



OCEANOGRAPHIC DECISION SUPPORT SYSTEM (ODSS) A TOOL TO IMPROVE EFFICIENCY OF BIOLOGICAL OCEAN STUDY

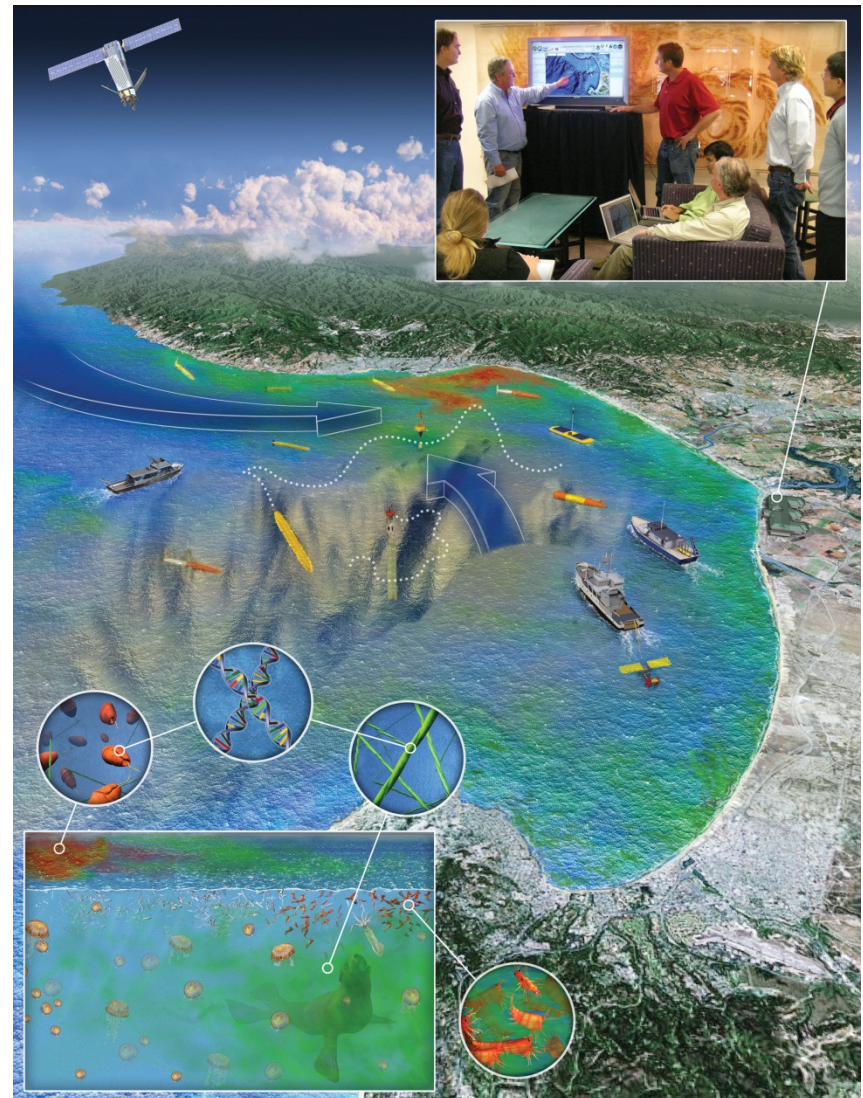
Maughan, T. G., MBARI, Moss Landing, USA, tm@mbari.org
Rajan, K. ., MBARI, Moss Landing, USA, kanna@mbari.org
Bellingham, J. G., MBARI, Moss Landing, USA, jgb@mbari.org
McCann, M. ., MBARI, Moss Landing, USA, mccann@mbari.org
Cline, D. ., MBARI, Moss Landing, USA, dcline@mbari.org
Gomes, K. ., MBARI, Moss Landing, USA, kgomes@mbari.org
O'Reilly, T. ., MBARI, Moss Landing, USA, oreilly@mbari.org
Edgington, D. ., MBARI, Moss Landing, USA, duane@mbari.org
Das, J. ., USC, Los Angeles, USA, jnaneshd@usc.edu
Chavez, F. ., MBARI, Moss Landing, USA, chfr@mbari.org

MBARI “CANON” Initiative

Controlled Agile Novel Observation Network

CANON Science

- Persistent ocean presence reveals ecosystem dynamics
- Four science research themes in CANON.
 - Coastal phytoplankton blooms
 - Zooplankton dynamics
 - Oxygen minimum zones and ocean acidification
 - Open ocean eddies and global primary production.



