In situ research in support of ocean color

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Thanks also to:

Stéphane Maritorena, Craig Carlson, UCSB

Mike Lomas, Natasha McDonald BIOS

Stan Hooker, Aimee Neely GSFC

John Morrow, BSI

Current Projects

- **BBOP** – Time series off Bermuda
- **CLIVAR** – Global long-section survey
- **Plumes and Blooms** – Time series in the Santa Barbara Channel
- **NSPB** – (NSF funded) next-gen in situ radiometer package for use at BBOP and elsewhere
- **Carbon flux study** (beginning 2011)

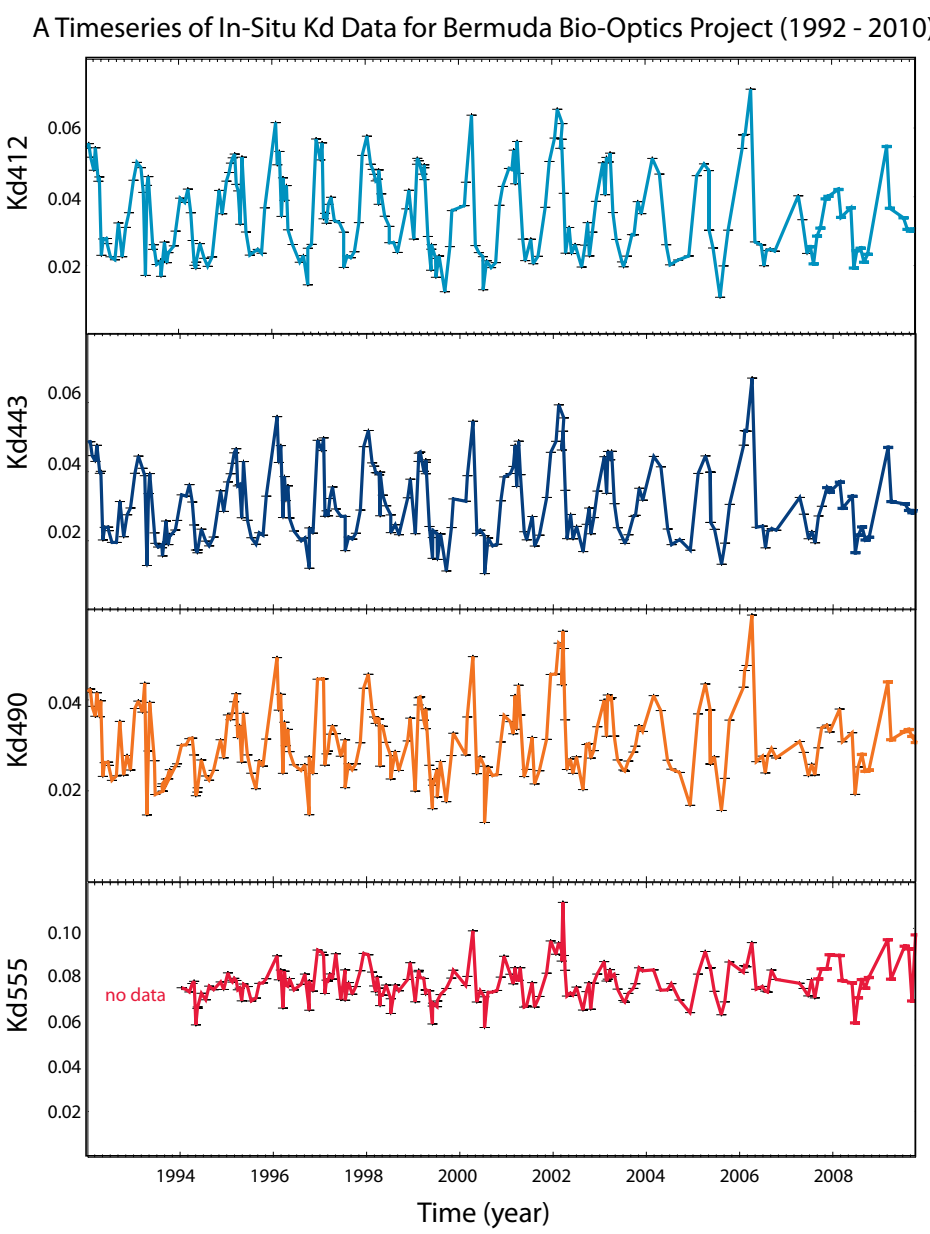
Bermuda Bio-Optics Project

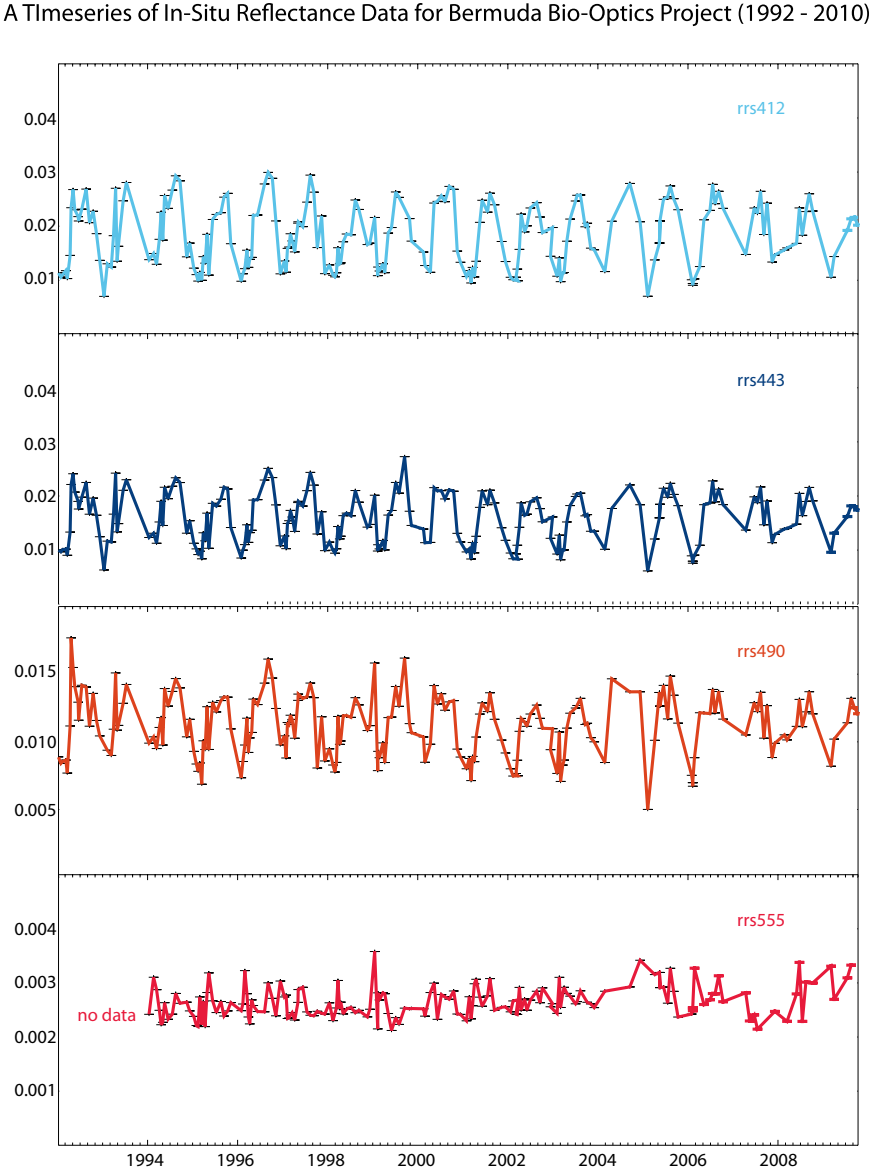
- Since 1992 Monthly to 2x monthly at the BATS site 65 miles SE of Bermuda, piggybacking on BATS cruises
  - Multichannel spectroradiometer profiles (Ed, Lu, Es)
  - Bottle sample component absorption spectra (ag, ap, ad)
- Annual meridional sections across Sargasso Sea

