Development of a Next Generation Platform and Instrumentation for Continuous Ocean Observations (PICO) for Reducing the Costs of Observations

Christian Meinig, William S. Kessler
Pacific Marine Environmental Laboratory, NOAA, Seattle, WA

Table of Contents

1. Project Summary 1
2. Scientific and Observing System Accomplishments 2
   2.1. Outreach and Education 6
3. Publications and Reports 7
   3.1. Publications by Principal Investigators 7

1. Project Summary

The purpose of developing a Platform and Instrumentation for Continuous Observations (PICO) is to advance the state of NOAA's open ocean observation systems with the development of an easy-to-deploy and low-cost mooring system that makes use of novel buoy technology and commercially available sensors and instrumentation (www.pmel.noaa.gov/pico). This Next Generation Climate Observation project is developing low-cost/high quality modular components of moored ocean sensor platforms to enhance and eventually replace the tropical moored arrays that are a cornerstone of the climate observing system. One module is the PRAWLER (Profiler + Crawler) mooring development, which will strengthen our moored sampling capability by producing well-resolved vertical profiles (an advance over the present few discrete samples), and adding reliable and routine salinity sampling to the suite of measurements. The sampling is also reconfigurable in real time, allowing adjustment for process studies, responses to storms or marine disasters, and power management. The PRAWLER is also significantly cheaper and easier to maintain than the Tropical Moored Buoy Array technology presently used. In FY12 we built on two years of development work by deploying two PRAWLER moorings in the subtropical Atlantic as part of the SPURS (Salinity Processes in the Upper Ocean Regional Study) experiment. After extensive testing over the past two years in Puget Sound and off Hawaii, the PRAWLER technology is ready for in-situ comparison per the Climate Monitoring Principles.

Users of this technology include: 1) ocean and atmospheric researchers and program managers studying the global water cycle; and 2) engineers at NOAA who are evaluating the quality and endurance of the PRAWLER moorings for possible future inclusion in the Tropical Moored Array by following the 10 GCOS Climate Monitoring Principles. Users of the data collected during the SPURS experiment are climate researchers, met services, warning and forecast managers, and industry.

2. Scientific and Observing System Accomplishments

This project involves the development and deployment of new technology. The main development in FY12 was a PRAWLER (Profiler + Crawler) instrument that uses wave energy to climb up a surface mooring line and then profile between selectable ocean depths (typically from 3m to 450 m). The PRAWLER presently incorporates a newly commercialized Seabird PRAWLER pumped CTD, but in future years could include a micro-current meter or bio-geochemical sensors such as DO or pH. The PRAWLER uses no battery power for locomotion and has a heave energy conversion rate of ~80%; that is, for every 1 m of wave heave, the PRAWLER climbs 80 cm. All sampling is done during (free-falling) descent at user-defined intervals and all data is returned in real time.

a. How did your project deliverables serve the observing system's program deliverables .

   The PRAWLER and buoy technology development serve the programs goals of:

   • *Sea Surface Temperature and Surface Currents, to identify significant patterns of climate variability and change*

   • *Ocean Heat Content and Transport, to better understand the extent to which the ocean sequesters heat; to identify where heat enters the ocean and where it emerges to interact with the atmosphere; and to identify changes in thermohaline circulation and monitor for indications of possible abrupt climate change*

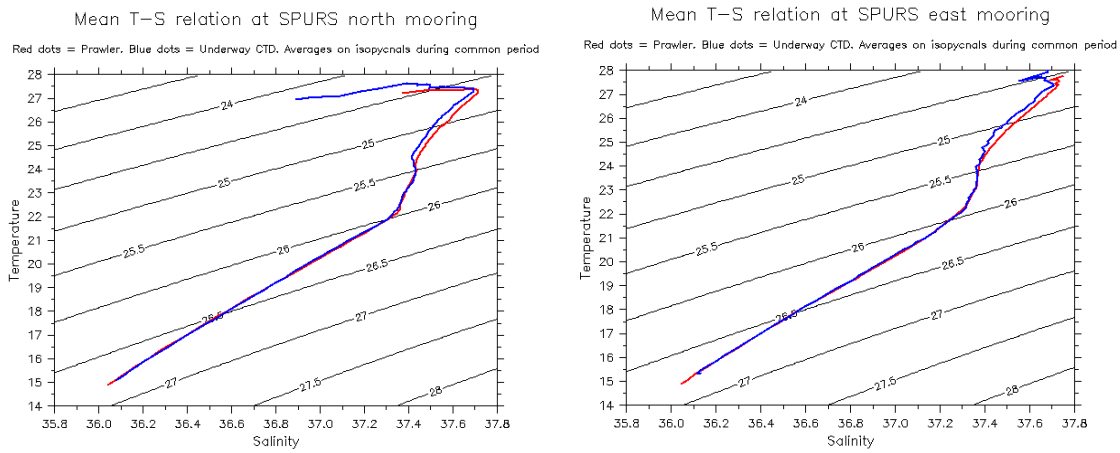
   • *Air-Sea Exchanges of Heat, Momentum, and Fresh Water, to identify changes in forcing functions driving ocean conditions and atmospheric conditions; and to elucidate oceanic influences on the global water cycle.*

