DRAFT

UNOLS Observatory Working Group Meeting
Holiday Inn - Logan Airport Hotel
Embassy IV Room
February 26, 2003

MEETING MINUTES

To download a pdf copy of these minutes, click here <wgmi302.pdf>

Appendices

I. Meeting Agenda
II. Participant List
III. Working Group Task Statement
IV. H2O Observatory (Alan Chave)
V. NEPTUNE and Cable Installation Tools (Gene Massion)
VI. Deck Handling and Mooring Deployment/Recovery Needs (Worcester/Wooding)
VII. ROV and AUV Requirements (Dana Yoerger)
VIII. Mapping Requirements (Larry Mayer)
IX. Coastal Observatory Requirements – West Coast (Mike Kosro)
X. Coastal Observatory Requirements – East Coast (Scott Glenn)

Introductions, charge to the working group and meeting goals – Alan Chave opened the meeting at 0830. Meeting participants introduced themselves. The meeting agenda is included as ***Appendix I*** and the participant list is included as ***Appendix II***. Alan provided the group with background information about why the working group had been formed. There are a variety of major ocean observatory development efforts underway on global, regional and local scales. Some of these observatories have already been established and are operational.

The Ocean Studies Board has established a committee to study "Implementation of a Seafloor Observatory Network for Oceanographic Research." Bob Detrick (WHOI) is chair of this committee. Their study will develop an implementation plan to establish a network of seafloor-based observatories to support multidisciplinary research. This network would include both cabled seafloor nodes and moored buoys, located in both coastal and open-ocean areas. The committee has been tasked to provide advice on the design, construction, management, operation, and maintenance of the network, including the need for scientific oversight and planning, appropriately phased implementation, data management, and education and outreach activities of the observatories. Additionally, they have been asked to examine the impacts on the UNOLS fleet and current submersible and ROV/AUV assets in the research community. Bob Detrick, in turn, has asked UNOLS for input regarding observatory facility needs and the impact these needs will have on the UNOLS fleet. In response, the UNOLS Council recommended the formation of a working group with individuals familiar with the establishment and operation of ocean observatories. The tasking for the working group is contained in ***Appendix III***.

Deep ocean observatory requirements for UNOLS vessels:

H2O Experience - Alan Chave provided a report on the H2O experiment. His viewgraphs are included as ***Appendix IV***. The viewgraphs include pictures of the installation and cable handling operations. H2O was the first deep water installation of an observatory by a UNOLS vessel, R/V THOMPSON. The observatory has been in operation for five years. ROV Jason was used for the installation and worked well.

A summary of Alan's comments, observations and recommendations follow:

- The deck gear on UNOLS ships is not adequate for installation and servicing of deep ocean observatories. Deck equipment with the ability to handle heavier loads than those currently installed on UNOLS vessels is needed for installation and service of observatories like H2O.
- Synthetic cable is needed.
- Experienced personnel, including a cable handler, are needed. An experienced cable handler assisted the H2O installation.
- A well-designed cable grabber tool is needed.
- A fantail "chute" is needed for cable handling.
- A cable spicing capability is needed on UNOLS vessels. This does not currently exist in UNOLS. There is industry expertise in this area.
- There are safety concerns that will need to be addressed. Heavier gear and work with heavier loads will require experienced support.
- User-friendly ROVs are needed.
- Below deck winches (fiber optic) would be beneficial. The best scenario would be to have two below deck traction winches (not just two spools).
- The ships will require a large, clear aft deck.

Alan described the H2O junction box deployment operations. The ROV work vehicle (Jason) support was very adequate during these operations. Jason could do everything that was planned. Pre-cruise planning and knowing the vehicle's capabilities were instrumental. There needs to be a strong interactive relationship between the user and vehicle operator for successful operation. Prior to the H2O cruise, trial runs with Jason were carried out at the pier. In the future, as the servicing and installation procedures are well established, these sorts of cable operations might be able to be done with commercially available ROVs.