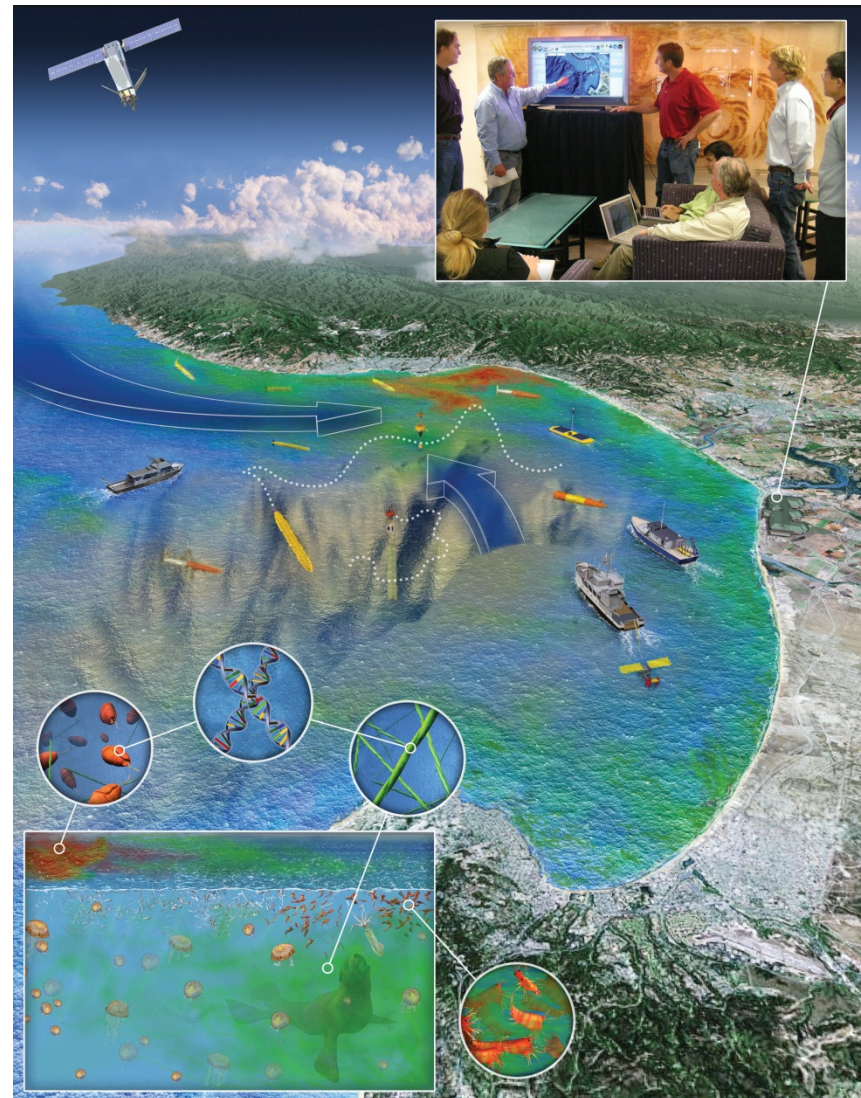
Copyright D. Fierstein

MBARI “CANON” Initiative

Controlled Agile Novel Observation Network

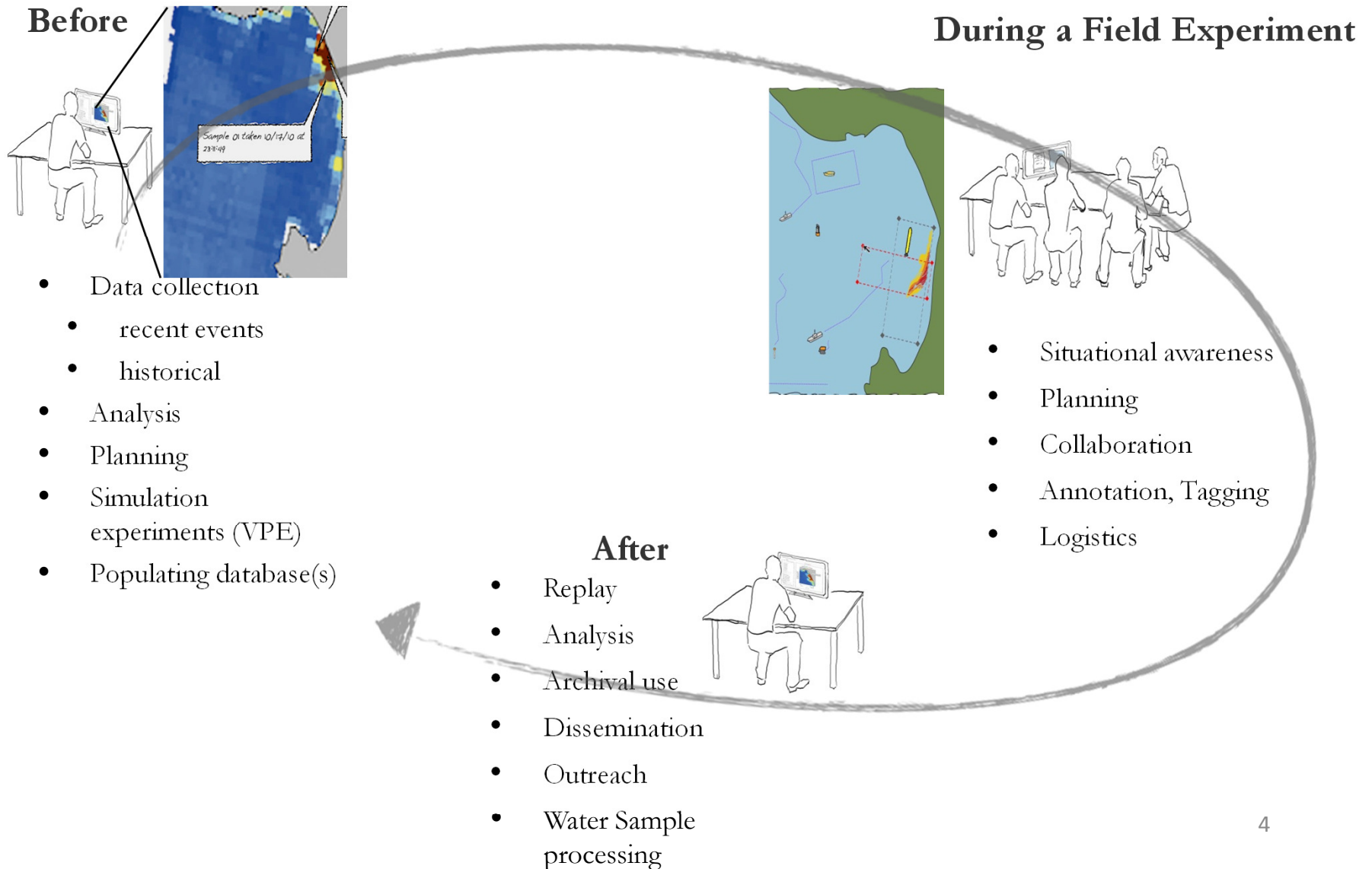
CANON Technology

- Each CANON science theme involves:
 - Process driven, ecologically oriented field experiments
 - Multi-platform, multi-sensor, multi-disciplinary, multi-scale
 - AUV, LRAUV, Gliders, Drifters, Ships, ...
 - ‘Patch Tracking’ - Map, Tag, Track and Sample.
- Technology themes in CANON
 - Sampling
 - Experiment and Data Management
- Need technology support for:
 - Experiment planning,
 - Collaboration and communication
 - Visibility on ‘what is happening’ in real time
 - Autonomous asset control
 - Logistic agility for platform planning
 - Centralized data access for analysis, data and results sharing
 - Experiment logging – why, what, where, when
 - Dissemination



Oceanographic Decision Support System (ODSS)

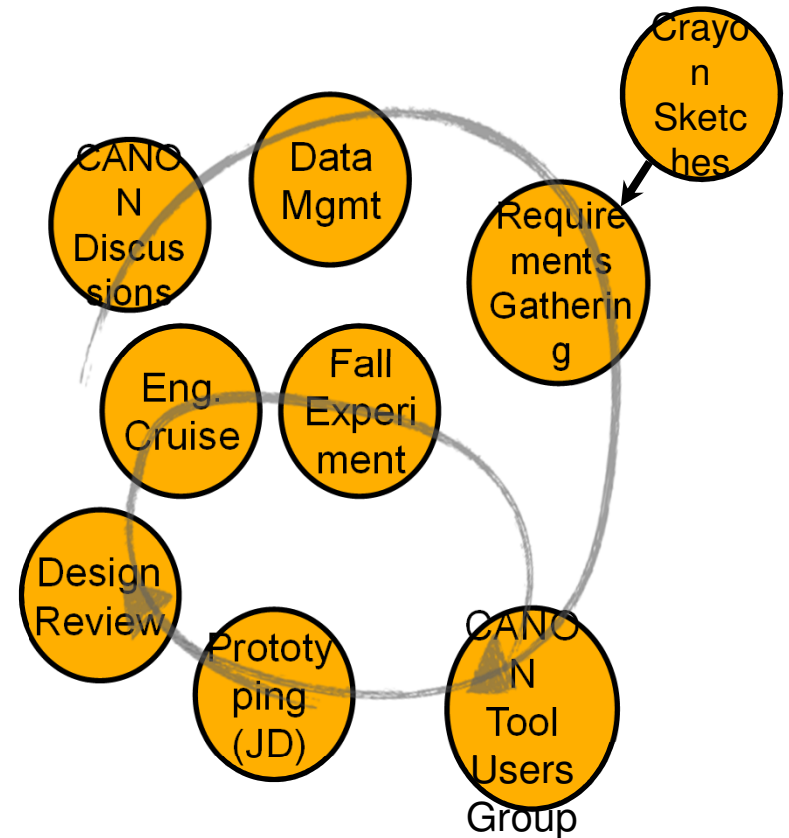
CANON Workflow



Software Development Approach

Spiral Development

- Feasibility study started in 2010 by the MBARI Autonomy group in collaboration with the AOSN team.
- CANON experiment workflow analysis
- Prototyping and 'agile' software development
- User requirements gathering:
 - Pencil sketches of feature ideas to aid the conversation with scientists



Click through examples of

PENCIL SKETCHES

CANON Decision Support System

Data

Data Planning Logistics

- Data Sources

- MODIS
- HF Radar
- MERIS
- Chlorophyll
- Current
- Provenance
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]

- Live Data

- + DSS Plan Data
- [Hatched Pattern]
- [Hatched Pattern]

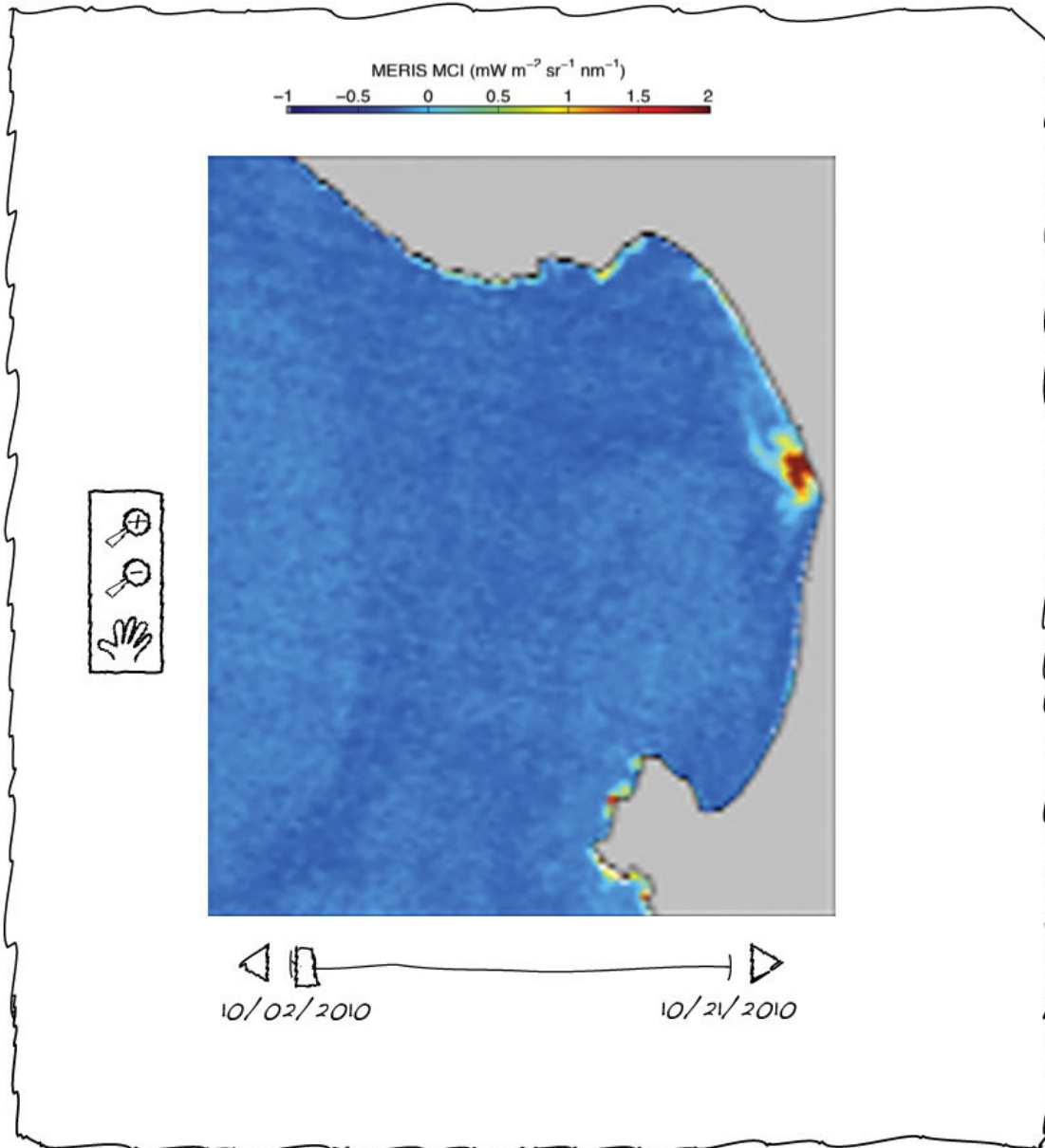
- Forecast

- 4D Bio-Physical Model
- [Hatched Pattern]
- [Hatched Pattern]

Event Notification

- [Warning Icon] [Hatched Pattern]
- [Warning Icon] [Hatched Pattern]

Visualization



CANON Decision Support System

Data

Data Planning Logistics

- Data Sources

- MODIS
- HF Radar
- MERIS
- Chlorophyll
- Current
- Provenance
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]

