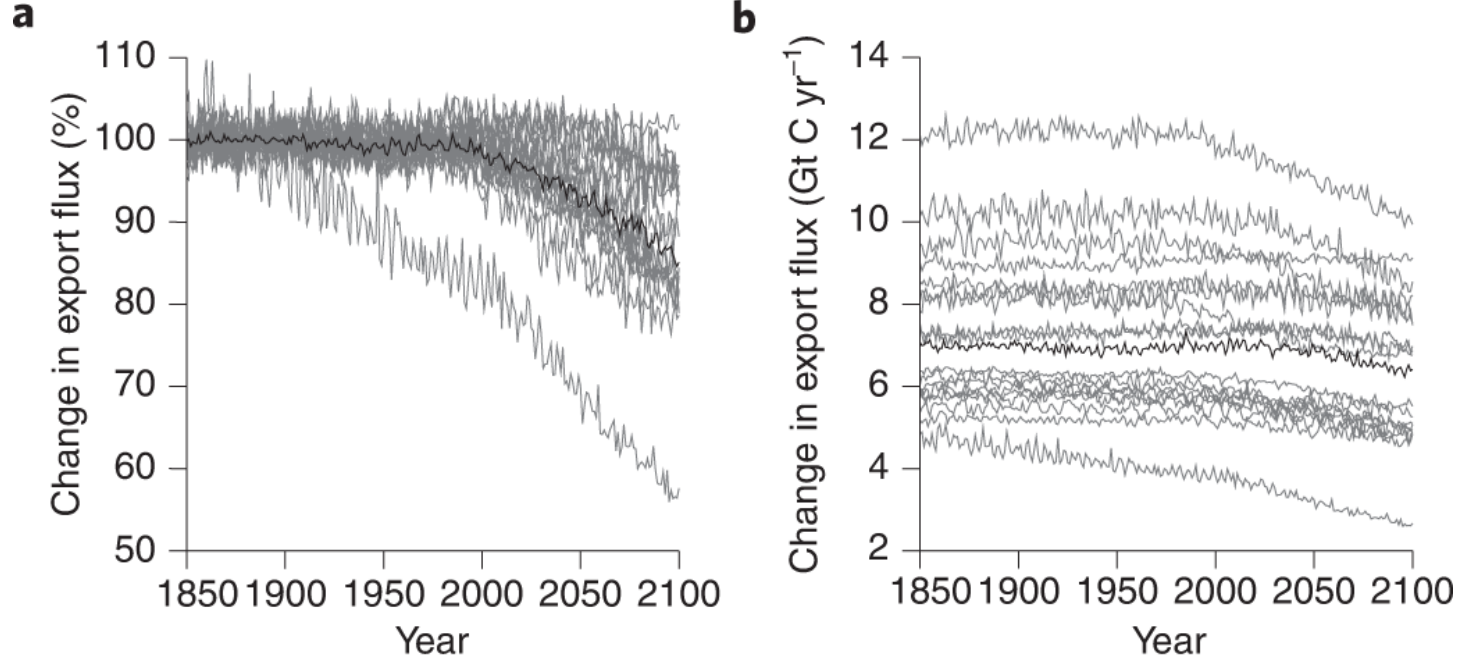
WHY DO WE CARE?

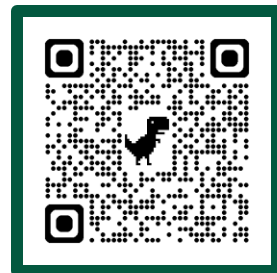


**a**

(Sub)tropical picocyanobacteria  and nitrogen-fixing cyanobacteria   
 Bloom-forming temperate coccolithophores  and diatoms 