NEPTUNE and Cable Installation Tools - Gene Massion continued with a report on NEPTUNE installation and servicing facility requirements. His viewgraphs are included as ***Appendix V***. The NEPTUNE observatory is designed as a regional network of cabled seafloor nodes. There will be 30 nodes.

Gene's observations, comments and recommendations are included below:

- NEPTUNE facility requirements are estimated to require three months of ROV and UNOLS Class I ship time for servicing of nodes. A typical academic ROV would be adequate. The three months includes the time needed to service the 30 nodes.
- There would be significant cost savings to observatory operators if UNOLS Class I vessels could be used to support the observatory.
- NEPTUNE facility support will be needed for recovery, repair and re-deployment of nodes to depths of 4000m
  - –Node weight - app 2000 lbf, 2.5m x 1.5m x 1m
  - –Cable weight – 3300 lbf for 4000m
- Typical UNOLS vessels and ROVs can carry out science research/experiments associated with the observatories.
- UNOLS Class I vessels as they are currently configured are too small to meet the NEPTUNE support requirements. More deck space is needed. Much of the required handling equipment can be cross-decked to a UNOLS vessel, but added deck space and deck strengthening would be needed.
- Procedures for safe handling of the heavy loads associated with observatory work are needed. This is a major safety concern.

Gene reviewed the handling equipment possibilities for NEPTUNE support:

- Minimal handling equipment requirements:
  - Aft chute for cable handling
  - 20000 lbf safe working load (swl) winch
  - 2 capstans (10000 lbf swl each for handling soft line) and stoppers applied on deck.
- Better handling equipment:
  - The minimum requirements plus…
  - 20000 lbf swl (while rotating) a-frame.
- Best handling system:
  - All of the above plus…
  - Either 2 LCEs or 2 cable drums (2-3m diameter, 3m required for routine passage of a joint).
- Generic equipment:
  - Capstans/tuggers,
  - Grappling gear,
  - Hard/soft stoppers,
  - Cable splicing gear (several transportainers),
  - Added deck space

As part of the Neptune process, they will look at various ship support options. These include:

- Leasing Commercial vessels
- Buying a commercial vessel
- Building a new UNOLS vessel designed for support of observatory.

In closing, Gene showed slides of a typical cable repair ship.

<u>Deck handling and mooring deployment/recovery needs</u> – Peter Worcester reported on the DEOS facility needs. His viewgraphs are included as ***Appendix VI***. He reviewed the design constraints for moored-buoy observatories. There are three types of buoys:

1. No power to the seafloor - low bandwidth, acoustically-linked discus buoy
2. Powered to the seafloor - Low-bandwidth, cable-linked discus buoy
3. Powered to the seafloor - High-bandwidth, cable-linked spar buoy

Peter showed a map with locations of moored-buoy locations. The map provided locations of the sites that are currently operating or funded, as well as those sites to be implemented during the pilot phase of DEOS. Some of the sites are in high latitudes where high sea state conditions can be expected. This map is a good graphic for future reference.

UNOLS vessels currently have the capabilities needed to service discus type buoys. No added handling gear is needed. In terms of ship time, however, there will be much higher demand.

Peter reviewed the DEOS spar buoy conceptual drawing features and service requirements:

- Requires servicing once or twice a year.
- The spar buoy is 40 m long and will not fit on a UNOLS vessel.
- For servicing and fueling, the ship and buoy would need to be secure to each other. Fuel spills are a concern during fueling operations.
- Between 20-40 DEOS spar buoys are planned.
- Deployments in high latitude regions are desired.
- The spar buoy design should be ready in FY06.
- Charter ships can be considered for servicing.
- Ship demand for the servicing is unknown.
- The oil industry currently deploys much larger spar buoys and their expertise should be explored.

Beecher Wooding continued the discussion and described a discus buoy deployment sequence. He remarked that the oil industry doesn't hesitate to service the anchor mooring of the buoy. The NDSF probably would be hesitant to operate the ROV in the area of the mooring anchor. The anchor depth can be in 5000 meter of water, which would require a Jason-type vehicle for moored buoy installations.