- Live Data

- + DSS Plan Data
- [Hatched Pattern]
- [Hatched Pattern]

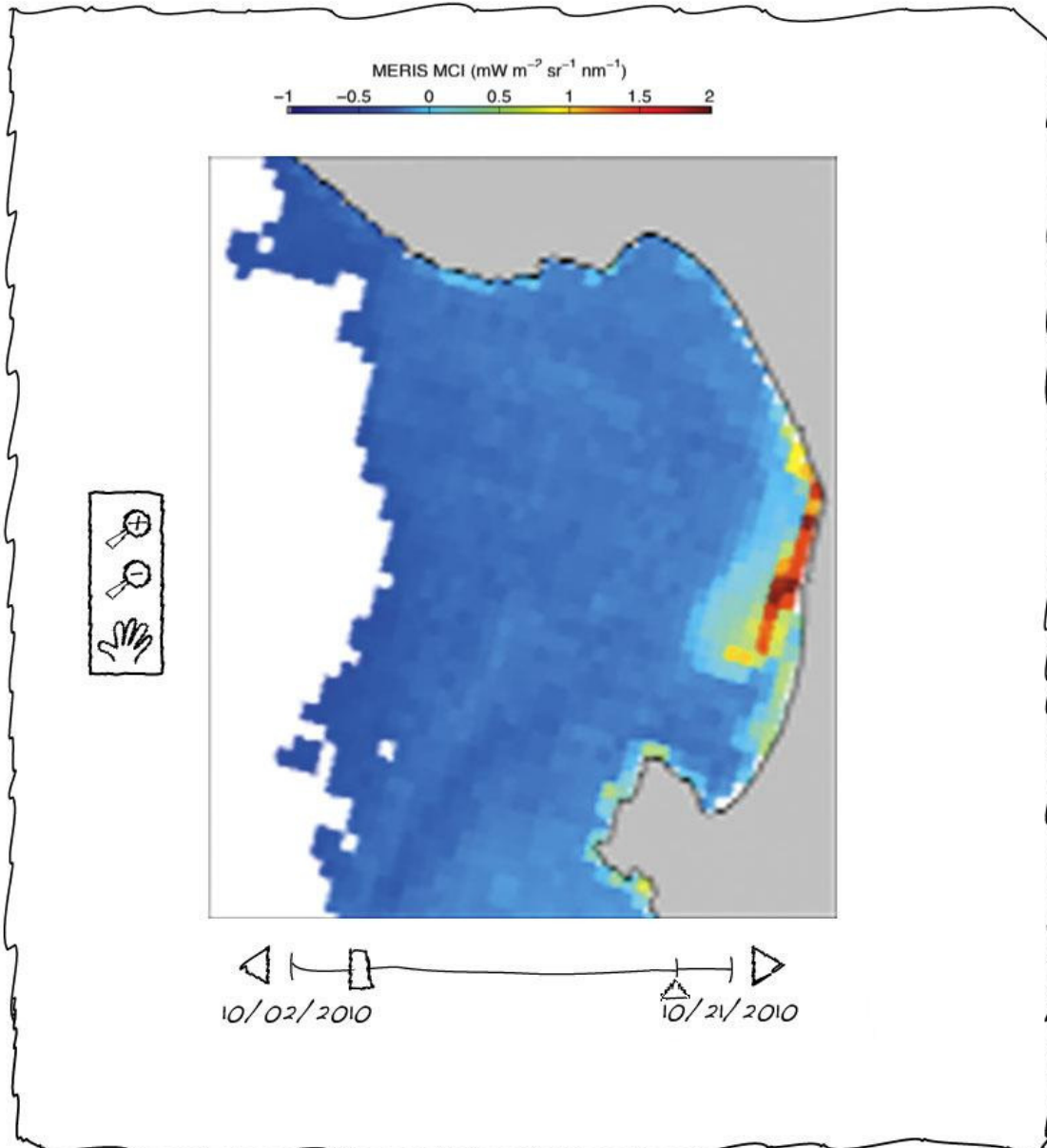
- Forecast

- 4D Bio-Physical Model
- [Hatched Pattern]
- [Hatched Pattern]

Event Notification

- [Hatched Pattern]
- [Hatched Pattern]

Visualization



CANON Decision Support System

Data

Data Planning Logistics

- Data Sources


- MODIS
- HF Radar
- MERIS
- Chlorophyll
- Current
- Provenance
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]
- [Hatched Pattern]

- Live Data

- + DSS Plan Data
- [Hatched Pattern]
- [Hatched Pattern]

- Forecast

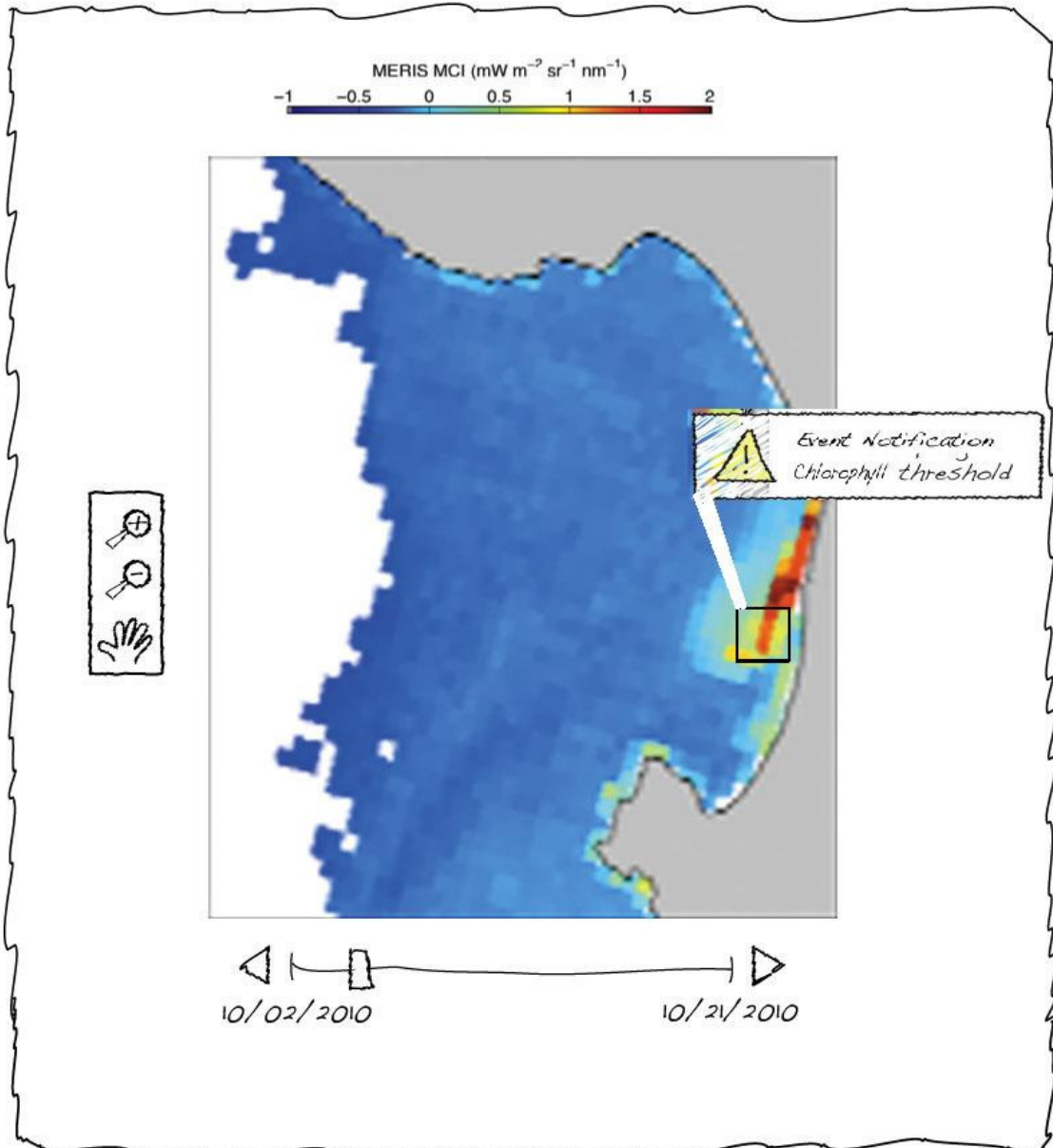
- 4D Bio-Physical Model
- [Hatched Pattern]
- [Hatched Pattern]

 Event Notification

[Hatched Pattern]

[Hatched Pattern]

