U. S. Strategies for Cooperation with the Soviets on Ocean Science

Report of a Workshop held

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U.S. STRATEGIES FOR COOPERATION WITH THE SOVIETS ON OCEAN SCIENCE

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INTRODUCTION

The idea of a workshop to discuss U.S.-Soviet ocean science cooperation was first broached during the February 1991 meeting of The Oceanography Society in St. Petersburg, FL. At that time the Bilateral Agreement on Ocean Studies had recently been signed, the Soviets were about to rejoin the Ocean Drilling Program, and individual and institutional contacts between the two nations' oceanographic communities were increasing dramatically. The major U.S. ocean science sponsors -- NOAA, NSF, and Navy -- agreed that given the challenges inherent in close cooperation with the Soviets in an area of militarily and economically significant research, it would be a good idea for federal agency representatives and academics to informally discuss the risks and advantages of cooperation, and to outline priorities and guidelines to improve our chances for successful and scientifically profitable collaboration.

Of course, it's tough to hit a chaotically moving target. By the time of the workshop it was clear that the Union of Soviet Socialist Republics was disintegrating. Although no one had any insight into the type of governmental or scientific structure that might evolve in what participants came to call the former USSR or FUSSR, it was clear that the ground rules for collaboration would be vastly different than in the days of a powerful Soviet Academy of Science and a highly centralized planning system.

In spite of the uncertainties, the sponsors determined that it would still be worthwhile to hold the workshop. Preparation for it offered the Navy and other involved agencies an opportunity to review their own policies and procedures. Participation would provide a relatively unusual opportunity for open discussion on a topic of common interest among representatives of a variety of pursuits . . . scientists from academia and from federal laboratories, businessmen with joint ventures in the FUSSR, military officers, civil servants from the Departments of State, Commerce, and Defense, and members of the intelligence community from Navy, OSD, and CIA.

Perhaps because of the challenge of dealing with uncertainty and the eclectic mix of individuals and viewpoints, the participants felt that the workshop was a success. In addition to identifying topics and individuals of interest in each of the areas of ocean science discussed, some common themes emerged. Equally as important, each of the groups gained an appreciation for the concerns, knowledge, and responsibilities of the others, so that simply through the presentations and discussion the U.S. infrastructure for interacting in ocean science with whatever system ultimately evolves in the FUSSR was improved.

The workshop format basically consisted of seven thematic panels, each dealing with an area of mutual U.S. and Soviet interest: physical oceanography, geology and geophysics, biogeochemistry, acoustics, space/remote sensing, the Arctic, and marine policy. Panel chairmen gave a brief overview of major issues in their area at an initial plenary session,

and then led a day-plus discussion with a charge to report back to a concluding plenary session the following information:

- o A brief reminder of major U.S. programs, priorities, and plans in each thematic area, and any deficiencies in our approach (be they scientific, technical, logistical, etc.).
- o Soviet priorities and plans in the field to the degree we understand them, and their relationship to U.S. programs and interests.
- o Similarities and differences in their basic approaches to major science issues; particularly, Soviet theories or programs (e.g., SECTIONS vs. WOCE; TRANSECTS vs. RIDGE) that are substantively at variance with ours (and, if understood, the reason for their approach).
- o Soviet unique strengths and weaknesses in the area (scientific, technical, infrastructure, etc.), particularly as they complement ours.
- o Things we would like the Soviets to do to support U.S. global scientific objectives, and the benefits to us.
- o Programs, projects, etc. in which we should urge Soviet participation, types of activity or support desired, and inducements for their participation.
- o Areas of cooperation we do not desire or should discourage.
- o Key Soviet individuals and institutions.

The reports of these thematic panels form the body of this workshop report. Because of significant differences in subject matter and consequently approach, panel chairmen chose to address their themes and the charge in various ways, and this is reflected in the format and content of their reports.

I have attempted to summarize the general conclusions of the panels, and the comments of plenary session speakers on U.S. policy perspectives and review mechanisms, in a section entitled Strategy Approaches and Concerns. Several of the introductory talks contained extremely useful information, and these are included as appendices.

As this report is being prepared, the economic situation in what is currently the Confederation of Independent States continues to worsen, and articles in scientific magazines discuss what can be done to "rescue" Soviet science. In spite of the turmoil, however, at least at WHOI our interaction with Russian, Ukranian, and other FUSSR colleagues continues apace. In the week before Christmas we hosted simultaneous visits by oceanographers from Vladivostok, Sevastopol, and three separate institutes in Moscow. All of our visitors came, did their research, presented papers, made plans for future cooperative efforts, and went home. There is, I believe, reason to think that cooperation with the Soviets in ocean science will be of continuing importance for both sides.

December 1991

Craig E. Dorman
Workshop Coordinator

EXECUTIVE SUMMARY

As the former Soviet Union started to open up in 1989, the initial impetus for U.S. cooperation with their ocean scientists was access. Access to minds, techniques, ideas, assets and areas which had effectively been closed to us for decades. U.S. academic oceanography is a very competitive process, however, and scientists faced very real disincentives to collaboration: the extraordinary time and effort required to make contact and identify good counterparts, the opaqueness of Soviet literature, suspicions about data quality, previous experiences (such as POLYMODE) where the benefits to the two sides were unequal, the unwillingness of sponsors to support the risk and uncertainties entailed in working from Soviet ships or with their scientists, both sides' red tape, and the potential hostility of a U.S. Navy which still faced a formidable Soviet military. A few venturesome U.S. scientists however were willing to afford the opportunity costs. When they derived considerable benefit others were encouraged, and as time went on a combination of agency and Institutional contacts, plus more activism on the part of the Soviets, reduced some of the logistics and communications burden.

As the political make-up of the former Soviet Union has shifted and the economic situation become even more desperate during the last few months, however, the conditions for cooperation have necessarily changed. For example even a year ago, Soviet Institutions would commit to programs, cruises, and 'free' ship time with reasonable certainty. Then, as the concepts of political reform and market economies started to catch hold, there was a scramble to form joint ventures and 'sell' services, and they began to request financial support even to conclude past commitments. Now we hear of first class research vessels like the R/V IOFFE (designed for acoustic experimentation) being converted to car ferries; reliable schedules are unheard of, and national ownership of some ships is even in doubt.

In spite of their increasing problems, however, Soviet researchers remain dedicated to their science and their Institutions, and they continue to actively seek cooperation for mutual benefit. We can expect the ground rules for collaboration to evolve further as their rapid disintegration continues. One thing is certain, however. For quite some time to come, the fiscal resources for any cooperative activity will have to originate on our side. For a while at least, and with a degree of increasing urgency, they will be "for sale". If there is something we want and we can come up with the funds, we can get it; but they simply will not be able to provide us their assets with their own resources.

This workshop -- to identify the advantages and risks of cooperation and provide guidance for an investment strategy -- was held as the process of Soviet disintegration was accelerating. Its participants were no more prescient regarding the direction and results of change than anyone else. It's legitimate to ask therefore if our deliberations have any residual significance. We believe that the answer is yes, at least in the sense of highlighting some fundamental national security realities, of identifying some Soviet assets we definitely

do want, and of suggesting approaches for interaction that should apply in most situations short of outright civil war.

Specific topical priorities are described in the working group reports; here we summarize the more general comments and recommendations. One initial caveat is that we took as a given the importance of there continuing to be a robust Soviet ocean science community with which to interact; our suggestions were oriented to helping the community survive (there) individually and evolve institutionally, both for our own benefit and for the sake of whatever structure ultimately emerges from the former USSR.

The President's National Security Strategy issued in August 1991 describes three agendas for meeting U.S. basic interests and objectives in the 1990s: political, defense, and economic. It also explicitly recognizes the impact of environmental security on our values, economy, and relations with other nations. Thus our future dealings with the Soviets must be conditioned by a new and broader conception of our own security imperatives than was the case when they were clearly the enemy. As Mr. Haver reminded the workshop in his Intelligence Overview (Appendix E), we no longer even use the term "threat" in our discussions of the Soviets, albeit we remain concerned with their internal stability and with the conversion of their economy and infrastructure from a military to a civilian perspective, and must remain so concerned until their military strength is reduced to a level consistent with their expressed peaceful intentions.

One very significant change in our relationship is the expansion of our "warning window". No longer toe-to-toe with threatening and alert military forces, the very nature of the questions we ask about the Soviets as well as other nations will shift. In ocean sciences it will be particularly important to understand levels of activity, priorities, and trends as we pursue our broadened security agenda. We will need, for example, to understand the economic implications of expanded use of the Northern Sea Route, and to appreciate the Soviet interpretation of "environmental security" and understand how their concern with environmental quality may influence their economic and administrative conversion, their reconstruction, and their inter-republic relationships.

If such new interests broaden our security perspective on cooperation with the Soviets, they by no means eliminate defense concerns. One constant amid all the changes is continued reliance by both the U.S. and the former Soviet Republics on the sea based leg of our mutual nuclear deterrent. Submarines remain the most secure element of strategic force structure, and both sides will be alert to anything that may put those forces at risk. Both the U.S. and the Soviets remain major naval powers; the Soviet submarine and mine inventory has not gone away. Those responsible for their nation's defense -- on both sides -- will naturally remain uneasy about scientific and technological interchange that may jeopardize their operational capabilities, and historically ocean science has been closely aligned with naval prowess. This relationship will not change.

The U.S. has developed a variety of mechanisms to regulate the transfer of knowledge and equipment. Export licensing, GOSSAT/GEESAT, and visa and port entry/EEZ research procedures were reviewed at the workshop, and our discussions and contacts should help the ocean science community both stay abreast of changes as they evolve, and address concerns as they arise. Recognizing -- in the aftermath of the war in Iraq as we learned of their progress toward nuclear weapons, and as we daily learn more from the Soviets -- that information, particularly scientific information, flows most freely in the modern world, we also evolved a new working relationship between the Intelligence community and academics at the workshop. The Intelligence community can be a most valuable source as well as a recipient of information, and in trying to understand long-term trends and assess security implications (in the broadest context) they will both be interested in our science and supportive of our overseas interactions and cooperation.

Our basic conclusions regarding security implications of U.S.-Soviet ocean science cooperation are that there should be no a-priori barriers on topics for scientific discussion; that established review mechanisms should and will provide guidance as discussions evolve; that there are areas in which it would be distinctly to our scientific advantage to increase cooperation and encourage Soviet openness; and that in the broad context of U.S. national security strategy goals and agendas, it is not only permissible but highly desirable to forge collaborative links with individuals and institutions in the former Soviet Republics that enhance our science, improve our insight, and help them shape their own evolving institutionalities in ways that are mutually advantageous.

We note that there are a good number of joint efforts already underway (see working group reports). While not untroubled, the results are generally positive and we should attempt to maintain continuity, to the degree possible, as their situation evolves. But given that expanded cooperation and access are desirable, what are the problems and some mechanisms for dealing with them? Virtually all of the panels cited communications, uncertainty, and residual military impediments as their major concerns.

Communications are a problem in almost every sense of the word. Language is a real barrier, as are our different approaches to literature, and thus accessibility of their data, procedures, and ideas. Expanded OMNET services have helped a bit with the physical aspects of communicating, but virtually every other element, from mail and telephone to visas and reservations are bad and getting worse. Even when physical connection is achieved, our colleagues can be frustratingly selective in their understanding and response to questions. We also have fundamental concerns with their data management and quality control, and have a long way to go to convince them that to be useful, data must be shared.

Even in the best of times their commitments have been shaky. Their organizational structure is now in such flux that institutional commitments and even personal schedules are meaningless; they often simply are unable to keep their end of a bargain. Cooperation, at least for the time being, must assume risk and uncertainty. And to restate, disintegration is rapid, and thus some opportunities may close. The spectre of data burned as fuel is all too real.

In spite of political changes, the power of the military and its associated bureacracy is still felt. Russian openness in the Black Sea and Atlantic may be contrasted with intransigence in the Arctic and Sea of Okhotsk. On our side, equation of "export" with "access" precludes much experimentation we would like to do with our equipment from their ships, aircraft, and platforms, and limits our ability to do scientific computing during visits.

There is no quick-fix to these problems, and they thus condition the nature of cooperation.

There was unanimity among the panels that we don't need or want a "national agenda" with priorities for the sake of science (though the government may want one for other reasons), and that by far the best way to proceed is via individual initiative. This is normal for U.S. science; nothing happens without the interest of the individual academic scientist. And, given their organizational flux, about the only thing we can rely upon there is identifying and collaborating with individuals, and the associated physical assets and data they control.

This approach puts a high priority on developing a clearing house, or directory, of Soviet ocean scientists and their interests and assets. The availability of a similar directory of U.S. scientists interested in collaboration is an appropriate item to barter for their support in developing such a directory. The next step is visits, them here or even better us there, for a few days or weeks, both to develop plans and to slowly work to more compatible approaches to literature, data sharing, and the like. This already goes on to a certain extent; we merely suggest simplifying and broadening the collaborator-identification step via a directory, and a modicum of support -- with visas, by funded workshops, through support for some travel and salary, by licensing export of equipment that will go and then return, etc. -- for proposals to interact that show good scientific promise. Resulting research proposals will have to stand on their own scientific merit; but the improved familiarity with Soviet partners and a more clear understanding of their resources that develops from expanded interaction should help program managers and sponsors evaluate the risks involved and make wise decisions on what to buy.

We believe this individually-oriented approach is simultaneously the best way to develop science projects that can successfully compete for U.S. funding, to manage the inevitable Soviet brain drain, to help them develop their talent and infrastructure in mutually beneficial ways, and to identify those assets we may wish to "buy", be they data, technologies, hardware, or use of their infrastructure.

Three cautions are that the transaction costs of this approach are not minor; that there is a sense of urgency as windows of opportunities close; and that not many U.S. scientists, particularly junior ones, can afford the risks given the way our science operates. In particular, developing the directory will be best done by a federal employee, preferably one who knows the science, is fluent in both languages, and really wants to help. Quickly, please.

WORKING GROUP REPORTS

REPORT OF THE PHYSICAL OCEANOGRAPHY WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

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II. INTRODUCTION

The discussion centered around the topics of 1) joint projects currently underway involving people in the working group, 2) special problems involved with working with colleagues from the Soviet Union, 3) places where government assistance could be useful for improving scientific cooperation, 4) "pressure points" in relations with Soviet colleagues, and 5) issues involving scientific exchange. Results of the discussion on each of these topics will be presented below sequentially. The term "Soviet Union" is used throughout, although it is not clear that this is the correct expression at this time.

III. JOINT PROJECTS CURRENTLY UNDERWAY

We acknowledge that our working group could only deal with work that we are personally involved with. The following summary is presented in the hope that it will represent a useful cross-section of experiences, rather than an exhaustive list.

- M. Baker is currently involved in analyzing microstructure measurements made by the Soviets on a cruise in the western Equatorial Pacific during 1990. At this time, he is primarily concerned with evaluating the quality of the data. He has future plans to look at scientific problems once the data quality is established. His experiences were generally positive, although he had some difficulty establishing exactly how reduced portions of the data sets were processed by the Soviet scientists. Slowness of communications with Soviet colleagues has been a problem. Further, some of the ongoing analysis would be expedited if his Soviet colleagues could receive some support from U.S. sources. It appears that the Soviet microstructure instrument used meets current western standards of performance.

- J. Swift is currently involved in plans for the Pacific portion of the WOCE S-4 hydrographic line, to be made on the AKADEMIK IOFFE, a Soviet vessel. Interactions with Soviet scientists have been successful, and communications by telephone have been successful. Some problems have been encountered in equipping the ship at a U.S. standard. The recent possibility that the ship could be converted to a car ferry has caused some concern. Aside from this potential problem, the interactions have gone quite well.

- B. Cushman-Roisin has been dealing with a number of Soviet theoreticians and numerical modelers interested in mid-ocean eddies. His experiences have been excellent, and he had high praise for the quality of his Soviet colleagues. Travel and communications have presented some obstacles.

- S. Riser has participated through a joint agreement between the University of Washington and the Pacific Oceanological Institution in Vladivostok. So far, the experience has worked well in terms of exchange of personnel and historical data. Experiences involving measurements at sea have been more problematical, at least partly because of Soviet Navy interference with working in sensitive waters in the Northwest Pacific. Further, some unevenness of the quality of the different labs caused some difficulties.

- R. Schmitt met, at Woods Hole, a number of Soviet scientists interested in double-diffusive phenomena with whom he would like to conduct future joint work. The problem he is facing is in raising the money to have them come to the United States and for his time spent in working with them and teaching them.

- R. Muench has been involved with the Soviets in both planning the drifting ice station in the Weddell Sea, and in prospective joint work in the Barents Sea. The Weddell Sea planning went very smoothly, with little

interference from Soviet bureaucracy. A significant potential problem was the relative slowness of the U.S. funding process. The Barents case was more difficult, because of its considerable naval importance. It seems possible, based on recent German and Norwegian experience, that no joint work will occur. Communications were again a problem.

- D. Aubrey has been involved in three programs carried out with the Soviets to date. The first was a joint waves experiment with the State Oceanographic Laboratory in St. Petersburg, with Prof. Davidan. He carried out a joint field experiment in Bulgaria with the Bulgarians and Poles. The experience was mixed: the Soviet gear worked well until the waves came. However, the Soviets are using some of their numerical surface wave prediction models, to compare with the data. These models appear excellent. Joint papers are in preparation. The second project was the Black Sea initiative, which he started in Nov. 1990, with encouragement from all Black Sea countries (see Appendix D). He was involved in a five-ship hydrographic cruise in the Black Sea: Hydroblack 1991. Results are excellent...cooperation was great, with minimal paperwork on his part. If there was any difficulty getting permission, the Soviets took care of it. Data exchange is simple, and joint papers again are being prepared. This cruise involved physical oceanography as well as biogeochemistry. The third experiment was SPASIBA, a joint French-Dutch-Soviet exercise to which he was invited. Results were not as spectacular. Fitting this program in the middle of existing programs, he had a narrow time window of only 1.5 months for a cruise of 2 weeks. Unfortunately, the August, 1991 coup and other activities delayed the cruise and in the end he was unable to participate. He will work with them in the following years, as this is an exciting Arctic program. Fewer problems are anticipated in the future, if the ships are actually available. The results obtained by others so far are encouraging, enough so Milliman and Aubrey plan to continue participation.

- D. Tolmazin, a former Soviet citizen, is currently involved in cooperative work involving Ukrainian rivers and their outflow in the Black Sea. This is primarily a modeling effort. Since he knows the Soviet community, he has been able to develop cooperation quickly with scientists of known quality.

- T. Joyce has been involved with Soviet oceanographers since the mid-1970s. His experiences have been positive. His more recent experiences with WOCE have convinced him that issues involving the quality of Soviet hydrographic data can be resolved in the near future.

- P. Niiler (invited, but not present) related his experiences with having drifters manufactured in the Soviet Union for deployment in WOCE studies.

The quality of experience of cooperation with the Soviet Union varied considerably from person to person, but some common themes included:

- o difficulty of communications
- o interference from the Soviet Navy in planning cruises in sensitive areas of the ocean.

IV. SPECIAL OR UNIQUE PROBLEMS

These fall into four particular headings.

a) Communications. There are many levels to this problem, ranging from the more obvious ones such as language and difficulty with mails and telecommunications to more subtle things such as cultural differences. It was often stated that even if words are understood, miscommunication occurs because of differing expectations and understandings of the other side's system. A very substantial problem arises because of the Soviet journals, which are often inaccessible to western investigators (especially those run by individual institutes). Further, Soviet tradition favors short articles which pay little attention to issues such as documentation of data quality and extensive display of the measurements and where they were made. While communication via FAX, Telex, telephone etc. all have their problems, there are some signs of a gradual improvement.

b) Access to sensitive areas, such as the Barents Sea or the Sea of Okhotsk. This is generally a problem created by the Soviet Navy, and the Soviet scientists seem much more cooperative in this regard.

c) Unpredictability of the Soviet system. In some cases, ship schedules are changed at the last moment, and it is difficult to make long term plans in the present environment. Further, travel plans by Soviet scientists to the West are often highly uncertain. In addition, obtaining visas to enter the United States is sometimes a difficulty for Soviet scientists, due to a small staff at the U.S. embassy in Moscow.

d) Customs and export permits. This can be a problem, but it is not really unique to dealing with the Soviet Union.

V. AREAS WHERE U.S. GOVERNMENT ASSISTANCE WOULD BE USEFUL

In general, it was felt that as much initiative as possible should be left to individual scientists. Nonetheless, a few areas where help could be used were isolated:

a) A bilateral agreement to set up a program of thematic, three-month workshops, analogous to the WHOI GFD program could help to build up contacts with young Soviet scientists. This would help U.S. scientists evaluate and meet potential colleagues, and would introduce young Soviet investigators to U.S. oceanographic practices. This should be sponsored by U.S. funding agencies (with new money) and be exclusively for scientists from the U.S. and former communist countries.

b) Easier access to information governing export of information and equipment would be useful. For example, we were all surprised to learn that access to even some low-level computers to Soviet citizens in the United States was much more closely regulated than we had expected.

c) It would be desirable to take measures to expedite the availability of U.S. visas to Soviet scientists in order to prevent travel delays.

d) New sources of money are needed to support both United States and Soviet scientists doing joint work in the United States. The time spent by a U.S. scientist in educating Soviet visitors, for example, teaching them how to write scientific papers to western standards, should not be totally paid out of traditional research grants.

e) High-level negotiation of bilateral agreements to conduct observations in sensitive Soviet territorial waters may be the only way to gain access to these areas. Agreements made on the laboratory level do not appear to have enough clout to overcome resistance from the Soviet Navy.

VI. PRESSURE POINTS

Two places were isolated where some pressure from above could improve U.S.-Soviet oceanographic relations. First, the Soviet Navy has not allowed studies in some of its territorial waters. Second, U.S. funding decisions, in some cases, could be accelerated in order to make decisions on time scales more nearly compatible with the short ones which the Soviet institute-based approach will allow.

VII. SCIENTIFIC EXCHANGE

This topic was seen as being of great importance. Several topics in this area have already been mentioned above. The process should include joint meetings, personnel exchanges for extended periods, expediting travel and communications. The process could be expedited by creating two "living documents":

a) A directory of U.S. scientists having active cooperation with Soviet scientists. This would help other U.S. scientists to learn where to make contacts.

b) A directory of Soviet ocean scientists, including information on interests and background. This would also help U.S. scientists to make contacts. This process could begin with requests for such information directed to all Soviet oceanographic laboratory directors, accompanied by comparable existing documents form U.S. academic institutions.

REPORT OF THE GEOLOGY AND GEOPHYSICS WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

I. PARTICIPANTS

The following individuals participated in the discussions of the Geology and Geophysics Working Group:

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II. INTRODUCTION

The rapidly changing political, economic, and social environment in Russia and the other former Soviet republics provides the U.S. geoscience community with the opportunity to forge a long-term research-cooperation environment that will be mutually beneficial and foster both small-scale (individual) and large-scale research projects. This is a unique opportunity that other nations also will be pursuing because of the extensive Soviet research framework that includes massive data bases, analytical facilities, data-acquisition platforms, and the facilitated access to regions of the world which were previously restricted to western scientists. The breadth and duration of Soviet research efforts have matched that of the west, yet only a small fraction of this work has been previously available to U.S. researchers.

The expansion of U.S. geosciences into global programs such as DSDP/ODP, RIDGE, GLOBAL CHANGE, GEOSECS, MARGINS, etc. has required global cooperatives that mesh the strengths and weaknesses of the research efforts of many different countries, building on the successes of individual research programs, sharing the resources available for such studies, sharing techniques, data, and results, and minimizing duplication of effort. A major missing component of these global cooperatives has been the Soviet research community, with existing efforts tapping only a small part of their capability.

The severe limitations that have existed in the Soviet scientific community make it essential that we do not initially treat Russian cooperative efforts on the same terms as cooperatives with British, French, Japanese, German, and other western scientific groups. This is because the similarities ("matches") between western research systems facilitates collaborative efforts, whereas major mismatches with the Soviet system provide major impediments to collaborative efforts. This situation could lead to the loss of opportunities for U.S. scientists and probably will cost our system extensively in terms of shared resources. Yet it is this "mismatch" in our scientific programs that provides the potential for large gains, via shared resources and diverse techniques and ideas, for the U.S. research community. The new environment for Russian scientific research is now being developed, and a successful U.S. strategy should include the goal of helping our Russian colleagues to embrace the better aspects of our system, avoid major problems, and to build their confidence in our scientific community as valuable partners.

III. SOVIET MARINE GEOSCIENCE PROGRAMS

The Soviet geoscience community is presently undertaking several global programs, including Project TETHYS and Project PaleoTethys of the Academy of Sciences (similar to RIDGE) and the geological and geophysical GEOTRANSECT program of the Ministry of Geology (an off-axis complement to the RIDGE program). They have been trying to develop their own equivalent of DSDP/ODP with their own drill ship. Project TETHYS is a multi-institution program that integrates geological and geophysical studies of the mid-ocean ridge system with land field work on ophiolite complexes around the world. Project PaleoTethys is a similar project that focuses on the geologic and geophysical records that constrain plate reconstructions and lithospheric evolution for the Tethyan region, with primary focus on the Asian regions. The GEOTRANSECTS program is a multi-institution, multi-year project to establish corridors (up to 1000 km wide) of dense geological and geophysical measurements and samples across the major ocean basins. The corridor between Brazil and Angola was completed about 4 years ago, with surveys conducted on 20 cruises over a 7 year period.

A vast number of major Soviet expeditions have traversed the globe with sampling and underway surveying programs. Results from these expeditions may prove to be invaluable contributions to the time-series aspects of the U.S. GLOBAL CHANGE and RIDGE programs and could provide essential background support for extended RIDGE and ODP programs. Soviet institutes have undertaken major sampling programs around the world focused on surficial sedimentary material (short cores, dredges, and grab samples), igneous and metamorphic rocks (large barrel dredges), heat flow, seismic-refraction profiles, etc. Many of their expeditions also carried out major underway geophysical surveying projects, acquiring a vast collection of bathymetric, gravity, magnetic, and seismic-reflection data. Their sea-floor photographic surveys have been scattered around the world, representing a potentially major data asset. In the last 5 years, these surveys have also included multibeam bathymetric systems, multichannel seismic-reflection systems, and side-scan sonar systems. With the

addition of two MIR submersibles with 6000m depth capabilities, the Soviet manned-submersible program represents a major asset for building cooperative studies in mid-ocean ridge transform zones, back-arc basins, trenches, etc. The Soviet Deep Seismic Sounding (DSS) program, which is characterized by large seismic experiments with large sources, represents a major data base for mantle seismic structures.

Research interests of Soviet marine geologists are very broad, but there are a few areas of particular interest and expertise. Sedimentology has long been a "strength field" for the Soviets, with extensive interaction between geologists and physical oceanographers. Petrologic and geochemical studies of seafloor samples have created a very large data base of analyses from around the world. Sea floor mapping and morphologic studies have been major components of many of their expeditions, and the Soviets were major contributors to the international GEBCO bathymetric mapping project. Although the Soviets have been criticized for their tendencies for provinciality or "formula" thinking and poor illustrations in their scientific papers, the availability of large amounts of manpower has enabled the Soviets to undertake several major data compilation projects (analog only) leading to the production of geologic and oceanographic atlases. These atlases have long been a major source of global information for western researchers. Regions of focus have included the Arctic Ocean basin, midocean ridge systems and back-arc basins.

IV. SOVIET AND U.S. RESEARCH FRAMEWORKS

There are numerous similarities but also large differences between the U.S. and Soviet research frameworks (i.e. how we carry out our science). Some of the most important similarities are in the facilities used in research (e.g. analytical equipment, computers, and ships) and the scientific problems being examined; many of the differences are related to the people and methods involved.

Soviet and U.S. geoscientists have been investigating many of the same broad-scale geologic problems. This common interest provides an opportunity for meshing research programs. There probably has been considerable duplication of effort, but there is also a likelihood for extensive sets of complementary studies, including research carried out on the same problem from very different perspectives. For example, the Soviet project Tethys is an integrated land/marine program on a scale that would be hard to duplicate under the western research-funding system. It has many of the same basic objectives as the U.S. RIDGE program, but approaches the problem from a different perspective. The U.S. program is focussed and often short term, with numerous individual projects. The focus of Soviet marine studies on "broad objective" programs has led to their undertaking numerous projects with spatial coverage and years of duration.

Much of the Soviet research has been undertaken using equipment purchased or copied from the west. This equipment is at various stages of advancement in comparison with U.S. equipment, but the general usage and data output characteristics are quite similar, making it moderately easy to mesh analytic capabilities and data sets. This aspect can be considered a similarity because the Soviets recognize the need for the

better equipment but they just cannot afford it. In the field of computers the Soviet scientists, especially those in the Academy of Science institutes, usually have poorer quality machines, but they often make up the difference with western computing capabilities via more ingenious programming development. They readily embrace the more advanced computers, and cooperation holds promise for important advances in software/hardware application development. Technology exchange in this type of environment has an immense potential for mutual benefit, and this needs to be reflected in the reconsideration of security restrictions.

In the field of data-acquisition platforms, the Soviets have always had platforms (ships, submersibles, aircraft, satellites, etc.) that are comparable with western platforms and often in greater numbers. For example, the Soviets have 20 research vessels (see Table 1) of the OCEANUS class or larger with global operational capability. The Soviets have offered to share these platforms with scientists from other countries, which in some cases may double the number of platforms available to U.S. scientists. The cost of this sharing of platforms has yet to be established, but numerous U.S. scientists have already had the opportunity to carry out cooperative research using Soviet platforms at very low cost (a few thousand $'s). Much of the Soviet marine research fleet may not be adequate for U.S. research needs (too big and inefficient), but their ice breakers are some of the best in the world and their two MIR submersibles rival the new French and Japanese deep submersibles in exploration depth capabilities. They have three "KNORR-class" vessels that are fine platforms with numerous winch systems, but essentially bare bones (i.e., minimal technical equipment). These vessels could provide U.S. scientists with the opportunity to penetrate remote regions more routinely.

The "mismatch" between U.S. and Soviet research frameworks provides an opportunity upon which we can build realistic cooperative projects. Recognition of these differences (which could be called strengths and weaknesses) is a major starting point for the development of a viable strategy. Obviously some aspects of the new Russian system will change rapidly from the Soviet system, but the fact that it will include many of the same people and facilities means that there will be considerable momentum to existing cooperative conditions. Several examples of important "mismatches" are indicated below.

1. Soviet geoscientists are concentrated in research institutes of the Academy of Sciences and Ministry of Geology and at a few major universities such as Moscow State University.

   U.S. geoscientists are distributed across a diverse set of universities, research institutions, government agencies, and industry labs.

2. Soviets tend to have "broad" objectives with minimal focus and limited detailed planning for research projects.

   U.S. scientists must have focused scientific objectives and realistic operational planning to obtain funding.

3. Soviet research was more directed towards long-term results published in mega-books with numerous "ideas" published as very short papers that contain little data in non-competitive publication vehicles.

   U.S. scientists must produce a more continuous stream of results, with ideas and supporting data merged and published in peer-reviewed (competitive) literature in order to maintain continued funding and promotions.

4. Soviet scientists usually have institute (Academy of Sciences or Ministry) support for research groups and do not have to obtain their own funding except as a group. This enables them to have broader research objectives and for senior managers to change research plans and shift resources readily.

   U.S. scientists in government agency labs have funding mechanisms similar to that of the Soviet institutes, but most of the U.S. researchers at universities have to justify and obtain their own funding and are less flexible to meet sudden changes and increases in needed support.

5. Soviet funding to institutes and subordinate labs is decided year by year. The level of support can change, but directors of institutes can shift funds to ensure that projects continue.

   Peer-reviewed basic research by U.S. scientists often involves a 1 to 2 year funding process with no guarantee of support until funds are awarded. Grants then often provide 2 to 3 years of continued support.

6. The Soviet system is (was?) very heavy on low-level support. Positions are described in a manner that creates an illusion of a large number of senior scientists, but the reality is a small number of research scientists and a large technical support staff. Soviet students are poured in large numbers into the institutes, often as advanced degree candidates, but many are used as support staff with minimal independence to undertake original research for a degree. They are not often involved in the research planning and publication of results.

   U.S. scientists have a minimum level of support staff which is dominated by specialist technicians and research assistants (i.e. students). The independence of these students and their active participation in all phases of research is a characteristic part of the U.S. system.

7. Data access has been restricted in the USSR, and this has created a type of scientific work that is not highly dependent upon providing clearly the data support for maps, interpretations, etc. Detailed, large-scaled maps are not easily obtained because of either military restrictions or limited

ability to make copies. Government restrictions on publishing detailed maps with geographic coordinates has led to an illustration style that is more schematic than factual. This limited data access, lack of required data support in publications, and territoriality on most institutes has inhibited data exchange between institutes and the development of comprehensive digital data bases.

The availability and documentation of data are essential aspects of U.S. research, and the construction of research-grade sample collections and digital data bases is a significant part of our research effort.

V. STRATEGIES FOR U.S.-SOVIET (RUSSIAN) COOPERATION

We have identified the need for two primary thrusts in a U.S. strategy for cooperation with the Russian (Soviet) research community:

1. To facilitate the establishment of small and large scale cooperative efforts, access to facilities and platforms, access to research results, and sharing of resources.

2. To evaluate (quality control), calibrate, synthesize, and integrate results from decades of Soviet research effort into a form that makes it readily available to U.S. and Russian researchers. This includes samples, raw data, analytical techniques, and "ideas" (including interpretations, models, etc.).

These two elements encompass the need to learn about and derive benefit from the decades of Soviet research as a precursor to undertaking cooperative research with Soviet (Russian) colleagues. Element 1 is the long-term goal, but the most immediate benefits will be derived from element 2. The mutual benefit aspect of the cooperatives is important and must be built into both elements. Specific items to carry out these two elements are outlined below.

VI. MECHANICS OF COOPERATIVE RESEARCH

There are numerous items that would facilitate U.S.-Russian (Soviet) cooperative research projects and most of them revolve around the exchange of information. The following list is not in prioritized order and it has been assembled in the form of questions primarily because we must establish a mechanism for answering these questions.

1. What are the Soviet research data bases?

   We need to have comprehensive, research-grade sample collections and digital data bases constructed for Soviet data. This item is probably the most important aspect of undertaking cooperative research with any group of researchers. We need to know the basis for any assumptions, analytical techniques, interpretations, and conclusions.

This operation is only achievable if carried out as part of a national strategy, with support from appropriate government agencies. A possibility would be to contract Soviet geoscientists and their support staff to undertake this effort as part of an Academy to Academy effort. We would need to provide the equipment, software, and expertise for compiling Soviet data and establish criteria for the quality control and calibration of this data. Without these latter two aspects of the compilation, most of the data will be useless. Previous experience has shown that much of the Soviet data is poorly documented, including locations, acquisition equipment and techniques, and analytical error determinations. Yet there are years of time-series data and spatial observations as well as laboratory results that could contribute significantly to our data bases. Our assistance in helping Russians construct research grade data bases will make these data finally available to more Russian scientists (as well as to U.S. scientists) and open numerous new research possibilities for their system.

2. What are the results of Soviet and U.S. research?

There needs to be a facilitation of access to published Soviet and western scientific literature.

This can be partially accomplished by sending multiple copies of western journals to all appropriate Soviet research institutions and libraries. Many Soviet researchers can read English, but they are hampered by limited access to western journals caused by the small number available. As a result of the extra effort to obtain western journals, only a few are actually knowledgeable concerning the results of western research.

