What does a Data Management and Translation Facility Look Like?
A View from the Rutgers University
Coastal Ocean Observation Laboratory (RU COOL)

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Introduction

The oceanographic community is now tasked with developing implementation plans for the future Ocean Observing Initiative (OOI) established through NSF's ORION program. One of the largest challenges remaining for the community is to determine how education and public outreach efforts are to be integrated within the overall ocean observing system structure. Rutgers University has been a pioneer in coastal ocean observing systems, and has a long tradition of intimately integrating education and public outreach efforts with the operations of the observatory network.

Here we will chronicle the history and organizational infrastructure of the Coastal Ocean Observation Laboratory (COOL), the Long-term Ecosystem Observatory (LEO) at 15 meters, and the Education & Outreach group at the Institute of Marine & Coastal Sciences (IMCS), highlighting how these three groups work together to support the operational application of our OOS. We will also present "lessons learned" from our experiences in managing a coastal ocean observatory, with the hope that these insights will support the development of a highly efficient and productive ORION/OOI OOS network.

Ocean Observing on the New Jersey Shelf
The Evolution of the Coastal Ocean Observation Laboratory

The Rutgers University Coastal Ocean Observation Laboratory (RU COOL) initially started out as the Marine Remote Sensing Lab in 1992, when it focused almost exclusively on the collection of satellite remote sensing imagery. At the time, the lab consisted of three people who used a SeaSpace L-Band satellite receiving system to collect sea surface temperature (SST) imagery for use in a variety of research projects.

In the late 90's, the size and scope of research conducted by the lab grew, primarily towards the concept of "adaptive sampling," in which a network of sustained observations are used to support operations during a directed research project, which typically involve large collaborations of several academic, commercial and government groups. These efforts were fueled by grants from the National Ocean Partnership Program (NOPP), ONR's HyCODE program and NSF's CoOP. Through these projects, the Rutgers observing "backbone" grew to

include not only satellite SST, but also coastal ocean radar (CODAR), a fleet of autonomous underwater vehicles (Gliders), and a wide variety of additional satellite products available from the international constellation of Earth observing satellites. Subsequently, the lab has grown to approximately 7 staff, 8 faculty members, and 4 graduate students to support ongoing operations. To date, funding for the operational network is still largely derived from research grants.

Concurrent with the development of the COOL lab, the Mid Atlantic Bight National Undersea Research Center (MAB NURC) established the Long-term Ecosystem Observatory (LEO) at an inner shelf site (15 meter depth) located directly offshore of the Rutgers University Marine Field Station at Tuckerton, NJ (LEO-15). LEO-15 intends to provide long-term ocean observations that will help to distinguish between natural and anthropogenic changes in the marine environment. LEO serves as a core element of a shelf-wide ocean observation network that we hope will increase our understanding of episodic events (such as storms, upwelling and hypoxia) that are poorly studied by conventional methods. The MAB NURC Center currently employs 7 staff, is now tasked with working on upgrading the now 13 year old nodes with new state of-the-art technology.

Finally, the Education & Outreach group at RU–IMCS also has been in existence since 1992. In the early days, the education and outreach efforts of IMCS were focused on the designation and subsequent management of the Jacques Cousteau National Estuarine Research Reserve (JCNERR) (see www.jcnerr.org). Early in the reserve's development, efforts were centered around the design and implementation of basic education programs that allowed scientists to communicate their science to K-12 educators and their students. Now a staff of 5, the E&O group at IMCS serves as a liaison for scientists to reach out to broad audiences including K-12 educators, students, coastal managers, and the public through informal science learning centers (Aquaria, Science Centers, JCNERR, etc) and the media (print, TV, and radio). To date, the E&O group is largely supported by private foundation and federal grants.

Working Together – Integrating Science, Data Management, Data Translation, and Education & Outreach

Collaboration between each of the groups described above has increased dramatically with each year of operation. While initially independent, today the groups are tightly integrated which aids greatly in accomplishing common goals (i.e. using oceanographic data visualizations to promote ocean literacy). Figure 1 depicts the organizational structure of the Operations and Outreach groups, and indicates how the two groups interact amongst each other to provide oceanographic products, programs and services to the larger user community. Also shown is how the data proceeds from acquisition to use through the two groups.

