”MOBY-Net, an ocean color vicarious calibration system”

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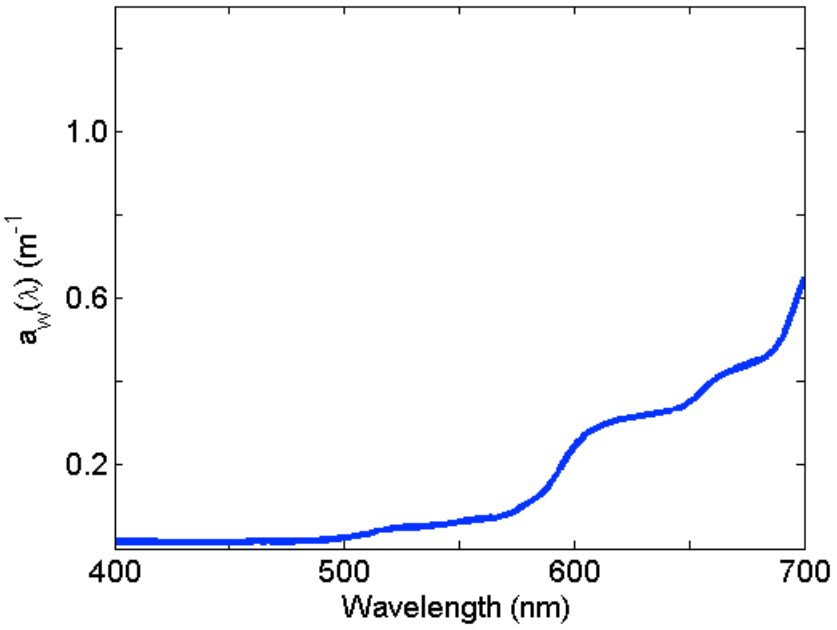
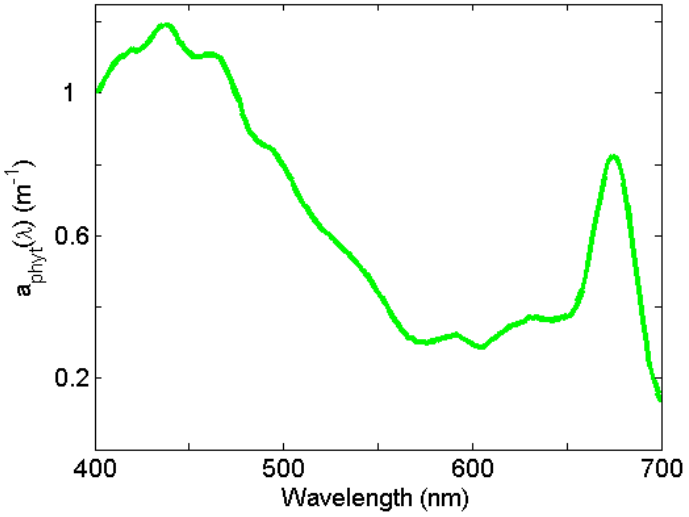
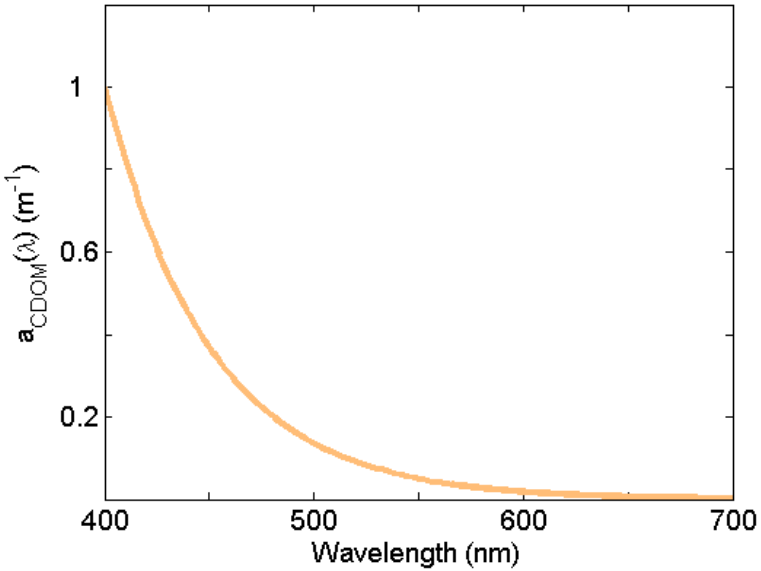
6/15, ESTF, Pasadena, Ca.

First a few basics: Water color (reflectance) is driven by a combination of scattering (which tends to be smooth spectrally) and absorption. Major absorption constituents are pure water, phytoplankton, and dissolved organics. These all effect the reflectance and color.