Since few U.S. researchers can read Russian, it is essential that a mechanism be established to facilitate the translation of the best Soviet research results into English. This is more than just the existing set of English-translation journals of Russian publications, since these papers are often too brief and too interpretive without supporting data. The mega-papers that usually contain the supporting data are not available, even in Russian because of the limited number printed. A more useful approach would be to contract with Soviet scientists to assemble syntheses of the research in different fields, emphasizing the need to include all relevant supporting data, data acquisition and analysis techniques, models and related assumptions, and significant findings.

The exchange of scientists on short- and long-term bases will be facilitated to create an increasing number of scientists who are familiar with both research systems.

3. How do we share research platforms with the Russians?

A significant part of marine research requires the access to remote areas, the use of multiple platforms, and/or the use of expensive vehicles (e.g. submersibles) which have limited availability. The Soviet platforms are now available to U.S. scientists, and their use provides some of the same problems as

we have faced with utilization of the platforms of other countries. We maintain our own platform capability while at the same time provide for our expanding platform needs with constant (or shrinking) research funds. With the collapsing Russian economy, they are likely to be forced to scrap some of their platforms if they cannot obtain adequate financial support from their own government or from outside sources. We need to consider a collaborative program that assists them in maintaining the more efficient platforms that are most useful for U.S. researchers, such as their ice breakers and moderate sized, newer research vessels. One method could involve exploring applied uses for these platforms and encouraging the Russians to provide platform time (for ODP site surveys, etc.) in lieu of hard currency as their cost share of cooperative programs. Involvement in international cooperatives is an important aspect now in determining their internal distribution of funding, and our strategy must account for this situation. Multiple platform experiments will require access to all platforms by U.S. and Russian researchers. Therefore we must undertake an evaluation of existing restrictions from this perspective of shared platforms.

4. Who are the Soviet and U.S. scientists?

There needs to be a detailed list of Soviet investigators including summaries of their past and future research interests and activities, education and degrees, publications, and addresses with telephone/telex/telefax numbers. Their system makes only a few of their scientists visible to western scientists, and these are not always the best researchers.

We need to provide the Soviets with the same type of information which is readily available at most U.S. libraries. This would mean making sure each institution and university has the essential biographical information on U.S. geoscience researchers. This is important so that the Soviets do not have to continually depend on a small number of contacts to link them into the extensive U.S. research system. At present, this is a very narrow funnel going both ways.

5. What are our major "group" research programs (e.g. ODP, GLOBAL CHANGE, RIDGE, TETHYS, etc.) and the diversity of our "individual" research projects?

It is important to emphasize the importance of individual research projects in the U.S. system, even when incorporated into one of our few mega-programs. A significant amount of Soviet research has been group efforts, yet mega-projects are small in number in the U.S.

6. How do we mesh the funding mechanism mismatches?

The sharp difference in available funds in the two systems must be reconciled in the acceptable contributions to cooperative efforts. There are numerous costs in these cooperatives that are not normally found in cooperatives with researchers from other western countries. Extensive amounts of travel funds will be required in all aspects of the cooperation (for both U.S. and Soviet

scientists) because of the mismatch between U.S. and Soviet planning and operational procedures and the inadequacy of the communication system in Russia.

VII. POTENTIAL AREAS OF COLLABORATIVE RESEARCH

Several areas of potential collaboration have been mentioned in the foregoing sections. The integration of some of our mega-programs such as RIDGE and TETHYS are obvious possibilities. Promising areas for initial cooperation are in the joint use of sample collections, construction of research grade sample and digital data bases, the sharing of specialized platforms, such as the MIR's, ALVIN, and ice breakers, and projects that require access to regions of restricted access or limited ability for U.S. ships to visit routinely. These latter areas include the Arctic, Black Sea, Sea of Okhotsk, Baltic Sea, Bering Sea, Barents Sea, South Atlantic, and western Pacific back-arc basins. Numerous cooperative studies are already underway, including studies of the mid-Atlantic Ridge on Soviet vessels, studies of back-arc basins in the Pacific and Goeringe Bank and Kings Trough in the Atlantic with the Soviet MIR submersibles, surveys in the northwest Pacific on U.S. vessels, and joint multichannel seismic studies in the Pacific. Two ship experiments are an obvious candidate for collaborative studies because of the scheduling problems of getting two U.S. research vessels in the same remote area.

TABLE 1

Soviet and United States Research Vessel Fleet

K.D. Klitgord - January 6, 1992

A comparison between the research fleets of the US and USSR that might be involved in cooperative projects is given below in terms of size. There are many more vessels in both fleets, with many different capabilities. Most of the smaller vessels (<50m) are unlikely to be involved in midocean studies, but they are listed for relative comparison.

VESSEL	OPERATOR		BUILT year	LENGTH meters	BEAM meters	DISPLACEMENT tons
Soviet Academy of Sciences Research Vessels						
A. Vernadsky	Mar.Hydrophys.Inst.,Ukraine		1968	124	17	6,930
A. Kurchatov	Inst.Oceanology		1966	124	17	6,828
A.D. Mendeleyev	Inst.Oceanology	MBB/SUB	1968	124	17	6,838 MIR
A.Sergei Vavilov	Inst.Oceanology	MBB	1988	?	?	6,500
A.Abram Vorffe	Inst.Oceanology	MBB	1989	?	?	6,500
A.M. Keldysh	Inst.Oceanology	SUB-SUB	1980	123	18	6,339 MIRS
A.Vityaz	Inst.Oceanology		1981	123	?	6,358
A.A. Nesmeyanov	Far East Res. Centre		1982	?	?	6,300
A.A. Vinogradov	Far East Res. Centre		1983	?	?	6,300
A.M. Lomonosov	Mar.Hydrophys.Inst.,Ukraine		1957	102.5	14.3	5,960
A.Boris Petrov	Inst.Geochem.	MBB	1984	76	15	2,600
A.N. Strakhov	Inst.Geology	MBB	1984	76	15	2,600
M.A.Lavrentyev	Far East Res. Cent.	MBB	1984	76	15	2,600
Prof.Bogorov	Far East Res. Centre		1976	?	?	1,737
Prof.Vodyanitsky	Inst.Bio.South Seas,Ukraine		1976	?	?	1,700
Prof.Shtokman	Inst.Oceanology		1979	?	?	1,611
Rift	Inst.Oceanology		1981	?	?	1,283
Morskoi geofizik	Far East Res. Centre		1975	?	?	1,124
Vulkanolog	Far East Res. Centre		1976	?	?	1,000
Dal'nie Zelenzy	Inst.Mar.Bio.,Murmansk		1978	?	?	1,000
Prof.Kolesnikov	Mar.Hydrophys.Inst.,Ukraine		1962	?	?	820
Ayu-Dag	Acad.Sci. Estonia		1961	?	?	820
Zarya	Inst.Earth Magnet.& Prop.Radio		1952	?	?	600
A.L. Orbeli	Inst.Oceanology		1954	?	?	411
Akvanavt	Inst.Oceanology,South.Br.		1976	?	?	273
Shelf	Inst.Oceanology		1977	?	?	273

VESSEL	OPERATOR		BUILT year	LENGTH meters	BEAM meters	DISPLACEMENT tons
U.S. Research Vessels						
N.B. Palmer	NSF-Antarctica	ICE BREAKER	1992	93	?	?
Discoverer	NOAA - Seattle	MBB	1964	92	16	3,959
Surveyor	NOAA - Seattle	MBB	1960	89	14	3,150
M.Baldridge (Researcher)	NOAA - Miami		1968	85	16	2,772
M.Ewing	LDGO	MCS-MBB	1983	73	14	2,665
Knorr(refit)	WHOI		1990	85	14	2,670
Knorr	WHOI		1969	75	14	2,415
Melville(refit)	SIO	MBB	1991	85	14	?
Melville	SIO	MBB	1969	75	14	1,915
AGOR-23	Univ.Washington		1991	75	16	3,250
Mt. Mitchell	NOAA - Norfolk		1966	70	13	1,800
Vickers	Univ.Southern Cal.		1973/91	67	11.6	1,750
Polar Duke	NSF-Antarctica	ICE	1983	66	13.1	1,645
Atlantis II	WHOI	MBB-SUB	1963	64	13	2,300 ALVIN
Conrad (gone)	LDGO	MCS-MBB	1962	64	12	1,370
T.Washington	SIO	MBB	1965	64	12	1,384
T.Thompson	Univ.Washington	MBB	1965	64	12	1,400
Moana Wave	Univ.Hawaii	SeaMark-2	1973	64	11	1,034
S.P.Lee	USGS	MCS	1968	63	16	1,297
F.Moore (gone)	Univ.Texas-Austin	MCS	1967	50	12	1,202
Oceanus	WHOI		1975	54	10	962
Endeavor	Univ.Rhode Island		1976	54	10	972
Wecoma	Oregon State Univ.		1975	54	10	970
Gyre	Texas A & M Univ.		1973	53	11	950
New Horizon	SIO		1978	52	11	1,080
Iselin	Univ. Miami		1972	52	11	794
Cape Hatteras	Duke Univ.		1981	41	10	348
Point Sur	Moss Landing Mar.Lab		1981	41	9.8	539
Alpha Helix	Univ. Alaska		1966	41	9.4	600
R.G. Sproul	SIO		1985	38	9.8	524
Cape Henlopen	Univ. Delaware		1976	37	7.1	165

LDGO=Lamont-Doherty Geological Observatory
SIO =Scripps Institution of Oceanography
WHOI=Woods Hole Oceanographic Institution
MBB=multibeam bathymetry
SUB=submersible mothership
ICE=ice strengthened hull
MCS=multichannel seismic-reflection system

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REPORT OF THE BIOGEOCHEMISTRY WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

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II. PRIOR JOINT U.S./USSR BIOGEOCHEMISTRY RESEARCH

The working group began its work by reviewing the areas in which joint U.S./USSR research in the area of biogeochemistry has been conducted. It was recognized that this was a broad area and that some cooperative work may have been omitted.

ARCTIC and BERING SEA RESEARCH

The University of Alaska has been especially active in U.S./USSR cooperative studies in this region. Science topics in which cooperation has occurred included:

- Rates of regeneration and flux of biogenic elements from Arctic Ocean and adjacent sea sediments. Particularly from continental shelf sediments since the Arctic region comprises only about 5% of the area of the global ocean but about 25% of the global continental shelf, much of which lies adjacent to USSR and U.S.

- Anthropogenic impact on cycling of biogenic material in the ocean. The continuous increase in flux of pollutants to the ocean determines a need to study the resistance of marine biogeochemical systems to anthropogenic impact. The dynamics of marine systems, including biogeochemical cycles, is closely related to the climate of the earth and its changes. In this context, the predicted global climate change may have a pronounced effect on vital ocean biogeochemical processes. This is of interest to both U.S. and USSR scientists since the ocean cycling of biogenic material determines the normal functions of the earth's climatic systems.

Prior Arctic systems joint studies have been carried out under a variety of sponsorship over the past few decades. These include:

- "Sea Mammal Research," bilateral agreement with the U.S. Fish and Wildlife Service and USSR Academy of Sciences.
- "Comprehensive Bering Sea Environmental Analysis," bilateral agreement with U.S. Fish and Wildlife Service and the USSR Academy of Sciences.
- "Bering Sea Fisheries," cooperative agreement between Institute of Marine Biology, Far East Branch, USSR Academy of Sciences and the School of Fisheries and Ocean Sciences, University of Alaska.
- "Studies of Ice Edge and Polynyas," cooperative agreement with the Institute of Marine Biology, USSR Kola Scientific Center in Murmansk and the School of Fisheries and Ocean Sciences, University of Alaska.

In addition, the agreement for establishment of a Soviet-American Scientific Research Center in Magadan, USSR, between the University of Alaska and the Far East Branch, USSR Academy of Sciences, will provide an important research support base and facilitate scientific collaboration in both terrestrial and marine research.

Other Bering Sea work (and some Pacific studies) have been conducted under the U.S./USSR Joint Committee on Environmental Protection that administers bilateral activity 02.07.2103 - Comprehensive Analysis of Marine Ecosystems and Ecological Problems of the World Ocean. This program is the result of an Agreement on Cooperation in the Field of Environmental Protection, signed by President Nixon in Moscow on May 23, 1972. In practice, this bilateral activity has resulted in three research cruises in the Pacific Ocean in 1978, 1984, and 1988. The study area has generally been the Bering Sea; but on the last cruise, the western tropical Pacific was studied as well. All cruises have been aboard the Soviet research vessel R/V AKADEMIK KOROLEV and approximately 20 U.S. scientists have participated each time. The next cruise is planned for 1992, possibly aboard a new research ship.

Key issues: In theory, this cooperative research is organized around pollutant effects on marine biological communities. The Soviets have focused on the distributions and biological effects of substances such as hydrocarbons, PCBs, pesticides and heavy metals. The major questions have been: 1) what are the distributions of these substances in the ocean; 2) what effect are they having (or be expected to have) on the distribution and metabolism of marine biota. However, during the last two research cruises at least, the U.S. scientists have done the types of production and chemistry that we would normally associate with biogeochemical studies - C-14 production, new production, bacteriology and nutrient chemistry.

OCEAN BIOLOGY AND PHYSICS

A new initiative studying the coupling between biological and physical structures of ocean eddies has been started under a joint research project between the Institute of Biology of the Southern Seas (IBSS, Ukr. SSR) and the Woods Hole Oceanographic Institution (WHOI). The objective of this project is to estimate the ecological impact and significance of oceanic eddies on the spatio-temporal structure and productivity of oceanic epipelagic ecosystems.

BLACK SEA STUDIES

At present, joint work here has been conducted in the studies of the input, fate and circulation of radionuclides from the Chernobyl accident. These Black Sea studies have been carried out under an institutional agreement between IBSS and WHOI and agreements between IBSS and the U.S. Environmental Protection Agency, Office of Radiation Programs. This work has focused on tracer studies of mixing and ventilation in the Black Sea, on river/coastal water mixing and in impact studies on health and the environment in the event of future large-scale releases of radioactive materials.

The new Cooperative Marine Science Program for the Black Sea being developed through a WHOI initiative from Dr. David Aubrey and scientists from Black Sea coastal states will offer a framework for broadening these studies to include a wide range of biogeochemical variables and processes of scientific interest in the Black Sea, including nutrients, metals, stable isotopes, bacteria, organics, pollutants, etc.

LAKE BAIKAL

Unfortunately, no one from the large community of marine and freshwater scientists who have worked cooperatively in this unique lake was able to attend the Woods Hole meeting. It was noted that a variety of studies have been carried out there. Three general themes have served as a focus of scientific interest:

- the past record of climate change recorded in the 4-kilometer thick sediment accumulation;
- the pristine nature of the lake has attracted many researchers to this isolated freshwater laboratory;
- the lake has some unique ecological properties which have captured the scientific interest of researchers from many countries.

VOSTOK ICE CORE PROGRAM

This ongoing study of the paleo-climatic record locked into the ice record was noted as an active area of joint studies. Again, none of the participants were able to be present to review progress in a very active ongoing study which is yielding excellent insight into the nature and variability of the earth's climate.

RUSSIAN AND UKRAINIAN RIVERS

For several years now, MIT researchers have participated jointly with a variety of Russian and Ukrainian research institutes in studies of large rivers draining into the Arctic Ocean and Black Sea. The scientific objectives of these studies is to characterize the chemical elemental input from these rivers to the world ocean. Budgets of river input globally have lacked reliable estimates from these previously inaccessible sources and some of the missing information is beginning to be collected. Rivers studied include the Lena, Dniester, Dnepr, Don and Danube. An essential component to the success of these studies is the involvement of the large hydrological institutes who often control access to the rivers and hold a vast resource of data on the scientific background of the various watersheds.

III. WORKING GROUP DISCUSSIONS

In the working sessions of the Biogeochemistry Working Group, a number of broad issues relevant to conduct of joint research were covered and formed the basis for defining a future framework for successful cooperative work. These included:

- Integration of U.S./Soviet research programs.
- Relevance of pollutant research in global biogeochemical studies.
- Procedures for funding U.S./USSR exchange and research.
- Issues of access to research areas of interest.
- Institutional, political and cultural barriers to scientific exchange.
- Data access and information exchange.
- Future opportunities and directions.
- Regional areas of cooperative studies.

IV. SOVIET STRENGTHS AND WEAKNESSES

The group noted that many of the strengths and weaknesses from the Soviet side in joint research were common to many of the working groups at the meeting. They identified the following which had been noted in the course of interactions and experiences from the group.

SOVIET STRENGTHS

- Ships
- Icebreaking capabilities
- MIR submersibles
- Intellectual resources

SOVIET WEAKNESSES

- Economic disaster
- Variable technological capabilities
- Lack of science coordination
- Frequent underemphasis on data management, exchange and quality control

V. PROBLEM AREAS

Three general areas were noted in which the group either foresaw or had experienced problems in working cooperatively with scientists from the FUSSR. These included funding, literature and planning issues.

FUNDING

- Salary support for U.S. involvement (bias <u>against</u> funding in review process)

  - uncertainties in ships, clearance, proposals

- Funding continuity -- too short cycles
- Funding timing -- often too close to cruises

FUSSR LITERATURE

- o No data tables, data quality control issues
- o Information catalogued -- not synthesized

PLANNING

- o Science plans need to be developed through individual interactions. Need extensive pre-proposal interactions to match interests and capabilities in science plan.

VI. FUTURE AND DESIRED COOPERATIVE AREAS

Several regions or research topics were identified by the group as areas which would be likely to have ongoing and potential interest for joint scientific studies. These included:

- o Joint fishery studies
- o Soviet river studies
- o Black Sea studies
- o Processes affecting biogeochemical cycling in the Arctic
- o Use of MIR submersibles in biogeochemical studies
- o Paleo-oceanographic and Pacific ventilation studies in the Okhotsk Sea.

REPORT OF THE OCEAN ACOUSTICS WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

I. PARTICIPANTS

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II. BACKGROUND

Until quite recently, there was very little U.S./USSR interaction in ocean acoustics. The few areas of contact comprised a rather short list.

- o Textbooks and Monographs

  (Brekhovskikhs "Waves in Layered Media" and Clay and Medwin's "Acoustical Oceanography" are two good examples of textbooks everyone owns!)

- o Journals

  (The Journal of the Acoustical Society of America and Soviet Physics Acoustics are the prime examples)

- o International Conference Contact

  (Typically well chaperoned on the Soviet side until recently)

- o A Few Scientific Visitors

  (Generally, very few both ways)

Indeed the best example of what U.S./USSR cooperation was supposed to be, from the U.S. standpoint anyway, was "Hunt for Red October."

In the past 1-2 years, however, much of this has changed. Some of the newer interactions with the Soviets include:

- o Acoustics experiment collaboration

  (Heard Island and its follow on, 1992 Barents Sea tomography, ...)

- o Numerous visitors

- o A desire by the Soviets to publish in U.S. journals

- o U.S. visitors being invited on and shown around Russian acoustics ships (e.g., VAVILOV and IOFFE)

- o A large influx of Russian students to U.S. graduate programs in oceanography and acoustics

- o Soviet offers to sell acoustics equipment to the U.S. (e.g., the Slavinsky low frequency source)

- o Soviet offers to rent acoustics research ships to the U.S.

These interactions are just a small reflection of the current political and economic situations in the former USSR.

III. CURRENT SOVIET ATTITUDES/MOTIVATIONS

An understanding of the current Soviet ocean acoustics communities' attitude and motivations is crucial to dealing with it. We have, based on the various contacts of the panel with the Soviet ocean acoustics community, tried to describe those factors here.

The basic attitude/motivation that can be discerned in the Soviet ocean acoustics researchers is trepidation about their basic survival as research scientists in their area of expertise. Both the Academy of Sciences and the Navy funded Soviet ocean acoustics, and both organizations are "on the ropes" now. Also, the USSR's breakup into republics threatens to isolate many labs from these traditional funding sources entirely. Given that militarily oriented research in general is probably going to decline sharply in the former USSR, their ocean acoustics community is now in the process of looking for other areas in which their expertise can be applied or to obtain funding for their traditional areas from the West.

The Soviet desire to interact with the West in ocean acoustics has many motivations, some of which we list here. They are:

- o Obtain western funding

  (Exploration geophysics, traditional ocean acoustics)

- o Improve chances for internal funding

  (International collaborations are higher priority, as they can lead to further possibilities)

- o Obtain western technology

  (Computers, data storage devices, etc. are mostly a decade or more behind western efforts)

- o Find western job openings

  (The Soviet brain drain will happen. U.S. decisions should be made on how to deal with it.)

- o Sell intelligence about Soviet acoustics

  (This is a calling card and potential point of entry to the U.S. for many would be emigres)

- o Obtain intelligence about western Navy acoustics

  (The Russian Navy is still highly suspicious of the U.S. and is no doubt taking advantage of the new openness to do some of its own intelligence gathering.)

IV. WHERE DO WE GO NOW?

Given the current situation and attitudes, both East and West, it appears that the doors are at least partway open to unclassified collaborations, information exchange, and technology transfer. But before going through any doors, we must first consider: 1) what are the benefits and 2) what are the risks and hazards. To answer these general questions, we have put together a list of detailed questions which, we are sure, is only partial at best. Specifically, we feel that we must answer:

1. What are their capabilities (experimental theoretical, computational)?

2. What areas of collaboration are desirable, allowable?

3. What areas of work are off limits?

4. What level are they really at in various areas?

5. Do we want to help them in weak areas?

6. Will they open up on showing field data? Should we?

7. What work can they afford, now and in the future?

8. Which labs will survive?

9. Who are their key people in various areas?

10. Will they open up their territorial waters to U.S. researchers?

11. What do we do about the flood of Soviet scientists who wish to emigrate to the U.S. (i.e., acquisition of good new people vs. displacement of our own)?

12. Do we use cheaper Soviet research ships at the expense of our own fleet?

There are numerous other concerns, also. Sensitive technology transfer, poor communications, problems with currency exchange, travel restrictions and travel unreliability are only a few items on a long list of possible barriers to interaction, even when both sides desire it.

V. AREAS FOR POSSIBLE COLLABORATION

Given that we do pursue some degree of interaction with the (former) Soviet republics, what areas look interesting and profitable from our point of view? Again, we briefly enumerate the possibilities:

1. Utilization of unique Soviet research facilities

   The (former) Soviets have some rather unique resources for ocean acoustics which we could use freely without any worries about competing against U.S. resources. For Arctic research, icebreakers and ice-camps come to mind. For general ocean acoustics research, the research vessels VAVILOV and IOFFE are unique platforms.

2. Data base acquisition

   The (former) Soviets have ocean acoustics data bases (of as yet undetermined quality and quantity) which could be of interest to us in many ways. It is

not absurd to think that some of their less sensitive data could eventually be acquired by the U.S. and perhaps re-examined using U.S. analysis techniques. This avoids acquisition costs for data in areas we have little or no data, allows us to evaluate Soviet progress in various areas, and gives us a chance to collaborate with their personnel. It also requires little investment from the Soviets, an important consideration for them at present.

3. Shallow water acoustics

Being bordered to the north by the Barents Sea, the Soviets have always been very good at shallow water acoustics. Due to the "regional conflict" scenario having become more important as the Soviet bluewater threat decreases, shallow water acoustics has also become a higher priority for the U.S. Navy of late. The Soviets seem willing to talk some about shallow water, so it behooves us to avail ourselves of their expertise.

4. Arctic studies

Again, the Soviets are an Arctic nation, and so have made a considerable investment in Arctic studies. Due to the fact that the Soviets seem more reticent to discuss Arctic work (the Arctic/Antarctic Institute in St. Petersburg characterizes this attitude) and that the Arctic has become less of a U.S. priority due to the lessening Soviet threat, this area should perhaps be downplayed at the moment.

Other areas of possible collaboration were also discussed, but seemed less certain than the above areas. They are:

- Lab "scale models" of acoustic propagation effects

  (Less expensive and potentially effective)

- Air-sea interaction studies

  E.g., bubble studies

- Scattering studies

  E.g., turbulence, internal waves

- Non-linear acoustics

- o Acoustic propagation modeling

  (Shallow water especially)

This list could be added to indefinitely, but we wished to keep the areas of (publicly) well known Soviet expertise.

VI. APPROACH

Again, given that we want to work with the (former) Soviets, and have chosen some areas of interest, how do we go about things? In this section we try to address that question.

To begin with, the committee recommended putting the emphasis on "acoustical oceanography" rather than Navy acoustics. (Acoustical oceanography is defined as "The use of sound to study parameters and processes of the ocean".) This emphasis was thought to be the most palatable (read "non-threatening") one for interaction from the points of view of both the U.S. and (former) Soviet Navies. However, this does not rule out considering "Navy applications" acoustics in some areas, e.g. shallow water, where the problems are generally less oceanographic and more applied. (In fact from the U.S. Navy's point of view, one might think that the more sensitive areas could be of higher potential Navy gain.)

In terms of classifying which areas of acoustic research are more or less sensitive, the committee sidestepped the issue a bit. Scientific merit and U.S. Navy security screening will eventually decide which research topics are funded and allowed anyway. Researchers should be allowed to explore all unclassified areas of potential research collaboration initially, giving due consideration to security issues. (In this area, the U.S. underwater acoustics community is fairly well informed and sensitive, overall). For instance, matched field processing is a classified area if one talks of actual equipment; however, the theoretical development of algorithms and their environmental sensitivities is a large area of open literature research. A Russian scientist's expertise and knowledge in this area could be of benefit to an important U.S. program, if the interaction is handled properly. We thus think that a case by case basis is the best way to treat U.S/Soviet interactions at the present. Hard and fast guidelines would probably do more damage than good at this point. (Also, there are still few enough of these interactions that case-by-case treatment makes logistical sense).

It was also thought that individual interactions are the best to pursue at present, given that present Soviet institutions are very unstable, and bureaucratic to boot. It was also suggested that some agency, panel, or committee should gather and sort out information on Soviet "players" and resources in areas of interest and distribute it to the U.S ocean acoustics community, in order to help them identify their Soviet counterparts, foster good collaborations, and avoid a plethora of sterile contacts. This report would have to be carefully done, to avoid both the "gossip column" and "Navy intelligence report" flavors.

VII. RECOMMENDATIONS

1. The Soviets have put major megarubles into ocean acoustics studies for many years. They have some world class resources and people, as well as unique data and techniques to offer. We should not let this unique opportunity for U.S. gain pass due to lack of effort to interact.

2. ONR should (eventually) allot some amount of travel funding to foment interactions.

3. We should create a database on Soviet key people and resources in areas of interest and distribute this to the U.S. acoustics community.

4. There needs to be well defined U.S. Navy point of contact and security review procedure for researchers wanting to know about the security status of acoustics research they plan with the Soviets. This could prevent useless starts and "aborts", as well as over-timidity on classification.

5. When the C.I.S. settles down, another meeting on "U.S./CIS relations in oceanography" should be held.

VIII. POSTCRIPT (by J.F. Lynch)

First, my thanks to my outstanding and lively panel, which was a joy to deal with. At the end of our brief day and a half of work together, I felt a definite sense of accomplishment, mainly due to their efforts and enthusiasm.

Second, my thanks to Craig Dorman for organizing this conference. The Soviets, while economically hampered at present, will eventually emerge again as a force in the world. Conferences like this one help us both deal with current events and shape future events in a rational, efficient manner. In the end, both the U.S. and the Soviets will benefit from the detailed discussion and careful planning this conference produced.

REPORT OF THE SPACE/REMOTE SENSING WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

I. PARTICIPANTS

The following individuals participated in the discussions of the Space/Remote Sensing Working Group:

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II. MAJOR U.S. PROGRAMS IN OCEAN REMOTE SENSING

Major U.S. programs in remote sensing of the ocean may be broken into two broad categories: research programs and satellite programs. A brief review of ongoing or planned unclassified projects in these areas is given in this section.

1. RESEARCH PROGRAMS

SAXON-FPN

SAXON-FPN is a joint U.S.-German research project centered around the German research platform FPN in the German Bight of the North Sea. The major goal of this project is to test theories of synthetic aperture radar (SAR) imagery of ocean waves under extreme conditions. A secondary goal is the comparison of microwave and acoustic scattering from the surface. The main experiment of this project took place in November, 1990 on the FPN. Real and synthetic aperture (RAR and SAR) imagery of the sea surface were obtained simultaneously with a variety of wind, wave, optical, and microwave measurements on the FPN. A second, smaller, experiment in this project is planned for November, 1991. SAXON-FPN is funded by the U.S. Office of Naval Research and the German Ministry of Defense.

SWADE/SWAPP

SWADE and SWAPP are the east and west coast components, respectively, of the Office of Naval Research's Waves Accelerated Research Initiative (ARI). SWAPP took place in October and November, 1989 from the Scripps Oceanographic Institution's research vessel FLIP off the coast of California. Primary goals of the experiment were to study wave breaking, Langmuir circulation, and mixed layer deepening and their detection by microwave and acoustic remote sensing. SWADE was carried out from October, 1990 to March, 1991 off the east coast of Virginia. The primary components of this experiment included an array of meteorological and directional-wave buoys, and several research ships and aircraft. The objective of the experiment was to examine our understanding of surface wave development and its remote sensing with microwaves. Data from these two experiments are presently being analyzed.

High Resolution ARI

ONR's High Resolution ARI is a five-year program designed to improve our understanding of the imagery of large-scale ocean surface features by high resolution microwave imaging systems. The program consists of a pilot experiment, a main experiment, and associated data analysis and modelling. The pilot experiment took place off the coast of North Carolina in September, 1991 and the main experiment is being planned for September, 1993. The pilot experiment consisted of detailed ship-board measurements of surface current gradients off North Carolina's Outer Banks along with simultaneous RAR and SAR imagery.

"Independent" Program

This program is a joint U.S./UK effort to study radar imagery of internal waves. The ongoing program has consisted of theoretical studies of microwave scattering and detection schemes along with a series of experiments in Loche Linnhe in Scotland. The Loche Linnhe experiments have consisted of SAR and RAR imagery of ship wakes along with a variety of surface measurements of wind, waves, and microwave backscatter. The latest in this series of experiments took place in July, 1991. A laboratory component is planned for this program consisting of microwave and surface wave measurements in a wind wavetank.

Other Research Programs

A variety of other programs are involved in this area. ONR, NASA, NOAA, and NSF have all funded individual basic research efforts. For the most part, these have consisted of studies of air/sea interactions, laboratory experiments, field experiments from fixed ocean platforms, shipboard, and aircraft experiments. In addition to these, several other major programs like TOGA-COARE, WOCE, and JGOFS have significant remote sensing components.

2. SATELLITE PROGRAMS

NOAA TIROS-N Series

Developed for the operational measurement of surface and atmospheric parameters, NOAA's TIROS-N satellite series was initiated in 1978. Typically two satellites of this series are simultaneously in orbit. Three of the instruments carried onboard TIROS-N are capable of sensing sea surface temperature in addition to atmospheric parameters. These are HIRS/2, MSU, and AVHRR. HIRS/2 is an optical and microwave radiometer capable of yielding sea surface temperature with a 17.4 km resolution. The MSU is a microwave radiometer which yields resolutions on the order of 100 to 300 km. AVHRR is a high resolution optical imaging sensor which incorporates a scanning mirror. It yields surface measurements with a resolution of 1.1 km.

GEOSAT

The U.S. Navy Geosat, launched in 1985, had a single instrument on board, a microwave altimeter. Its purpose was to measure the earth's geoid from the time of flight of the altimeter's pulses, to measure global wind speeds from the mean backscatter levels, and to measure global mean square waveheights from the slope of the leading edge of the pulses. The Geosat altimeter operated at 13.5 GHz and had a spatial resolution of 2.2 to 13 km. A Geosat follow-on mission is scheduled for launch in 1995 and will contain both a microwave altimeter and a nadir-looking two-channel microwave radiometer.

DMSP

The Defense Meteorological Satellite Program is operated by the Air Force and has been in existence since 1983. The present satellite carries instruments for visible and infrared imagery of the surface and a microwave radiometer, called the special sensor microwave imager (SSM/I), which measures surface wind speed over the ocean as well as ice cover, atmospheric water vapor content, and precipitation. Present indications are that the SSM/I may be able to determine a mean wind direction also. The SSM/I operates on four channels, approximately 19, 22, 37, and 85 GHz; it collects both H and V pol radiation except in the 22 GHz band where it collects only H.

SIR-C

The Shuttle Imaging Radar - C is the third in NASA's series of SAR's to fly on the Space Shuttle. Due to be launched in 1993 and again in 1994, SIR-C is designed to operate at L and C bands, to be fully polarimetric, and to have an incidence angle variable from 15 to 65 degrees. A German X-Band SAR will be flown on the same mission. At C-Band, an on-board SAR processor will operate over the ocean to produce ocean wave spectral estimates in real time. These radars will remain in orbit only during the shuttle's time aloft, about one week.

Topex/Poseidon

This joint U.S.-French venture is a satellite designed to carry three microwave altimeters with state-of-the-art pulse length. The very short pulses will allow the measurement of ocean surface height to a few centimeters. From this measurement of dynamic topography, general ocean circulation patterns will be determined. Wind and wave information will also be available from the altimeters. One U.S. and one French altimeter will operate at Ku-Band with the remaining U.S. instrument operating at C-Band. The satellite is due to be launched in 1992.

SeaWiFS

The Sea-viewing, Wide Field of View Sensor (SeaWiFS) is an ocean color sensor similar to the Coastal Zone Color Scanner flown on NIMBUS-7. This instrument will determine the distribution of photosynthetic organisms in the global ocean. It will have a spatial resolution of 1.13 km for local area coverage near shore and 4.5 km resloution for global coverage. It is scheduled to be launched in August, 1993.

NSCAT

NSCAT is the NASA scatterometer originally designed to fly aboard the Navy's Remote Ocean Sensing System (NROSS) of satellites. With the demise of NROSS, NASA negotiated with the Japanese to launch the instrument as part of the Japanese ADEOS (Advanced Earth Observing Satellite). Launch is now set for 1995. NSCAT will measure global wind speeds and directions over the ocean. It operates at Ku-Band.

EOS

Preliminary development is underway for NASA's Earth Observing System (EOS). This system is to consist of a 15 year series of polar-orbiting satellites flown two at a time, each with a five year lifetime. At present, this system contains no SAR but is planned to have scatterometers and altimeters on board. The earliest proposed launch date for this series of satellites is 1998.

III. SOVIET PRIORITIES IN OCEAN REMOTE SENSING

Again we may break the programs into categories relating to research and to satellites. Below is a summary of current and planned Soviet activities as we understand them.

1. RESEARCH PROGRAMS

Soviet basic research in ocean remote sensing seems to concentrate on much the same areas of interest as that of the U.S. Over the years, they have pursued research in wind wave tanks in the laboratory, from towers in the Black and Caspian Sea and elsewhere, from ships, and from aircraft. The range of this research covers the areas of air/sea interactions, microwave backscattering, radar imagery, and microwave radiometry in much the same manner as U.S. work.

One difference between the Soviet and U.S. programs is that major, cooperative programs involving several institutions seem to be missing from the Soviet agenda. In fact, the impression of the group was that communication between institutions pursuing remote sensing of the ocean in the Soviet Union was almost nonexistent.

2. SATELLITE PROGRAMS

The Soviets have had major programs for flying visible spectrometers, infrared radiometers, and microwave radiometers for many years. In fact, the Soviets put the first microwave radiometer in space. These instruments have flown on the early Meteor and Kosmos series of satellites and continue to be flown on the more recent satellites discussed below.

Meteor Series

The continuing Meteor series which the Soviets initiated in 1969 contains visible, infrared, and microwave instruments capable of sensing the ocean surface as well as instruments for atmospheric sounding. The visible and infrared sensors are scanning instruments capable of imaging the surface in different wavenumber bands. The visible imagery generally has a field of view on the order of 2000 km and a resolution of 1-2 km at nadir while the infrared sensors cover a region of about 2600 km to a resolution of 8 km at nadir. High resolution microwave radiometers operating at X-Band yield a surface resolution of about 1 km while a three channel radiometer operating at 0.8, 1.3, and 8.5 cm yields a resolution of about 30, 30, and 100 km respectively. While the ocean measurement of the latter instrument is primarily that of sea surface temperature, the X-Band system is said to produce near-surface wind speed and direction.