Each of the major elements of the current COOL group is described below in an effort to articulate the level of integration and collaboration between the two groups.

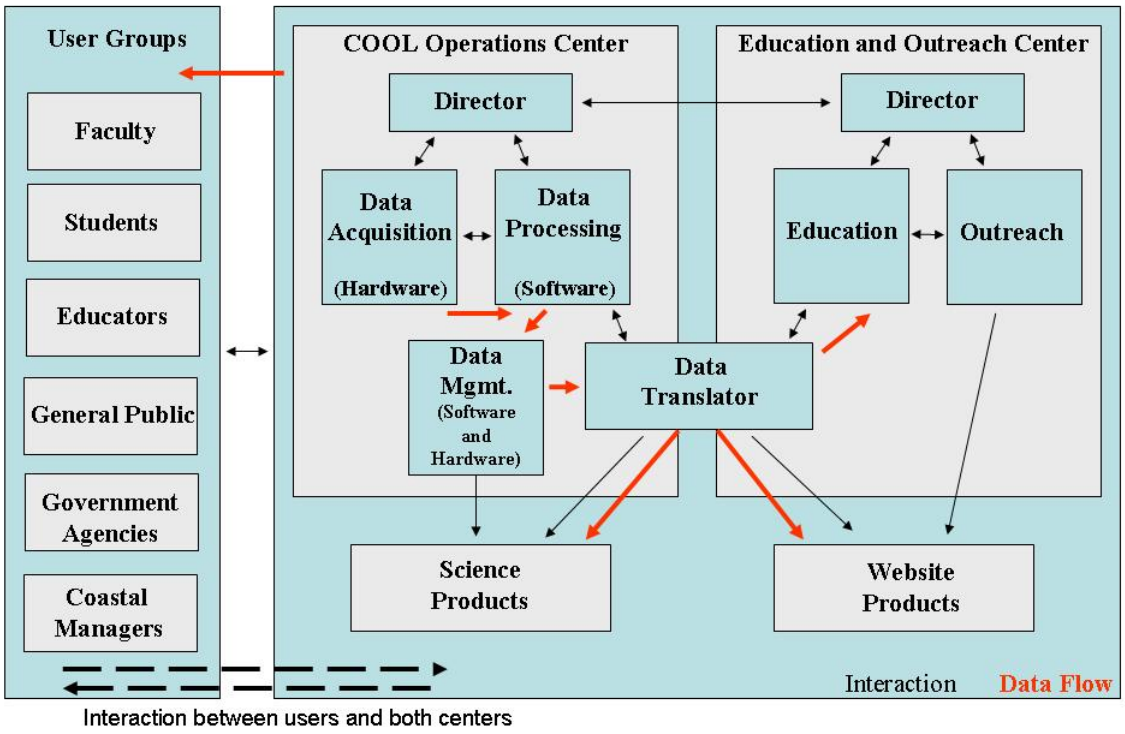

Figure 1: Organizational chart of the RU COOL Operations Center and the E&O group at IMCS.

COOL Operations Center

The COOL Operations Center maintains one of the communities most advanced coastal ocean observatories. Start-of-the-art sampling capabilities are continuously upgraded as new technologies, developed by the research group, are immediately transitioned into the operational setting of the center. Sustained spatial sampling of the coastal ocean is accomplished with a variety of new platforms and sensors that include:

1) The local acquisition of satellite imagery from the international constellation of thermal infrared and ocean color sensors,
2) A triple-nested multi-static HF radar network for surface current mapping and waves,
3) A fleet of long-duration autonomous underwater gliders equipped with physical and optical sensors, and
4) A cabled observatory for water column time series.

Raw datasets are shared with a variety of super-users throughout the U.S. for real-time backups, data archiving, and advanced product generation. Operational

data products are produced in real time and displayed on the World Wide Web for use by scientists, educators, decision-makers and the general public. Website access peaks in the summer, averaging over 140,000 hits per day in 2004. Each of these technologies provides long-term, synoptic scale data that are an invaluable asset for researchers conducting process studies within the observing system region.

