Assessing the Impacts of Ocean Acidification on Phytoplankton Functional Types – A Case Study for the Amazon River Plume

Joaquim I. Goes , Helga Gomes and Kali McKee
(Lamont Doherty Earth Observatory, Palisades, NY, USA)

Tegan Galina
New York University, New York, NY, USA

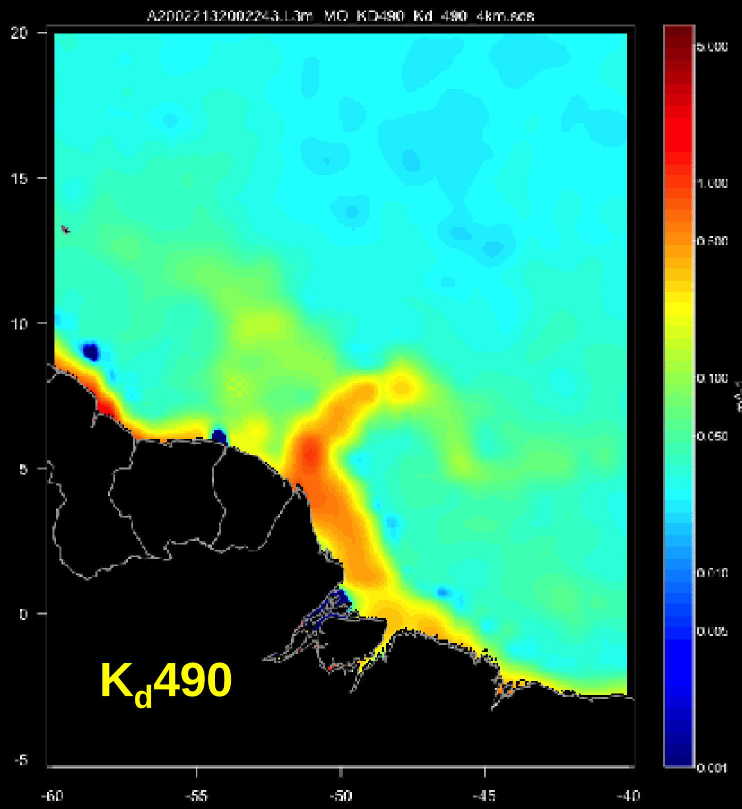
Therese Chen
UCLA Fielding School of Public Health, Los Angeles, CA, USA

Marisol Diaz Turkowsky Lund
University, Stockholm, Sweden

Patricia Yager
University of Georgia. Athens, GA, USA

Edward Carpenter
Tiburon Marine Laboratory, San Francisco

UNIQUE FEATURES OF THE AMAZON RIVER PLUME

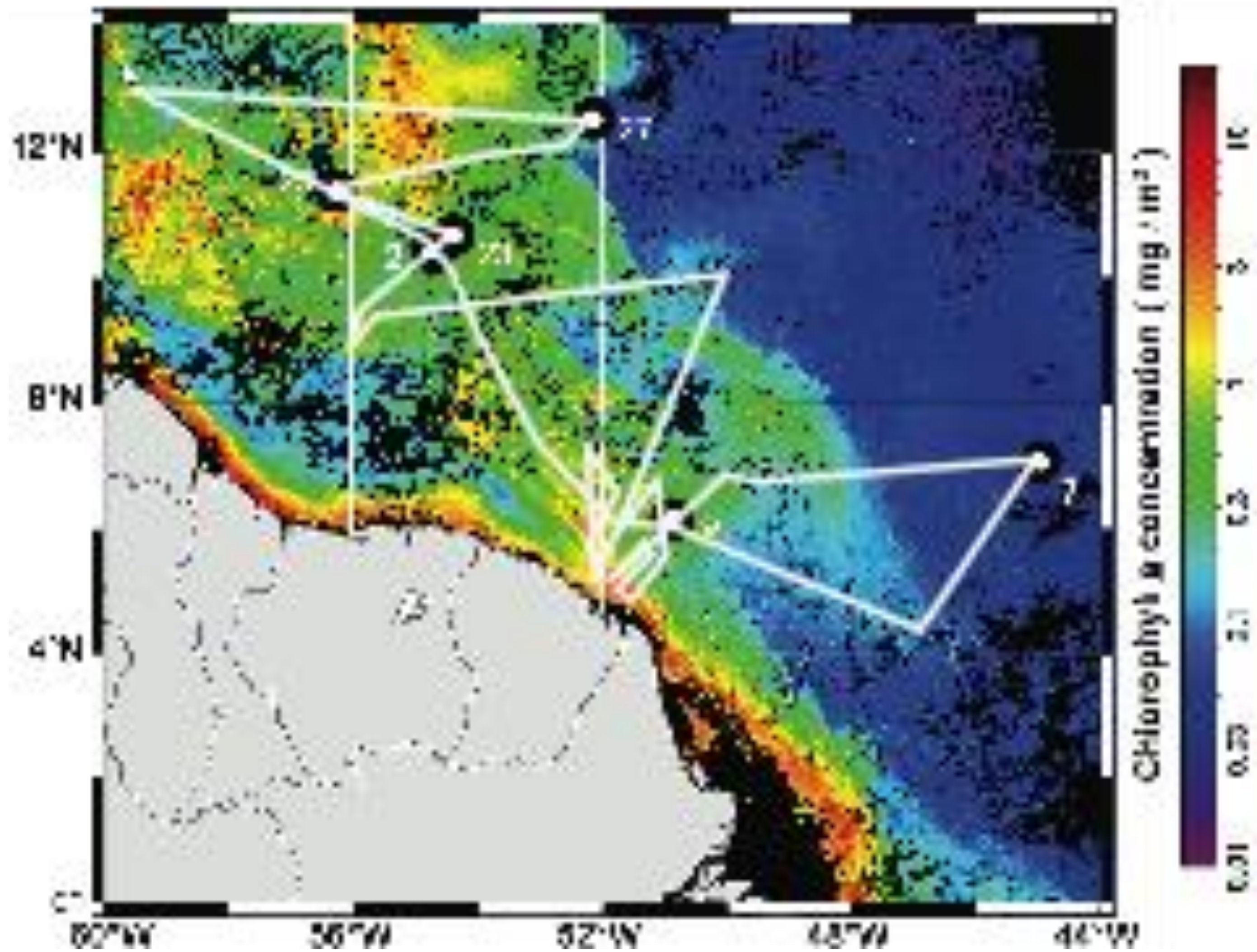


Monthly variability of Chlorophyll a and K_d490 as observed by MODIS-Aqua

1) **The Amazon flows through the world's largest and most densely populated forests, carrying with it massive amounts of sediments, nutrients and dissolved organic material.**

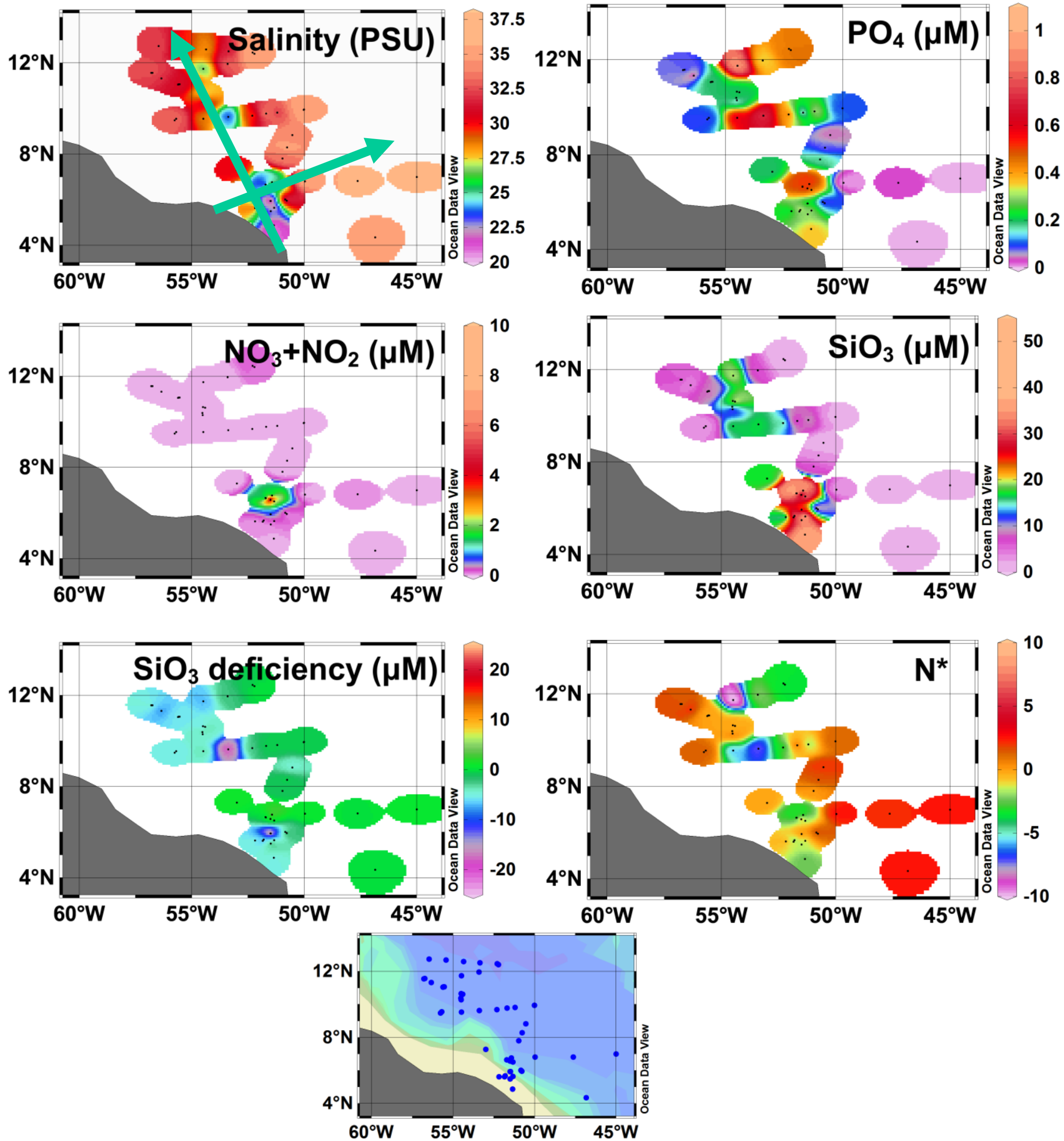
2) **Sediments and CDOM impart a greenish color to the water that can be visible several thousands of kilometers from the mouth from space.**

