



The CARIACO Ocean Time-Series: two decades of biogeochemistry and ecological research to understand ocean and climate variability

F. Muller-Karger, L. Lorenzoni, E. Montes, C. Benitez-Nelson, M. Scranton, G. Taylor, R. Thunell, R. Varela, Y. Astor, and many, many others

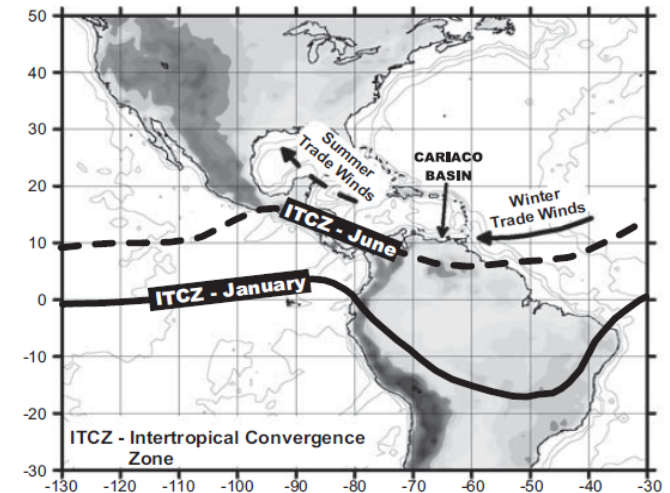


The CARIACO Ocean Time-Series

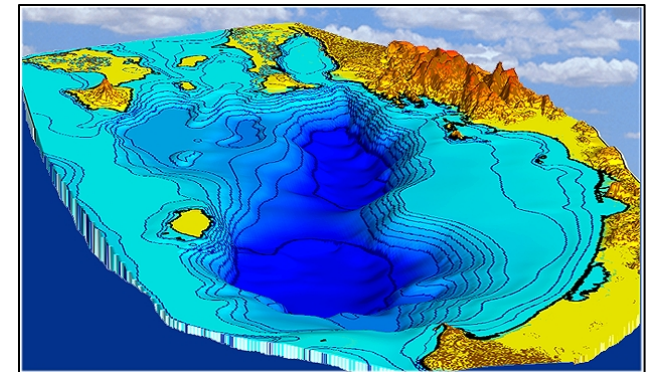
- 1995-present



- The Cariaco Basin: large tectonic depression located on the continental shelf off E. Venezuela
- Strong seasonality:
 - ITCZ migration leads to:
 - Dry, upwelling conditions / Dec-May
 - Rainy, reduced upwelling / Aug-Nov
- Restricted circulation and high primary production ($>400 \text{ gC/m}^2/\text{y}$)
➔ anoxic below $\sim 250\text{m}$



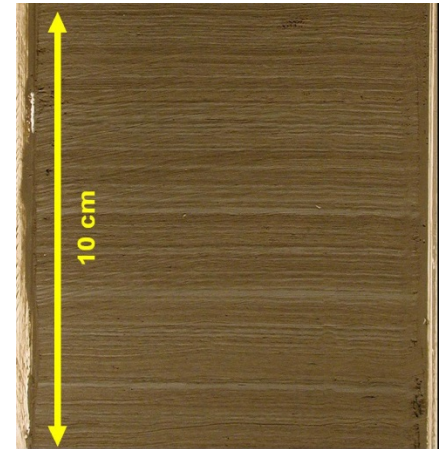
Goñi et al., 2009



<http://imars.marine.usf.edu/cariaco>

The CARIACO Ocean Time-Series

Sediment at bottom of Cariaco Basin is 'varved': composition and quantity changes under varying ocean surface conditions (>600,000 year record)