Kosmos 1500/ Okean Series

With the launch of Okean 3 in June, 1991, the Soviets continued their strong tradition of flying real aperture radars (RARs) in space. This satellite was the sixth in the series which began with Kosmos 1500 in 1983. The RARs which are flown in these spacecraft generally operate at wavelengths of about 2 cm and yield resolutions of 1-2 km. While not as high resolution as synthetic aperture radars (SARs), these RARs are much

simpler instruments and may allow the imaging of large-scale ocean features in nearly the same manner as a SAR.

Kosmos 1870/ Almaz-1

The Soviets began their civilian spaceborne SAR imagery with the launch of Kosmos 1870 in 1987. This satellite is also called Almaz-0 since a subsequent satellite called Almaz-1 was launched in March 31, 1991 also carrying a SAR, and another called Almaz-2 is planned for the near future. Characteristics of the SAR flown on Almaz-0 are given below:

Orbit height	300 km
Orbit inclination	77.3 degrees
Wavelength	10 cm
Swath width	30-40 km
Polarization	HH
Mean incidence angle	36 degrees
Azimuth resolution	15 m
Range resolution	7.5 m

Almaz-1 has similar characteristics with slight improvements in swath width, resolution, and AGC. The latter allows observation of both land and water in the same swath.

Almaz-2

Current specifications of Almaz-2 are quite different from the first two satellites. Plans are that Almaz-2 will carry an altimeter, a scatterometer, a variety of radiometers, and a multi-frequency SAR, probably operating at the frequencies of L, S and X-Bands. It will be in a higher orbit than previous satellites of this series, probably operating at 600 km. The SAR will have a swath width of about 100 km and a resolution similar to that of the earlier Almaz SARs. The current status of Almaz-2 was a bit of a mystery to the working group. It could be anywhere from the planning stages to well into development.

Priroda

A manned spacecraft called Priroda which will carry multiple sensors including a low resolution SAR operating at L- and S-Bands is well along in its development. This satellite will be launched from the Mir space station in 1993. The working group considered this satellite to be a prestigious, national showcase and therefore to carry a higher priority in Soviet planning than either Almaz-2 or Ecology (see below). It will fly at an altitude of 360 km in a 51.6 degree orbit. The SAR will apparently operate at L-Band and will have 150 m resolution if processed by an onboard processor, 50m 4-look resolution if processed on the ground.

Ecology

The Soviets also have plans for the launch of a satellite called Yantar, Ecology in Russian, in the next few years. It is envisioned to carry visible, IR, and microwave radiometers, dual side-looking RARs and a single SAR. The status of this particular satellite was uncertain to the working group.

IV. COMPARISON OF U.S. AND SOVIET PRIORITIES

In basic research programs, the areas of interest in U.S. and Soviet endeavors do not differ substantially in content. Both countries appear to understand the importance of investigating conditions just above, at, and just below the air-sea interface in order to fully implement remote sensing techniques. Both pursue investigations from a variety of platforms including towers, ships, and aircraft. There are, however, major differences in the manner in which the work is carried out. The Soviets tend to place higher priority on analytical theoretical investigations because of the relative inaccessibility of computing systems. The U.S. seems to be making more attempts to foster multi-institutional projects and interactions between the various institutions involved in ocean remote sensing.

While U.S. and Soviet programs are similar in the visible and infrared ranges, they tend to be almost complementary in the microwave region. The U.S. has emphasized altimetry, scatterometry, and radiometry far more than active microwave imagery. No RARs have been flown in space by the U.S. while SAR imagery has been relatively scarce in the past and very few SAR systems are planned for the future. The Soviet program, on the other hand, while pioneering radiometry techniques has tended to strongly supplement them with active microwave imaging techniques. They have flown RARs in space for many years and are presently supplementing these with SARs. Their plans for the future appear to call for continued flights of RARs and an increasing number of flights of SARs. The Soviets, so far as the group could determine, have never flown a scatterometer in space and have flown only one, apparently unsuccessful, prototype altimeter in a satellite.

V. SOVIET STRENGTHS AND WEAKNESSES

The Soviet program has several areas of strength compared with the U.S. program. While there is some indication of decreasing quality in analytic theoretical studies, Soviet work in this area in the past has been strong and productive. They have tended to view this area as extremely important and have produced techniques which have greatly aided both their program and western research. They have a multitude of research facilities such as towers, ships, and aircraft available and, apparently, underutilized in this time of turmoil in their country. The frequency of their satellite launches provides them means of rapidly checking out newly developed techniques for spaceborne ocean remote sensing. They have well-developed techniques in microwave radiometry due to their long concentration in this area. Some of their knowledge of microwave radiometry appears to

surpass that of the U.S. Finally, the long series of RAR imagery from space provides the Soviets with a set of imagery of resolution intermediate between SAR and microwave radiometric imagery which is invaluable in investigating global interactions between ocean and atmosphere.

The Soviet program also exhibits significant weaknesses, however. Their lack of fast computing systems capable of handling large data sets effectively eliminates them from competition in areas requiring such capabilities. Without these machines, they cannot develop numerical modelling techniques for weather, wave, or ocean circulation as effectively as the U.S. They cannot develop the techniques for assimilating remotely sensed data into such models without the capability of handling large quantities of data in a timely manner. They cannot perform the numerical studies of non-linear phenomena which are becoming important to the U.S. program without a significant increase in computing power.

In the area of microwave technology, the Soviet program is also hindered by inadequate techniques. The quality of the Soviet SAR imagery available in the West indicates that they have difficulty obtaining adequate power from their oscillators and amplifiers, especially when coherence is required. This probably accounts for the lag in their development of coherent SAR techniques compared to incoherent RAR techniques. Even today their spaceborne SARs do not employ pulse compression techniques. This in itself necessarily limits the power they can transmit in an individual pulse. Finally, their systems seem to be relatively unreliable compared to U.S. systems, indicating a lack of quality control in their production techniques. Ironically, this weakness when coupled to the availability of their satellite launch opportunities in some sense produces a strength. This is because they are willing to launch instruments into space without the strict quality controls imposed by U.S. requirements. This results in cheaper launches, easier check out of new techniques, and faster spaceborne application of these techniques.

Perhaps because of their reliance on analytical rather than numerical techniques and their hardware limitations, Soviet researchers tend to make theoretical and experimental assumptions which would not be acceptable in the U.S. One example of this is the consistency with which they make and utilize non-directional wave spectral measurements in situations where U.S. investigators would feel the need of the complete directional wave spectrum. Another example is their tendency to treat the transfer functions necessary to infer surface wave properties from microwave backscatter as constants. U.S. researchers have spent much time and money trying to determine the dependence of these functions on microwave and environmental conditions. A final example is their willingness to ignore the effects of flow distortion when making measurements of air-sea interactions. Thus they make a multitude of measurements from ships which U.S. researchers would question and are planning to deploy a new research tower with very large legs in the Black Sea for studying air-sea interactions.

A final weakness of the Soviet system as perceived by the group is the lack of detail communicated in their typical journal articles. Examples were given of plots of data represented only by regression curves, unlabeled axes, paucity of information of experimental locations and techniques, and theoretical developments in which multiple steps were skipped. Their method of providing these missing details is apparently long reports or monographs which are distributed through informal arrangements. This technique, however, makes it difficult, especially for western scientists, to identify and obtain the relevant information since these reports are rarely referenced in the journal articles.

VI. POSSIBLE COOPERATIVE AREAS

The group was overwhelmingly of the opinion that cooperative research with the Soviets should be pursued only if it is mutually beneficial and justifiable on its scientific merit. Several possible areas which could meet these criteria were identified and are outlined below.

The availability of the large data base of spaceborne RAR imagery which the Soviets have accumulated opens the possibility of cooperation in analyzing these images. The benefit to the U.S. is, of course, access to this large data base while the benefit to the Soviets is the ability to have the data processed by computers (presumably based in the U.S.) which are capable of handling this amount of data efficiently. Scientifically the project is very adequately justified on the basis of investigating large scale correlations between atmospheric turbulence and oceanic roughness. Furthermore these data provide a very valuable basis for investigating the genesis and propagation of severe storms which are easily visible in the imagery. Such imagery shows more detail of a storm than does the typical visible imagery of cloud patterns.

The Soviets have many years of experience in microwave radiometry of the ocean. In this time, they have developed techniques for obtaining short wave directional spectra and wind speed and direction from radiometric measurements which are virtually unknown, or at least unused, in the U.S. By comparing their techinques with our own radiometers and with our scatterometer output, we could determine the viability of their techniques and, perhaps, develop alternatives to scatterometry for the determination of the wind vector from space. The Soviets would gain access to accurate meteorology, scatterometry, and comparative radiometry measurements while the U.S. would gain an understanding of a new technique.

The utilization of Soviet aircraft facilities to pursue investigations of interest to U.S. scientists is another area of possible cooperation. Of particular interest in this regard is an aircraft system operated by the Ukrainian Institute for Radio Engineering and Electronics. In addition to a suite of visible, and IR instruments, this plane carries RARs at X and Ka-Bands and SARs operating at 20 and 180 cm. The latter operating wavelength is much longer than that of any U.S. instrument and could produce

images which complement those at the higher frequencies of U.S. instruments. Concurrent measurements of the same ocean scene with these Soviet instruments and with U.S. SARs have the potential to increase our understanding of ocean imagery over a wide range of frequencies.

The low altitudes at which the first two Almaz satellites were flown and at which the Priroda satellite will be operated make the SARs flown on these spacecraft attractive for determining spectra of ocean surface waves on a global basis. This is due to the fact that distortions and azimuthal cut-offs increase as SARs fly higher or slower. Thus SARs on low-flying satellites can view shorter waves with less distortion than can SARs on high-flying satellites. Applications of good global measurements of ocean surface waves are too numerous to detail here but provide obvious benefits to both sides. Again the Soviets would gain access to data processed on powerful U.S. computers.

The possibility of using Soviet ships for a variety of investigations was proposed. Since these ships are presently underutilized, the benefit to the Soviets would be the income derived from using the ships for scientific research while the U.S. would gain access to inexpensive research vessels. One possible such project is the use of Soviet ships by NASA for validation of SeaWiFS after its launch.

Finally, the group discussed the possibility of utilizing Soviet space equipment for cooperative research. The possibilities ranged from putting U.S. equipment aboard Soviet satellites to the U.S. purchasing Soviet satellites to the possibility of using Soviet launch vehicles to put U.S. satellites into orbit. All of these possibilities seemed fraught with difficulties, some of which will be discussed in the next section.

VII. PROBLEMS IN COOPERATION

Several potential problems in cooperating with Soviet scientists recurred throughout this workshop and these were echoed in this particular working group. The difficulty which individual Soviet scientists would have in being able to honor cooperative commitments in such an uncertain social situation was pointed out. Difficulties beyond language problems in communicating with Soviet scientists was another area of concern within the group. It was pointed out that faxes and telexes often do not reach their intended recipients in the Soviet Union, that telemail addresses exist for relatively few Soviet scientists, that the telephone was almost impossible to utilize given the existing state of Soviet telephone lines, and that computer networks as we know them really do not exist in the Soviet Union. The best hope that the group saw for improving this situation was the involvement of western companies in attempts to rebuild the Soviet infrastructure.

Similar difficulties exist in assessing the quality of their research efforts and therefore in justifying them in proposals to U.S. funding agencies. This situation exists partly because of the type of journal articles typically published in the Soviet Union as

pointed out above. But it is exacerbated by the difficulty of U.S. investigators accessing original data and, indeed, by the difficulty of getting Soviet researchers to even understand the need to access this data. These difficulties were underscored by reports by members of the working group of their attempts to obtain various types of Soviet imagery. It was pointed out that mechanisms ostensibly exist for purchasing Soviet visible and SAR imagery but that the probability of actually obtaining the desired data is very low. For instance, the SAR onboard Almaz-1 was not turned on as the spacecraft passed over the U.S. Hi-Resolution Experiment off the east coast of the U.S. despite assurances by Soviet officials to the U.S. PI only the week before that this would be done. In the case of the wealth of RAR imagery, the situation is apparently even worse. The only mechanism which has been established by which U.S. investigators can obtain this data is personal contact with the Soviet custodian of the data. Thus far such personal appeals have yielded no imagery.

Ideas for using U.S. equipment on Soviet satellites or rockets similarly were perceived to be difficult to carry out. Although the Soviets will carry U.S. equipment on their satellites there are many restrictions on the type of U.S. equipment to which the Soviets may have access. NASA has successfully flown a total ozone measuring system on a Soviet satellite but the difficulties encountered in protecting sensitive parts of the equipment make it uncertain whether the effort was worthwhile. Such effort might be more justified in the case of an entire U.S. satellite being launched by a Soviet rocket but this might encounter stiff opposition within the U.S. rocket community. The outright purchase of Soviet satellites seems to involve national policy issues and at the present stage of relations could probably be carried out only with great difficulty.

Finally, in the area of remote sensing of the ocean, military considerations still preclude cooperation with Soviet scientists in several ways. Many geographical areas of interest to scientists are still considered militarily sensitive to remote sensing and cooperative projects in these areas are not likely to be approved. Furthermore, the regulations governing the shipment of U.S. radar equipment to the Soviet Union for use by U.S. investigators, for instance on a Soviet research tower, appears to be so restrictive that most active microwave equipment of interest to U.S. scientists could be used within the Soviet Union only with difficulty.

VII. KEY SOVIET INDIVIDUALS AND INSTITUTIONS

The group identified the following individuals and institutions as being those most important in Soviet ocean remote sensing:

Institute of Radio Engineering and Electronics, Moscow
- Dr. Boris Katusa - Head of Radar Group
- Dr. Anatoli Shutko - Passive Microwave

Institute for Space Research, Moscow
Prof. Valentin Etkin - Head of Remote Sensing Group
Dr. Moiseev - Meteorologist
Dr. Yuri Trokhimovsky - Passive Microwave

Shirshov Oceanology Institute, Moscow
Prof. Vadim Pelevin - Head of Remote Sensing Dept.
Dr. Olga Koblentz-Mishke - Ocean color
Dr. Anna Ginzburg - Ocean Circulation

Marine Hydrophysical Institute, Sevastopol
Dr. Gennady Korotaev - Deputy Director
Dr. Belyaev - Academician
Dr. Vladimir Efimov - Air/sea interaction
Dr. Soloviev - Surface Waves

Institute of Radio Physics and Electronics, Kharkov
Dr. Anatoly Kalmykov - Head of Remote Sensing Dept.
Dr. F.G. Bass - Radar Scattering

Hydrometeocentre of the USSR, Moscow
Dr. Peter A. Nikitin - Laboratory Head

Pacific Institute of Oceanology, Vladivostok
Dr. Leonid Mitnik - Chief of Laboratory of
Satellite Oceanography

Institute of Oceanology, St.Petersburg
Dr. Yosif M. Levin - Head of Laboratory of
Ocean and Atmospheric Optics

Institute of Applied Physics, Nizhnii Novgorod
Dr. Yermakov - Surface and internal waves

Research and Development Company "SCAN", Moscow
Dr. Vladimir Gershenzon - Passive Microwave
Dr. Alexi Ivanov - SAR

Research and Production Company "VEGA", Moscow
Dr. Leon Neronsky - Chief Scientist

VNIRO, Moscow
Dr. Yuri Zonov

Institute for Lake Research, St. Petersburg
Dr. Kirill Kondratyev - Academician

REPORT OF THE ARCTIC WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

I. PARTICIPANTS

Knut Aagaard, NOAA
Stan Bolsagna, NOAA
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Roger Colony, APL/UW
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Richard Hayes, Navy
Sus Honjo, WHOI
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George Newton, Arlington, VA
Richard Pittenger, WHOI (Chairman)
Alan F. Walker, USCG
Wilford Weeks, U. Alaska

II. INTRODUCTION

In the context of this meeting, it is appropriate to single out the Arctic and Arctic Science for special attention because "Arctic" is almost synonymous with U.S.-Soviet interaction. This is true from both scientific and geo-political-military standpoints (Figure 1).

The Soviet Arctic is of enormous scientific interest because (interalia) of its huge continental shelf, massive fresh water (and pollution) source, and the transpolar drift - the world's largest heat transfer body originates on the Soviet (Russian) Arctic coast. The Arctic is one of the least well understood, most difficult to observe regions in the world.

The Arctic is also a region where scientific and security interests have clashed sharply. The Navy has been the major funder of ocean science in the Arctic. The Navy's reasons are not all altruistic. In the Arctic, information is power; and knowledge gained of the Arctic is not perishable, that is, it does not lose its value with time. Said differently, the environment plays a major role in naval operations; this is especially true in the Arctic where the environment is the dominant factor. So historically, the Navy has been both the dominant funder of Arctic ocean science and also one of its major benefactors. The "golden rule" applies.

Figure 1

INTRODUCTION

U.S./Soviet Workshop

Arctic is a place. Navy defines it as being any area covered by ice, including seasonal ice - so "Arctic" includes: Sea of Okhotsk, Bering Sea, Canadian Arch, Davis Straits, Greenland Sea Norwegian Sea, Barents Sea.

- **Arctic almost synonymous with U.S.-Soviet interaction**
  - both politically and from geographic/scientific standpoints

- **Soviet Arctic of enormous scientific interest**

  - **Huge continental shelf**
  - **Massive fresh water (and pollution) source**
  - **Transpolar drift - ice from Soviet Arctic - feed N. Atlantic water - largest heat transfer body**
  - *Global change*
  - *Ice covers geologic features*
  - *Least understood region*

- **Also an area where scientific and security interests clash**

  - **Navy major funder of science**
    (has been, will be) Reasons not all altruistic. Information is power - information is not all perishable.

  - **Navy major beneficiary of science knowledge**

  - **Navy major source of data**
    - **Ice camps**
    - **Submarines**

  - **NSF-ARCSS ocean science program just beginning**
    i.e. NSF Arctic ocean science program has been very weak

  - **Interactions with "Soviets" indicate similar sensitivities by their Navy (flaky - undependable)**
    Challenge is to find out who can say yes and make it stick.

In contrast, other federal agency Arctic ocean science funding has been weak. The NSF-ARCSS is just getting started and so has not attracted a large soft-money-researcher following. Nevertheless, its growth is encouraging and encouraged.

Similarly, interactions with the "Soviets" in the recent past indicate similar sensitivities by their Navy.

The challenge in dealing with new Russian powers will be to find the agency or individual who can say "yes" to a science request and make it stick.

III. ARCTIC SCIENCE AGENDA AND FUNDING MECHANISMS

The Arctic subcommittee did not attempt to set down its own Arctic Research agenda; this has been adequately addressed in a variety of ways, some of which are listed below. What is needed is the funding and follow through in Washington to implement them. Most of these mechanisms are relatively new and unproven in terms of their ability to facilitate the conduct of science. The committee urges nurturing of these efforts, especially NSF's ARCSS-OAII.

- ARCSS -- Ocean Atmosphere-Ice-Interactions
  Good, but only recently on the scene (one year). Not well established or trusted.

- Interagency Arctic Research Policy Committee
  "Strategy for Integrated U.S. Arctic Research Program
  Again, new and untested.

- International Arctic Science Committee (IASC)
  Just being established. May be effective in the future. Could use WHOI Black Sea (Hydro-Black) as a model of success.

- Ocean Studies Agreement - O.S.A.
  "What's a Soviet?"

- Basic Science Agreement
  Ditto

IV. WHY DO WE NEED TO COLLABORATE WITH THE "SOVIETS" IN ARCTIC? AND HOW?

Some of the reasons are listed here. We need access:

Geographically to:

- Continental shelves, rivers, estuaries, and to the deep basin in the Russian EEZ

To unique data sets:

- Ice, buoy data, SAR data, etc.

To "Soviet" Arctic infrastructure:

- Ice camps, airlift, ships, communications, shore facilities on the Arctic coasts.

Note: While we are aware that the "Soviets" have some excellent scientists, we were unable to identify specific scientific theory or hypotheses to which we wanted "access".

The Committee tried to identify which of the many available mechanisms might facilitate improved cooperation with the "Soviets" in the Arctic. The most promising are listed in Figure 2. What it comes down to is that there is no single perfect mechanism. But a variety of agreements and initiatives have shown varying degrees of success in the past. At the present, success requires a lot of work to cultivate personal contacts through one of the numerous bilateral, multilateral governmental and non-governmental agreements.

Several recent successful examples are noted. For example, under the Ocean Studies Agreement, NOAA (PMEL, Knut Aagaard) has been able to put together a joint program to measure Chukchi Sea circulation. The Soviets cooperated completely on this project, providing a ship one year, approving access to Soviet EEZ, etc. Interestingly, they did not contribute to the design of the experiment or analysis of the data.

The location of data stations are shown on Figures 3 and 4.

Figure 2

MECHANISMS
POTENTIAL

Bilateral Agreements

Soviet Arctic research agreement initiative. Soviets have floated but Washington has turned down - no new agreements.

- **O.S.A., Basic Science Agreement** - *Examples: Gas Hydrates, Chukchi Sea*
  Example *of successful Arctic Science under OSA:*
  NOAA/PMEL --- Hydromet/AARI
  CHUKCHI Sea Circulation

- **International - non-governmental**
  WCRP - *Soviets interest in climate change*
  International Arctic Buoy Program

- *Multi-lateral Norway - Japan*

International Agreements/Arrangements
- more applied than basic

AMAP - (Finish initiative)
Monitoring program
- **Heavy metals, noise, nuclear, oil, acid, CFC, global contaminants**

SAR - Univ. of Alaska, NASA, NOAA, ESA, etc.

Interpersonal - "networks"

- **R. Colony - AARI - Air, snow temperatures, etc.**

- **K. Aagaard - Soviet river outflow data** *(Asked for it, got it)*

- **Exchange Programs**
  Emigres - *not fair to Soviets*
  Exchange scientist/investigators - *more than just tourist-like visits.*

- **Electronic Networking** - *overcomes the bureaucracy*

Figure 3

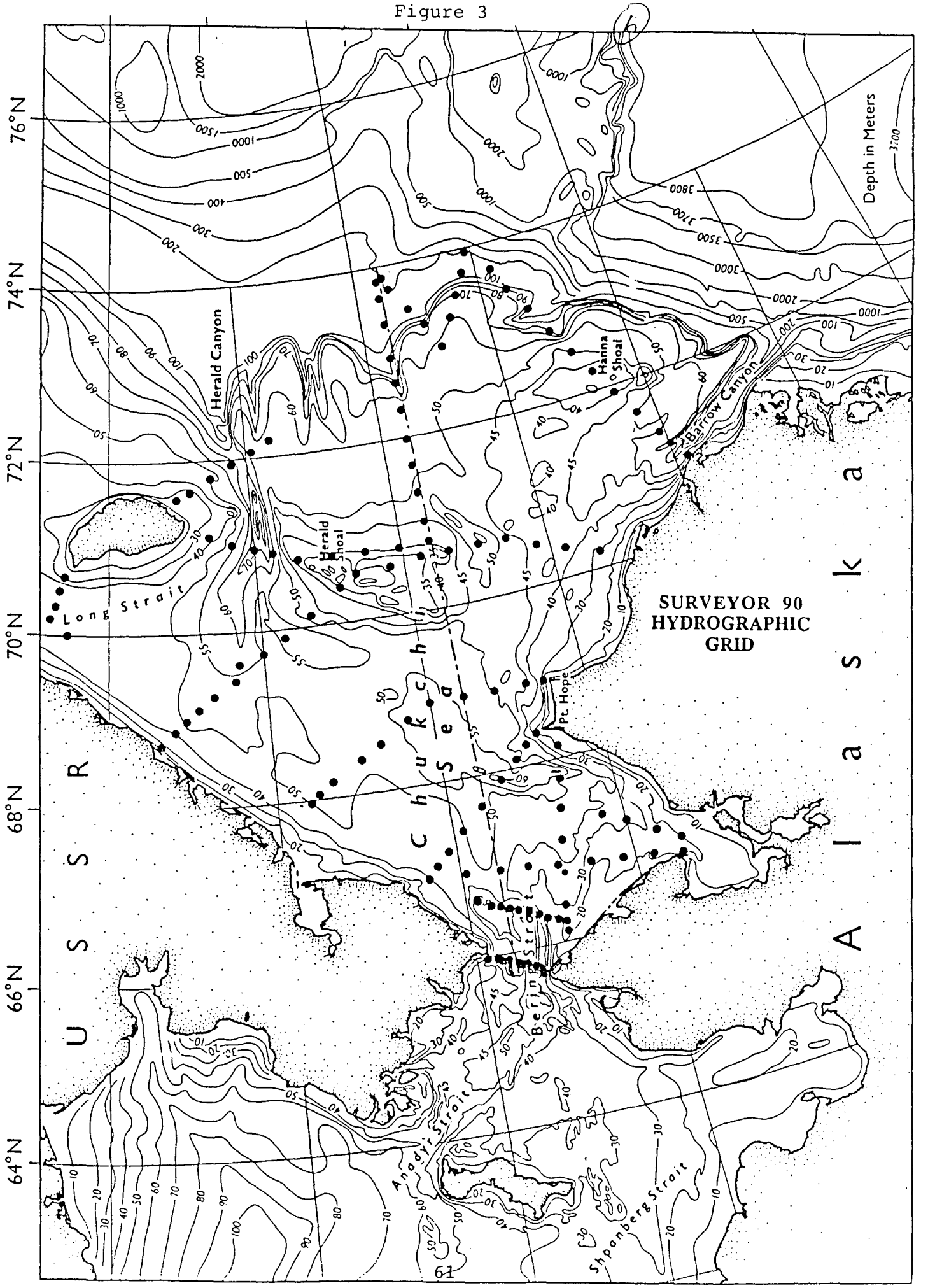
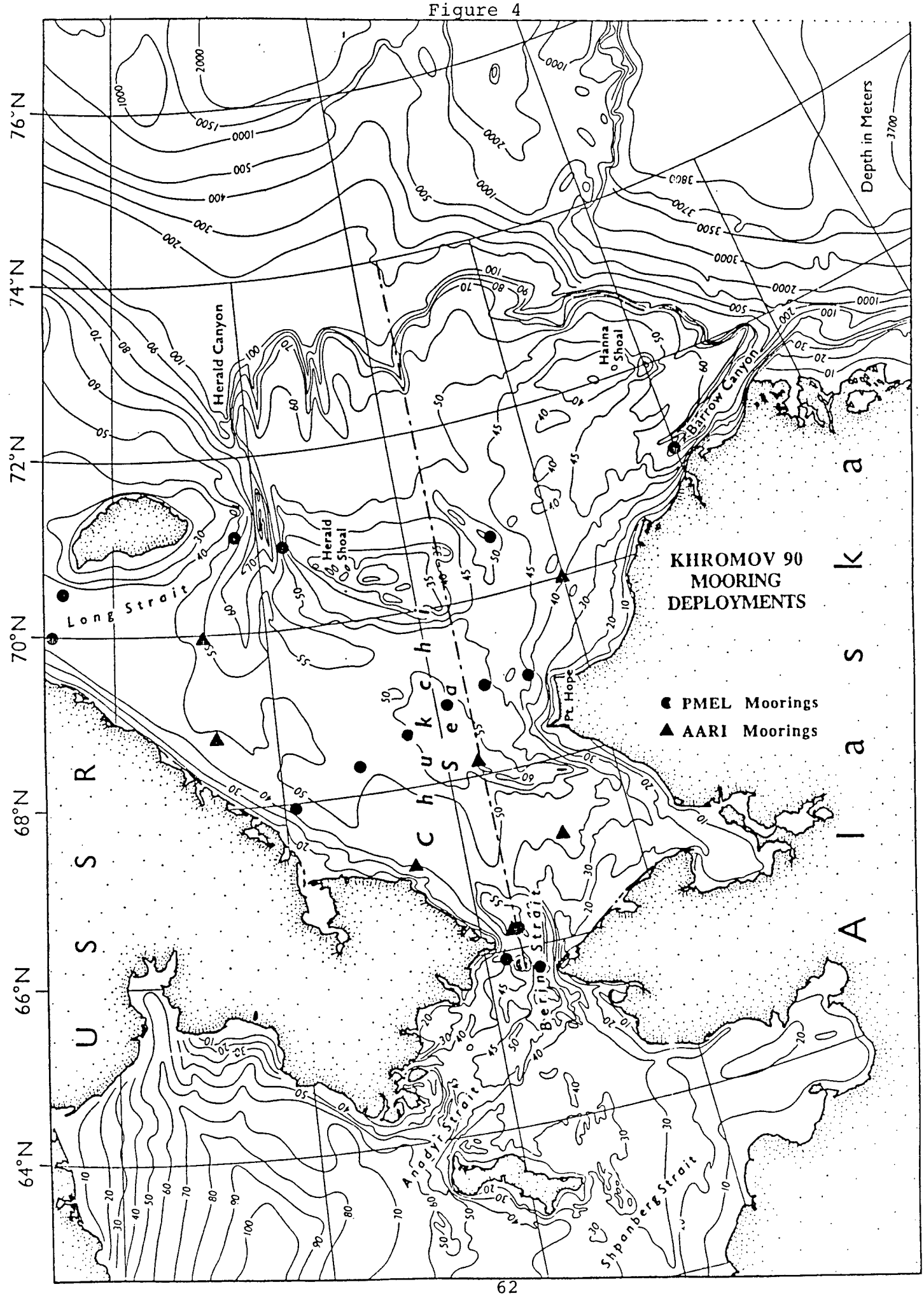

76°N
74°N
72°N
70°N
68°N
66°N
64°N
Herald Canyon
Herald Shoal
Hanna Shoal
Barrow Canyon
Long Strait
Chukchi Sea
Pt. Hope
Bering Strait
Anadyr Strait
Shpanberg Strait
U S S R
Alaska
Depth in Meters
SURVEYOR 90
HYDROGRAPHIC
GRID

Figure 4


KHROMOV 90
MOORING
DEPLOYMENTS
PMEL Moorings
AARI Moorings
Depth in Meters
Herald Canyon
Herald Shoal
Hanna Shoal
Barrow Canyon
Long Strait
Pt. Hope
Bering Strait
Anadyr Strait
Shpanberg Strait
Chukchi Sea
U S S R
Alaska
76°N
74°N
72°N
70°N
68°N
66°N
64°N

The matrix in Figure 5 depicts a summary view of keys to successful Arctic ocean science.

Organizations:

- The Soviet NOAA counterpart, Hydromet and its science arm AARI, were seen as being the most helpful organization.

- Navies on both sides are seen as impediments, with the Soviet Navy being most sensitive about geographic access issues for obvious reasons, and the U.S. Navy being most sensitive to technology transfer issues. The unevenness of application of controls was noted by several committee members.

Agreements:

- None of the agreements in place are completely effective, but they are somewhat useful.

Funding:

- We simply cannot do science without adequate funding. NOAA, and NSF-ARCSS OAII are particularly underfunded from our view. And there is concern that ONR Arctic funding might wane.

V. INFRASTRUCTURE

The Committee notes the obvious - that Arctic science logistics are extremely difficult and expensive. We are concerned by the lack of robust U.S. infrastructure to support Arctic science. This is shown in comparison to our Antarctic efforts in Figure 6.

In contrast, the Soviets have a huge Arctic presence. We would hope and urge that we could find a way to access this infrastructure and also build up our own.

Figure 5

KEYS TO SUCCESSFUL ARCTIC OCEAN SCIENCE

Organizations	HELP	HURT
Hydromet/AARI	X	
Navy - Soviet		X (Geog.)
Navy - U.S.		X (Tech.)

Agreements

- Ocean Studies Agreement	X	
- Basic Science Agreement	X	
- NOAA MOU (new)	X	
- IASC (new)	X	

U.S. Science Funding

- NOAA		X
- ARCSS		X
- ONR		X

Cannot do science without money

Figure 6

Comparison of Antarctic and Arctic Programs

	Antarctic	Arctic
INFRASTRUCTURE		
. Full-time Personnel	> 1500	< 100
. Full-time Science Support Bases	3 - Antarctica 1 - New Zealand	None
. Dedicated Air Support (NSF owned Navy operated)	7 LC 130 (ski-equipped) 6 Helo's	None
. Dedicated Ships (Ice Capable Ice Breaker)	*Polar Duke*-chartered *Nathanial Palmer*- under construction	None (U.S. considered "have not" nation as regards ships)
. Yearly Chartered	Coast Guard Icebreaker MSC resupply ships MAC C-141, C-5 heavy lift	Coast Guard Ice Breakers available for science but not highest priority

80-90% of cost of high latitude science cost is for logistics. U.S. Arctic suffers from a severe lack of infrastructure support.

REPORT OF THE MARINE POLICY RESEARCH WORKING GROUP
to
The Workshop on U.S. Strategies for Cooperation with
the Soviets on Ocean Science

I. PARTICIPANTS

The following individuals participated in the discussions of the Marine Policy Research Working Group:

Susan Bales, Navy
James Broadus, WHOI (Chairman)
William Erb, State Dept.
Robert Freidheim, USC
Norm Kahn, CIA
Barbara Moore, NOAA
William Porter, MISS
Gael Tarleton, SAIC
Kathleen Trivers, NAS
Don Walsh, IMI

II. INTRODUCTION, J. BROADUS

Our working group on marine policy is an effort to develop an agenda of social science and policy studies for collaborative research. As an example of the kinds of topics I have in mind, please refer to the latest book produced at the WHOI Marine Policy Center: The Soviet Maritime Arctic, edited by Lawson Brigham and published by the Naval Institute Press. Another example is research on the topic of "environmental security" and the oceans. We have done this work over the past year with the Department of Oceans and Environment in the Institute for World Economy and International Relations (IMEMO) of the Soviet Academy of Sciences. The idea is that environmental affairs are taking on the same quality of strategic interdependence among nations that geo-political and military affairs have had. Our two groups (comprising some 30 social scientists, economists and lawyers) have defined "environmental security" as "the reasonable assurance of protection against threats to national well-being or the common interest of the international community associated with environmental damages." We add some criteria for determining critical problems of international environmental security: (1) problems that are likely to de-stabilize the normal relations between states; and (2) that are likely to lead to international countermeasures.

As we examine the kinds of topics and opportunities that seem most promising for further collaborative work, I did want to offer you some thoughts about strengths and

weaknesses in the social sciences. Unlike in the earth sciences and natural sciences, the Soviets are not particularly strong theorists and they are not strong in empirical and analytical capabilities. A colleague of mine was saying the other day that it is her impression the Soviets have recently made great progress in their research capabilities on political and economic topics. In the old days, she said, there was a clear-cut formula they followed. Many of you know it. First, identify the problem. Second, quote from Lenin and the current party leader. Then, thirdly, jump to a rhetorical imperative for recommended actions. The progress, she says, is that now they identify the problem and jump straight to the rhetorical recommendations for action.

The Soviets are, however, strong in descriptive capabilities. Perhaps their greatest strength, as in the ocean sciences, is that the new openness provides us with unprecedented opportunities for access to Soviet data and information. Who pays for access, though?

The deteriorating situation in the former Soviet Union makes it clear that there's a desperate problem of access to resources. We're going to have to be thinking in terms of a bargain, of a trade. As recently as a year ago, the Soviets were eager to make their research assets available to us for collaboration and we were getting very good offers. Now the offers are more likely to be, whatever you want, you'll have to pay for.

