International Geosphere-Biosphere Program (IGBP)

- Land-Ocean Interactions in the Coastal Zone (LOICZ-2)
- Surface Ocean-Lower Atmosphere Study (SOLAS)
- Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) outgrowth of JGOFS and GLOBEC

These programs provide critical links for observing systems to science needs and research-based observations

They are interdisciplinary and involve good connections to the OOPC concerning Carbon & other interdisciplinary variables

OOPC interests matched in forcing and feedbacks for biogeochemistry, ecosystems, and climate variability

Surface Ocean-Lower Atmosphere Study (SOLAS)

Air-sea interaction

CO_2, DMS, & other radiatively active gases & their effects

Penetrative component of solar radiation and its modulation

pH as it is decreasing : effects on coral algae etc.

Integrated Marine Biogeochemistry & Ecosystem Research (IMBER)

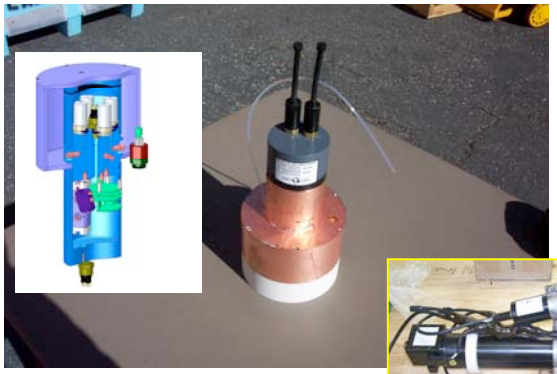
Global change, natural and anthropogenic forcings and impacts on biogeochemical cycles and ecosystem dynamics

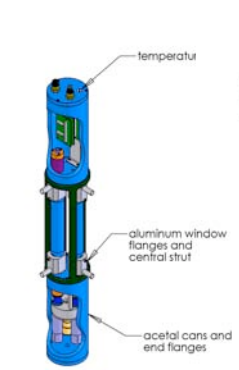
How impacts alter relations between elemental cycling and ecosystem dynamics

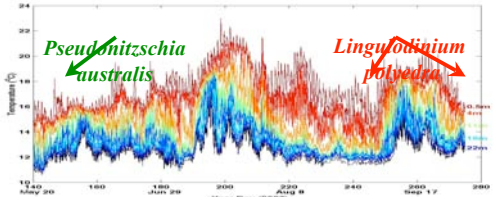
Feedback mechanisms of Earth system from these changes

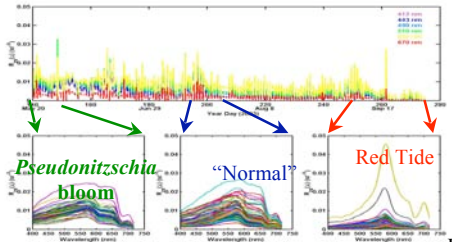
Developed Sensors/Systems

- CO_2 / O_2 – ships (underway), moorings, drifters
- Macronutrients (nitrate, phosphate, silicate, ammonia) – ships (underway), moorings, drifters, AUVs, gliders
- Micronutrients/Trace elements (iron) – ships, moorings
- Optics – PAR, Spectral to hyperspectral inherent and apparent optical properties for quantifying variables including penetrative component of solar radiation, particle size distributions, phytoplankton biomass, primary productivity, phytoplankton by groups/species (i.e., HABs, etc.), particulate organic carbon, bioluminescence – most platforms including profiling floats, color satellites (hyperspectral coming) [see *Oceanography* June 2004]
- Fluorescence - phytoplankton biomass, carbon assimilation rates – most platforms for fluorometers







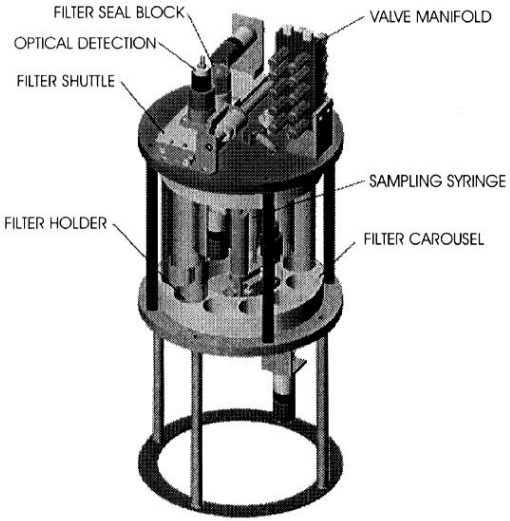


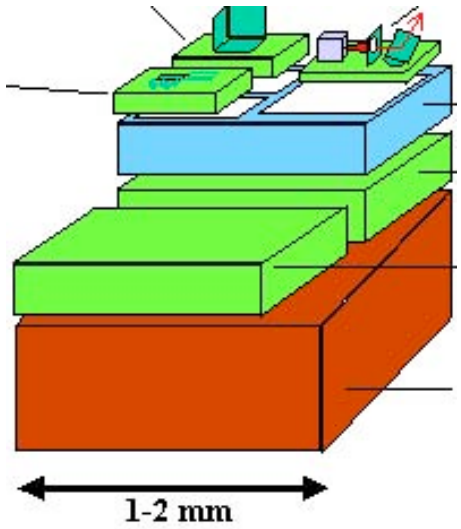
Dolphin/Sea Lion Kills
Domoic Acid

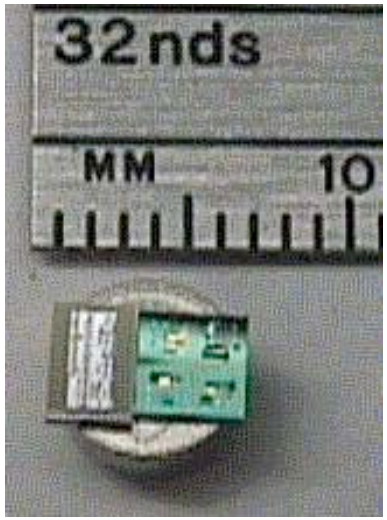
Fish Kills
Anoxia

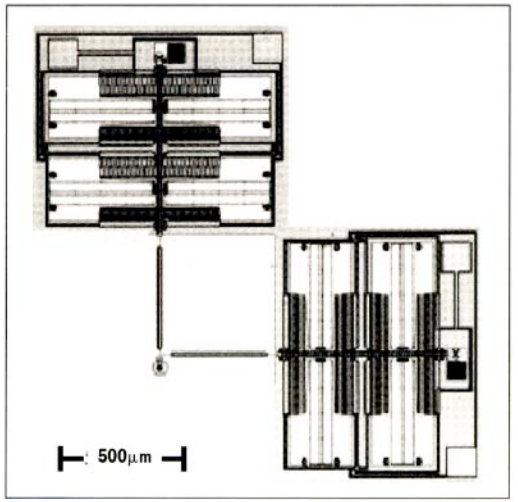
Sensors/Systems

- Optical plankton counters (sheet optics) – ships, moorings, AUVs, cables
- Video systems for identifying plankton – ships, moorings
- Acoustic backscatter (single and multi-frequency) for zooplankton biomass and distributions – ships, moorings
- DNA samplers – ship samples, moorings
- Mass specs and flow cytometers – moorings, large AUVs
- Chemistry and biology on a small chip - Micro and nano technologies emerging





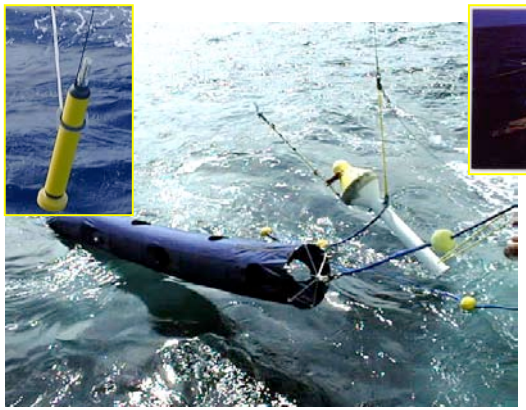


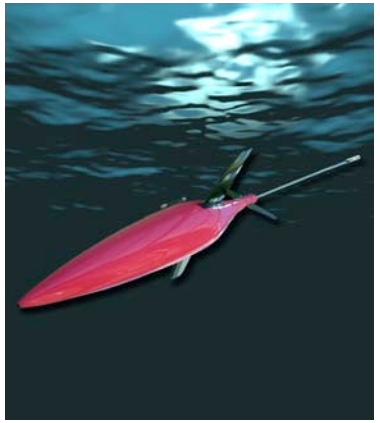


Several workshops and reports

Platforms

- Ship capabilities – towed platforms, deployment of other platforms like moorings, floats, gliders, AUVs, ROVs, cable servicing
- Moorings –interdisciplinary capacity, profilers emerging
- Drifters & Profiling floats – interdisciplinary capacity emerging
- AUVs – range from very small to large (AUTOSUB); interdisciplinary capacity emerging
- Gliders - interdisciplinary capacity emerging
- Fiber optic and EM cables - interdisciplinary capacity emerging