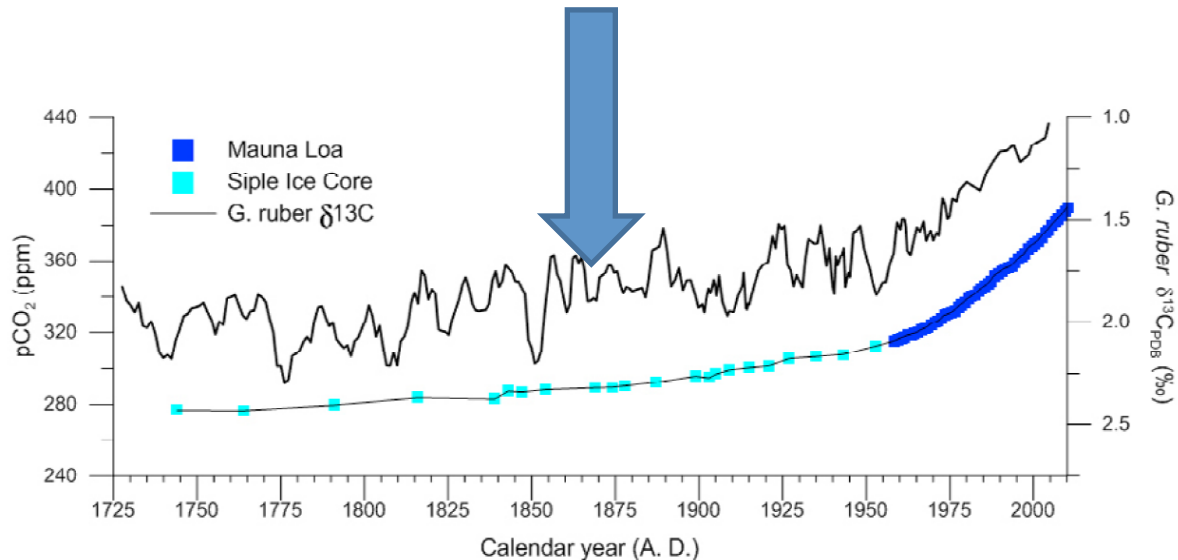


- Important implications for the paleoclimate record (light/dark laminae)



The CARIACO Ocean Time-Series

Coccolithophores in sediment shows dilution of ^{13}C isotope due to anthropogenic fossil fuel combustion since 1800's

