Meeting Summary
Submarine Arctic Science Program (SCICEX)
Science Advisory Committee (SAC) Meeting
December 6-7, 2007
Arctic Submarine Laboratory, San Diego, CA

Captain Ed Hasell opened the meeting by welcoming SAC members and members of the Interagency Committee (IAC) in attendance.

Attendees
SAC members attending:
Jackie Richter-Menge (Chair) – Cold Regions Research and Engineering Laboratory
Tim Boyd – Oregon State University and Scottish Association of Marine Science
Ray Sambrotto – Lamont-Doherty Earth Observatory
Terry Tucker – Consultant, Terry Tucker Research
Mark Wensnahan – Polar Science Center, University of Washington
Jeff Gossett – Arctic Submarine Laboratory
CAPT Paul Stewart – Office of Naval Research

SAC members not attending:
Margo Edwards – University of Hawaii
Bill Smethie – Lamont-Doherty Earth Observatory

IAC members attending:
John Farrell – US Arctic Research Commission
Simon Stephenson (via conference call) –National Science Foundation
CAPT Paul Stewart and Jeff Gossett are also members of the SAC

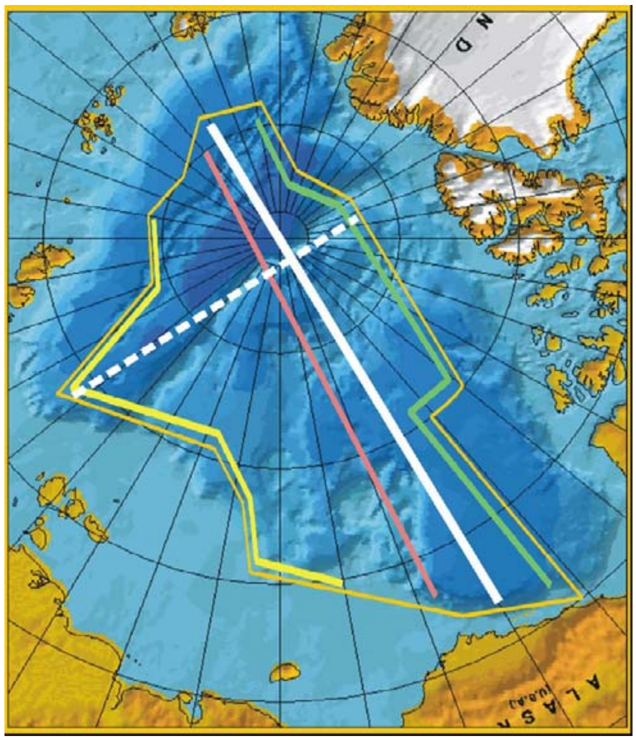
Also attending was George Newton, Advisor to the US Arctic Research Commission

Meeting Objectives and SAC role and responsibilities
Chair Jackie Richter-Menge reviewed the planned agenda for the meeting (agenda.12.07.final). She then reviewed the Memorandum of Agreement (MOA) signed in 2000 by representatives of Commander, Submarine Atlantic Fleet, Commander, Submarine Pacific Fleet, Chief of Naval Research, and the National Science Foundation (http://www.csp.navy.mil/asl/Scicex/SCICEX_MoA.pdf). The MOA was drafted at the conclusion of the dedicated science cruises during the 1990's. The purpose of the MOA was to continue scientific data collection by Navy submarines when opportunities emerged during Arctic missions. The principal objective of the newly appointed SAC and this meeting is to reinvigorate and formalize the SCICEX SAC and take maximum advantage of possible cruises of opportunity. It was made clear by CAPT Hasell and Jeff Gossett that such cruises will be accommodation cruises in which limited science is accommodated on transit or other missions to the Arctic. There will be no dedicated science cruises for the foreseeable future due to fewer attack submarines and very high priority military missions. Jeff emphasized a strong need for a prioritized science plan by

which short notice Arctic cruises could collect useful data should "science" time become available.

Recent SCICEX Guidance

The Chair then reviewed recent guidance to ASL that was solicited from involved arctic scientists in an informal sense via e-mail and occasional memos (SCICEX.12.06.07). In 2002, the highest priority cruise tracks included: (1) the repeated transpolar track across the Canada basin from near the Alaska coast extending to the top of the SCICEX box on the Eurasian side of the North Pole, (2) a track on the Canada side of the box as close to the Canadian EEZ as possible, and (3) a track along the Eurasian margin of the box.



Proposed Tracks

In 2005, the track on the Canada side was dropped and later a perpendicular line from the Canada side of the box to the Eurasian side was added. Ice profile data, bathymetry, sail-mounted CTD, XCTD, and water samples were to be collected on these track lines. A meeting of the SCICEX SAC in March, 2005 in Monterey, CA (SCICEX SAC REPORT.03.21.05) addressed many of the sampling issues including instrumentation, desired sampling locations, rates and frequency of sampling, and handling and analysis of water samples. Most of these issues were resolved via e-mail correspondence following the Monterey meeting.