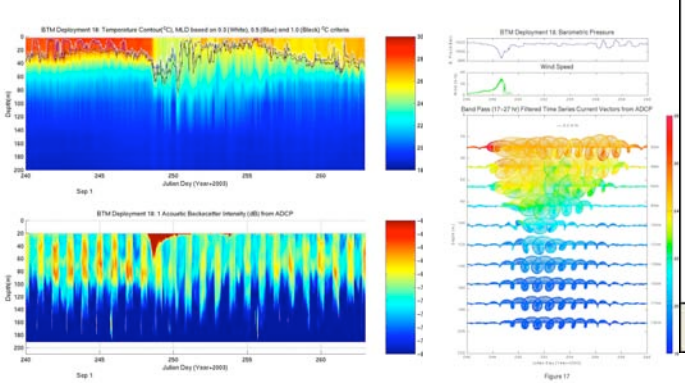
Several recent workshops and reports

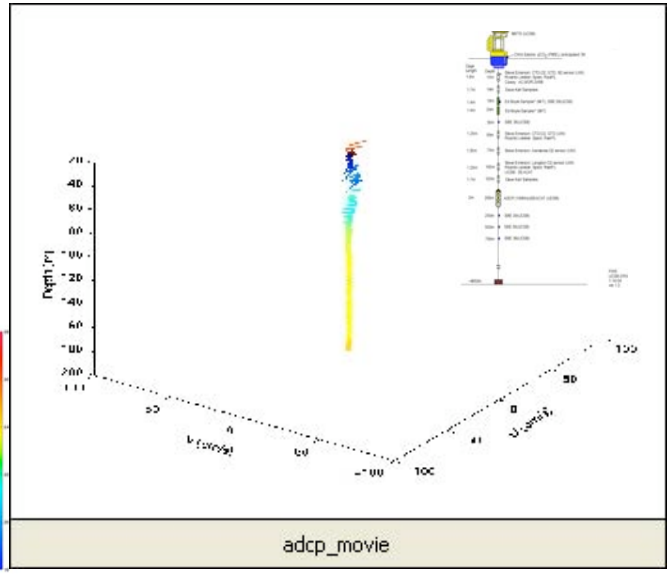
Challenges

- Endurance of autonomous platforms and sensors – under adverse environmental conditions (e.g., ice, high sea sates, hurricanes, typhoons, etc.)
- Biofouling of sensors

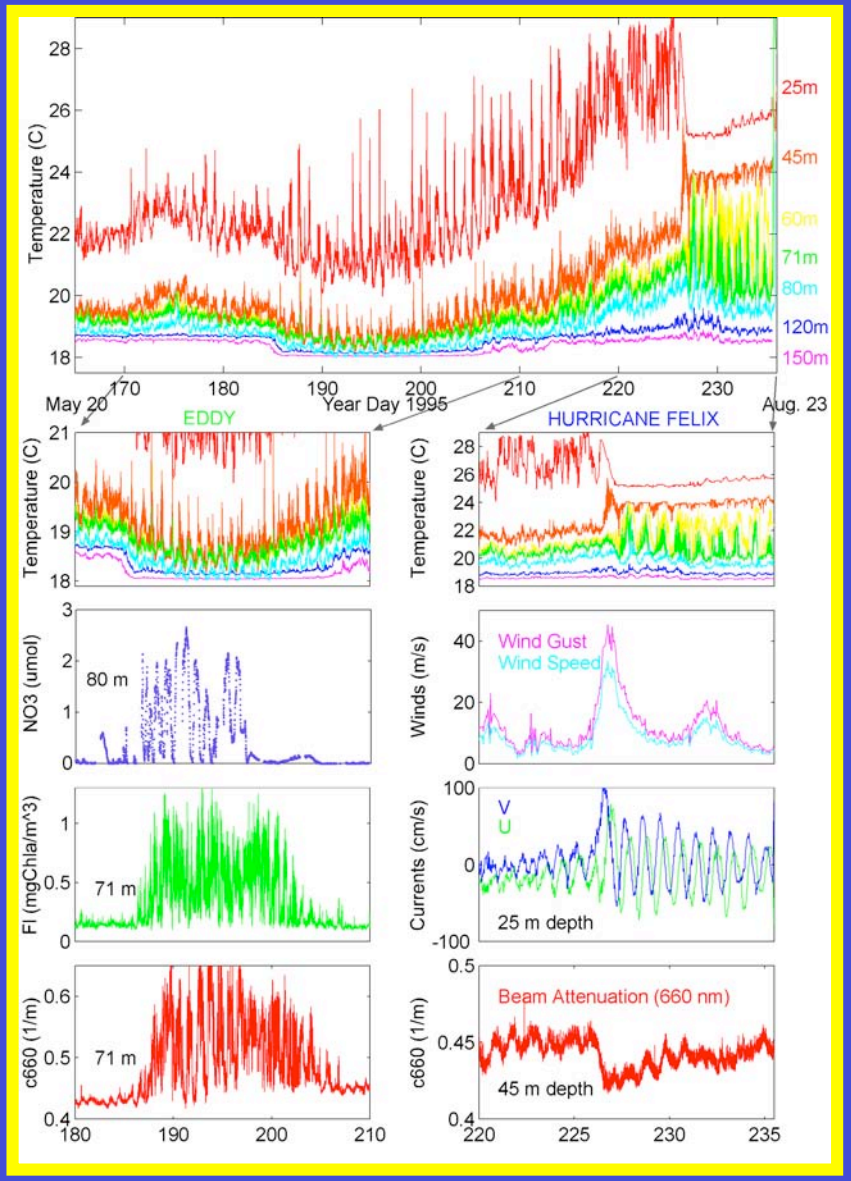
  [progress – 400 day optical data set off Japan; Manov, et al. - JAOT]
- Integration of sampling systems
- Cost/platform and sensor
- Numbers of platforms and sensors
- Development of new interdisciplinary sensors – Who will fund?
- Optimal sampling strategies – use of models (OSSEs) – Who will facilitate?
- Power for some sensors and systems
- Data telemetry (bandwidth) - adaptive sampling
- Data synthesis – models
- International cooperation/coordination/capacity bldg