Visualization




CANON Decision Support System

Planning

Data

Planning

Logistics

- AUV-CTD 

Volume Survey

Gulper


Transect

Drifter Located

+ LRAUV 

+ ASV 

+ ROV 

+ Drifters 

+ Gliders 

+ ESP 

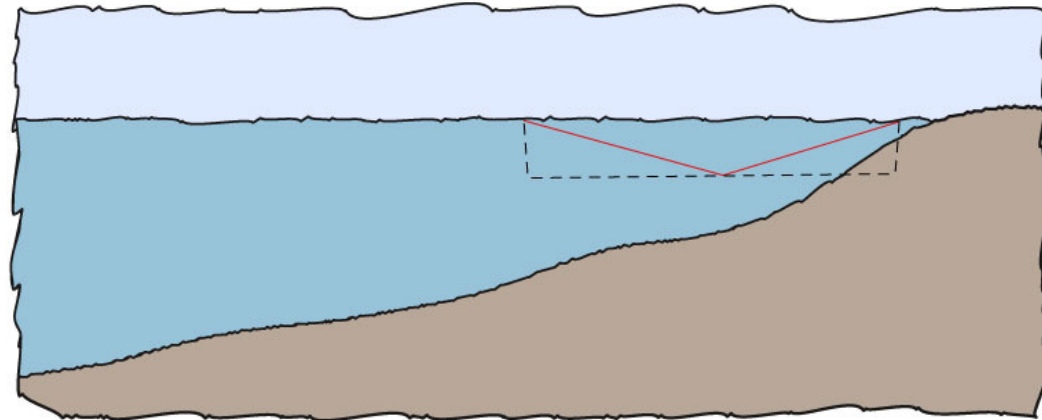
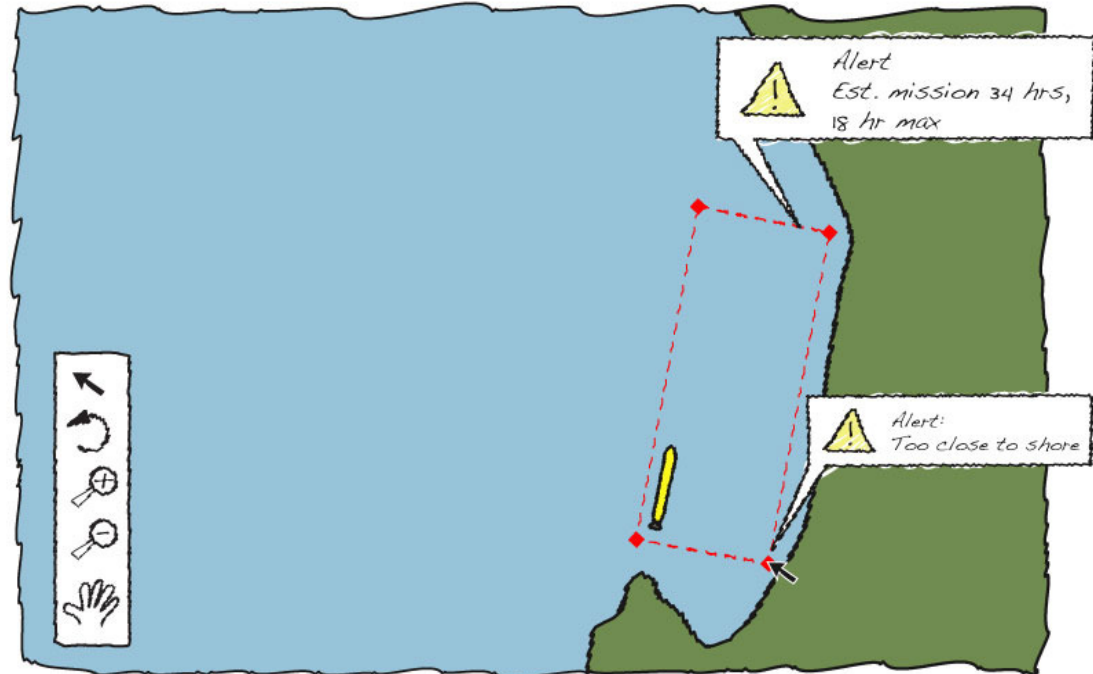
+ Ships 

Annotate

Generate Script

Submit Plan

Visualization



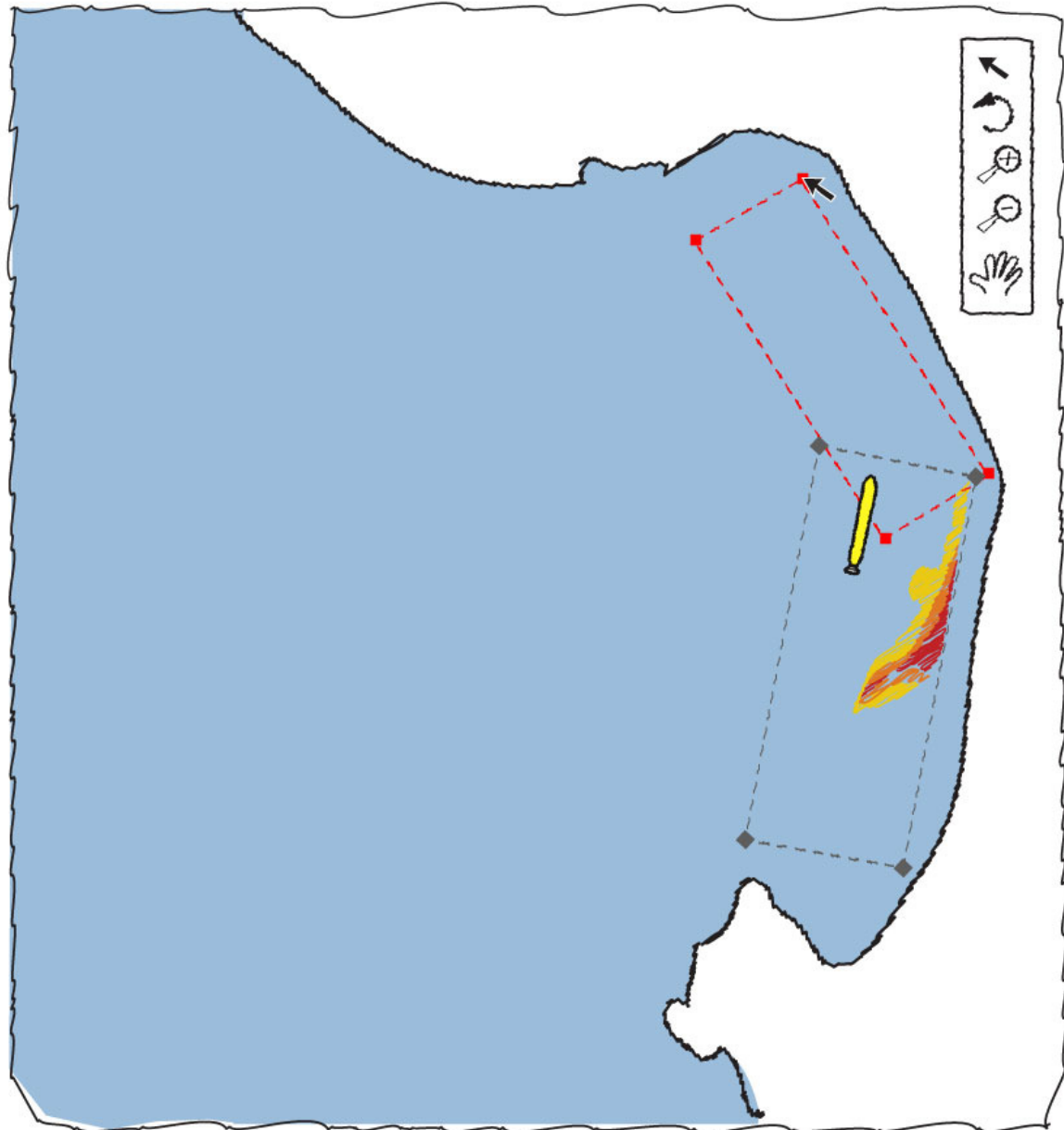
CANON Decision Support System

Planning

Data | **Planning** | *Logistics*

- AUV-CTD 
 - Configure Transect pattern
 - Configure Sampling
 - Configure AUV Automation
- LRAUV 
- ASV 
- ROV 
- Drifters 
- Gliders 
- ESP 
- Ships 