History of SCICEX: Scientific Contributions

Jackie reviewed some of the accomplishments of past SCICEX cruises, focusing on the dedicated cruises of the 1990's (SCICEX.12.06.07). The scientific contributions have been numerous and are well described by Edwards and Coakley (2003) and the report resulting from the SCICEX 2000 workshop (Rothrock et al., 1999). Thus far, there have been 54 peer-reviewed publications that have resulted directly from data collected on SCICEX cruises.

SCICEX Today: Current Assets and Capabilities

Jeff Gossett reviewed current arctic submarine operations and capabilities (ASL 6 Dec). Currently, 1 to 3 submarines per year transit the Arctic Ocean to save time getting to a designated mission area. Also there is a Navy ice camp normally every 2 years in which one or more submarines are involved focusing on classified testing. The transit cruises may offer opportunities for some science accommodation. Jeff mentioned that a science accommodation cross-basin science transect (presumably on the repeated track line) would cost about a week in time over a normal transit of the basin.

Submarines

The Sturgeon class (637) submarines, the platforms for the dedicated science cruises of the 1990's, are no longer in service. Current numbers of submarines and their classes are:

- 25 Los Angeles (688) – no sail hardening (unable to surface through ice)
- 23 Improved Los Angeles (688I) – some sail hardening (surface through thin ice)
- 3 Seawolf – unlikely to go to the Arctic
- Virginia – just entering the fleet

Instrumentation

- Ice draft topsounder:
  - The 688 class vessels are equipped with the OD-84 topsounder which is compatible with the ASL Digital Ice Profiler System (DIPS)
  - BSY-1/BSY-2 combat systems on the 688I and Seawolf classes are not compatible with DIPS. The BSY-1 produces a rectilinear analog profile of the ice draft which could possibly be digitized. The analog profile produced by the BSY-2 system appears to be too faint to be digitized.
  - Digital ice profile systems are being installed on the Virginia class and will be backfit to the 688 and 688I classes. The backfit to all submarines is expected to take approximately 8 years.
  - The Ice Keel Avoidance and Precision Underwater Mapping (IKA-PUMA) systems will also be backfit. These systems can provide digital swath mapping of the ice bottomside 800 – 1000 yards wide.

- Bathymetry – All classes have single beam sonar.

- Expendable sound velocity probes are carried and can be launched by all classes.

- Expendable conductivity temperature depth probes (XCTD) – Currently XCTD's produced by Sippican do not work on the submarines. This problem was taken on as an action item by the SAC.

Other ASL instrumentation that can be installed:

● Hull-mounted CTD – Seabird SBE – 19+ or SBE – 49 with SEASOFT operating software and custom ASL display software. Water is pumped from outside the sail into the CTD.

● Submarine Remote Video System (SVRS) – low light underwater cameras utilizing natural light to identify surfaceable features and aid in positioning while surfacing.

● Side-scan sonar -125 kHz sonar mounted on the sail which covers approximately 500 yds to either side of the track, used to map surfaceable features.

Other instrumentation will require development of an Installation Package which would require funds and time (about 18 months and $50 to $100k depending on the instrumentation and complexity of the installation). ASL will install and remove the instrumentation.

Data Distribution

Jeff noted that ASL will distribute the post-cruise data to the National Snow and Ice Data Center (NSIDC), the repository that has been designated by ONR. A topic of some discussion was that some data (e.g. bathymetry, ice draft) will require substantial pre-processing before sending it to NSIDC.

IAC Perspectives

Members of the Interagency Committee discussed their perspectives of the relevance of the SCICEX program.

CAPT Paul Stewart (Code 32, Office of Naval Research), the ONR IAC representative, noted that although the ONR High-Latitude program has been phased out, the Oceanographic program can fund Arctic research. Further, the Navy has recently indicated a stronger interest in operating in the Arctic given the increased accessibility. He further noted that ONR is particularly interested in AUV and glider applications, most appropriate to the Arctic.

John Farrell, Executive Director of the USARC discussed an ongoing Government-wide high-level review of Arctic policy. The existing policy is being reviewed due to recent dramatic changes in arctic climate. The white paper resulting from the review will be submitted to the National Security Council. John also discussed the current and planned efforts involved in mapping (bathymetry, seismic, gravity and magnetics) the limit of the continental shelf. There is a fairly substantial budget for this effort with funds going to NOAA, USGS and other agencies. On a final note John mentioned the Arctic Observing Network (AON) in which the Interagency Arctic Policy Committee (IARPC) has expressed strong interest. John's view is that submarines should be an important element of the AON.