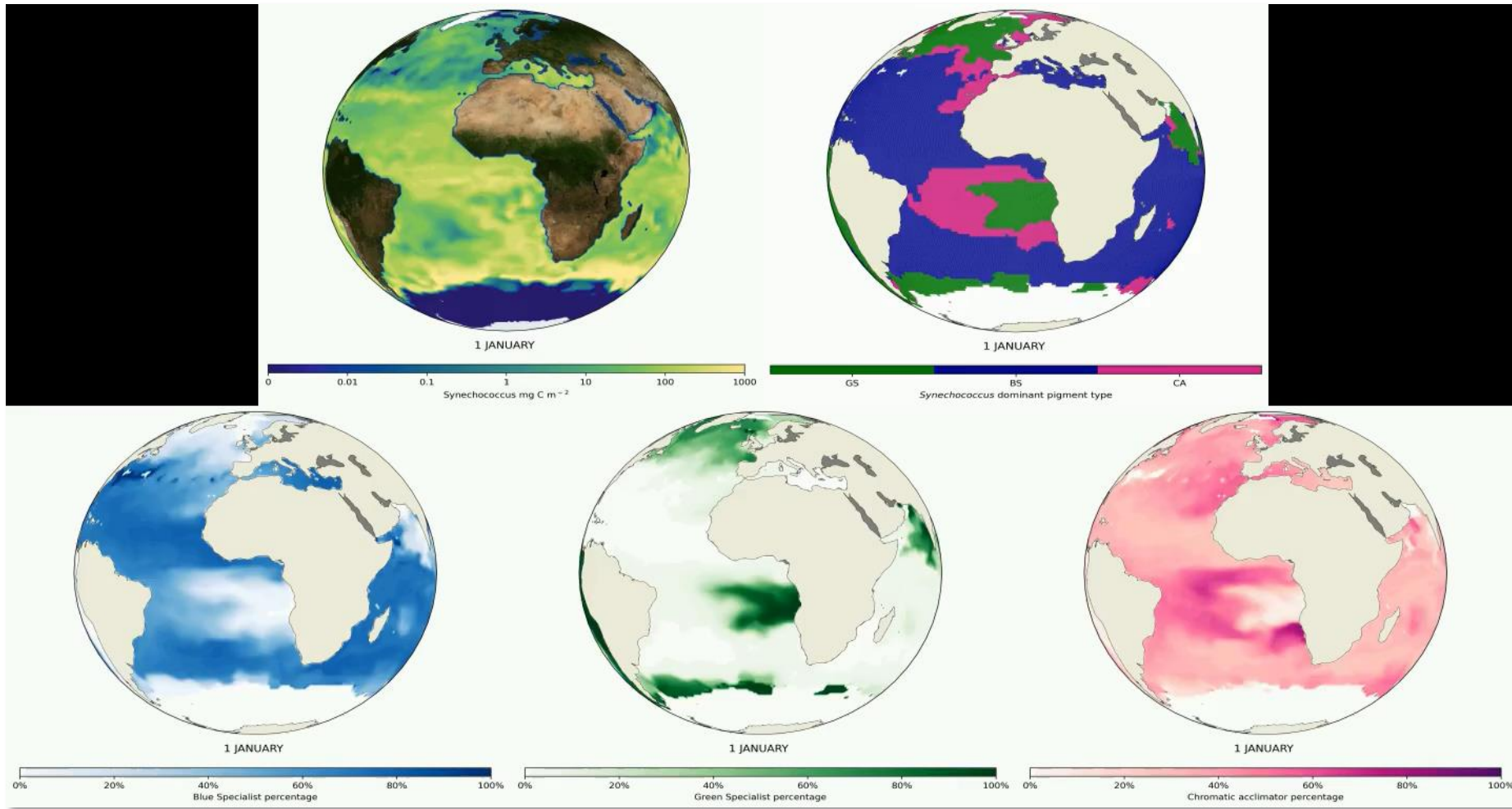
**b**





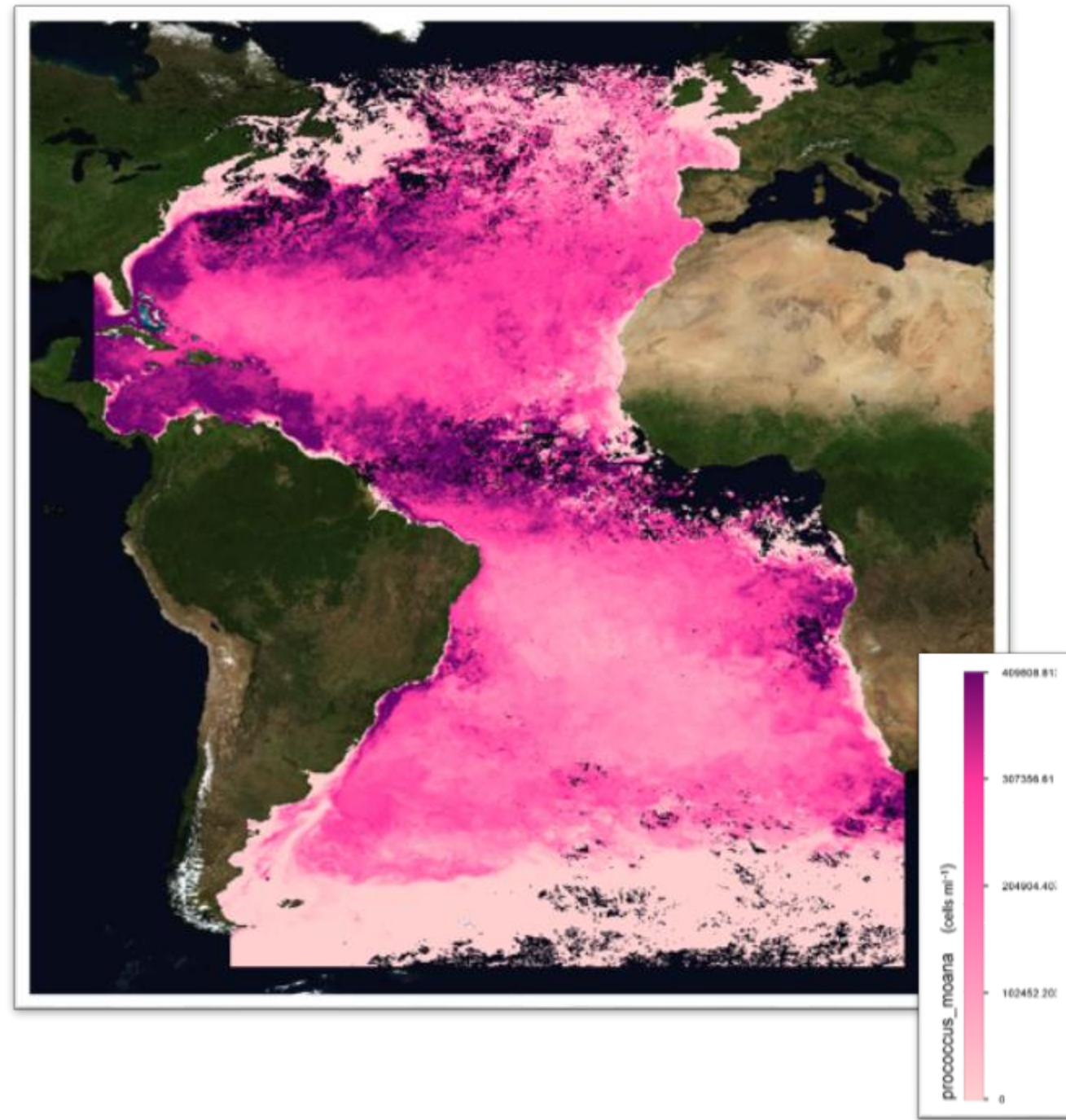
Next steps for MOANA?  
Validation

# Next steps for MOANA? Global expansion