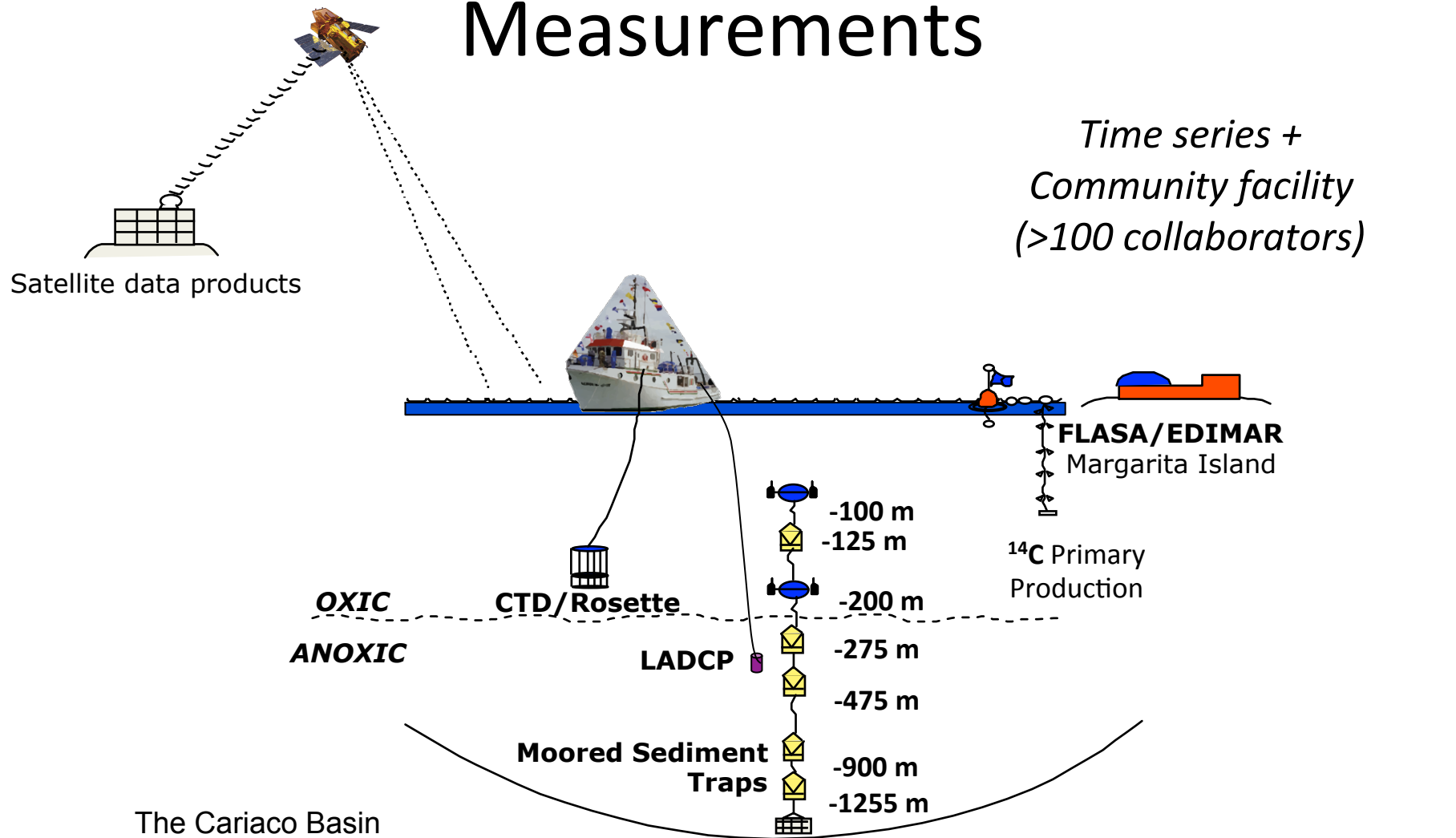


Black et al., 2011

The CARIACO Ocean Time-Series: Objectives

- Understand the variability in the composition and quantity of settling particles related to
 - Ecology
 - Ocean chemistry
 - Terrigenous inputs
 - Hydrography
- Identify links between local ecosystem changes and regional/global climate processes.
- Deconvolve bacterial production and carbon decomposition across the oxic-anoxic interface

The CARIACO Ocean Time-Series: Measurements



CARIACO cruises and data policy

Since Nov 1995:

222 core cruises (September 2015)

39 sediment trap and current meter recovery-redeployment cruises

29 biogeochemical and microbial process cruises

6 regional cruises

Policy for open and public sharing of samples, data, and information

CARIACO Methods Manual
(Spanish and English)

<http://cariaco.ws> (Spanish)

<http://www.bco-dmo.org/project/2047>

<http://imars.marine.usf.edu/cariaco> (English)



The screenshot shows the website of the Institute of Marine Remote Sensing (IMARS) and the Biological and Chemical Oceanography Data Management Office (BCO-DMO). The main header includes the IMARS logo and the text "Institute of Marine Remote Sensing". Below this is a navigation bar with links: HOME, SATELLITE IMAGERY, PROJECTS, EDUCATION, IMARS TEAM, and CONTACT IMARS. The main content area is titled "CARIACO Ocean Time-Series Program" and "PROYECTO CARIACO". It features a search bar, a sidebar with a list of links, and a main section with a table of statistics and a description of the program.