I was recently talking with someone who is very familiar with American thinking about strategic affairs. He said he'd heard it mentioned, not entirely in jest, that if you are worried about the disposition of the Soviets' nuclear arsenal, why not just buy it? In virtually all aspects of access to former Soviet capabilities or assets, that has to be seriously considered. The financial resources are going to have to originate on our side, asymmetrically, and other assets on their side.

Substantively, there are good opportunities now for comparative studies, wonderful opportunities for historical retrospective, for confirming or invalidating our earlier theories and speculations. There are good opportunities for studies of institutions and the development of policies in the former Soviet Union. Environmental topics are a central opportunity. In environment, economics, and law and institutions, there is tremendous flux now in the former Soviet Union. Our joint research activities are likely to have certain qualities of a technology transfer: the exchange of methodologies and capabilities, at least, for their information. A wild card is non-governmental organizations. Environmental advocacy groups in this country have become a potent political force. There's a great ferment in the former Soviet Union now in terms of developing equivalent non-governmental organizations. There may be a research opportunity there related to ocean affairs.

What our group is going to attempt, then, is first of all to complete an inventory of existing cooperative programs, with some description of participation, goals and sponsorship. Also, to identify specific research opportunities, to identify centers of

potential collaboration in the former Soviet Union, and to forecast a bit, to indulge in some speculation about the evolving context there and the implications for future collaboration. We have a good group assembled to undertake this work.

III. WORKSHOP REPORT: MARINE POLICY RESEARCH

These are the social studies and policy issues. I suppose it's characteristic of most programs to sort out the policy issues after the fact, and this program is not unique. Our working group wanted to make the point that policy issues are likely to arise at any point in a social process; even with careful forethought we cannot expect to anticipate and dispose of them all in advance, as uncertain events unfold. We had what turned out to be a great group (Attachment A). Not everybody got to participate for the whole time, but everybody involved in the group made a significant contribution.

Start with strengths and weaknesses on the two sides in social science and policy studies. Our group agreed that, much more than in the physical and natural sciences, our colleagues in the former Soviet Union are weak in theory and weak in methodology. The political climate there for so many years has had a much more oppressive and retarding effect on the social sciences than it has even on the natural and physical sciences. The exceptions to their weaknesses, methodologically, are perhaps in international law and in descriptive geography. Their strengths are access to information and a strong base of detailed information about things Soviet and Russian.

We listed the existing cooperative programs that we could identify and came up with nearly 30 (Figure 1). This excludes programs under the auspices of multi-lateral organizations. We are certain there are many other relevant activities underway that we did not identify. We identified some centers for collaboration (Figure 2). These would usually be institutes of the Academy of Sciences, with some ministry or state committee institutes. The point that was stressed, however, is that those organizational structures are in great flux. The disposition of the organizational context is very fluid, and it remains to be seen how that's going to settle. So what we really want to do is identify collaborating individuals and track them and the physical assets that are there. Because the individuals and the physical assets can be kept up with, while all the organizational structure is in flux.

We identified some interesting and important research areas and opportunities (Figure 3). Research areas are broad ranging, and I've arrayed them from those that are more or less freestanding marine policy topics, involving natural resources management and international relations and not directly related to the conduct of marine science, through research about marine scientific research.

Comparative studies of resource and ocean use management/practices in our countries would be useful, and particularly close attention to what the evolving situation is in the successor institutions of the former Soviet Union. U.S. and former

Soviet Union transboundary issues, many of which are concentrated in high latitudes in the Bering Sea regime, the jurisdictional "donut hole" in the Bering Sea, and the issues involving anadromous fisheries in the north Pacific also call for joint attention. Following the work already underway here at Woods Hole, there was a feeling in the group that further work is warranted in developing theory about what "environmental security" means exactly and how to achieve it. There are other topics popping up in international decision making, often buzz words actually, such as "sustainability." There needs to be some careful thinking together about what that means and the implications of the application of things "sustainable" to public policy. Ditto for the "precautionary principle," which is an emerging rule of environmental decision making under uncertainty in an international context. In its strongest form this says, unless you can prove that something will cause no harm you can't do it. As ridiculous as that may sound to many of you, this is actually being put forth in international forums as a principal of international conduct.

We identified topics in mutual military security issues. One interesting point made by a participant in our group, Bill Potter from the Monterey Institute, was concern about possible secondary effects of the relaxation of export controls. The situation is deteriorating so quickly in the former Soviet Union that we may, if we are responding to what we see as a reformed center by relaxing our export controls, in fact be opening an avenue for export of sensitive technologies into the hands of bandits and nefarious actors who are in effect out of control, and thereby create another channel for the export of potentially harmful technologies into other countries or even within the former Soviet Union. For example, there is a company now in existence, advertising publicly within the former Soviet Union and into other countries that its services for hire are the application of nuclear explosions for civil purposes.

Other topics include determining jointly what the Russian and other Soviet successors' research agenda is, what their interest is in collaboration. What is the role of ocean science, and the sciences more generally, in improving policy? Opportunities might also exist there in military conversion for environmental monitoring purposes.

How can our countries combine our ocean research capabilities and assets in order to cut costs, the joint total cost involved? How might joint expeditions, research coordination, and barter schemes be most effectively organized? In that context, we identified an important research topic for which there was great federal agency interest: optimization of capacity formation and utilization through cooperation. What kinds of mixing and matching are feasible? What are the characteristics, the strengths and weaknesses, the availability, the scheduling, and so forth, for physical assets and human skills? What mechanisms exist or are needed to mesh capabilities? What are the restrictions on either side? One restriction mentioned was the Jones Act and what exclusions that might present to us and our efforts to take advantage of Soviet research vessels.

A related topic was effective management of the inevitable (in fact, already underway) brain drain. How do you take the best advantage of that situation, how do you screen and identify the most promising individuals to try to help out? It would be useful to go back and examine historical parallels, where there were immigrant waves available to the United States. What kinds of policies were put in place, for example, to take advantage of the immigrants from Germany in the early days of the Nazi regime and the uses of some of that brain power for the Manhattan project? How to identify the best bets, specifically in the ocean sciences?

We spent a good bit of time discussing some related observations and thinking about the evolving context in the former Soviet Union. Obviously any collaborative research is going to be taking place within a U.S. foreign policy context, and we would like to know more about what that policy is in order to make judgements about how best to shape U.S. collaborative efforts. Maybe the closest we came to hearing a statement of that policy within our group was, "no new commitments." So, in a way, we're on hold with U.S. policy, and that will have implications for U.S. government support for collaboration. Why should we expect support from the government? Is collaboration for its own sake? No, obviously not. Two other possibilities we might call selfish collaboration. The first is to serve pure scientific advance. The second is to serve other national interests. It's clear that we scientists, in developing our collaborations and looking for support from the government, need to keep clear on those two different motivations of the government.

Building new cadres within the former Soviet Union is an activity we thought might warrant further examination. It could enhance collaborative results, we could further U.S. preferences, we can influence to some extent the interests and the skill base that are available to us for collaboration. It is probably in our interest to think about how to do that and what we would want to do. Our National Academy of Sciences has a young investigators program that is aimed at very much that kind of thing. Again, the question of managing the brain drain arises. How do you select, how do you screen? Here, unlike the development of individual research programs, it probably is going to be necessary for the government to establish some kinds of priorities. This goes beyond the ocean sciences and is an opportunity across the board, in all fields of endeavor. Finally, on this point and on the other observations, we want to recall that we don't always need to think on bilateral terms. There may be situations in which there are advantages to going a multi-lateral route, and we should always be alert for what those are. Cost sharing is an obvious example; and funding questions do keep popping up as a crucial issue.

Now, what about the evolving context in the former Soviet Union and some implications of that? If there's anything that distinguishes the points coming out of our group from those heard from the other groups, it was our much greater sense of rapid disintegration and of urgency. We felt that there is very, very rapid disintegration underway there. Windows of opportunity are slamming shut.

There was some discussion of the ships, for example. If we had had this meeting two years ago, or even four years ago, and recognized the capabilities and the availability of those assets, we might have really been able to make headway. Now it's not clear that it hasn't gone too far. It's not clear those ships are going to be maintained. We may just lose those assets by the time we get it sorted out. So there is a very strong sense of urgency in sorting out what we want to do and getting on to do it.

Involving the contacts that we can make over there, I've mentioned the organizational framework is caput. We're going to see that increasingly in coming months, and so the important issue is to identify individuals, to focus on the skills that are embodied in individuals and on the disposition of physical assets.

That leads us to this common theme of some kind of a clearinghouse for information, some sort of a directory perhaps; although that is a forbidding task in the context of the Soviet scientific structure. There was a strong sense in our group that a service of this sort ought to be mobilized and made available to the community.

There was also a feeling that it is not necessary, for scientific purposes, to try to establish a national agenda with priorities. But there may be reasons for the government to want to establish its own agenda, with priorities for other reasons.

We have one distinct recommendation. It is that NOAA, as the U.S. executive in the bilateral Ocean Studies Agreement, should publicly report the ocean proceedings portions of the government's joint Working Group on Soviet Science and Technology (GOSSAT). That would be a very useful service for those of us who are involved in Soviet ocean relations. We had consensus within our group that this would be an appropriate and useful service for NOAA to perform.

We discussed the role of the bilateral scientific agreements. Oddly enough, as things have come apart in the Soviet Union, this may resurrect some of the motivation and usefulness of the bilateral agreements for our scientists. The bilaterals do exist, they are already in place, and they don't require new commitments in order to build some structure within them, some added details. They provide a short-range vehicle for information and collaborative exchange within our community. And they provide a focus for government organizations and for some decisions about priorities and funding allocations. There is an opportunity coming up in the spring of '92, a planning session for the Ocean Studies Agreement, to try to provide some more details for the joint program.

On commitments and funding, finally, we emphasize again that we are looking at a funding flow from us to them. They are "for sale." We can get what we want if we're willing to pay for it. In simple minded terms, if we can identify it, if we can find it on the menu, and if we can come up with the cash, it's ours. In exchange, what we're getting are real assets. We should operate on the assumption they are not going to be

able to provide these assets to us with their own resources. So, it has to be a kind of a one way cash transaction, money for things or for other benefits. There are potential savings. If we can mix and match capabilities and assets effectively, the total bill might be less for us than it would have been without taking advantage of the availability of their assets and capabilities at distressed prices. But there will be high transaction costs in getting that done, and we may not have time to do it.

Again, this is bigger than the oceans. It's a systematic stepwise increase in the risk and uncertainty we're dealing with. There are a number of ways to deal rationally with that kind of increase in risk and uncertainty. Waiting and seeing is one thing it makes sense to do, and we have been doing a lot of that. Another reasonable thing to do is to reduce the uncertainty by buying information, investing in research. We could probably do more of that. Diversification and insurance are institutional ways to face uncertainty, and we can do those things. Another response is to reduce fixed commitments and, perhaps above all else, maintain a flexible posture. It is a very risky thing for our young scientists to invest in and bank on collaboration with former Soviet scientists. It's less risky, perhaps, for more established, older, senior scientists.

Figure 1
Marine Policy Research

EXISTING COOPERATIVE PROGRAMS

- **PROJECTS** (~ 10)
  - WHOI/IMEMO "Environmental Security and the World Ocean"
  - Monterey Institute for International Studies "Monitoring Environmental Developments"
  - Dartmouth "International Regime Formation"
  - American Society for International Law US/USSR Ocean Law Project
  - "Ocean Policy" USC-Santa Cruz
  - Clark University (CENTED) "Critical Environmental Zones"
  - Geography? (Phil Pryde/San Diego State)
  - National Research Council Polar Research Board/"Arctic Social Science" (4/91)
  - National Academy of Science Young Investigators (~ 22) "Biodiversity" (Summer '92 US; Summer '93 USSR)
  - SUNY-Brockport "Changing Environmental Institutions" (Barbara J. Webster) (Pending 12/91)

- **EVENTS** (≤ 9)
  - Law of the Sea Institute (Annual)
  - Law of the Sea Institute/SMLA "Navigation" (~ 1989)
  - Council on Environmental Quality EPA-Bilateral "Beringia Legal Issues" (6/90)
  - ISAR/Soc. Ecological Union NGO "Environmental" Conference (3/91)
    - -- Workshop "Dams, Seas & Estuaries"
    - -- "Ecological Economics"
    - -- "Biodiversity"
  - Inter-Academy Meeting "Ice Mechanics" (6/91)?
  - Inter-Academy Meeting "Remote Sensing" (6/91)?

- **STANDING PROGRAMS** (~ 9)
  - Joint Academies Commission on "Ecological Security: (Defunct?)
  - International Studies Assocation (ISA): Environmental Commission (SOROS), International Law, International Organization
  - ISA study on Common Property
  - ISAR/Soc. Ecological Union, Moscow Environmental Clearinghouse
  - EPA (1972) Bilateral/(Part 6) Marine Pollution, (Part 11) Legal
  - OSA Bilateral??
  - Space Bilateral?
  - Basic Science Agreement Bilateral?
  - Merchant Marine Bilateral?

Figure 2
Marine Policy Research

List of Potential Collaborating Institutions for US-USSR Marine Policy Research

Moscow

USSR Academy of Sciences:
- Institute of World Economy and International Relations
- Institute of Geography
- Institute of Systems Studies
- Institute of State and Law
- Institute USA/Canada
- Institute of Ethnography

Ministry of Fisheries:
- Institute of Fisheries and Oceanography

Ministry of Nature Protection

Northern Sea Route Administration

Moscow State University

Nongovernmental Organizations
- EcoDevelopment Association
- Foreign Policy Association
- SocioEcological Union

Inter-Republican Agreements (?)

Ukraine

Ukrainian Academy of Sciences:
- Institute of Biology of Southern Seas
- Institute of Economics (the branch in Odessa)

Vladivostock

Academy of Sciences Far East Branch
- Institute of International and Economic Problems of World Ocean

Ministry of Fisheries
- Pacific Institute of Fisheries and Oceanography

Leningrad

Institute of Arctic and Antarctic Research (Hydromet)
Leningrad University

Kaliningrad

Ministry of Fisheries
- Atlantic Institute of Fisheries and Oceanography

Figure 3
Marine Policy Research

RESEARCH AREAS/OPPORTUNITIES

- COMPARATIVE STUDIES OF RESOURCE & OCEAN USE MANAGEMENT PRACTICES (& SUCCESSOR INSTITUTIONS)
  - -- Post-UNCLOS
  - -- Environment, NAV & Transit, Fisheries, Minerals
  - -- What are Rules & Practices?
  - -- What Works, What's Failed?
  - -- Who Benefits, Who Loses?

- US-FUSSR "TRANSBOUNDARY" ISSUES
  - -- Beringia
  - -- Bering Sea
  - -- Donut Hole
  - -- Anadromous Stocks
  - -- Arctic Peoples & Science
  - -- Northern Sea Route Development
  - -- Maintaining Antarctic Treaty System

- ENVIRONMENTAL SECURITY
  - -- Theory
  - -- Common Understanding Pollution Causes/Cures
  - -- Especially Land-Based Marine Pollution
  - -- Examine Presumption of Global Commons
  - -- Analysis of "Sustainability"
  - -- "Precautionary Principle"
  - -- Long-Term Consequences/Intergenerational Issues

- MUTUAL MILITARY SECURITY ISSUES ("HIGH POLITICS") (Mutual Interest in Stability & Deterrence)
  - -- Ocean Arms Reduction (What's Negotiable?)
  - -- I.D. Threats to Stability With Changes in FUSSR
  - -- Conversion Avenues

- SECONDARY EFFECTS OF EXPORT CONTROL RELAXATION

- TRANSNATIONAL INSTITUTIONS
  - -- How to Upgrade/Improve Through Coordination/Cooperation?

- DETERMINING RUSSIAN (& OTHER FUSSR "SUCCESSORS") AGENDA
  - -- What Are They After Through Collaboration?
  - -- How Does That Affect Our Aims?

- ROLE OF (OCEAN) SCIENCE IN IMPROVING POLICY
  - -- Pattern Detection in Science Cooperation
    - What works best, limitations, etc.
  - -- Patterns of Cooperation for Application of Science
    - Global Warming eg.
    - Role of Epistemic Communities
  - -- What Are Effective U.S. Arrangements for Dealing with FUSSR Change?
  - -- Mutual Treatment & Implications for Marine Scientific Research
  - -- Military Conversion for Environmental Monitoring?
  - -- How to Combine to Cut Costs?
    - Joint Expeditions?
    - Coordination/Barter?

- CAPACITY FORMATION/UTILIZATION OPTIMIZATION THROUGH COOPERATION
  - -- Mixing & Matching
  - -- Mechanisms
  - -- Jones Act Issues & Exclusions

- EFFECTIVE MANAGEMENT OF BRAIN DRAIN
  - -- Human Resources Policy Research
  - -- Historical Parallels
  - -- I.D. Best Bets in Ocean Studies

ACADEMIC INTERESTS: BENEFITS AND PROBLEMS

While there may well be national interests that are served by cooperation with the Soviets in oceanography, academic scientists will actively get involved only if the cooperative projects lead to scientific advance. Four general categories of such cooperation were identified by the thematic panels: participation in ongoing U.S. or international projects, evaluation of novel Soviet techniques, use of Soviet infrastructure and assets, and joint studies which are possible only with their cooperation.

Successful Soviet participation in international or major U.S. programs depends on their ability to meet acceptable standards of accuracy and precision. Where there are real or perceived differences in quality, this can be achieved by letting them use, copy, or buy U.S. equipment, by sending U.S. technicians to sea with them, and by intercalibration. WOCE is an example of a program where all of these techniques will be employed. In some aspects of science, e.g., pollution monitoring, fisheries, and meteorology, the Soviets routinely meet established international standards; this is particularly true for applied research and environmental monitoring. In any case, Soviet participation in international efforts such as WOCE, JGOFS, INTERRIDGE and ODP, and U.S. programs such as SUBDUCTION and ASTEX, provides a solid and well defined context for cooperation. As their organizational and programmatic base disintegrates, such activities will afford them a modicum of scientific structure on which to build continuity. Such participation also is an effective mechanism for overcoming cultural differences in data management, literature, approach, etc., and it can complement U.S. efforts with minimum risk to individual scientists.

Isolation between the Soviets and the West has resulted in structurally different approaches to some problems. Soviet skill in theoretical and analytical techniques is frequently ascribed to their lack of computers, and traditionally has been a rich area for U.S. interaction. This is probably of less significance for oceanography than for many other aspects of science because of our reliance upon at-sea observations; and in marine policy related social sciences, Soviet theory and methodology are weak and dogmatic.

In many instances U.S. scientists will choose to reject large bodies of Soviet effort because the differences in approach have led to incommensurable hypotheses or measurements. Further, much Soviet instrumentation is rudimentary, and they often make assumptions or simplifications unacceptable in the West. In some other cases however, e.g., satellite programs, our experimental approaches have been almost complementary and they have both experience and data which could be very useful, at low relative cost, to our science. In general, their literature is sufficiently opaque that only through direct scientist to scientist interaction will we understand the differences and their rationale for their approach. Even then, controlled experimentation with their equipment may be required to assess the value of their approach and the validity of their contentions.

One of the most straightforward approaches to cooperation is use of their assets. We have had some experience with their ships and manned submersibles, little with their aircraft and spacecraft, and almost none with the systems likely to be most valuable to us, namely specialized platforms for which we have nothing comparable. Examples include icebreakers and icecamps, their acoustic research vessels R/V VAVILOV and IOFFE, and ROVs. Although such hardware is certainly available at a price, it's difficult at this point to figure out who to deal with (multiple new firms offer the same equipment), and their initial efforts at pricing have been unrealistic. There is also legitimate concern about undercutting our own resources.

Soviet data is probably an even more valuable resource than their infrastructure. Their satellite based real aperture radar data, extensive geological collections, river outflow data, and social science information bases were cited as examples. In the Soviet system such data is tightly controlled by individuals, so as with their techniques it will require scientist-to-scientist interaction to identify and evaluate it.

Without question, access to territory controlled by the Soviet Republics has great value. Their rivers, lakes, coasts and marginal seas are of extreme scientific interest for all oceanographic disciplines. We have already had some success in mounting joint or multi-lateral efforts in these areas. The Black Sea project, geological exploration of Lake Baikal, the Vostok ice core, and NOAA/Hydromet surveys of the Chukchi Sea are examples discussed during the workshop. While each of those projects entailed considerable organization and management, there have also been many examples of successful single-scientist participation with the Soviets in joint expeditions in their territory, usually conducted from Soviet ships or planes. These types of projects, when they can be arranged, are often the most mutually beneficial form of cooperation. In addition to yielding data otherwise unattainable, they involve personal interactions which familiarize and train our Soviet counterparts in western analytical and publishing procedures.

A fifth category of cooperation is U.S. scientists' participation on Soviet cruises and expeditions. While many researchers have benefitted from this in the recent past, workshop participants generally felt that their system now is in such flux that future opportunities will be very rare, and that our efforts would be most productive -- for them as well as for us -- when we play a more substantive role in planning and directing collaborative efforts. Such opportunities if offered should not be shunned, if only because they are an excellent mechanism for establishing personal contact; but our system is ill-equipped to fund them, particularly since the scientific outcome is highly unpredictable.

While the advantages of some forms of cooperation are thus well recognized, there are some very real impediments, both logistical and because of 'impedence mismatches' in our approaches to science. Some of those which were discussed include the following:

- In the past, major Soviet projects have been characterized by broad and rather grandiose objectives, but a minimum of detailed planning. This has given

them considerable tactical flexibility and in some cases permitted a greater degree of experimentation with technique, but has limited U.S. interest and willingness to participate.

- Their journal papers typically are short and lack detailed references and substantiation of hypothesis with data. They thus are almost impossible for western readers to understand, let alone use. Detailed substantiation of much of their work is in large books, reports or theses which are inaccessible. This makes it very difficult not only to apply their results, but to evaluate either their science or their scientists.

- Research institutions are quite separated from the university structure; it is difficult to exchange students and postdoctoral investigators, and to assess the quality of applicants.

- Their hierarchical structure has limited their scientists' initiative and made it difficult for us to identify and assess quality scientists who are working in the laboratories of a few well known individuals. Support flowing through the institutions, vice competitively to individual investigators, has restricted the joint or team efforts that characterize much of U.S. science. It has been difficult to work with more than one Soviet scientist or institute at a time, and they have been reluctant to cooperate among themselves.

- Data is tightly controlled by individuals; there is neither an ethic of sharing and collaborating, nor a system whereby data is catalogued and annotated. Storage conditions are rudimentary, leading to deterioration, and much data is of questionable quality, location, and provenance.

- There is no U.S. mechanism for broadly supporting the 'dog work' necessary to establish contacts and develop collaborations; and at least in the past, the U.S. and Soviet time frames for proposals, scheduling, etc., have been incompatible.

- Logistics are terrible, and will get worse before getting better. Visas are a hassle, transportation unpredictable. Export license restrictions, if followed to the letter, would preclude us from showing or working with them with even routine U.S. equipment during their visits here, and we usually can't bring our hardware there. Funds to support their travel and stay here are hard to come by. Lack of facilities and supplies makes it hard or impossible for us to visit them, and when we do, inefficiencies drastically limit our productivity.

- Both sides remain reluctant to permit joint experiments in militarily sensitive regions. While these are small and unimportant in the U.S., for the Soviets they include the majority of their northern and eastern borders. Even when

their scientists and institutes are willing and interested, it is usually impossible to identify who can say yes and make it stick.

- o Their commitments must be taken with a large grain of salt. Even with the best of intent, there are enough residual blockages in their bureaucracies, let alone confusion and disruption, to cause well laid plans to come apart.

While these problems don't rule out cooperation, they severely condition it. Indeed, although U.S. academics recognize the benefits, the impediments are so great that some form of governmental encouragement, assistance, or at least understanding is necessary to make cooperation with the Soviets more attractive than the many available alternatives.

U.S. POLICY PERSPECTIVES

Although scientific interest will drive opportunities for academic cooperation in oceanography, national policy will help determine which are supported and approved in universities, and will control the activities of federal labs. The only clear statement of U.S. policy made at the workshop was that no further scientific bilateral agreements and commitments would be made for the time being, to avoid influencing the political evolution in the former Soviet Union. Given the degree of their organization flux, it may well be that scientific interests and initiatives such as those discussed at the workshop -- if pursued at a reasonable pace -- could influence the course of eventual discussions leading to any new formalism. Existing mechanisms and agreements permit both ongoing and suggested interactions, so the development of new bilateral international agreements is somewhat decoupled from shorter term scientific collaborative relationships.

On the other hand, comments by government representatives to the workshop, while avoiding explicit statements of policy, made quite clear their views about which elements of our relationships with the Soviets had and had not changed, at least as they influence cooperation in ocean science. Mr. Haver's speech (Appendix E) emphasized that the Soviets are no longer the "threat" or the "enemy", and that our warning window -- the lead time to react to a military attack -- has widened from minutes and days, to years. The Soviet military machine has not been dismantled, however, and until it is reduced to a level commensurate with an economic and production system converted to civil pursuits and consumer products we must remain wary. And irrespective of such changes, strategic and tactical submarines remain critical elements of both sides' naval forces and therefore there will always be concern about anything that may put them at risk.

Navy representatives emphasized the continuity of their concerns with transfer of knowledge and technology that could adversely impact the defense agenda of our national security strategy.

Ocean science has historically been of great interest to our Intelligence and operational naval communities because of its direct relevance to defense capabilities at sea.

ONR was established in the late 1940s to maintain the close linkages to academic scientists that were so important during World War II. Oceanography remains the foremost of ONR's core competencies today. The Soviet Navy has likewise had very close ties to their ocean science community. Indeed the elimination of Navy funding and support -- if not influence -- is one of the major factors shaping the change in the Soviet oceanographic institutional structure. Both Navies will continue to be conservative forces in reviewing and agreeing to cooperation in ocean science.

The collapse of the Communist idea and the reshaping of the Soviet structure have, of course, drastically changed our overall national perceptions and concerns. The President's "National Security Strategy of the United States", of August 1991, opens with a discussion of our aspiration for a new world order and raises our economic agenda to equal prominence with our political and defense agendas. Trade, technology, energy and the environment receive equal billing in this strategy with arms control, illicit drugs, nuclear deterrence and reconstitution. As Mr. Haver points out, our national perspective will diversify, and our view in time lengthen. To the degree that oceanography is relevant to all of these agendas and concerns, our scientific progress and the cooperation of our scientists with those of other nations will be of central interest to those responsible for formulating and implementing national policy.

Another factor which will influence our ability and willingness to cooperate with the Soviets is our changed perceptions about the nature of information flow in today's world. The startling degree of progress that Iraq had made toward development of nuclear weapons is strong evidence that knowledge and technology move very freely despite our attempts to impose restrictions. One major concern about the breakdown of Soviet structure -- as discussed by our Marine Policy Panel -- is the potential for their advanced military technologies to be sold or bartered to unstable or hostile organizations, governmental or otherwise. Further, we are inundated with offers from the former Communist block, and it's very difficult to sort out which are legitimate and to assess the quality of the offerers. A concern of all our panels was in fact the difficulty of identifying their best scientists and assessing the quality of those seeking cooperation.

It was also recognized that cooperation with the Soviets during this period of disintegration and reformation allows us an opportunity to help shape their perceptions and institutions in mutually beneficial ways. They have invested heavily in their ocean science community, and we face common global environmental issues. Mixing and matching our resources may prove to be an inexpensive and effective way to augment our own infrastructure. Helping them learn how to contribute to the mainstream of western scientific literature is a quick and inexpensive way of expanding the international oceanographic community. If we determine that our national policy is to actively assist them in their conversion to a democratic government and a market economy, our workshop's preparatory work in defining areas where we desire to cooperate in ocean science would enable us to move swiftly. Preservation of their scientific structure during this period of flux when their national priorities will be elsewhere will not be easy, but

there are actions that the U.S. ocean science community could take if support was available.

In sum, U.S. policy is evolving as the former Soviet Union itself changes. Although there are clear scientific gains from cooperation and we understand both the benefits and risks, other than casual and individual efforts will require a policy-based commitment that is not currently apparent. There are, however, structural federal mechanisms for effectively managing U.S.-Soviet ocean science collaboration at whatever level may be desirable.

COOPERATIVE AGREEMENTS AND GOVERNMENT REVIEW MECHANISMS

Bilateral agreements such as the 1990 U.S.-USSR Agreement on Cooperation in Ocean Studies (Appendix J) provide the formal context for federal interaction and encouragement of scientific interchange. They do not, on the U.S. side, provide funding, approval of specific projects, or a mechanism for detailed project planning.

Many of the thematic panels listed a variety of multi-lateral and bilateral agreements which further establish working relationships and provide venues for interaction, and Dr. Baker outlined some of the inter-institutional agreements under which individual projects are conducted (Appendix C). In general, although such agreements have helped identify mutual interests, they have been of more importance to the Soviets than the Americans. Under their previous structure they were essential for travel approval and helped in their budgetary process. As their structure evolves, they may well prove important as avenues of communication and aids to planning. NOAA, as coordinator of activities under the overall National Bilateral Agreement on Ocean Science, has encouraged these inter-institutional agreements as appropriate vehicles for helping define and plan cooperative projects, and for reinforcing the activities of U.S. government agencies.

Inter-institutional agreements, by themselves, are not subject to any government review process. Since they usually contain no explicit commitments regarding equipment transfer or science funding, review is imposed at the point of sponsorship and licensing.

Representatives of the Department of State and the Navy discussed export licensing procedures and the recent revisions to the COCOM Strategic Commodities core list, and the review process of the Working Group on Soviet Science and Technology (GOSSAT) (Appendices F, G). Without reiterating the widely publicized details of these procedures, two points of particular significance to academic participants were emphasized:

- GOSSAT (or GEESAT) review is required whenever U.S. government agencies propose science or technology agreements, or specific cooperative activities whether or not under such agreements, with counterparts in the former Warsaw Pact countries. The process recognizes that complementary activities are conducted by quasi-governmental and non-governmental

organizations, and GOSSAT will review such activities -- whether or not government funded -- when they are voluntarily submitted. GOSSAT desires the opportunity to hear presentations on such activities, especially when they involve new or expanded programs, to facilitiate coordination with U.S. government activities and policies. For example, NSF routinely forwards proposals involving cooperation with Soviet scientists for GOSSAT review.

- Under Export Control regulations, the term "Proscribed Destination" includes proscriptions on exposure of applicable technologies (those on the Commodity Control list, Munitions list, and Nuclear Referral list) to citizens of designated nations. The oceanographic community encountered these procedures when access limitations were installed on JOIDES RESOLUTION as a condition of Soviet participation in the Ocean Drilling Program. Since much oceanographic equipment -- for example high resolution wide swath bathymetric survey systems, many other sonars, and some computers -- are on the export control lists, care must be exercised to ensure that Soviet visitors are denied access. As the number of students, postdoctoral scholars and temporary visitors from the former Soviet Union increases, and as we deal with growing numbers of emigres, these restrictions will become much more difficult to comply with. In particular, academic research vessels are not fitted with access restrictions, and literal interpretation of export licensing procedures could preclude training and cooperative programs at sea. State and Commerce Department representatives agreed to provide tailored guidance.

SCIENCE SPONSORING AGENCY VIEWS

As the U.S. Executive Agent for the U.S.-USSR Agreement on Cooperation in Ocean Studies, and as a U.S. Co-chair of Working Group 02.08-10 (WG VIII) (The Influence of Environmental Change on Climate), of the U.S.-USSR Agreement on Protection of the Environment, NOAA is effectively the U.S. government lead agency for cooperation with the Soviets in Ocean Science. Through its activities as Executive Agent and Co-chair, through cooperative programs conducted by its laboratories, and by encouraging academic contacts and interactions, NOAA has actively stimulated discussions leading to scientific interchange.

NOAA representatives noted, however, that U.S. Bilateral Agreements are designed to promote national interests and not explicitly to support science per-se, and do not provide funding. Funding for individual efforts comes through normal programmatic routes. Academic scientists participate in NOAA collaborative projects with Soviets in much the same manner as they would in any other NOAA project. In the past, NOAA has been extremely effective in establishing cooperative programs with and through Soviet State organizations such as the State Committee on Hydrometeorology, the Arctic and Antarctic Research Institute, and the State Hydrological Institute. Although joint planning

continues it is unclear what authority, responsibility and resources will remain with such counterpart organizations.

The National Science Foundation considers cooperative efforts in two ways. The Division of International Programs supports individual proposals for joint seminars and workshops. This is intended to help identify potential research participants and start preparation of proposals for long term joint research projects. Such proposals are then considered by the appropriate NSF Research Division, through the normal peer review process and with the normal, science quality driven criteria. NSF also has mechanisms to respond quickly to opportunity, but will not normally support individual scientific visits. The NSF representative stressed that cooperative research projects with Soviet partners are effectively treated as 'business-as-usual'.

While the Office of Naval Research would consider supporting projects involving Soviet participation (the Heard Island Tomography Experiment is an example), Navy is primarily involved through the interagency review process. Navy's input is coordinated through the Navy International Programs Office. OON representatives have participated with NOAA in joint meetings associated with our bilateral agreements, and have been active in reviews of Soviet participation in the Ocean Drilling Program and classification of high resolution bathymetry data. Navy representatives stressed that in their review process they must balance opportunity versus risk, and urged the community to ask, early in the discussion and planning process, about any military concerns.

STRATEGIES FOR COOPERATION

The working group reports have identified some specific scientific interests for cooperation. These should prove very useful to federal sponsors and reviewers in initiating, supporting, or approving particular efforts in disciplines or regions of interest to them. The group discussions also helped the participants identify common areas of interest, and focus their efforts on the most profitable opportunities for collaboration.

Overall, though, given the recognized flux and disintegration in the former Soviet Union, the U.S. government's general willingness to support cooperative projects that don't harm our own national interest but lack of funding sources oriented explicitly to supporting U.S.-Soviet collaboration, and logistic and communication impediments to collaboration, the following points seem most central to a long-term strategy:

- The key to cooperation is individuals. Individual initiative is the driving principle of U.S. science, and individuals are about the only stable thing left in the former Soviet Union. Further, individuals control Soviet data and samples. Therefore, as much initiative as possible should be left to individual scientists, though they can be encouraged and assisted by Institutions and federal agencies.

- Individual interaction is best stimulated by scientific exchange. This includes joint meetings, workshops, personal visits, students, and postdocs. Substantive exchanges, not tours.

- To expedite such exchange, it's important to increase both sides' familiarity with the other's scientists. A directory of U.S. scientists with interests and established contacts would help other U.S. scientists get started, and provide entry points for interested Soviets. A directory of Soviet ocean scientists and students and their interests is almost essential if we are to identify and encourage the best ones to interact.

- Preparation of joint presentations and papers, based either on joint experiments or available data jointly analyzed, is an effective way to get potential collaborators attuned to the requirements of western science.

With **INDIVIDUAL INTERACTION** the central focus of a U.S. Strategy for Cooperation with the Soviets in Ocean Science, the following comments and guidelines for assistance emerged from the workshop discussions.

- Transaction costs are high, and U.S. academic scientists often can't afford them. Federal employees are best able to do much of the dog work needed to get started, and they can then serve as conduits to academia. Further, work like setting up the suggested directory almost has to be done by someone with a government funded salary, be they in an agency, a federal laboratory, or one of the rare few "salaried" by government in academia.

- Money is going to be needed to support the individual interactions, both to bring Soviets here and fund the U.S. academics who get involved. Traditional research grants cannot (more importantly <u>should</u> not) support, for example, the time spent educating Soviet visitors on how to write scientific papers to western standards. As another example, Soviet students and postdocs often can't even come up with the money to take GEDs or to send in applications for schools and fellowships. They frequently get stopped before they get started. At the same time, U.S. institutions can't process an infinite number of applications, and can't afford a free ride to any special group.