Bermuda Bio-Optics Project
Science Goals

- Climate - ecosystem connections
  Decadal - scale changes in optical observables (CDOM, phytoplankton) related to local and regional processes, climate oscillators

- Ocean color product validation
  Reflectance, chlorophyll, absorption


A Timeseries of In-Situ Kd Data for Bermuda Bio-Optics Project (1992 - 2010)
Kd412
Kd443
Kd490
Kd555
no data
Time (year)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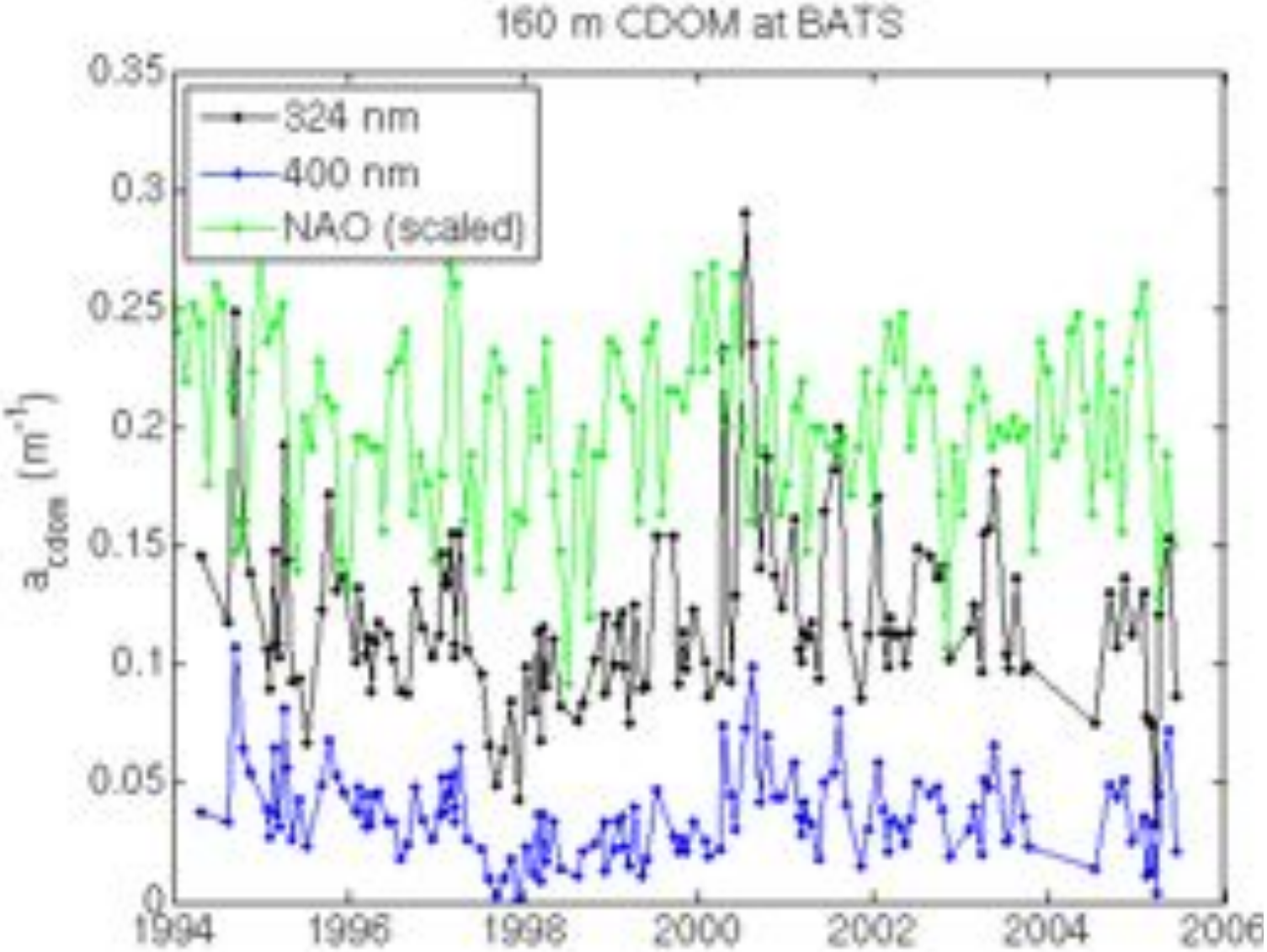
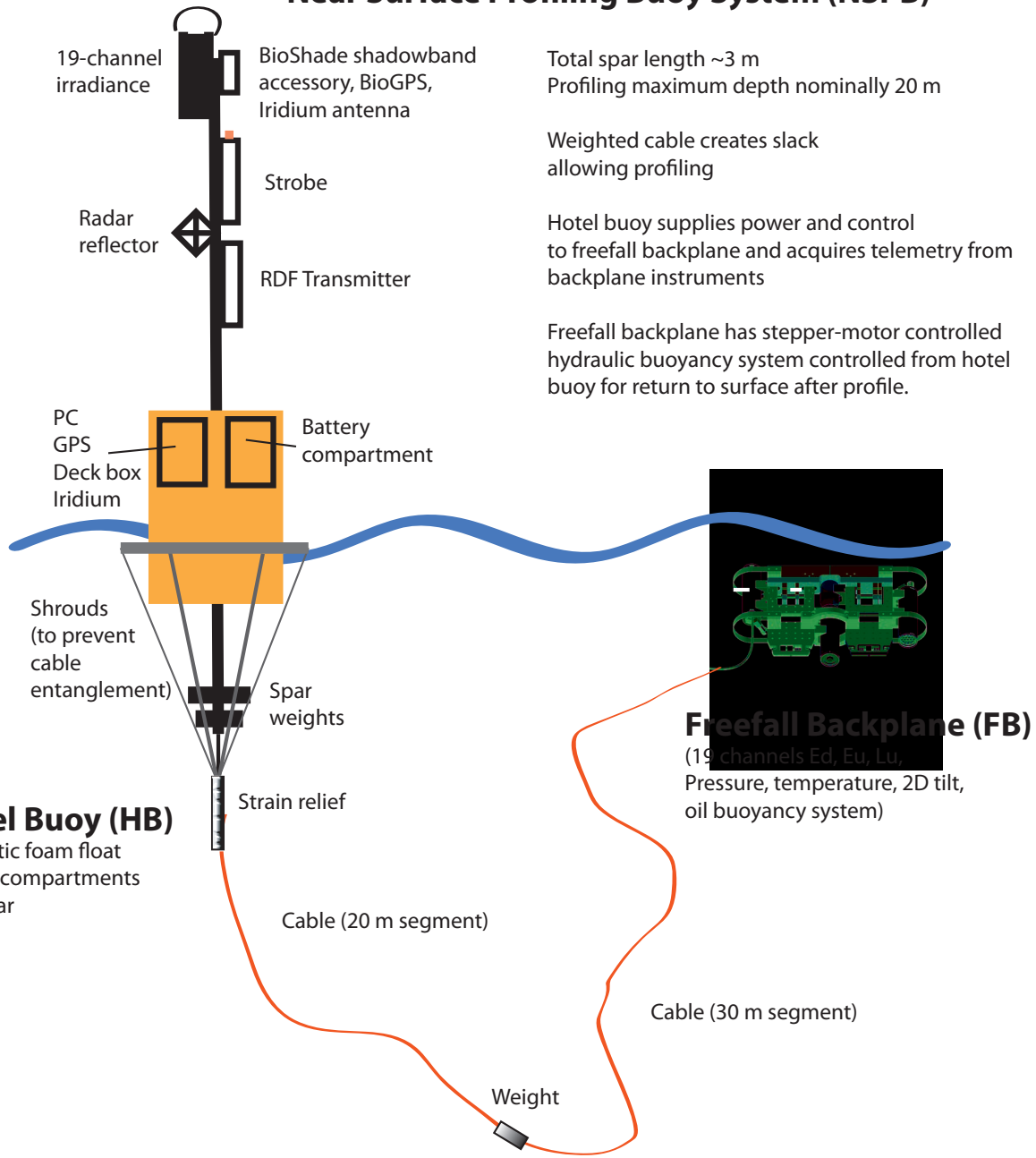
rrs443
rrs490
rrs555
no data