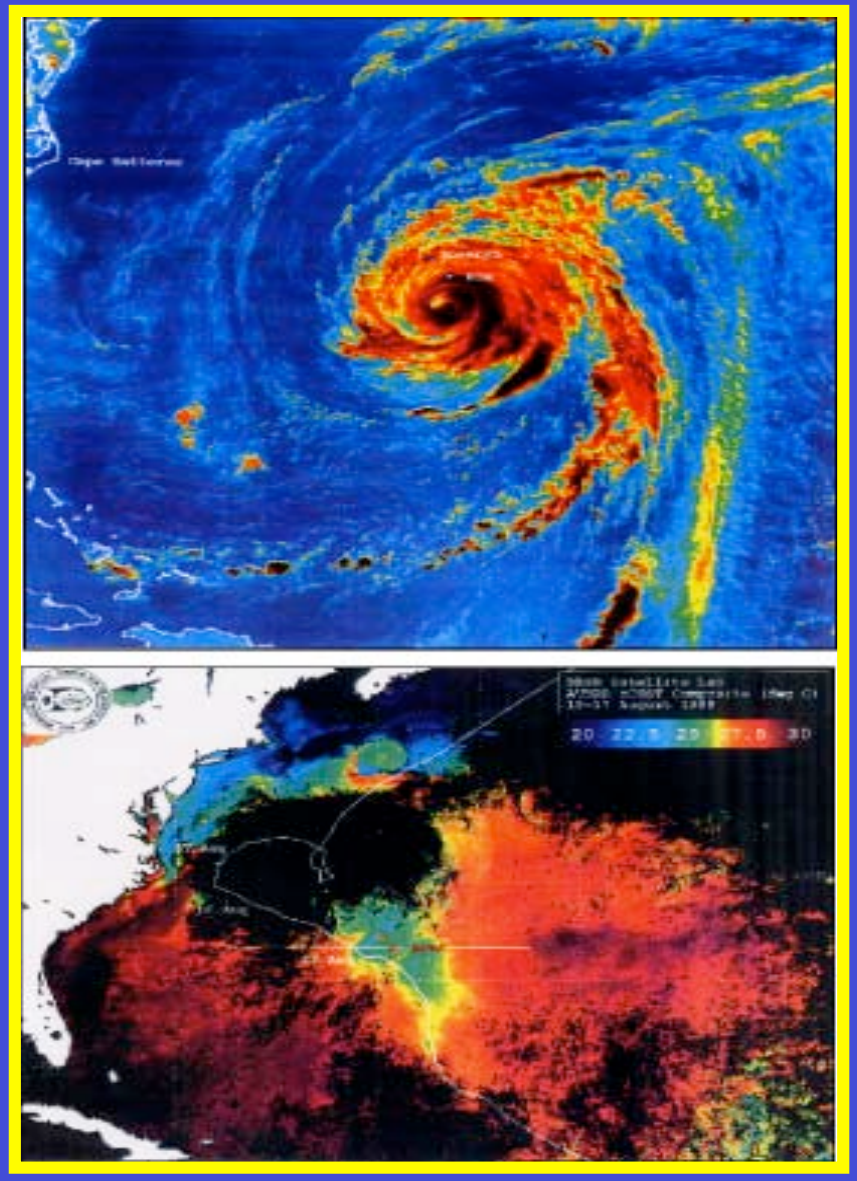
Fabian Sept. 2003





Eddy and Felix @ Bermuda Testbed Mooring Site





Dickey et al., 1998a,b, 2001a; McGillicuddy et al., 1998, McNeil et al., 1999

Response to Felix: Data & 1-D Simulations

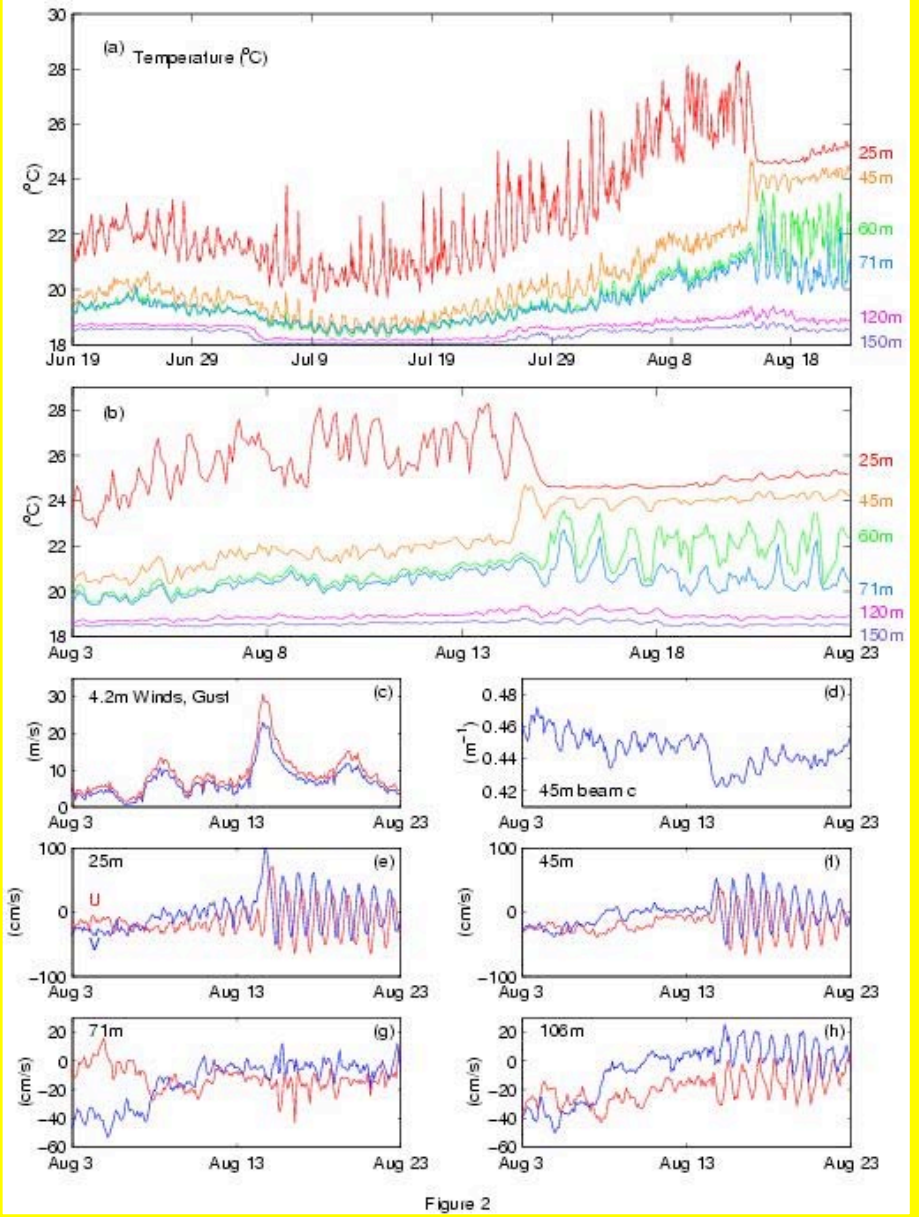


Figure 2

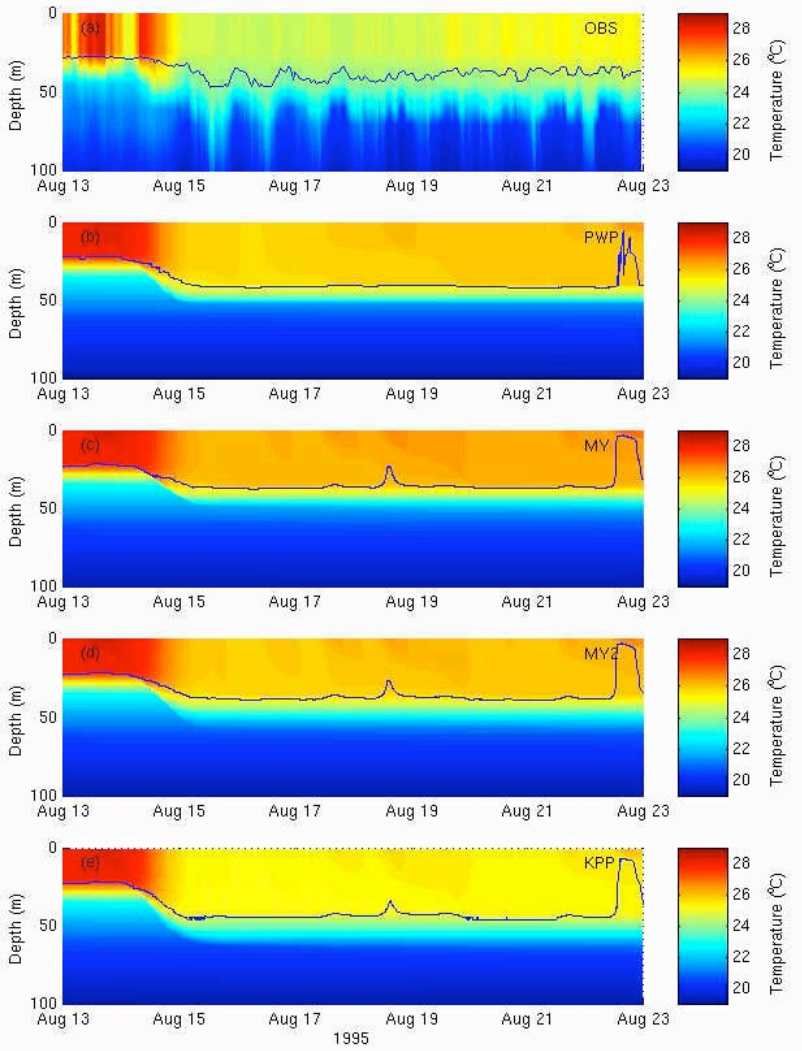
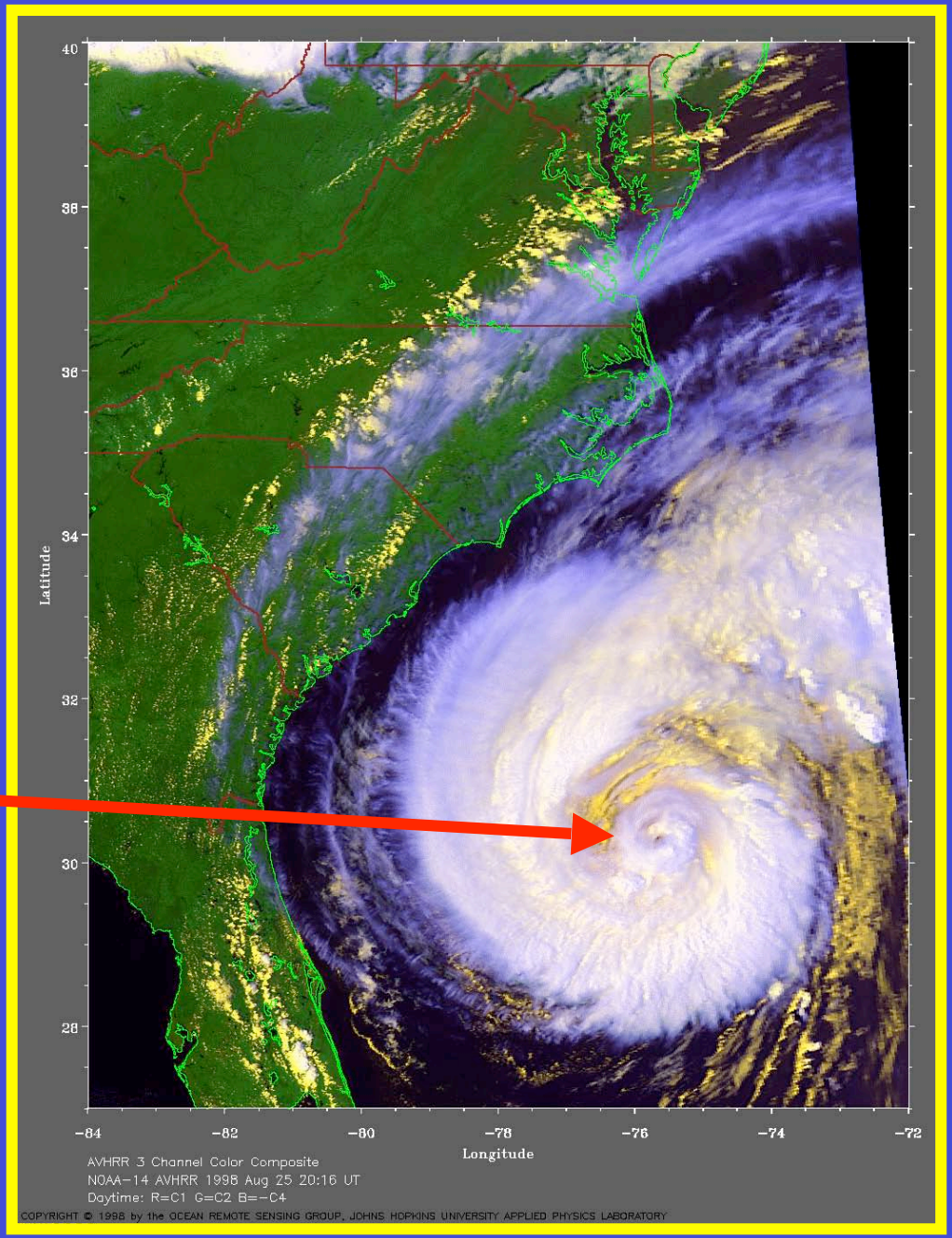