- Publication and wide dissemination of GOSSAT's proceedings and discussions of ocean issues would give the ocean science community improved insight into government interests, and encourage submission of academic initiatives for knowledge and review.

- Tailored export licensing procedures would help us accept Soviet visitors and students, and use our normal equipment during joint projects or scientific visits. Assistance with expediting visas -- both ways -- would reduce logistical

hassle and the need, as often occurs now, of canceling long planned visits at the last minute.

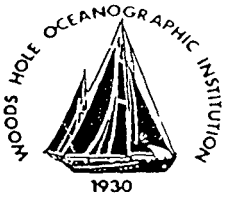
- Most Soviet institutions need basic assistance (hardware and software) in data management. A concerted effort, perhaps by NOAA, to provide them assistance in this area could pay big dividends in making their data both accessible and useful to us.

- Greater accessibility of our journals in their labs would help both them (to learn our standards and access our work), and us (so our literature is available to us during visits). The reverse is not necessarily true, although assistance in translation -- and in improving their English writing skills -- would be very helpful.

- Although the key to effective long-term collaboration is individual interactions, Institution and federal agreements are needed to help with infrastructure and access. It would be desirable to have some group identify major elements of Soviet equipment and facilities (e.g., satellites, submersibles, ships) that are of particular interest, and discuss uses that are not competitive with our own plans and resources. Since such equipment is available, it makes sense to conduct an explicit study of how to mix-and-match what we and they have, in our own best interest. Specific interactions and agreements to obtain such equipment or use-rights are also beyond the ability of individual scientists and will require formal government agency action.

- Help, and government pressure, also will be needed to gain access to scientifically important areas like the Arctic and Sea of Okhotsk. Scientists can readily design interesting and important projects in these areas, but are powerless in identifying, let alone leveraging, Soviet bureaucratic and military impediments. Given the scientific and environmental importance of many of these areas, dedicated efforts by federal agencies to make ACCESS a central element of new agreements is appropriate.

APPENDICES



U.S. Strategies for Cooperation With the Soviets on Ocean Science

Agenda

October 29, 1991 Clark Lab, 5th Floor

0730		Registration, Continental Breakfast	
0830		Welcome, Purpose, Charge to Panels	C. Dorman
0845		U.S./Soviet Oceanography Cooperation: Setting the Stage	N. Ostenso
	0900	Physical Oceanography	K. Brink/T. Joyce
	0915	Geology & Geophysics	K. Klitgord
	0930	Biogeochemistry	H. Livingston
	0945	Acoustics	J. Lynch
1000		Break	
	1015	Space/Remote Sensing	W. Plant
	1030	Arctic	R. Pittenger
	1045	Marine Policy	J. Broadus
1100		Institutional Agreements & Programs	J. Baker
1130		International Black Sea Program	D. Aubrey
1200		Lunch Clark 5	
1300		Panel on U.S. Policy Perspectives	
	1300	Introductory Remarks	R. Winokur
	1315	Intelligence Overview	R. Haver
	1345	Soviet Ocean Science Structure	N. Kahn
	1415	Technology Transfer	A. Cameron
	1445	Military Sensitivities & Concerns	RADM Jordan
1515		Break	
1530		Panel on Government Review Mechanisms	
	1530	Introduction	L. Glover
	1535	COCOM Sensitive Technologies	M. Urbina
	1545	GOSSAT	W. Erb
	1555	Port Security Concerns	W. Erb
	1605	How to Make the Process Work	L. Glover
1615		Break to Theme Groups (see Pg 2 of Agenda for Breakout Group locations)	
1730		Reception Clark 1st Floor Lobby	
1845		Dinner Clark 5th Floor	

Woods Hole, Massachusetts 02543—Phone 508·548·1400—Telex 951679

October 29 Theme Groups Locations:

1615-1730

Room Assignments	
Acoustics	Fenno House
Arctic	Clark 331
Biogeochemistry	Clark 271
Geology & Geophysics	Carriage House
Marine Policy	Fye
Physical Oceanography	Clark 201
Space/Remote Sensing	Clark 237

October 30, 1991

0730 Continental Breakfast Available at each Location

0800-1730 Theme Groups Meet (see below for locations)

1200 Box Lunches available at two locations:
Quissett Campus: 1st floor lobby of Clark
In the Village: Redfield lobby

Room Assignments	
Acoustics	Bigelow 217
Arctic	Redfield 204
Biogeochemistry	Clark 271
Geology & Geophysics	Carriage House
Marine Policy	Fye
Physical Oceanography	Clark 201
Space/Remote Sensing	Clark 237

1730 Reception and Dinner Clark Lab 5th Floor

October 31, 1991 Clark Lab 5th Floor

0730 Continental Breakfast Available

0800 Workshop Reports

Concluding Remarks — RADM Chesbrough, C. Dorman, N. Ostenso

1200 Lunch Clark 5

APPENDIX B

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APPENDIX C

INSTITUTIONAL AGREEMENTS AND PROGRAMS

FOR THE WORKSHOP ON
US STRATEGIES FOR COOPERATION
WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

D. James Baker
Joint Oceanographic Institutions Incorporated
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1. INTRODUCTION

I would like to focus on institutional agreements and programs that have been developed by the academic community, mostly directly with their Soviet colleagues. I have a special emphasis here on what has worked, what hasn't worked, and what some of the opportunities are. We've heard some of these points raised already by earlier speakers.

I might start with a personal note. I made my first trip to Moscow for the IUGG meeting in 1966, then worked with Soviet colleagues on the international Polar Experiment as part of the Global Atmospheric Research Program, on the International Southern Ocean Studies Program (Terry Joyce will remember some interesting visits to Leningrad as part of that program!), with MODE, then ocean drilling (the Deep-Sea Drilling Project and more recently the Ocean Drilling Program), and most recently the Tropical Ocean Global Atmosphere program and the World Ocean Circulation Experiment.

Just my limited experience reminds us of the breadth of oceanography and earth science interest and expertise in the Soviet Union and the importance of linking to that community. I'd like to thank Craig and Ned for putting this workshop together, because it is an important step in our strengthening these relations.

I'll start with a brief list of examples of existing institutional agreements between U.S. and U.S.S.R. institutions and what is going on under these. Some of these are carried out as part of umbrella agreements, some of them are just done institution to institution in good independent oceanographic tradition. Some common themes emerge from experiences here, and I will finish my talk with a brief discussion of these.

2. INSTITUTIONAL ARRANGEMENTS

In this section I will briefly describe the cooperative arrangements now in place at five different institutions and then discuss interactions with the USSR in two programs: Ocean Drilling and the Global Seismic Network.

WOODS HOLE OCEANOGRAPHIC INSTITUTION

WHOI has a number of current and proposed bilateral agreements, and more than twenty WHOI scientists have visited the USSR in the past year, some for cruises or stays of several months. Soviet scientists have made long-term visits to WHOI, and there are three Soviet students in the Joint Program with MIT. Activities are being conducted between WHOI and a number of Soviet institutes.

At the Institute of Applied Physics, discussions have been held about acoustic propagation experiments and acoustic tomography in the Barents Sea, the Pacific Ocean, and in the Sea of Okhotsk. At the Institute of Atmospheric Physics, the main interest is in boundary layer flux measurements as an element of subduction. At the Institute of the Biology of the Southern Seas, studies have been undertaken to track Chernobyl fallout. Interdisciplinary studies on the physics and biology of eddies are pending.

At the Institute for Space Research, the primary interests are radar backscatter and real and synthetic aperture radar. Aircraft sensors will be part of these efforts. At the Institute of World Economy and International Relations, interests focus on the definition of environmental security and nation's environmental impact on others. At the Marine Hydrophysical Institute, joint studies related to WOCE subduction studies, intercalibration, and Black Sea experiments are underway currently. These could develop into major multi-year, multi-national efforts.

At the Shirshov Institute of Oceanology, joint work is carried out with MIR submersibles in the Atlantic, and on the Lena River and in Lake Baikal. A variety of other active but less formal exchanges with Soviet institutions are also taking place. The appendix provides more details.

UNIVERSITY OF MIAMI

The Rosenstiel School of Marine and Atmospheric Science has a number of scientists working on joint projects with the USSR. For example, Eric S. Saltzman is working on the Vostok Ice Core Project which is funded by the NSF Division of Polar Programs under a U.S./France/U.S.S.R. agreement. The agreement is currently being updated. Saltzman is also working with the Soviet American Gas and Aerosol Experiment (SAGA-3). The latter experiment involved a cruise in the equatorial Pacific last year. Saltzman's participation was funded by NSF, and the project was managed by NOAA/PMEL.

Patrick J. Walsh is currently carrying out a collaborative study with Dr. Kir N. Nesis of the Institute of Oceanology, USSR Academy of Sciences, Moscow, on the systematics, biology, and biogeography of the Histioteuthidae, a family of mesopelagic squid. Mark Harwell is working with a postdoctoral researcher associate, Dr. Nicholas Kuckyanov, on ecological modelling of the Florida Bay. Funding is being provided by EPA.

Lynn Keith Shay is working on a joint project called the Upper Ocean Response to Typhoons, part of the ONR Tropical Cyclone Motion Experiment (TCM-90). The study was conducted in the western Pacific Ocean between August 1 and September 30,

1990, using several observing platforms, including four Soviet research vessels. Chris Mooers has ongoing collaborations in the areas of coastal ocean prediction and research. A Soviet postdoctoral fellow, Jacob Roginsky, is working with Dr. Yamamoto in the Division of Applied Marine Physics.

UNIVERSITY OF WASHINGTON

UW has ties to a number of Soviet institutions, particularly those affiliated with the Far East Division of the USSR Academy of Sciences in Vladivostok. The agreement is separate from the one that the Canadians have that is jointly signed by Scripps, UW, and the University of Alaska. There is presently a post-doctoral fellow at UW, and a graduate student might come. The agreement includes joint field activities focused on study of water masses, mixing zones, and interactions between marginal seas and subtropical and subpolar gyres in the Northwest Pacific but to date nothing has happened along those lines (apparently there are difficulties with the Soviet Navy). UW has formal MOUs and bilateral agreements with the following:

(1) Pacific Oceanological Institute and Institute of Automation and Control Processes
Far East Division, USSR Academy of Sciences
Vladivostok
(2) Far East Technical Institute of Fish Industry and Economy
Vladivostok
(3) Far-Eastern Regional Hydrometeorological Research Institute
Vladivostok
(4) Institute of World Economy and International Relations
USSR Academy of Sciences
Moscow
(5) Moscow State University
(6) Institute of Economic and International Studies of Ocean Development
Far-Eastern Branch, USSR Academy of Sciences
Nakhodka

LAMONT-DOHERTY GEOLOGICAL OBSERVATORY

LDGO has one institutional agreement. Otherwise, the arrangements are scientist-to-scientist only. LDGO scientists involved are W. Menke and A. Lerner-Lam (Seismology), A. Gordon (Oceanography), and M. Langseth (Marine Geophysics).

Arnold Gordon is the designated coordinator for a combined U.S./U.S.S.R. program which involves a February 1992 launching of the first manned Antarctic research station ever established on floating ice of the Southern Ocean. The study will focus on the poorly understood ocean/atmosphere/ice interactions in the Weddell Sea. Participants will include Soviet scientists from the Arctic and Antarctic Research Institute in Leningrad and U.S.

scientists from LDGO, Oregon State University, the Polar Science Center at the University of Washington, the U.S. Cold Region Research Environmental Laboratory in Hanover, NH, the Science Application International Corp. in Seattle, WA, and McPhee Research Company in Naches, WA. Satellite research will be contributed by NASA and JPL.

TEXAS A&M UNIVERSITY

TAMU Department of Oceanography has a wide variety of joint activities, primarily focused on work in the Southern Ocean. TAMU scientists led by Worth Nowlin have been involved with physical oceanography of the Antarctic Circumpolar Current, mixing processes, and air-sea interaction. A long-standing collaboration involves Sayed El-Sayed and his USSR colleagues in studies of the krill in the Antarctic. TAMU has hosted several Soviet scientists for visits, both short-term and long-term.

UNIVERSITY OF HAWAII

Scientists from the School of Ocean Engineering, Science and Technology at the University of Hawaii who have been involved with Soviets recently on joint cruises include Alex Malahoff, Barbara Keating, John Sinton, and Brian Taylor.

Judging from these joint cruises with Soviet scientists, local MOUs and institutional arrangements have worked quite well, with little or no bureaucracy and quick results. However, Barry Raleigh believes that a national strategy for coordination and scheduling, and well as identifying funding, would be helpful for these scientist-to-scientists enterprises.

OCEAN DRILLING PROGRAM

The Soviets were a member of the Deep Sea Drilling Project, and we were able to handle most of their administrative and travel arrangements directly through JOI. Only one glitch, when their first payment for the program was deposited directly in the personal back account of the Director of the National Science Foundation! Towards the end of that program, they had some difficulties in paying dues, and fell behind. By the time they agreed to pay up, the Reagan Administration decided that the cooperation should stop. For almost ten years, the U.S. and international scientific community worked to get this decision changed, and with the Bush Administration the ban was dropped. Early in 1991 the agreement was signed for them to be the 20th member country in the Ocean Drilling Program, with payments of $2.75 Million per year required. As of now, the first two quarterly payments have come in (on a Swiss Bank!), and they have asked for invoices for the next two for this year. We do not know whether they will have funds to continue, but they are hopeful, and so are we.

As a consequence of being excluded from the program for so many years, they began about three years ago to build their own ocean drilling ship. This ship is being constructed on the Black Sea and is partially constructed. At the last meeting of the Executive Committee for the program, the USSR representative, Dr. Nikita Bogdanov, asked if it might be possible for some other countries or a consortium to help them finish the ship. A visit to the ship is planned for later this year, but it is unlikely that funds can be found from already limited budgets.

SEISMOLOGY PROGRAMS

The Ocean Drilling Program has cooperated with the Incorporated Research Institutions for Seismology (IRIS) to develop a global seismic network. The first hole for a seismometer was drilled and cased off Hawaii last March. The USSR has been a key player in that program, and there are some interesting joint activities already in place, mostly on land.

IRIS/USGS and the Institute of Physics of the Earth of the USSR have agreed to develop a facility in Moscow to analyze and archive data from the US/USSR Joint Seismic Program. IRIS provides equipment for the Data Analysis Center (computer systems, printers, software, fax machines. The Institute of Physics of the Earth is responsible for developing applications software and for the operations and maintenance of the computer facilities. Most of the personnel come from the USSR, but one or two people will come from the U.S. All data from the program are shared by scientists from both countries and are available by request without restriction on an international basis.

3. LESSONS LEARNED

1. Culture differences

All of us who have dealt with the Soviets have found it difficult to get information. They are not used to sharing it. Part of this is due to the fact that they don't want to show information or details that they feel are inferior, part due to military security requirements, and part to a long-standing cultural bias about dealing with outsiders, which was a characteristic even of the Tsarist regimes.

I remember well a visit to Leningrad in the mid-1970s when we were negotiating details of an air-sea-ice program in the Arctic at the Arctic and Antarctic Institute for the Global Atmospheric Research Program. Halfway through the week, our Soviet colleagues told us that they could no longer discuss any joint programs. Apparently their military had become aware of the program and told the Institute to break off discussions. Because of the difficulty in changing flights, we spent the rest of the time talking about science results and as a U.S. group

decided not to pursue joint Arctic studies for some time to come.

Moreover, often what we get is not adequate for truly understanding the science. Specific details on instrumentation, lists of data points, adequate documentation, etc are most often lacking. The Soviet literature is difficult to assimilate because of this lack of important detail. At joint meetings, one of the most common complaints is that the U.S. side prepares detailed information for all of its programs, and then finds that the Soviets have only very limited information. After several exchanges like this in the International Southern Ocean Studies (ISOS) program, we decided that we would not put more energy into what appeared to be a very one-sided program.

2. Communications

Communications in general has been a problem. Until the recent telemail boxes established by WHOI and others, delays of weeks to months for responses were (and are!) still common. Fax does not seem to work very well, and most responses seem to come through telex. As a consequence, it is very hard to get a Soviet to be a responsive member of a research group or of a planning committee.

What's more, institutions don't communicate with each other (that is not just a Soviet problem!). In our visit earlier this year to establish the USSR as a member of the Ocean Drilling Program, we mentioned to the Institute for the Lithosphere that there was a telemail box at the Shirshov Institute of Oceanology. We suggested that they might be able to use that box for messages or to establish their own with the experience of the Shirshov. After several denials that there was any telemail in the USSR, they finally agreed that the system existed but that they could not share it. We are currently trying to arrange it from outside with hard currency.

I was involved recently in trying to organize a visit of oceanographers interested in ocean remote sensing to various laboratories in the USSR. One of the big problems we had there was that there was no easy way to discuss the agenda of the meetings. They sent a list of interests and possible discussion topics which did not overlap very well with our list. But because of communication problems, we could not converge on an agreed-on list fast enough to organize the trip. So we have postponed it indefinitely. The community has only so much patience with these things.

3. Quick response

In order for these joint activities to work, a quick response is needed that cannot always happen within governments. There is a special role for institutions here; Craig Dorman has

shown what can be done by providing institution funds at the right time, for example to help Henry Dick join the Akademik Boris Petrov in 1990 for Mid-Atlantic Ridge dredging.

4. OPPORTUNITIES FOR THE FUTURE

1. Ships and other platforms

The U.S. community has a shortage of research vessels; the Soviets have an overabundance of research vessels that they can operate inexpensively. I understand that five of the eight Shirshov ships are tied up at present because of lack of hard currency. Their ships are available for our use, at a price. Long-term chartering agreements would give us the best price and permit better outfitting of the ships. Arnold Gordon has called for a UNOLS-like program that couples the Soviet ship capability with the U.S. science interests. We need to coordinate long-term charters and put together U.S./Soviet groups going to the same places. Naturally, cooperation with Soviet oceanographers is recommended, so programs can become "joint". This may force a bit of Soviet input to the field expenses, i.e., better price for us and maybe some good science help. A potential downside with long-term chartering of Soviet ships may be less U.S. vessel use.

2. Global Ocean Observing System

The US and the USSR each have long-standing interests and capabilities in global ocean observations. It is clear that some sort of system will be set up in the coming decades, as part of a global climate observing system being supported by a variety of Earth science disciplines and environmental health interests. If such as system is to work, the capabilities of both countries must be brought to bear in the overall global context.

Both satellite and in-situ programs will be required. Although government agencies will take the formal lead for planning and implementation, it is clear that institution-to-institution agreements should be part of the overall planning for the GOOS, since much of the work to be carried out will be done by individual institutions.

For satellites, the areas of interest for cooperation include remote sensing and satellite navigation. In the first instance, the question is one of getting access to data that the Soviets have collected. The most recent example is the synthetic aperture radar data from ALMAZ, now delayed because of computer problems in the USSR.

For navigation, there is a Soviet system similar to GPS called GLONASS. Morsviazsputnik, the Soviet satellite communications organization and Inmarsat signed an agreement in 1989 under which the USSR will provide technical consulting

services to Inmarsat to aid development of an international system. Receivers are available to collect data from both systems.

3. Communications

We need to establish better links by telemail and fax. The technology does not seem to be the program, since such systems are in place. The problem is getting them to work. Probably someone needs to be on the spot to learn the institutional problems. We also need to see if any joint ventures might work.

In my recent trip to Moscow, I was impressed with the number of joint ventures in communication. On the communication side, I picked up a copy of Moscow Magazine, joint venture of United Dutch Publishers, the Moscow Organization of Soviet Journalists, and the Tokobank. It is actually published in the Netherlands. There are joint ventures in networks, for example Sprint Networks USSR is a joint venture between Sprint International and the Central Telegraph of the USSR Ministry of Posts and Telecommunications. A joint Soviet-Finnish venture called INFOCOM also allows outlets to international informational networks. This is all just beginning, but we need to use it to start our links.

I believe that if we could get good communications links between the two countries, that many of our problems would go away. From their side, it would greatly improve their ability to be part of global oceanography on a true give and take basis.

5. BACKGROUND PAPERS

Woods Hole Oceanographic Institution
Letter from C. Dorman to J. Baker, 8/16/91.

University of Miami
Letter from B. Rosendahl to C. Dorman, 8/28/91.

University of Washington
8/22/91 telemail from R. Heath; 10/16/91 telemail, 10/17/91 note, and copy of bilateral agreement from Steve Riser.

Lamont-Doherty Geological Observatory
8/7/91 telemail from G. Eaton; 8/12/91 note and press release from A. Gordon; 9/5/91 telemail from A. Gordon.

University of Hawaii
8/1/91 telemail from B. Raleigh.

IRIS Newsletter, Summer/Fall 1991, Volume X, No. 2, describing the USSR agreements.

APPENDIX D

COOPERATIVE MARINE SCIENCE PROGRAM FOR THE BLACK SEA

FOR THE WORKSHOP ON
US STRATEGIES FOR COOPERATION
WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

David G. Aubrey et al.
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543
(508) 457-2000, ext. 2852

COOPERATIVE MARINE SCIENCE PROGRAM FOR THE BLACK SEA

D. G. Aubrey, Z. Belberov, A. Bologa, V. Eremeev, and U. Ünlüata

ABSTRACT

Since April, 1991, a cooperative marine science program has been developing to investigate the science and environmental problems of the Black Sea. This program has incorporated strong participation from all riparian countries of the Black Sea, as well as the United States. Major accomplishments of this program include a successful five-ship cruise to the Black Sea (HYDROBLACK '91), comprising nearly 300 hydrographic stations and 100 biogeochemical stations. This experiment was the first basin-wide quasi-synoptic cruise throughout the Black Sea, and represents the first cooperative marine science effort among all the Black Sea countries. In addition, an international workshop was held in Varna, Bulgaria, in September and October 1991. This week-long workshop presented the state of knowledge of the Black Sea as it exists within each country, as well as a series of interdisciplinary topics co-authored by scientists from all Black Sea riparian states. The workshop also defined major science and management goals for the Black Sea for the next decade, as a framework for future cooperation. In addition, a Steering Committee was established to conduct the Cooperative Marine Science Program for the Black Sea during the upcoming decade. Among the terms of reference for this Steering Committee are:

- Coordination of national marine science programs for the Black Sea,
- Fund-raising in the international arena to offer new opportunities to improve the scientific capabilities of these riparian countries,
- Planning and implementing of interdisciplinary cruises to afford coordinated science activities.

The success of this program is but an illustration of future possibilities. The recent dissolution of the Soviet Union (into the Commonwealth of Independent States) and the opening of eastern Europe brings with it significant scientific opportunities within regional seas such as the Black Sea. Previously difficult to work within, with restricted access or data sharing, these areas have now opened dramatically. The science opportunities afforded by these events are unprecedented, and offer fresh new science opportunities that may make global science a reality. The enthusiasm of the scientists in these countries is contagious, and can accelerate the pace of the

science for eastern European as well as western participants. Availability and low cost of ships in these regions, at least to date, afford other opportunities for less expensive science.

INTRODUCTION

The recent opening of eastern Europe has rekindled interest in research within marginal seas controlled by these countries. One such area, the Black Sea, has intrinsic scientific interest because it is the largest anoxic marine basin in the world, and serves as a useful analogue to conditions in proto-oceans of the Mesozoic. Moreover, the severe pollution of this nearly enclosed basin provides a useful prototype for severely affected marginal seas the world over.

The Woods Hole Oceanographic Institution has a long history of research in the Black Sea (Table 1). Although previous cruises have included use of U.S. ships in the Black Sea, access has been limited, particularly during the past 20 years. For instance, the 1988 cruise of the KNORR into the Black Sea was restricted to Turkish waters, covering less than 40% of this basin (Figure 1). New opportunities for collaborative research have opened, and are described here briefly.

TABLE 1
SUMMARY OF RESEARCH CRUISES TO THE BLACK SEA FROM THE WOODS HOLE OCEANOGRAPHIC INSTITUTION*

R/V Chain #21, October, 1961
: A geophysical and hydrographic cruise in the Mediterranean Sea was extended briefly into the Black Sea.

R/V Atlantis II # 49, 16 March-7 May, 1969
: Geochemical, geological, geophysical and biological research in the central basin deeper than the 200m. contour. Water chemistry at the oxic-anoxic boundary, source and nature of sediments, heat flow, acoustics, gravity and magnetics were studied jointly with Turkish and Soviet scientists.

R/V Chain # 120-1, 15-30 April, 1975
: Microbiological and biogeochemical research in the western basin. Extensive water column sampling, especially at the oxic-anoxic boundary and careful (undisturbed) sediment sampling at the sediment-water interface was done to study the microbial role in sulfur cycling.

*D/V Glomar Challenger, May-June 1975
: Deep drilling of sediments in the central basin to: obtain a complete Quaternary litho-stratigraphic and bio-stratigraphic section, detail glacial-eustatic sea-level changes and periods of lacustrine sedimentation, establish a record of paleoclimate, core to Neocene deposits, determine age and composition of several acoustic reflectors and study organic diagenetic changes.

R/V Knorr # 134-8, 16 Apr.-7 May, 1988
: Research of spatial and temporal variation in sedimentation and biogeochemical variability through anoxic history of the Black Sea water column, particulate sampling and careful sediment surface provide material for biogeochemical cycling studies. Scientists from Turkey, Canada and Germany as well as the United States participated.

*not a WHOI vessel/WHOI co-chief scientist

Although the present discussion addresses the Black Sea in particular, the program is illustrative of the types of programs that may be conducted within many marginal seas of the former Soviet Union. SPASIBO, a western European-Soviet marine science investigation, is one program in the Arctic Sea of Laptev, where similar cooperation is taking place. Thus, the Black Sea program can be thought of as a new and useful mechanism for coordinating, conducting, and funding science in the international arena.

To illustrate briefly the program, brief discussions of HYDROBLACK '91 and of the Varna Workshop are presented. Remembering that the first planning meeting for these events was held in April, 1991, in Sofia, Bulgaria, the progress is exemplary, illustrating the enthusiasm of the riparian countries for cooperation and collaboration. The Sofia meeting was followed by a June, 1991, meeting in Constantza, Romania, and then by a July, 1991, meeting in Erdemli, Turkey. The meetings were conducted by an *ad hoc* group of scientists from all Black Sea riparian countries, as well as the Woods Hole Oceanographic Institution. Copies of reports of these meetings are available from the senior author.

HYDROBLACK '91

This extensive hydrographic cruise of the Black Sea served two purposes: first, to obtain high quality scientific data of unprecedented coverage throughout the Black Sea, and second, to see how well the riparian countries could work together given long histories of military, political, cultural, economic, and social differences. The scientific objective of HYDROBLACK '91 was to establish a definitive phenomenology to understand, quantify, and model the fundamental physical processes and their interactions with biological and chemical processes. This experiment was to form a basis for further studies on transport and dispersion of material, productivity, efficient utilization, exploration and exploitation of marine resources, management of the environment, control of pollution, etc. The following are some specific problems to be addressed to achieve this objective:

- Intercomparison of the main forcing mechanisms; the wind versus thermohaline forcing, source/sink flow through straits and their spatial as well as seasonal, annual, interannual variabilities, and budgets,
- the roles played by the topography and the irregular coastline,
- the process of convection associated with the cold intermediate water formation and its subsequent sinking, spreading and mixing characteristics,
- identification of major features of circulation, its energetics, and basic space and time scales of its variability,
- analysis of available historical data sets and satellite imagery (both AVHRR and CZCS),

- determination of the dissolved oxygen and hydrogen sulfide levels and the oxic/anoxic interface,
- implication of the circulation for the distribution of biological and chemical properties,
- determination of important sources and sinks of nutrients and the role of eddies in nutrient transport and primary productivity,
- determination of horizontal and vertical material fluxes within the sea and their variability,
- investigation of the primary biogeochemical processes of the euphotic and aphotic zones of the water column,
- impact of eddies and other features of circulations on fisheries through recruitment and/or production.

This cruise contained not only hydrographic and biochemical measurements, but also remotely sensed data to place those measurements in context, as well as links to numerical modeling results to compare modeling techniques and assumptions.

In April, 1991, a decision was made to conduct this multi-ship operation in the Black Sea. In June, 1991, a draft cruise plan was presented by U. Ünlüata of Middle East Technical University in Erdemli, Turkey, for review by the Steering Committee. Finally, in July, 1991, a cruise meeting was held in Erdemli, Turkey, to firm up details of the program. The cruise plan included components characteristic of most international efforts, specifying not only scientific goals, objectives and methods, but also communications protocol, publication policies, etc.

Five ships participated in HYDROBLACK '91 (Table 2). These ships all provided data from several different brands of CTD's, using to the extent possible similar procedures as outlined in the HYDROBLACK '91 cruise plan.

HYDROBLACK '91 completed nearly 300 hydrographic stations (Figure 1), using ships from three different Black Sea riparian countries. Two Ukrainian vessels (Kolesnikov and Parshin), two Turkish ships (Bilim and Piri Reis), and one Bulgarian vessel (Akademik) participated, occupying for the first time stations quasi-synoptically over the entire Black Sea within a period of three weeks. Station spacing was approximately 20 nm.

TABLE 2
SHIP AND CTD INVENTORY
HYDROBLACK '91

Vessel	Country	CTD	Dates	Number of Stations
R/V Akademik	Bulgaria	Sea Bird SBE-9	2 - 12 Sept 91	53
R/V Bilim	Turkey	Sea Bird SBE-9	5 - 23 Sept 91	104
R/V Prof. Kolesnikov	Ukraine	Istok V	9 - 29 Sept 91	94
R/V Parshin	Ukraine	Hydrozond	8 - 12 Sept 91	40
R/V Piri Reis	Turkey	Sea Bird SBE-9	7 - 17 Sept 91	16
		TOTAL	307	

The data were exchanged following the cruise by all parties, on board the R/V Kolesnikov in Varna harbor, Bulgaria, in early October. From 1-15 December, 1991, an Intercalibration Workshop was held at the Woods Hole Oceanographic Institution, with participants from all Black Sea riparian countries except Romania (visa problems). A Technical Report describing the intercalibration exercise (Aubrey et al., 1992) is in press. The intercalibration of the hydrophysical data was a labor intensive exercise because of the various CTD's used. However, the results were of high quality. As an example, the dynamic topography calculated at the 5 db level relative to 900 db level (Figure 2) shows considerable structure characteristic of the Black Sea: two central cyclonic basin-scale gyres, with intense anticyclonic eddies around the margin of the Black Sea. These anticyclonic features are quasi-permanent, and result from interactions of the rim current with topography and bathymetry, and likely from baroclinic instabilities. A temperature section from the Danube Delta to the southeast shows more characteristic Black Sea features (Figure 3). The surface mixed layer is warm (exceeding 22° C), floored by a strong thermocline. Beneath the thermocline is the cold intermediate layer (CIL: defined generally by water cooler than 7.5° C), with an increase in temperature below that level. Other dynamic topography maps and section data illustrate other aspects of the Black Sea oceanography.

In February, 1992, the cruise participants will meet in Sevastopol, Ukraine, to present and intercalibrate the other measurements from HYDROBLACK '91, including oxygen, hydrogen sulfide, nutrients, and secci disk depth. The data will be used for interdisciplinary investigations of the biogeochemical cycling within the Black Sea. Also, plans for HYDROBLACK '92A and '92B will be made at the Sevastopol meeting.

In summary, HYDROBLACK '91 was successful from both a logistical and scientific viewpoint, demonstrating the capabilities and interest of the Black Sea riparian countries for collaboration. Future work will include an expanded scientific program of investigation, including

data collection, modeling, and interdisciplinary work. Now that the program has been initiated successfully, broader collaboration is encouraged.

INTERNATIONAL WORKSHOP ON THE BLACK SEA, VARNA, BULGARIA

At the first planning meeting of April, 1991, in Sofia, Bulgaria, the interim Steering Committee agreed to host an international Workshop on the Black Sea. The intent was to limit the participants of the workshop to make for more effective scientific interaction during the working sessions. The Workshop was held at Varna, hosted jointly by the Bulgarian Academy of Sciences, Institute of Oceanology and the Coastal Research Center of the Woods Hole Oceanographic Institution.

The workshop had several goals:

- To review and assess what data exist on the environmental and scientific issues of the western Black Sea shelf.
- To re-establish collaboration of the marine scientific community within Eastern Europe, as well as with external scientists.
- To derive a holistic multi-year research plan (Action Plan) consisting of both natural and social science components addressing the environmental issues of the rivers, deltas and shelf of the Black Sea

The Workshop consisted of a series of plenary presentations (Table 3), including country profiles describing the progress of marine scientific knowledge in each Black Sea country during the past decades, and a series of interdisciplinary papers prepared and presented by a panel of experts from all the Black Sea riparian countries. The workshop concluded with a series of working groups (Table 4), which prepared a listing of science priorities and objectives for the next decade (Action Plan), as well as a means of implementing these objectives.

TABLE 3
PLENARY PRESENTATIONS

WORKSHOP ON THE BLACK SEA WITH FOCUS ON THE WESTERN BLACK SEA FALL, 1991

COUNTRY PROFILES AND SYNTHESES

MARINE PHYSICS	BULGARIA
MARINE CHEMISTRY	ROMANIA
MARINE BIOLOGY	TURKEY
MARINE GEOLOGY & GEOPHYSICS	USSR
MARINE POLICY/MANAGEMENT	FOREIGN
MONITORING	

INTERDISCIPLINARY RESEARCH ISSUES

- EUTROPHICATION/PLANKTON BLOOMS AND HYPOXIA
- COASTAL AND SHELF SEA DYNAMICS AND FLUXES, AND THEIR INTERACTION WITH THE DEEP
- MONITORING AND DATA BASE MANAGEMENT
- WATER MASS FORMATION MIXING AND DISPERSAL
- RIVER AND ATMOSPHERIC INPUT
- LAND-BASED INPUTS (INCLUDING OIL)
- HYDROGEN SULFIDE PHENOMENA
- BENTHIC PROCESSES
- ECOLOGICAL ISSUES RELATED TO LIVING MARINE RESOURCES
- CLIMATE CHANGES AND EFFECTS
- INTERNATIONAL POLICY AND LEGAL ASPECTS
- ENVIRONMENTAL MANAGEMENT (INCLUDING MARICULTURE AND FISHERIES)
- RECENT GEOLOGICAL PROCESSES AND GEOMORPHOLOGY OF THE BLACK SEA
- RIVER DELTAS: SCIENCE AND MANAGEMENT

TABLE 4
WORKING GROUP SESSIONS

INTERDISCIPLINARY ISSUES

- ENVIRONMENTAL ISSUES: (E.G., POLLUTION, CLIMATE CHANGE)
- COASTAL AND OPEN SEA DYNAMICS AND TRANSPORT
- BIOGEOCHEMICAL PROCESSES: (E.G., NUTRIENTS, H_2S, METHANE)
- APPLICATIONS AND IMPLICATIONS OF MANAGEMENT, POLICY AND LEGAL REGIMES: (BOTH LIVING AND NON-LIVING RESOURCES)
- DATA BASE MANAGEMENT

The meeting was a success, although so much interest was expressed that participants arrived without invitation and unannounced, thwarting our original attempt to limit participation. By limiting the working group sessions, however, some significant advances were made.

The results of the Workshop are being presented in two volumes. The first is a summary of the Workshop, including copies of the country profile reports, Working Group Summaries, and recommendations (Action Plan) for the future. The second is a larger volume including the Interdisciplinary scientific papers presented during the meeting. An editorial committee has been established to prepare these volumes, which will likely be printed within eastern Europe.

