Towards an Autonomous Global Ocean Carbon Observatory

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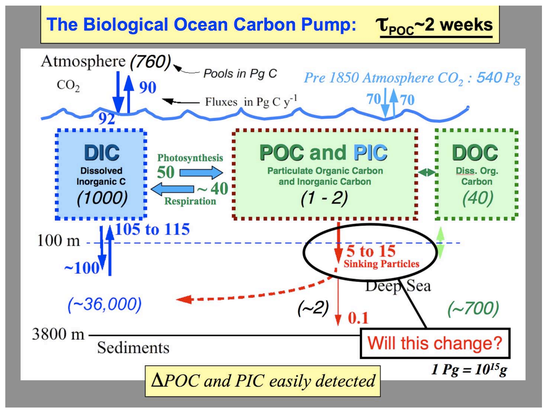
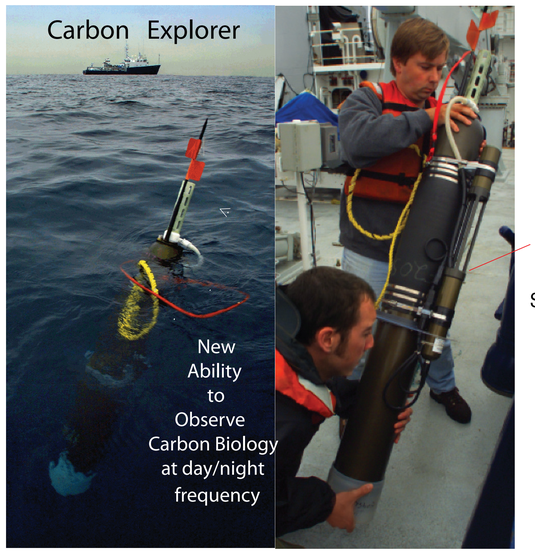
Abstract. Acidification and changes in circulation of the ocean due to increasing atmospheric CO_2 will have profound but unpredictable impacts on the natural ocean biological carbon pump, a process that naturally transports ~10 Pg C y^{-1} to waters below 100 m. The stability of the pump is in question. Prediction of future changes in the ocean carbon cycle requires cost-effective all-weather all-season observations of biotic carbon flows on appropriate time and space scales. This poster summerizes our work to address the space/time gap in ocean carbon observations.



1. Robotic Carbon Explorers Follow POC Variability 24/7 Year Round in Stormy Seas

Since 2001, a dozen low-cost long-lived robotic Carbon Explorers (optics and telemetry enhanced ARGO floats) have been deployed return real-time information on the daily variation of particulate organic carbon (POC) concentration and systematic changes in POC sedimentation to kilometer depths in the ocean. 7 years of data now.



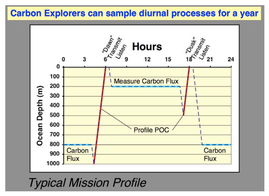
Optics Enhanced Lagrangian Float
(diurnal profiles to 1000m)

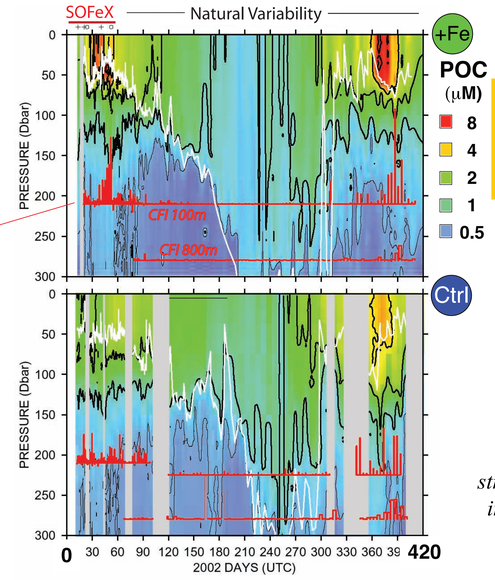
Long Lived ~1 year

Real Time Bi-directional Satellite Telemetry

Temperature, Salinity
Particulate Organic Carbon
Particulate Carbon Flux Index
Scattering

$25k per explorer = 1 ship day





ANTARCTIC CIRCUMPOLAR CURRENT 55°S

2 float "ensemble" gives two different outcomes.

Less Bloom
But Higher Export to 800 m

Wind Stress & Solar Illumination at the Surface are the same.

Wintertime Transient stratification events more frequent in Ctrl => enhanced production and less starved consumer communities.

Bishop, J.K.B., R.E. Davis and J.T. Sherman (2002) Robotic Observations of Dust Storm Enhancement of Carbon Biomass in the North Pacific. Science 298, 817-821.

Bishop, J.K.B., T.J. Wood, R.E. Davis and J.T. Sherman (2004) Robotic Observations of Enhanced Carbon Biomass and Export at 55S. Science 304, 417-420.