Figure 7

Zedler , Dickey, Doney, Price, Yu, & Mellor, JGR 2003

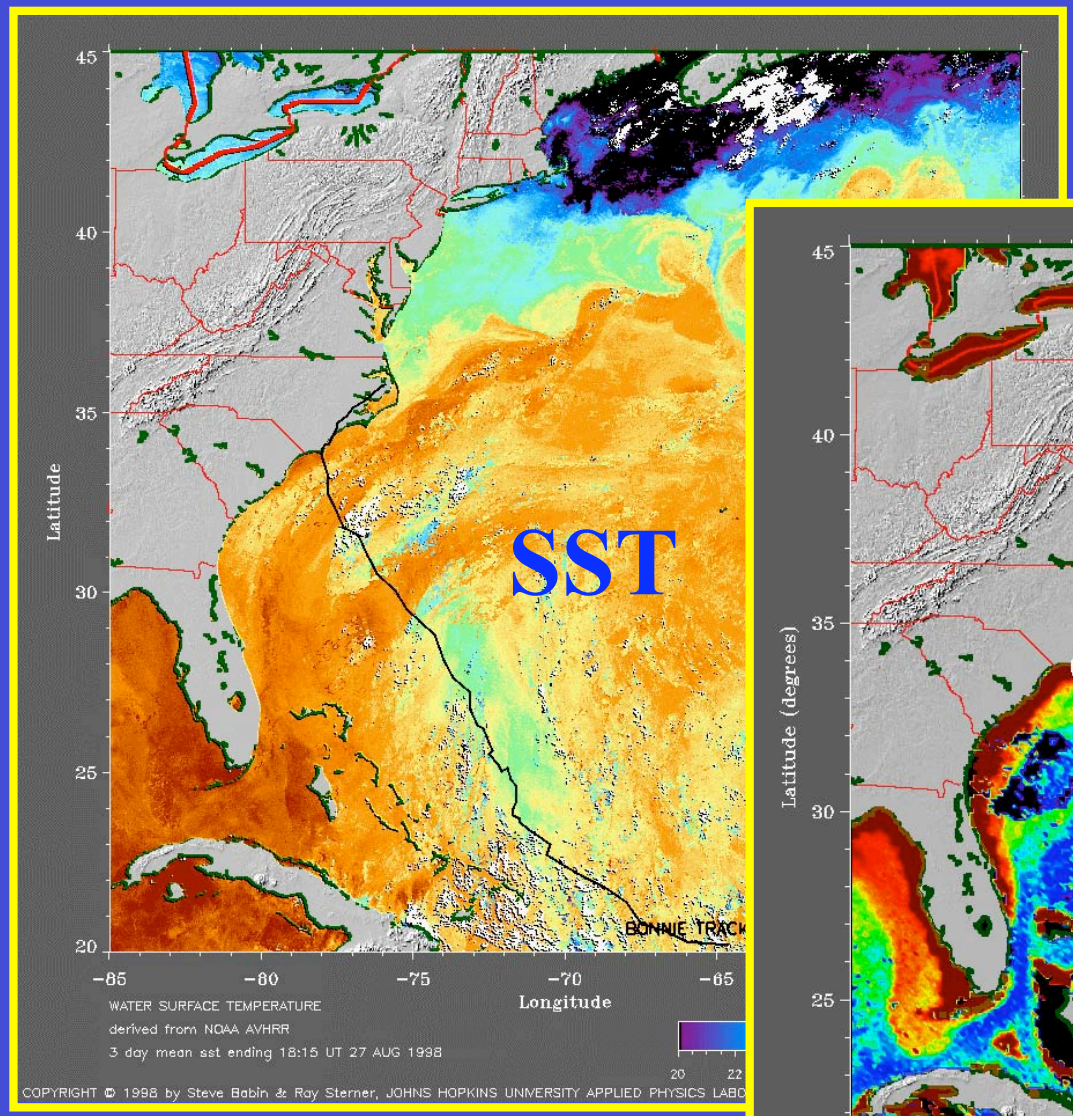
Satellite data for studying bio-optical & biogeochemical responses to hurricanes in the N. Atlantic, 1998-2000

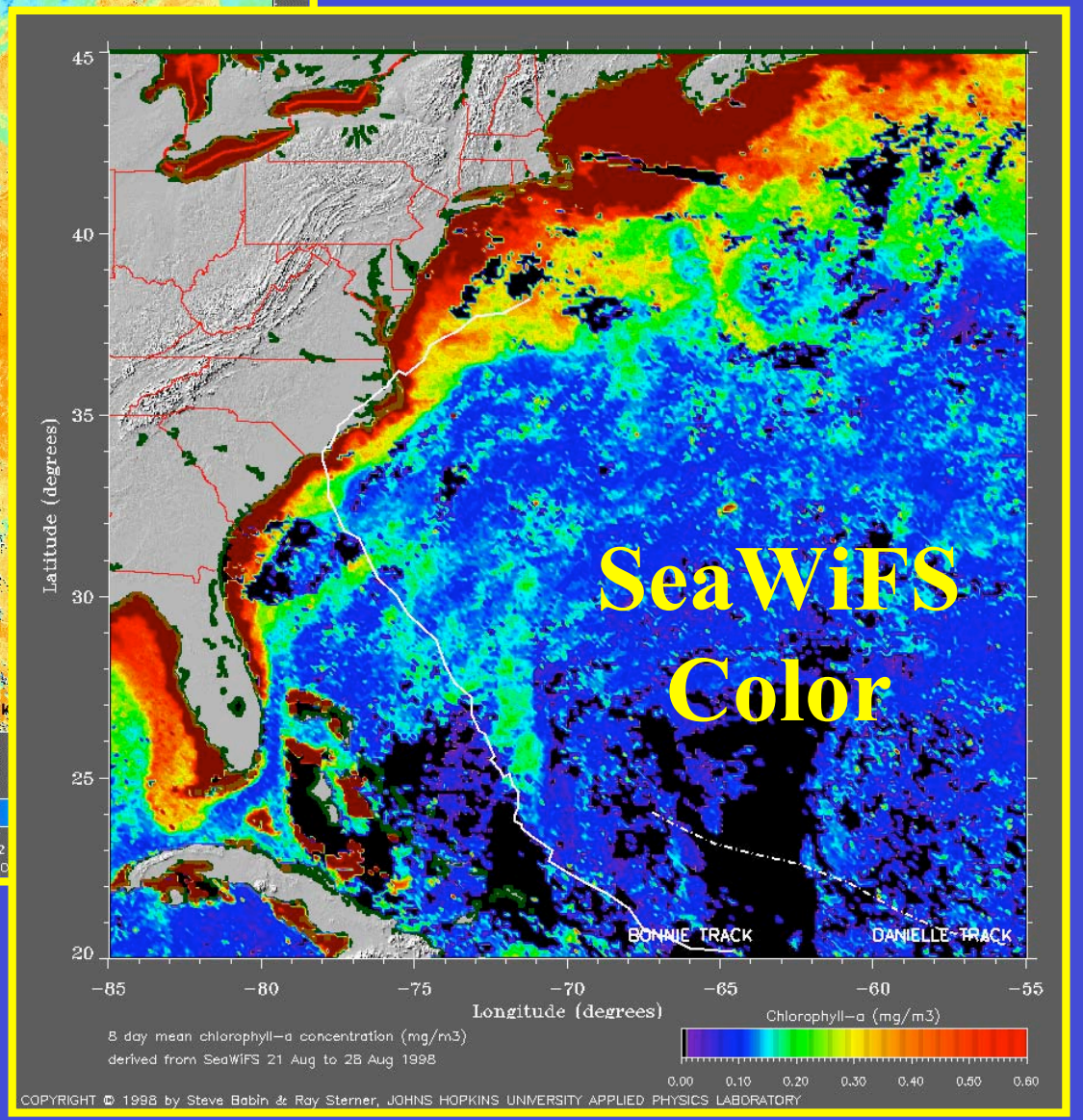
Hurricane Bonnie August 1998



Babin, Carton, Dickey, and Wiggert, JGR 2004

Babin, Carton, Dickey, and Wiggert, JGR 2004





Upper Ocean Response to Hurricane Bonnie: 1998

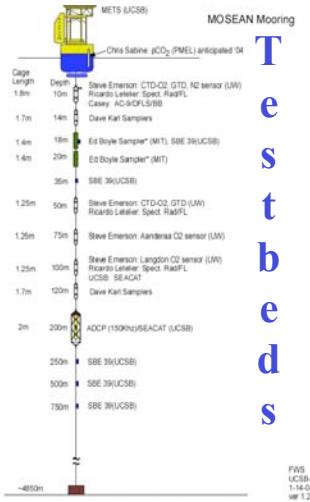
Analysis of North Atlantic Color Response to Hurricanes

- Period of analysis: 1998-2001 (13 events)
- SST response – few ^{0}C decrease
- Chlorophyll increased with few exceptions
- Typical Chl increase ~ 20 to 40%
- Maximum Chl increases ~ 60-90%
- Cause? Chl (and/or CDOM) entrainment, and/or enhanced prim. productivity (via more nuts. & light)? Open Question.

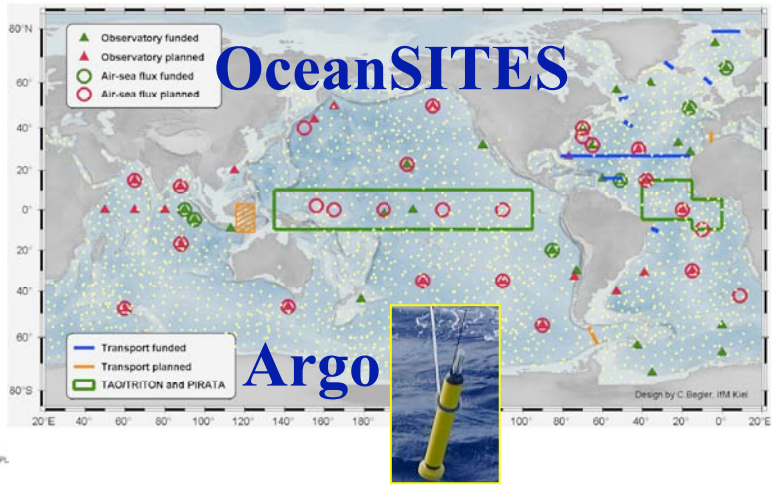
Babin et al., JGR 2004

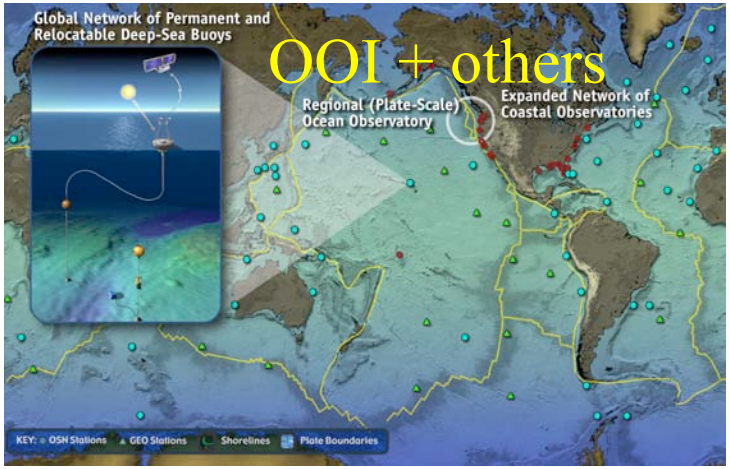
Opportunities

- Availability of more capable in situ and satellite platforms and cable systems (more power and bandwidth)
- Technology transfer from outside oceanography
- Testing of new interdisciplinary sensors from moorings, AUVs, gliders, floats, drifters via current and future programs
- Focused interdisciplinary experiments – i.e., regional experiments, purposeful tracers, iron fertilization, etc.
- Global ocean observation system emerging at national and international levels – capacity bldg. efforts (i.e., POGO)
- Growing interest in data assimilation – merging of data and models -Adaptive sampling demonstrations