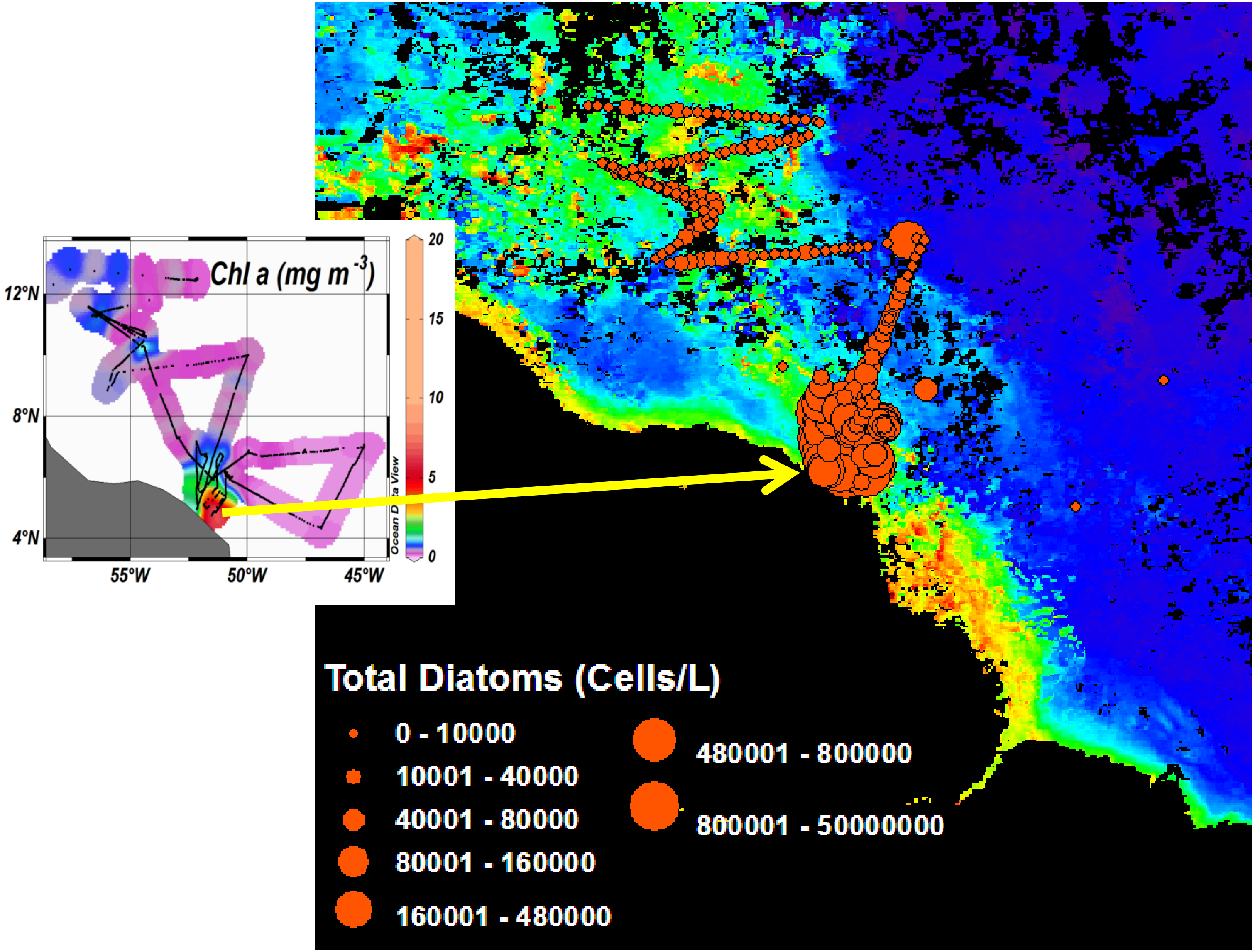
3) **As the river flows into the western tropical North Atlantic Ocean, a distinct gradient in environmental conditions develops along and across the axis of plume that has a profound impact on the pelagic ecosystem.**



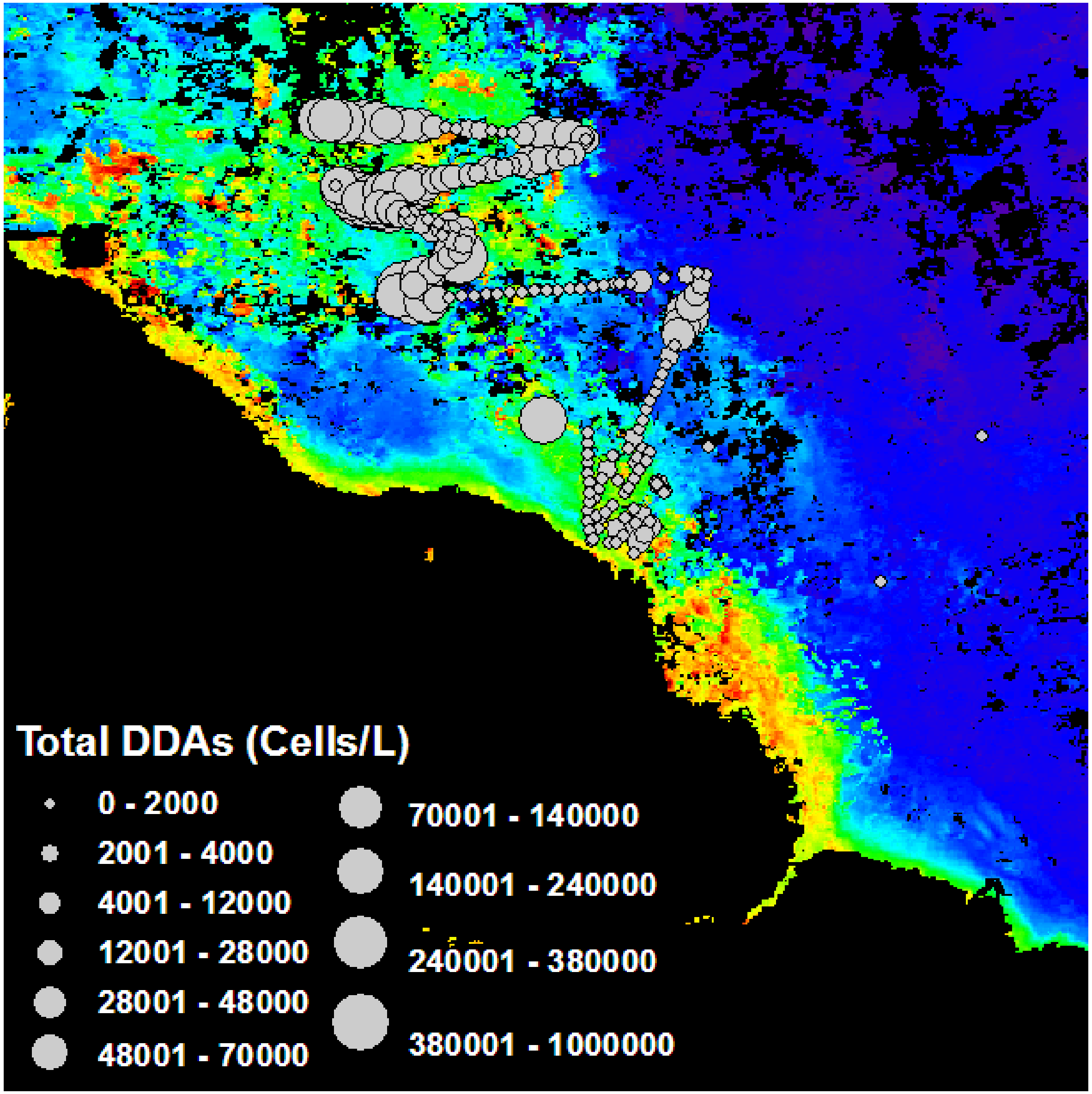
Cruise track and station locations of May-June 2010 Amazon plume cruise. Background color is satellite-based chlorophyll.