160 m CDOM at BATS
324 nm
400 nm
NAO (scaled)
a_{cdom} (m^{-1})
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1994
1996
1998
2000
2002
2004
2006

NSPB - Near Surface Profiling Buoy

- "Wire time" at a premium on time series studies - interactions with overpass times, clouds, etc. adding up to fewer valid profiles
- In response NSPB now under development (NSF instrumentation funds) UCSB / BSI / GSFC
- Drifting 'hotel' buoy with tethered profiler (active buoyancy control)
- Instrumentation includes Ed, Lu, Eu, Es + shadowband, BSI microradiometer tech
- Emphasis on surface optical properties, f/Q

Near Surface Profiling Buoy System (NSPB)



Total spar length ~3 m
Profiling maximum depth nominally 20 m

Weighted cable creates slack allowing profiling

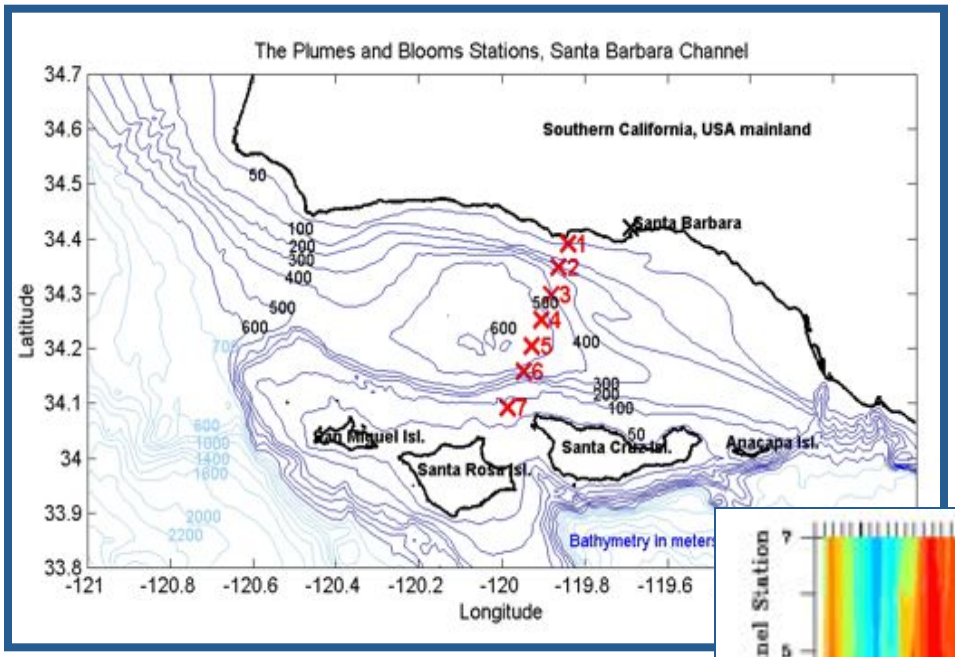
Hotel buoy supplies power and control to freefall backplane and acquires telemetry from backplane instruments

Freefall backplane has stepper-motor controlled hydraulic buoyancy system controlled from hotel buoy for return to surface after profile.

Plumes & Blooms

- Understand, predict & utilize changes in ocean color in the Santa Barbara Channel
- Monthly day cruises (7 stations w/ CINMS' ship)
- Field observations started in 1996
- Measurements
  - CTD/optics ($L_{wN}(\lambda)$, $a(\lambda)$, $b(\lambda)$, $b_{bb}(\lambda)$, PSD, etc.)
  - NUTs, Chl, HPLC pigments, DOC, DIC, pSi, etc.
  - LAC satellite imagery analysis
  - Glider obs starting this summer (w/ SBC LTER)