Testbeds

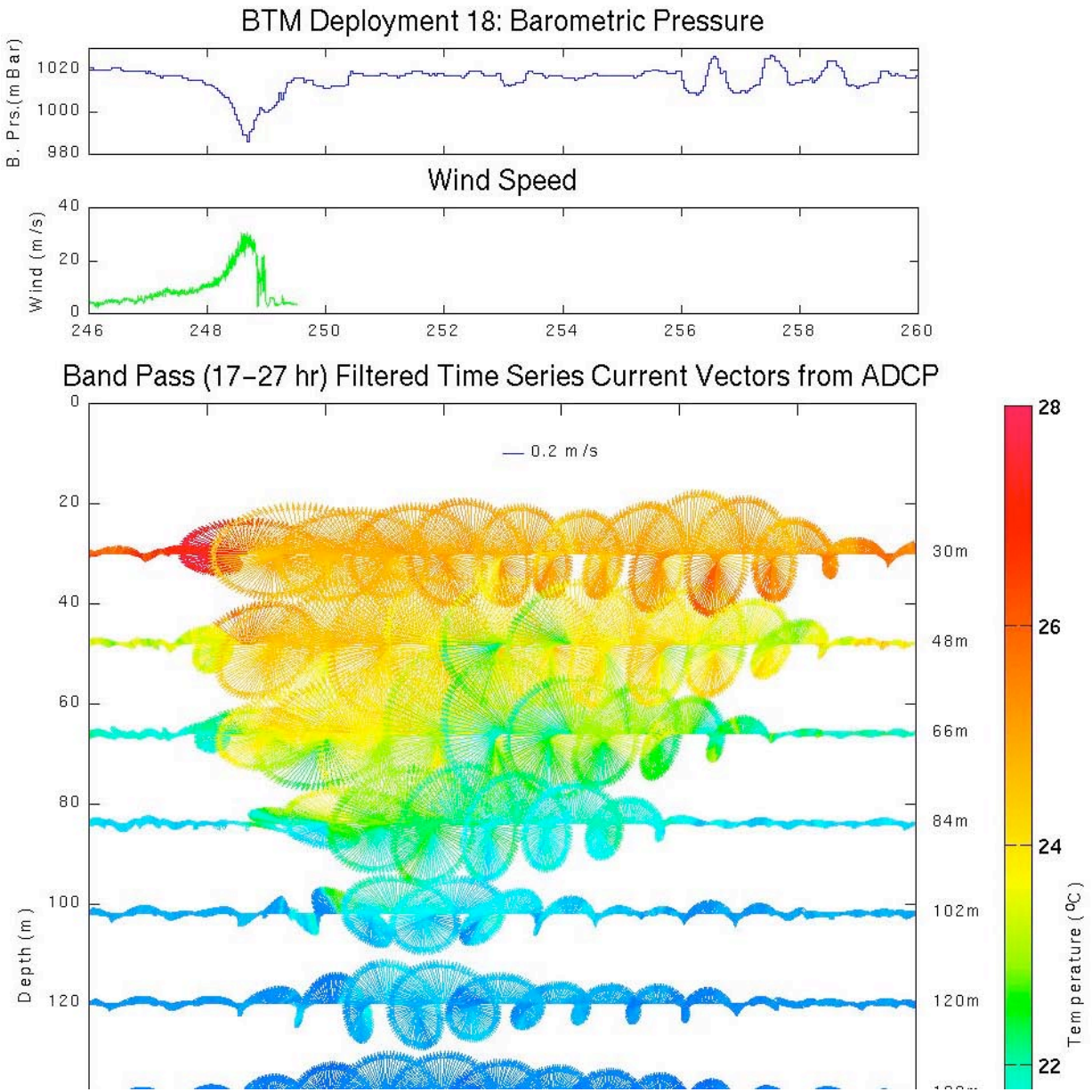




Possible Action Items

- **Short technical paper outlining key climate relevant biogeochemical processes, sensors and systems, and observational programs in progress and planned (e.g., Hood, Dickey, Fischer) – This would address climate relevant biogeochemical processes as requested in TORs**
- **OOPC website could be used to develop information databases for existing ocean climate observational systems (i.e., moorings, floats, VOS, etc.). The site would provide up-to-date info. on what measurements (incl. interdisc.) are being taken and where and what new sensors are being developed. Site could be divided into operational versus research-based. Links to other programs could be provided (i.e., Carbon, SOLAS, IMBER, CLIVAR, etc.)**

International Geosphere-Biosphere Program



(LOICZ)

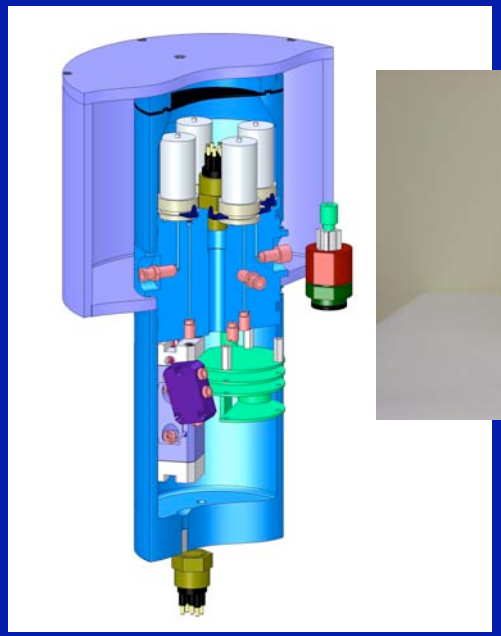
LAS; R. eller)

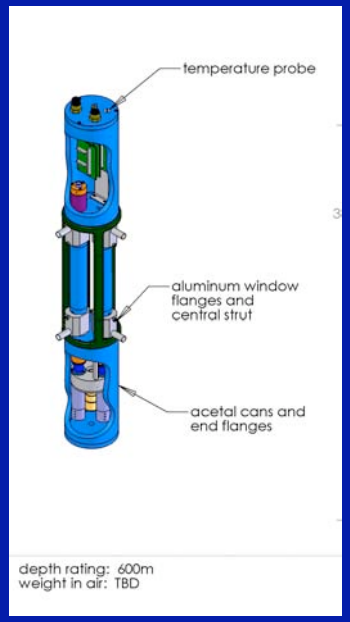
/stem Research

(Paris,Jan. 2003;

O-SCOPE BLOOMS II System: Chlorophyll fluor., VSF, & Spectral L_u & E_d

Casey Moore (WET Labs) , UCSB OPL, and Satlantic




temperature probe
aluminum window flanges and central strut
acetal cans and end flanges
depth rating: 600m
weight in air: TBD