The mission of the center is to sustain operations of key observing technologies for:

- Scientific Research
- Technology Development
- Education and Outreach

Under the leadership of a director (Dr. Josh Kohut), the group consists of staff members who oversee the following elements:

- Hardware – Responsible for maintaining the instrument platforms, sensors, communications and telemetry, insuring data makes it from the field to the lab in real-time. This currently includes:
    - Maintaining the CODAR remote site hardware and communications (Dr. Hugh Roarty and an additional FTE-*currently vacant*)
    - Deployment, recovery, maintenance and diagnosis of the Glider fleet (Hugh Roarty, with Chip Haldemann (part-time) and Trisha Bergmann (part-time) and FTE- *currently vacant*)
    - Maintaining the satellite receiver dish and electronics (Jen Bosch)
    - Maintaining the LEO-15 node (NURP Staff - 2 FTEs)
- Software – Responsible for processing acquired data, generating real-time visualizations for the web, establishing and implementing QA/QC procedures, maintaining quality controlled archived data (data management), and systems control software for mission control. This currently includes:
    - Satellite dish control, data acquisition, image processing and data management (Jen Bosch)
    - Codar data processing and management (Josh Kohut)
    - Glider control, data processing and management (John Kerfoot)
    - LEO-15 data processing (John Kerfoot)

Data Translation and Product Development

As both the E&O group and Operations Center have matured, it was determined that a joint appointment would provide the ability to improve data products, visualizations, and delivery mechanisms for the data products. A Data Translator (Sage Lichtenwalner) was hired to work with the leads from the data acquisition and data processing teams to develop relevant visualizations for a range of user groups (anyone from a scientist, to K-12 educator, to the media). This position fosters collaboration between the two groups, by ensuring the operations group is aware of the visualization needs of E&O efforts, and provides the E&O group with access to upcoming data products and research findings for story

development. Additionally, the data translator is currently assisting the data processing team in the development of a data management system and new operational visualizations to ensure smooth an efficient collaboration between data archiving, retrieval, and data product delivery to relevant user groups.

Education and Outreach

The mission of the IMCS Education and Outreach (E&O) group is to promote ocean literacy through the development of a broad range of products and services that use the unique scientific resources and assets of IMCS. The group serves a variety of *clients,* including those in:

- K-12, community college, and university education and scientific research
- the private sector
- local, regional, state, national, and international government agencies
- nonprofit organizations
- news media
- legislature
- the general public. (We use the term general public to represent a broad range of interest groups and potential audiences).

Under the leadership of a director (Janice McDonnell) the group consists of staff members who oversee the following elements:

- Communications (1 FTE) – The Communications Specialist (Corinne Dalelio) serves as web master for numerous web sites (including the COOL Classroom – one of our observatory's based education products), calendars/correspondence for our docket of education and outreach initiatives, and finally, our point-of-contact with numerous outside contractors* who support education and outreach projects associated with the group.

- Science Education (2 FTEs) – Education Specialist (Eric Simms) works to link scientists (within IMCS, RU and other institutions within the Mid Atlantic) with quality education programs. His main objective is to assist scientists in the creation of quality broader impact statements (BIS), now required by many granting agencies. Eric develops both 1) programmatic applications for the BIS statements (projects designed, implemented within the E&O group) and 2) partnering opportunities with appropriate external partners (informal learning centers, non profits, etc) where projects are managed/implemented by external partners. A second Science Education Specialist (Lisa Auemuller) works primarily on informal and formal education efforts of the Jacques Cousteau National Estuarine Research Reserve, managed by IMCS. She runs the Coastal Training Program (CTP), designed for coastal decision-makers (which include coastal managers, municipal officials, and local elected officials) as well as the Marine Activities Resources & Education (MARE) professional development program (a K-8 professional development program) and public interpretive programs offered in conjunction with our Reserve

partner, the Tuckerton Seaport. COOL data products are used with all of these user groups.