General ship needs for moored-buoy operations:

- More deck space, increased deck strengthening, and heavy-lift deck handling equipment.
- Two traction winches, or the ability to make a quick transfer of wire spools.

General discussion followed and a variety of facility suggestions were made:

- Explore the concept of a dedicated UNOLS ship for support of observatory work and perhaps long core operations. The ship would be capable of cable laying and servicing, spar buoy installation and servicing, and perhaps long coring. The ship would have a specialized crew with expertise in heavy load handling. It would be a specialized facility.

- Explore the market of used commercial vessels. The cable industry currently has used ships on the market that could be obtained at relatively low cost. Determine if there are any constraints in acquiring a used ship that was foreign built.

- Observatory support will require specially trained people experienced in deployments and recovery of heavy loads. A dedicated support team is recommended. This dedicated crew could also serve to train others within UNOLS for observatory support.

- Operations in higher sea states will be desired, including ROV operations. Ships, crew, and equipment will need to be able to support these types of operations.

- Explore using heavy load winches that have been surpluses by the Navy.

ROV and AUV requirements – Dan Yoerger reported on ROV and AUV requirements for ocean observatories. His viewgraphs are included as ***Appendix VII***. ROVs are needed during four observatory phases: planning, installation, preliminary operations, and general operations.

The ROVs would be involved with two different types of observatory activities, installation and support of the infrastructure and the science resulting from the observatory. The intervention tasks related to the infrastructure (once established) should be predictable and well defined, therefore should be appropriate for commercial ROV contracts. It is envisioned that observatories will generate much work similar to our conventional vehicle science operations, and are probably best suited to a facility such as we operate presently.

The ship/ROV tasks related to observatory installation and maintenance will require a focused capability, rather than general-purpose vehicles. However, the regional observatories will demand a higher sea-state capability for year-round operations. More sophisticated DP systems than are currently available in the UNOLS fleet will be required. These should be designed with the ship. The sea state conditions typical of regional observatories should be evaluated so that ROV launch/recovery operations can be carried out in these conditions.

The following are suggested as sufficient ROV capabilities for service of observatories:

- Depth (5000 m) – The actual depth requirements and commercially available ROV capabilities need to be examined.
- Power (shorter, larger cable?)
- Manipulation: friendly subsea infrastructure - off the shelf capability.
- Reduced crew – accept more limited capability – most of the observatory installations are completed in six hours of work. This, combined with less complex systems could allow reduction in crew size.
- Limited mission flexibility – there would be little prototype/experimental work involved with servicing operations.
- Large deck space is needed.

- For servicing operations there will be no need for mapping, data logging, large control vans, and large science parties.

Dana continued with discussion on the status of AUV development. The AUV development needs to transition from expeditionary operations to observatory-based operations. AUV support for observatories is still a long way off. There is a long, planned process for developing an AUV servicing capability:

- Define roles of AUVs for each phase of observatory development.
- AUV Technology development
  - Vehicles
  - Docking systems
  - Sensor packages
  - Navigation/comms infrastructure
- Demonstrations of observatory servicing.
- Operations

AUVs offer exciting scientific capabilities for research applications.

ROV/AUV Recommendations:

- Include a dedicated ROV on the observatory support ship. The ROV does not need to be as sophisticated as Jason II.
- The conventional science ROV capability will need to be expanded in terms of numbers.
- Explore development of an AUV servicing capability.

Mapping requirements – Larry Mayer reviewed ocean observatory mapping requirements. His viewgraphs are included in ***Appendix VIII***. From a regional context, mapping is needed for cable route surveys. Large area coverage with the best resolution possible is needed for site selection. Surveys could include bathymetry mapping and sidescan sonar. If the cable is to be buried, coring and CPT may be required. Surveys are needed for detection of obstacles with 1 m lateral dimension and to detect hazards such as, surface faulting, tectonic deformation, turbidity flows, unstable slopes, potential liquefaction, gas charged sediment, rocky outcrops, hard bottom (if ploughed), steep slopes, pinnacles, boulders, seismic activity, high currents, trawl marks, anchor marks, proximity to cables, pipelines, manmade debris or hazardous materials, signs of oil or oil exploration, Etc. Real time processing or near real-time for decision-making is needed during mapping operations.