CHEMISTRY OF THE AMAZON RIVER PLUME

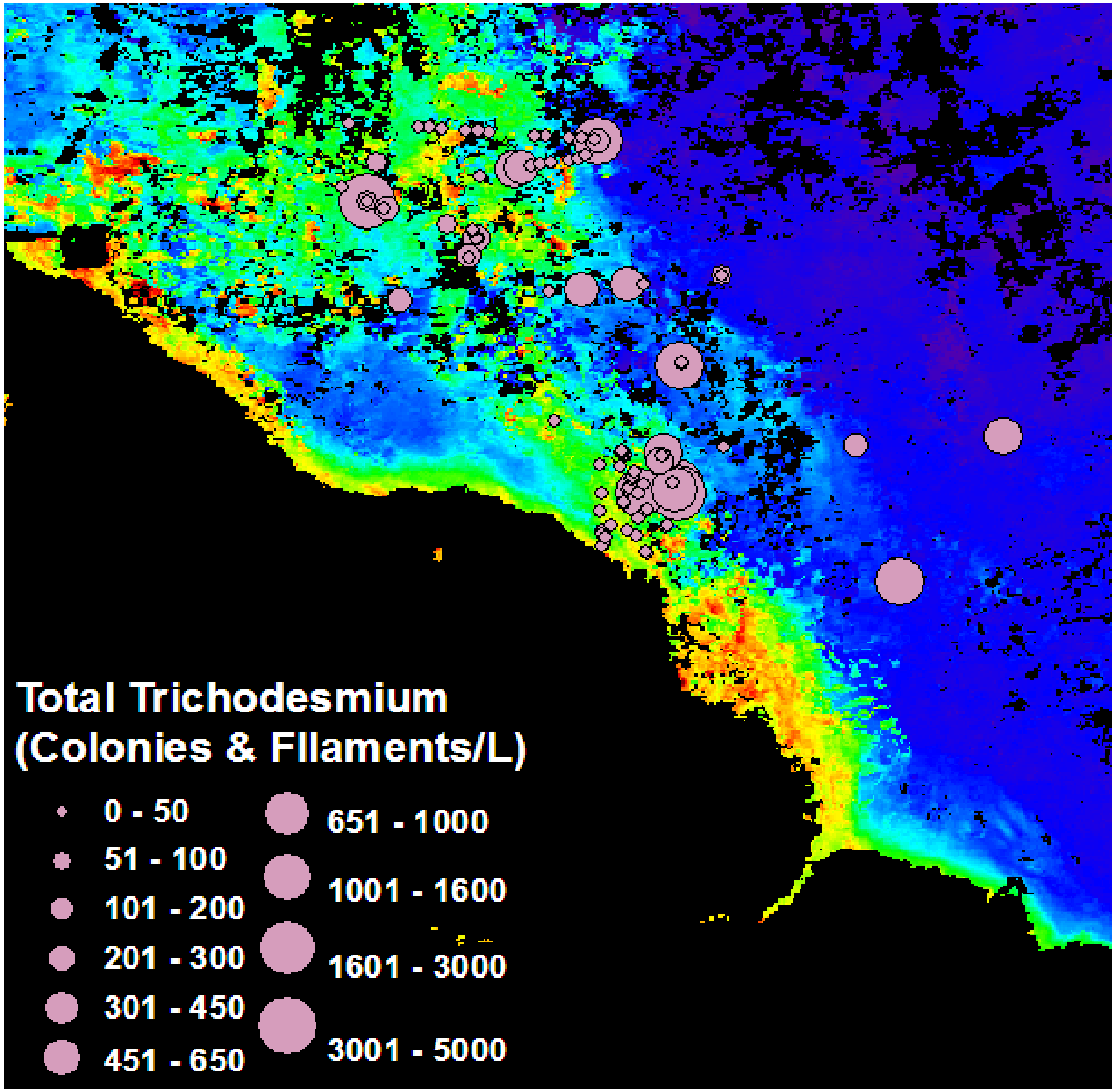




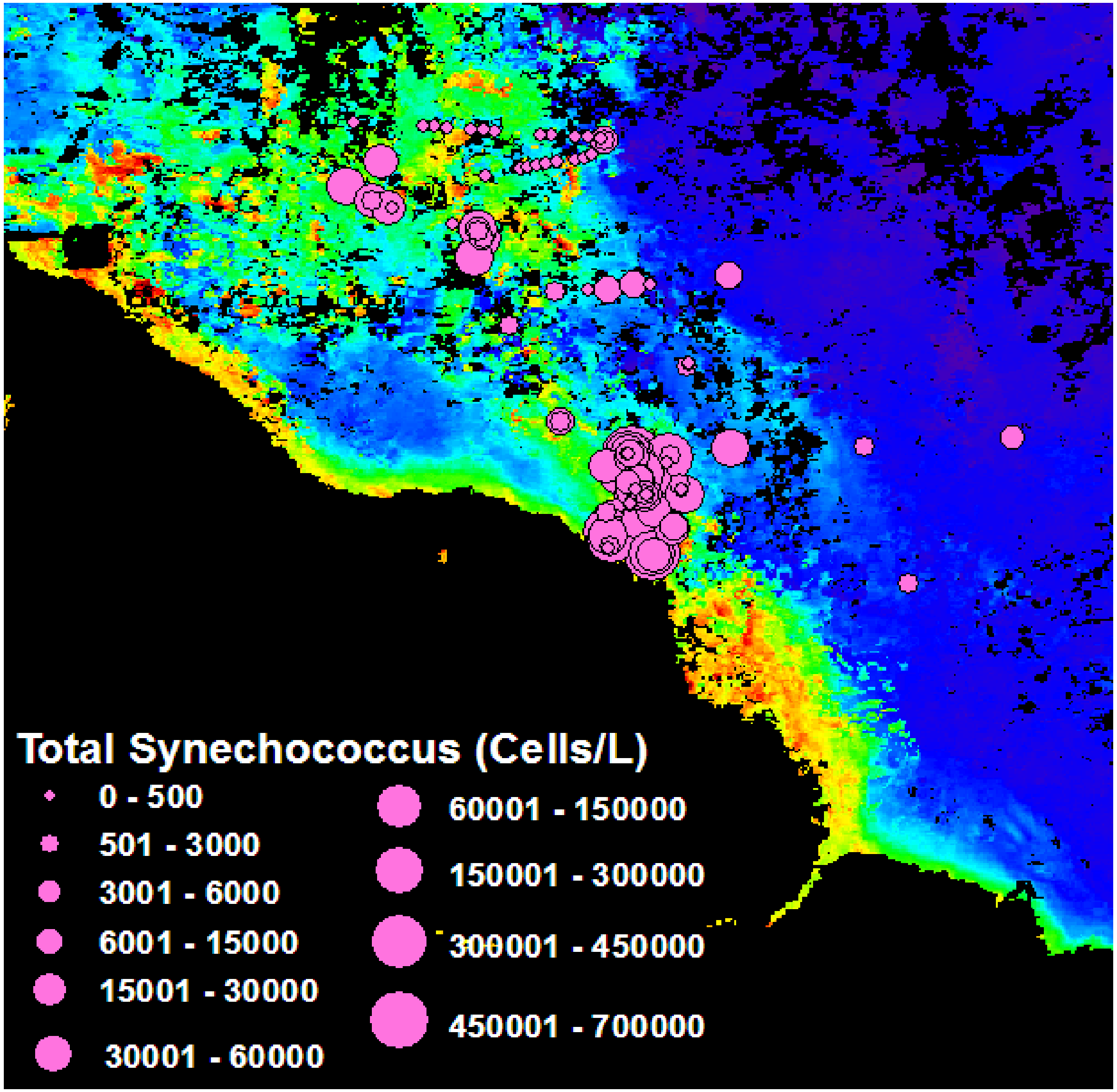
Distribution of diatoms along the cruise track



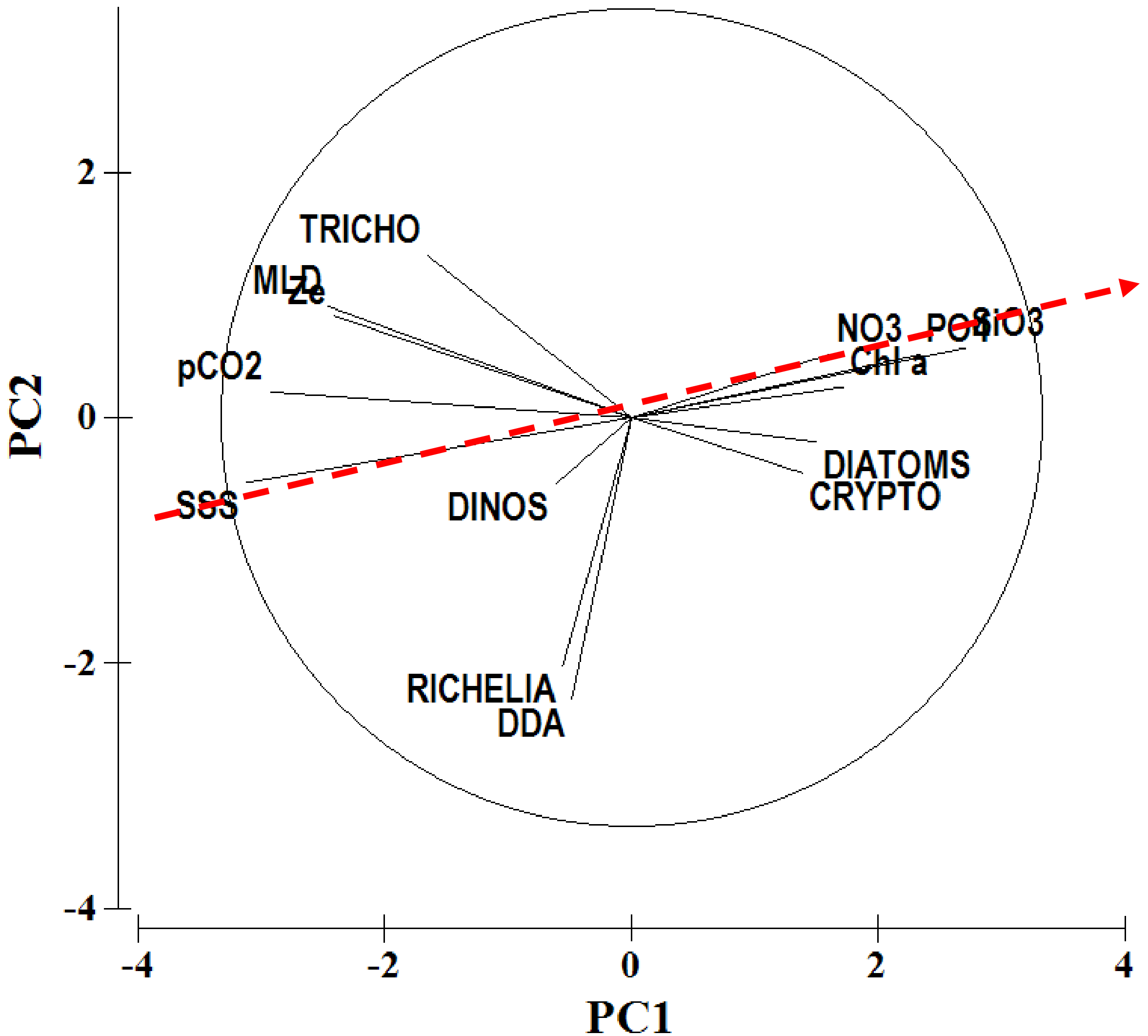
Distribution of Diatom-Diazotroph Association (DDAs) along the cruise track



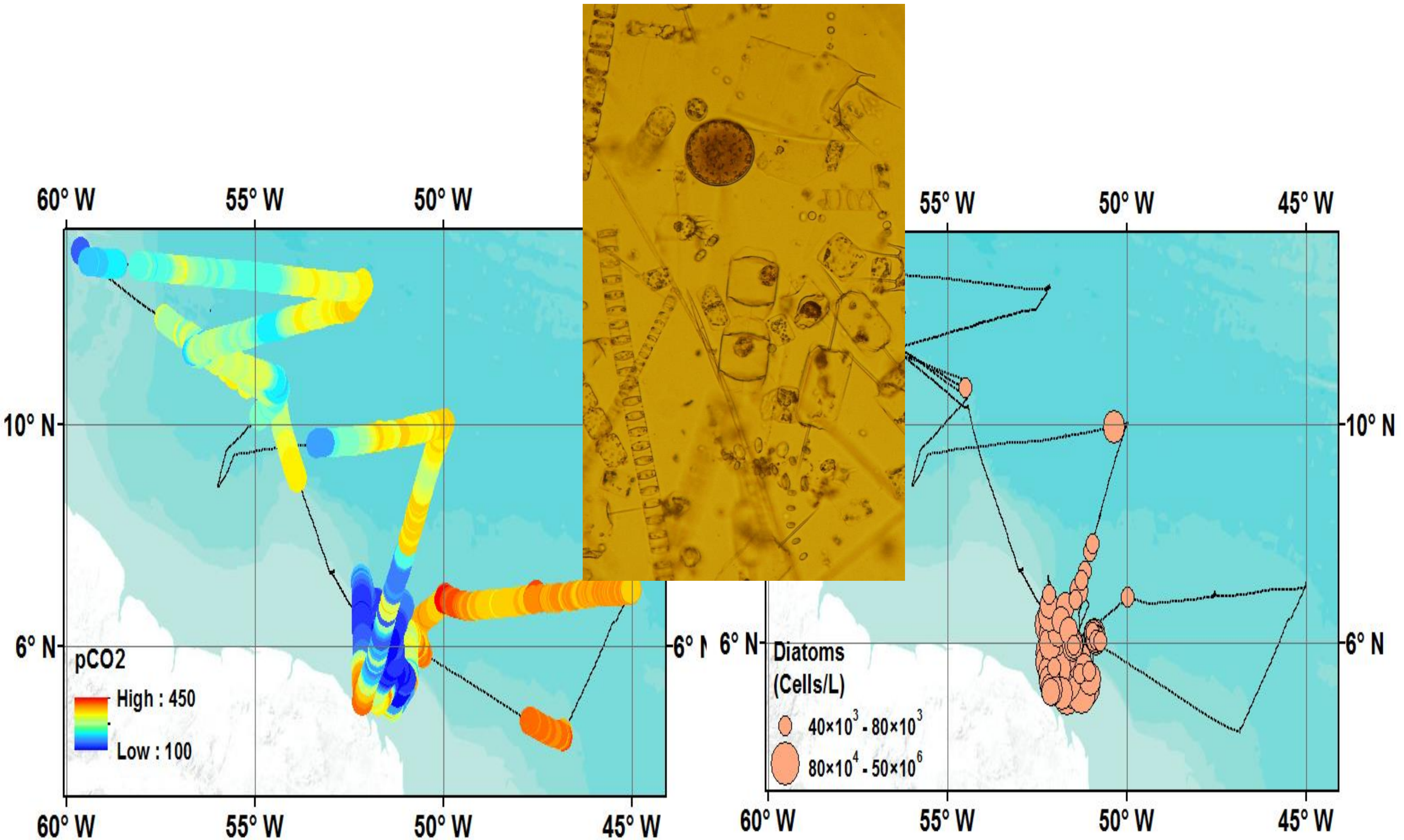
Distribution of *Trichodesmium* along the cruise track



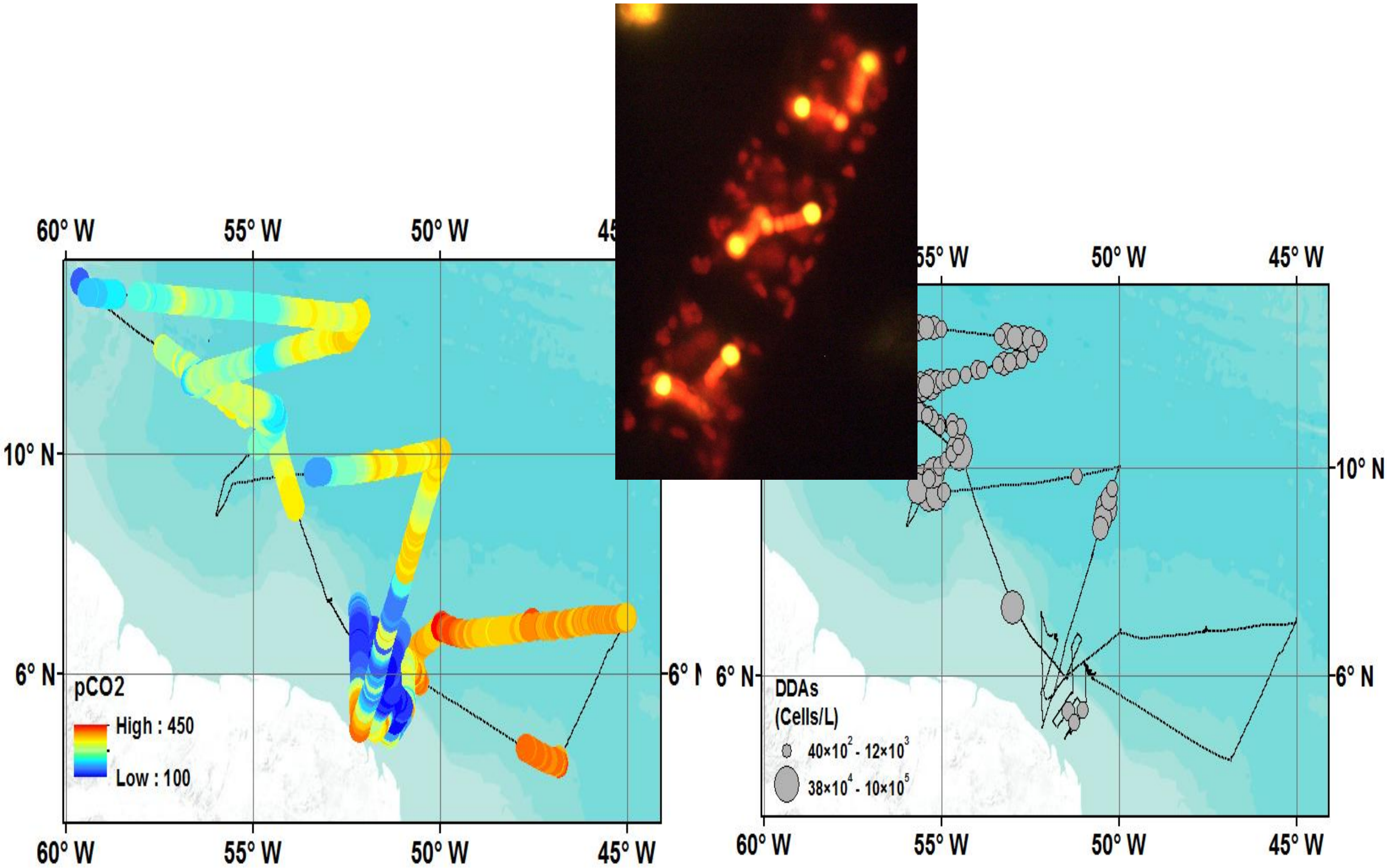
Distribution of Green and Blue water *Synechococcus* along the cruise track