DATABASE	
Programs	34
Projects	574
Deployments	2148
Datasets	7648
Instruments	377
Parameters	1358
People	1899
Affiliations	444
Funding	68
Awards	1199

Project: CARIACO Ocean Time-Series Program

Acronym/Short Name: CARIACO
 Project URL: [Project Web Site](#)
 Start Date: 1995-11
 Geolocation: CARIACO basin
 Datasets: 10
 Collections: 10
 Deployments: 1
 Cruises: 1

Programs:

- Ocean Carbon and Biogeochemistry [OCB]
- U.S. Joint Global Ocean Flux Study [U.S. JGOFS]
- Ocean Time-series Sites [Ocean Time-series]

Description

Since 1995, the CARIACO Ocean Time-Series (formerly known as the CARbon Retention In A COLOred Ocean) Program has studied the relationship between surface primary production, physical forcing variables like the wind, and the settling flux of particulate carbon in the Cariaco Basin. This depression, located on the continental shelf of Venezuela (Map), shows marked seasonal and interannual variation in hydrographic properties and primary production (carbon fixation rates by photosynthesis of planktonic algae).

This peculiar basin is anoxic below ~250 m, due its restricted circulation and high primary production (Muller-Karger et al., 2001). CARIACO observations show annual primary production rates exceed 500 gC/m²y, of which over

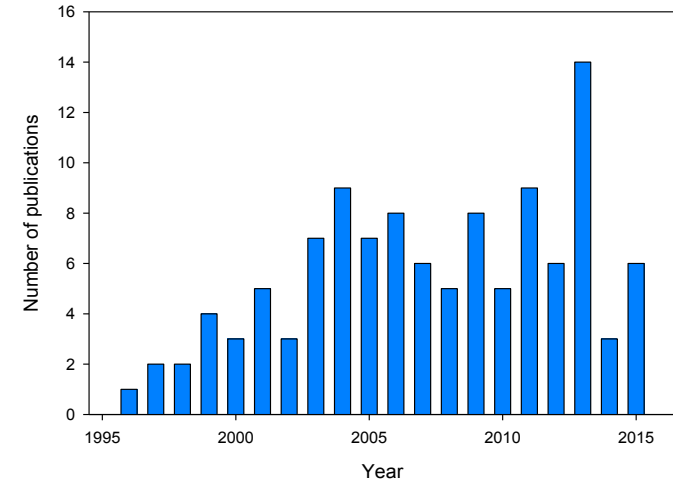
Publications

113 peer reviewed publications
through 09/2015

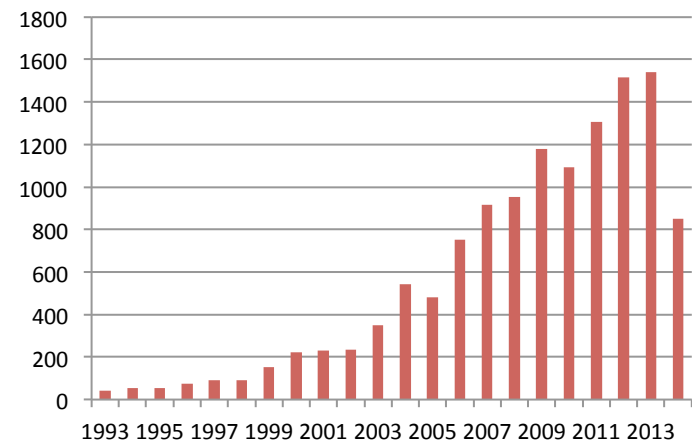
CARIACO as a community platform

>100 scientists from around the world
have participated or received data/
samples from the CARIACO program