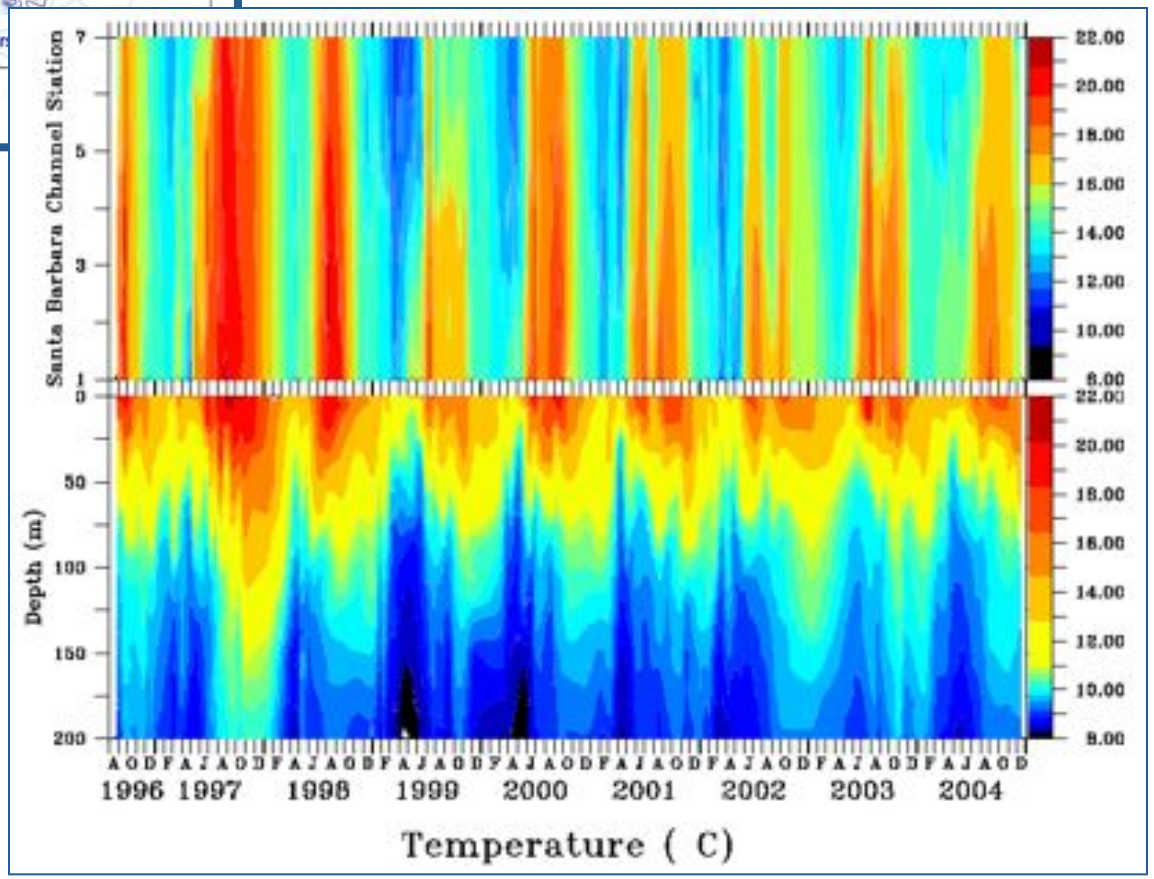
PnB Sampling Program



Cross-channel SST
(Station 1 off Campus Point)

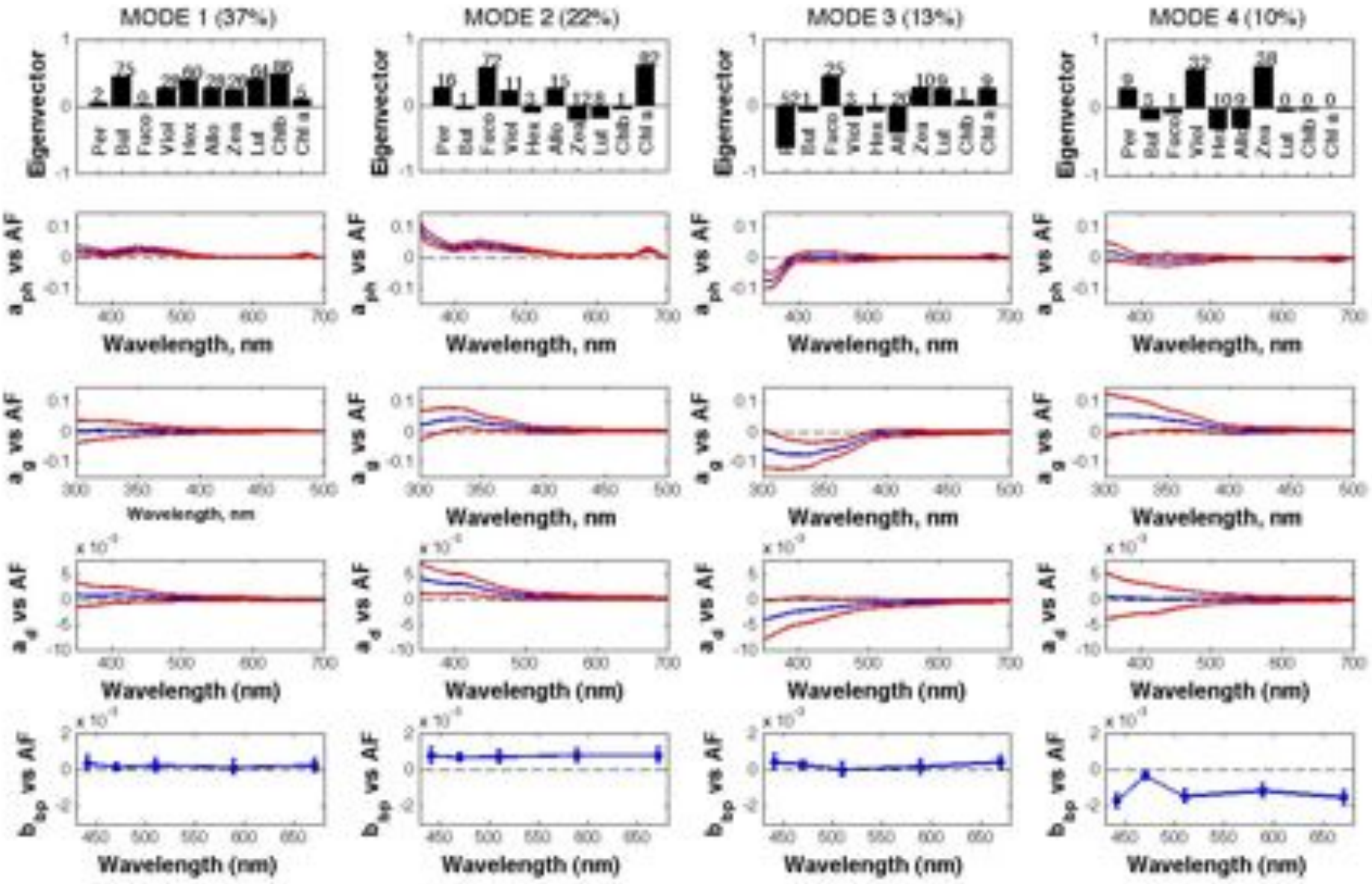
Station 4 Profile
(channel center)

www.icess.ucsb.edu/PnB



Relationship between PFT EOF Amplitudes & IOP's

Nano's | Micro's | Diatoms vs Dino's | Pico's



PnB PFT Modeling Results

- EOF analyses provides straight-forward way of distinguishing Phytoplankton Functional Types
- Preliminary assessment of the relationship to ocean color relevant IOP's

  Suggests a coupling between PFT's & all IOP's - not just for phytoplankton absorption

  Interesting UV absorption signals with dino/diatom mode

  Building blocks for future PFT algorithms

CLIVAR Ocean Color

(originally Global CDOM Project)