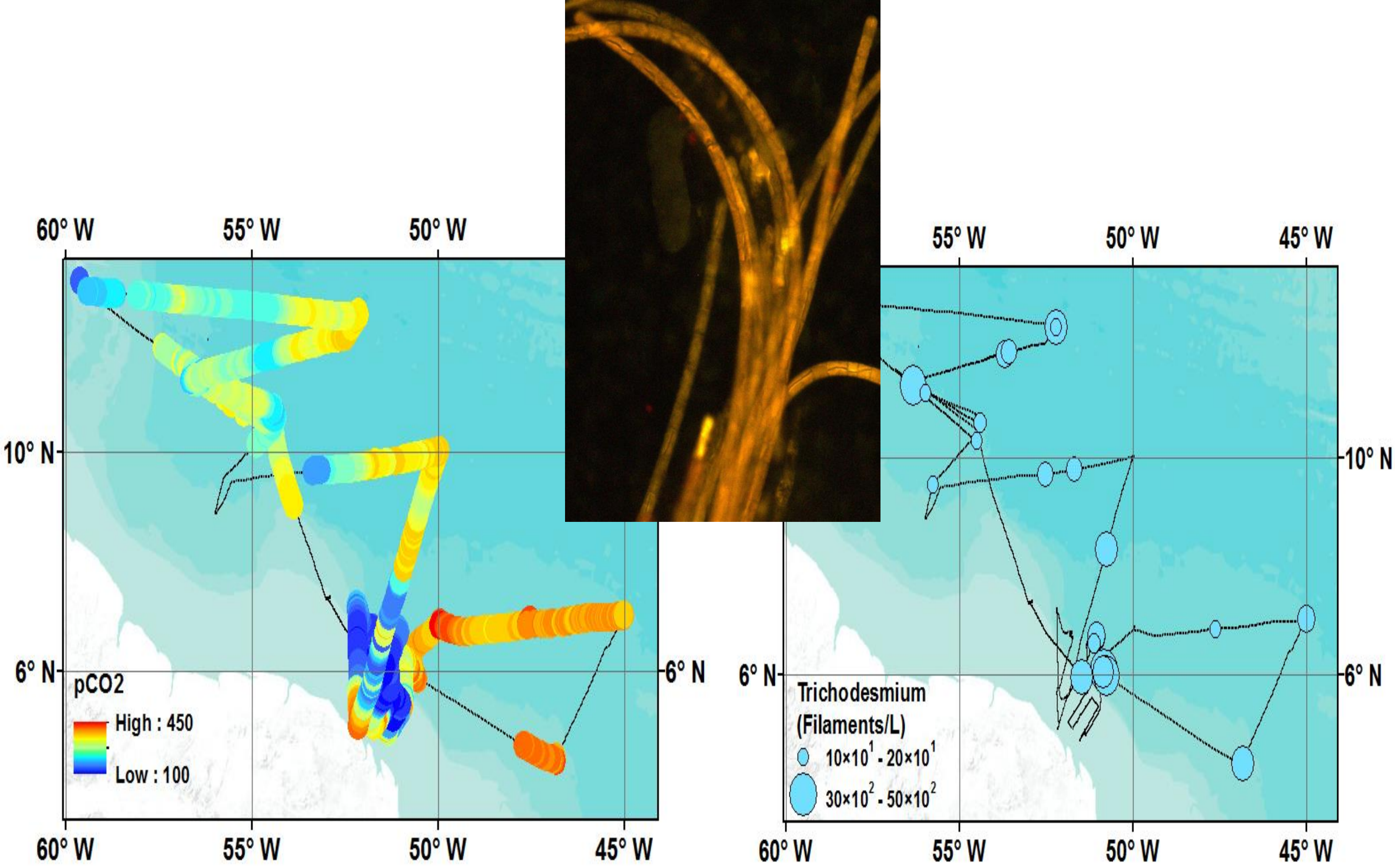
PCA shows that while river-sourced nutrients align opposite sea surface salinity (SSS), different phytoplankton groups vary independently of salinity, nutrients and *p*CO_2 along the river-ocean gradient.



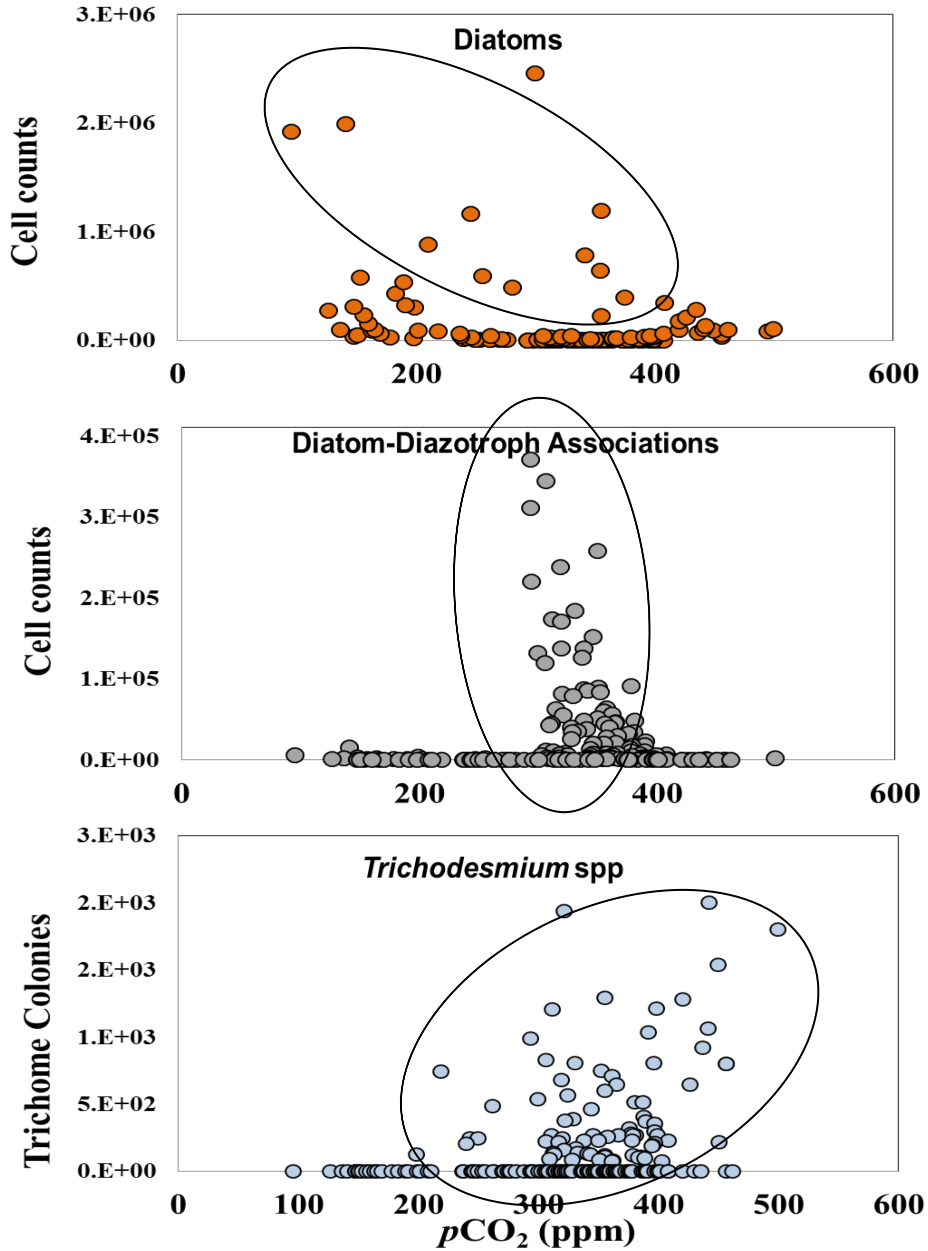
Along-track variations in *p*CO2, and Diatoms during May-June 2010 Amazon River Plume Cruise



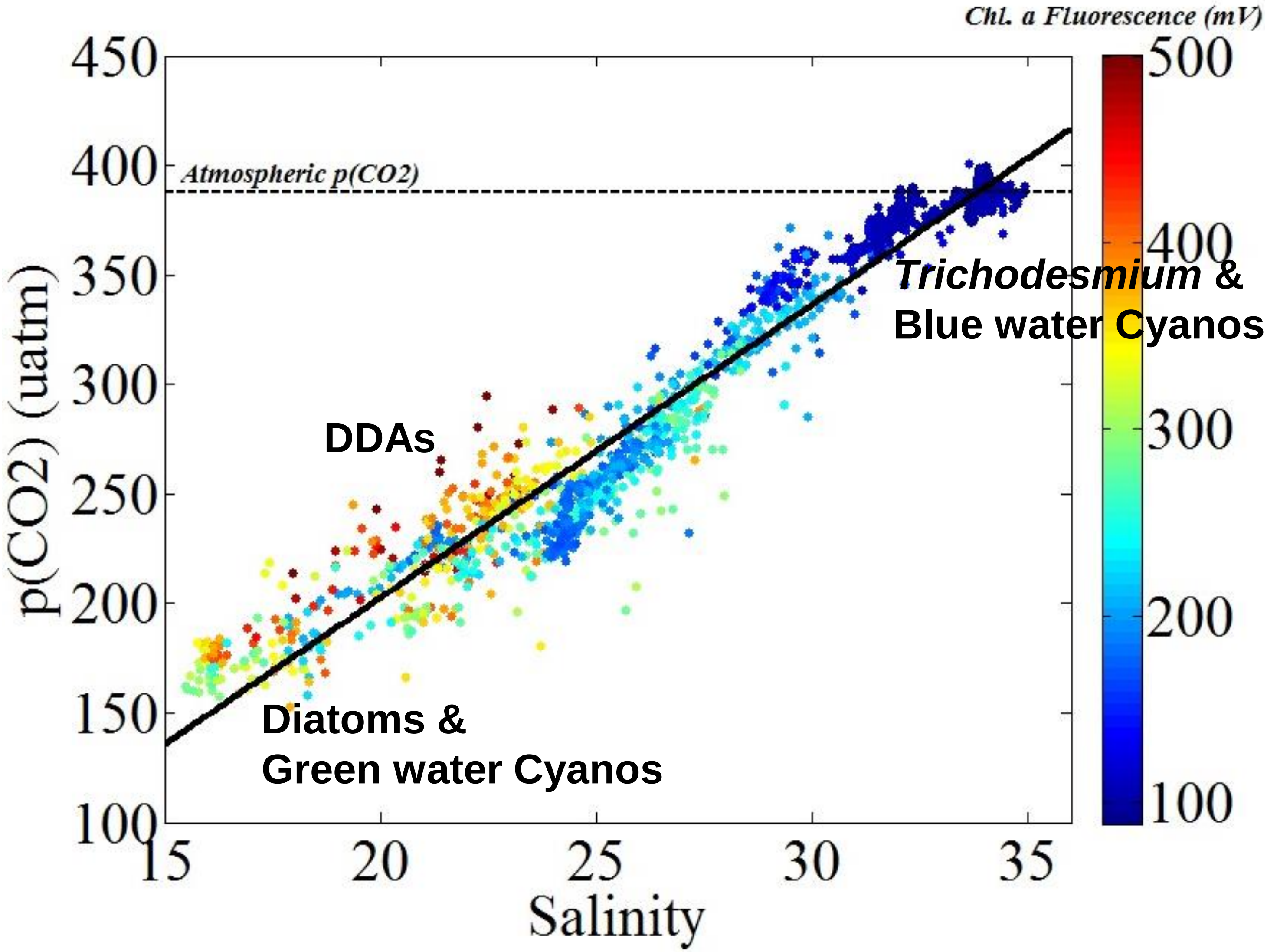
Along-track variations in *p*CO2, and DDAs during May-June 2010 Amazon River Plume Cruise