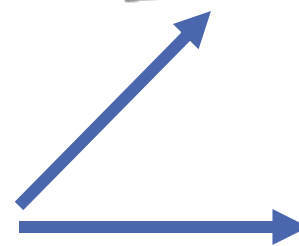
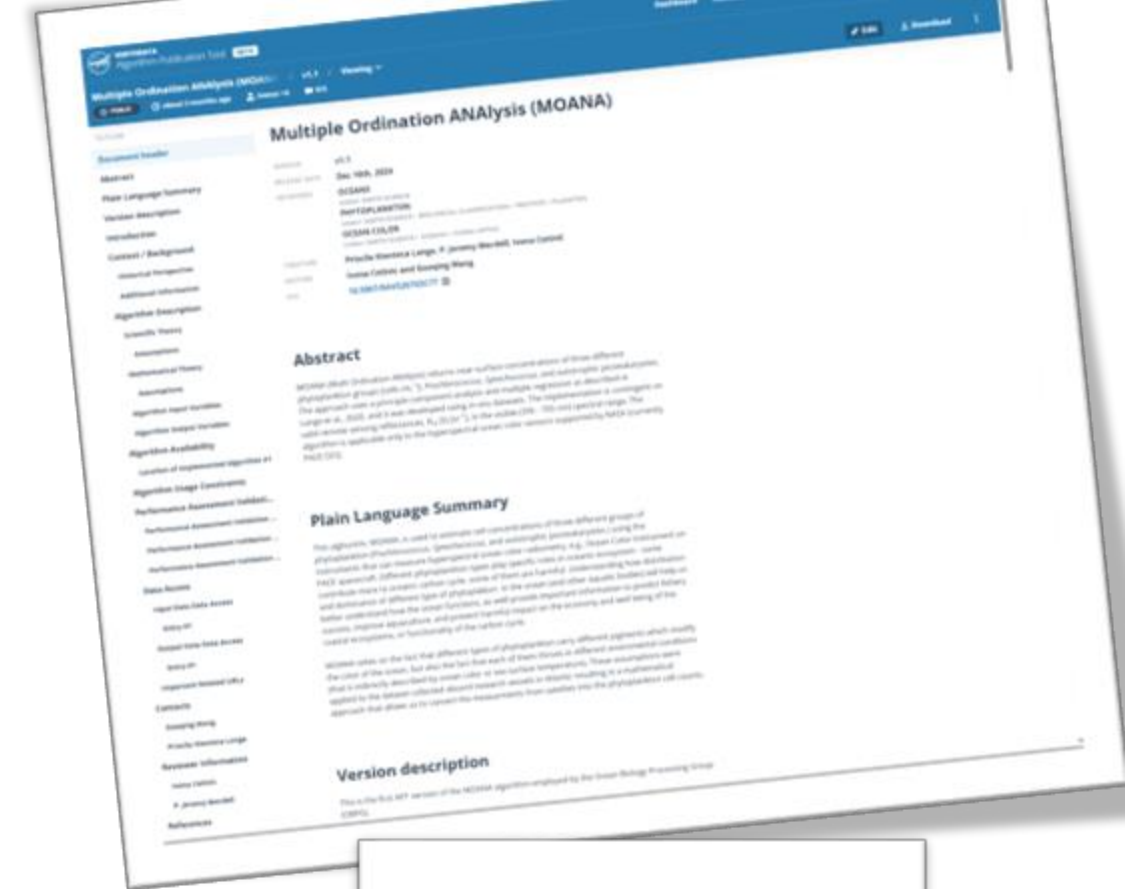
BLUE  
SYNECHOCOCCUS  
GREEN  
SYNECHOCOCCUS  
CHROMATIC  
ACCLIMATOR  
SYNECHOCOCCUS