Larry reviewed multibeam system features and capabilities. There are tradeoffs between swath width and capability. Many of the multibeam systems can now do backscanning. The challenge that they face is correction of roll, pitch and yaw. Larry reviewed the advances that have been made in offshore positioning, motion sensors and computing power.

The UNOLS Fleet includes several multibeam systems:

- REVELLE - EM120 (12 kHz)
- ATLANTIS - SB2000 (12kHz)
- THOMPSON - EM300 (30 kHz) + Hydrosweep DS (15kHz)
- EWING - Hydrosweep DS-2 (15 kHz)

- MELVILLE - SB2000
- KNORR - SB2000
- KILO MOANA - EM120 (12 KHz) + EM1002 (95 kHz)

The CAPE HENLOPEN replacement vessel is being designed to include a Reson 8101, 240 kHz system.

Additionally, the Polar vessels are equipped with:

- NATHANIEL PALMER - EM120 (12 kHz)
- HEALY - SB2100 (0 kHz)

There are several high-frequency systems available (mostly EM3000 - 300 kHz), including systems at SUNY Stony Brook and USF. Other mapping assets are available to the community and include:

- AUVs
- ABE w/ Simrad SM2000 - 200 kHz
- Mesotech and other 675 KHz sector scanners
- MBARI w/ Reson 7000 series
- ROVs - JASON and others - SM2000 sector and scanning sonar - very fine bathymetry
- Towed Vehicles - single beam bathy and sidescan
- DSL-120 - phase comp bathy
- Deep-Tow

Larry reviewed the swath-mapping beam forming sonars and interferometric sonars. There are also "hybrid" sonars that use interferometry for high-quality imagery and some beam forming for ambiguity resolution. The trend is for better algorithms for interferometric solutions which translates to higher resolution bathymetry while maintaining high-quality, co-registered imagery and wide swath – also SAS. "Focused" sonars compensate for wavefront curvature to allow focusing in the near field. There is much higher target resolution. The future of sonar systems is the CHIRP multibeam sonars. Its benefits include:

- Increased bandwidth = increased temporal resolution
- Increased bandwidth = "multispectral" thematic mapping
- Increased bandwidth = multiple pings in water = increased sounding density

There are advances in data processing resulting in faster, cheaper, better products. The products include:

- Real-time 3-D updates and data fusion for quality control and interpretation.
- Near-real-time derivative maps.

In concluding, Larry commented that the UNOLS fleet capabilities appear to be sufficient to meet many of the observatory survey needs. More shallow water systems may be needed. Chartering of commercial ships for survey work could be considered; however, there is usually a mobilization cost, which can be approximately $300k. This would be in addition to the regular ship day rate. Collaborations should be considered if chartering is to be used.

Lastly, it is important that survey work be included in planning for ocean observatory initiatives.

<u>Coastal observatory requirements</u> – Mike Kosro began the presentation on coastal observatory requirements. His viewgraphs are included as ***Appendix IX***. There is a wide range of "observatory" groups:

- Alaska
  - CAOS
  - GEM (Gulf Environmental Monitoring; oil spill recovery)
  - DART (tsunamis)
  - PORTS (NOAA)
- Hawaii
  - HOTS
  - HF array
- Northwest
  - Oregon Coastal Observing System (OSU)
  - CORIE (Columbia River)
  - Puget Sound (UW)
- California
  - Monterey (many) ICON, MOOS, MISO, MARS, COTS
  - NEOCO (UCs) and CI-CORE (CalStates)
  - Santa Barbara Channel
  - PORTS (San Francisco)
  - CDIP (waves)
- ACCEO (coastwide CalCOFI)
- Federal agency programs
  - NDBC buoys
  - Tide Gauge network
  - PORTS
  - DARTS (tsunamis)
  - NMFS

Mike went on to describe the components of the Oregon coastal observing system:

- Repeat Ship-based Sampling.
- Long-term moored measurements.
- Extensive HF remote-sensing (CODAR) array for surface current mapping, with real-time reporting.
- Satellite remote sensing: SST, color, winds, and altimetry.
- New techniques: dye studies, AUV, video.
- Observations strongly coupled with high-resolution coastal modeling (physical, biological, meteorology).