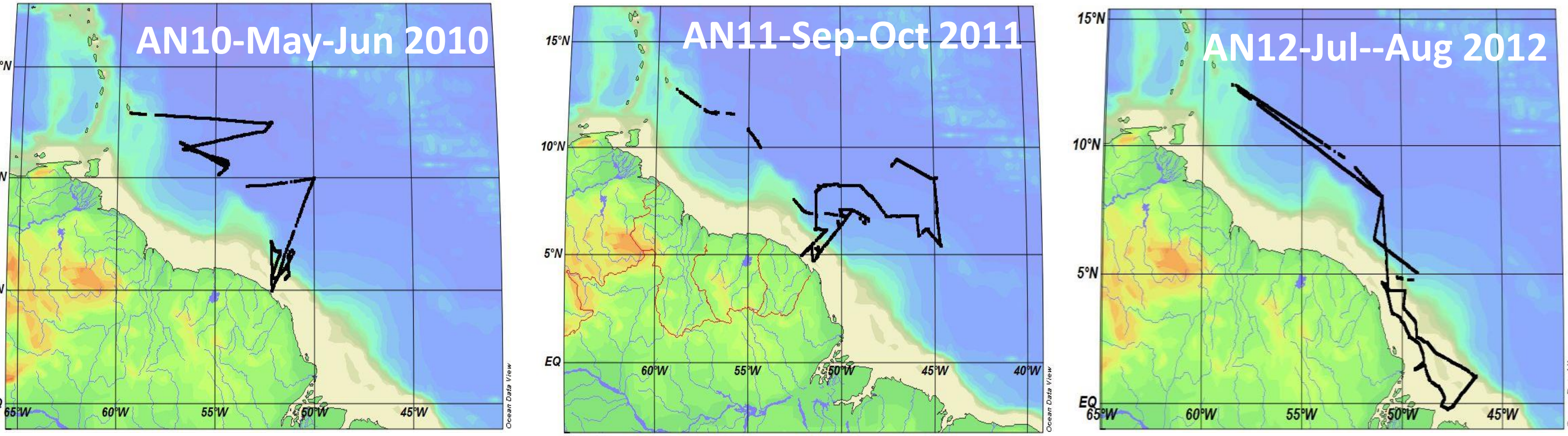
Along-track variations in *p*CO2, and *Trichodesmium* during May-June 2010 Amazon River Plume Cruise

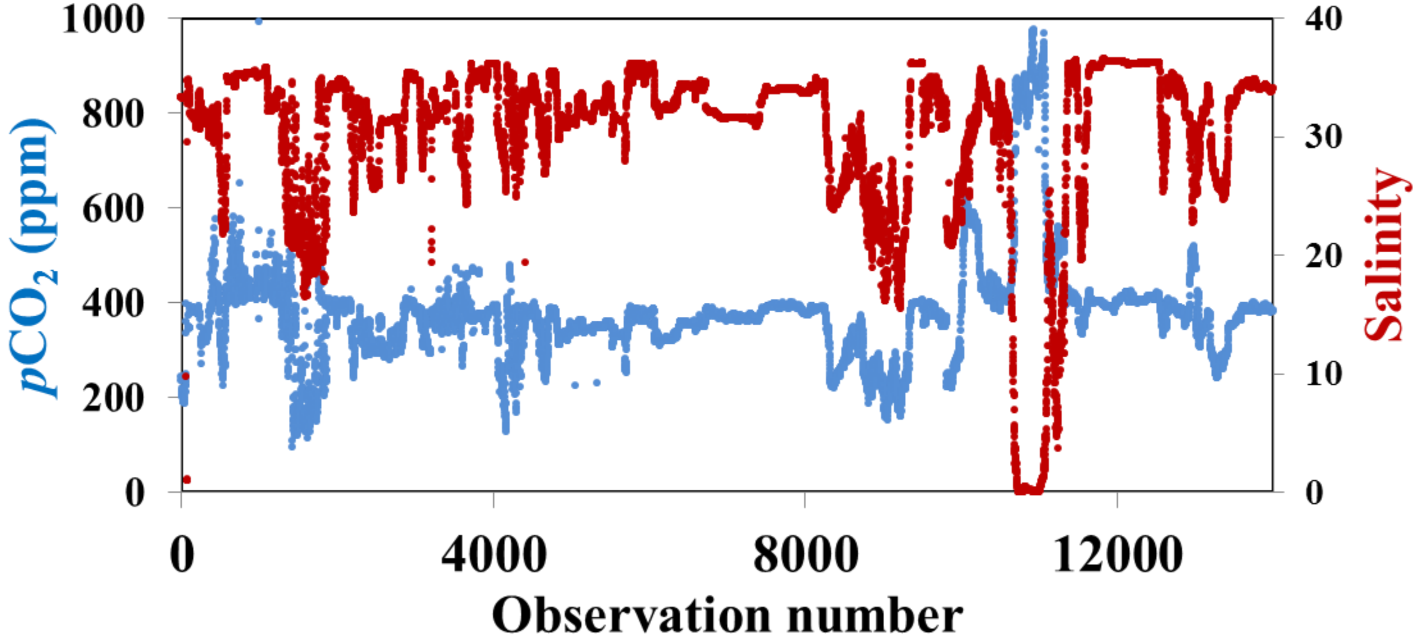


Distribution of major phytoplankton groups along the pCO2 gradient of the Amazon River Plume



pCO$_2$ versus salinity (x-axis) and Chl *a* fluorescence (color scale, mV) in the Amazon plume (during May 2010) showing the range of pCO$_2$ observed. The line is a least square's fit, not a mixing line.





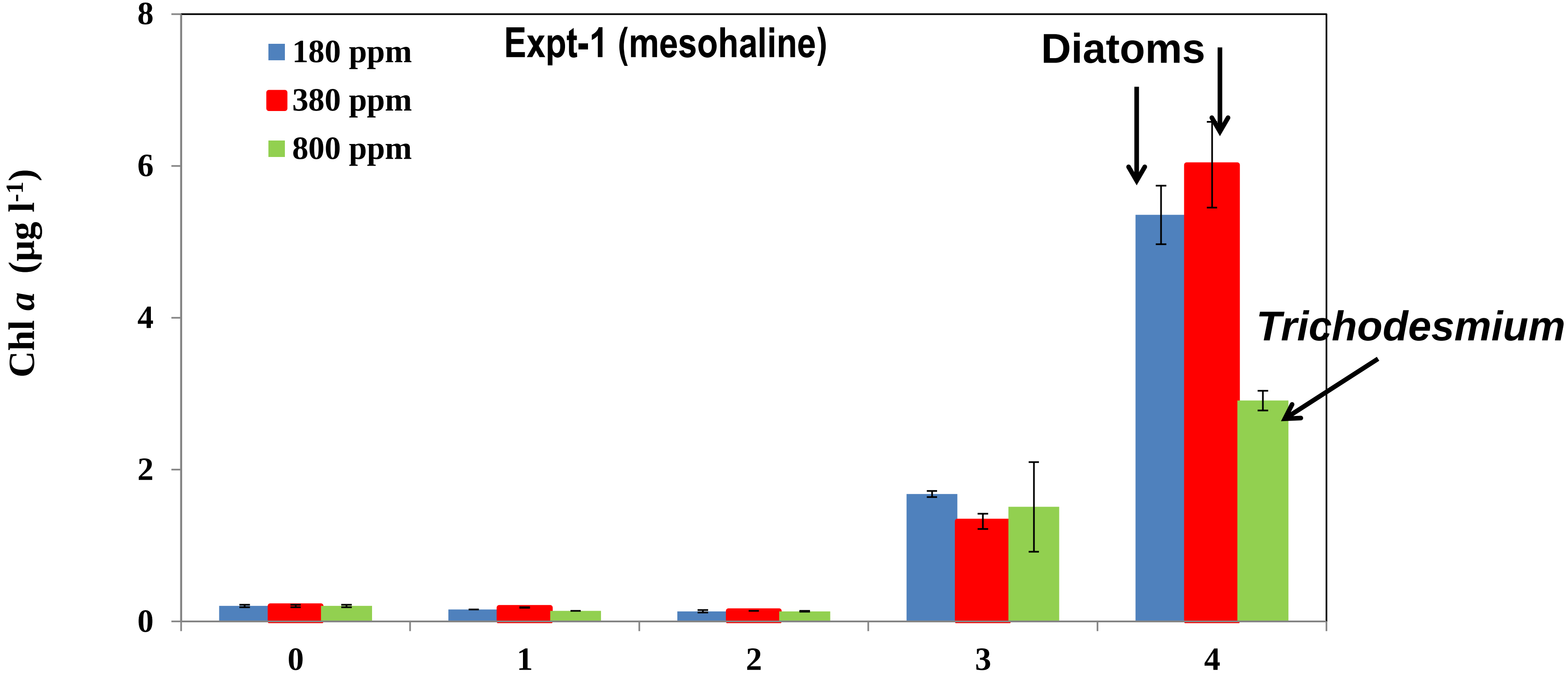
Cruise tracks of AN10, AN11 & AN12 and along-track distribution of salinity and *p*CO2 in the Amazon River Plume