Visualization



CANON Decision Support System

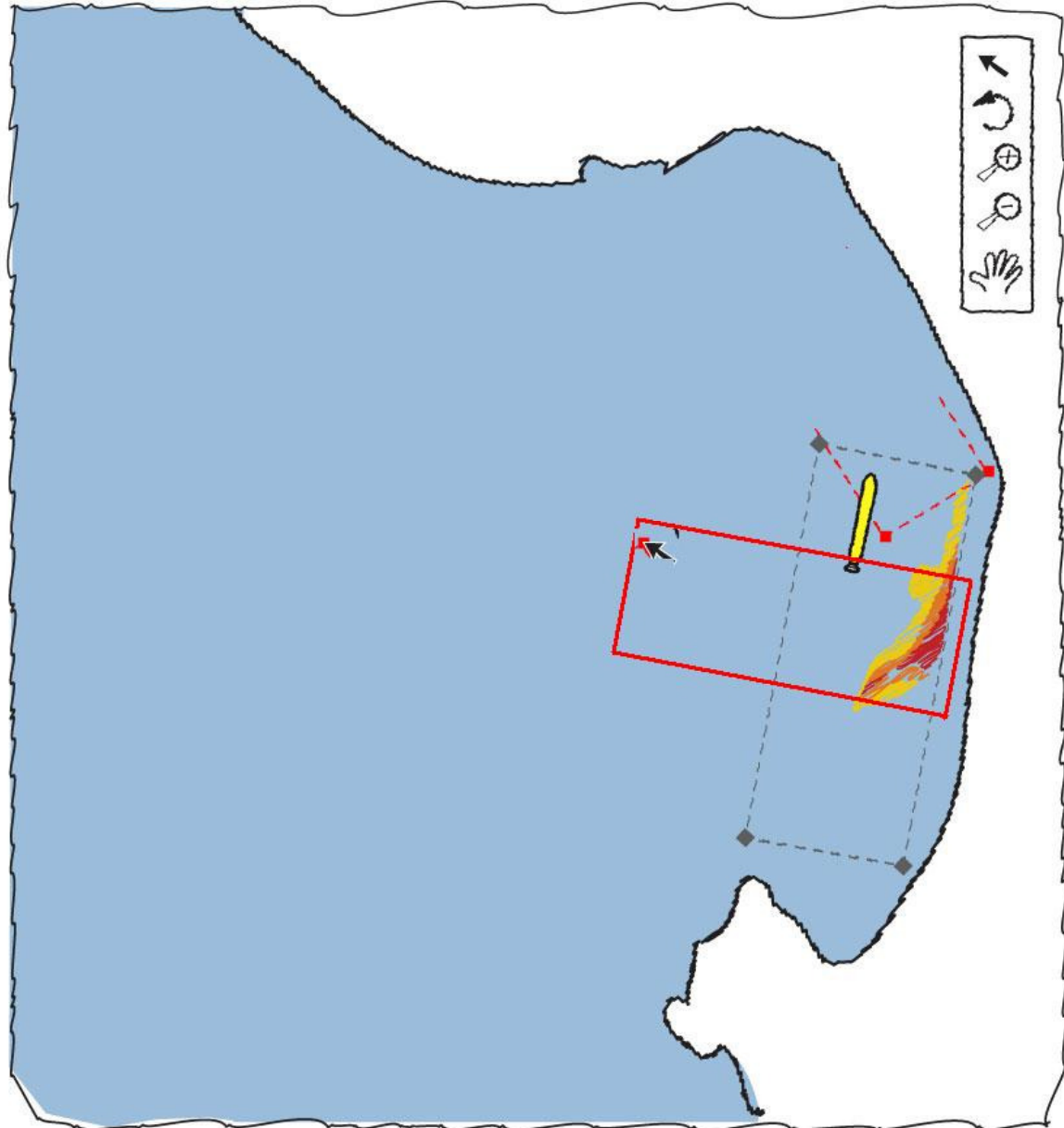
Planning

Data Planning Logistics

- AUV-CTD 
- Configure Transect pattern
- Configure Sampling
- Configure AUV Automation

- LRAUV 
- ASV 
- ROV 
- Drifters 
- Gliders 
- ESP 
- Ships 

Visualization



CANON Decision Support System

Planning

Data | **Planning** | Logistics

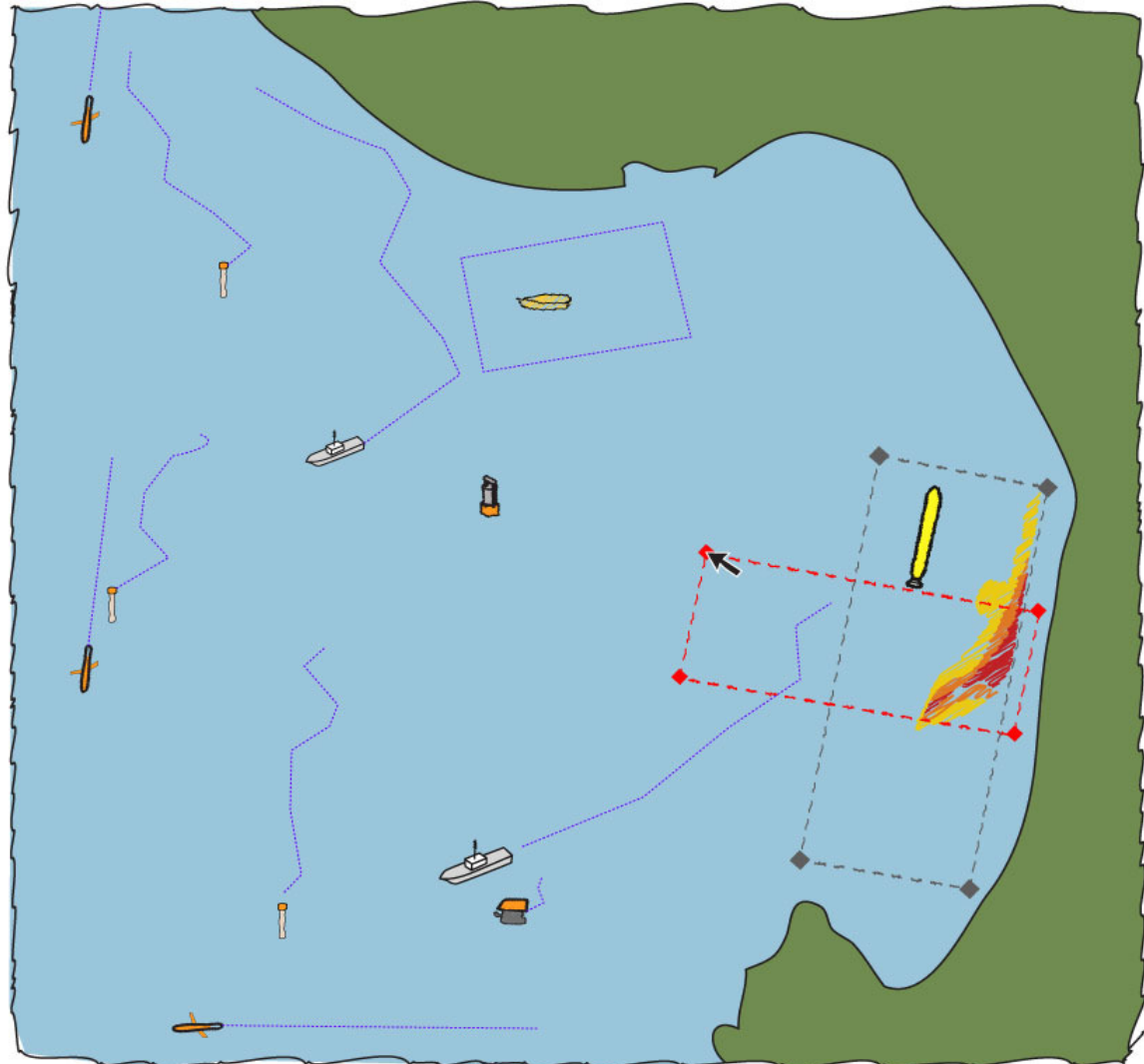
- AUV-CTD 
 - Configure Transect pattern
 - Configure Sampling
 - Configure AUV Automation
- LRAUV 
- ASV 
- ROV 
- Drifters 
- Gliders 
- ESP 
- Ships 

Annotate

Generate Script

Submit Plan

Visualization



Show only today



CANON Decision Support System

Planning

Data Planning Logistics

- AUN-CTD 
- Configure Transect pattern
- Configure Sampling
- Configure AUN Automation

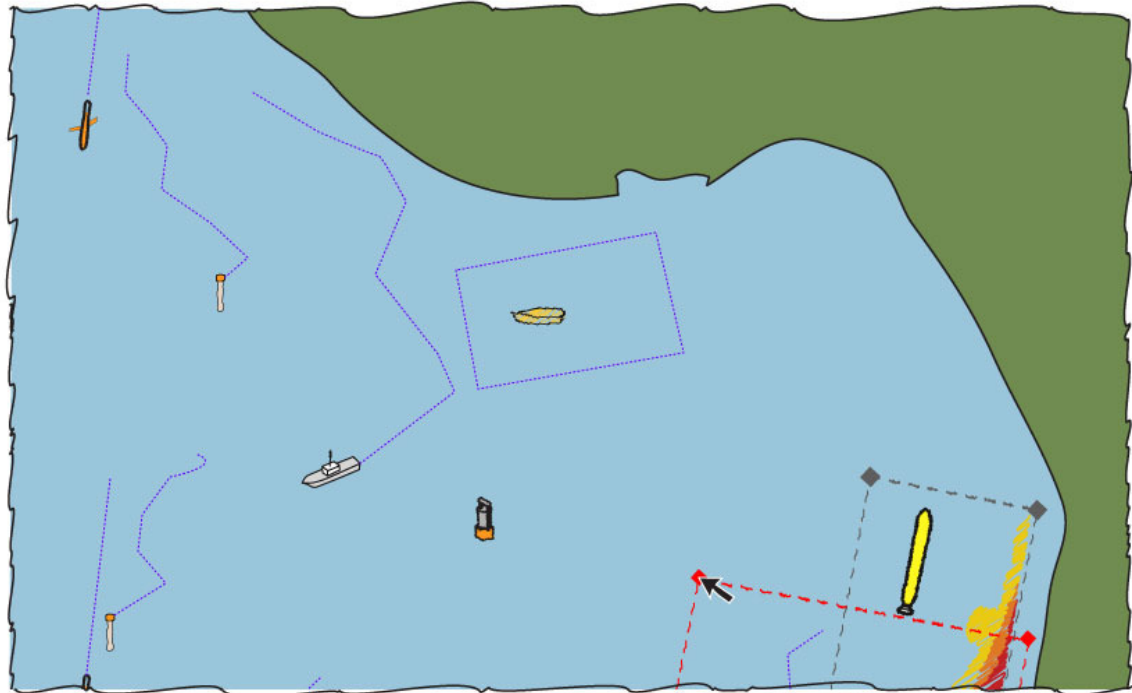
- LRAUN 
- ASV 
- ROV 
- Drifters 
- Gliders 
- ESP 
- Ships 