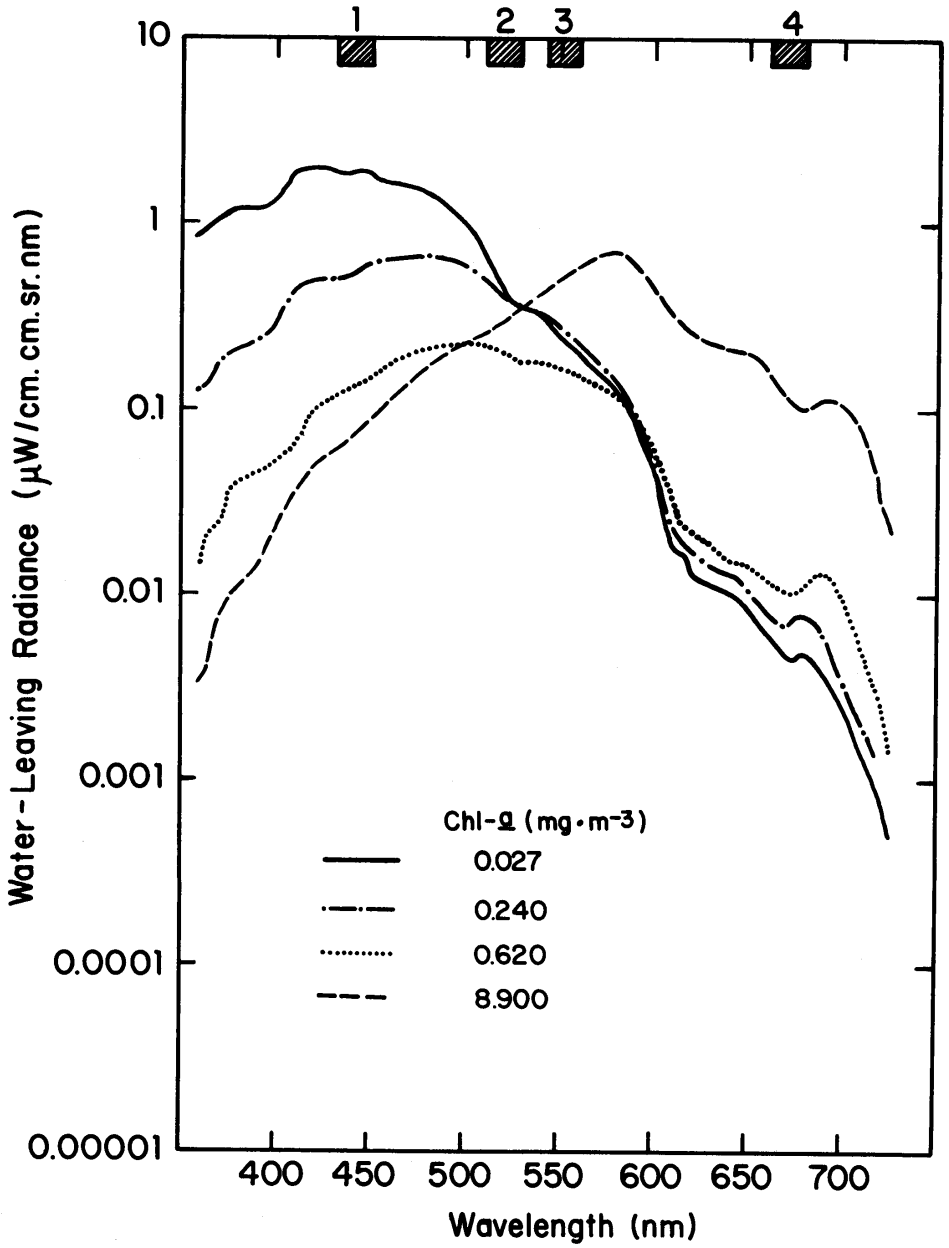




From Ocean Optics Web book, Collin Roesler

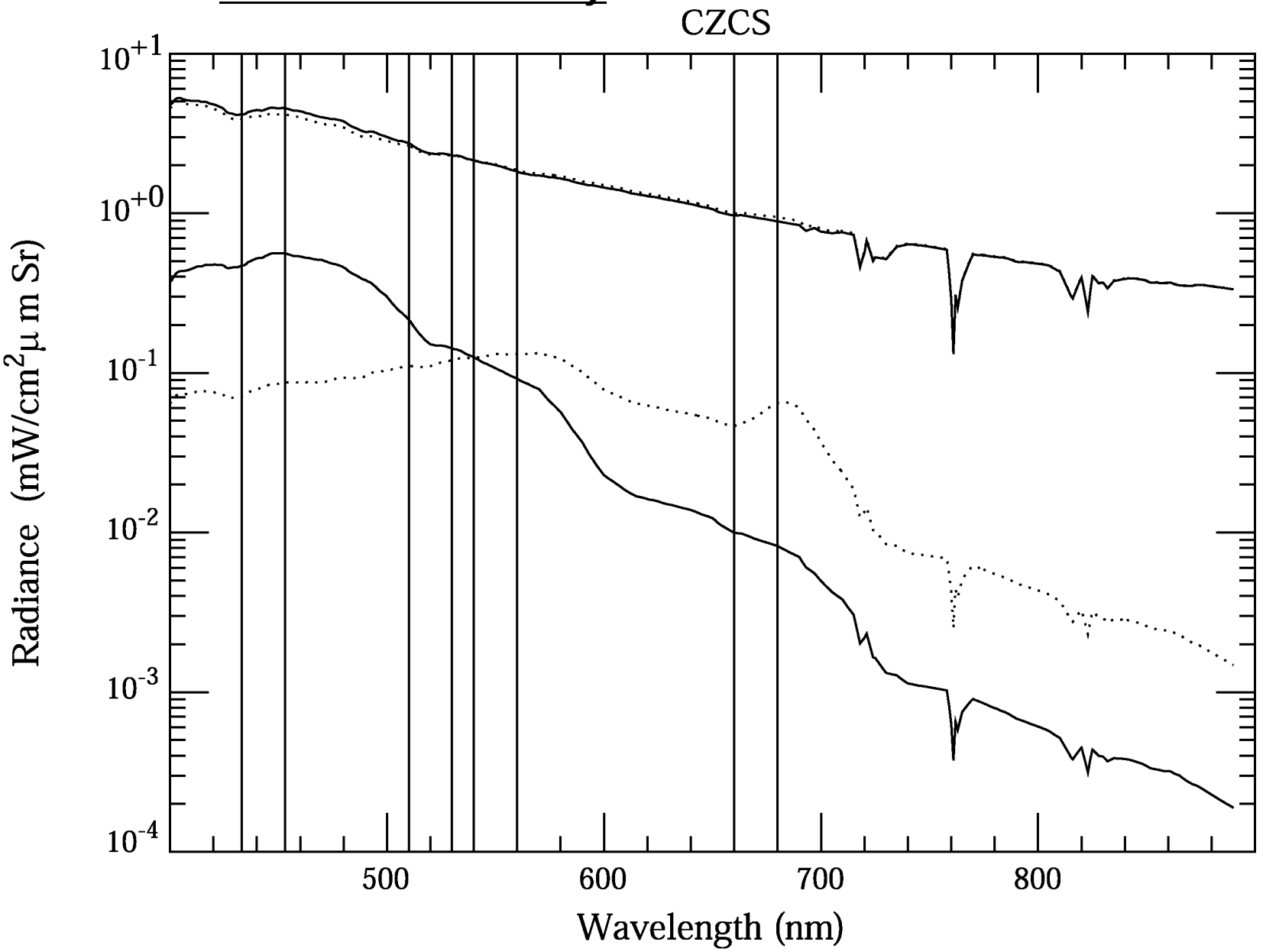
Ocean Color opportunity:

Clarke, Ewing and Lorenzen's aircraft measurements (Science, 1970) relationships have been pointed out between surface Chl and the spectra of the water leaving the ocean.



From Gordon et al.1985, in Satellite Oceanic Remote Sensing

Ocean Color Difficulty



Atmospheric correction requires a well calibrated instrument, and has a very long “lever arm”.

Rule of thumb….water is 10% of signal. Desired accuracy for Lw is 5%, so need Top of Atmosphere accuracy to be 0.5%.....Result is satellite instrument system needs to be vicariously calibrated.

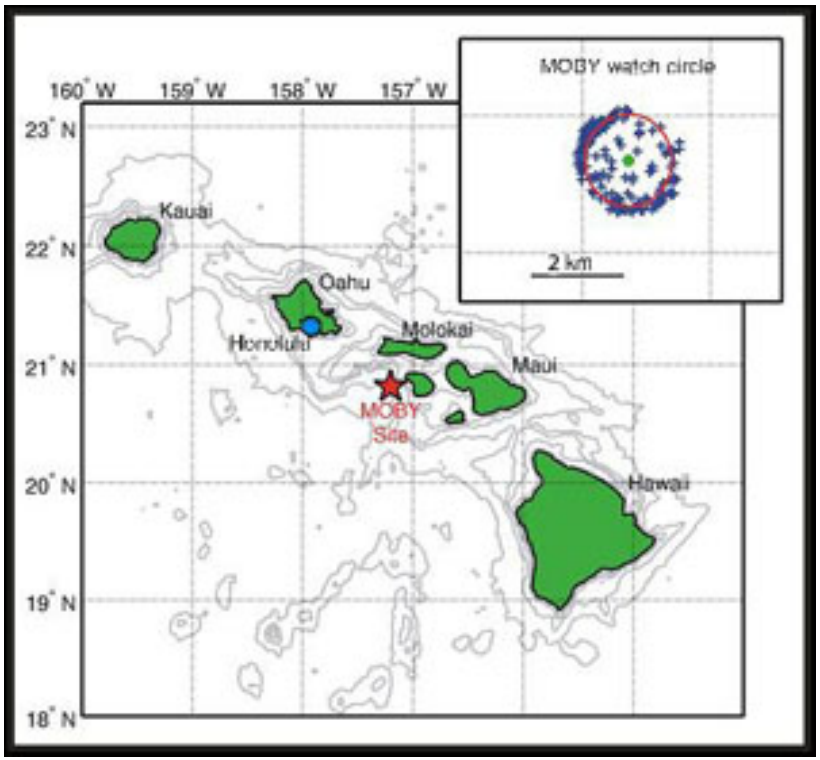
Dennis Clark (NOAA) developed an autonomous platform as a result of the CZCS experience (55 days at sea, 9 good stations).

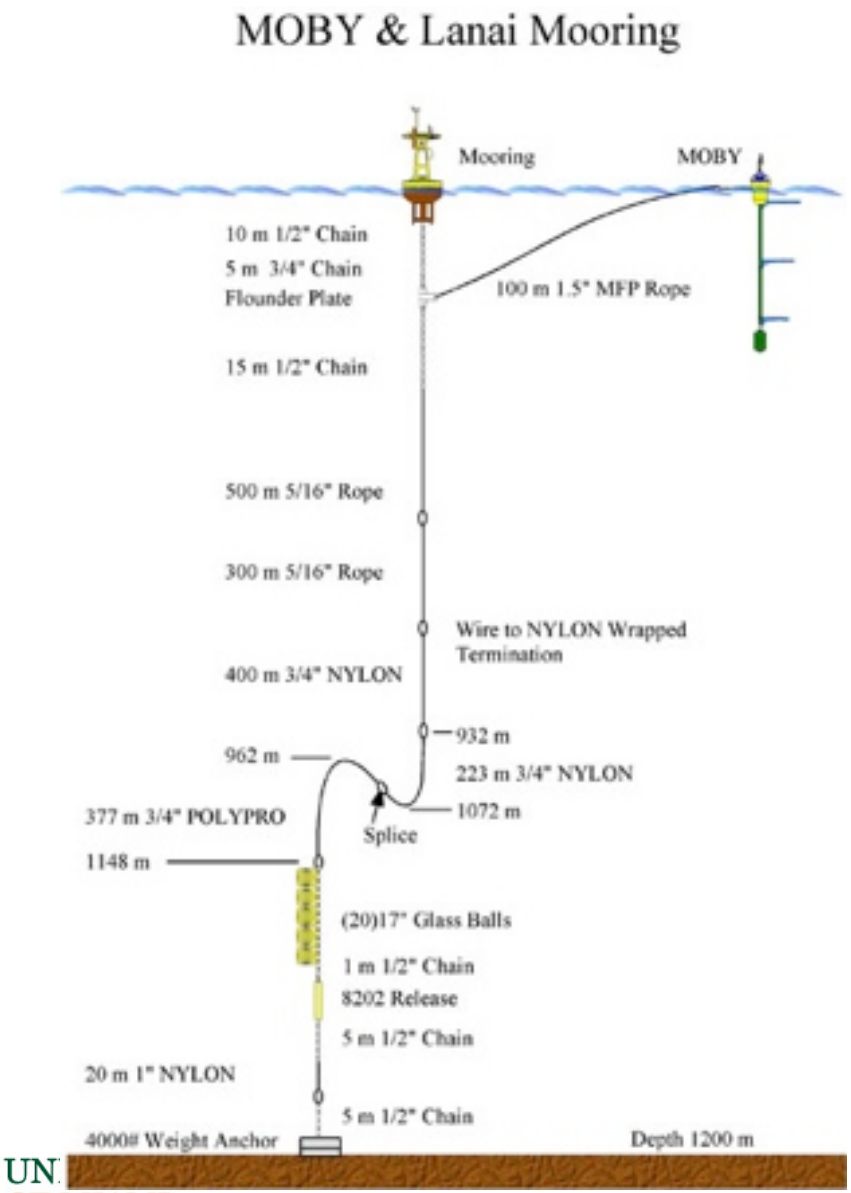
- Collect and send back data daily
- Site requirements:
  - Reasonable clear sky statistics
  - Homogeneous waters with a clean atmosphere
  - Logistically possible (close to a source of ships, reasonable chance of low sea state)
  - Communication daily (cell phone)