So how does one  
get some pretty  
moana data?



# MOANA

- Test algorithm
  - Products that have been implemented as production-capable science code
  - Test feasibility and resource requirement assessment
  - Validation pending data availability
  - Not on Earthdata Search, only on local OB.DAAC
- L3
  - Daily, 8-day, monthlies
  - 4 km or 0.01 degrees
- Algorithm Theoretical Basis Document (ATBD) available



Let's choose a data category:

Spacecraft Data In-Situ Data

Here are options for accessing spacecraft data.



Mission

If you know the mission name...

To find data by mission, you may use the following methods:

- » [File Search](#)
- » [Level 3 & 4 Browser](#)
- » [Earthdata Search](#)



Data Compositing Period

Compositing Periods for Daily, 8-Day, Monthly, Seasonal or Annual

Select data compositing periods using these tools:

- » [Level 3 & 4 Browser](#)
- » [Direct Data Access](#)
- » [Earthdata Search](#)



Locate individual file(s)

If you only need a few files

Download from:

- » [Direct Data Access](#)
- » [File Search](#)
- » [Earthdata Search](#)



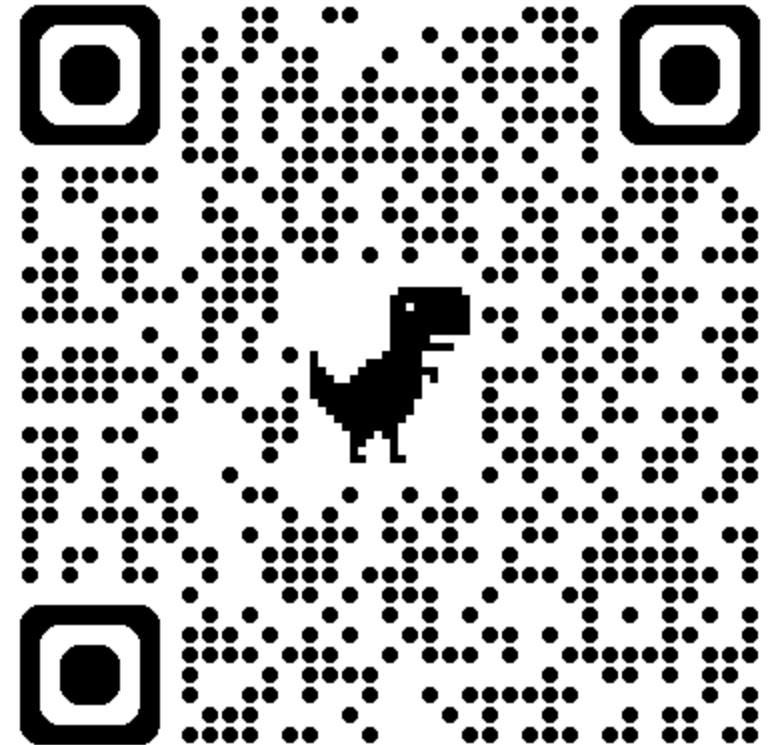
File Listing

Get a listing of files

Use these tools:

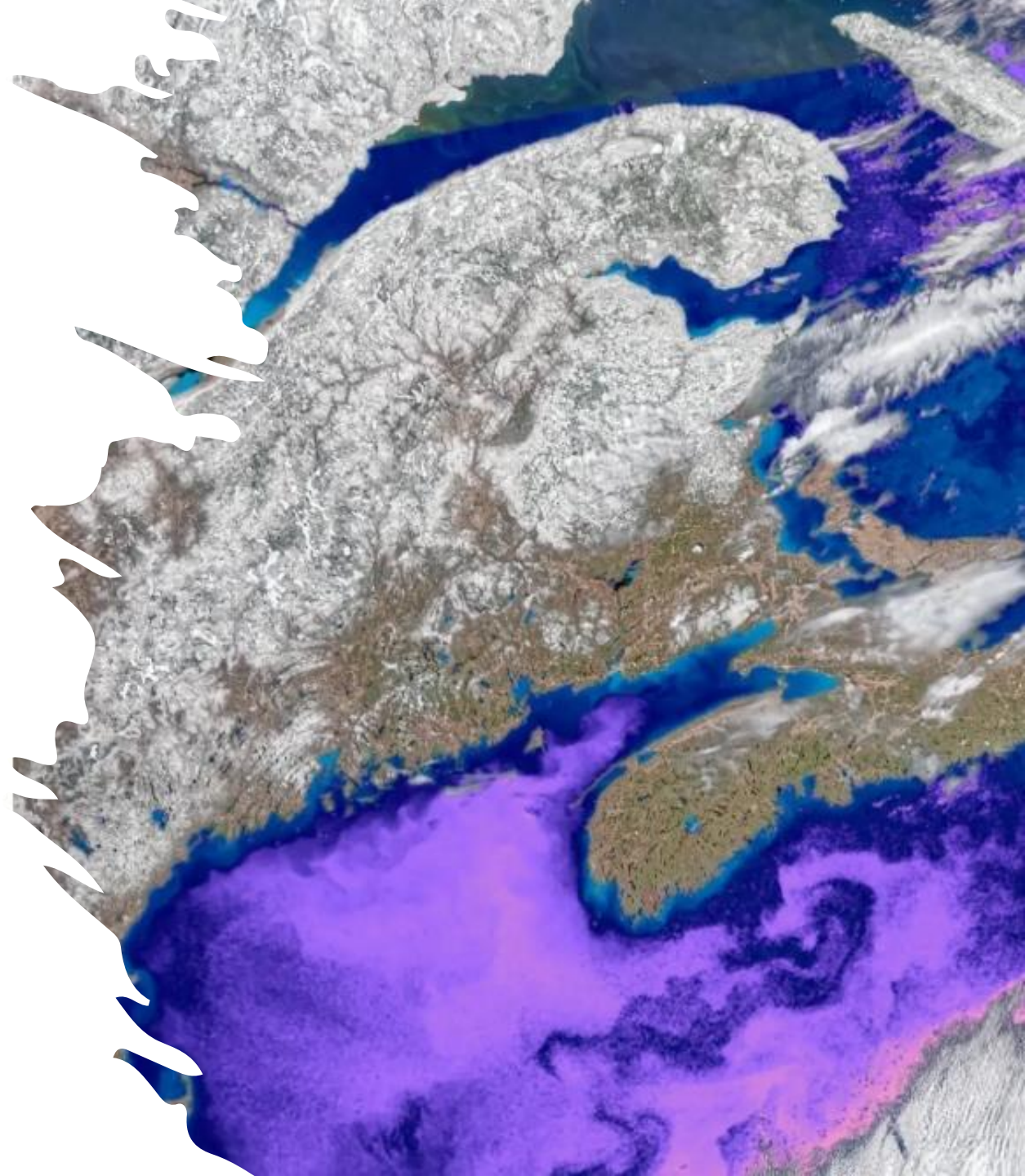
- » [File Search](#)
- » [Direct Data Access](#)
- » [Earthdata Search](#)

# Getting to data



THANK YOU FOR  
YOUR ATTENTION!!

MORE  
PHYTOPLANKTON TO  
COME !!!!



After this presentation, a live data access demonstration was presented to show where the Test MOANA data can be accessed.

Please watch the recording of this event for this demonstration as well as the audience question & answer session afterwards.