Repeat Sampling for the Oregon coastal observing system includes:

- Ship-based CTD, ADCP, zooplankton, nutrients, fluorescence, bioacoustics
- Newport Hydrographic Line: long-term record:

- 1961-1971, typically 6-12 repeats/year
  1997-present, 5 repeats/year
- 2/month sampling from small *Elakha* during spring and summer
- Four occupations/yr of lines at Heceta Head, Coos Bay, Rogue River, and Crescent City

- Drifter Releases - 5 drifters, 3 times per year (Apr, July, Sept)
- SeaSoar Surveys - High horizontal resolution, repeated over 4 years
- Newport Long-Term Mooring:
  - 80m on the Newport Line (NH10)
  - Near historical CUE mooring sites.
- Coos Bay Long-Term Mooring- 1981-1991 (OSU); 1997-present (Hickey)
- Rogue River Mooring
- COAST moorings
- COAST met buoy
- PISCO buoys
- PISCO shore stations

The Oregon HF mapping array on the shelf (conventional-range systems) started in 1997 with two sites and they have operated continuously. It is expanded now to five sites. The resolution is 2km range and 5 degrees angle. They combine measurements from different sites to get full vector currents. Hourly maps in near real time are produced.

The HF mapping array on the slope (Long-range systems) is a long range array of 180 km. It is always on and measures surface currents. The resolution is 6 km range and 5 degrees angle. Data is brought from coast every two hours. The maps are to be presented on web in near real-time. They recently expanded to four coastal measurement sites.

Mike reviewed the components of the Center for Integrated Marine Technology: DATA, which consists of satellite-based measurements, shore-based measurements, mooring-based measurements, and ship-based measurements. In detail, these include:

- Satellite-based Measurements:
  - Sea surface temperature (AVHRR)
  - Surface chlorophyll (SeaWIFS)
  - Primary production
  - Sea surface winds
- Shore-based Measurements
  - Surface Currents
- Mooring-based Measurements
  - Atmospheric pressure
  - Wind
  - Sea Surface Temperature
  - Ocean Temperature at Depth
  - Chlorophyll at Depth
  - Ocean Currents at Depth
  - Macronutrients – Nitrate, Silicate

  - Micronutrients – Iron
  - Phytoplankton Abundance and Structure
  - Zooplankton Abundance– active hydroacoustics
- Ship-based Measurements
  - Water temperature with depth
  - Macro/Micronutrient distribution and abundance
  - Sea surface chlorophyll
  - Phytoplankton community structure
  - Zooplankton abundance and distribution
  - Zooplankton community structure
  - Schooling fish distribution and relative abundance
  - Seabird distribution and abundance
  - Marine mammal distribution and abundance
  - Sea turtle distribution and abundance

Observatory needs will require additional ship time. Examples of traditional ship-based observatories include:

- ACCEO (West Coast CalCOFI)
- HOTS
- Newport Hydrographic Line

IOOS proposes an array of 500 moorings. These will require ship servicing.

The observatories will provide more real-time data on ocean conditions and in turn will make adaptive sampling more feasible. Data assimilating models will provide inspiration for adaptive sampling. There will be an increased need for flexible ship scheduling and low operating costs.

Mike closed by commenting that observatories will require two-way high bandwidth information exchange:

- Receive inputs from data sources
  - Satellite SST, color, and altimetry
  - HF current maps
  - Model now-casts and forecasts
- Provide ship-based results to shore quickly
  - Share with partner investigators in coordinated surveys
  - Provide input for model assimilation
- Provide access to the wider world of information via www.
  - Emphasis on http for data discovery in present planning.