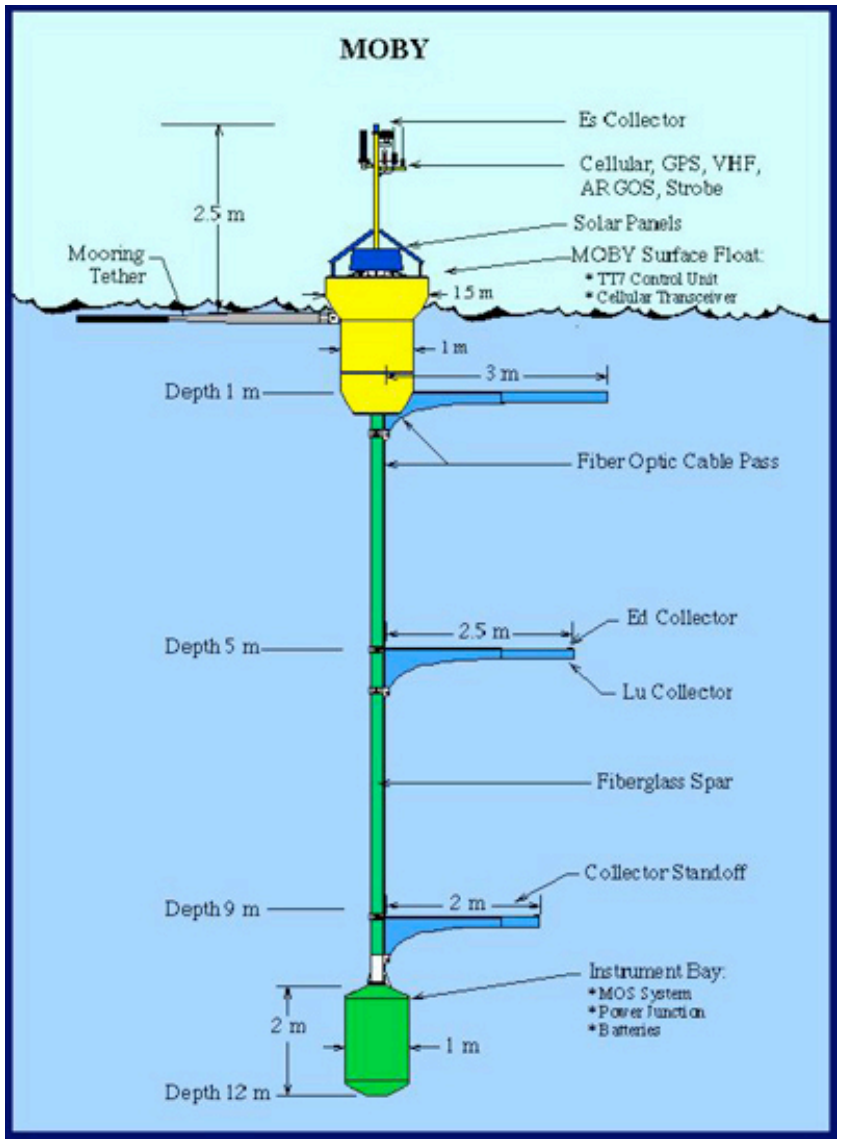
The current MOBY site is off of Lanai, Hawaii.

Tent constructed on UHMC site

Ships available







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This system has been extensively characterized

- Stray light characteristics on SIRCUS repeatedly measured, with corrections added to data
- Pre-post radiometric response with direct traceability to NIST scales and additional custom instruments monitoring of calibration sources
- Diver calibrations/cleaning monthly
- On board sources monitored daily
- Area around the site has been characterized

Pre-Aerosol, Cloud, and ocean Ecosystem (PACE) mission. Expected launch now 2022. Primary goal: “Understand and quantify global ocean biogeochemical cycling and ecosystem function in response to anthropogenic and natural environmental variability and change.”

This work is a response to the vicarious calibration development call for PACE.

PACE will measure from 350 nm to 2100 nm. Previous ocean color instruments started at around 412 nm.