>60 students have been supported
under CARIACO or have worked
directly with it

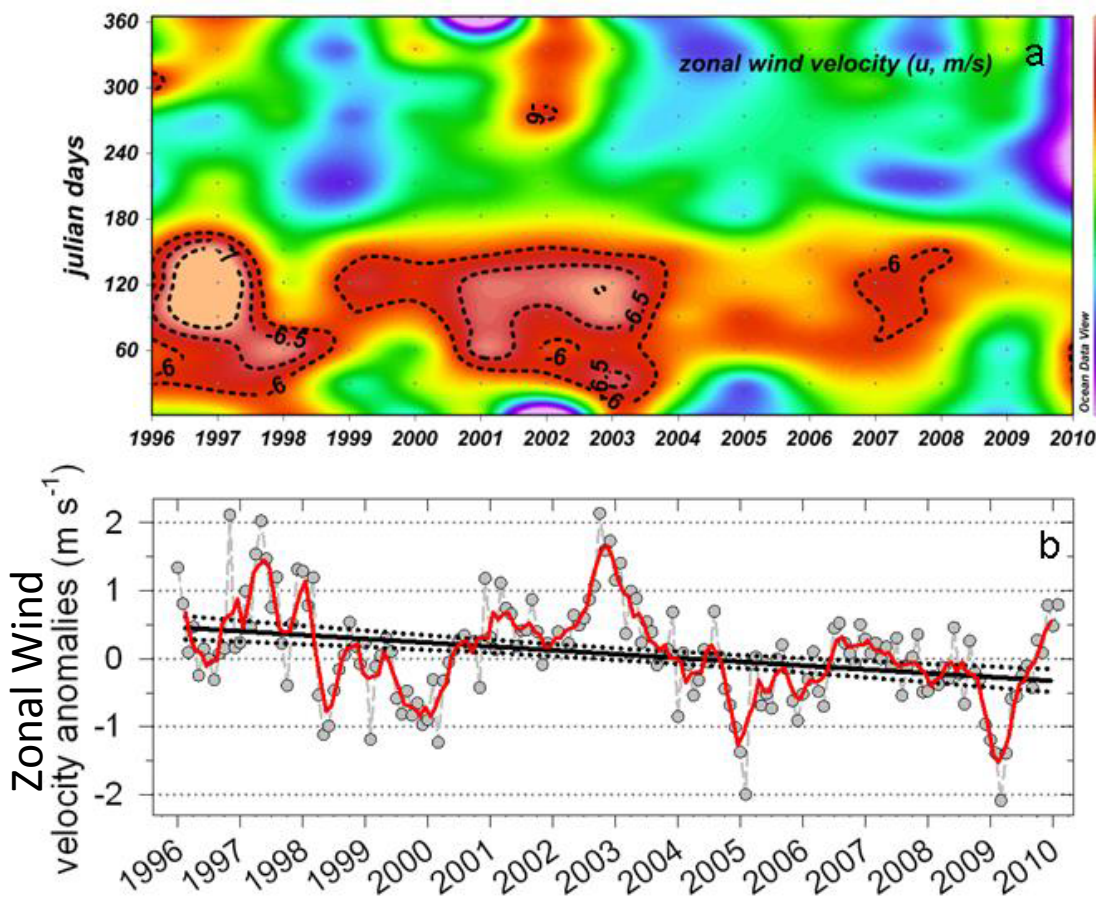


Number of publications generated by the CARIACO project.



Number of citations that include the 'Cariaco Basin' as a topic.