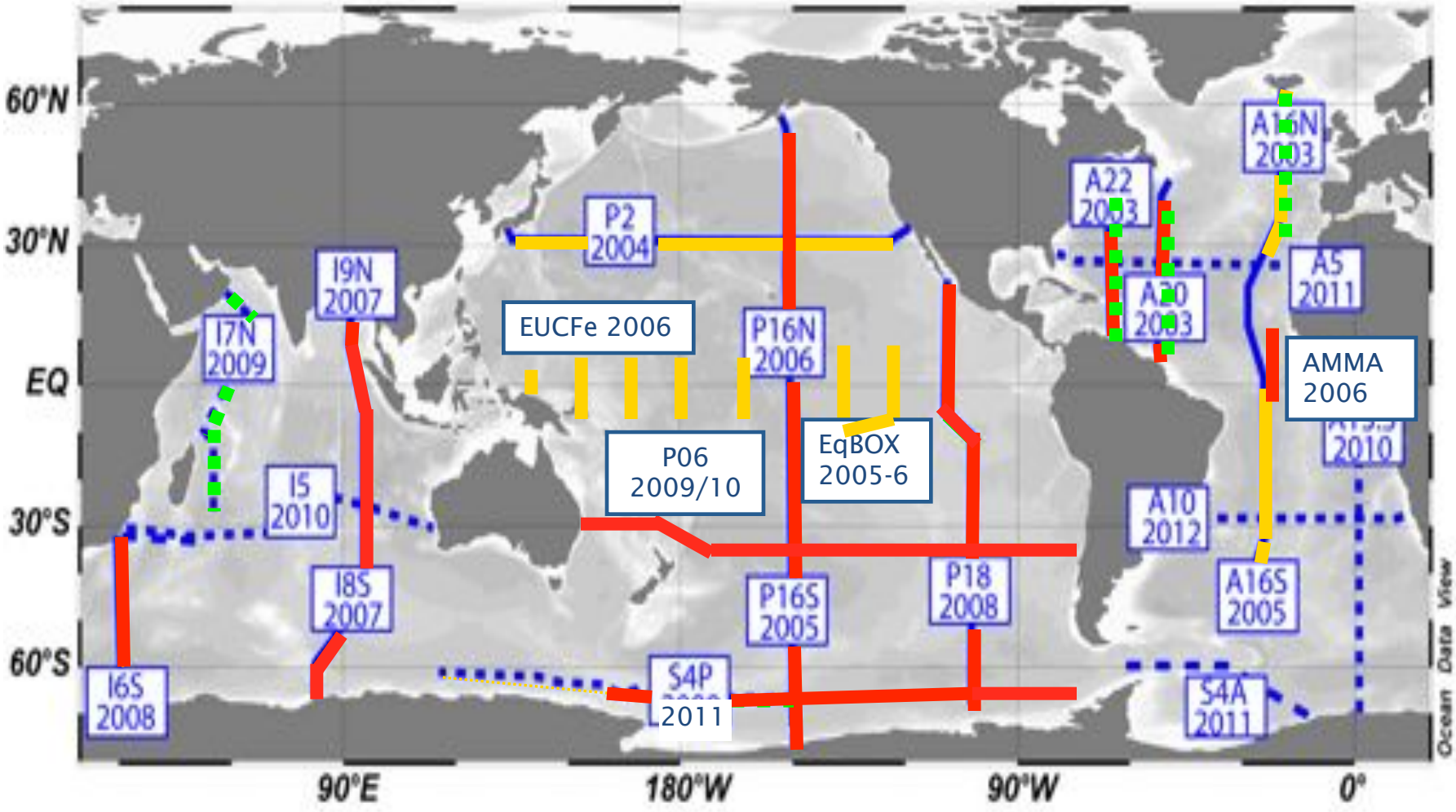
- Piggybacking on U.S. CO_2/CLIVAR Repeat Hydrography sections (all oceans except Arctic)
- Daily spectroradiometer casts
- Bottle samples incl. CDOM profiles, HPLC, particulate absorption
- New: Alongtrack system with switching filter for particle optical properties including bbp and ap spectra, LISST-100X(B) on next deployment
- Collaborators - ship CDOM / other samples to us from cruises of opportunity

CLIVAR Ocean Color
Science Goals

- Global CDOM distribution and dynamics (surface and deep ocean)
- Microbial community structure - connections with optics and physical processes
- Assembling data for algorithm development - new ocean color products

Global CDOM Project Sections

(primarily CO_2/CLIVAR Repeat Hydrography)



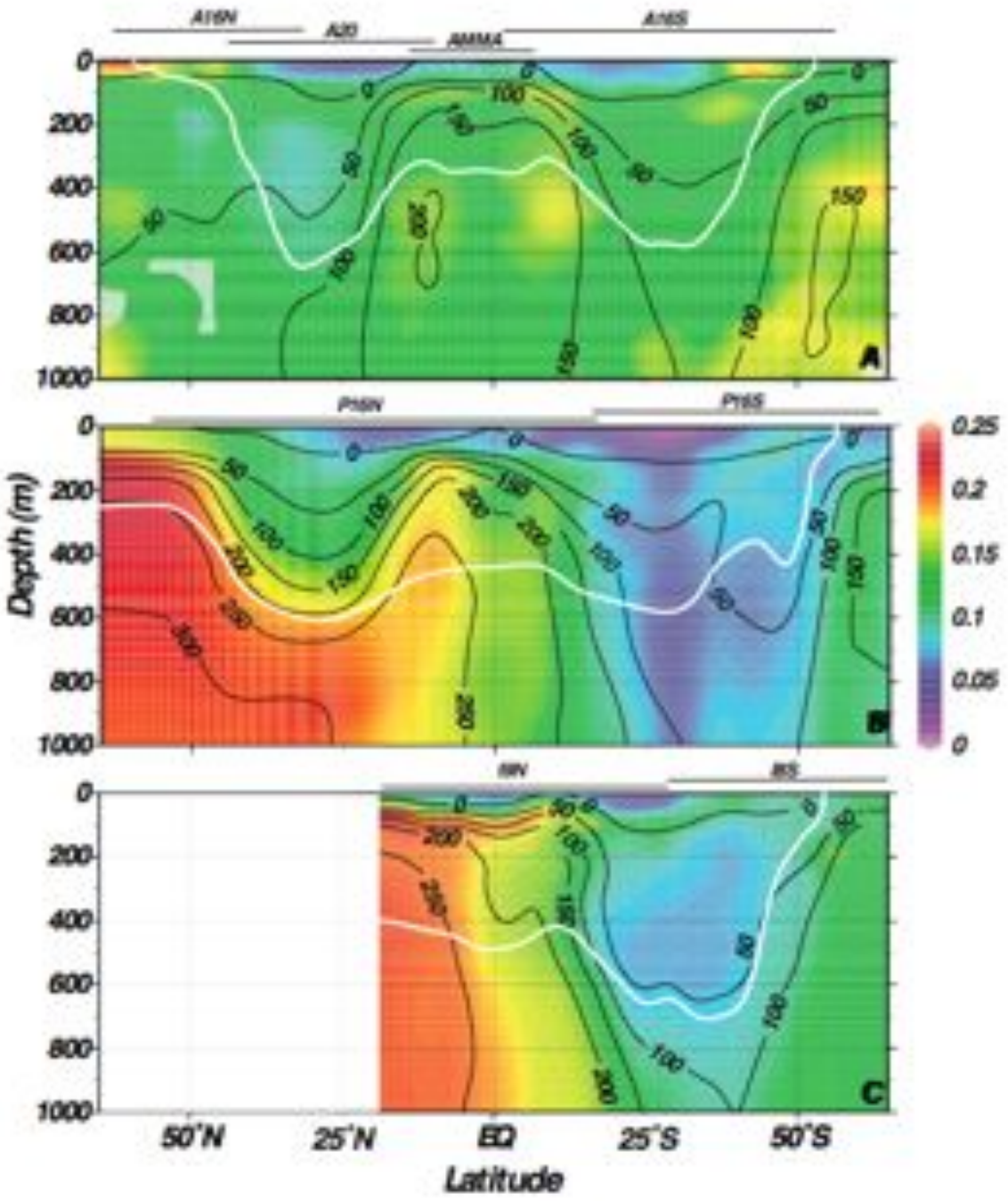
Completed (full measurement set including CDOM, microbes, optics)

Completed (limited measurement set, CDOM and hydrography)

Future (in planning)