* Note: The E&O group is heavily supported by outside contractors, including a full time evaluator (Chris Parsons) for all education and outreach products, 2-3 science writers (including RU's University Relations Department and a group of independent freelance writers), 3-5 web design firms who assist with specific project needs, and 1-3 media firms who assist with print (brochures, posters, etc), and media development (Web products – such as Flash, JAVA, etc) and CD-ROM production. These outside contractors are hired on an "as needed" basis to facilitate the design and/or implementation of a specific product/program/service (such as a Flash data visualization) for a predetermined audience need.

E&O Output: The E&O group delivers approximately 3-4 professional development workshops/institutes for K-12 educators (> 3 day programs), 20-30 one day in-service professional development programs or consultations, or coastal decision maker workshops for municipal officials, 4-8 public/family science programs, 1-2 outreach events, and 3-6 print products annually. In addition, the group consults and assists in the writing of 15-25 "broader impact statements" annually, either serving the programmatic needs of the scientists directly or "brokering" the service to a partner in the informal or formal education community.

E&O staff members work together to

1) Assess the needs of user groups and provide feedback to data product developers (both on staff and contracted)
2) Engage K-12 educators and informal educators together with expert educational design experts (including curriculum developers, exhibit designers, etc) to develop relevant education products that utilize COOL data,
3) Promote access by the media to relevant COOL "stories" of interest to the press (print and TV/radio media),
4) Implement distribution of products and services developed (including professional development programs, CD-ROMs, brochures, etc) and evaluate the impact/success of products developed (including formative and summative assessments).

Elements of Our Success

The COOL group (both Operations and E&O) have been active members of the evolving ocean observing community. Our success as a group can be attributed to a clear mission between and within each group. We established good communication at the early stages of program development that results from 1) regular facilitated meetings between team members and 2) close physical proximity in the working environment. The COOL office suite, physically, is a heterogeneous mix of a senior scientist, educators, administrative support staff,

and graduate students. This integrated work space allows for easy exchange of ideas and a cooperative working environment. Additionally, program directors provide strong leadership for the development of good science initiatives and the integrated application of quality education and outreach strategies designed for creating positive impacts for our target audiences. All staff feels equally vested and valued in the overall center mission.

Lessons Learned from COOL that can be Applied for the Development of National and Regional Observing Systems

How can we apply the experiences of the COOL Operations and E&O group to the ORION Data Translation Facility Concept? From our experience with COOL, success occurs when there is a mutual stated desire and clear path for scientists, data managers, and educators to work together for a common goal of providing quality education products to the public. All parties have to believe they are equally vested in the process. Figure 2 depicts a possible infrastructure of three distinctly linked offices or centers. This diagram could be functional at the regional association or national level. Note that the user groups (defined as scientists, K-12 educators, students, general public, etc) provide input in terms of data needs to all three centers within the program. Innovations also come from the science community who are developing new technologies and new data streams of possible use by the user groups.