Expansion into UV does two things:
1) in coastal waters, with high CDOM allows atmospheric correction to use the UV (water dark again) to constrain the lever arm.
2) in other cases, gives a better measurement to differentiate Chl from CDOM.

This work: MOBY-Net

Objective: Develop a vicarious calibration instrument which can return MOBY level Lw data from alternate sites and meets the recent IOCCG white paper goals of developing multiple vic/cal sites with:

A) identical instrumentation

B) centrally, and consistently characterized and calibrated

C) consistent and uniform data processing

This system would take advantage of the work to update and enhance the current MOBY instrument. Also addresses criticism of MOBY site (lower N.H., in glitter for MODIS and VIIRS during the summer… non tilting systems).

MOBY-Net

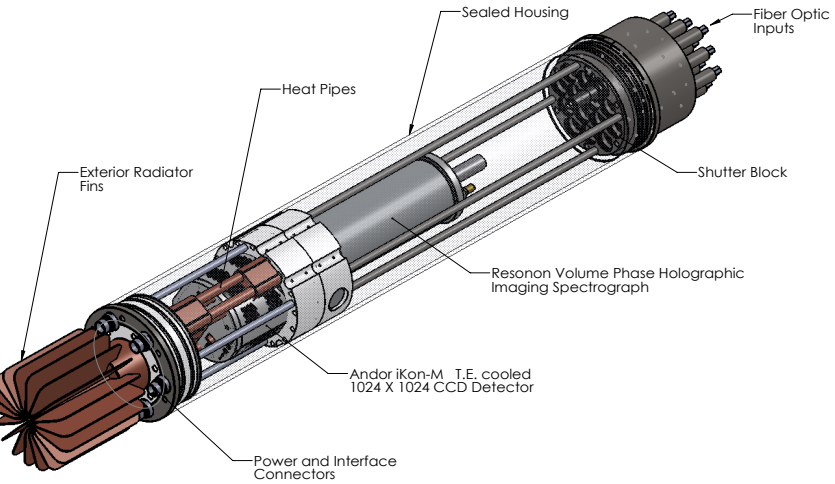
Project: Build two prototype MOBY-NET buoys that will have:

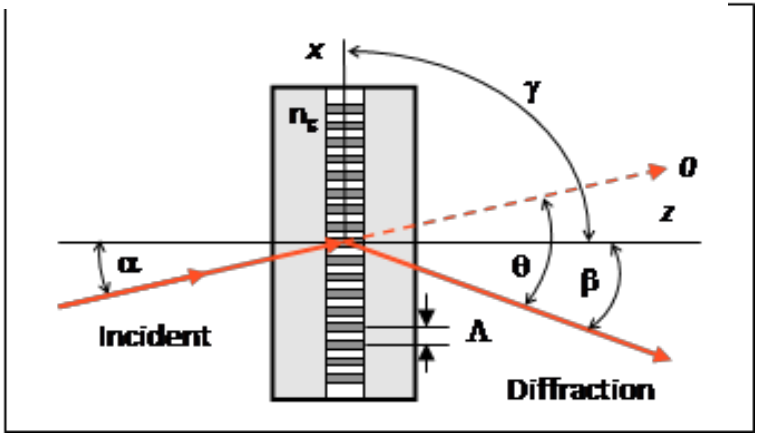
A) a buoy hull with the major structure similar to MOBY but can fit in a 40’ container and be able to accept modular optical system.

B) a modular, stable, optical system allowing installation and removal from buoy hull as an intact piece

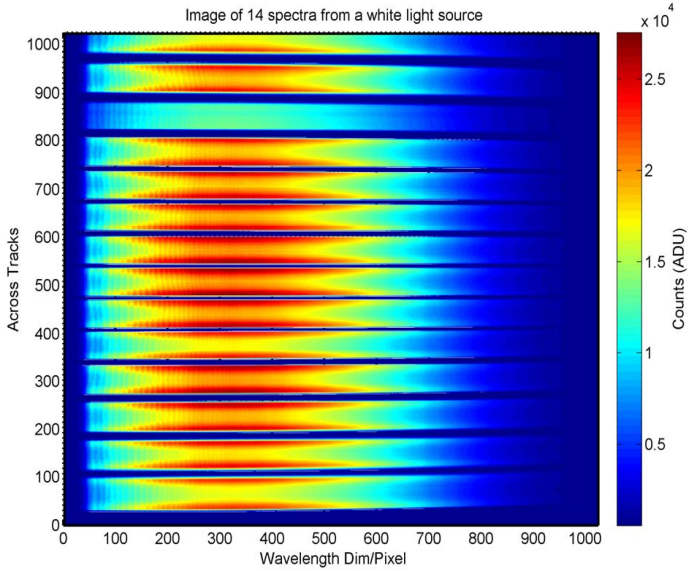
C) A separated stable source and radiometer, transported with the MOBY-NET optical system to verify system performance pre/post deployment at remote site.