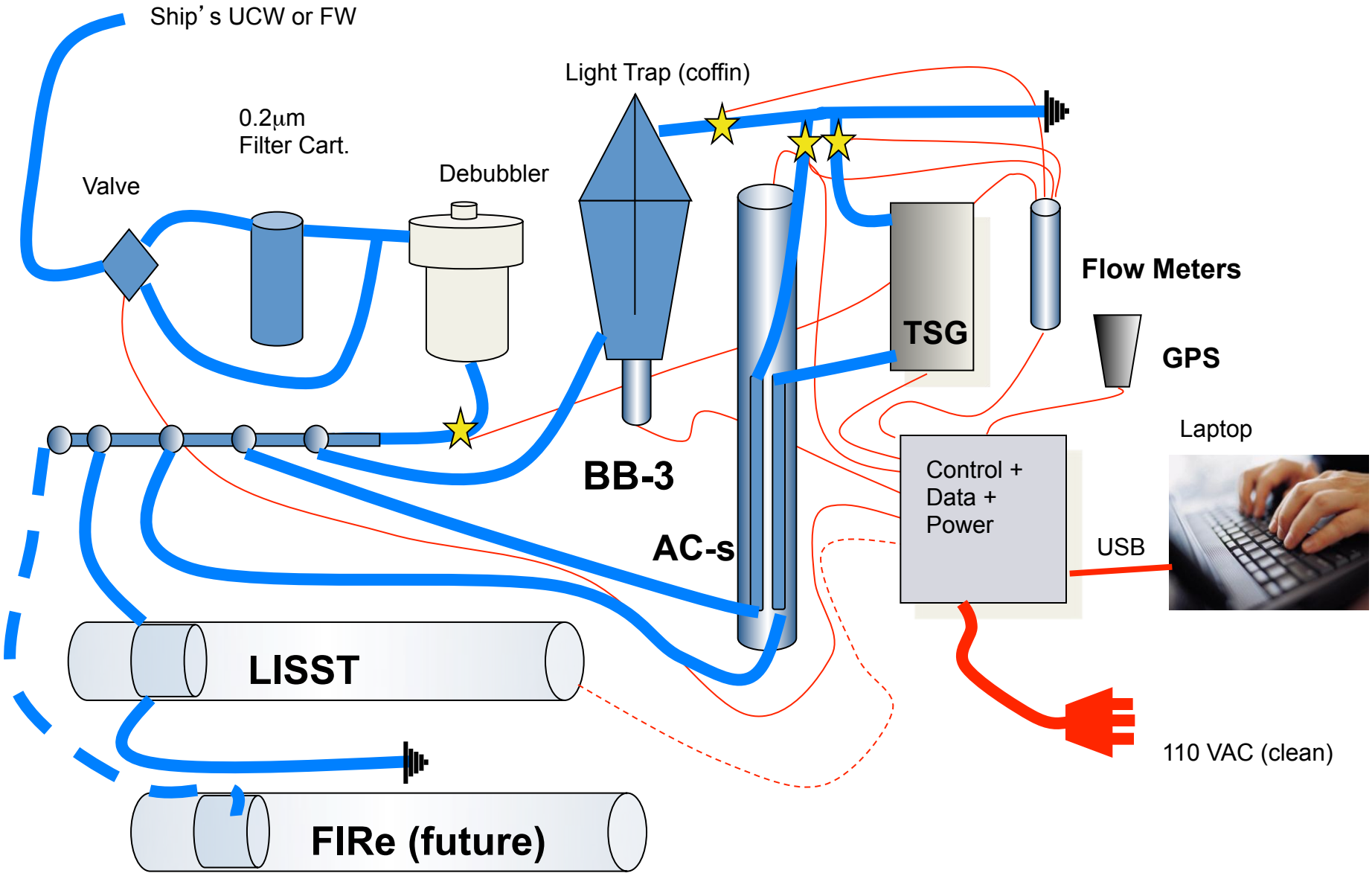
CDOM and AOU Distribution

- Atlantic
- Pacific
- Indian

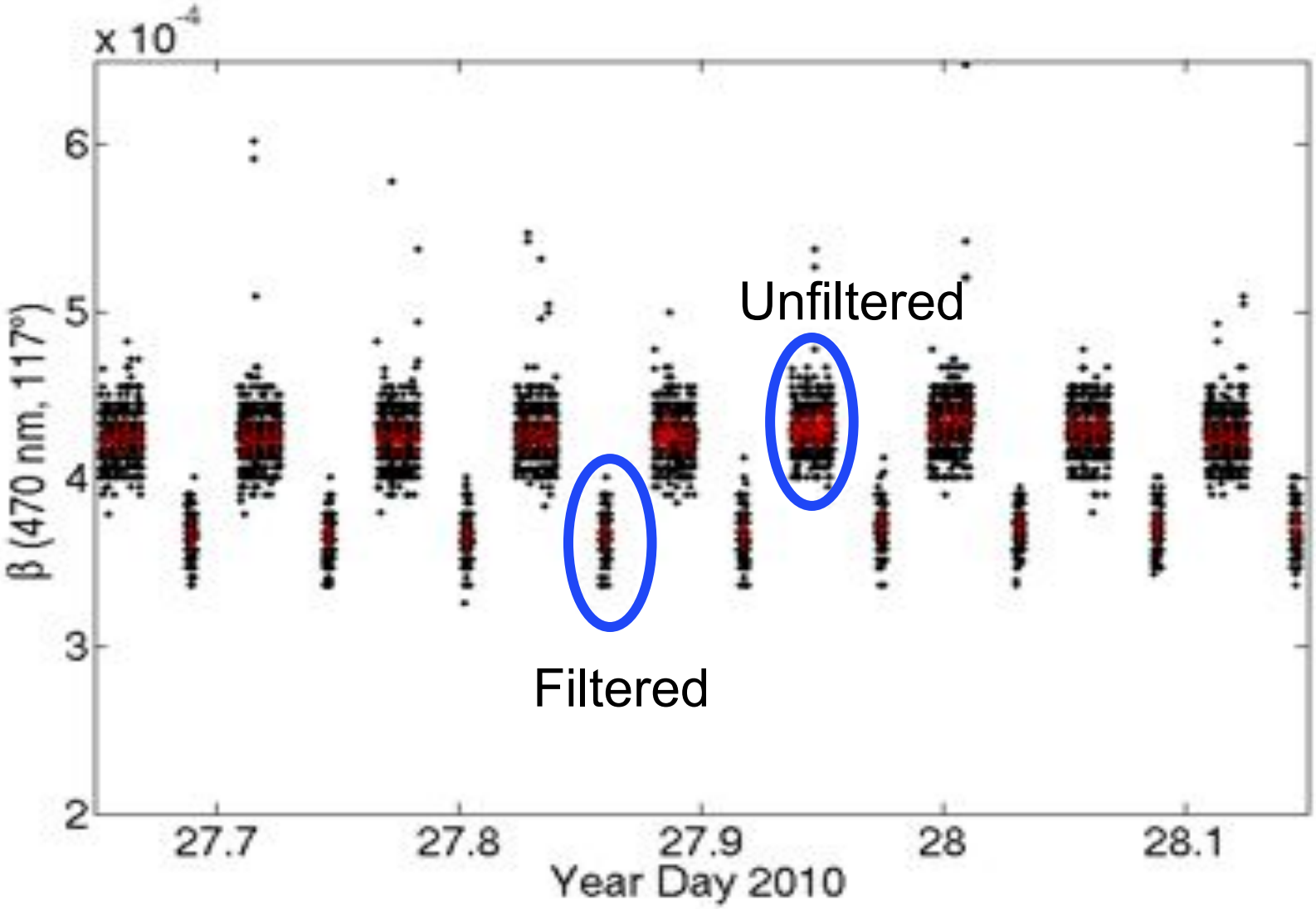