In addition to the scientific components, a permanent Steering Committee was established, with three members from each Black Sea riparian country and three from abroad (Table 5). A five member Executive Committee was formed from the Steering Committee to coordinate the overall program. Additional members to the Steering Committee will likely be added from western Europe and the international agencies, during the next Steering Committee meeting in Turkey in April, 1992. A non-governmental organization was proposed and accepted, and named the Cooperative Marine Science Program for the Black Sea. Terms of reference were defined and adopted (Table 6). The Steering Committee's primary functions are to serve as an initiator, facilitator, and coordinator of Black Sea science addressing oceanographic and environmental issues of critical concern to the riparian countries. Although governmental participation in this Steering Committee is limited, close contact with the ministries and the governments is attempted.

TABLE 5
STEERING COMMITTEE MEMBERS

COOPERATIVE MARINE SCIENCE PROGRAM FOR THE BLACK SEA

Bulgaria:	
Dr. Zdravko Belberov	Institute of Oceanology, Bulgarian Academy of Sciences, Varna
Dr. Georgi Detchev	Institute of Ecology, Bulgarian Academy of Sciences, Sofia
Dr. Emil Stanev	University of Sofia, Sofia
Romania:	
Dr. Alexandru Bologa	Romanian Marine Research Institute, Constantza
Dr. Nicolae Panin	Institute of Geology and Geophysics, Bucharest
Dr. Anghelutso Vadineanu	State Secretary of the Environment, Bucharest
Turkey	
Dr. Altan Acara	State Planning Office, Ankara
Dr. Erol Izdar	Inst. of Marine Sciences and Technology, University of Dokuz Eylul, Izmir
Dr. Ümit Ünlüata	Inst. of Marine Sciences, Middle East Technical University, Erdemli
U.S.S.R.	
Dr. Valery Eremeev	Marine Hydrophysical Institute, Sevastopol
Dr. Stanislav Konovalov	Institute for Biology of the Southern Seas, Sevastopol
Dr. Mikhail Vinogradov	P.P. Shirshov Institute of Oceanology, USSR Academy of Sciences, Moscow
Foreign	
Dr. Hugh Livingston	Woods Hole Oceanographic Institution, Woods Hole, MA
Dr. James Murray	University of Washington, Seattle, WA
Chairman:	
Dr. David Aubrey	Woods Hole Oceanographic Institution, Woods Hole, MA

EXECUTIVE COMMITTEE

Dr. Z. Belberov
Dr. A. Bologa
Dr. V. Eremeev
Dr. U. Ünlüata
Dr. D. G. Aubrey, Chairman

TABLE 6
TERMS OF REFERENCE
COOPERATIVE MARINE SCIENCE PROGRAM
FOR THE BLACK SEA

- Implementing the recommendations of the Workshop on the Black Sea,
- Coordinating Marine Science activities, as appropriate, among the Black Sea riparian nations and foreign countries,
- Improving communication among scientists in these countries,
- Providing highest quality science, published in refereed literature, to provide decision makers with a solid scientific framework for management, policy, regulatory, and legal issues regarding the Black Sea,
- Serving a fund-raising function for the member nations, and
- Serving as a non-governmental body to communicate with the involved governments as well as national, international (including UNEP, as well as the Convention for the Protection of the Black Sea) and local programs on the Black Sea.

The methods used for implementation of the above terms of reference include:

- Establishment of sub-groups for carrying out specific goals related to the Marine Science Program,
- Hosting workshops with the sub-groups to achieve specific goals for those sub-groups,
- Encouraging cooperative marine science projects, such as those outlined in the Working Group reports, by coordination and where possible by fund-raising,
- Hosting Black Sea meetings to encourage rapid and free dissemination of recent results, and close interaction with management, legal, and policy interests,
- Publication, where appropriate, of scientific articles and books on the Black Sea,
- Encouragement or implementation of a monitoring, data base management, and geographic information system(GIS) for the Black Sea riparian countries,
- Strengthening of ties with private, national, or international science bodies.

CONCLUSIONS

A non-governmental Cooperative Marine Science Program for the Black Sea has been established, and will be promulgated during the next decade. The Woods Hole Oceanographic Institution will maintain a significant role in this research effort, as it has already in the formation of the program.

The success of this program depends on a number of factors, including funding, continuing interest of the governments and economies of the member countries, and so on. It appears however, that the enthusiasm and openness in these emerging democratic countries will help assure a successful science program that will enable improved management of this environmentally-degraded resource.

U.S. efforts should expand in the future, with increased participation by more U.S. universities, as well as government agencies (EPA, NOAA, and USGS, for example). The U.S. government will be able to help in the future by channeling appropriate funding for the program (for science, training, facilities improvement, personnel exchange, and the like), by easing problems with visas for visitors, and by essential agency participation and coordination.

REFERENCE

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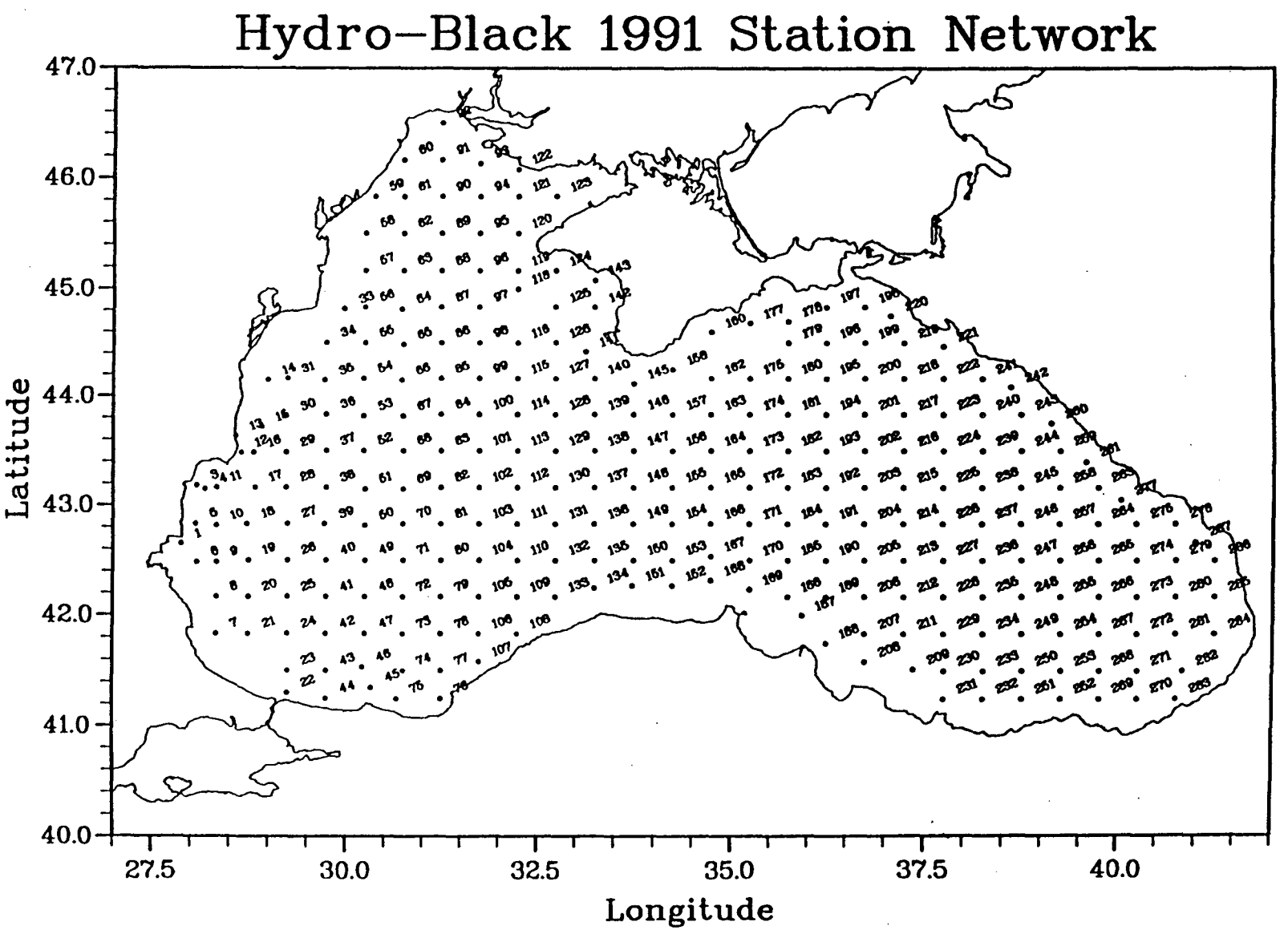

Figure 1: HYDROBLACK '91 station locations.

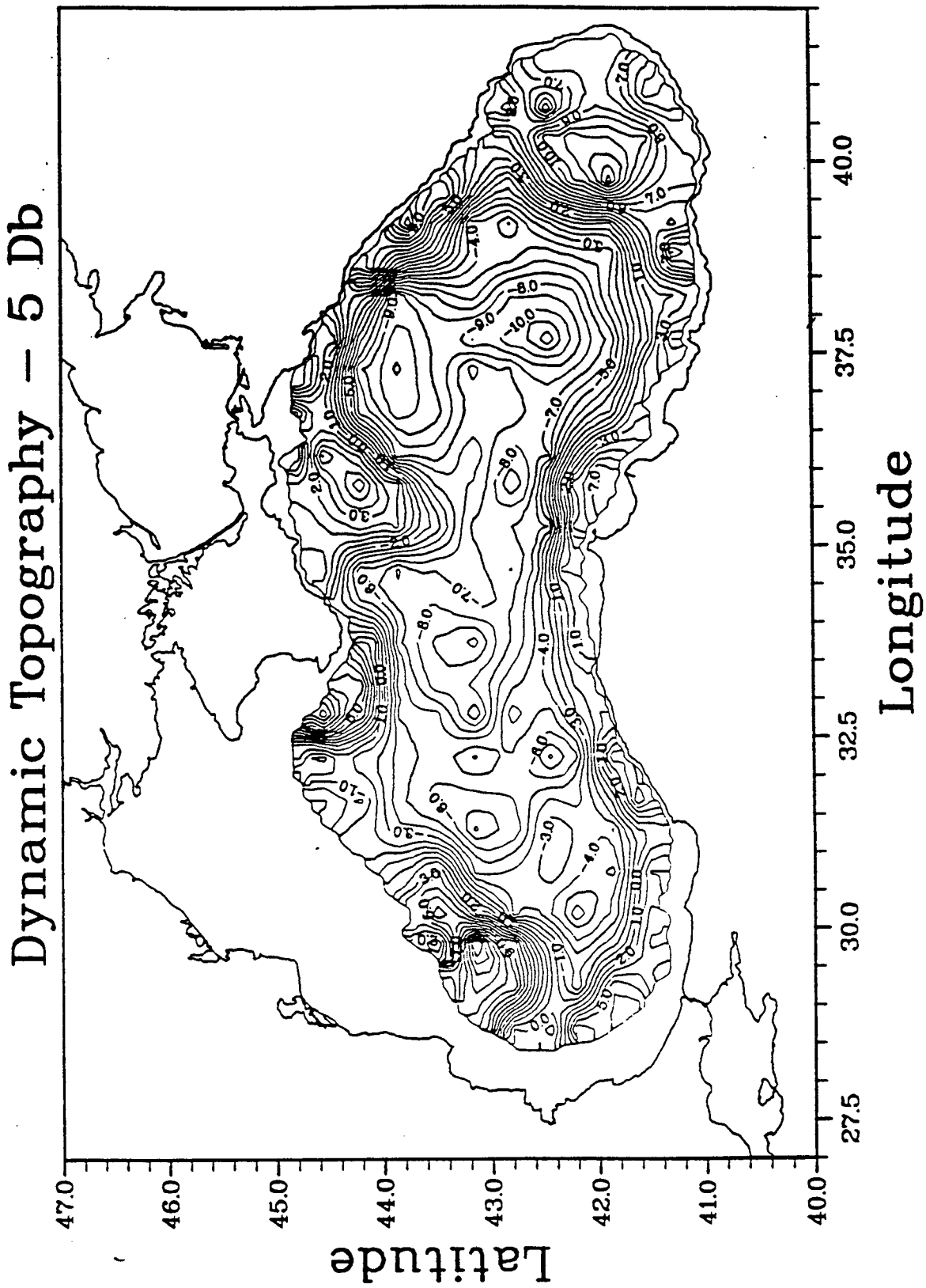

Figure 2: Dynamic topography, in centimeters, at the 5 db level relative to the 900 db level.

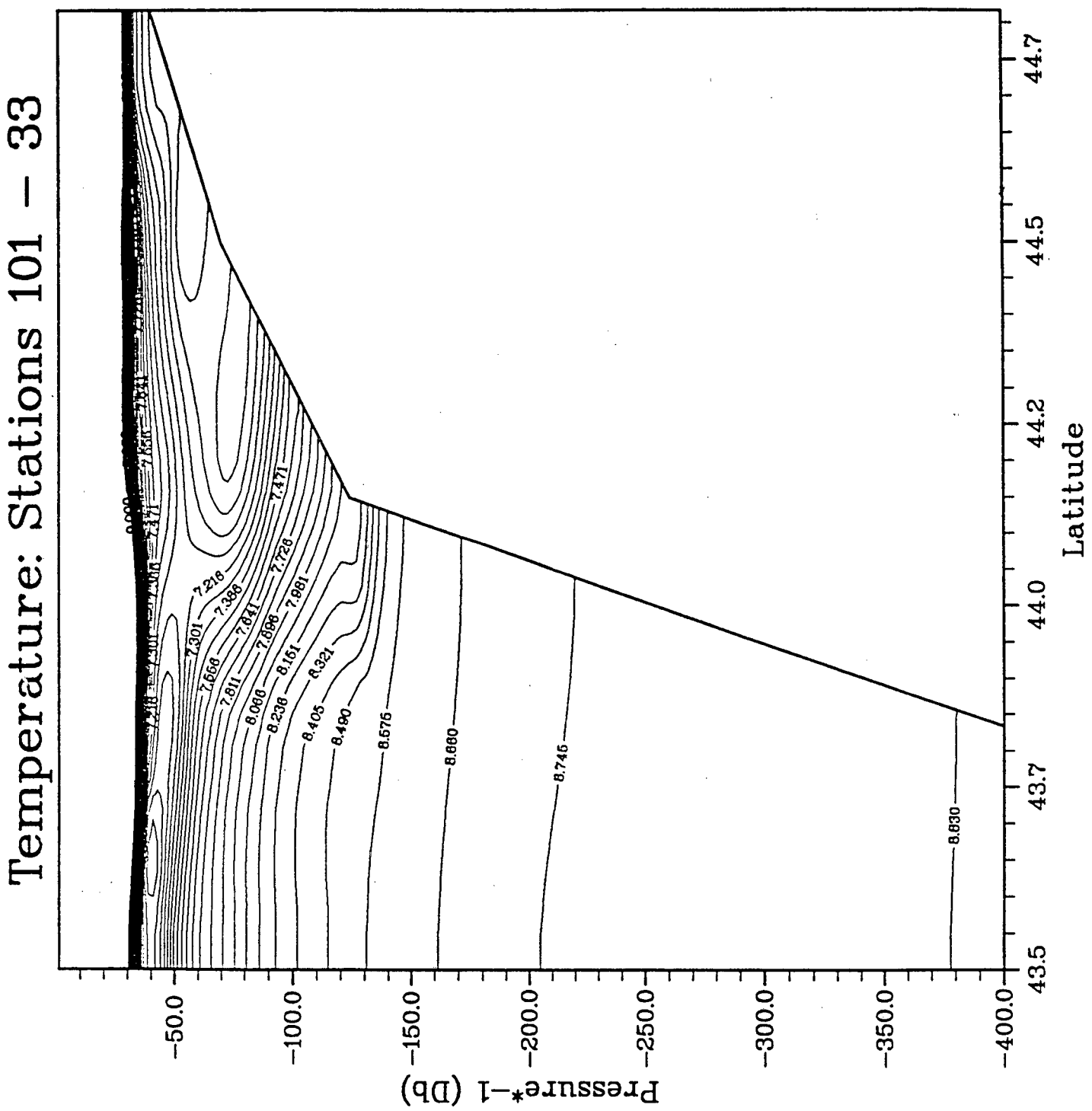

Figure 3: Cross section of temperature from the Danube Delta to the southeast, showing the strong stratification and presence of the Cold Intermediate Layer.

APPENDIX E

INTELLIGENCE OVERVIEW

FOR THE WORKSHOP ON US STRATEGIES FOR COOPERATION WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

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INTELLIGENCE OVERVIEW

Richard L. Haver

The topic of intelligence overview reminds me of events that are occurring in the world as we speak, and a story about General Schwartzkopf shortly after he retired. The General was trying to make good on his seven-figure advance for his memoirs, and was vacationing in South Carolina on the beach. He took a laptop computer with him, drafted charts of the Middle East so that he could refresh himself about the lay of the land, and was sitting in one of those big easy chairs out on the sand, poking away, and he noticed that the tide was coming in. As he glanced out the waves were lapping at his toes, and there was a bottle there. So, typical of anyone on the beach who sees a closed bottle, he pops the top, and out jumps a genie. Amazing. Norman finally got lucky: war's over and here's a genie. The genie says "I'll grant you one wish, master." Norman thought there were three wishes but this turned out to be a third rate genie on his way up, only granting one at a time. So Norman says "Okay, well look, here's a map of the Middle East. This place is a mess, it has been a mess for 2000 years. I want peace in the Middle East." The genie takes a look at the map, scratches his head, and said "Look, this is beyond my power. You can ask for it, but this is one I just can't grant you." Norman muttered, "Just my luck, I get a genie who can't produce"; so he goes back to his laptop. The genie says "Well, I can't go back in the bottle unless I have granted you a wish. You gotta give me a second wish." Norman was working on his intelligence chapter -- you may have heard some of it in his testimony before Congress -- and he said "Well, look, if you can't figure out the Middle East, the U.S. intelligence community is a disaster. It can't get the right information, what I need to know, when I need to know it. Straighten out this mess in the U.S. intelligence community!" The genie took a look at him and said, "Can I see those charts of the Middle East again?"

Maybe, once we get through the affairs in Madrid, we can come back to Washington and get Mr. Gates confirmed and get on with straightening out the U.S. intelligence community.

I'll talk a lot about change, so I'll start off with what <u>isn't</u> changing. And what isn't changing, from the point of view of the intelligence community, are three things that relate directly to this workshop. Even though there is a lot of legitimate science without any immediate military benefit being done by those in this room, none of us live in a vacuum.

The first non-change is that regardless of what you have seen and read, if you look at the details of the major arms control proposals -- the President's speech of about a month ago, Gorbachev's response, Yeltsin's response behind that, and the way the arms control discussions are now headed -- you will see that there has been very little said or done to touch the sea-based leg of our strategic posture. There have been reductions in land-based missiles, significant moves to control bomber delivered weapons and tactical weapons, etc.,

but it's quite clear that neither side seems to be very comfortable with letting go of its most secure nuclear deterrent capability. And of course the French and the British are also major parties to those discussions, and they haven't moved forward with any enthusiasm to put those devices on the table either. That truth, I believe, means that the intelligence community will continue to have to pay very close attention to the issue of the security of those sea-based strategic forces, assessing and constantly reassessing the issues of what sort of capabilities might put those forces at risk, how those forces should be operated to minimize their risk, and what needs to be done in the way of National Security Policy, Disclosure Policy, to maintain their security. Anything that could put technology into the hands of any party that may not wish this country well and therefore jeopardize those strategic systems, will be an intelligence issue for some time to come.

The second is that even though there is a major change in the world about military posture, about alliances, it is clear that the U.S. is still going to have to play a major role as a world policeman. As the only superpower, the fact is that we will clearly have a role to play. And as you saw in the Gulf War, the importance of maritime power, the importance of the sea lines of communications will remain. Again, looking at it from a purely dispassionate point of view about what the consumers of the intelligence community's product are interested in, anything that can upset the ability of the U.S. to go in to any given area of the world's ocean and control that area militarily so that the President's policies and the nations of the United Nations' will can be acted out, will be important. Without question this will involve anti-submarine warfare. It will undoubtedly involve all of the scientific and technical issues that relate to our ability to continue to operate in the face of whatever ASW threat can be put out there to oppose our submarine forces, or conversely the ASW capabilities that our forces need to prevent a foreign country's submarine capability from being used against our objectives.

I think those two non-changing things make sure that the third one will always be the same. That is, there will always be people from the intelligence community attending meetings like this. There will always be people from CIA, or DIA, or Naval Intelligence, snooping around the ocean science world. Until there is a complete outbreak of peace, what happens in this scientific community is understood by just about everyone in the intelligence community as important. This is where breakthroughs in technology and in the application of scientific principles can have immediate effect on the security balance, and therefore you'll find the intelligence community around. I think that's a constant. It's been that way probably for a hundred years. It had nothing to do with the Cold War. It was simply accelerated and intensified by the Cold War period; and I don't think that the demise of the Cold War is likely to cause us to diminish our interest. We may shift, we may adjust, we may have a few more assets to do the job, but I doubt if you are going to see the intelligence community walk away from ocean science.

However, there is great change, and it relates directly to many of the discussions I've heard this morning. If you simply have picked up some of the materials put out by the National Security Establishment in the last six months, you will have noticed two things

from the most cursory review of them. First of all, the word "threat" is like a dirty word now. You don't see it anymore. You don't see big charts showing order of battle. You don't find us bludgeoning the non-existent Warsaw Pact as the great threat. Do you remember our Soviet Military Power Book that was published every year for seven years, emblazoned with all of those charts and photographs? Now it's done in black and white, it's stapled together instead of glued, and it's called "A Military in Transition". You can read all the subtleties in that, but the fact of the matter is that the U.S. Defense establishment, the National Security Establishment, is reacting to the change and to the perception not only here at home but overseas about the reality of change in the former Soviet Union and just what sort of a threat it constitutes. And you will not see Russia or its fourteen associated Republics hung out there as the absolute reason why the U.S. military exists and why the forces are built to the level they are, etc. This is no longer going to be the approach used.

I think this change will also assist those interested in scientific exchange, and the expansion of agreements in areas where it's quite clear that science is the motivation and that science is the end product. You'll find that it is an easier process because you don't have to bludgeon yourself against this "absolute threat", against contentions that you are aiding and abetting our enemy, if you hand over this form of information or avail them with this type of technology. You don't find the word "enemy" attached to the Soviet Union or to Russia any longer. And look who's going to stand up and host tomorrow's meeting in Madrid. It's real hard to stand there with your arm around Gorby calling him the evil empire or the enemy. It's not going to be done.

I think there's also a great deal of real concern about what's happening in the former Soviet Union. I understand why everybody stood up and talked about the Soviets and the Soviet Union this morning. If you were wandering around the most classified rooms in Washington listening to intel briefs, you'd find the same rhetoric. Then you find it all corrected, because in many respects we're not talking about the Soviet Union any longer, they don't even call it the Soviet Union any longer, the word Soviet is passing out of parlance with every passing day. Yeltsin's speech on Monday maybe is as important in the long run as the events of August 22nd or 23rd. He says he's not going to pay any money into the central government anymore; this is like the Articles of Confederation reborn. If they don't get any taxes, you won't have much of a central government for very long. How does that relate to who controls their military, who controls the budgets of their scientific organizations?

I understand, when I hear people who are dealing with the Soviets, the Russians, or the Ukrainians, or the Moldavians, or the Latvians, stand up here and say these people are nervous, these people are anxious, these people are looking for other avenues to fund their pursuits. It's absolutely true. And it goes not just for their scientific community. Their whole industrial machine is that way. Mr. Atwood, the Deputy Secretary of Defense, left on Sunday night for the Soviet Union. He's traveling with an entourage of U.S. industrialists. They're visiting a wide range of Soviet military construction facilities,

factories, warehouses, the whole infrastructure; and they're talking about conversion. They're talking about what we know that may help them. To some degree you could also say the trip is so they can show us the sincerity of their effort to work this conversion from military to civilian production. And we have a lot to learn, and there's a lot of convincing to be done, about exactly where that conversion is.

You can go look back at our own record after the second World War, and you get a somewhat irregular view about how well we converted our war-geared system in 1946 and '47 back to commercial pursuits. But over and above all that, the principal concern is the economic disaster area known as the Soviet Union today. Money is worthless, never was worth much, now it's worth even less. I'm reminded of that old adage from when I was a young kid growing up in Maryland: "save your Confederate money, boys, the South will rise again." Well, you almost feel like "save your rubles, boys, the USSR may come back some day." It's basically a disaster. If you look at productivity, if you look at inflation, if you look at any serious measurement of economic activity, the Soviet Union is about in terms of relative state of mind where the U.S. was in 1933. Boris Yeltsin almost has to stand up and say "the only thing you have to fear, former comrades, is fear itself."

The Soviet Union, Russia, is in desperate condition. I think one of the biggest problems any of you are going to have is trying to figure out what effect that reality has on any real cooperative arrangement, any commitments that you make. It undoubtedly is something that plagues your Soviet counterparts, the Russians themselves, or the Ukrainians who are trying to deal with you. They don't know what commitments they're really signing up to. They don't know who's behind them, they do not know what support they have. It's clear from talking to a number of them, and also with eastern Europeans -- I was glad to see the Black Sea brief talking about Romania, Bulgaria and their interest in this area -- all of these people are in a quandary about how to apply what they have been doing for the last 45 years inside a market economy. Inside some form of economic and social system that rewards good deeds and positive product with either grants or with profit or whatever it happens to be.

They had been in the greatest state supported nursery school in the history of mankind, and it has now completely collapsed. The guy who used to write them checks has run out of town. The checks bounced. There's no one who understands where they are. People aren't getting paid now. At least, before August 19th, the paychecks came in. The problem was that Pavlov was in the backroom running off a printing press. Just manufacturing these things. He was known as the mad paper hanger. Well, Pavlov is out of action, and what you have is nobody running the presses anymore. Terrible situation.

The intelligence community, in terms of an overview about how it sees this problem, is reacting in two ways: the first way is a recognition that our problem -- in terms of the next decade or two of concerning ourselves about U.S. security and what the consumer needs to know about the rest of the world in a foreign intelligence sense -- is to diversify ourselves. Russia's still there, it still has 10-, 20-, or 30,000 nuclear weapons, it still has the

world's largest standing army, etc. You can't just wave your hand and say that doesn't exist. We will keep our eye on it. But, we now have to deal with a multi-polar world.

If you walked in the Secretary's office today you would see as much time and attention paid to Zaire and Haiti as is paid to the Ukraine; which, of course, doesn't make much sense in terms of the direct threat to the survival of the United States posed by Haiti, as opposed to that which might be posed by SSA Teams parked in the middle of the Ukraine. But it's a reflection of the way the world political situation has shifted, and the sense of urgency about solving problems that are of a national security concern.

So you will see the intelligence community snooping around your world, interested as much in exchanges with the French, the Japanese or the Germans as they are with the Russians. Is it because this exchange is bad? No, not at all. It's just reflective of the importance of this area of science and technology. Not because anybody necessarily is spying on anybody else, but because it's important to understand what that level of activity is. It's important to understand what the trends are inside this particularly important area of ocean science and technology, and what they might portend. Because, like it or not, we will have a major stake at sea from this country's national security point of view, for an indeterminant period of time.

We in the intelligence community will diversify ourselves; diversify ourselves because the immediacy of the threat of the former Warsaw Pact members is less, and because as a result of the economic well-being in the western world, there's a great deal more activity in these other nations than there used to be. Looking for cooperative understanding about this is important. Understanding what level of technology is out there, who's doing what, is an important part of the process.

The last side of this, I think, is that out of these new structures some new international order is bumping along toward fruition. The intelligence community, from the point of view of its equities inside this whole question, will have to start asking a whole new set of questions of the academic community, the industrial community, as well as the government itself. The new questions are really relating to . . . What should we be looking for? What are the trends, what are the issues that are going to arise, not necessarily this year but five years out?

The whole window of warning has changed. If you could have sat inside the intelligence community five years ago, you'd have seen that we were up on the edge. We had the Third Shock Army literally surrounding Berlin. We had bombers and submarines and land-based missile systems on alert. We were facing the Soviets toe to toe across the inter-German border and in a variety of other areas. We were talking about warning windows of days, hours, at the most weeks. There was an obsession with that inside our community. Most of our assets were geared to that. We still had people working on science and technology, yes; but they were fewer in number, given only a scant amount of attention, because of the immediacy of the Soviet military problem. You can already see

that waning. The Third Shock Army is back in Russia somewhere, building their own housing. Hardly toting gun barrels around Berlin. The Russians that are in East Germany are more surrounded by the Germans than they are occupying Germany. The whole idea of immediacy has changed.

I sense the intelligence community's window of concern has widened from days, or weeks, or at the most months, to years and to decades. We're now concerned about much larger questions, much broader issues about what is the technological level of certain nations, or certain groupings of nations, what sort of problems may emerge in the future. The consumers, the National Security consumers -- not so much the Military CINCs because those people have an immediate problem of running forces and troops today, but the people just a step above them -- are concerned with these larger issues. And my word to you is that I believe. . . and I think this is healthy, not negative at all, and it's not necessarily something of excruciating pain due to mountains of security and concern about sources and methods because a great deal of this information is out there for the easy plucking, you don't have to have your KGB credentials to find out about it. . .you will find us, hopefully, if the intelligence community reacts in the way I think it will, being more and more involved with you, and to some degree perhaps more and more cooperative.

We will be more and more involved with you, not just in asking questions and snooping around, but in providing information, being a clearing house for data on certain questions; being more cooperative and inherently more interested than we've been in the past. I understand, from having worked with Admiral Dorman for years, that to some degree the intelligence community has "put off" those in the other pursuits, because we show up with "You can't see this, answer our questions, we're not answering any ourselves, this is not a dialogue, this is a one way exchange!" I believe you will see a change in this. We will still have our little compartments, we will still have our security issues, etc. But I think you will find the intelligence community, at its analytical level, working on a broader, more open plane with this whole question. And I hope that if it's done correctly, it can benefit both sides.

That is, it can benefit you, the community that's interested in the pursuit of science, because we have information that can be of use to help you understand whether, for example, some particular organization is credible or not. One of the things you will see in the next brief from CIA is at the unclassified level, what we know about the Soviet system. And believe me, we know a great deal more today at the unclassified level, than we knew at the highly classified, compartmented level five or ten years ago. Simply because it's all out there on the streets. The Soviets have dumped it there as part of their effort to make contact. And, I suspect, that that's just a sample.

Five years from now, if you hold a second conference on this same subject and you invite somebody from DIA or Naval Intelligence or CIA to give a briefing, it will be even more. And I hope we can build bridges so that when you are involved with some organization we can help you evaluate and relate to them. I was somewhat amazed to see

all those activities described by the workshop chairmen this morning. I mean, I knew in a general sense they were going on, but hardly the details; it's not my job to know details any longer. But obviously, some of those organizations you deal with are legitimate, solid scientific organizations that people should want to do business with. Others are probably fly-by-night outfits. Like in any organization that's been torn apart and put back together, the chances of producing charlatans out of that woodpile, I think, is relatively high. All of the natural controls of the free marketplace have allowed the fly-by-night crazies inside our own systems to get squeezed out. I mean no one will do business with them, so they disappear. I think in the eastern European residue, you'll see a number of fairly flaky individuals trying to do business. I hope that we can figure out a way, and forums like this are excellent, to make connections so that what we know we can pass on to each other.

The bottom line on all this though is, I think, in two parts: First, it is a changing world. One in which a lot of the old mores, and the old dictums, and the absolute, "that's bad, that's good", are gone. As my boss has said more than once "We may well look back five years from now, on the Cold War, as the good old days". When everything was obvious. They were for us, they were against us. Black and white. You had an issue and if the Soviets were on this side of the issue, we knew what side we had to be on. It didn't take a lot of brain power, we didn't have to get very involved. If somebody was over there lined up with the Russians, he obviously wasn't on our side of the fence. What we're talking about today, quite frankly, is that all those lines are blurred. It's no longer quite so clear.

But that aside, the dichotomous part of this speech is the second part. Until there is a major, permanent change in the political complexion of what is now Russia, until its capabilities militarily are reduced to some level that's consistent with their goals as opposed to what they currently are now -- which is grossly exceeding the ability of their nation to support it -- we still have a major concern. The Soviet Union is broke today because of the extraordinary sums they invested in a completely worthless military machine. Worthless from the point of view of improving the lives of any given Russian. In effect, we bankrupted them. If you ask me, that's the bottom line on the d War.

Until that military machine is brought down, until there's more balance, and until the military thread is significantly contained, you will still find us, in the National Security System, concerned about it. Somewhat reluctant to go too far to help or share; somewhat reluctant to be out on the edge of this issue of openness. Rather, holding back. This may frustrate people. It may cause some to wonder if we lost leave of our senses and are failing to grasp where things are going. But if you read Russian history for the last five hundred years or so, it is regrettably a long story of cold hard winters followed by very brief intermittent springs. Peter the Great and others came along and lightened the country and brought it up where the rest of the world was. And then, unfortunately, other forces drove it back. It is now clearly emerging out of one of those long dark winters. Hopefully, the change in the great world order will allow this to be a much longer, perhaps continuous updating of it. But until that's obvious, I think you will continue to see those of us with

National Security responsibilities hedging our bets, worried about the reality of their capabilities.

I think that two years ago the question was: Here are Soviet's capabilities. Unmistakable. Here are Soviet's intentions. I don't know what they are. I don't know whether I believe Gorbachev or not, I don't know whether I believe Yeltsin; I'm not sure whether Perestroika and Glasnost, are simply phrases, a clever way, a new ruse, a new Potemkin village.

I would say the change today is that while they still have all these military capabilities, they have significantly changed in terms of their probability of being employed. We've seen, in this coup attempt, a stark contrast between those who want to turn the clock back and those who want to go forward. Now the question isn't what Yeltsin's intentions are; now the question is what are his prospects for success? What are the prospects that this country really can emerge out of this long hard winter into some 21st century state?

And there, quite frankly, I end. The jury is still out. If there is anybody here who really knows, if he or she out there in the audience has a very good idea of exactly where the system is headed, I do sincerely have a very good job for you in Washington. Because you are a unique individual.

APPENDIX F

DOD INTERNATIONAL POLICY AND TECHNOLOGY TRANSFER PROCEDURES

FOR THE WORKSHOP ON US STRATEGIES FOR COOPERATION WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
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OCTOBER 29-31, 1991

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DOD INTERNATIONAL POLICY AND TECHNOLOGY TRANSFER PROCEDURES

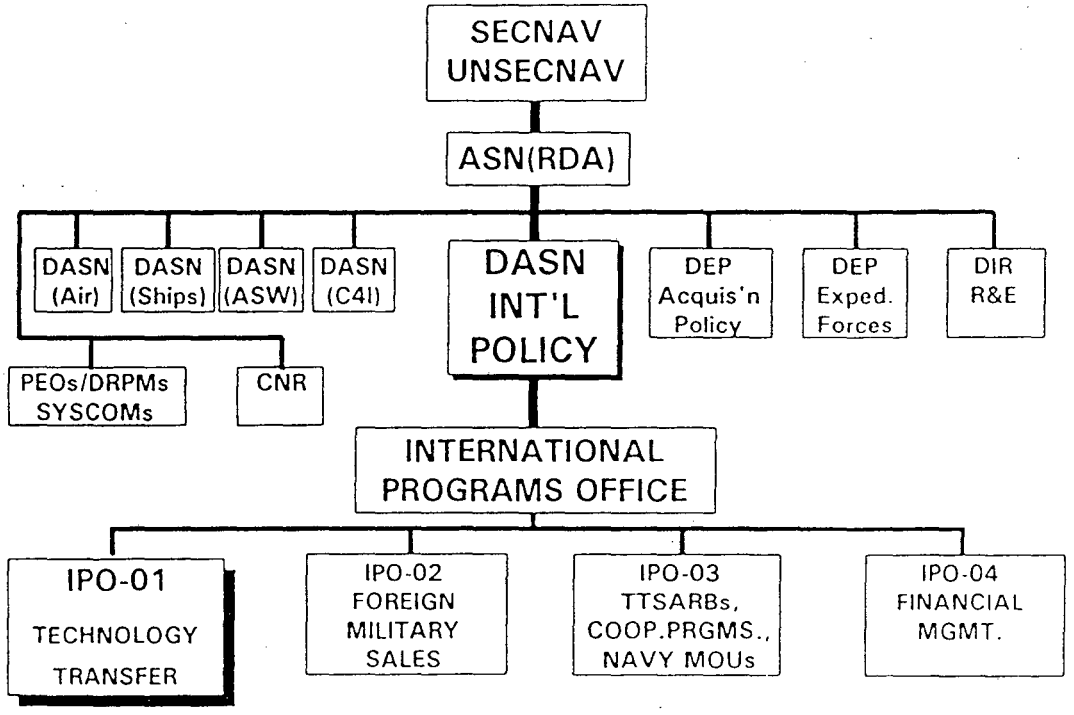
Alan W. Cameron

Good afternoon. I have been asked to talk to you today about the Navy's role in the government's current policies and procedures for cooperation with the Soviets on ocean science, particularly regarding technology transfer.