Via phone conference, Simon Stephenson, NSF Arctic Program manager, expressed NSF's interest in using submarines for sustained observations of the Arctic. He particularly favors the multidisciplinary science conducted from submarines. NSF is most interested in receiving a science plan from the SAC which emphasizes how submarine science can enhance observations of Arctic environmental change. NSF would also be interested in expanding the use of submarines. Funds for NSF sponsored in SCICEX accommodation experiments would come through the normal proposal process yet some funds for short fuse missions may be arranged through interagency agreement. The SAC should generate a science plan with priorities such that funds can be allocated. The SAC should also engage the community with science plan to foster feedback.

Common Points of Interest

The following topics of national interest in which submarine-based science could play an important role emerged from the discussions with the IAC members:

- Use of submarines as part of the Arctic Observing Network to monitor environmental change
- Law of the Sea – mapping the extended continental shelf
- National Security Council review of policy – who will be responsible for the Arctic Ocean given environmental change; which observations will help predict future conditions?

SAC Actions

The meeting attendees addressed specific issues that need to be accomplished. Each of these was discussed in some detail (SCICEX.12.07.07).

High Priority Actions (6 mo)

1. Develop a science plan – The workable science plan should include priority measurements and desired cruise tracks. Assuming the SCICEX part of the cruise will be on a transiting submarine, scenarios should be developed to make best science use encompassing a range of SCICEX accommodation times from ½ day to 7 days. The science time allotted includes repositioning the submarine to a desired track or sampling location. Priorities of measurement type should be established for each time allocation increment. The SAC envisions developing a matrix of types of measurements to be made versus the time allotted.
2. Resolve instrument concerns –
   - Currently manufactured XCTDs are not compatible for submarine use. These need to be resolved with the manufacturer.
   - Examine the water sampling flow-through system. Water samples are now collected in engineering spaces and may be contaminated. Are they sufficient for most measurements or can another source be installed?
3. Inclusion of the SCICEX program as a vital component in the IARPC Arctic Observing Network
4. Produce a quality map of past SCICEX tracks.
5. Communication with the science community

- Identify host for central SCICEX web site
- Request feedback on the science plan

Medium Priority Actions (1 yr)

1. Implementation plan
   - Data analysis and archiving
   - Funding
     - Science funding
     - Sample analysis/Data processing/managing/archiving
     - ASL funding
   - Timeline
2. Communication with community
   - Include list and description of available data

Other Actions

1. Release of existing, classified data
2. Build on scenarios; increased use of submarines
3. Extending the release box boundaries
4. Maintain data collection and analysis, independent of personnel
5. Instrument development
6. Consider other data that can be collected from water samples

Science Plan

Further discussion centered on development of a science plan for possible accommodation cruises in the next few years.

Motivation for the Science Plan

- Increased accessibility to the Arctic Ocean
  - Update of US Arctic Policy for the National Security Council
  - Extended Continental Shelf Initiative
  - Increased interest and presence by the US Coast Guard

- Observing and understanding environmental Change
  - Arctic Observing Network

Science Plan Scenarios

- Guidance from the Submarine community (ASL)
  - Data collected only on transit track
    - Totally releasable
    - Releasable with rounding
  - Transect (science driven track line)

- Establish priorities
    - Review baseline measurements
        - Address lingering concerns
    - Consider region and season for desired data

- Include assumptions
    - Speed and depth
    - Time available

<u>General Expectations for Science Plan Development</u>

- Use of standard equipment and systems
- CTD profiles from expendable probes
- CTD from hull-mounted system
- Bathymetry from single beam fathometer
- Ice profile data from topsounder (DIPS where possible)
- Salinities from water samples
- Supporting unclassified navigational and operational data
- All data stored in national data repository

<u>Additional Possibilities</u>

- SVRS recordings
- Side-scan sonar of ice cover
- CTD add-ons

Example of Per Measurement Unit Time Cost on Transit

Ice Draft (Continuous) – depth, speed limited – 2 hr per 50 km segment
Water samples – 3 depth spiral basic parameters – 2 hr per spiral
Bathymetry (Continuous) – no cost
Expendable CTD Probes – 30 min per launch
Hull-mounted CTD (continuous) – no cost

References

Edwards, M.H. and B.J. Coakley (2003) SCICEX Investigations of the Arctic Ocean System. Geochemistry 63, 281-328.

Rothrock, D., W. Maslowski, D. Chayes, G. Flato, J. Grebmeier, R. Jackson, R. Sambrotto, W. Smethie, W. Sternberger, J. Swift, J. Tarduno, and A. Thorndike (1999) Arctic Ocean Science from Submarines – A report based on the SCICEX 2000 Workshop. Applied Physics Laboratory, University of Washington, Seattle, WA, 27 pp with 7 app.