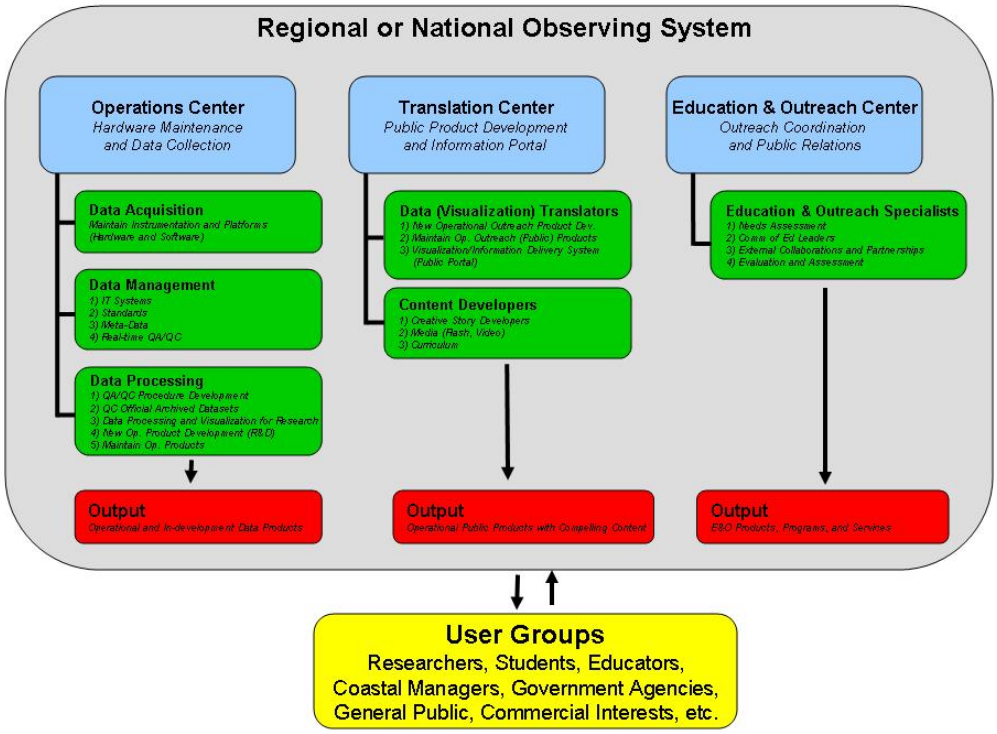

Figure 2: Proposed organizational diagram for the regional or national observing system.

The Operations Center(s) is responsible for the data collection, processing, and management. It seems that most of the details or protocols for this sector of the ORION program will be handled by the Cyber Infrastructure (CI) group.

The Data Translation Center will receive the data streams and a range of "storylines" from the scientists involved in operations. This group will then be responsible for the development of public data products and a public portal for real time data visualization. Data visualization experts would be responsible for the development of real time, near-real time, and event-driven data visualizations. These experts must have a working knowledge of several programming languages and applications, including data visualization (i.e. Matlab, IDL, MapServer), content management (PHP, MySQL, shell scripting, JavaScript, DHTML), and content development (Flash, Final Cut Pro). They must be familiar with the Unix, Windows, and Macintosh working environments. Additional requirements include strong oral and written communication skills and experience with applying data visualization and analysis tools to support inquiry-based pedagogy and resource development. These "visualizers" will work closely with a team of content developers (science writers, producers, and curriculum design experts) to develop an engaging content package that can be used in a wide range of venues including classrooms, science center exhibits, Internet, television, and programs designed for adult and student learners. Coupled with good writing, good visual displays of data should communicate ideas with clarity, precision, and efficiency.

Finally, the Education and Outreach Coordinating Office or Center will provide the infrastructure to coordinate the community of educators within the community (either at a regional or national level). This office will:

- Ensure adequate user input (in form of needs assessments),
- Build capacity within a network of education leaders (i.e. develop implementation strategies),
- Develop and maintain collaborators and partners essential to the network (i.e. media coordination) and
- Evaluate the impact of the data translation facility (including formative and summative assessment).

Staff Composition of an Ideal Data Translation Center

We propose that a Data Translation Center would best work with the following *ideal* staff composition:

- A **Director**, who understands the OOS priorities, has an excellent working knowledge of potential stories coming out of the network from the Regional Associations and who will maintain excellent communication and collaboration with the Coordinating Office.
- **2 Science Writers**, who can prioritize and construct the stories, develop press releases and develop contacts within the press/media community.
- **2-3 data Visualizers**, one who can deal with the overall real-time data portal development, a second who can develop packaged OOS

visualizations (for print/TV media), and a third who has a background in illustration (graphic arts) who can support the other two visualizers in the group (through the development of quality graphics and images that can be animated, enhanced, etc. for end user groups).

- A **Webmaster**, to design a web presence, maintain content, and archive the visualizations.
- **1-2 Educators**, who can direct the collection/interpretation of needs assessment data from the regional associations to feed into product development, work with the community of OOS education leaders to develop quality K12 formal and informal lesson plans that support the visualizations, and finally assist in the development of "capacity building" products, services, training for the community of OOS educators to increase their ability to engage and serve OOS target audiences.

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Please feel free to contact us for more information.

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McDonnel, J. and L. Hotaling, 2003. Who Uses the COOL Classroom? Community College and Middle/High School Educators, That's Who. Oceanography 16 (4), p. 12.

Web Sites

K-12 Education: http://coolclassroom.org
Operations Center: http://thecoolroom.org
Research: http://marine.rutgers.edu/cool/