University-National Oceanographic Laboratory System

# Polar Research Vessels and UNOLS

**Polar Research Vessel Committee Update**

**FIC and Council**

**October 24 & 25, 2011**

## Polar Research Vessel Committee

Rob Dunbar/Stanford- Chair

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Eugene Domack/Hamilton

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## PRV Committee Goals

The key charges to this committee are:

- Update the science questions and review/modify the vessel science mission requirements defined in an ARVOC study conducted between 2002 and 2006
- Articulate and evaluate emerging new science drivers
- Utilize the UNOLS model for developing science mission requirements based on current and broad science community input
- Submit a report to NSF in two stages with an interim report due in August 2011 and a final report due by December 2011

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PRV Committee last met in Palo Alto on May 5 & 6 to continue to identify science questions and writing the interim report.

Interim Report Submitted to NSF/OPP on 31 August 2011

Interim Report sent to all of the Workshop Participants requesting feedback.

PRV is working on edits and fine tuning document.

UNOLS and PRV are developing science capability tables

Next Meeting is December 1 & 2, 2011 at NSF

Final report due at NSF late 2011, early January 2012.

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## Interim Report- Approach Taken

- Review the Science Questions developed in the 2002-2006 study to determine if still valid.
- Determine new science drivers and grand challenges and attempt to predict out 30 years
- Careful not to get bogged down on science mission requirements, but to identify science capabilities which come out of science questions.

## Grand Challenges

- # 1- The Ice Sheet to Marine Transitions zone- understanding the processes and thresholds at the boundaries between the ice sheet and ocean.
- #2- What is the role of the polar oceans in the global carbon cycle?

## Additional Science drivers

- What is the geologic nature and extent of the polar continental shelves and what natural resources do they contain?
- How do polar organisms respond to environmental change?
- What will be the effects of sea level rise?
- How will unique polar marine ecosystems respond to climate change?

# Interim Report- Initial Findings

- RVIB Nathaniel Palmer has given us 20 years of polar research, yet vessel has limited ice capability which prevents year round access.
- U.S. has fallen behind other nations in building ice capable vessels and in maintaining a leadership role in polar research.
- Polar Regions are experiencing a rapid rate of change.
- Improved and year round access to polar regions is required.
- Principle ship characteristics and design from 2006 is still valid, with a few changes.

| Objective # | General Cat. | Target Objective |
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| 1 | Berths non-Crew Scientists | 45 non-crew berths to accommodate the science party. |
| 2 | Endurance | 90 day Endurance with full complement |
| 3 | Speed | 12kt in open water (2006) |
| 4 | Range | 25,000nm (assumes 90 days @12knt) |
| 5 | Draft | ~9m |
| 6 | Motion Criteria | Must have sea-keeping capabilities that permit work in rough seas of the Southern Ocean and sufficient environmental control to allow year round work in the polar seas. |
| 7 | Icebreaking Capability | Icebreaking Capability 4.5ft at 3knots, ABS A3 (2006) capable of 50km transects through moderately heavey sea-ice (up to 4.5m thick) to include operations in both polar regions year-round. It is noted that this will not include the central Arctic area. |

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| 8 | Acoustically quiet ship | Significant efforts should be directed towards making the ship as acoustically quiet as practical. Significant and detailed technical compromises are necessary to achieve a reasonable balance between the performance of ships' acoustic systems and the power and strength necessary to be an efficient icebreaker.<br><br>Special consideration should be given to machinery noise isolation, including heating and ventilation. Propeller(s) are to be designed for minimal cavitation, and hull form should attempt to minimize bubble sweep down. Airborne noise levels during normal operations at sustained speed or during over-the-side operations using dynamic positioning shall conform to standards in USCG NVIC No. 12-82 and IMO Resolution A.468(XII), "Code On Noise Levels On Board Ships." Sonar self noise should meet or exceed manufacturer's requirements. Underwater radiated noise and airborne noise specifications should be developed using an experienced shipboard noise consultant.<br><br>With regard to sonar systems, the design should strive to achieve less than 45 dB re $1_{\mu}$Pascal at 1 meter in the frequency band from 3 kHz to 200 kHz to avoid compromising the performance of permanent and visiting sonar systems. The design effort to accomplish this goal should be developed using an experienced shipboard noise consultant. The actual levels should be measured and documented as part of the acceptance and/or science trials. The ship should be equipped with a system to measure and record broadband (2-200kHz) noise and the measurements should be compared to historical data as part of the normal science operation. |
| 9 | Box Keel | The ship should have a box keel in which the Acoustic systems are located in order to lessen the affects of bubbles and ice on the acoustic systems. |