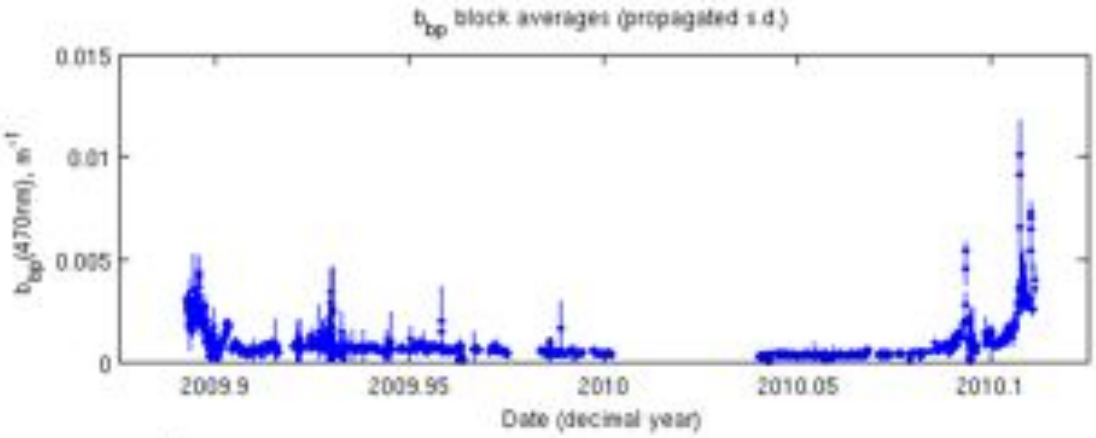
[Nelson et al. 2010]

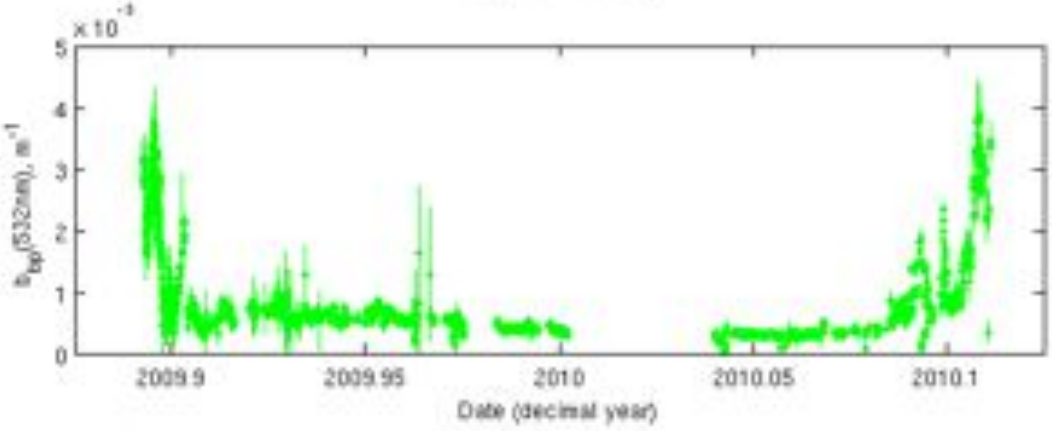
CLIVAR Ocean Color Alongtrack System Schematic

