

Data Management for an in situ Ocean Acidification Experiment

Headley, K.L.¹, Peltzer, E.T.¹, Herliem, R.A.¹, O'Reilly, T.C.¹, Miller, M.², Fountain, T.R.², Edgington, D.R.¹, Tilak, S.², Kirkwood, W. J.², Barry, J.P.¹, Brewer, P.G.¹

- 1) Monterey Bay Aquarium Research Institute, 7700 Sandhill Rd, Moss Landing, CA
- 2) California Institute of Telecommunications and Information Technology, UCSD La Jolla, CA, 92093, USA
- 3) Cyclonia, Lacombe, NH, 93346, USA



Contact: headley@mbari.org



In situ ocean acidification experiments pose data challenges

Questions regarding the use of laboratory studies of the effects on ocean acidification (OA) have led researchers towards conducting more integrative field studies. New techniques and methods are emerging to observe the systemic, long-term effects of increasing atmospheric CO₂ on various ecosystems and habitats.

Monterey Bay Aquarium Research Institute (MBARI) has been developing a package of technology and expertise called *swFOCE* (seawater Free Ocean CO₂ Enrichment). *swFOCE* aims to enable researchers to draw on existing technology, methods, and expertise to conduct cost-effective in situ ocean acidification experiments.

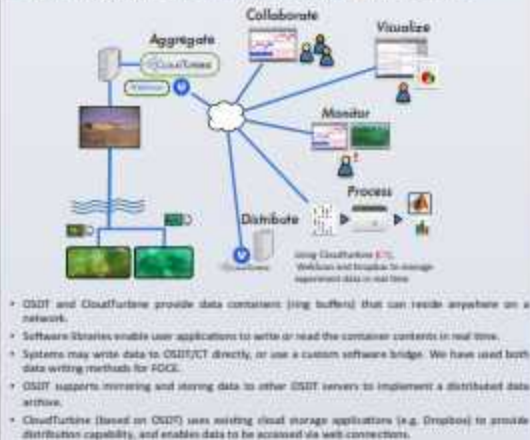
In situ experiments will be multifaceted, use complex apparatus, and require long time scales, producing a large volume of science and engineering data.

Collaboration will increase scientific productivity and reduce cost, but introduces new data management needs. Application will also increase the volume of data to archive and use. Here we explore the use of some recent software to increase research productivity, to help collect and distribute *swFOCE* data, and enable collaboration.



Open Source DataTurbine, CloudTurbine help manage and use data

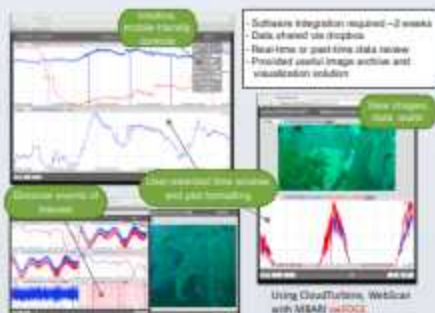
- Two MBARI *swFOCE* implementations use low-cost hardware and custom software for basic data acquisition and archiving.
- Open Source DataTurbine (OSDT), CloudTurbine (CT) and WebScan enable users to view experiment data streams and images in near real time, using a web browser from remote locations.
- CloudTurbine, WebScan used in science and system operation workflows during *swFOCE*.



- A typical CloudTurbine configuration consists of:
- PC running CTServer, handles requests for CT archive data.
 - A web server supports WebScan access to the CT server.
 - CT archive data is organized using a naming convention based on timestamps.
 - Data is written to the CT archive directly from user applications, or using the Client software library component.

Using CloudTurbine, WebScan with swFOCE data

- Desktop PC hosted experiment data mirror site and CloudTurbine server.
- *swFOCE* system software updated server data from experiment every five minutes.
- Two simple applications written to bridge CloudTurbine with *swFOCE* experiment and camera data streams.



- CTServer and WebScan used in *swFOCE* operation and science workflows.
- Users control WebScan time window, number of plots, and plot formats.
- CTServer displays time ranges of seconds to several weeks.
- *swFOCE* data mirrored and shared externally using Dropbox.
- WebScan was useful for sharing data in meetings, and helped to detect a software fault.
- CloudTurbine, WebScan provided complete, basic image archive solution.
- User experience feedback provided to WebScan and CloudTurbine developers.

Conclusions

- Open source DataTurbine, CloudTurbine, and WebScan provide useful, easy-to-use data management capabilities that would be expensive and time consuming to develop.
- The functions enable data distribution, archiving, collaboration, monitoring and data visualization for science experiments. For the *swFOCE* experiment, CloudTurbine and WebScan were easy to integrate into the existing software architecture with minimal new software development.

Resources

Open Source DataTurbine	http://dataturbine.org	OSDT	CT
CloudTurbine	http://cloudturbine.net	FOCE	swFOCE
swFOCE	http://www.mbari.org/PdfA-1350&L=FOCE		
eFOCE	http://www.efoce.org		

Acknowledgements

We gratefully acknowledge the funding support provided by the National Science Foundation and the David and Lucile Packard Foundation, as well as the support and interest of the MBARI *swFOCE* team and the *swFOCE* developer community.