Annotate

Generate Script

Submit Plan

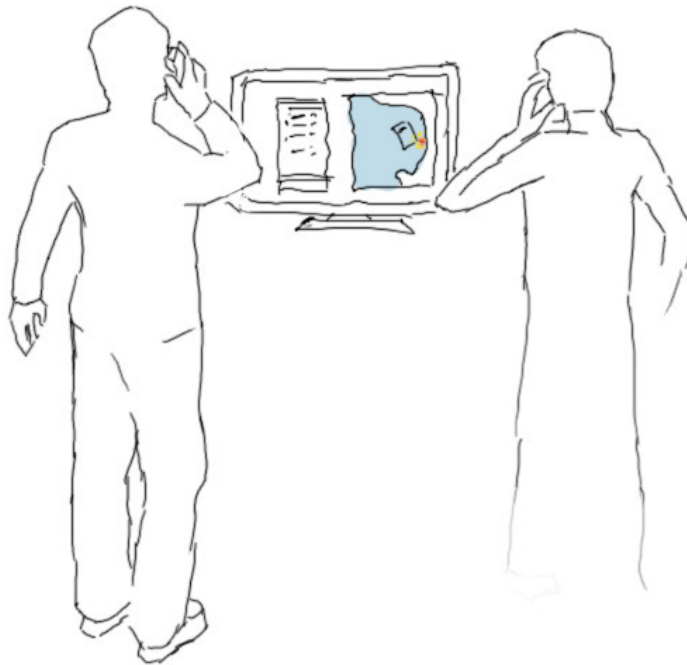
Visualization



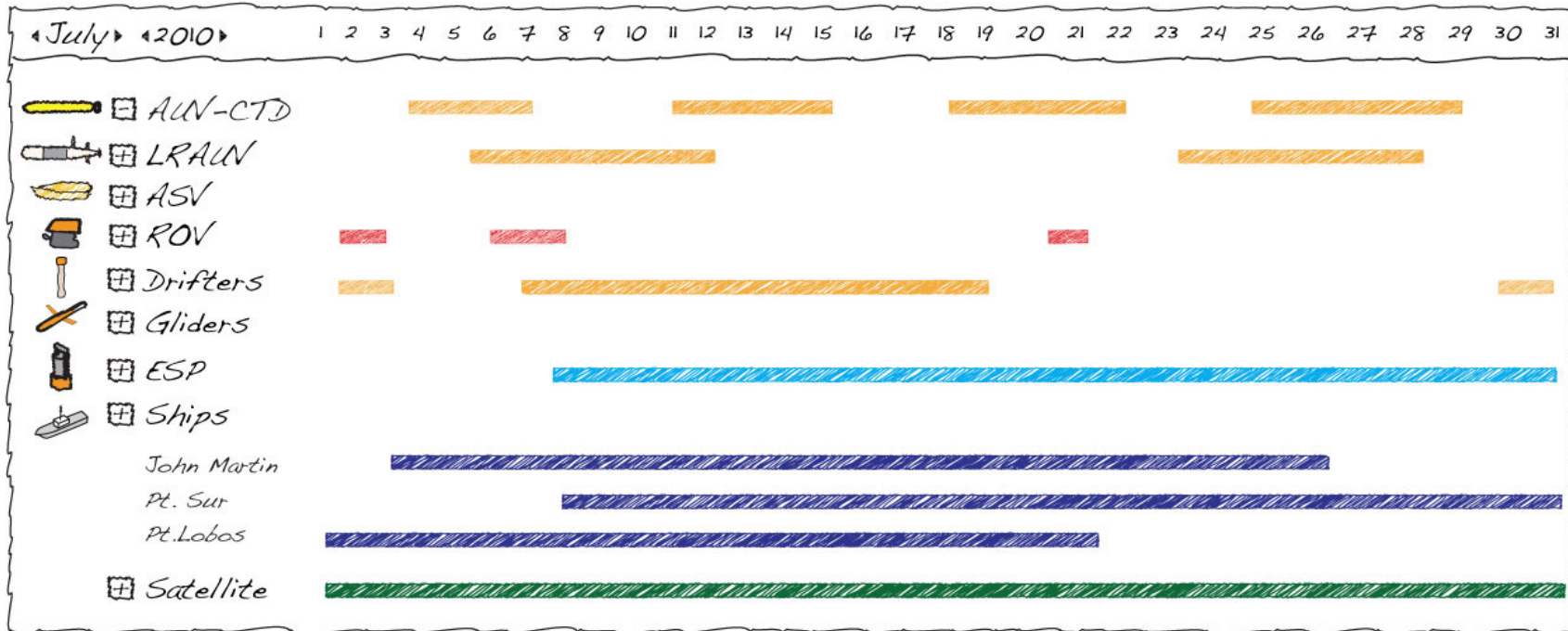
AUN plan submitted for review -----

Control Scripts Generated -----

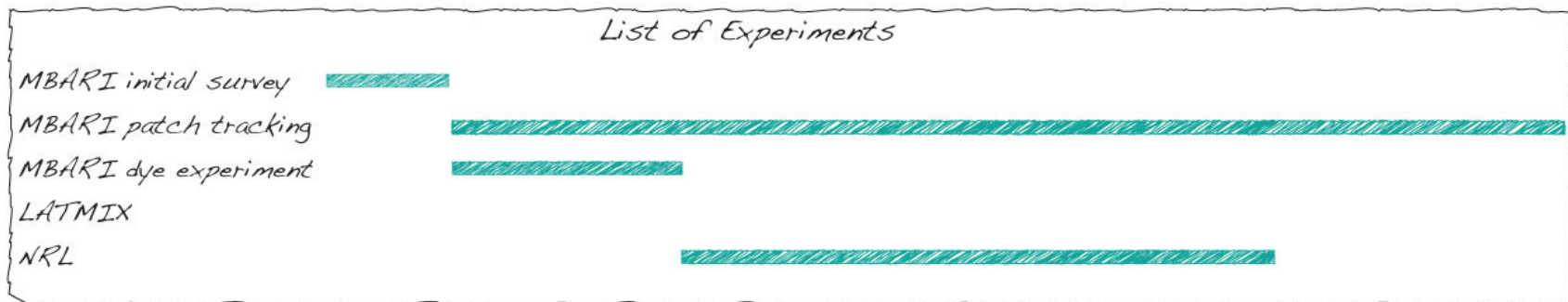
```
#####  
#####  
#####  
#####  
#####
```