Integrated coastal observatory – Scott Glenn continued with a presentation on an integrated coastal observatory, LEO-15. His viewgraphs are included as ***Appendix X***. LEO-15 is a regional ocean modeling system (ROMS). Its features include:

- Cabled observatory
- AUV – propeller type and gliders
- Moored buoys

- Satellites
- Adaptive sampling with aircraft sensors
    - Small aircraft
    - High flying
    - Slow flying
    - Autonomous

Rutgers University marine remote sensing includes use of the L-Band satellite that has been operational since 1992. It tracks NOAA-12, 16, 17, SeaWiFS, FY1-C, and FY1-D. The X-Band satellite senor will be installed in 2003 and will track MODIS Aqua/Terra, Oceansat, Radarsat, ADEOS 2, and HY1.

Scott showed an example of a nested Multi-Static CODAR Array which consist of a beach unit, buoys, and boats. Aircraft sensors, as well as, the REMUS AUVs have been used for adaptive sampling of coastal observatories.

Coastal work requires small vessels with simplified handling systems. In the next decade a national network of regional observatories could evolve. It is estimated that there will be 121 offices nationwide with 34 coastal offices.

Scott described the UNOLS vessels that have been and are being used for coastal observatory work. These include:

- ENDEAVOR
- CAPE HENLOPEN
- CAPE HATTERAS
- SAVANNAH
- ALPHA HELIX

Other, non-UNOLS vessels that have been used include:

- R/V CONNECTICUT
- FAY SLOVER
- ARGO MAINE

Scott provided more detailed descriptions of the various UNOLS and non-UNOLS ships used for coastal observatory operations:

- R/V ENDEAVOR is owned by the National Science Foundation and operated by the Graduate School of Oceanography at the University of Rhode Island. Originally built in 1975, the ship underwent a major mid-life refit in 1993. In many respects, this size vessel is too large for coastal observatory work.

- R/V CAPE HENLOPEN is a general purpose, coastal research vessel operated by the University of Delaware. The ship's normal operating area is the Delaware and Chesapeake Bays and the adjacent coastal waters out to 200 nautical miles. However, work is periodically conducted as far north as the Gulf of Maine, as far south as Florida, and as far off shore as Bermuda. The ship can accommodate up to 12 scientists on missions lasting up to 10 days. It is equipped with a full range of oceanographic instrumentation including portable chemistry labs; a conductivity, temperature, and depth profiling system; an acoustic Doppler current profiler; a meteorological and sea-surface mapping system; and a variety of sediment and water sampling equipment. This is a good platform for support of coastal observatories.

- R/V CAPE HATTERAS is owned by the National Science Foundation and operated the Duke/University of North Carolina Oceanographic Consortium. Areas of operation are the North American coast from Nova Scotia to the Caribbean, and beyond Bermuda. The vessel is operated primarily as a coastal zone research vessel and is a good platform for coastal observatories.

- R/V CONNECTICUT is a steel hull, single screw, diesel powered research vessel, outfitted for year-round coastal and near continental shelf service. The vessel was launched in July 1998 and is homeported at the Marine Sciences & Technology Center in Groton, CT. The vessel can accommodate up to 30 people for day trips and up to 12 people for overnight and extended science missions. Endurance is 7-10 days. The design favors stability and precise low speed handling and positioning capability, which is accomplished with bow and stern pump jet thrusters. The ship features wet and dry laboratory spaces and a mid-ship mounted, 20" diameter, instrument wet well which allows transducers or sampling gear to be installed through a main deck access hatch. Hardwire connections can be routed to all science spaces. Science vans up to 20' in length can be placed on the large work deck and a full suite of deck machinery is available. This is a good platform for coastal observatory support.

- R/V SAVANNAH entered the UNOLS fleet in September 2001. The ship is operated by the Skidaway Institute of Oceanography. The R/V SAVANNAH is ideal for biological, chemical, physical, and geological oceanographic studies in estuarine and continental shelf waters throughout the southeastern US Atlantic and Gulf Coasts.