In-line Volume Phase Holographic grating



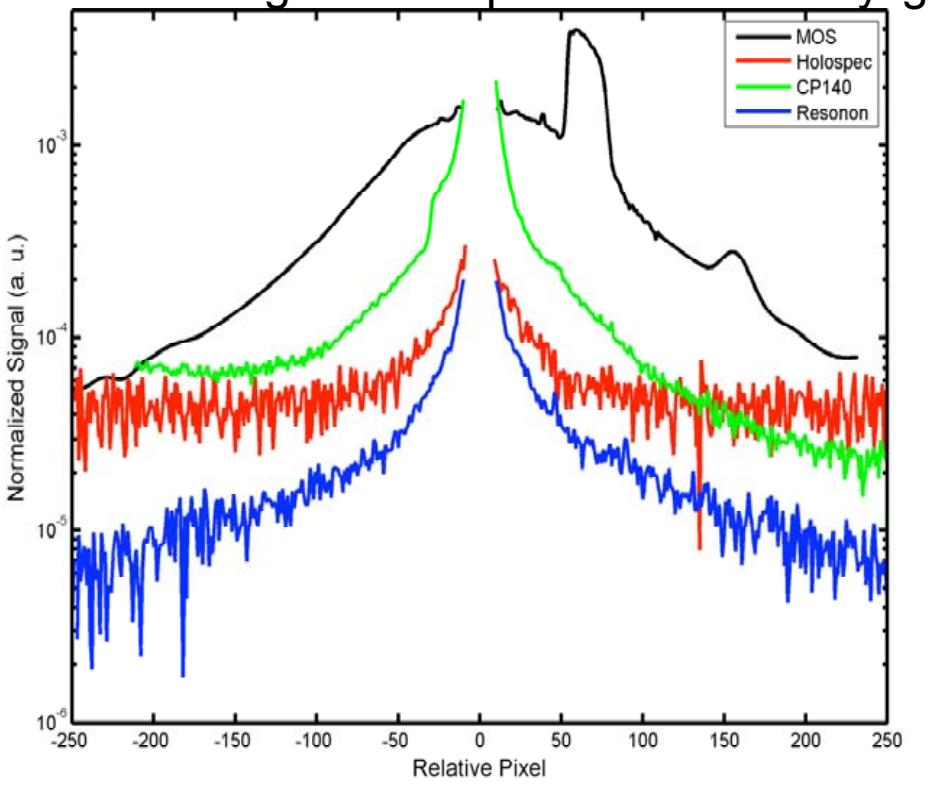


From http://www.bayspec.com/technical-support/definitions/vpg/

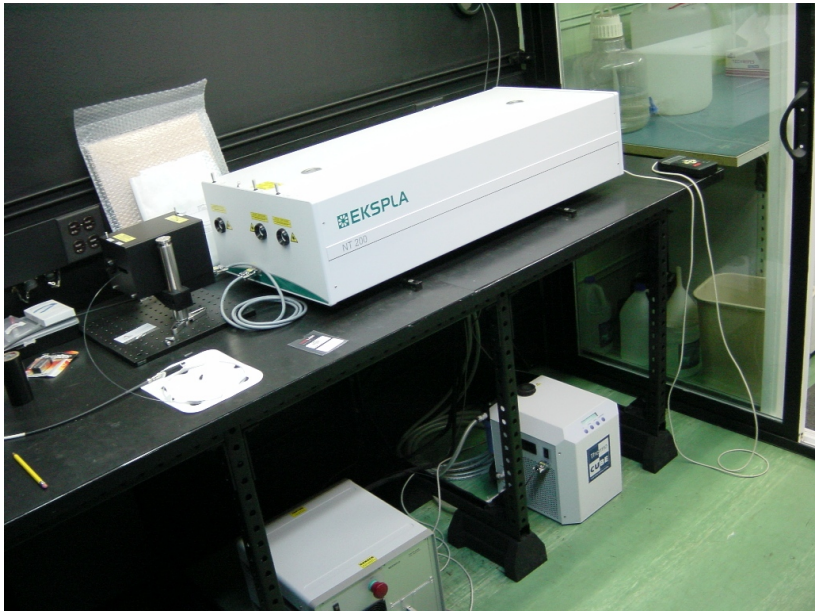


Expected Straylight response

Shown is the straylight response of the current MOBY buoy (MOS), and 3 spectrometer systems that we tested as prototypes. The blue line, labeled Resonon, is the prototype that we selected. There is more than an order of magnitude improvement in straylight performance over MOS.



The tunable laser we will be using in Hawaii to characterize the Straylight response.



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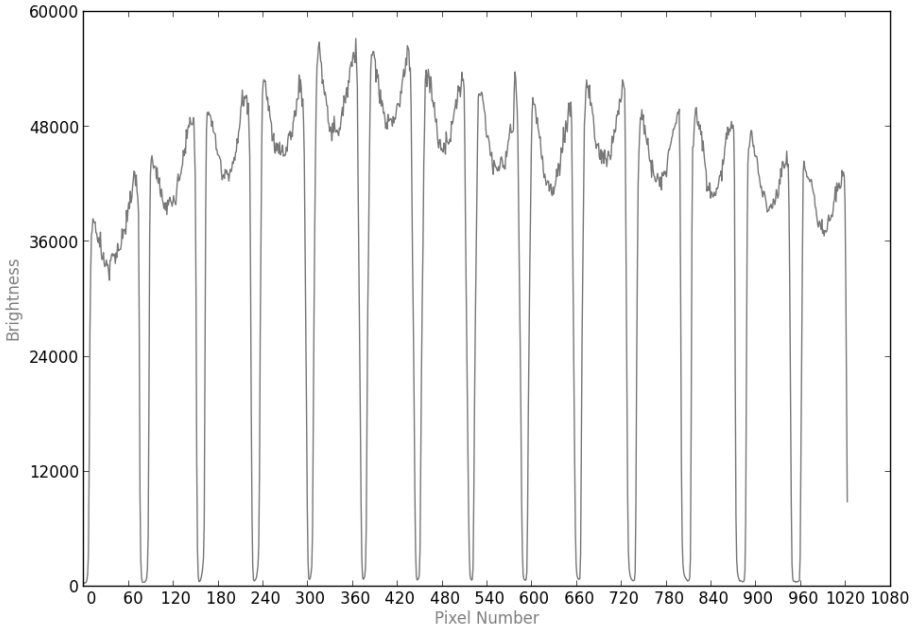
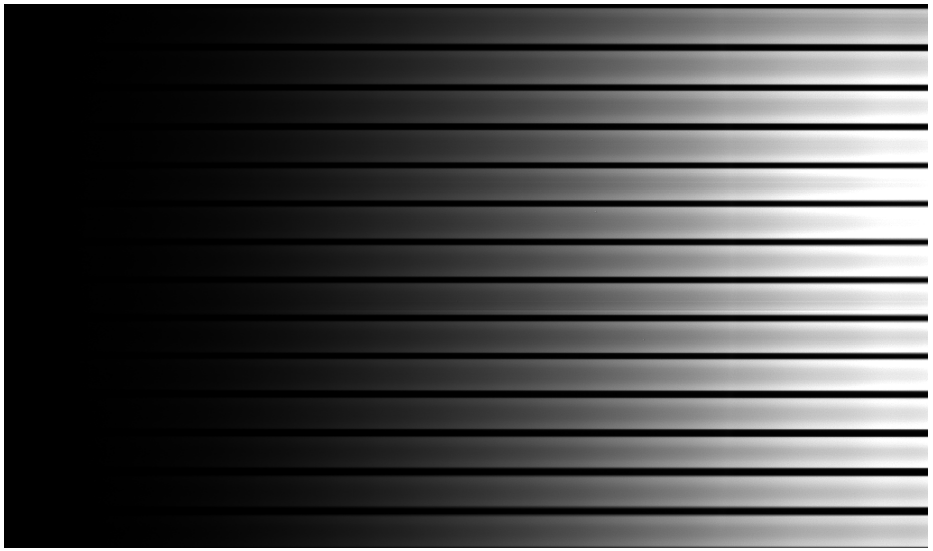
Preliminary results from the blue spectrometer prototype