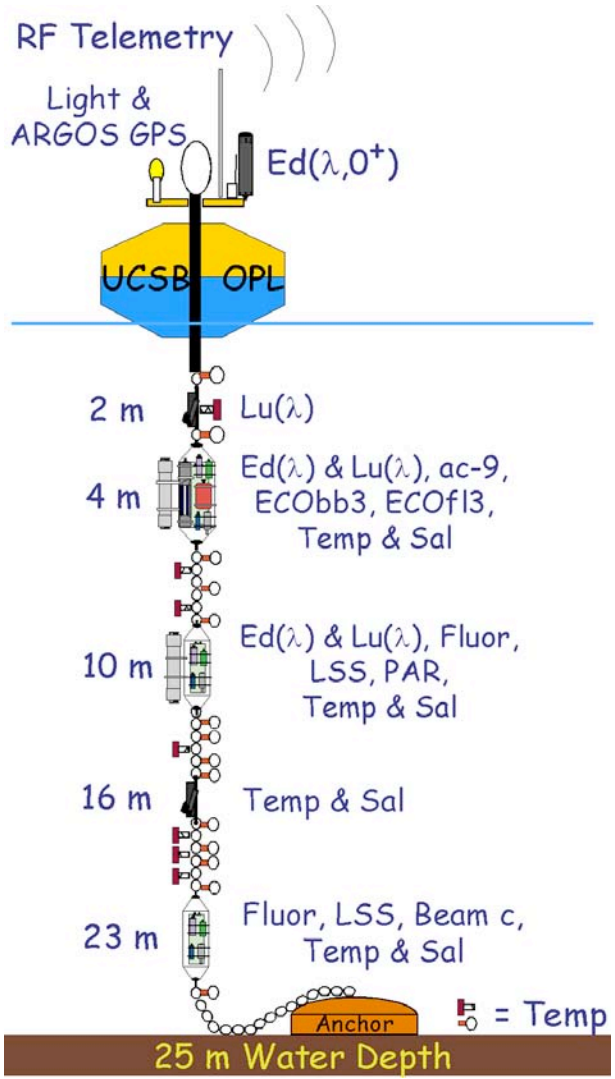
Physics Lab
opl
U C S B

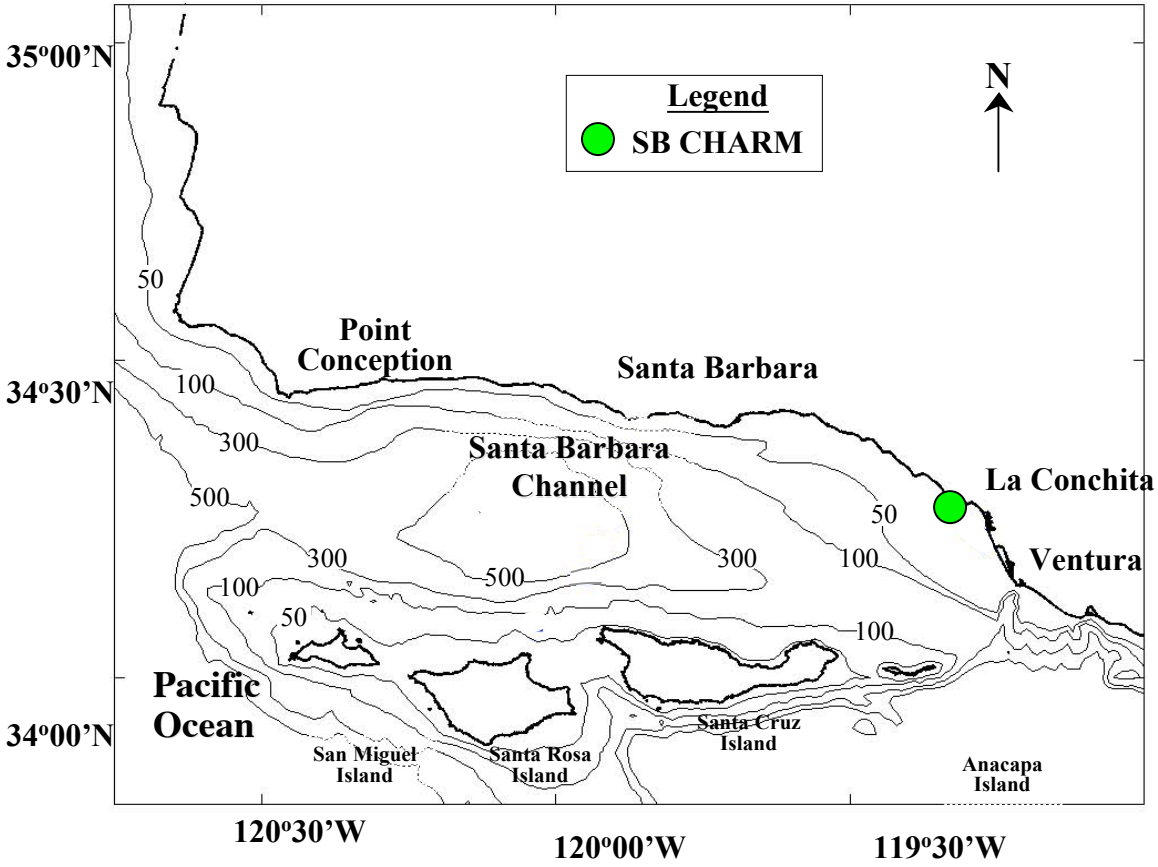
CHARM Data and Biolminescence photo??

CHARM Mooring Site in Santa Barbara Channel

#1 May 19 – Oct. 2, 2003

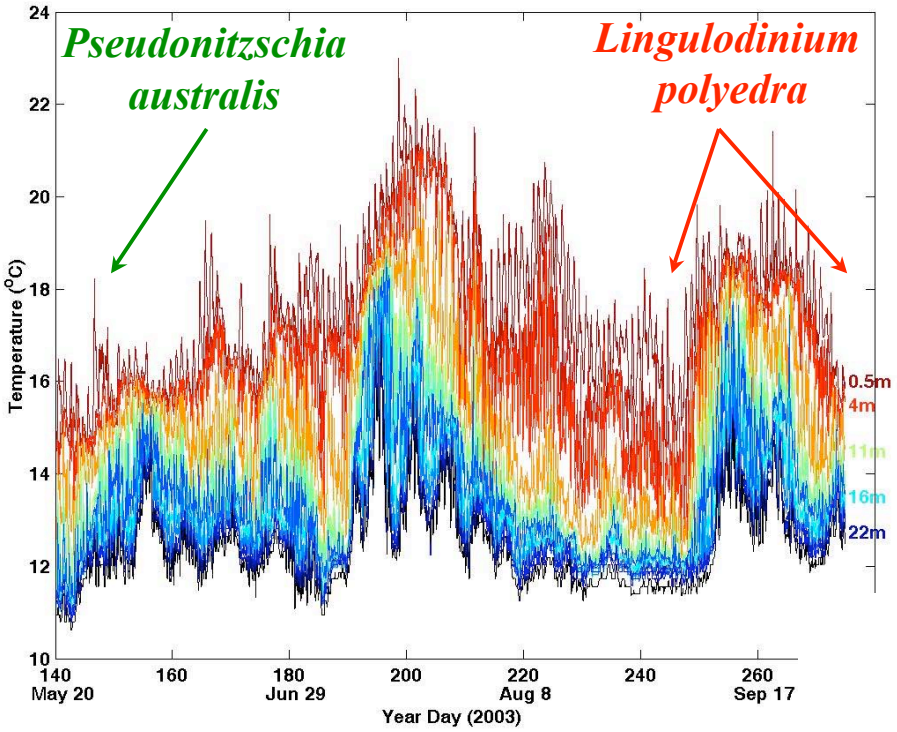
#2 Feb. 11 – May 5, 2004





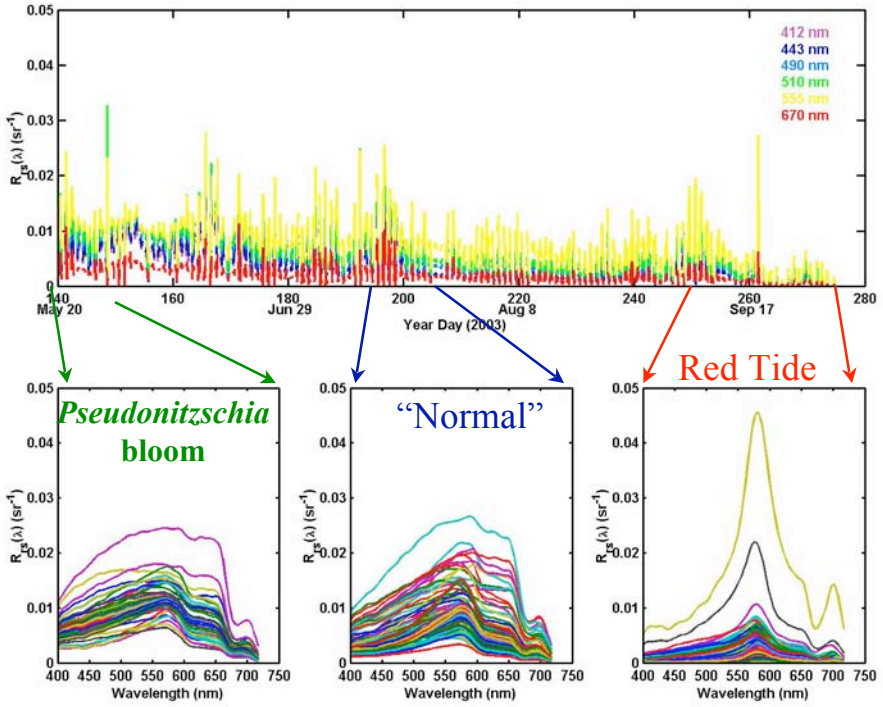
Real-time data telemetry to La Conchita

Automatic data processing and web display



- *Pseudonitzschia australis* → domoic acid event → sea lion and dolphin mortality (May – June 2003)
- *Lingulodinium polyedra* → anoxic conditions → massive fish kill (August – October 2003)

See poster by Chang et al., Hyperspectral signatures in Case 2 Waters session



HALE-ALOHA Mooring
1st Deployment June 2004

Tommy Dickey (UCSB) Physics, bio-optics
Dave Karl (UH) Water samplers
Casey Moore (WET Labs) Bio-optics
Al Hanson (SubChem) Chemicals
Ricardo Letelier (OSU) Bio-optics
Steve Emerson (UW) Chemicals
Ed Boyle (MIT) Chemical samplers
Chris Sabine (PMEL) pCO2
Mark Huntley (UH)/Alex Herman OPC
Fred Duennebier (UH) Cable
Mike DeGrandpre (UMT) pCO2
Ken Smith (SIO) Bottom sampling

Charlie Eriksen (UW) Gliders
Bruce Howe (UW)/Roger Lukas (UH)/
Emmanuel Boss (UME) Profiler
Bob Weller (WHOI) Mets
Roger Lukas (UH) Physics)
Others TBD

FWS
UCSB-OPL
1-14-04
ver 1.2

Team BTM

SEE NSF REPORT FOR MORE USERS??