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| 10 | Green Ship | Every effort should be made to incorporate recycled materials, non-polluting equipment and instrumentation and fuel efficient or alternative fuel technologies to make these vessels as environmentally friendly and cost effective as possible. |
| 11 | ADA Compliance | Implement as many of the ADA Guidelines as possible within the budget and size constraints for the vessel. ADA Guidelines for UNOLS Vessels_Final_Feb08.pdf |
| 12 | Geotechnical Coring | The ability to acquire long stratifraphic sections (50m via Jumbo Piston Coring or other long core system) in ice covered areas. |
| 13 | ROV/AUV Operations | A new PRV must be able to host and deploy/recover Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV), both with a wide variety of capabilities. Most likely, such operations will take place in ice covered seas and hence vehicles will be need to be deployed through a moon pool or over the side after ice clearing. |
| 14 | Net Tows & Trawls | Ability to tow nets and instruments from the stern during ice-breaking. |
| 15 | Geotechnical Drilling | Capable of accommodating temporarily-installed geotechnical drilling to 100 m below sea floor, at water depths of up to 1200 m in ice covered areas. |

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| 16 | Moon Pool Operations | The moon pool shall meet the following requirements:<br>4 meters X 4 meters in size, with sufficient overhead clearance to allow temporary installation of drilling rigs (see Geotechnical Drilling above).<br>The moon pool must be closed to the sea when not in use.<br>Capable of being pumped down free of water and ice when the bottom door(s) for the pool are closed.<br>Accessible from an environmentally controlled compartment with sufficient space and support systems to enable the deployment of scientific gear including CTDs, ROVs, VPRs, nets, drilling systems, portable ADCPs, etc.<br>Shall be supported by the same oceanographic winches that support over the side operations.<br>Located as close to the center of motion of the ship as is practicable so as to minimize the impact of the ship's motion. |
| 17 | UAV Operations | The vessel should be capable of launching small drone aircraft for ice survey and reconnaissance (remotely or autonomously operated). |
| 18 | Hydrographic Winches | 2ea Hydrographic winches capable of 10,000m of 0.322 E-M and/or 3/8" wire rope. |
| 19 | Heavy-Duty Winches | 1 trawling/coring winch capable of handling 10,000m of 9/16" wire rope and 1 deep-tow winch capable of handling 10,000m of 0.681 F-O cable. |
| 20 | Cranes | Cranes Capabale of reaching all areas of the working deck including the flight deck to move cargo. |

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| 21 | Helicopter Operations | Ship operations in remote areas of both polar regions necessitates helicopter capability to support transfer of personnel, vessel logistics, ice recon, expanded scientific reach with the vessel as a mobile science base, and emergency medical evacuations. The ship shall be capable of landing and supporting two be able to make 150 nm round trips with 3 passengers and 1200 lbs. of cargo (eg Bell 412, Sikorsky S-70, or landing a (USCG) HH60). The flight deck shall be structurally capable of landing a larger single rotor helicopter.<br><br>The hangar shall be sized to house the two smaller helicopters with the rotors folded and the necessary storage/shop capability. On board aviation fuel capacity shall be adequate to support two helicopters for up to the endurance of the ship, based on flying one helo for four hours for 1/3 of the underway days. Accommodations for the helicopter crew and technicians would come out of the science berths. |
| 22 | Portable Labs | Space to carry 5-6(2006) ISO standard 8 foot x 20 foot portable deck vans ("UNOLS Standard" lab vans). |

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| 23 | Laboratory Spaces | Labs to accomodate 45 scientists. Lab spaces to include:<br>Main Lab -<br>Wet-Lab-<br>Computer Lab - Separationg of computing facilities in a climate controlled, limited vibration space (2006)<br>Dry Lab -<br>Hydrolab -<br>Refrigerated Lab - 2ea (2006)<br>Microscope Lab - 2ea (2006)<br>Gimballed platform (2006)<br>Electrophoresis equipment (2006)<br>TMC lab (2006)<br>Core Processing Facilities (2006)<br>Built-in climate controlled workspaces.<br>Built-in refrigerators/freezers |

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| 24 | Uncontaminated Seawater System | Uncontaminated seawater should be supplied to most laboratories, vans, and several key deck areas via two systems/pumps. This water must be collected as close as possible to the bow and piping must be made from materials acceptable to the majority of science users. As a minimum, two uncontaminated seawater intake are required.<br><br>The first system/pump will feed a flow-through science sea water system: ~10-20 liters/minute maximum, for instrumentation (TSG, fluorometers, nitrogen analyzer, flow-through mass spectrometers, DO, pCO2 etc.) only.<br><br>The second system will feed the Incubator/sampling/washing water: 400 liters (~100 gallons) per-minute delivered to the location of the incubators. Also delivers water to science sinks, vans sites, science working deck areas. |
| 25 | Deionized Water | A tank or system to supply feedwater to a deionizing system in the laboratories shall be provided. |
| 26 | General Specifications | The passageway on the main deck should be 8 ft wide, inter-deck elevators (2006) |