HYPOTHESES

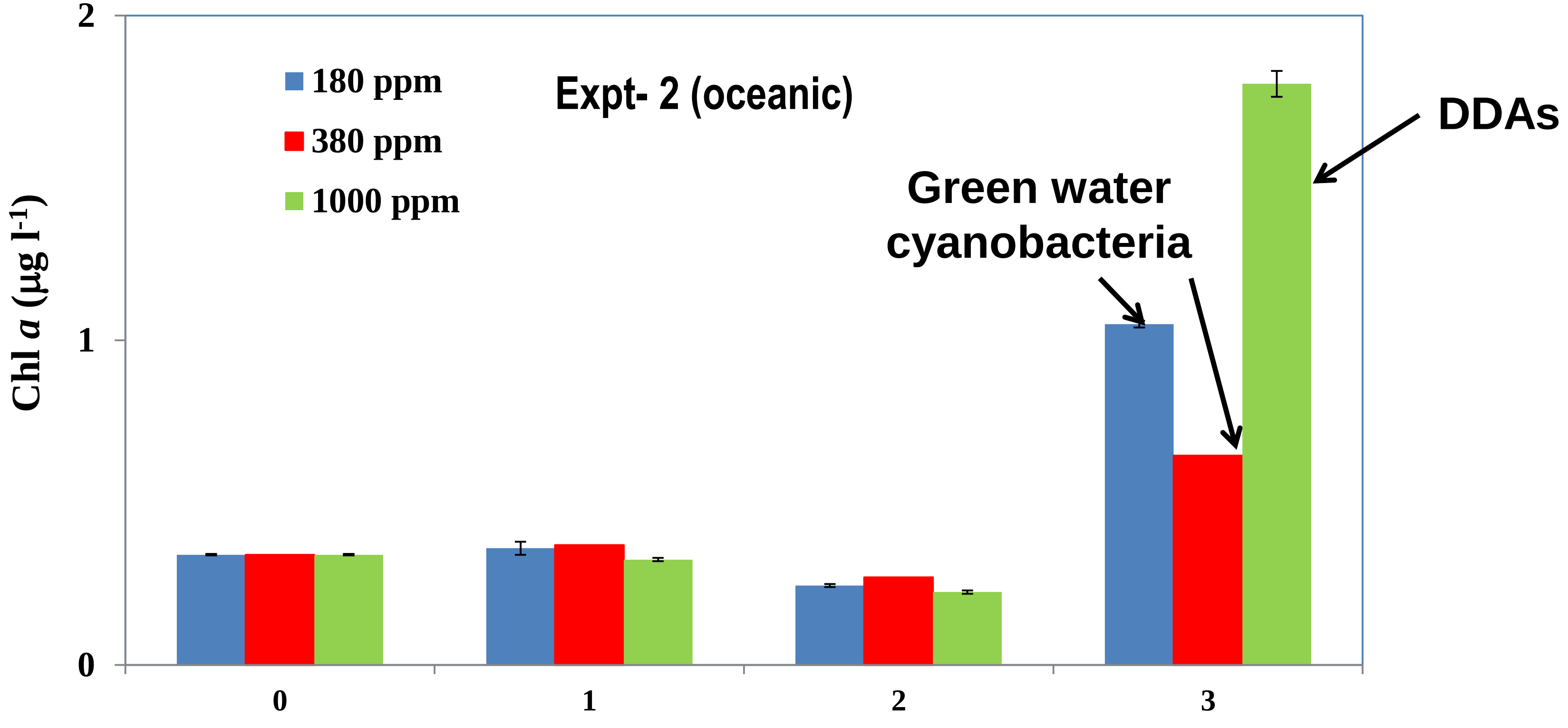
1) Amazon river plume phytoplankton are typically exposed to a wider range of *p*H than their truly oceanic counterparts but are as susceptible to ocean acidification as their oceanic counterparts

2) Distribution of phytoplankton communities in the Amazon River plume is controlled by their sensitivity to the carbonic acid system.

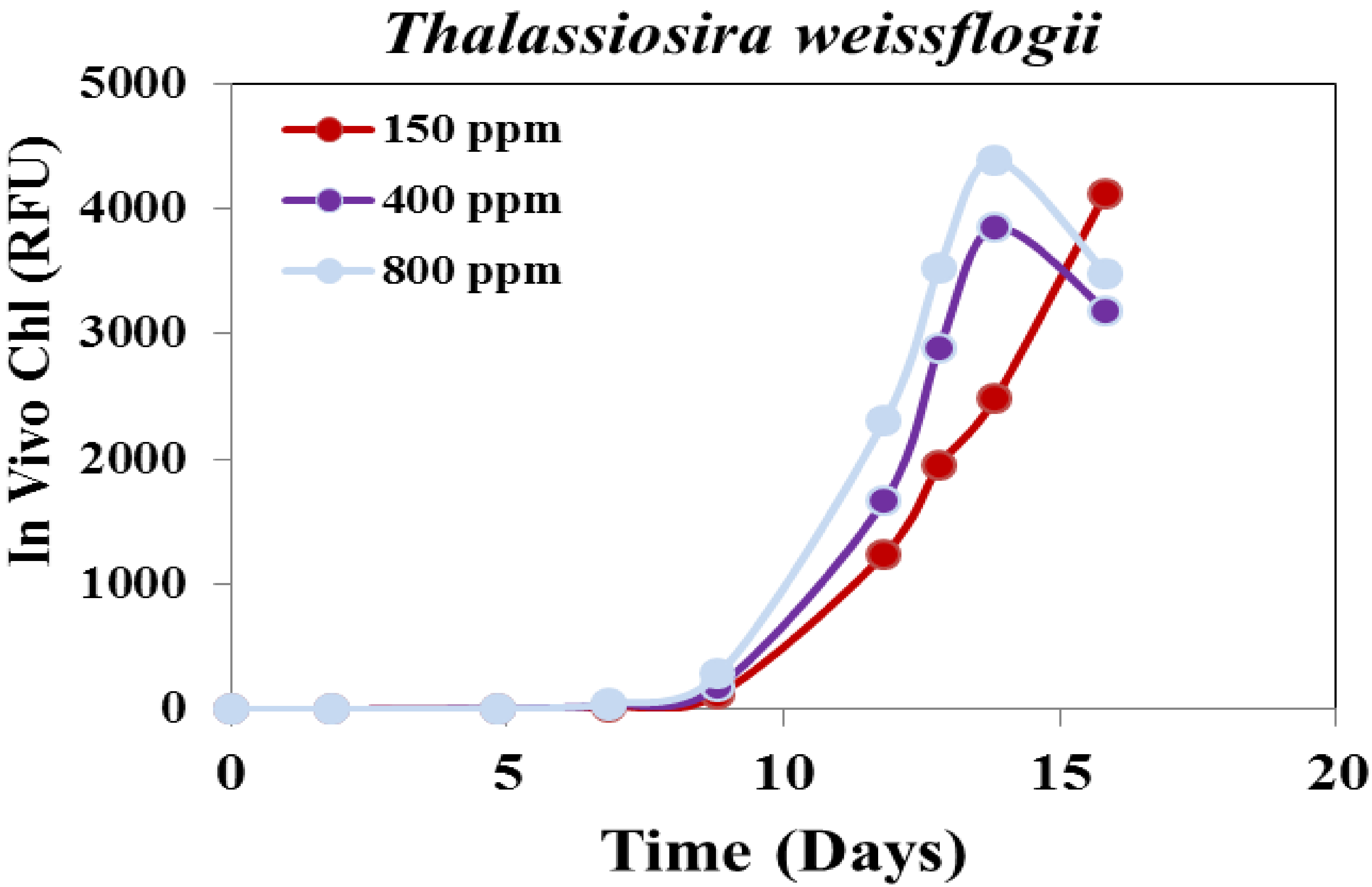
3) The wide range of variability in carbonic acid system of the Amazon River Plume makes it a perfect natural laboratory to study the effects of ocean acidification on marine phytoplankton



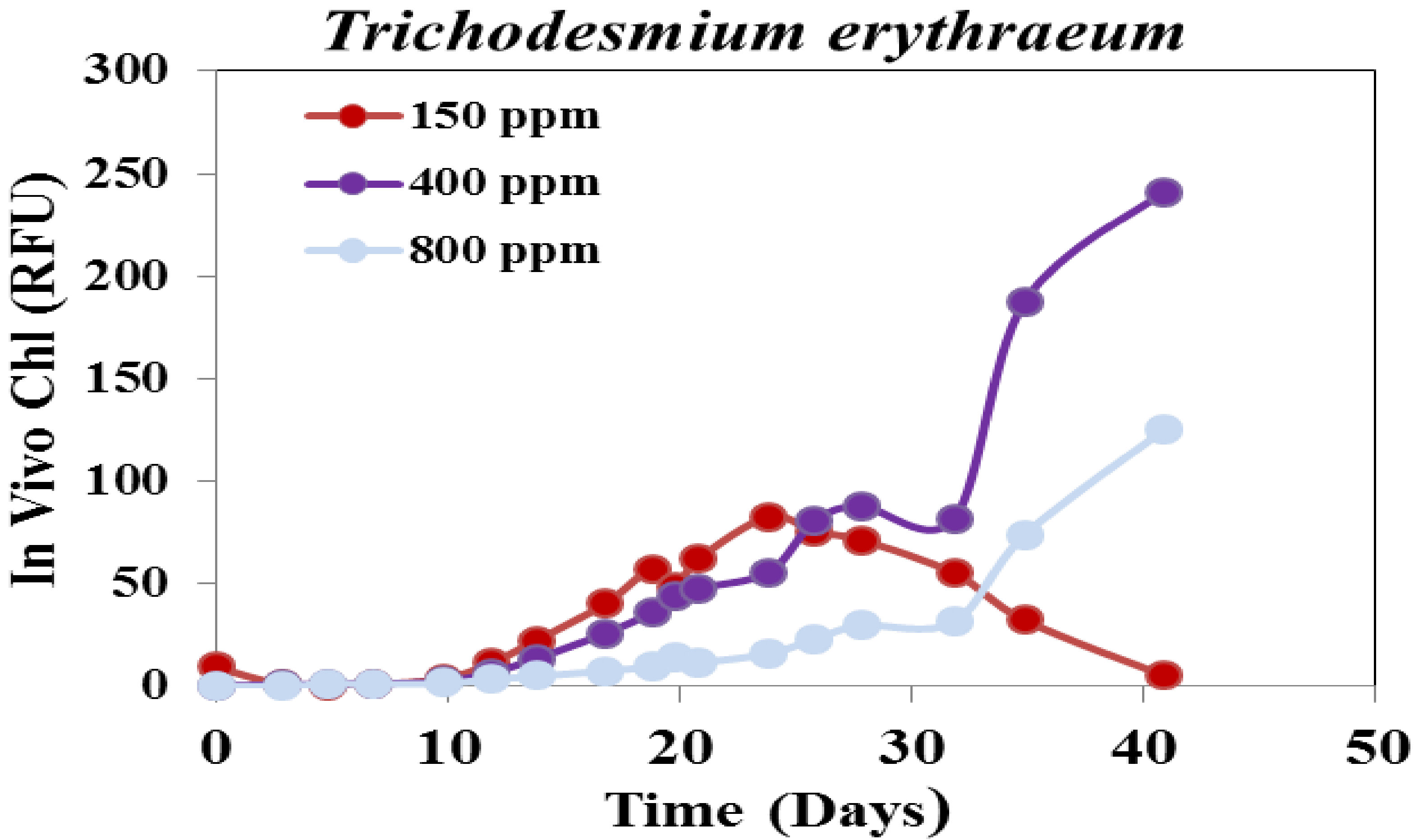
Phytoplankton biomass changes observed in shipboard *p*CO_2 manipulation experiments conducted with mesohaline waters of the Amazon River plume during cruise of 2011



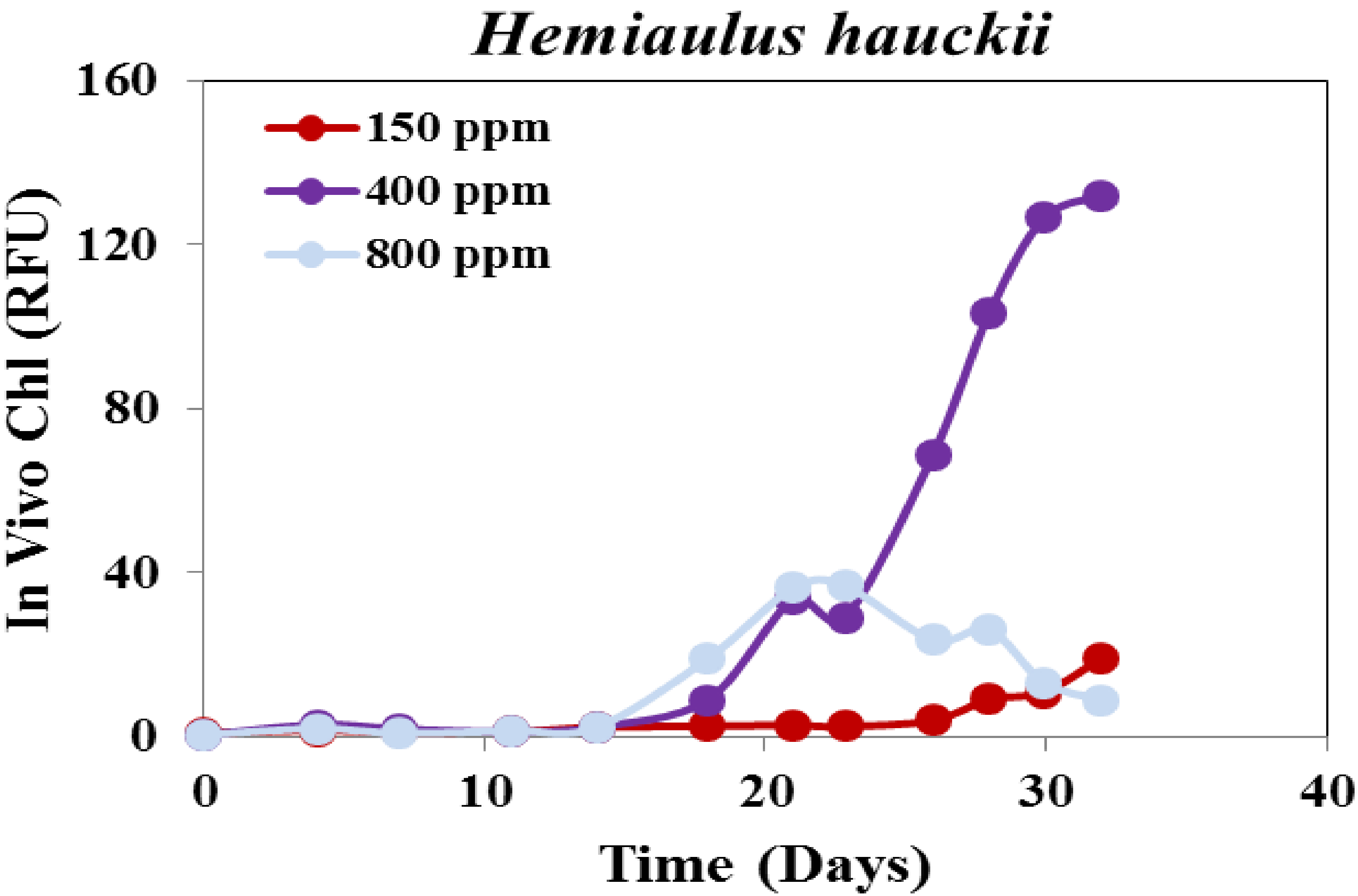
Phytoplankton biomass changes observed in shipboard pCO_2 manipulation experiments conducted with open ocean waters adjacent to the Amazon River plume.