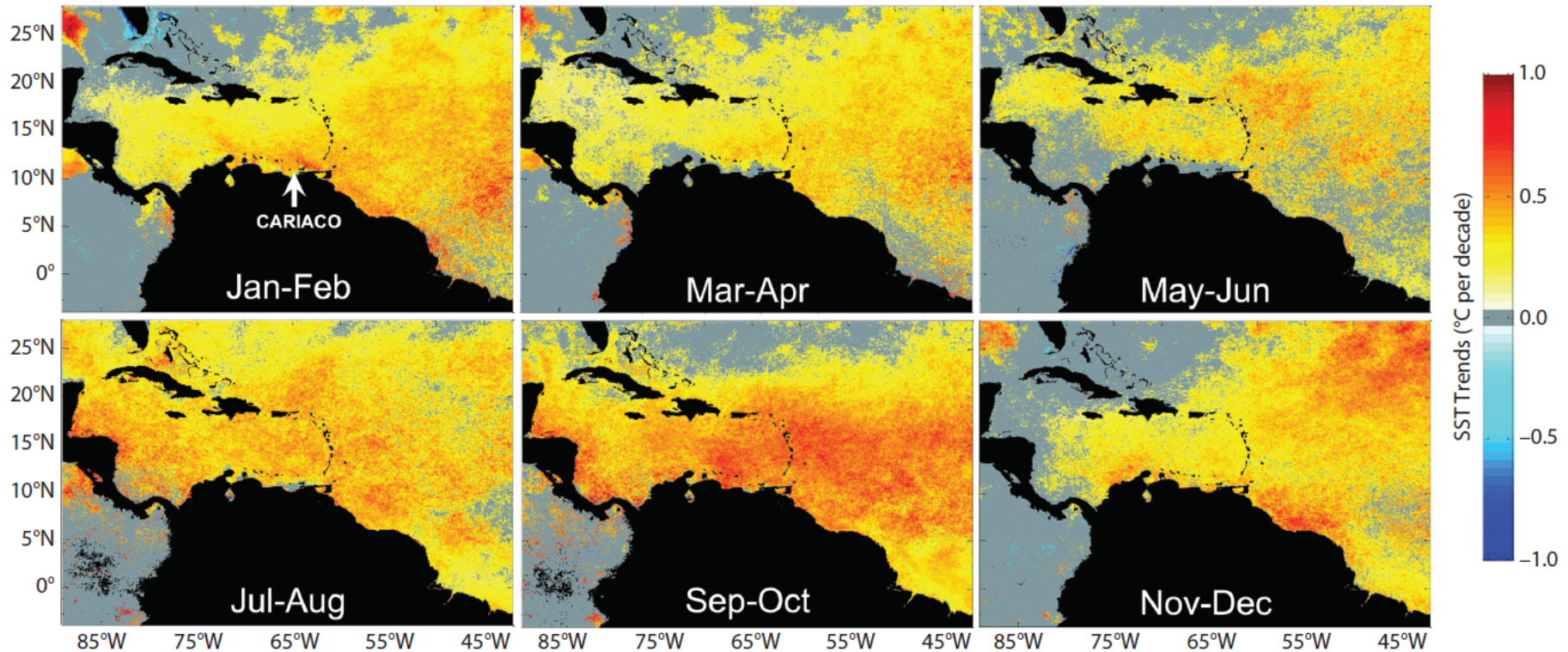
The CARIACO Ocean Time-Series: insights from 20 years of measurements



- Sea surface temperature increased $\sim 1\ ^\circ\text{C}$ since 1995.
- Net Primary Production has decreased $\sim 20\%$
- Ecosystem shift: from larger to smaller phytoplankton cells; increase in zooplankton biomass.
- Change in the Trade Winds and upwelling intensity