b. What did you achieve during FY 2012?

   The deliverables for FY 2012 include:
   (a) recovery of two systems that had been deployed for 6 months off Oahu (January 2012 from the contract vessel M/V KAHANA) and
   (b) redeployment of the same two systems in the subtropical Atlantic (25°N 38°W in September 2012 from the R/V KNORR) as part of the SPURS project. The two SPURS PRAWLERS were placed 20km north and east of the SPURS anchor mooring. This gives us a year-long check on PRAWLER performance, while the PRAWLERS provide the essential temperature and salinity gradients that allow advective fluxes to be calculated at the anchor mooring. Four new SPURS PRAWLERs were built, calibrated, and updated with the latest software that includes an expanded set of bi-directional commands for better vehicle control and data reporting. The systems were extensively tested in Puget Sound to further the software testing and evaluation prior to shipping to SPURS. The systems deployed at SPURS in Sept '12 include the following measurements:

   a) CTD profiles from 5-450m (typically 8 profiles per day)
   b) Wind, AT/RH, Baro, Rain (hourly)

c) GPS, time (daily)

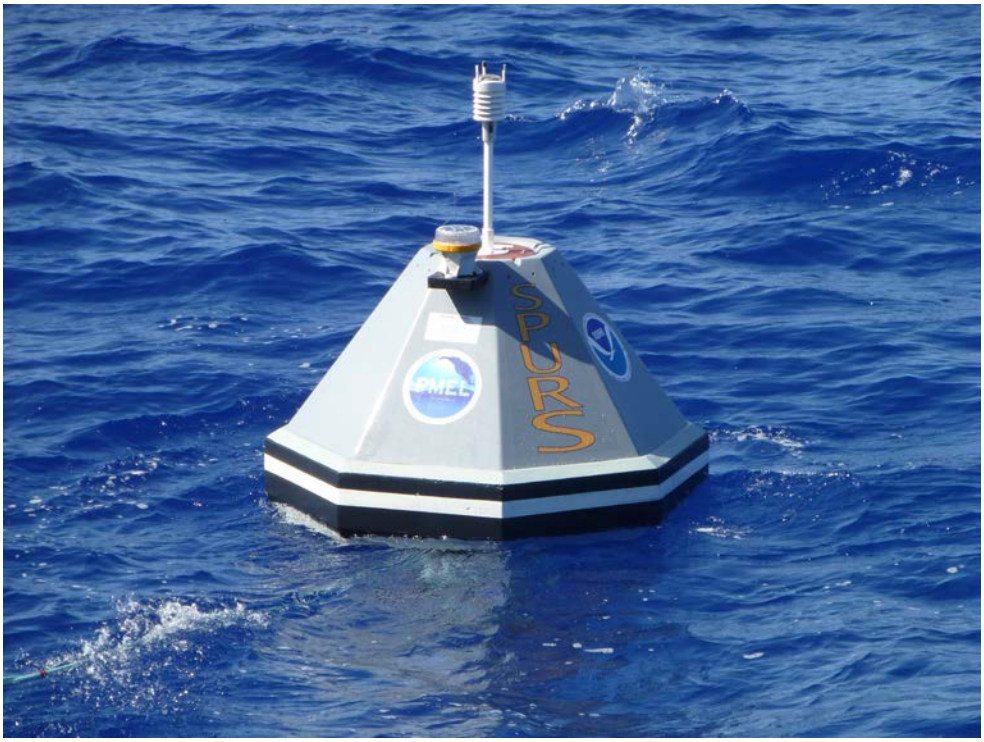


Mean T-S relation between PRAWLER and U-CTD from 70 U-CTD Profiles and 88 PRAWLER Profiles Sept. '12

c. What scientific advances were made and/or facilitated through your activities?