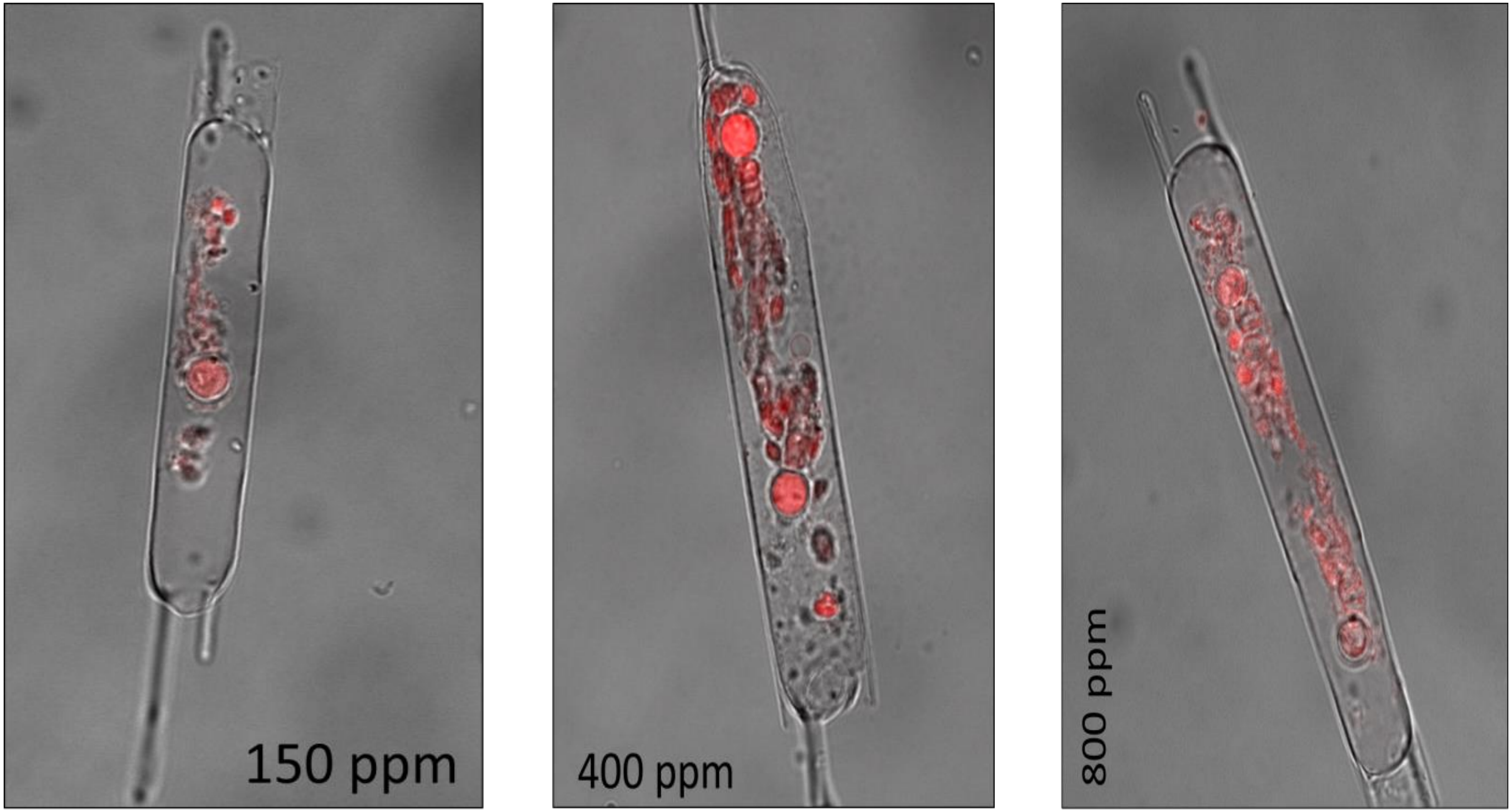
Results from laboratory experiments showing the growth response of *Thallasiosira* sp. (Diatom) to varying concentrations of pCO_2.



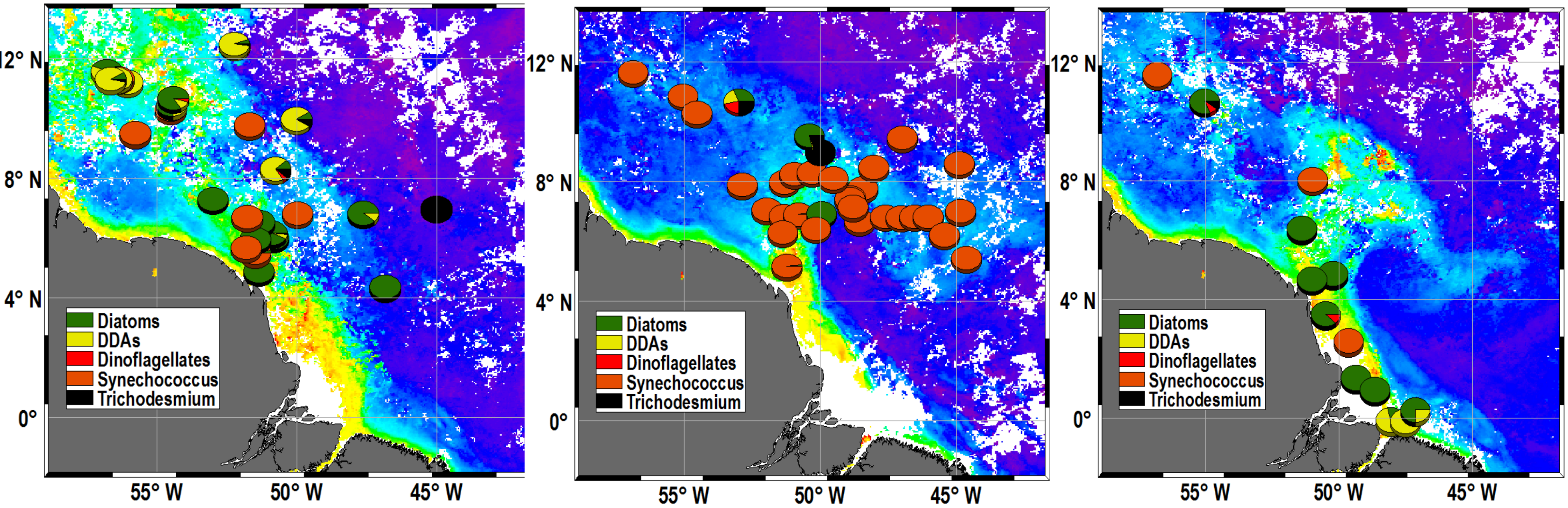
Results from laboratory experiments showing the growth response of *Trichodesmium* to varying concentrations of pCO_2.



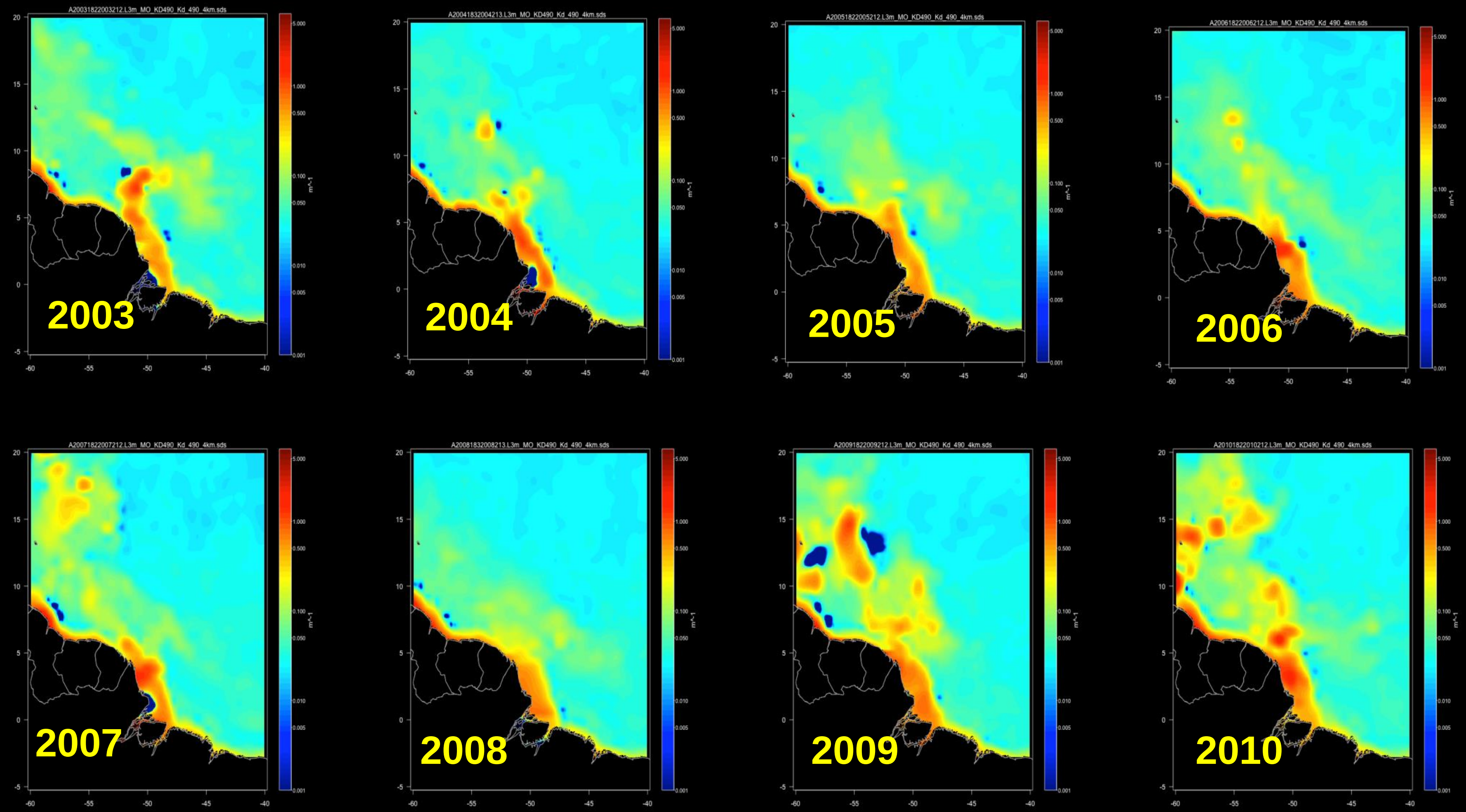
Results from laboratory experiments showing the growth response of *Hemiaulus hauckii* (DDA) to varying concentrations of pCO_2.