White light illumination

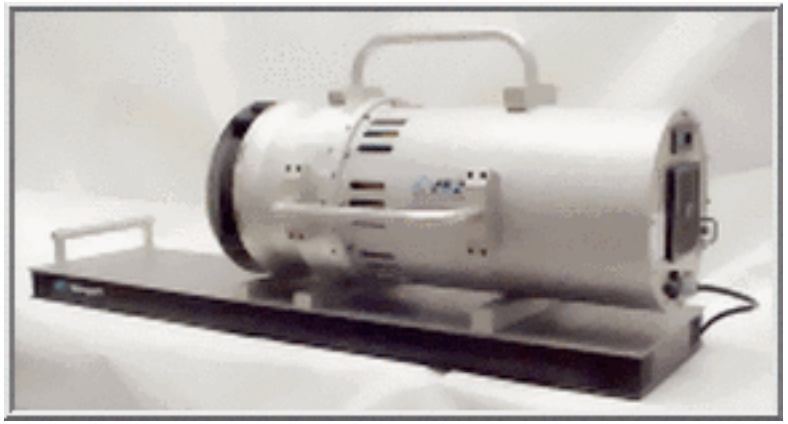
Showing spatial resolution



We will be doing spectral resolution, stray light analysis on the system in Hawaii.

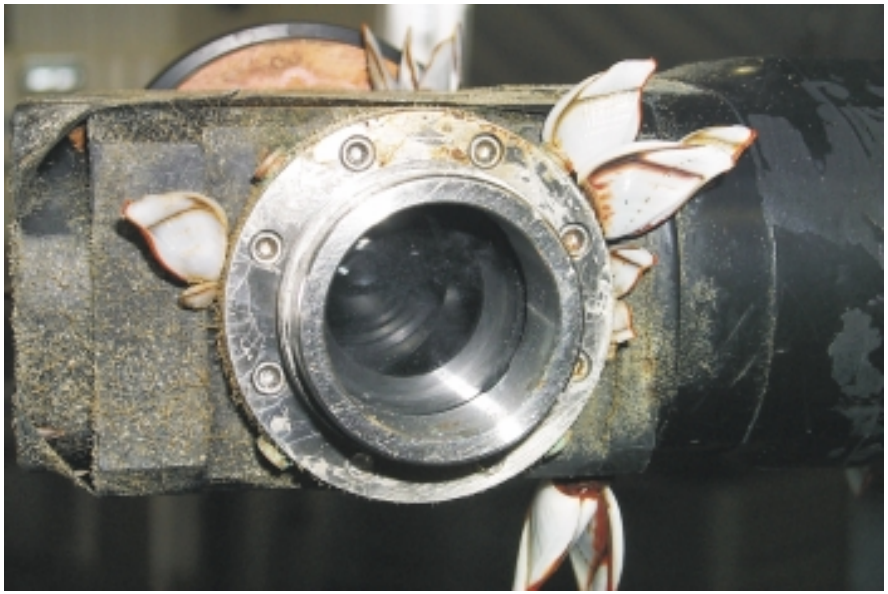
Instrument systems CAS 140CT system to be used for monitoring stability source. NIST has a lot of good experience working with these spectrometers.

Yankee Environmental Systems SQM – 5002 source that we will be using as the stability source. It also has internal detectors (two filtered detectors, one unfiltered) to monitor the lamp rings and integrating cavity.