The technology advances made during this year include improvements in the reliability and software of the PRAWLER vehicles. An improved magnetic coil actuator was run thru 12,000 cycles (1 year at sea) without failure or degradation. New software commands allow for remote reboot of the PRAWLER and additional flexibility in the number of profiles per day, CTD sampling frequency and power savings in the sampling scheme, based on scientific needs.

PICO buoy recovery from M/V KAHANA Jan '12



PICO-PRAWLER deployment in SPURS, Sept‘12

PRAWLER on SPURS Deployment Sept’ 12

d. What is the significance of these advances?

The significance is developing alternative and complimentary technology that is much more cost effective than traditional Tropical Moored Buoys. CTD profiles offer researchers an additional and adaptive tool rather than fixed discrete-level measurements. The present SPURS comparison with WHOI discrete sensors will provide insight on the performance and value of the Prawler. Additionally MET comparisons will allow an evaluation of the ability to make accurate met measurements from a very small buoy.

e. What, if any, information was jeopardized due to a lack of funding, lack of instrumentation, or inability to carry out the work?

Because of lack of funding, advance tests had to be conducted in Puget Sound rather than in the ocean, which may not give a true representation of the systems robustness. The current SPURS test is the ocean prototype test of the complete system.

Also, additional test on the complete 'easy-to-deploy' PICO system have been suspended until additional funding is available. The all in one system is the goal to provide a flexible and low-cost Tropical Moored Buoy to the oceanographic community.

f. What is the web site for your program?

www.pmel.noaa.gov/pico. Data from SPURS is currently being evaluated by Dr. Billy Kessler on an internal server at PMEL and is being compared with shipboard CTDs and with each other. However, the WHOI buoy data is not available in realtime, so those comparisons will most likely be complete in FY'14.

For projects involved with data collection, please address the following questions:

a. Are your data distributed in real time on the Global Telecommunications System?

As this is a technology development project, the data are not distributed in realtime via the GTS.

b. Where do your real time data reside? Are the data available online?

The data are available in realtime on an internal PMEL server and are currently being compared to ship-based Underway CTD and shipboard CTD profiles that were taken on the R/V KNORR during the SPURS cruise.

c. Where do your delayed mode data reside? Are the data available online? What is the date of the most recent data available publicly?

In case of telecoms failure all data are backed up on-board the PRAWLER and will be evaluated once the systems are recovered.

d. Where are your data archived and with what frequency?
N/A

e. ***REVISED***: What is the web site where the data for your program can be accessed? If you haven't updated your web site recently, please do so now.

www.pmel.noaa.gov/pico

f. ***REVISED***: Have you successfully retrieved your program's data from the website or Data Assembly Center where your data reside, just to ensure the accessibility of the data?
N/A

g. ***NEW***: Do you have a data management plan for the data collected as part of your project? If so, list the url where the data management plan can be found.
N/A

h. ***NEW***: Is your observing project compliant with the National Environmental Policy Act (NEPA) and other NOAA Environmental Statutes (e.g. Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), Essential Fish Habitat (EFH), and the National Marine Sanctuaries Act (NMSA)?

Unknown at this time.

2.1. Outreach and Education

Education and outreach was primarily accomplished thru an updated website www.pmel.noaa.gov/pico and on the PMEL Buoy YouTube channel: http://www.youtube.com/playlist?list=PLE575643A95F6CED2&feature=plcp

International collaborations included outreach and training to Japanese, Indian and Australian engineers and scientists. Also, during FY'12~50 middle school students at NOAA Summer program were given tours of the technology and the importance of climate observations. Additionally ~12 tours were given to students and academics and an open house to the general public highlighting NOAA developed technology, including PICO and PRAWLER.

Additionally, talks have been on-going with the San Francisco Exploratorium, http://www.exploratorium.edu/ that is very interested in featuring realtime climate observations in the museum with exhibits of PMEL technology.

3. Publications and Reports

3.1. Publications by Principal Investigators

- Proceedings from conferences

Meinig, C., Milburn, H., Stalin, S., Gliege, B., 2012: CTD Profiling Using Wave energy from a Surface Mooring, next steps toward next-gen Tropical Moored Buoys. 9 th ONR-MTS Buoy Workshop Proceedings., CD-ROM, S.7.