Asset Timeline



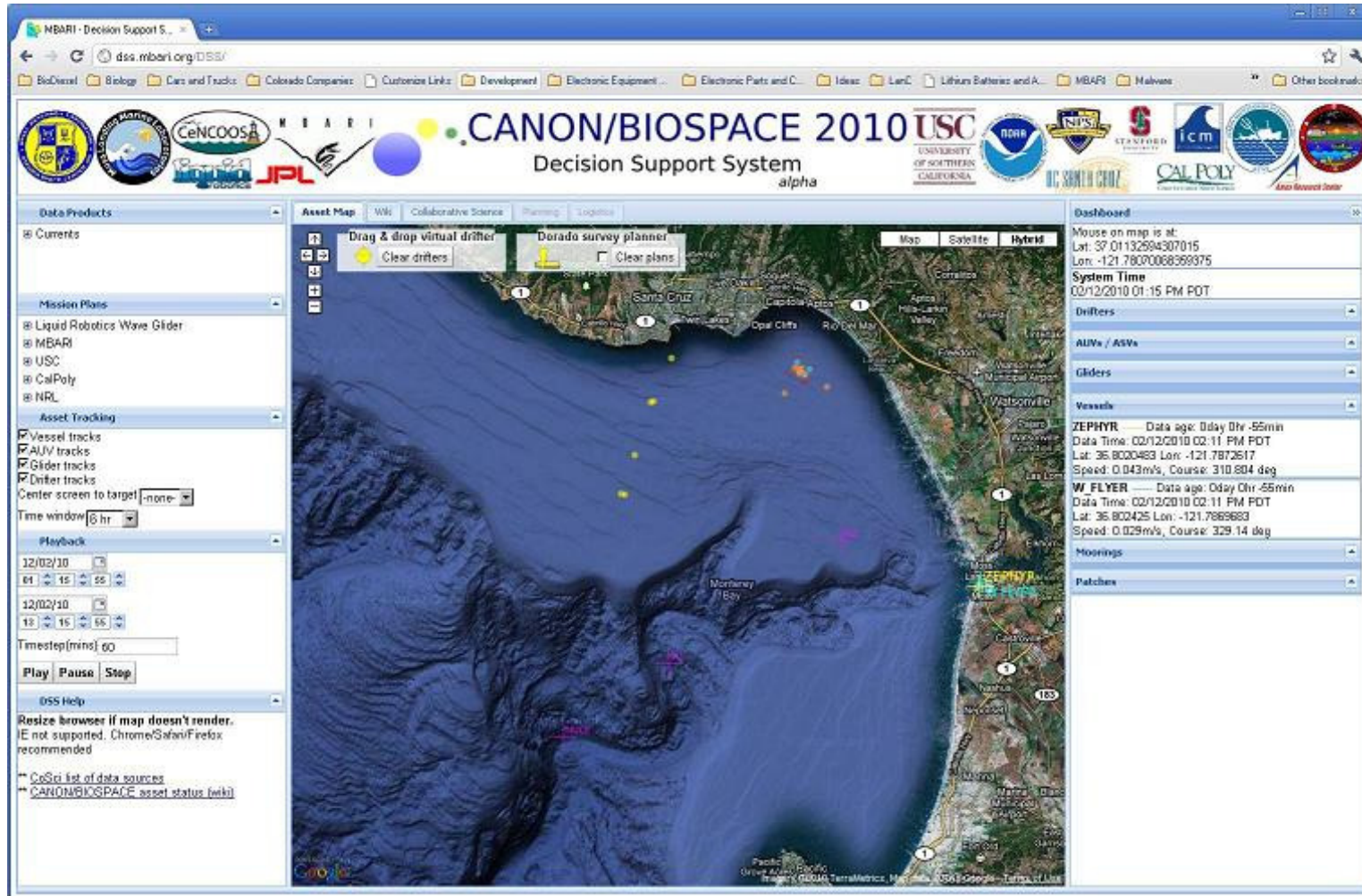
List of Experiments



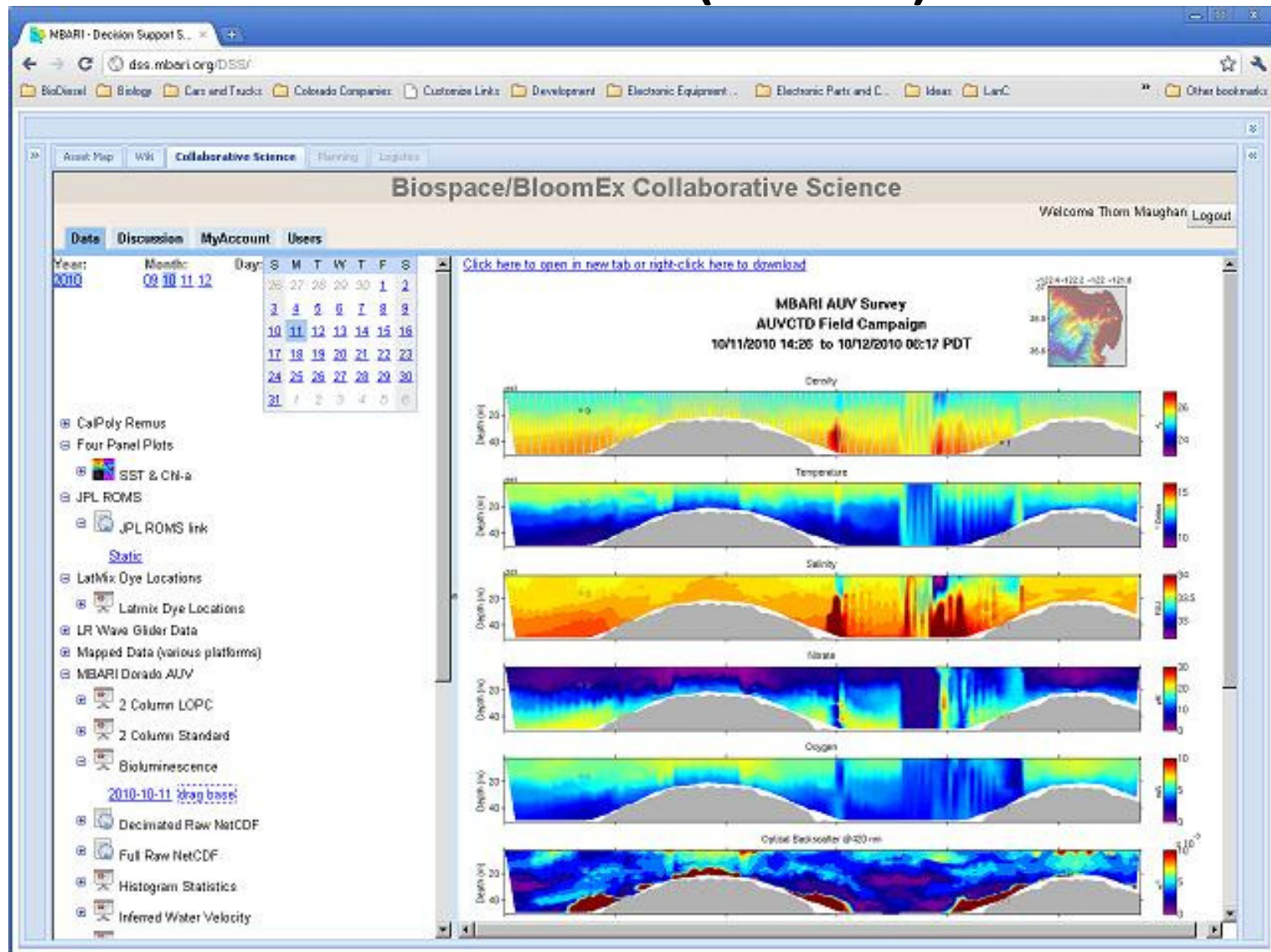
First Prototype ODSS

- Sep 2010, J. Das, a grad student from USC ‘volunteered’ to do a quick prototype from the pencil sketches.
- Feature focus
 - Situational Awareness
 - Data products, vehicle tracks, sensor tracks, playback, drifter projection
 - Integration of collaborative science tools developed in ONR funded MBARI program called AOSN
- Data sharing: Experiment context provided through archive of discussion behind daily experiment planning

ODSS First Prototype Situational Awareness



ODSS First Prototype Collaborative Science (CoSci) Data Tools



ODSS First Prototype CoSci Threaded Discussion Tool

The screenshot shows a web browser window displaying the ODSS First Prototype CoSci Threaded Discussion Tool. The browser address bar shows the URL dss.mbari.org/DSS/. The page title is "Biospace/BloomEx Collaborative Science". The user is logged in as "Thom Maughan" and is viewing the "Discussion" tab. The main content area displays a list of discussion threads on the left and a detailed view of a selected thread on the right. The selected thread is titled "Hehapa plots for Oct. 20-21" and is from Burt Jones, dated Thursday, October 21, 2010, at 10:55:09 GMT-7:00. The thread includes three attachments: "hehapa_MB_Oct20_21_T.png" (1942988 bytes), "hehapa_MB_Oct20_21_S.png" (1959679 bytes), and "hehapa_MB_Oct20_21_ch.png" (19699 bytes). The message content reads: "Hi all - I have attached the latest data plots from HeHaPe. Let me know if you have any questions on the data. We are giving you the quick look - not fully QA/QCed. Burt Jones, Professor (Research) Marine Biology and Biological Oceanography, University of Southern California, Los Angeles, CA 90089-0371. Phone: 213-740-5765, Email: bjones@usc.edu. Web pages: Jones Lab: <http://usclab.usc.edu>".

Browser: MBARI - Decision Support S...
Address: dss.mbari.org/DSS/
Navigation: Back, Forward, Refresh, Home, Stop, Print, Star, Search
Bookmarks: BioDivers, Biology, Cars and Trucks, Colorado Companies, Customize Links, Development, Electronic Equipment..., Electronic Parts and C..., Ideas, LanC, Other bookmarks

Navigation: About Map, Wiki, Collaborative Science, Planning, Logout
Welcome Thom Maughan Logout

Navigation: Data, Discussion, MyAccount, Users

Discussion List (Left):

- [JAXA Add Post](#)
- [Colors of BloomEx Add Post](#)
- [Faculty Position - Marine Ecosystem Modeler\] Add Post](#)
- [Over Add Post](#)
- [Spray glider salinity anomaly Add Post](#)
- [strong poleward current in HF radar and ROMS Add Post](#)
- [JPL/UCLA ROMS forecast update: upwelling diagnostics Add Post](#)
- [Hehapa plots for Oct. 20-21 Add Post](#)
- [Bloom update Add Post](#)
- [USC Glider data Add Post](#)
- [Calpoly data is up for today Add Post](#)
- [This week's Tethys Mission Add Post](#)
- [CalPoly data is up on the server Add Post](#)
- [calpoly data is up Add Post](#)
- [CalPoly remus location for today Add Post](#)
- [calpoly remus and data Add Post](#)
- [E-mail problems at MBARI Add Post](#)
- [Tides Add Post](#)
- [DORADO surveys from yesterday/today Add Post](#)
- [strong upwelling in the north MB: ROMS diagnostics Add Post](#)
- [Oct 13th Meris Add Post](#)
- [Point Sur update Add Post](#)
- [LCPC data for yesterday's DORADO run Add Post](#)
- [This week continued Add Post](#)
- [circulation Add Post](#)
- [This week Add Post](#)

Thread Details (Right):

Reply Print

Topic: Hehapa plots for Oct. 20-21

From: Burt Jones

Date: Thu Oct 21 10:55:09 GMT-7:00 2010

Attachments:

hehapa_MB_Oct20_21_T.png	1942988 bytes (image/png)	hehapa_MB_Oct20_21_S.png	1959679 bytes (image/png)	hehapa_MB_Oct20_21_ch.png	19699 bytes (image/png)
--------------------------	---------------------------	--------------------------	---------------------------	---------------------------	-------------------------

Message:

Hi all - I have attached the latest data plots from HeHaPe. Let me know if you have any questions on the data. We are giving you the quick look - not fully QA/QCed.

Burt Jones
Professor (Research)
Marine Biology and Biological Oceanography
University of Southern California
Los Angeles, CA 90089-0371
Phone: 213-740-5765
Email: bjones@usc.edu
Web pages:
Jones Lab: <http://usclab.usc.edu>

Data collaboration with CENCOOS

The screenshot displays the CeNCOOS Data Portal interface. The main header features the CeNCOOS logo and the tagline "Integrating marine observations to inform decision makers and the general public". Navigation tabs include Home, About Us, News & Events, Current Conditions, Data Products, Download Data, Classroom, and Models.