The world may have changed, but we are still concerned about leakage of sensitive technologies. We understand the benefits of cooperation, but we also need to protect the things that are important to our security and the operating capabilities of our forces.

Navy's current organization for dealing with these issues is depicted in this first figure.

INTERNATIONAL PROGRAMS ORGANIZATION



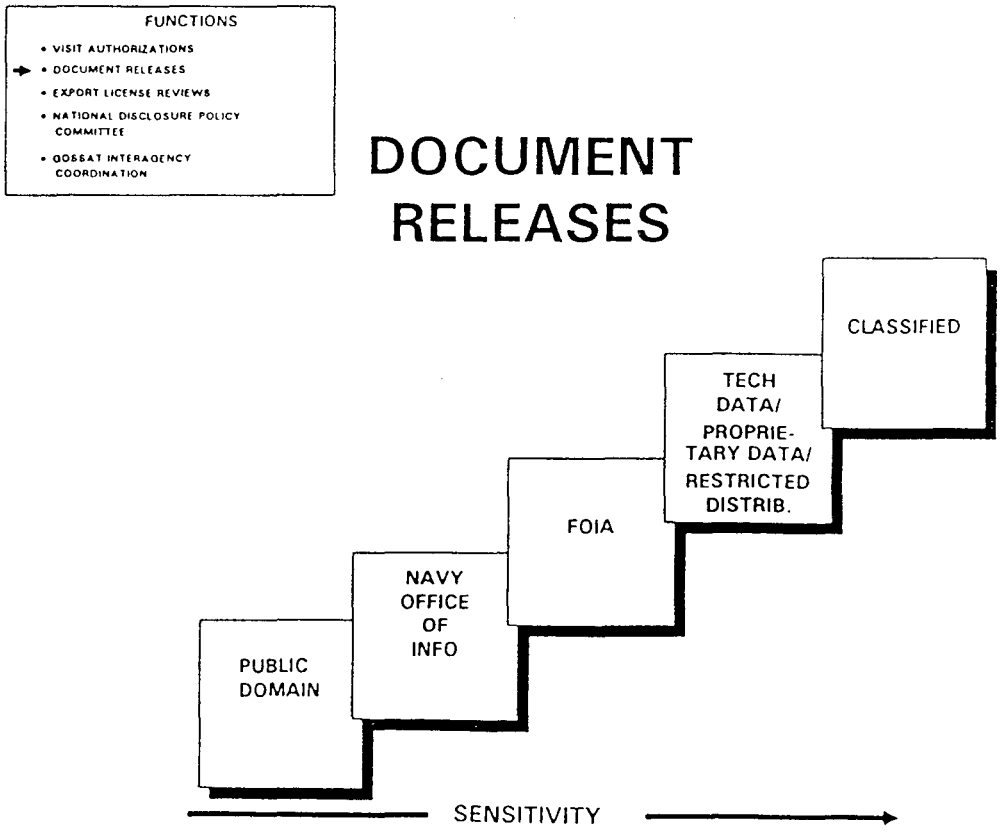
Tony DiTrapani heads the International Program Office (IPO). By design, to assure balance and improve communications and coordination, IPO deals with both cooperationist and protectionist aspects of Navy's international activities. Two staff elements -- IPO-02 which oversees our security assistance program and handles foreign military sales, and IPO-03 which manages information exchange agreements, reviews foreign comparative testing, and evaluates acquisition of foreign items -- deal strictly with our allies and often are as much in the marketing or bartering business as anything else.

IPO-01, on the other hand, is the protectionist side of our house. They are responsible for foreign disclosure and technology transfer control. Basically, they prepare Navy decisions on which classified and unclassified information, equipment, and technology we believe it is or isn't in the U.S. interest to disclose or release to various foreign governments, international organizations (e.g., NATO), and foreign firms. Until recently, of course, the Soviets and Warsaw Pact were totally excluded. The ocean science community has interacted with this staff on issues such as classification of high resolution bathymetry data, and the conditions under which the Soviets can participate in the Ocean Drilling Program.

Navy IPO functions pertaining to the Soviets include visit authorizations, document releases, export license application reviews, the National Disclosure Policy Committee, and Working Group On Soviet Science and Technology (GOSSAT) interagency coordination. Let me briefly deal with each of these.

Visit Authorizations: Visit requests from the Soviet government are forwarded via the Washington Embassy to the State Department for visas. State checks the appropriateness of the visa and area clearance requests with other interested agencies. The Defense Investigative Service (DIS) coordinates approval of information disclosures with host military departments, and Navy IPO gets involved in authorizing disclosures of Navy information, and visits to Navy facilities or Navy contractors. Historically, there have been almost no Soviet visits. Recently we have had requests from dozens of academicians. All have involved unclassified, oral/visual disclosures. Navy does not have the authority to disclose classified information to Soviets, but if we believed it to be justified, could seek a special exception from the National Disclosure Policy Committee.

Document Releases: The figure displays the range of information we must consider.



Across the spectrum of Navy Department information we have:

- Unclassified information in the public domain (libraries, subscriptions to publications, etc.)
- Unclassified information readily available to the Soviets through the Navy Office of Information
- Unclassified information which may be releasable to requestors, including the Soviets, under the Freedom Of Information Act (FOIA)
- Unclassified technical documents carrying limited distribution statements subject to export control criteria and usually limited to U.S. government agencies, or for "Official Use Only")
- Classified information

Navy IPO is primarily responsible for documents that fall into the last two categories. Although none have yet been received, the Soviet Embassy could request such documents according to the procedures outlined in "Guide for naval attaches accredited to the Department of the Navy" just as any foreign government can request controlled Navy documents.

We are generally aware that the Soviet government has historically taken full advantage of various means of obtaining U.S. government information available to the public sector.

Export License Reviews: Navy IPO is responsible for advising on, and implementing COCOM restrictions. COCOM stands for the Coordinating Committee for International Technology Transfer. Its members are the NATO member nations (except Iceland), plus Japan and Australia. Recognizing that it makes little sense for some "western" allies (most highly industrialized nations) to embargo certain strategically valuable technologies while others export the same technologies to the USSR and "proscribed destinations", the COCOM members have agreed to maintain comparable export control to the proscribed destinations.

Currently (10-29-91), the "proscribed destinations" are:

Albania	Mongolia	USSR
Bulgaria	North Korea	Vietnam
China	Romania	

Poland, Czechoslovakia and Hungary recently were placed in "special status" pending probable removal from the list. The outcome depends on the effectiveness of their export

The recent trend has been to have "higher fences around fewer items", i.e., better enforcement by COCOM member nations of export controls covering only the most sensitive technologies.

There are three COCOM lists: A Core List, previously called the "Industrial" List, which includes "dual-use" items, i.e. those with both civilian and military applications. This list has recently been reduced from 120 to 90 items, arranged for better understanding into nine categories (electronics; advanced materials; materials processing; telecommunications; sensors, sensor equipment, and lasers; navigation and avionics systems; marine technology; computers; and propulsion systems). The second list is the Munitions List, which deals principally with military items. The third is the Atomic Energy List.

The U.S. also has parallel national lists, more restrictive and containing additional items (although there is continuing effort to rationalize our lists with those of COCOM). These are the Commodity Control List (CCL) for dual-use items, the Munitions List for military and defense items, and the Nuclear Referral List. The first two are very important to the ocean science community.

First, it is important to understand that the term "proscribed destination" means just that, and includes proscriptions on exposure of the listed technologies to citizens of the proscribed states. Second, "technology" means not only equipment, but information and technical services which are considered "items" on the list. Further, for dual-use items, performance thresholds are specified beyond which the item has military utility. Finally, "export" means any access.

CCL items are licensed by the Commerce Department. An example of one of interest to this community, from section 6A01a, is wide-swath bathymetric survey systems for seabed mapping. Swath mapping systems are controlled if they:

- Take measurements at an angle exceeding 10 degrees from the vertical and exceeding 600 meters below the water surface, and

- Incorporate multiple beams any of which is less than 2 degrees or to provide data accuracies of better than 0.5 percent of water depth across the swath averaged over the individual measurements within the swath.

Effectively, this means that Soviets and foreign nationals from other proscribed states may not be exposed to such equipment or information about it, without an export license. By the letter of the law, then, an export license would still be required before foreign nationals could be embarked on U.S. research vessels carrying and using such equipment. The control levels above are such, however, that all currently available systems on the commercial market are decontrolled and therefore require no license.

Items on the Munitions List are licensed for export by the State Department. These are military items to which access by nations on the proscribed list must be denied, and access to any nation requires a license. Again, when oceanographers are involved in working with non-U.S. scientists, caution is necessary. An example of items on this list from Category XI, Military and Space Electronics, is: Electronic equipment with military designation or specially designed, modified, or configured for military application, or commerce equipment having very sensitive military applications. The category includes, but is not limited to, underwater equipment, towed arrays, electronic beamforming sonar, sonic depth finders, electro-mechanical beamforming sonics, navigation, and object locating equipment.

In addition to those lists, DOD maintains a Militarily Critical Technologies List (MCTL) which is a reference list for use by the export licensing reviews. Basically it is a catalog of critical embedded technologies, that helps us identify alternate applications for the same technology, for example a license application may indicate that the intended use is medical when in fact the item is of intrinsic military utility. There are both classified and unclassified versions of the MCTL.

National Disclosure Policy Committee: The NDPC was established by the President in 1971. It is jointly controlled by the Secretaries of State and Defense, and comprise members of defense and non-defense agencies that produce classified information.

It sets maximum limits for classified disclosures to foreign governments and international organizations, including our allies and NATO. Classified information can be disclosed to Soviets only by NDPC exception, of which there has not yet been any.

GOSSAT: This Working Group on Soviet S&T operates under, and in accordance with, interagency procedures established by the National Security Council Policy Coordinating Committee on "International Oceans, Environment, and Science Affairs". There is a similar group called GEESAT that deals with east European former Warsaw Pact countries.

Basically, the GOSSAT procedures call for interagency review of all proposed U.S. government agency S&T cooperation with the Soviets.

For example, if NOAA proposed a joint weather satellite monitoring project, or NIH proposed joint work on bone reconstruction, it would receive GOSSAT review. NSF forwards proposals involving work with the Soviets for GOSSAT review. The vast majority of GOSSAT proposals represent either basic R&D or applied R&D which is not militarily sensitive. Examples include: mathematics, basic physics, health and medicine, agricultural research. Some areas of ocean science become sensitive based upon the access to physical sites, or access to processing facilities or supercomputers.

Navy IPO coordinates Navy Department reviews of the GOSSAT proposals which are circulated for interagency review upon submission by other government agencies. Navy IPO attends GOSSAT meetings and provides Navy representation.

In conclusion, Navy IPO is the vehicle for Navy input to the federal decision making process regarding technology transfer and interaction with the Soviets. It's important for ocean science institutions to understand the licensing and restriction procedures, and we are available to provide advice and assistance.

APPENDIX G

GOSSAT AND GEESAT PROCESSES

FOR THE WORKSHOP ON
U.S. STRATEGIES FOR COOPERATION
WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

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GOSSAT AND GEESAT PROCESSES

William Erb

The GOSSAT and GEESAT processes are coordinated by the State Department's Office of Cooperative Science and Technology Programs in the Bureau of Oceans and International Environmental and Scientific Affairs. The Office is responsible for coordinating interagency review of science or science and technology agreements and activities with Warsaw-Pact countries, in consultation with other appropriate offices in the Bureau. The GOSSAT (Working Group on Soviet Science and Technology) Committee reviews proposed cooperative science or science and technology agreements and activities with the Soviet Union and the GEESAT (Working Group on Eastern European Science and Technology) Committee is responsible for reviewing all proposed agreements and activities with other Warsaw-Pact countries.

U.S. policy seeks to encourage mutually beneficial, cost-effective science and technology cooperation with Warsaw-Pact countries consistent with U.S. national security interests. These procedures are established to govern all science or science-related agreements and activities with Warsaw Pact countries. They are designed to ensure that this cooperation will advance the national and international objectives of the United States and that such cooperation is consistent with U.S. law and Administration policies in the areas of science and technology, technology transfer and management, national security, budget, U.S. trade, commercial linkages, and competitiveness (including intellectual property), scientific merit, and equity of access. For these reasons, these agreements and activities will be reviewed in a distinct interagency process to ensure that these concerns are addressed and that such agreements and activities protect and advance U.S. interests. This process will involve both technical and policy-level review of proposed agreements and activities.

Interagency Review of Agreements

U.S. Government agencies proposing to undertake cooperative science or science and technology agreements with counterpart agencies, organizations or institutions in Warsaw-Pact countries must consult with the Department of State prior to entering into negotiations. This prior consultation requirement applies to extensions, renewals and modifications of existing agreements, as well as to new agreements. Some cooperative science or science and technology agreements with Warsaw-Pact countries automatically renew under their terms unless either Party notifies the other of termination or its intent to terminate within a specified period prior to the renewal date. With respect to such agreements, the agency which serves as executive agent or lead agency must consult with the Department of State at least six months prior to the date by which notification of termination or intent to terminate must be given to allow sufficient time for appropriate interagency review of the agreement and to identify any changes that the United States may wish to propose.

Agencies wishing to negotiate or conlcude a cooperative science or science and technology agreement must transmit to the Department of State a draft text or summary of the proposed agreement, normally 45 days prior to beginning negotiations. On receipt of the transmittal the Department initiates the review procedure. The Subcommittee on Exchanges (COMEX) of the Technology Transfer Intelligence Committee (TTIC) is asked to review proposed agreements with Warsaw-Pact countries. Also under the review procedure, all members of GOSSAT are asked to review proposed agreements with the Soviet Union, and all members of GEESAT are asked to review proposed agreements with other Warsaw-Pact countries. Reviewers consulted in the Circular 175 Procedure must provide their written views to the Department of State within two weeks of receipt of the proposal. In the absence of written comments within the deadline specified, reviewers will be presumed to have no objection to the proposed agreement. All reviewing agencies are encouraged to work directly with the proposing agency to resolve questions or concerns.

Interagency Review of Cooperative Activities

U.S. Government agencies proposing to undertake specific cooperative activities, whether or not under existing or proposed science or science and technology agreements, with counterpart agencies, organizations or institutions in Warsaw-Pact countries must submit proposals for such activities to the Department of State for interagency review under these procedures. All proposals must be reviewed and approved in this process before U.S. representatives may negotiate them with counterparts in Warsaw-Pact countries on behalf of the U.S. Government.

All agency proposals for specific cooperative activities must be reviewed by the Subcommittee on Exchanges of the Technology Transfer Intelligence Committee (TTIC/COMEX). All other members of the GOSSAT (in the case of the Soviet Union) and the GEESAT (in the case of other Warsaw-Pact countries) must be notified of agency proposals for specific cooperative activities with Warsaw-Pact countries and be provided with an opportunity to review them. For purposes of this section, "specific cooperative activities" means specific programs of activities or projects proposed for approval and significant changes in programs or projects previously reviewed and approved.

Within the Department of State the Office of Soviet Union Affairs (EUR/SOV), Bureau of European and Canadian Affairs, is responsible for coordination of interagency review of proposals for specific cooperative activities with Soviet agencies, organizations and institutions. The Office of Cooperative Science and Technology Programs (OES/SCT) is responsible for coordinating interagency reviews of such proposals involving other Warsaw-Pact countries. Normally, the agency which serves as U.S. executive agent under an agreement is responsible for coordinating development of the package of proposals for cooperative activities. Proposing agencies will, to the extent possible, identify in their written proposals specific equipment to be used and specify what access to such equipment will be needed.

The executive agent, lead or proposing agency is responsible for submitting proposals for specific cooperative activities to the Department of State (EUR/SOV in the case of the Soviet Union; OES/SCT in the case of other Warsaw-Pact countries). Each submission

must be accompanied by an abstract. The Department of State initiates interagency review, forwarding the full proposal or package of proposals to TTIC/COMEX. The Department of State simultaneously forwards the abstracts of all proposals to all members of the GOSSAT (in the case of the Soviet Union) and all members of the GEESAT (in the case of other Warsaw-Pact countries) requesting notification within two weeks of any abstract with respect to which any member wishes to review the full proposal. Reviewers must submit their written views to the Department of State within six weeks of receipt of the full proposal or package of proposals.

The Department of State will provide the proposing agency with the written views received from TTIC/COMEX and all other GOSSAT or GEESAT members within one week of the deadline for submission of written views and will ensure interagency review for any unresolved issues. The Department of State will maintain a permanent file of the written views of TTIC/COMEX and all other GOSSAT and GEESAT members. In the absence of written views within the deadline specified, reviewers will be presumed to have no objection. When there is no disagreement among agencies, further interagency review normally will not take place, and implementation of the specific cooperative activities may proceed. U.S. representatives to all meetings of joint commissions and joint committees must operate on the basis of written instructions that incorporate such written stipulations.

Revision of Procedures

In light of significant political, economic, and military changes occurring in Poland, Czechoslovakia, and Hungary, the Policy Coordinating Committee on International Oceans, Environment, and Science Affairs (OES/PCC) reviewed the Procedures in September 1991.

Based on the OES/PCC recommendations, the following guidance is provided:

-- The Procedures continue to apply to Poland, Czechoslovakia, and Hungary for six months with the expectation that the requirement for mandatory review of S&T activities with these three countries may no longer be necessary at that time.

-- For Poland, Hungary, and Czechoslovakia, the Procedures are modified as follows: the interagency review period for proposed, new S&T activities is reduced from six to three weeks; the number of agencies normally reviewing such proposals is reduced to a Review Group consisting of the Departments of State, Defense and Justice and OMB, OSTP, and the Committee on Exchanges; and proposing agencies may submit alternative documentation deemed adequate by the Review Group.

-- The Procedures shall be renamed "Procedures for Interagency Review of Cooperative Science or Science and Technology Agreements and Activities with Central and East European Countries and the Soviet Union".

APPENDIX H

COCOM SENSITIVE TECHNOLOGIES

FOR THE WORKSHOP ON
U.S. STRATEGIES FOR COOPERATION
WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

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COCOM SENSITIVE TECHNOLOGIES

M. Urbina

It is a great pleasure to participate in this year's Woods Hole Workshop.

CDT

The Department of State has placed its arms export control authority at the Center for Defense Trade in the Bureau of Politico-Military Affairs. The Center for Defense Trade in the Bureau of Politico-Military Affairs was created in January, 1990 and charged with four primary missions:

1. speed up the licensing review process;
2. reduce the number of licenses required for export;
3. shorten the U.S. Munitions List and rationalize it with the COCOM International Munitions List; and
4. facilitate and support U.S. contractor's efforts to compete and cooperate overseas.

The Center is composed of the Office of Defense Trade Controls, which carries out munitions export licensing, and the Office of Defense Trade Policy, which provides defense trade policy guidelines for the U.S. defense industry and within the State Department.

CONCEPT OF EXPORT CONTROL

Strategic technologies control is a complex intra- and intergovernmental process, involving academia and industry, undertaken by the United States and its COCOM allies to minimize the transfer of military critical western technology to the USSR, and other proscribed destinations, while promoting technological cooperation among the allies.

The process includes the identification of critical technologies, international negotiations leading to a multilateral agreement on technologies to be controlled, the formulation of effective policies and procedures to implement these controls, and the licensing of products and technologies based on these policies and procedures.

ABOUT COCOM

COCOM stands for the Coordinating Committee for Multilateral Strategic Export Controls. It is an intergovernmental coordinating body for the multilateral control of strategic commodities and technology which might be used to strengthen the military potential of the proscribed countries. COCOM is based in Paris and has been in existence since 1950.

COCOM member countries are (17): Belgium (Luxembourg), France, Italy, Netherlands, United Kingdom, United States, Canada, Denmark, Federal Republic of Germany, Norway, Portugal, Japan, Greece, Turkey, Spain and Australia.

COCOM maintains three lists of items, which are embargoed for west-to-east trade:

(1) International Industrial List (IIL). The IIL is also known as the dual-use list, which embargoes products and technologies that have both civilian and military applications. The new IIL was implemented on September 1, 1991;

(2) International Munitions List (IML). The IML embargoes weapon systems and their related technologies to which foreign availability is not a consideration for deletion; and

(3) International Atomic Energy List (IAEL). The IAEL includes commodities and technologies related to nuclear power generation and production of fissile materials. A regular list review of both the IAEL and IML is underway in COCOM.

The COCOM IIL is the basis for U.S. government controls of dual-use strategic commodities and technologies controls, administered by the Department of Commerce via the Commodities Control List (CCL) (certain items, however, fall under State jurisdiction because of an item's inherent military characteristics). The COCOM Munition List is the basis for part of the controls administered by the Department of State. This is logical since the State Department is presidentially mandated to control the export and import of defense articles and defense services. By definition an item or service which is inherently military falls under State jurisdiction. Exports which are not subject to the controls of the State Department are generally under the regulatory jurisdiction of the Department of Commerce.

RECENT SIGNIFICANT CHANGES IN COCOM

On 2 May 1990, President Bush announced that he was recommending to COCOM that significant changes be made in the list of technologies subject to export control. The President's action was in response to the changes that had occurred in eastern Europe and the Soviet Union. The President proposed that of the 120 categories of COCOM's Industrial List, 30 be eliminated or modified completely (done in May) and the scope of another 13 be reduced substantially. This major redirection resulted in the complete overhaul of the COCOM Industrial List -- also referred to as the "Core List".

The new "Core List" is over 50 percent shorter than the old COCOM Industrial List that it replaces. What's left under controls are items and technologies considered essential for export control in light of present day political, economic and military circumstances.

Reorganization of the controls in this area makes the controls more logical and easier to enforce.

This list of items is organized into nine categories: (1) advanced materials, (2) materials processing, (3) electronics, (4) computers, (5) telecommunications and "information security", (6) sensors and lasers, (7) navigation and avionics, (8) marine, (9) propulsion.

I will now briefly go over several changes in export controls of significant importance to you, both in terms of technical content and revised format: [NOTE: I would characterize the COCOM changes as being very beneficial to the academic/research community because COCOM did make some significant relaxations].

FIRST THE GOOD NEWS:

IN THE AREA OF MARINE ACOUSTIC SYSTEMS [Category 6]:

-- Of significant importance to your community, COCOM decontrolled most commercial models of SEABEAMS [referred in COCOM as wide-swath bathymetric survey systems for seabed topographic mapping (6AO1a)] and similar systems manufactured by German and Finnish firms. This is a major relaxation.

-- COCOM also greatly reduced controls on side-scan sonars [Object Detection or Location Systems (6A1a1b)], including certain systems that go below 1000 meters.

-- There was some relaxation in the controls of towed acoustic hydrophone arrays (6A1a2b) which operate above 35 meters water depth.

-- COCOM added several items under control which may have some effects on your research. For example, correlation-velocity sonar log equipment designed to measure the horizontal speed of the equipment carrier relative to the seabed at distances between the carrier and the seabed exceeding 500m (certainly, not all are caught by COCOM!).

-- In the area of submersibles [Catergory 8], COCOM relaxed some controls and reformatted the submersibles entry. [Combined in this entry are: submergence vehicles; manned underwater autonomous vehicles and submersible salvage systems.]

-- The most important changes vis-a-vis previous embargo limits are that certain towed sleds (A1C) and certain unmanned, tethered vehicles capable of

operating below 1000 meters (A1D) are controlled only if they are equipped with other controlled equipment such as sonars, etc.

-- Previous controls of submersibles have been replaced by better parameters. Submersibles are now divided into four new categories, each with their own set of parameters. The four new categories are: manned, tethered; manned, untethered; unmanned, tethered; unmanned, untethered.

-- As you may be aware, COCOM embargoes numerous marine-related assemblies and components. For example, COCOM embargoes remotely articulated manipulators, underwater vision systems (cameras), photographic cameras and lights.

-- In this important area, COCOM released virtually all commercial cameras and lights and only added two important new controls on low light cameras. [COCOM liberalized some underwater vision systems, e.g., low light T.V. systems and photographic still-cameras (Nikons).]

-- COCOM decontrolled atmosphere regeneration systems.

-- Under the material section, COCOM relaxed control on syntactic foam designed for operating at less than 1000 meters and decontrolled microspheres used in the production of foam.

AND NOW THE OTHER NEWS:

-- COCOM specified controls on low-light level T.V. cameras and C.C.D. cameras.

-- Of limited interest, under the section controlling assemblies and components, COCOM maintained control of automated navigation equipment and air-independent propulsion systems.

-- COCOM controls fiber optic hull penetrators and connectors at all depths.

-- With regards to underwater communication systems, the controls in COCOM remain the same as the previous COCOM entry known as IL 1502. However, the entry is less confusing as it has been re-written as a positive embargo statement.

-- Highly skewed propellors are not embargoed. However, software and technology controls were added for the development, production, repair, overhaul, and refurbishment of such propellors.

-- COCOM continues to control active noise reduction systems including magnetic bearings.

-- Water tunnels designed for measuring acoustic fields within strategic parameter limits are controlled by COCOM.

-- We also made minor but significant changes in the areas of magnetometers and gravimeters, including those that incorporate SQUIDS.

-- It is also very important to note that both software and technology are controlled by COCOM. The general software note states that COCOM controls software specially designed or modified for the development, production or use of equipment embargoed under the marine and sensor categories. The general technology note controls all technology for the development and production of all equipment and material embargoed in all the COCOM categories.

CONCLUSION

As noted in my brief presentation, there have been substantial relaxation of COCOM controls in all categories, including Sensor and Marine. The U.S. and our COCOM partners have undertaken a substantial liberalization in the controls and procedures for licensing exports to the Soviet Union for civil uses of items remaining under control. Given these changes, COCOM's system of multilateral export controls should not be an impediment in furthering cooperative ventures between the U.S. and the USSR. In some instances, certain projects may require restrictions and in others it may not. It is clear that the trend is for greater U.S.-Soviet cooperation. On the other hand, it is important to note that there are significant strategic national security concerns with the proliferation of certain items and technologies. If in doubt, on whether an item needs a license, do not be afraid to talk to us. We are very committed to work with you in the new initiatives.

APPENDIX I

MILITARY SENSITIVITIES AND CONCERNS

FOR THE WORKSHOP ON
U.S. STRATEGIES FOR COOPERATION
WITH THE SOVIETS ON OCEAN SCIENCE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASSACHUSETTS
OCTOBER 29-31, 1991

RADM W. Jordan
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MILITARY SENSITIVITIES AND CONCERNS

RADM Wesley Jordan

You have heard Mr. Haver talk about the changing world situation, and how the Soviet Union appears to be both more peaceful and more unstable. Dr. Cameron has discussed some of the Navy's policies and procedures for fostering international cooperation within constraints that avoid threatening our Navy fleet or our country's security.

I am the Director of Antisubmarine Warfare on the staff of the Chief of Naval Operations, and I would like to share with you -- as much as is possible in an unclassified forum -- why we need to impose limits on cooperation with the Soviets. I'll focus on potential areas of joint ocean research and why the possible military applications raise concerns for the Navy.

To start with the broadest perspective, the oceans are the operating environment of our fleet -- the submarines, surface combatant ships and the "carriers" of our naval aircraft. The oceans hide the Navy's TRIDENT Ballistic Missle Submarines, a warfighting force so potent that its existence helped through decades of cold war to keep the peace. The oceans are the environment in which we develop and exercise our capabilities in submarine and antisubmarine warfare, surface warfare, naval aviation strike warfare, and shallow water amphibious warfare, mine warfare and mine countermeasures. We've learned a lot over the last few decades about how much an improved understanding of the ocean environment can affect our offensive and defensive capabilities in all of these areas.

I expect all of you have some awareness of the impact of ocean fronts and eddies on the propagation of sound underwater -- and how knowledge of these features can improve the hiding or hunting of submarines. Atmospheric conditions at the air/sea interface affect electromagnetic propagation and thus radar performance, and this is considered in planning for air operations and for anti-aircraft defense aboard our ships. The hunting and clearing of mines depend very heavily on a range of characteristics of the sea floor and water column -- softness, topography, and acoustic reflectivity of the bottom, magnetics, water temperature, salinity, and conductivity.

We in the Navy are always concerned about any exports or cooperative programs with potential adversaries that could significantly enhance their military capabilities. The Soviet Union, in particular, has in the past been quite organized in transferring western know-how and technologies from civil applications to their military operations and weapons development.

Let me give you some examples of specific ocean research-related technologies that can raise Navy concerns:

o Multi-channel seismic towed arrays and their associated data processing equipment are not greatly different from the towed array systems used by warships and submarines. We have enjoyed a great lead over the Soviets in this technology which has enabled us to maintain superiority in the area of antisubmarine warfare. However, if the Soviets were to close the gap in the area of towed array development and utilization, the security of our operating submarines would decrease.

o Underwater acoustic research is an especially sensitive area because of its applications to antisubmarine warfare. The increasingly quiet modern submarines require a greater focus on acoustic understanding of the ocean environment. Volume scattering and reverberation data, across a wide range of frequencies, affect the design and operation of military sonar systems. Sea floor characteristics also affect sonar performance, especially in shallow water areas, as do ambient noise from waves, rain, and biologic activity. Even some of the on-going global change research, such as tomography experiments, have potential applications for military acoustic equipment.

o Some side-scan sonars having numerous civil and scientific applications also have direct military applications. The imagery that side-scan sonars collect can be used for mine placement and detection, an area of warfare whose importance is becoming more evident following the recent Gulf conflict. In addition, side-scan sonars could be used to detect objects on the sea floor (for example a downed aircraft), which can then be destroyed, retrieved, or otherwise tampered with.

o Sophisticated computers and data-processing software are vital to the performance of today's high technology weapons. For forty years, our nation's military doctrine has centered around the theme of "quality over quantity". Quality people and equipment -- the technology edge -- becomes even more important as we downsize our armed forces. The key to our advantage across a wide range of military systems is our data processing capability. Not only are we concerned about the actual sales of computers, but the experience gained in operating and programming U.S. manufactured computers would close the technological gap that presently separates the U.S. and Soviet military capability. We must maintain our lead in computers if we are to fulfill our mission as a Navy while we continue to decrease in size.

o Another example of technology transfer that is not specifically ocean research related, but had significant impact on the nation's defense was the illegal transfer of restricted numerical controlled multiaxis milling machines to the Soviets by a Norwegian company (Kongsberg Vaapenfabrikk) and Toshiba Machine Company. The machines allow the manufacture of sophisticated very quiet submarine propellors. Combined with other Soviet submarine quieting efforts, these new propellors make the newer classes of Soviet submarines a significantly more difficult adversary.

o Numerous other technologies allow man to operate effectively at great depths in the ocean. These technologies include manned and unmanned submersibles, ocean salvage systems, underwater fiber optics, syntactic foam, underwater cameras, and imaging equipment. These equipments are widely employed for commercial and scientific uses but also have direct military applications. Navy reviews export licenses and cooperative research proposals involving such technologies carefully to limit Soviet access to certain levels of capability.

I am aware of the argument that keeping our technology edge requires that we keep our research community active and healthy. But in international scientific cooperation -- especially with non-allied nations -- the scientific benefits must be balanced against the potential military risks.

We have a number of Navy personnel here who are familiar with the military sensitivities surrounding ocean research, and we appreciate the opportunity to work with you in mapping out a strategy for U.S./Soviet ocean science cooperation that includes a consideration of the military concerns.

APPENDIX J

AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA
AND
THE GOVERNMENT OF THE UNION OF SOVIET SOCIALIST REPUBLICS
ON COOPERATION IN OCEAN STUDIES

The Government of the United States of America and the Government of the Union of Soviet Socialist Republics (hereinafter referred to as "the Parties");

Recognizing the importance of comprehensive studies of the oceans of the world for peaceful purposes and for the well-being of mankind;

Striving for more complete knowledge and rational utilization of the oceans of the world by all nations through broad international cooperation, in oceanographic investigations and research;

Aware of the capabilities and resources of both countries for studies of the oceans of the world and the extensive history and successful results of previous cooperation between them;

Desiring to combine their efforts in the further investigation of the oceans of the world and to use the results for the benefit of the peoples of both countries and of all mankind;

Noting the General Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Contacts, Exchanges and Cooperation in Scientific, Technical, Educational, Cultural and Other Fields, signed November 21, 1985; the Agreement on Cooperation in the Field of Environmental Protection, signed May 23, 1972; and the Agreement on Cooperation in the Field of Basic Scientific Research, signed January 8, 1989; and

Desiring to continue the cooperation carried out under the Agreement of Cooperation in Studies of the World Ocean, signed June 19, 1973

Have agreed as follows:

ARTICLE 1

1. The Parties will develop and carry out cooperation in ocean studies on the basis of equality, overall reciprocity and mutual benefit.

2. All cooperation under this Agreement will be subject to approval of the Parties and to the national laws, regulations, and international obligations of each country, as well as the availability of appropriated funds and personnel.

ARTICLE 2

1. In their ocean studies, the Parties will direct cooperative efforts to the investigation of important and mutually agreed scientific topics.

2. Cooperative efforts may be considered in the areas of: (a) physical oceanography; (b) chemical and biological oceanography; (c) geological, geophysical and geochemical investigations of oceans; (d) biological productivity and the functioning of oceanic biological communities; and (e) marine meteorology.

3. Projects of initial cooperation are set forth in Annex I, which constitutes an integral part of the Agreement. Other projects may be added by mutual agreement of the Parties.

ARTICLE 3

1. Cooperation provided for in the preceding articles may take the following forms:

    a. Cooperative scientific research projects, including field studies; the exchange of participating scientists, specialists, and researchers; and the exchange and joint publication of their results;

    b. Joint scientific conferences, symposia, and workshops;

    c. Exchange of scientific information and documentation;

    d. Appropriate participation by both countries in multilateral cooperative activities sponsored by international scientific organizations;

    e. Facilitation by both Parties of use of appropriate port facilities of the two countries for ships' services and supplies, including provision for rest and changes of ships' personnel, in connection with carrying out cooperative activities.

2. Other forms of cooperation may be added by mutual agreement of the Parties.

ARTICLE 4

1. Cooperation in ocean studies under this Agreement will be within the framework of jointly approved projects and programs and in accordance with written arrangements for their implementation.

2. The Parties will ensure, in accordance with agreed cooperative activity, that access to institutes, scientists and other specialists participating in joint cooperative activity under this Agreement, and to scientific data, will be made available on an equal, reciprocal and mutually beneficial basis.

ARTICLE 5

1. The implementation of this Agreement will be carried out by a U.S.-USSR Joint Committee on Cooperation in Ocean Studies. This Joint Committee shall meet, as a rule, once a year, alternatively in the United States and the Soviet Union, unless otherwise mutually agreed.