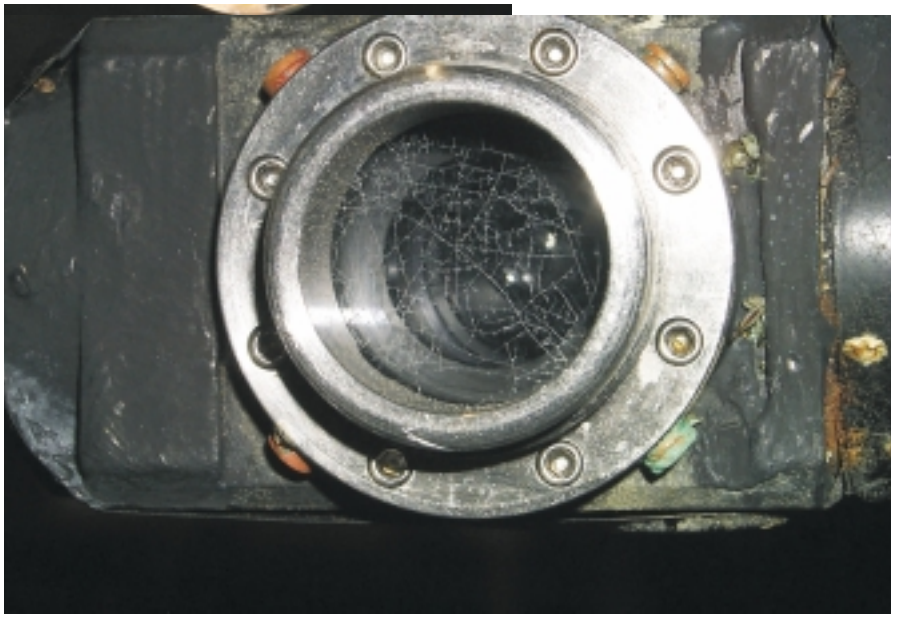


Major cost for maintaining the site is shiptime for swapping buoys.

NOTE THESE ARE EXCEPTIONALLY BAD CASES!



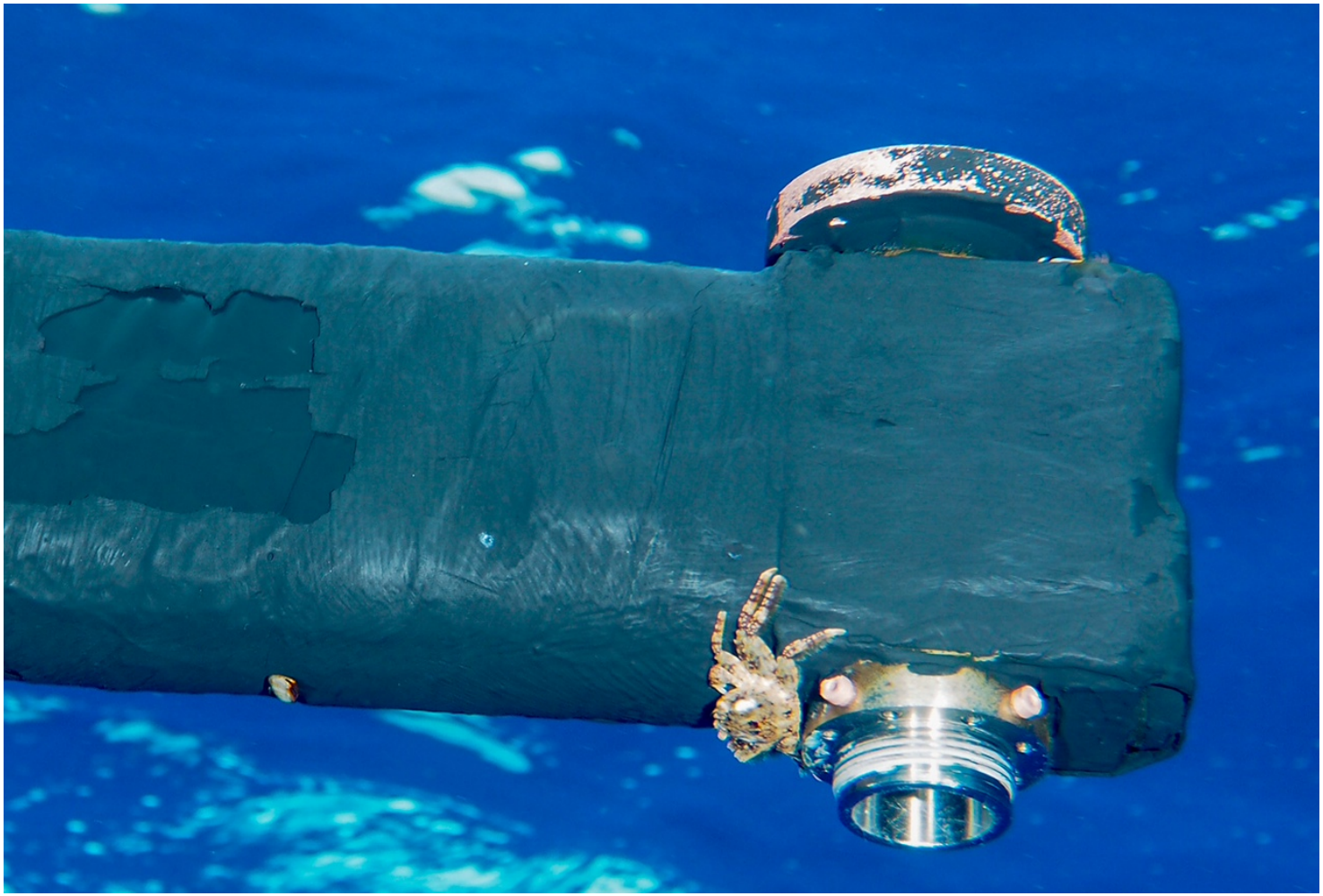
Deployment M217
6/2/2001 – 9/25/2001



Deployment M225
11/12/2003 – 2/3/2004

- Add UV Led Biofouling unit to radiometer heads. Illuminate window with 285 nm.

Will be difficult to stop these….



Conclusions

- At this point we are only 9 months into the project that consists of a lot of long lead time acquisitions.
- We are starting to get some preliminary data on instrument performance and have just gotten some prototypes to work with.
- Expect much more to report by the next ESTF meeting.