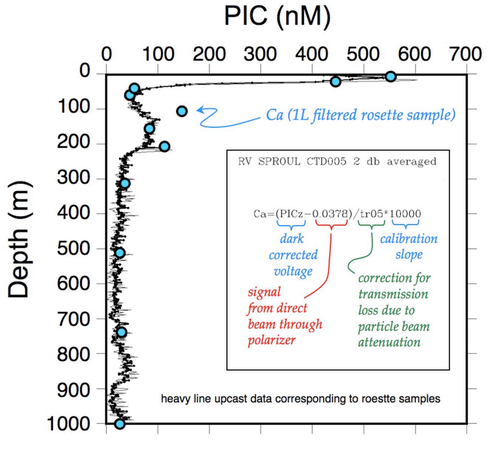
Dust delivered iron (from GOBI desert storm 2001) to HNLC N Pacific has transient (weeks) effect on phytoplankton productivity.

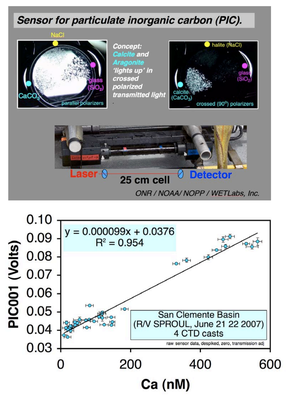
Purposeful iron fertilization has longer lived (~months) effect.... Different from dust iron. Carbon Export enhanced (at 55 S) where not expected.

Carbon Export to depth depends on population and diet of grazers in the twilight (100-1000 m) zone, and is not always proportional to surface biomass, as generally assumed.

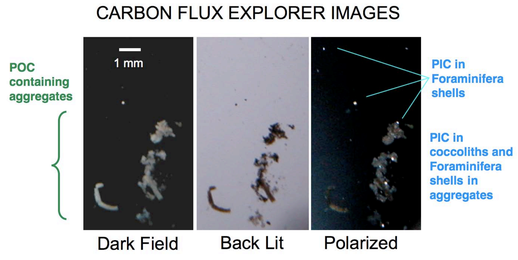
2. New PIC sensor uses Polarized light

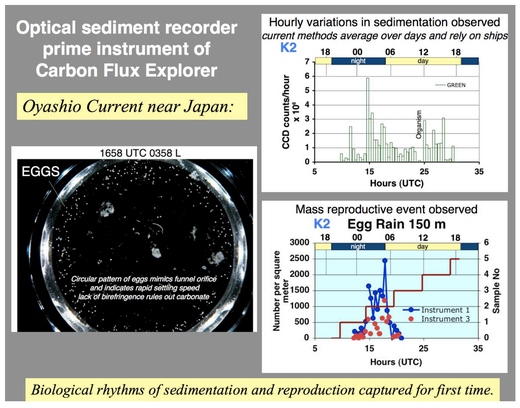
Particulate inorganic carbon (PIC) ranges from 10 nM to 40 μM in the ocean. Our sensor for particulate inorganic carbon (PIC) is now ready for commercialization. It can profile full ocean depths and detect the effects of ocean acidification on carbonate particles and producers. Power: 50 mW; ideal for all ocean platforms from floats to ship-CTDs.





3. Carbon Flux Explorer can capture hourly biological rhythms of POC and PIC sedimentation for seasons.



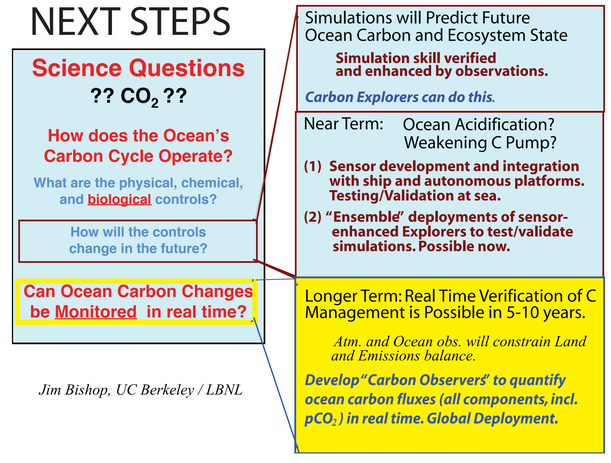


Biological rhythms of sedimentation and reproduction captured for first time.

The first Carbon Flux Explorer completed its first 2 day sea trial with operations to 800 m in June 2007. Realtime data communicated by Iridium Satellites.

4. Current and Future Effort

The immediate focus of our research is to provide fundamentally new observations on how biotic carbon flows respond to surface forcing and how ecosystem processes determine the depth profiles of particulate organic and inorganic carbon remineralizatrion.



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Carbon Explorer team: (Scripps, IDG) Russ Davis and Jeff Sherman (orbcom SOLO); (WETLabs Inc)Casey Moore, Alex Derr (POC sensor); Carbon Flux Explorer team: (LBNL) Derek Yegian, Zack Radding, Bill Edwards, Sergio Zimmerman, Jean-Francois Beche, Bryan Holmes, Russ Wells, Yoichi Kajiyama, Bill Ghiorso; (Scripps IDG) Lloyd Regier (Iridium SOLO). PIC sensor team: (WETLabs Inc) Alex Derr; (LBNL) Chris Guay, Arlon Hunt, Phoebe Lam , Alexandra Thompson (UK Antarctic Survey)..

The 50th Anniversary of the Global Carbon Dioxide Record Symposium and Celebration, Nov 28-30 2007, Kona, Hawaii

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