- Old Dominion University's new vessel, R/V FAY SLOVER is 55-ft LOA and offers an expanded research capability in the Hampton Roads and Chesapeake Bay regions. High horsepower diesel engines power the ship to speeds of 20 - 24 knots, thereby expanding the daily range of research operations. The ship is outfitted with onboard instrumentation and monitoring equipment.

- The 133-foot UNOLS research vessel, ALPHA HELIX, is operated by the University of Alaska for the National Science Foundation. The ship's homeport is Seward, Alaska.
- ALPHA HELIX is maintained and used as a year-round platform supporting oceanographic research on the open ocean and in Alaska's shelf and coastal waters. Its ice-strengthened hull permits surveys in regions covered by seasonal sea ice and in areas adjacent to the numerous tidewater glaciers occurring in Alaska's coastal zone. The vessel accommodates 15 scientists and a crew of nine. Working spaces include a large general-purpose laboratory opening to the working area on the stern, an electronics room, a walk-in freezer, a temperature control room, a machine and wood shop, a library, and a wet laboratory. A bow thruster is available for station keeping at sea. Modern sampling equipment includes a global position system (GPS) navigation, an acoustic Doppler

current profiler, a quantitative echo-sounding and integration system, on board computers and satellite voice and data links to the Fairbanks campus and worldwide. This vessel is the oldest in the UNOLS Fleet.

Scott reviewed the coastal science facility recommendations that have been made from the CoOP and SCOTS reports. The CoOP Report recommends a "Pioneer Array" to consist of 30-40 moorings. Mobile platforms (ships and AUVs) will be required. Also needed will be remote platforms, such as, hyperspectral satellites and HF Radars. The SCOTS Report recommends cross-shelf lines of cabled science nodes with spidering subnodes deployed in water depths from shallow diver-serviced depths to deep water.

Scott reviewed the capabilities/features that a midsize coastal vessel should have if it was to support observatory operations:

- Shallow water operations O (10m)
- 24 Hour operations (this needs to consider Marine Technician support)
- Sustained operations for several days
- Standard sensor suites (not always standard on small vessels) - Met, ADCP, CTD, Bio-optics, Acoustic Mapping
- Broader bandwidth communications with shore
  - Send data back in real time
  - Access observatory datasets of websites
- Computer Lab
- Electronics Shop
- Wet Lab
- Deck space for a portable Lab van
- Towing Capabilities (Outside the wake, both sides)
  - Undulaters (ex., SeaSoar)
  - Towbodies (ex., Batfish)
  - Nets for Fisheries
- Autonomous Vehicle Operations
  - Short-term propeller-driven AUVs when stationary
  - (Ultra Short baseline navigation)
  - Mission-duration (or longer) Glider AUVs
  - Autonomous Aircraft
- Mooring Servicing
  - Atmosphere/Ocean Physical/Bio-optical Moorings - (typically four 2-m diameter moorings per trip)
  - HF Radar transmitter moorings
- Bottom System servicing
  - Cabled observatory nodes
  - Bottom tripods deployment and recovery
  - ROV capabilities for servicing and sampling
- Acoustically quiet
- Ice Capable - Alaska

How many midsize vessels will be needed to support coastal observatory requirements? There is a trade off between shorter duration missions and the transit time between staging facilities. The typical mission duration is 5 to10 days. There will be multiple ship demands during peak periods. As an examples, the peak spring discharge from the estuaries will increase demand on ship time. Additionally, multiple ships for the same experiment will be needed. There will be increased need for servicing missions to maintain long-term, continuous observations, both scheduled and emergency maintenance. There will be an increased need for rapid response to events. Currently, the scheduling process for the UNOLS fleet does not provide a mechanism for rapid response operations.