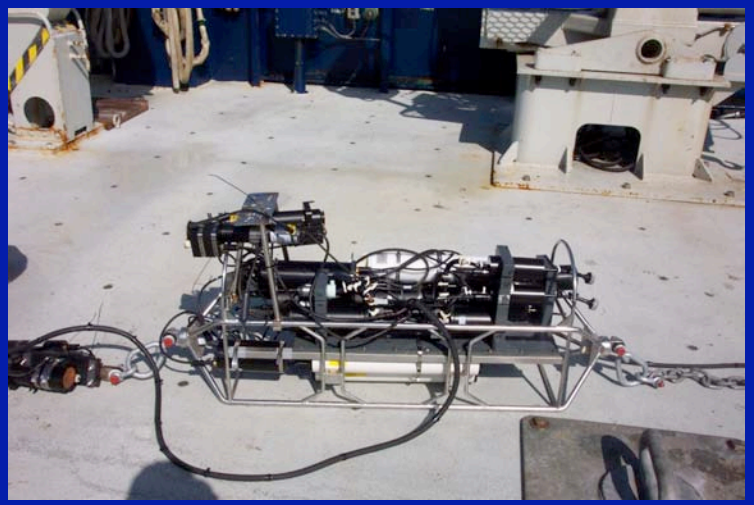
For references etc.

www.opl.ucsb.edu

tommy.dickey@opl.ucsb.edu

3-Channel Spectral Fluorometer (Left) & Single-Channel Fluorometer (Right)

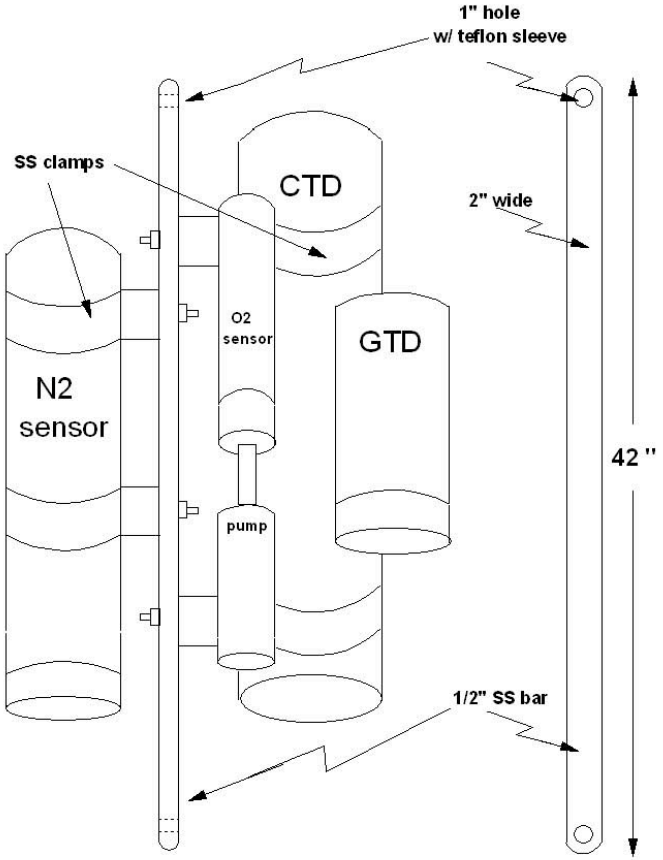
WET Labs

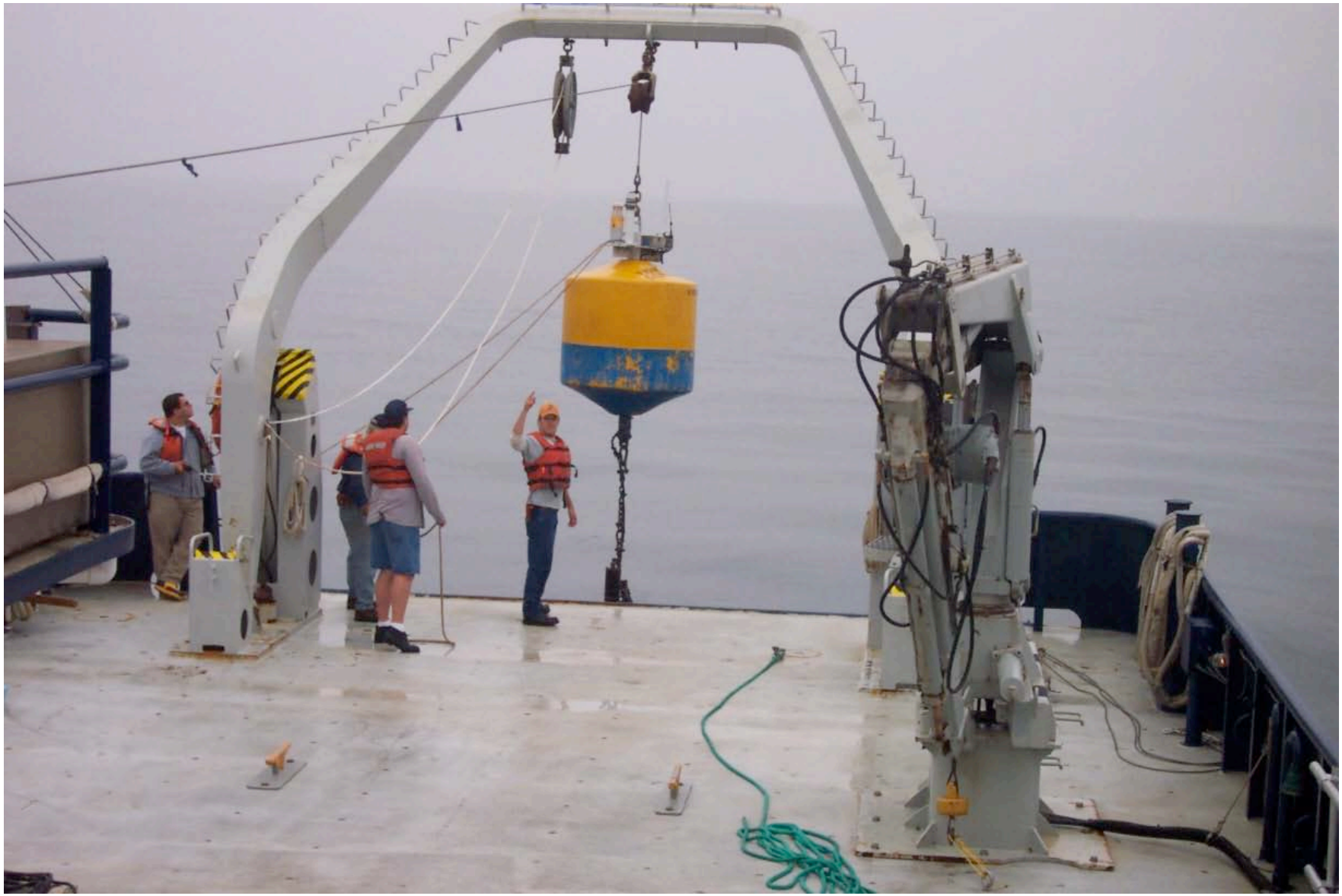


Submersible Chemical Analyzer

- Real time results
  - Fast response
  - High resolution profiles
  - Multi-chemical capability
  - Trace concentrations
  - *In situ* calibration
  - Accurate determinations

Typical Emerson Deployment





The Multi-disciplinary Ocean Sensors for Environmental Analyses (MOSEAN) Program

Tommy Dickey (UCSB)

Al Hanson (SubChem Systems)

Dave Karl (University of Hawaii)

Casey Moore (WET Labs)

Grace Chang (UCSB)

Derek Manov (UCSB)

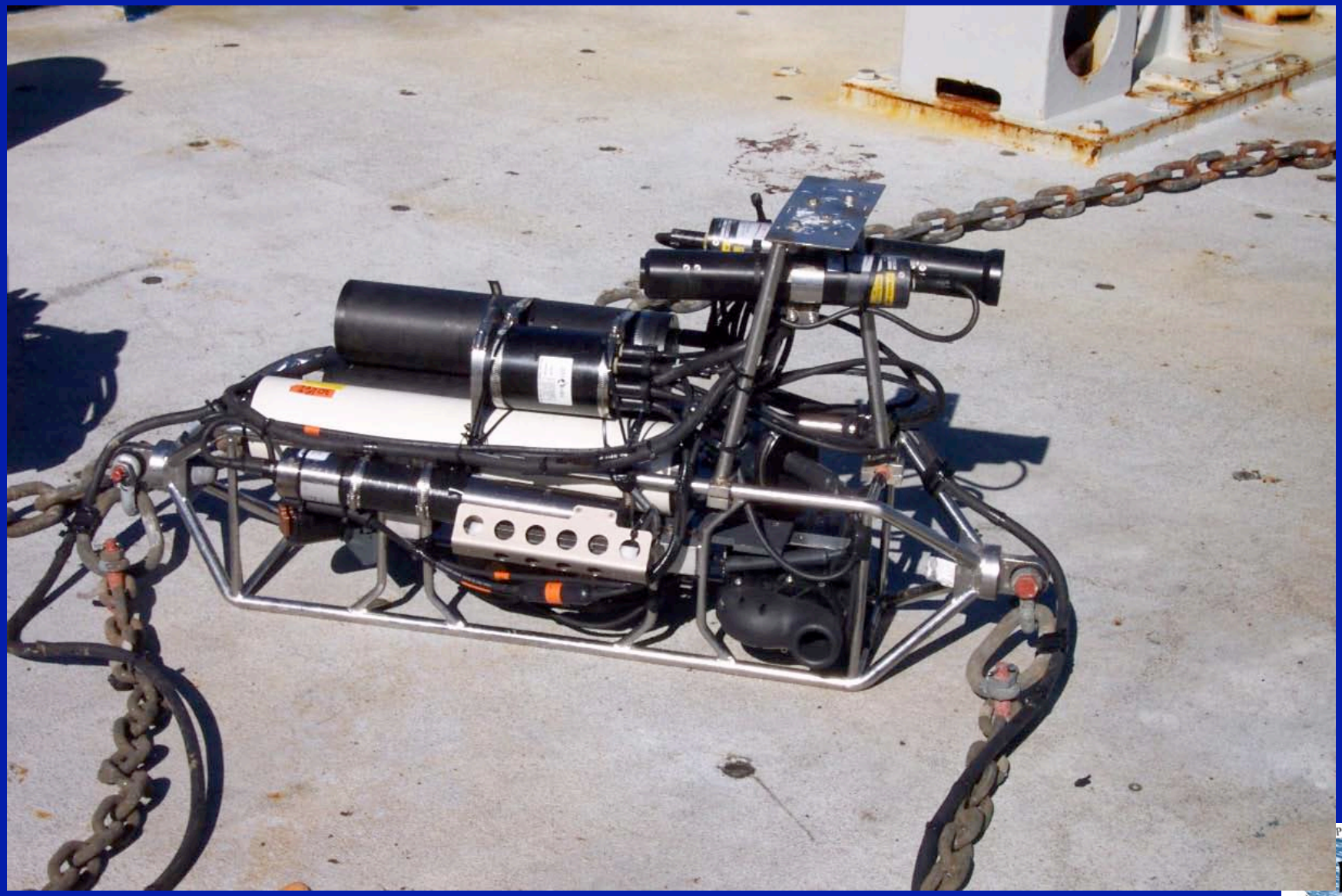
Frank Spada (UCSB)