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| 27 | Frozen Science Storage Space | 200ft$^2$ (2006) to contain redundant cooling systems. |
| 28 | Science Storage | How many containers? Easy access to the container hold (2006). |
| 29 | Workboats | The addition of more sea-worthy boats (2006) |
| 30 | Science Mast | The main mast shall be provided with yardarms capable of supporting five scientific packages each weighing 100 pounds and measuring 2 feet wide by 2 feet long by 3 feet high.<br><br>The ship design will incorporate a location with good to excellent full-sky visibility for mounting navigation and attitude antennas. Additionally, the area should be easy and safe to access to mount antennas with easy cable runs to the labs.<br><br>A second lightweight and removable mast shall be provided on the foredeck. The secondary mast shall be located as far forward on the bow as possible in a region where airflow is as little disturbed as possible by the ship's structure. The secondary mast shall be designed for easy servicing of installed scientific packages and instruments.<br><br>The secondary mast shall be provided with yardarms capable of supporting 5 scientific packages weighing 25 lbs. each and measuring 1 foot wide by 1 foot long by 2 feet high. The secondary mast shall be of adequate height and stiffness to properly support the scientific packages in a region of undisturbed airflow. The secondary mast shall be provided with means (ex. hand-winch) for raising and lowering to allow servicing of installed sensors in one hour or less. The cranes or oceanographic winches shall not be used for raising or lowering. |

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| 31 | Dynamic Positioning | |
| 32 | Communications Internal | Primary high speed Internet access will be provided by a Very Small Aperture Satellite (VSAT) system. A location for installing a 2 to 3 meter VSAT or similar actively stabilized antenna will be provided in the design with a full-sky view. Above 80o degrees Internet connectivity will be provided by ganged (load equalized) systems via Low Earth Orbit (LEO) satellite systems such as Iridium OpenportTM. The operating area and schedule of the ship will probably require it to be outside of VSAT footprints often and therefore a location for an InmarsatTM antenna such as a Fleet Broad BandTM will also be required. |
| 33 | Communications External | Primary high speed Internet access will be provided by a Very Small Aperture Satellite (VSAT) system. A location for installing a 2 to 3 meter VSAT or similar actively stabilized antenna will be provided in the design with a full-sky view. Above 80o degrees Internet connectivity will be provided by ganged (load equalized) systems via Low Earth Orbit (LEO) satellite systems such as Iridium OpenportTM. The operating area and schedule of the ship will probably require it to be outside of VSAT footprints often and therefore a location for an InmarsatTM antenna such as a Fleet Broad BandTM will also be required.<br><br>Ship-based weather satellite receivers (e.g. TerascanTM and Dartcom) provide real- time visual and infrared imagery from NOAA HRPT and DMSP satellites with no delay. The PRV design will have a suitable mounting location for a 1.5m dynamic antenna to support direct satellite reception. |

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| 34 | Data Processing | High-speed data processing facilities capable of handling large data sets for rapid processing, display, evaluation, and archiving. Typical data sets might include: LiDAR elevation surveys from glaciologists, seismic imaging, and multibeam swath map output. |
| 35 | Science Navigation Systems | Globally Corrected Differential Global Navigation Satellite Systems (gnss) navigation and GNSS-aided inertial navigation systems will provide navigational and dynamic vessel attitude in support various instrumentation onboard (multibeam, DP, etc). |

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| 36 | Multibeam, Deep Water | Reliable, well-known deep water multibeam swath mapping echo sounders with a 1° x 2° array? 1° x 1° array? installed behind ice protection windows (eg Kongsberg EM122TM). Supporting equipment for the multibeam systems will include primary and backup attitude, position, and heading reference providers, such as the Applanix POS/MVTM. |
| 37 | Multibeam, Shallow Water | Reliable, well-known deep water multibeam swath mapping echo sounders installed behind ice protection windows (eg EM710TM) for high quality data collection on continental shelves and upper slopes. Supporting equipment for the multibeam systems will include primary and backup attitude, position, and heading reference providers, such as the Applanix POS/MVTM. |
| 38 | Echosounder | Reliable, ice-protected, hull mounted sub-bottom profiler operating in the 3.5 kHz range. Typical systems are either FM-modulated (CHIRP) such as a Knudsen 3260, parametric (narrow beam) system such as the Atlas Parasound or Kongsberg Topas. The sub- bottom may be integrated with the multibeam, e.g. Kongsberg SBP120TM. |