Confocal microscope changes in intracellular *Richelia* populations within *Hemiaulus hauckii* when exposed to different CO_2 levels



Seasonal shifts in the distribution of major phytoplankton groups in the Amazon River Plume

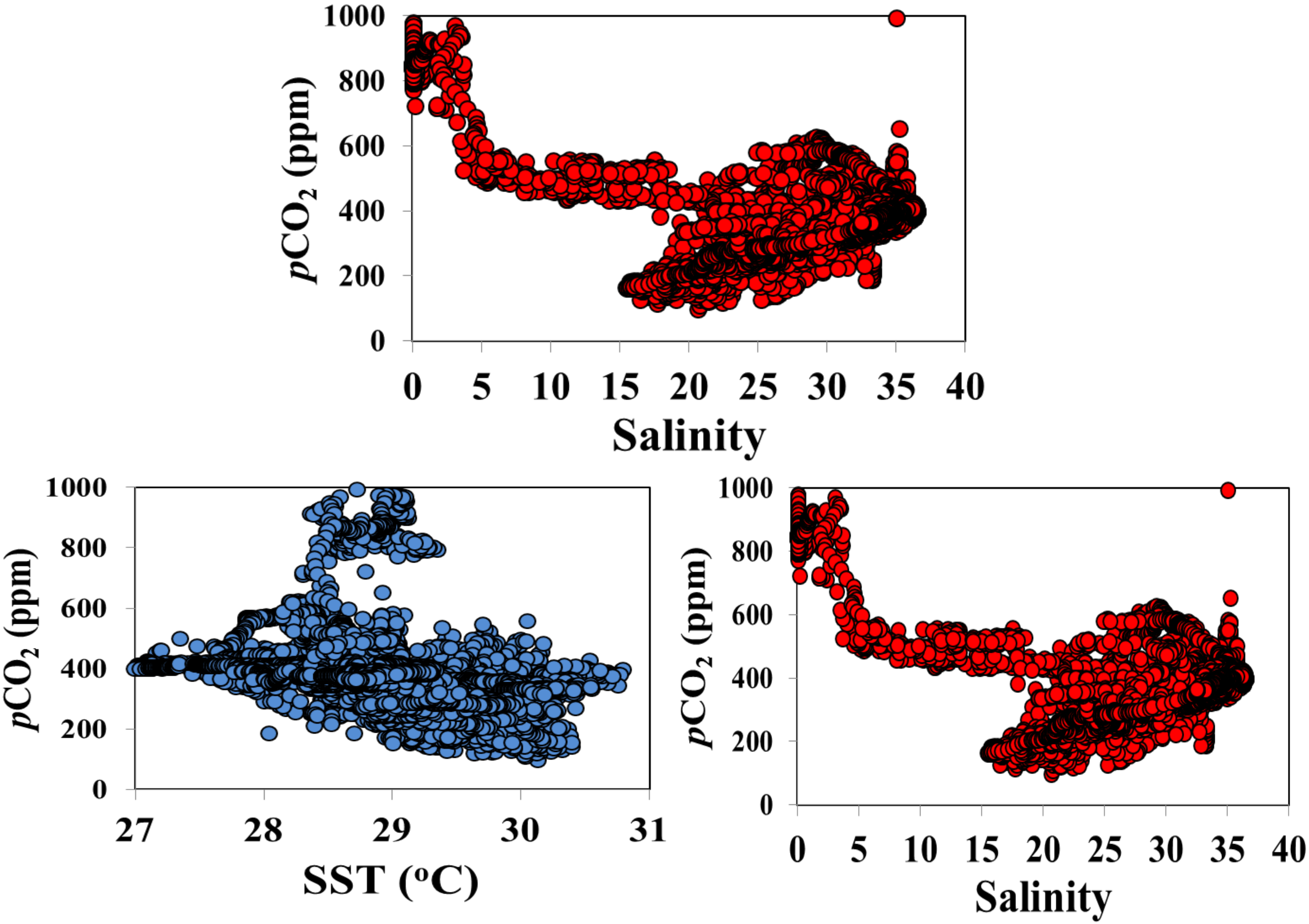


MODIS-Aqua K_d490 for the month of May showing Interannual variability of the size of the outflow of the Amazon River Plume

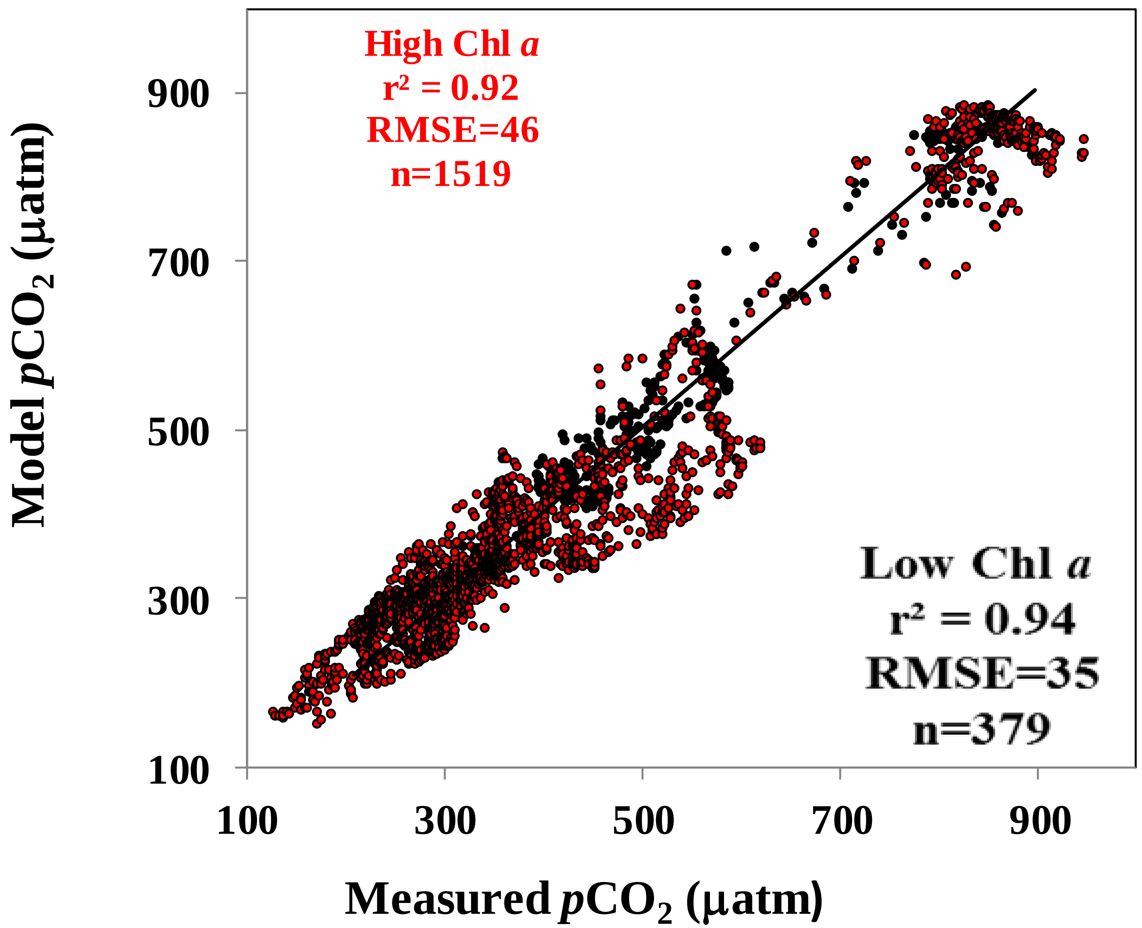
Can remote sensing data be utilized to study:

- **the carbonic acid system and its impact on phytoplankton distribution in the Amazon River Plume?**

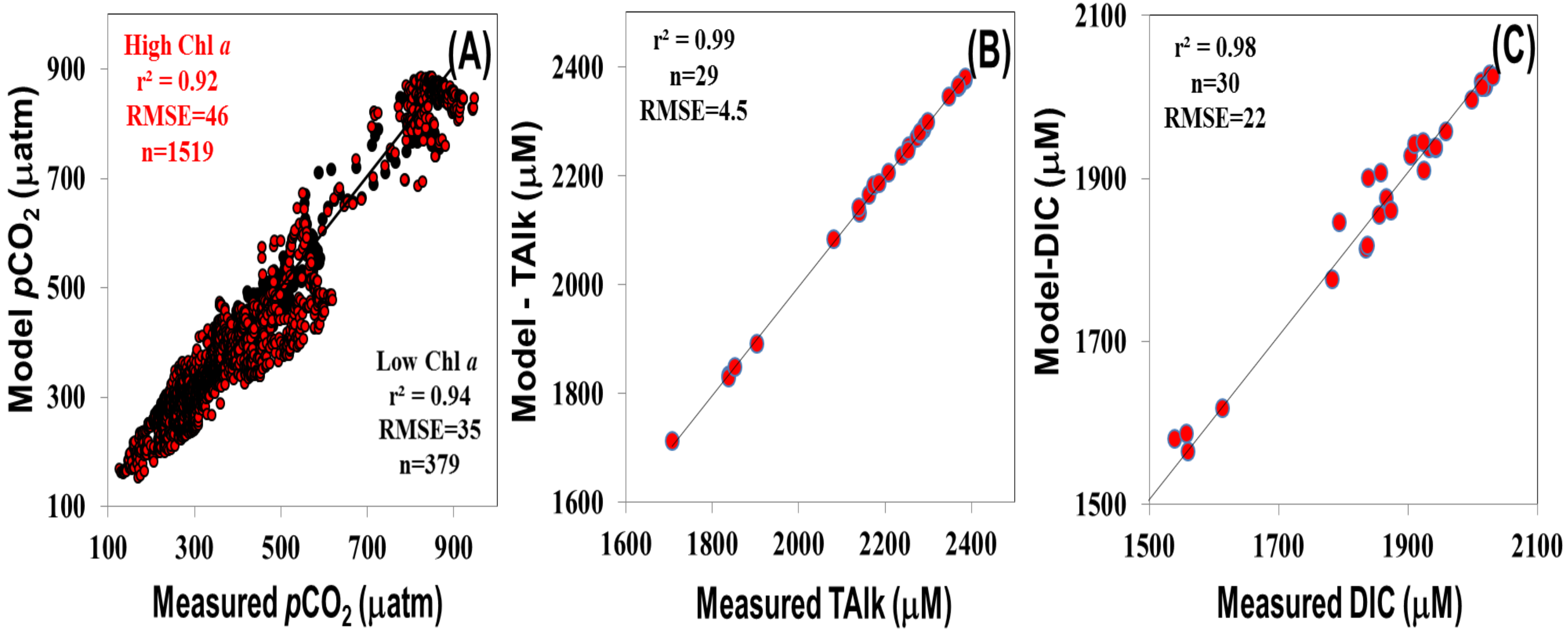
- **Inter-annual changes in the *p*CO_2 gradient and phytoplankton community structure across Amazon River plume due to changes in river discharge**



Relationship of pCO_2 to remotely sensed proxies .



Shipboard pCO_2 versus satellite derived pCO_2



Comparisons of shipboard measured and modeled estimates of
A) near surface *p*CO_2 obtained as a function of SSS, SST and Chl *a*
B) DIC obtained as a function of SST and SSS and
C) TAlk obtained as a function of SSS and SST).

WORK IN PROGRESS

- **Bio-optical data collected during cruises is being used to develop phytoplankton functional type and phytoplankton size class algorithms**

ACKNOWLEDGMENTS

This work was funded by NASA and the NSF. We are specially thankful to Dr. Paula Bontempi for supporting this idea of studying the ocean acidification angle of this study