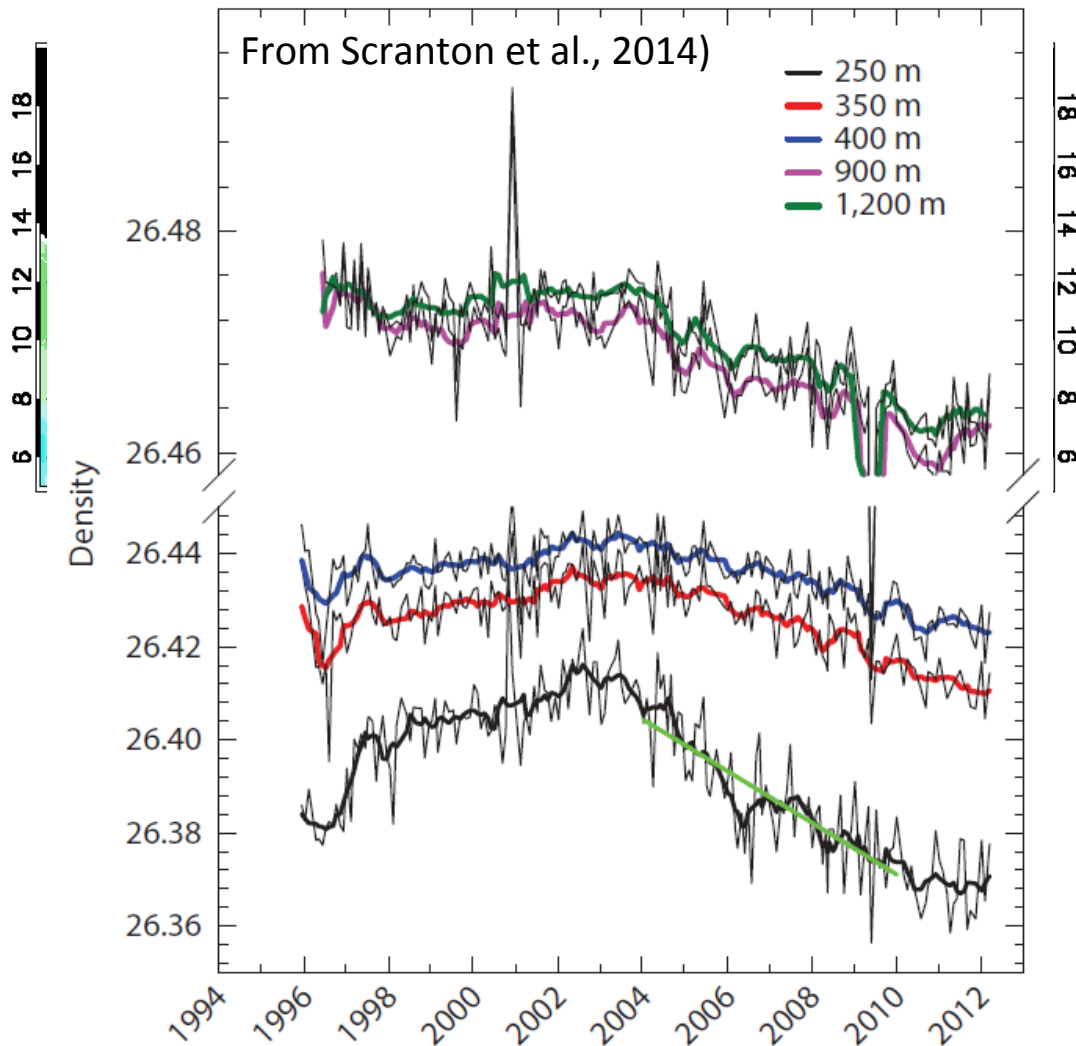
From Taylor et al., 2012

The CARIACO Ocean Time-Series: insights from 20 years of measurements



- Tropical western North Atlantic has also warmed; CARIACO is representative of SST and Chl changes in the Tropical Atlantic.
- Southern Caribbean change of ~ 0.5 C per decade because of diminished upwelling

The CARIACO Ocean Time-Series: insights from 20 years of measurements



- Circulation and ventilation of Cariaco Basin impacted by eddies.
- Decrease in ventilation of anoxic waters since 2004.
- Decrease in intrusions of denser Caribbean water caused decreasing density (dominance of vertical mixing)

CARIACO: where are we now?

- Documents physical and ecosystem changes over the past 20 years.
- Provides records of net primary production (NPP) variability and export fluxes in a tropical, upwelling-dominated continental margin.
- CARIACO captures changes that occur at larger spatial scales (e.g. tropical North Atlantic)
- Data are open and free <http://imars.marine.usf.edu/cariaco>

CARIACO: where are we going?

- High temporal resolution, long-term measurements, needed to quantify relationships between carbon production, export, and seasonal to climate-scale change.
- Understanding the relationship between physical drivers and biogeochemistry at CARIACO is important for reconstructing past ocean and climate conditions using the basin's sediment record.