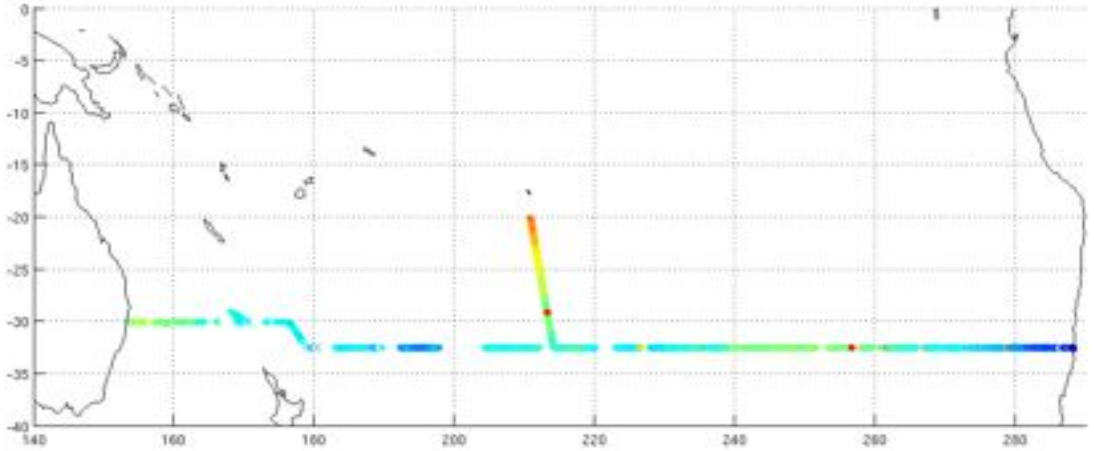


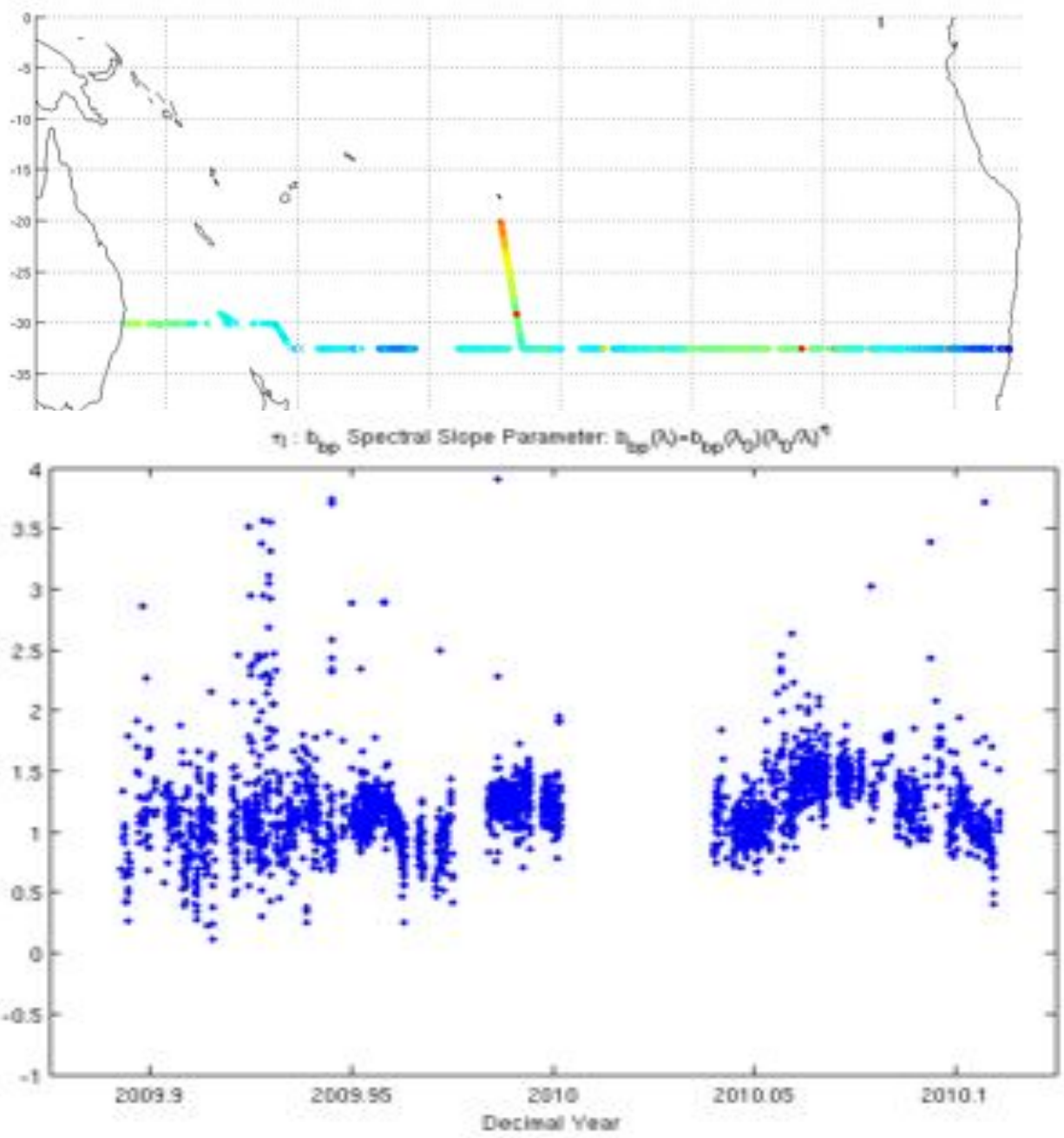
Alongtrack system raw data

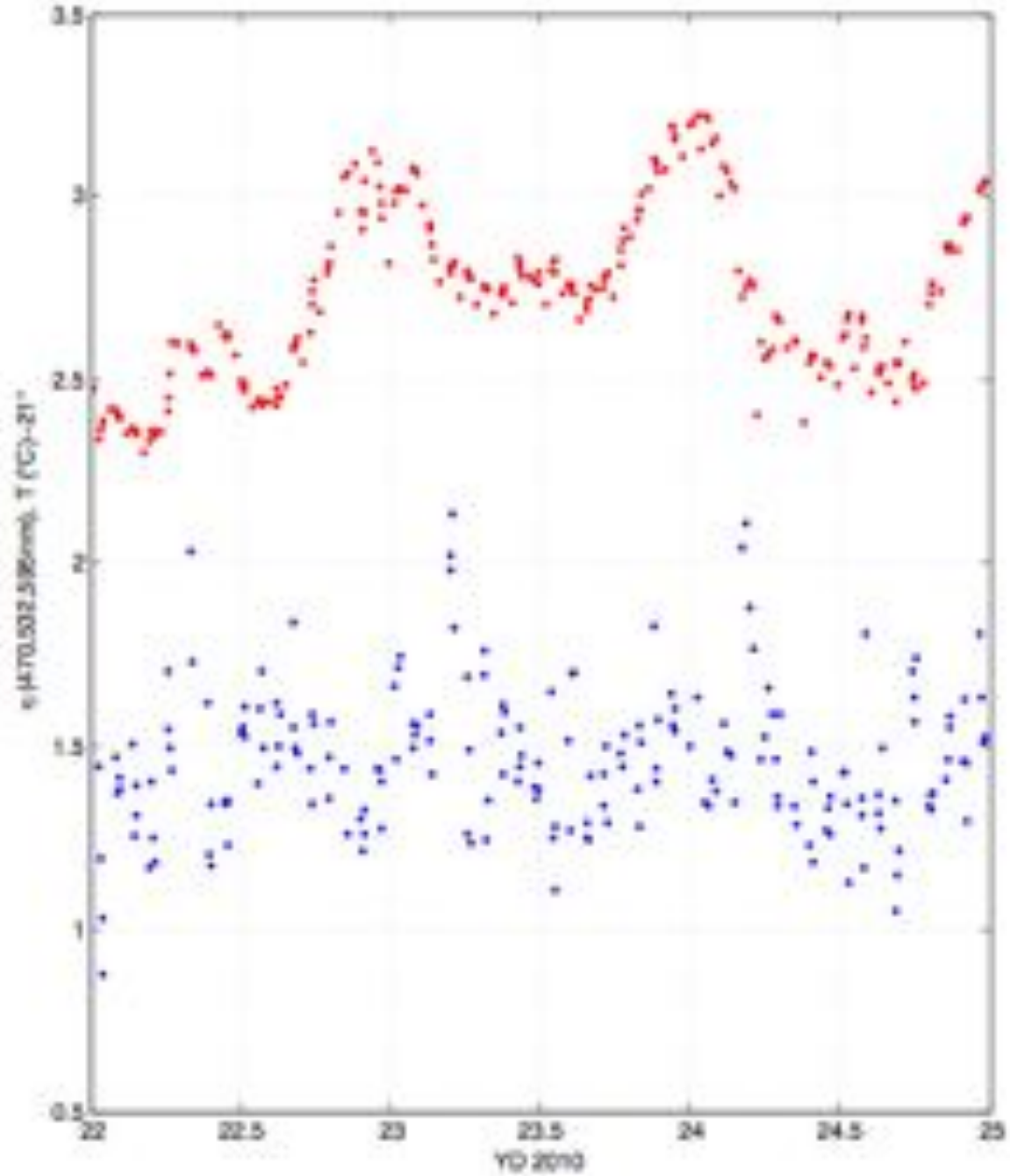



b_{bp} block averages (propagated s.d.)
0.015
0.01
0.005
0
b_{bp}(470nm), m^{-1}
2009.9
2009.95
2010
2010.05
2010.1
Date (decimal year)


x 10^{-3}
5
4
3
2
1
0
b_{bp}(532nm), m^{-1}
2009.9
2009.95
2010
2010.05
2010.1
Date (decimal year)


0
-5
-10
-15
-20
-25
-30
-35
-40
140
160
180
200
220
240
260
280


η : b_{bp} Spectral Slope Parameter: $b_{bp}(\lambda)=b_{bp}(\lambda_0)(\lambda_0/\lambda)^{\eta}$
η (470, 532, 595 nm)
Decimal Year
2009.9
2009.95
2010
2010.05
2010.1


3.5
3
2.5
2
1.5
1
0.5
22
22.5
23
23.5
24
24.5
25
YD 2010

Carbon Flux Project

- Study of particle flux processes and related observables (joint with WHOI, BIOS, others)
- Section east of Bermuda from 40N to P.R. (BATS Validation section), fall 2011, -12
- Radiometer and IOP instrument profiles, HPLC, CLIVAR-alongtrack system
- What are the impacts of biological community structure and physical processes on particle flux / P:E ratio?

Ongoing Research

- Continuing to address science questions in the field while opportunistically collecting data for cal/val + algorithm development
- Transition to new technology for radiometric observations at BBOP
- Increasing implementation of IOP / other measurements for future/improved OC algorithms & validation
- Question - what are the phytoplankton groups or community structure parameters we wish to represent in OC data products?