Regional priorities may require differ types and numbers of ships. A first-cut at the locations that will require facility support for coastal observatories include:

- Gulf of Maine
- Middle Atlantic Bight
- South Atlantic Bight
- Eastern Gulf of Mexico
- Western Gulf of Mexico
- Southern California
- Northern California
- Oregon
- Washington
- Southern Gulf of Alaska
- Northern Gulf of Alaska
- Bearing Sea
- Arctic Seas

<u>Vessel characteristics, possible improvements, and recommendations for new vessel designs</u> - Wes Hill, Relief Captain for R/V REVELLE (UNOLS Class I vessel), commented on ship capabilities that would be needed to meet the observatory installation and servicing requirements. This sparked discussion among the meeting participants. Suggestions, comments and recommendations are listed below:

- High latitude work will require the ability to work in high sea states.
- Redundancy in the DP system is recommended. This is common on industry cable ships.
- Investigate collaborations with Integrated Ocean Drilling program.
- INCREASED SAFETY MEASURES – provide special training to ship's crew for observatory operations (cable handling and buoy servicing).
- Power safety for handling cables – they must be powered down before servicing.
- Examine the feasibility of modifying UNOLS Class I ships to accommodate observatory work. This could include:
  - Remove the hanger and lab space, to make more desk space.
  - Improved visibility to aft is needed for over-the-side and end operations.
  - Move bridge/superstructure forward for added aft deck space.
  - Single staterooms for increased crew habitability.

- Deck strengthening and more capable handling equipment with ability to handle heavy loads
- Taller frames with greater reach
- Cranes – greater reach, increased load
- Shrouded nozzles for protection from propeller/cable interference.

Action List – Alan closed the meeting by providing a list of action items and responsibilities. He circulated this list by e-mail after the meeting. Responses to the action items should be completed in roughly a month.

1. Investigate the issues surrounding the servicing of large buoys from UNOLS Class I vessels, including dealing with oil spills during refueling and general operations involving refueling (Hill/Schwartz).

2. Investigate the issues surround switching between trawl and f/o cables on REVELLE and the feasibility of using two traction heads vs. one that opens up to avoid having to reterminate (Wooding).

3. Get information on long core winch and deck hardware (Wooding/Chave).

4. Get information on cable repair ship or comparable ship capability and availability (Chave/Massion/Hill/Schwartz).

5. Get information on industry ROV types and capability (Bowen/Yoerger).

6. Investigate feasibility of purchase or lease of multipurpose heavy lift shift, including crew trained for heavy lift ops. Ship should be capable of large core ops, large buoy (including 40 m spar) ops, and some types of cable ops (Chave/Massion/Hill/Schwartz).

7. Investigate issues surrounding shifting vessel flag from foreign to US (with Ewing as a key example) (DeSilva/Chave).

8. Produce a first cut at ROV and AUV needs for deep ocean and coastal ops (Bowen/Yoerger/Glenn/Kosro).

9. Produce a set of recommendations re mapping sonars for UNOLS vessels suitable for observatory ops (Mayer).

10. Investigate regional class vessel SMR and compare to proposed midsize coastal vessel functional requirements. Either make suggested changes to regional SMR or put together new one (Glenn/Kosro).

11. Document aircraft needs for coastal observatories (Glenn/Kosro).

12. Investigate improvements to AGOR-23 DP similar to those recently accomplished on KNORR (Yoerger/Hill).

13. Get feedback on observatory ops from marine crew (Hill).

14. Investigate trade-offs between lab space and deck space on AGOR-23 class, with possibility of removing hangar and aft lab space to increase deck space. Added benefits include improved visibility of fantail from bridge and improved deck load. Two scenarios are envisioned: short-term changes and those associated with mid-life refit (Worcester/Chave/Wooding/Hill/Schwartz).

15. Review ocean class SMR and comment (all).

16. Investigate a-frame deck strengthening issues, with particular emphasis on how these were handled for Atlantis. The goal is to double a-frame capability (Chave/Wooding).

17. Investigate the use of shrouded nozzles for z-drives on AGOR-23 (Hill/Schwartz)

18. Investigate redundant DP systems for UNOLS Class I vessels (Hill/Schwartz).

19. Put together conceptual deck layout for cabled observatory maintenance ops (Massion/Wooding/Chave).