2. The Joint Committee shall take such action as is necessary for effective implementation of this Agreement, including, but not limited to, approval of specific projects and programs of cooperation; designation of agencies and organizations to be responsible for carrying out cooperative activities; and making recommendations, as appropriate, to the Parties.

3. Each Party shall have an Executive Agent to assist the Joint Committee. The Executive Agent of the United States of America will be the National Oceanic and Atmospheric Administration (NOAA), a constituent agency of the U.S. Department of Commerce. The Executive Agent of the Union of Soviet Socialist Republics will be the USSR State Committee for Science and Technology (GKNT).

4. The Executive Agents of the Parties will be responsible for carrying out this Agreement during the period between meetings of the Joint Committee. The Executive Agents will maintain contact with each other; keep each other informed of activities and progress in implementing this Agreement; and coordinate and supervise the development and implementation of cooperative activities conducted under this Agreement.

ARTICLE 6

Nothing in this Agreement will be interpreted to prejudice other agreements between the Parties or commitments of either Party to other international oceanographic programs.

ARTICLE 7

Each Party, with the consent of the other Party, may invite third countries to participate in cooperative activities engaged in under this Agreement. Such participation will be consistent with the provisions of this Agreement.

ARTICLE 8

Protection of intellectual property and rights thereto shall be as set forth in Annex II, which constitutes an integral part of this Agreement.

ARTICLE 9

1. This Agreement will enter into force upon signature by both Parties and will remain in force for five years. It may be modified or extended by written agreement of the Parties.

2. Cooperative activities being conducted when the effective period of this Agreement ends will, unless terminated by either Party, be continued to their conclusion in accordance with the terms of this Agreement.

3. Either Party has the right to terminate this Agreement on six months' written notice to the other Party.

4. Upon entry into force, this Agreement shall supersede the 1973 U.S.-USSR Agreement on Cooperation in Studies of the World Ocean, as amended and extended.

IN WITNESS WHEREOF, the undersigned, being duly authorized by their respective Governments, have signed this Agreement.

DONE at Washington, this First day of June 1990, in duplicate in the English and Russian languages, both texts being equally authentic.

James A. Baker, III

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA

Eduard Shevardnadze

FOR THE GOVERNMENT OF THE UNION OF SOVIET SOCIALIST REPUBLICS

ANNEX I

TO THE AGREEMENT BETWEEN

THE GOVERNMENT OF THE UNITED STATES OF AMERICA

AND

THE GOVERNMENT OF THE UNION OF SOVIET SOCIALIST REPUBLICS

ON COOPERATION IN OCEAN STUDIES

Cooperation under this Agreement will initially be implemented in the following projects:

a. Southern Ocean Dynamics

b. Mid-Atlantic Ridge Crest Processes

c. Geochemistry of Marine Sediments

d. Arctic Erosional Processes with Special Attention to Gas Hydrates

ANNEX I

TO THE AGREEMENT BETWEEN

THE GOVERNMENT OF THE UNITED STATES OF AMERICA

AND

THE GOVERNMENT OF THE UNION OF SOVIET SOCIALIST REPUBLICS

ON COOPERATION IN OCEAN STUDIES

Pursuant to Article 8 of this Agreement:

I. GENERAL

A. For purposes of this Agreement, "intellectual property" is understood to have the meaning found in Article 2 of the Convention Establishing the World Intellectual Property Organization, done at Stockholm July 14, 1967.

B. The Parties shall ensure adequate and effective protection for intellectual property created or furnished under this Agreement.

II. COPYRIGHTS

The Parties shall take appropriate steps to secure copyright to works created under this Agreement in accordance with their respective national laws, except as otherwise specifically agreed. The following provisions shall apply to copyright protection for works created under this Agreement:

1. Except as otherwise agreed, each Party is entitled to a nonexclusive, irrevocable, royalty-free license under a copyright, secured in accordance with the national laws of either Party, to translate, reproduce, publish, and distribute published scientific, technical, and medical works in its own territory, with the right to grant sublicenses in this territory in accordance with this Party's laws and practices. Any such copyrighted work shall indicate the names of all persons who participated in the joint work. Either Party is entitled to a license in third countries upon request.

2. Rights to other copyrighted works (such as computer software) shall be allocated in Article III, Paragraphs B - E of this Annex. A Party receiving rights pursuant to this provision to copyrighted works which embody business-confidential information shall protect such information in accordance with Article IV of this Annex.

III. INVENTIONS

A. For purposes of this Annex, "invention" means any invention made in the course of cooperation under this Agreement which is or may be patentable or otherwise protectable under the laws of the United States of America, the Union of Soviet Socialist Republics, or any third country. An invention "made" means one conceived or for which an application for patent or other title of protection has been filed or which has otherwise been reduced to practice.

B. Between a Party and its nationals, the ownership of rights and interests in inventions will be determined in accordance with that Party's national laws and practices.

C. As between the Parties, unless otherwise specifically agreed, the Parties shall take appropriate steps to implement the following:

1. If the invention is made in the course of a program of cooperative activity that involves only the transfer or exchange of information between the Parties, such as by joint meetings, seminars, or the exchange of technical reports or papers, unless otherwise specifically agreed:

   a. The Party whose personnel make the invention ("the Inventing Party") has the right to obtain all rights and interests in the invention in all countries in accordance with applicable national laws of such countries;

   b. In any country where the Inventing Party decides not to obtain such rights and interests, the other Party has the right to do so.

2. If the invention is made by personnel of one Party ("the Assigning Party") while assigned to the other Party ("the Receiving Party") in the course of a program of cooperative activity that involves only the visit or exchange of scientific and technical personnel:

a. The Receiving Party has the right to obtain all rights and interests in the invention in all countries in accordance with applicable national laws of such countries;

b. In any country where the Receiving Party decides not to obtain such rights and interests, the Assigning Party has the right to do so.

D. For other forms of cooperation, such as joint research projects with an agreed scope of work, each Party has the right to obtain all rights and interests in its own country in any invention made as a result of such cooperation, whereas the Party in whose country the invention was made has first option to secure legal protection of that invention in third countries, as well as the right to license or transfer such rights and interests in third countries. However, if the Parties agree that the application of this paragraph to a particular cooperative activity would lead to an inequitable result, they shall agree to an equitable allocation of rights with respect to that activity.

E. Notwithstanding the foregoing, if an invention is of a type for which exclusive rights are available under the laws of the Party but not of the other Party, the Party whose laws provide for exclusive rights shall be entitled to all rights in all countries which provide rights to such invention. The Parties may agree, however, to a different allocation of rights to such invention.

F. The Parties shall disclose to one another inventions made in the course of programs of cooperative activities and furnish to one another any documentation and information necessary to enable them to secure any rights to which they may be entitled. The Parties may ask one another in writing to delay publication or public disclosure of such documentation or information for the purpose of protecting their respective rights related to inventions. Unless otherwise agreed in writing, such restriction shall not exceed a period of six months from the date of communication of such information. Communication shall be through the Executive Agents.

IV. BUSINESS-CONFIDENTIAL INFORMATION

A. The Parties do not expect to furnish to one another or create business-confidential information in the course of cooperation under this Agreement. In the event that such information is inadvertently furnished or created or the Parties agree to furnish such information, the Parties shall give full protection to such information in accordance with their laws, regulations, and administrative practices.

B. For the purpose of this Annex, "business-confidential information" means information of a confidential nature which meets all of the following conditions:

1. It is of a type customarily held in confidence for commercial reasons;

2. It is not generally known or publicly available from other sources;

3. It has not been previously made available by the owner to others without an obligation concerning its confidentiality; and

4. It is not already in the possession of the recipient Party without an obligation concerning its confidentiality.

C. Any information to be protected as "business-confidential information" shall be appropriately identified by the Party furnishing such information or asserting that it is to be protected, except as otherwise provided in the Parties' laws, regulations, and administrative practices. Subject to the aforesaid laws, regulations and administrative practices, unidentified information will be assumed not to be information to be protected, except that a Party in writing, within a reasonable period of time after furnishing or transferring such information, that such information is business-confidential under the laws, regulations, and administrative practices of its country. Such information will thereafter be protected in accordance with paragraph A above.

V. OTHER TYPES OF INTELLECTUAL PROPERTY

"Other types of intellectual property" means any intellectual property protectable in accordance with the laws, regulations and administrative practices of either Party or any third country other than those described in Articles II and III above and includes, for example, scientific discoveries, maskworks and trademarks. Rights to other types of intellectual property shall be determined in the same manner as for inventions, as set forth in Article III, Paragraphs B - D of this Annex. If an intellectual property is one for which protection is available under the laws of one Party but not of the other Party, the Party whose laws provide such protection shall be entitled to all rights in all countries which protect such intellectual property. The Parties may agree, however, to a different allocation of rights to such intellectual property.

VI. MISCELLANEOUS

A. Each Party shall take all necessary and appropriate steps to provide for the cooperation of its authors, inventors, and discoverers which is required to carry out the provisions of this Annex.

B. Each Party shall assume the responsibility to pay to its nationals such awards or compensation as may be in accordance with its laws and regulations. This Annex does not create any entitlement or prejudice any right or interest of the author or inventor to an award or compensation for his or her work or invention.

C. Intellectual property disputes arising under this Agreement should be resolved, if possible, through discussions between the Executive Agents. If the Executive Agents cannot resolve such a disagreement, it shall be settled through consultations between the Parties or their designees.

VII. EFFECT OF TERMINATION OR EXPIRATION

Termination or expiration of this Agreement shall not affect rights or obligations under this Annex.

VIII. APPLICABILITY

This Annex is applicable to all cooperative activities under this Agreement, except as otherwise specifically agreed.

APPENDIX K

OMNET: SCIENCEnet ACCESS VIA IASNET, THE SOVIET DATA NETWORK

Omnet

Electronic Mail
Services
and Support

Omnet Europe Limited
Killaloe
County Clare
Ireland
353 67 23407

Omnet, Inc.
137 Tonawanda Street
Boston, Massachusetts
02124
617 265 9230

SCIENCEnet Access via IASNET, the Soviet Data Network

Soviet subscribers can pay for the data connection to the the United States by getting an account with the Soviet data network. IASNET (also called VNIPAS) accepts roubles from Soviet institutions **only.** (Visitors, joint ventures, etc. must pay hard currency.) IASNET quotes the rates in mixed dollars and roubles and then bills the dollar part at the "auction rate," currently 30 roubles to the dollar.

Monthly account fee	- 45 Roubles (R)
Time charges	- 15R/hour + $5/hour
Traffic charges	- 16R/Kilosegment + $8/Kilosegment

For any normal usage, the kilosegment charges will dominate the effective rouble charges. For instance -- using the 30 rouble/dollar exchange rate -- reading a 1000-char message at 2400 baud will cost about 4 roubles (assuming maximum segment efficiency) in traffic charges as against maybe 20 kopecks in time charges. Note that the IASNET charges are just for **access.** Someone still has to pay Omnet $0.26/minute for the **mailbox.**

IASNET contact:

Prof. Oleg L. Smirnov
Institute for Automated Systems
2-A Nezhdanova Street
Moscow 103009
Phone: (095) 229-7846
Fax: (095) 229-3237
Telex: 411809

SCIENCEnet Access Via Sprint USSR

Omnet subscribers can dial directly into SCIENCEnet via access numbers in Moscow and St. Petersburg. No need for a data network account.

Omnet mailbox charges via direct Soviet access numbers:

Monthly account fee	- $15
Time charges	- $0.99/minute
Traffic charges	- $0.06/kilocharacter

IASNET Access VS Sprint USSR Access

Omnet's monthly mailbox fee and traffic charges remain the same no matter which way a Soviet subscriber logs on -- only the time charge varies. Access via a data network is $0.26/minute. Access via a Soviet access number is $0.99/minute.

IASNET access can cost up to 1/3 less than Sprint USSR access, depending on efficiency. With Sprint USSR access numbers, it's the minutes that count. With IASNET access, volume costs are more heavily weighed.

The two access options are not mutually exclusive. Sprint USSR access might best be used as a back up when IASNET is not available. There was no interruption in dial-in access during the recent coup attempt.

Sprint USSR direct-dial access to your SCIENCEnet mailbox

Direct access procedures in the Soviet Union are identical to access procedures in the U.S. -- with one exception. Access at 300/1200 baud requires the CCITT modem standard, not the Bell standard used in the U.S. A 1200 baud modem may be switchable between the two standards. (All 2400 baud modems are CCITT.)

Communications parameters are: 7 data bits, 1 stop bit, even parity.

1. Make the connection to one of Sprint USSR's number by dialing

   Moscow (7-095) 928-0985 (all speeds)

   St. Petersburg (7-812) 110-7792 (all speeds)

2. At 300 or 1200 baud: Press <cr> once per second

   At 2400 baud: Wait 6 seconds and press the @ key, then <cr>

When you see:	Type:
SPRINT USSR	
XXX XXX	

3. TERMINAL= <cr>

4. @ MAIL <cr>

5. User name?

Account Services and Technical Support in the Soviet Union

SCIENCEnet mailboxes, billing in the Soviet Union, computers, software, 2400 baud MNP modems, telecommunications training and consulting services are available from:

Dr. Andrei Lapenis
TELE-BALTICA
m/b 41
Nevsky prospekt, 176
St. Petersburg
USSR 193 167

Phone: (812) 524-0278

SCIENCEnet: A.Lapenis

SCIENCEnet Subscribers in the Soviet Union:

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Holding Group DTI.LENINGRAD SU
DTI Holding Group, Leningrad

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Adventive Information & Marketing, Kazan

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Marine Hydrophysical Institute, Sevastopol

Kamenkovich, Vladimir V.KAMENKOVICH SU
USSR Academy of Sciences, Shirshov Inst of Oceanology, Moscow

World Data Center B1 WDCB1.USSR SU
Institute of Hydrometeorological Information, Obninsk, Kaluga

APPENDIX L

EXAMPLES OF JOINT VENTURES IN OCEAN SCIENCES: AMRUSSCO, ALMAZ, IRIS, SOYUZ MARINE SERVICE

Note: This Appendix in no way pretends to be complete, or even exemplary. It contains only descriptions of four joint ventures which happened to be available at the time of the workshop. The inclusion herein implies no support, recommendation, or certification by the workshop or any of the sponsors.

AMRUSSCO

A SOVIET-AMERICAN JOINT VENTURE COMPANY

In 1989, a joint venture was struck between INTERMARINE, a North American oceanography company, and VNIRO, the research arm of the Soviet Ministry of Fisheries and Oceanography. The result was the formation of the joint venture company, AMRUSSCO, with an office in Moscow staffed by VNIRO engineering and administrative personnel. Regular visits by INTERMARINE personnel and daily communications by electronic mail keep the two companies working smoothly together.

AMRUSSCO can provide a variety of services to North American organizations interested in working with groups in the new Commonwealth of Independent States (C.I.S.). The following list provides an outline of these services:

1. MANUFACTURING

Utilizing the excellent machining capabilities, the supply of inexpensive raw materials, and the low cost labor available in the C.I.S., AMRUSSCO contracts with local factories to produce small components and pressure housings for underwater use. These products are made of titanium, stainless steel, or aluminum to western companies' drawings.

Custom designed aluminum instrument enclosures with extruded plastic card guides have also been supplied.

Discussions are underway for the manufacture of such diverse products as titanium bicycle frames and acoustic windows. Requests for the manufacture of other products, particularly from titanium, will be considered.

2. EXPORTING

Drop forged, finish machined titanium and aluminum spheres, up to two meters in diameter and suitable for deployment to full ocean depth, are now available.

High capacity, rechargeable silver-zinc batteries are produced in a variety of sizes by a factory in St. Petersburg. These batteries are comparable in price and performance with lithium-sulphur dioxide cells, except that they are rechargeable up to 60 times. They also eliminate the risk of spontaneous explosion.

INTERMARINE has recently been granted a license to manufacture PVC water sampling bottles designed by a western oceanographic institute. Production in Moscow and an international marketing program will soon be underway.

3. CUSTOM ENGINEERING

With the availability of inexpensive raw materials such as titanium and aluminum, and the engineering expertise of the AMRUSSCO staff and associates, custom engineering and design assistance for a variety of products are available.

4. SALES INTO THE C.I.S.

INTERMARINE represents many western oceanographic, marine and electronic equipment manufacturers. To assist our C.I.S. clients in earning hard currency to purchase western equipment, many of the transactions involve counter trade. As a joint venture company, AMRUSSCO maintains both ruble and hard currency accounts in Moscow banks thus allowing payment by a variety of means.

5. EQUIPMENT INSTALLATION/TECHNICAL TRAINING IN THE C.I.S.

The technical, bilingual staff of AMRUSSCO are capable of installing much of the western equipment they sell in the C.I.S. For other equipment, AMRUSSCO is prepared to fly engineers to western factories for specific training in installation and field support.

AMRUSSCO personnel can provide technical training to ensure good customer comprehension of new products. Western manufacturers can take advantage of low per diem rates and inexpensive domestic air fares in the C.I.S. to ensure that their C.I.S. customers are trained in a most cost-effective manner. They can also depend on AMRUSSCO personnel to be there when problems arise.

AMRUSSCO now imports, delivers, installs and supports modest communications systems in the C.I.S. This allows electronic mailbox holders to get "on-line" quickly and maintain their strategic connections with the west.

6. SCIENTIFIC DATING SERVICE

INTERMARINE and AMRUSSCO are in close contact with most, if not all of the oceanographic institutes in the C.I.S. and the Baltic States, as well as the majority of such organizations in the western world. Electronic mail and fax links between Moscow and our Canadian and U.S. offices facilitate rapid and efficient transfer of messages. AMRUSSCO can provide connections between western and C.I.S. scientists and assist in arranging joint projects. Neither INTERMARINE nor AMRUSSCO profits directly from this service but both recognize the advantages of strengthening contacts within the world oceanographic community.

7. RESEARCH VESSEL LEASING

Seventy-five modern Soviet research vessels, varying in size from a few hundred up to 7,000 tons, are available for lease through INTERMARINE. These ships are equipped with up-to-date western instrumentation appropriate for the study of all of the scientific disciplines of oceanography and seismic exploration. They are staffed by crews experienced in deploying and recovering oceanographic instruments and in using the laboratory instruments and computers onboard.

The fleet includes a mother ship with two 6,000 meter manned submersibles, twelve fisheries research vessels built in the late 1980s, as well as helicoptors and fixed-wing aircraft.

Per diem lease costs are very competitive and time sharing arrangements are explored where possible to further reduce costs and promote international cooperation.

CONTACTS

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IAF-91-153

ALMAZ SATELLITES

G. A. Yephremov
General Director and General Designer
NPO Machinostroenia
Moscow, USSR

and

William B. Wirin
The ALMAZ Corporation
4400 Forbes Boulevard
Lanham, MD 20706

42nd CONGRESS OF THE INTERNATIONAL ASTRONAUTICAL FEDERATION

October 5–11, 1991/Montreal, Canada

IAF-91-153

ALMAZ SATELLITES*

G. A. Yephremov
General Director and General Designer
NPO Machinostroyenia
Moscow, USSR

W. B. Wirin
President, ALMAZ Corporation
Washington, D.C., USA

Abstract

NPO Machinostroyenia designed and built the Salyut space stations. As a result of their expertise in this area, Kosmos 1870 was designed and flown. Kosmos 1870 was an experimental synthetic aperture radar system. It used the bus design created for the Salyut space station. Kosmos 1870 was a SAR satellite with 25 meter resolution and produced analogue imagery.

The ALMAZ-1 satellite is the follow-on to Kosmos 1870. It also uses the Salyut bus design. The ALMAZ radar is 11-18 meter resolution and is digital. This satellite was launched March 31, 1991. Its estimated life is until December 26, 1992.

Plans are now underway to build and launch a successor to ALMAZ-1. This satellite will have essentially the same capability as the current ALMAZ-1. ALMAZ-2, with significantly increased capability will be launched in the 1995-1996 time frame.

Introduction

NPO Machinostroyenia has taken the lead in the Soviet space industry to commercialize its capability for Western customers. Marketing efforts began one year prior to launch of ALMAZ-1. There has been considerable interest by Western customers. These customers include various governments, commercial enterprises and scientific investigators. Because of the relative newness of SAR imagery, NPO Machinostroyenia looks to the world community to be innovative in developing new uses of radar imagery.

Technical Characteristics - ALMAZ-1

ALMAZ-1 has an orbital inclination of 72.7 degrees and an altitude of 300 kilometers. Its orbital position is corrected every 18-31 days. The satellite weighs 18.3 metric tons so considerable fuel is used in correcting its position.

The original life of the satellite was calculated to be 2-2 1/2 years. Due to the failure of solar activity to decrease as anticipated, more fuel than expected has been used. Solar activity was expected to reach its 11 year high in the summer/fall of 1990. Solar activity heats the earth's atmosphere. This causes the atmosphere to expand to higher altitudes. The atmosphere at higher altitudes increases drag on this very large satellite which flies at a very low altitude.

The wave length is 9.6 centimeters. This wave length was chosen for its ability to sense the Earth without interference from storms and weather conditions on Earth. Polarization is horizontal.

The radar was designed with both a right and left antennae. The left antennae did not fully deploy. It is believed this was caused by activation of a thruster during deployment producing heat which fused a swivel arm. Attempts continue to achieve full deployment. In the interim, the right antennae is working perfectly. Without full deployment of the left antennae, stereo pairs between 40 degrees North and 40 degrees South are more difficult.

The satellite antennae is fixed. Different angles of observation are achieved by rolling the satellite. There are two modes. The standard working mode is from 32 degrees to 50 degrees. This is calculated from the satellite. Accordingly, 32 degrees is close to the satellite and 50 degrees is farther from the satellite. Using the term "depression angle" it would be 58 degrees to 40 degrees.

Experimental modes are from 20 to 32 degrees and 50 to 63 degrees. In the first zone, nearest the satellite, a loss of information and resolution occurs. In the second zone, shadowing (ghosting) occurs particularly when there is a sharp contrast, i.e., ocean/land boundaries. Additionally, a high signal to noise ratio develops reducing contrast in the imagery.

Resolution of imagery is nominally 11 to 15 meters. The greater the look angle from the satellite, the higher the resolution. At 32 degrees, the resolution can be expected to be 18 meters. At 63 degrees, 11 meters.

The satellite records imagery on its tape recorders, transmits the digital data to a relay satellite which downlinks it to the Moscow Central Receiving Facility. The hologram is recorded on a high density tape. The image can then be visually produced as a hard copy photograph of six strips, 6-7 millimeters each. This picture is approximately 1:100,000 scale.

Alternatively, a digital tape can be processed. Digital Level A imagery is synthesized (mosaicked). Level B imagery is processed further to include georeferencing and geometric correction. It is not geocoded. The four corner points of the image have positional

accuracy of 1-3 kilometers calculated from the satellite's ephemeris data.

The standard scene is 40km x 40km but strips 40km x 280km can be produced in increments of 40km. Photographic products with a scale of 1:24,000 have been produced with acceptable photographic quality.

Almaz 2

Pending completion of the system definition phase, Almaz 2 will be launched on a Proton M. Expected payload capacity of Almaz 2 will be 6.5 tons. Instrumentation will include 3 SAR sensors, optical sensors, a multispectral scanner, a scatterometer, an altimeter, a photometer, and a variety of spectrometer instrumentation. Equipment to be supplied by international partners is still in the discussion phase.

NPO Machinostroyenia has determined that three types of SAR instrumentation are likely necessary; 23 cm for optimal evaluation of vegetation and soil moisture content; 9.6 cm is optimal for avoidance of storm interference; and 5.6 cm is necessary for accurate evaluation of ice and wave patterns. Typical resolution will nominally be 10 - 15 meters with a swath band width between 75 and 50 meters with a swath band of 500 kilometers. Close look capabilities of 3 - 20 km and wide angle swath capabilities of 1200 km will be also available using radiometric instrumentation.

The intent is to make Almaz 2 a complete space ecological laboratory. It is expected to be placed in a 73 degree orbit at a height of 600km, with a life expectancy of 5 years. Power consumption will be a steady 2 Kw with peak available power around 10 Kw. Satellite hardware, as well as the command and control system instrumentation is expected to be newly designed, with added improvements to data handling capabilities.

Conclusion

NPO Machinostroyenia is committed to serving commercial customers with radar imagery. A follow-on satellite to ALMAZ-1 is scheduled to be launched in 1993/94. ALMAZ-2 with increased capabilities will be launched in 1995/96. Suggestions are solicited as to appropriate instrumentation to solve the world's remote sensing needs. Additionally, NPO Machinostroyenia is desirous of working together with companies in other nations to achieve international cooperation and support the capital requirements of new satellites.

IRIS Newsletter

SPECIAL SUPPLEMENT

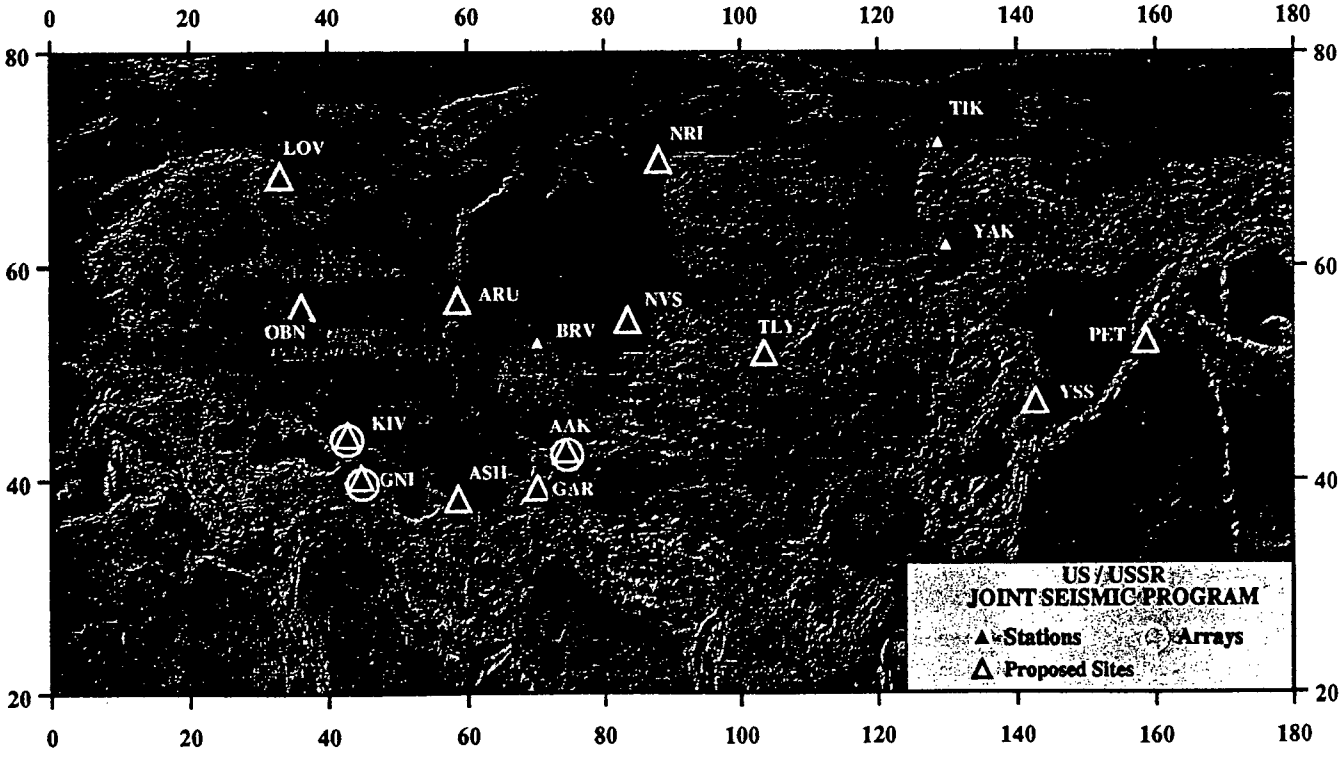
Moscow Data Analysis Center Opens

The IRIS Consortium, the Institute of Physics of the Earth (IPE) of the Academy of Sciences of the USSR, and the Scientific-Engineering Center (SEC) of the Academy of Sciences of the USSR announce the opening of the Moscow Data Analysis Center.

On February 8, 1991 the IRIS Consortium, the Institute of Physics of the Earth (IPE) of the Academy of Sciences of the USSR, and the Scientific-Engineering Center (SEC) of the Academy of Sciences of the USSR agreed to develop a facility in Moscow to analyze and archive data from the US/USSR Joint Seismic Program.

The Data Analysis Center is located near the center of Moscow at 12 Dimitrievskaya. The facilities of the Center are available without restriction to all scientists involved in the US/USSR Joint Seismic Program. In addition to the Institute of Physics of the Earth, which is a signatory of the agreement, the US/USSR Joint Seismic Program currently involves scientists from the Institute of Dynamics of the Geosphere, the International Institute of Earthquake Prediction Theory and Mathematical Geophysics, the Academy of Sciences of Kirghiz SSR, the Armenian Academy of Sciences, the Yakutsk Science Center, World Data Center B, and other institutions. Seismologists from all of these organizations are invited to make full use of the Moscow Data Analysis Center.

Approximately 200 square meters of office space belonging to the Scientific-Engineering Center have been renovated to house the facility. IRIS has provided equipment for the Data Analysis Center, including three SUN 3 computer systems, a color workstation, a laserwriter, a scanner, a PC computer, a copy machine, a FAX, spare parts, and supplies. Software, for the analysis of seismic data, is being contributed to the Center from several American universities. The Institute of Physics of the Earth, in turn, will be responsible for developing applications software and for the operations and maintenance of the computer facilities.



In addition to the new Moscow Data Analysis Center, the facilities of the US/USSR Joint Seismic Program include Global Seismic Network stations (marked with triangles), telemetered networks and arrays of seismic instruments (marked with yellow circles), and a Data Collection Center in Obninsk.

About the US/USSR Joint Seismic Program

The US/USSR Joint Seismic Program is a cooperative program in seismology between the United States and the Soviet Union. IRIS and the US Geological Survey represent the United States, and the Institute of Physics of the Earth of the Soviet Academy of Sciences represent the Soviet Union. The purpose of the program is to provide facilities and data to understand seismic wave propagation, geologic structures, and tectonic processes. Research and data from the Joint Seismic Program can be applied to such policy issues as the mitigation of earthquake hazards and the monitoring of underground nuclear explosions. In 1991, the United States Congress declared the US/USSR Joint Seismic Program to be a special Congressional interest item because of its contribution to improving our capability to monitor nuclear testing treaties and the proliferation of nuclear weapons. All data from the program are shared by scientists from both countries and are available by request, without restriction, on an international basis.

For more information regarding the US/USSR Joint Seismic Program please contact the following:

the
IRIS
CONSORTIUM

The IRIS Consortium
1616 N. Fort Myer Drive
Suite 1440
Arlington, VA 22209
Telephone: 703/524-6222
Fax: 703/527-7256
Telex: 7400457IRISUC

Data Available Through Center

In addition to providing advanced computer facilities for Soviet scientists, the Moscow Data Analysis Center will be the Soviet archive for all US and Soviet data from the US/USSR Joint Seismic Program. The Center will be connected to the IRIS Data Management System in the United States through a direct computer-to-computer link. By connecting to the IRIS Data Management System, Soviet scientists will have access to the full archive of IRIS seismic data.

The Data Analysis Center will include data sets from the facilities shown by the map on the previous page; specifically:

- USSR Global Seismic Network (GSN) station data *(open and closed triangles)*
  Data from each of the GSN stations within the USSR will be available through the Center. The solid triangles indicate stations that are either operating or being installed. The open triangles represent sites of future stations.

- Kirghiz Telemetered Network data *(yellow circle around AAK triangle)*
  At the request of the Soviet Union, a telemetered network of seismic stations is being installed in Kirghizia. Each of the ten stations will record high and low gain, 3-component, broadband seismic data along with six low sample rate ancillary channels. The network will provide a comprehensive data set for one of the most earthquake prone areas in the Soviet Union.

- Caucasus Network data *(yellow circle around KIV triangle)*
  A telemetered broad-band array and a regional array of portable instruments are being deployed in the Caucasus using both Soviet and US equipment. The data from these arrays will allow scientists to study the seismicity, tectonics, and structure of one of the world's few active continental collision zones.

- Garni Dense Array data *(yellow circle around GNI triangle)*
  A portable, high-resolution array of 12 sites has been installed by the US Geological Survey in a 3-dimensional pattern in and around a tunnel at the Garni Observatory in Armenia. The Garni array data will allow seismic mapping and improved hazard analysis for Yerevan, the capital of Armenia. Yerevan, with a population of 1.2 million, is an area of high earthquake risk.

The Data Analysis Center will also serve as the Soviet archive for data from stations outside the USSR and from joint experiments with the small aperture array, including the following:

- US Network Day tapes
  Data from seismic stations within the United States are provided to the Soviet Union as a part of the US Geological Survey network day tapes. The tapes, which are sent to World Data Center B in Moscow, include data from approximately 50 stations. These data are in addition to the Global Seismic Network data available through the IRIS Data Management System.

- Data from US and USSR experiments with the small aperture array
  A portable 25-element 3-component array has been developed for use by US and USSR scientists. The small array, which was deployed in Pinyon Flat, California in 1991, provides a capability to study in detail Earth structure and very low magnitude seismicity. In 1992, the array will be deployed in the USSR.•

SOYUZ MARINE SERVICE (SMS)

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Donald L. Keach
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Suite 217
San Pedro, California 90731
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Fax: (310) 514-8380

Soyuz Marine Service (SMS) was incorporated in the former Soviet Union (USSR) in August, 1989 as a Soviet/American joint venture. SMS' primary business is to provide worldwide underwater inspection, repair and maintenance services for merchant, fishing, research and other commercial vessels. The primary customers for these services were to be vessels of the Ministry of Merchant Marine (MORFLOT), the Ministry of Fisheries (VNIRO) and the Soviet Academy of Sciences. Services were to be performed both in the Soviet seaports and overseas through a network of affiliated commercial diving companies.

Corporate offices are located in Moscow. The original development plan was to establish ship diving services facilities at Murmansk, Leningrad, Odessa, Novorossiysk and Vladivostok. Prior to the 1991 dissolution of the Soviet Union the Murmansk and Novorossiysk

bases were operational. The overseas network of 20 commercial diving companies serving 30 countries was established in 1990.

In addition, SMS has also become involved in other marine-related areas such as equipment marketing, information transfer, scientific liaison services, etc. as opportunities have been developed by the partners. Expansion into new business directions are under continuing consideration by the joint venture. We also assist other companies, agencies and organizations to gain access to the marine market in the former USSR.

The joint venture is owned 55% by U.S. and 45% by Russian interests. Parker Diving Service (PDS), founded in 1945, is the major American partner (of a total of three U.S. partners). This commercial diving company, located in the Los Angeles-Long Beach harbor, has been involved with underwater ship services for nearly a half century. Donald L. Keach, President of PDS, is also Chairman of the Board of SMS.

The P.P. Shirshov Institute of Oceanology in Moscow is one of the three major Russian partners. Professor V.S. Yastrebov, Director of the Institute, is co-chairman of the SMS Board of Directors.

With the breakup of the former Soviet Union, there has been a temporary slowdown in SMS business development. However, the basic requirements for our services remain as important as before. Therefore, the joint venture has been active in developing new linkages with the emerging new government and private sector structures. SMS now finds its primary business focus to be in the Russian Republic and its maritime shipping companies. Once the current business base is stabilized, SMS will begin to look for additional opportunities in those republics having requirements for commercial diving services. We are very optimistic about the opportunities for significant business opportunities in the Confederation of Independent States.