On the left side, there are filters for Region (set to "-All-"), IOOS Variables (set to "-All-"), and a Station ID Search field. Below these is a "Hide Station List" section with a table of station information:

Organization	ID
BML	fpt
BML	bml
CALPOLY	cpxc1
CALPOLY	lm1
CDIP	142
CDIP	156
CDIP	157
CDIP	158
CDIP	168
CDIP	180
CDIP	029
CDIP	094
CDIP	128
CDIP	076
CDIP	071
CO-OPS	9415144
CO-OPS	9411406
CO-OPS	9413450
CO-OPS	9414290
CO-OPS	s06010

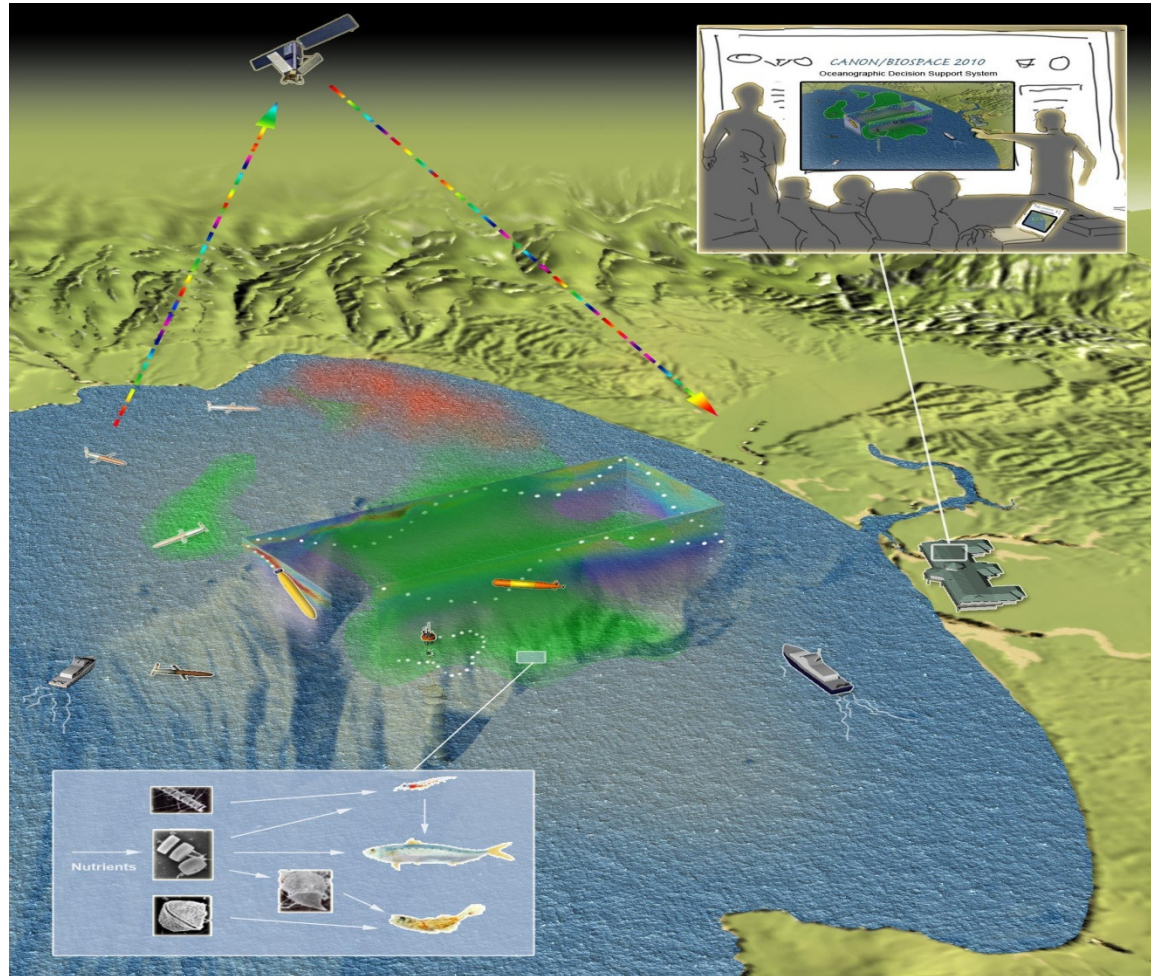
The central map shows the Monterey Bay area with various station locations marked by colored icons. A popup window titled "Winds" is displayed over the map, showing a line graph of wind speed data from 02/17 00:30 to 02/17 21:30. The graph shows wind speeds ranging from 4.72 m/s to 16.72 m/s. The popup also includes a "Date Range" of 2007-05-15 to 2011-02-17, "Start Date" and "End Date" both set to 2011-02-17, and options to "Update" and "Get" data in "CSV" format.

At the bottom, the browser's developer tools are visible, showing the HTML structure of the page and the current time as 4:43 PM.

http://www.cencoos.org/sections/news/MontBay_HAB_experiment_2010.shtml

ODSS used in Oct. 2010 BloomEx / BioSpace

R/V Pt. Sur
R/V John Martin
R/V Zephyr
R/V Shanna Rae
Dorado Gulper
LRAUV
Remus 100's
Remus 600
Drifters
Moorings
Two Airplanes
Spray Gliders
UCSC Glider
Web Glider
Model ROMS
Model COAMPS
NASA Aqua
ESA MERIS
SeaWiFS
HF Radar



MBARI
NRL SSC
NRL DS
NPS
USC
UCSC
Cal Poly
Liquid Robotics
CenCOOS
Stanford
U of H
UCB

Logistics, Planning, Operations, Communications, and the data...
Can we get that in 4D, near real time?

2011 Activities

- MBARI engineering resources added
- Lessons learned from 2010
- Strong data management system foundation, integrate LRAUV platform.
- Standards based web services architecture
- Robust messaging and communications infrastructure
- Integrate 'shore-side' autonomy capability – “robot ballet”
- Explore web app software technologies
- Three field campaigns in 2011 – April, June, September

ODSS Web Application 2011

The screenshot displays the ODSS Web Application 2011 interface within a browser window. The browser tabs include "MBARI - Decision Support S...", "REMUS data :: Marine Sci...", and "MBARI CANON Bioscience...". The address bar shows "odss-staging.shore.mbari.org:8080/dss-0.4.0-SNAPSHOT/".

The interface features a header with the MBARI logo and the text "Monterey Bay Aquarium Research Institute". Below the header are navigation tabs: "Situational Awareness", "Planning", "Analysis", and "Logistics".

The main content area is divided into several panels:

- Feature Query:** Includes a "Select date range and click a feature" section with a "Date Range" dropdown set to "Aug 29 - Sep 29, 2010".
- Layers:** A list of layers with checkboxes and categories. The "24-hour tracks" layer is checked. Other layers include "OpenGeo", "states", "Others", and "Basic WMS".
- Map:** A central map showing a topographic view of Monterey Bay. Red arrows indicate a path or trajectory on the map.
- Asset Summary:** Displays "System Time" as "29/03/2011 09:55 PM PDT". It includes a "Playback" section with "Start" and "End" date/time pickers, a "Step (secs)" slider set to 300, and "Play", "Pause", and "Stop" buttons.
- AUVs:** A list of Autonomous Underwater Vehicles (AUVs) with their status and location information. The listed AUVs are "DORADO", "ZEPHYR", and "W FLYER". Each entry shows "Data age: 0day 0hr 0min", "Data Time: null", and "Lat: 0 Lon: 0".

The bottom of the screen shows a Windows taskbar with various application icons, a search bar, and the system clock displaying "9:55 PM".

2012 Activities and Next Steps

- Lessons learned from 2011
 - Bug fixes and replace SmartGWT, etc. web components used in Situational Awareness
- Start work on “Data Analysis” capability
 - Define requirements for data access system
 - Access privileges for sensitive data
 - Automate the execution of ‘select’ data analysis
- Implement visual planning capability
- May and September field experiments

Thank-you and Acknowledgements

- Many thanks to the David and Lucille Packard Foundation for MBARI funding.
- Special thanks to Kanna Rajan, originator of the ODSS concept based in part on his previous research at NASA Ames. Also thanks to Frederic Py for his contributions.
- Special thanks to Jim Bellingham and Mike Godin for the ONR funded AOSN program and contributions on collaboration tools. Also for the concepts on data management and visualization contributed from the LRAUV program. Thanks to Yanwu Zhang for his work on sampling algorithms.
- Thanks to Jnaneshwar Das of USC and NSF for his funding, also his advisor Gaurav Sukhatame of USC.
- Thanks to MBARI engineering (co-authors), science and marine operations
- And a most important thanks to CANON Principal Investigators: Francisco Chavez, Jim Bellingham, Kanna Rajan, John Ryan, Chris Scholin, Ken Smith, Bob Vrijenhoek, Alex Worden, Steve Haddock.

Links

- CANON: <http://www.mbari.org/canon/>
- AOSN: <http://www.mbari.org/aosn/>
- Autonomy: <http://www.mbari.org/autonomy/>
 - AUV Curtain plots:
http://www.mbari.org/autonomy/TREX/Sep_2011.htm
- CENCOOS: <http://www.cencoos.org/>
- ODSS: <http://www.mbari.org/canon/DSS.htm>

Backup slides

Abstract: AN OCEANOGRAPHIC DECISION SUPPORT SYSTEM (ODSS) , A SOFTWARE TOOL TO IMPROVE EFFICIENCY OF BIOLOGICAL OCEAN STUDY

- The Controlled, Agile, and Novel Observing Network (CANON) team at MBARI is creating new ways to remotely assess biological ocean conditions and collect samples of microorganisms. In addition to science, the CANON program has an engineering component.
- The coordination of multiple science objectives and multiple mobile platforms provides a rich problem domain for engineering.
- MBARI engineering studied the workflow of the CANON science campaigns created requirements for an Oceanographic Decision Support System (ODSS).
 - The tool provides a set of perspectives that map to the workflow of the experiment. The high level functionality provided in the tool: 1) Situational Awareness: platform trajectory and real time data 2) Logistics and planning of asset deployment. 3) Collaborative discussion workspace 4) Real-time mobile platform control and coordination 5) Data access and analysis.
 - The engineering team is following an iterative development process and is hosting the software as an open source project. The presentation will cover the high level requirements, architecture, implementation overview and lessons learned in the CANON experiments.
- The team has fielded various iterations of the ODSS software tool in several CANON experiments. The ODSS has successfully facilitated scientists in their efforts to adaptively follow, sense and sample the changing conditions of upwelling driven algal bloom.