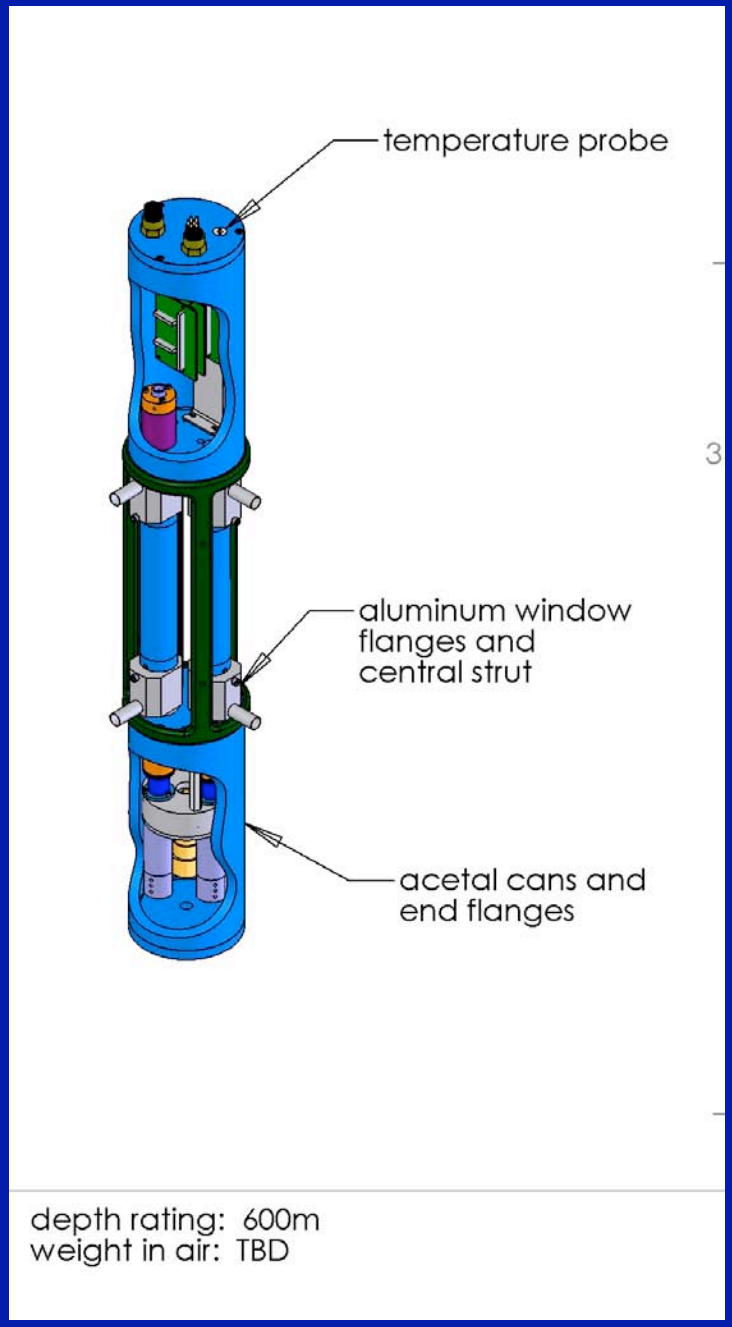
ASLO/TOS 2004 Ocean Research Conference

Honolulu, Hawaii

MOSEAN Instrument Package

Conductivity and Temperature Sensors, Fluorometer, and Hyperspectral Radiance, Irradiance, and Bioluminescence Sensors

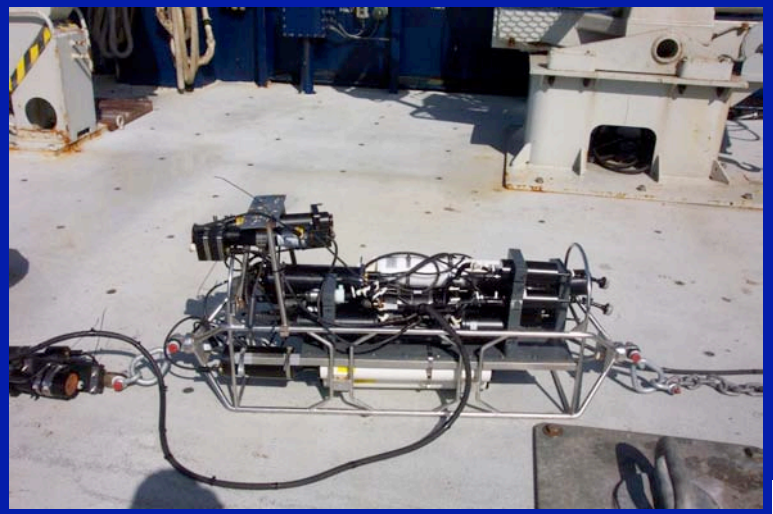




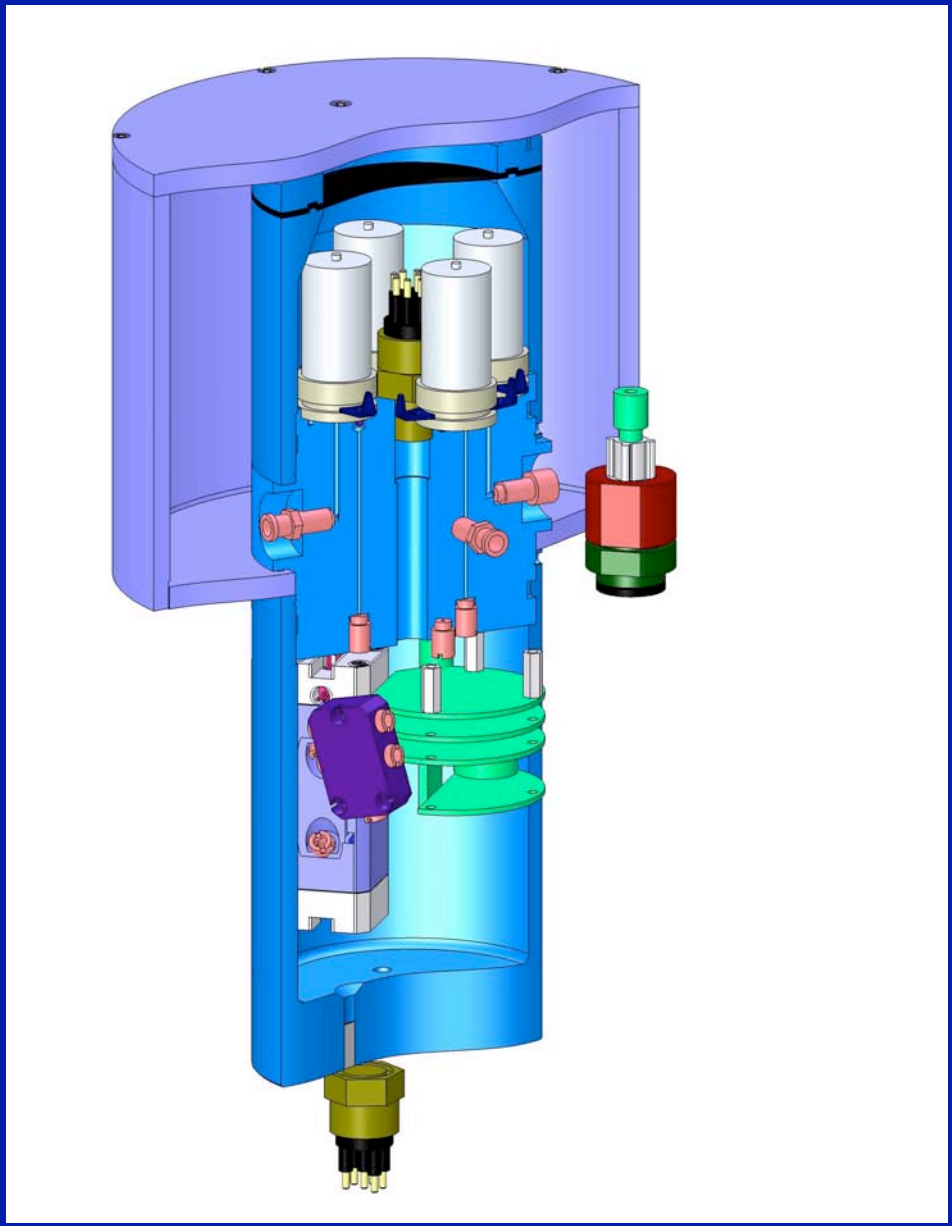
ac-s hyperspectral absorption-attenuation instrument

Deployed Feb. 11, 2004 off La Conchita, CA

Data are being telemetered in real-time (Free-wave modem)



WET Labs



Single channel nutrient analyzer for long-term deployments

Nitrate, phosphate, silicate, ammonia, iron

SubChem/WET Labs

Goals of MOSEAN

1. Development & testing of new interdisciplinary instruments

2. Scientific studies - e.g., extreme & episodic events

MOSEAN Sites

1. Santa Barbara Channel – a coastal setting

   CHAnnel Re-locatable Mooring (CHARM)

2. Hawaii HOT site – an open ocean setting

   HALE-ALOHA Mooring

Hurricane Felix: August 1995