

e-mail: gwong@odu.edu
May 22, 2000.

The Department of
Ocean, Earth & Atmospheric Sciences
Old Dominion University
Norfolk, Virginia 23529-0276
(757) 683-4285
Fax (757) 683-5303

Dr. Cheng-I Weng, Chairman
National Science Council, R.O.C.
No. 106, Ho-Ping E. Rd., Sec. 2
Taipei, Taiwan, R.O.C.

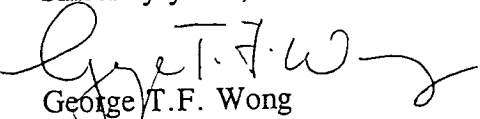
Dear Dr. Weng:

On behalf of the Advisory Committee of the National Center for Ocean Research, I congratulate you for your appointment as the new Chairman of the National Science Council. As an island-society, the importance of the influence of the oceans to the well being of Taiwan can hardly be over-emphasized and I look forward to the progress in the oceanographic sciences in Taiwan under your leadership.

The Advisory Committee, together with two external reviewers, met on May 13 to 15 and completed the three-year review of the Center. Enclosed please find a report on our meetings and our recommendations on the future operations of the Center. I shall be glad to provide any additional information that you may wish to have if you have any question on our report and recommendations.

Please note that the Advisory Committee was created and its members were appointed by Chairman Liu in the Summer of 1997 to assist in the first three years of operation of the Center. Our terms are up by the end of this Summer and our responsibilities for this three-year period have been discharged. There is no plan for us to meet again as a Committee. If the National Science Council still feels that there is a future for the Center and that some or all of the members of this Committee may have a role to play in this future, we shall be glad to consider to continue to serve the communities in the oceanographic and atmospheric sciences in Taiwan.

Sincerely yours,


George T.F. Wong
Coordinator, Advisory Committee

Encl.

cc. Vice Chairman, Division Head of Natural Sciences, Program Manager of Ocean Sciences, NSC
Members, Advisory Committee and Executive Committee of NCOR

**THREE-YEAR REVIEW OF
THE NATIONAL CENTER FOR OCEAN RESEARCH
OF THE NATIONAL SCIENCE COUNCIL**

a report prepared by

The Advisory Committee and External Reviewers

for

The National Science Council

Advisory Committee

George T. F. Wong, Coordinator
Chih-Pei Chang
Ya Hsueh
Teh Lung Ku
William K. M. Lau
Yuan Hui Li
I-Chiu Liao
Absent: Kenneth Hsu

External Reviewers

Tsung-Hung Peng
John Wang

May, 2000

I. OVERVIEW

Given the limitations that the National Center for Ocean Research had to operate under in the last three years since its inception in September, 1997 to the present time, **it has succeeded beyond our expectations.** We are fortunate that a group of bright and enthusiastic young scientists has been assembled in the Center. They have the potential to become the next generation of movers and shakers of oceanography in Taiwan. Both the Taiwan Strait Nowcasting (TSNOW) project and the South East Asian Time Series Study (SEATS) are high quality research projects and they are carrying them out admirably. The initial data are promising. With continued development, their work should result in a number of publications in international journals within the next three years.

In the next three years, the development of the Center will be at a critical stage. In spite of its successes to date, the present state of operation of the Center cannot be sustained much longer under the present support structure. The limitations in resources and personnel policies on the operations of the Center make it unattractive to our young scientists, post-docs and assistants. The weight of these limitations has accumulated in the last few years to the point that the Center is likely to crumble under this weight and self-destruct within the next few years if remedial actions are not taken immediately. **In fact, the Center is now in an imminently critical stage.**

Under this backdrop of great potential and great urgency with the possibility of a near-term collapse of the Center, we recommend the following possible lines of action:

1. If the vision of the National Science Council for the National Center for Ocean Research is to be realized fully, we recommend **in the strongest term possible that, as soon as practical, the Center should be converted from a virtual Center into a "hard" independent Center** with its own research and administrative buildings, dedicated docking and marine-operations facilities and a permanent staff. We support in concept the plan proposed by Dr. Min-Pen Chen and his colleagues for organizing a hard Center. However, we feel that the first mission of the Center should be to promote high quality oceanographic research rather than national practical oceanographic research. If a Bureau of the Oceans is to be established, there should still be a "hard" independent Center to carry out the research missions of the present Center. The service missions of the present Center can be handed over to the Bureau.
2. In the interim, if the activities in the Center are to be limited to its present level, we recommend **that the Center be converted from its virtual state into a pseudo-hard Center with additional senior technicians and technicians** (similar in status to those positions presently available in the Precious Instrument Center) to staff the laboratories, the data bank and the Precious Instrument Center.
3. If there is no prospect of additional resources for the Center, we recommend **that the Center be dissolved and its responsibilities/assets be reverted to the universities or that the Center will only be responsible for its administrative and/or service missions.** However, we consider this option to be unacceptable if Taiwan desires to develop a vibrant oceanographic presence.

II. REVIEW

A. Introduction

The National Science Council has assigned the following missions to the National Center for Ocean Research:

1. to promote cutting edge research in oceanography
2. to integrate the use of the oceanographic fleet
3. to establish an oceanographic data bank and to survey the marine resources of Taiwan
4. to promote international oceanographic research collaborations
5. to promote the use of remote sensing in oceanographic research.

These missions are appropriate for a national center and are necessary for the development of a vibrant oceanographic presence in Taiwan. The performance of the Center was reviewed by its fulfillment of these assigned missions.

B. Mission Review

1. Cutting Edge Research in Oceanography

In response to this mission, the Center has initiated two well conceived research projects: TSNOW (Taiwan Strait Nowcasting) and SEATS (South East Asian Time Series Study). An initiative in coastal oceanography which is to start in the next fiscal year has been proposed for consideration.

a. TSNOW - Taiwan Strait Nowcasting

The TSNOW program led by Dr. San Jen with guidance from Professor Shen-Yu Chao has made remarkable progress over the past three years. Although studies of the tides around Taiwan have been carried out in the past, TSNOW represents a first effort in putting the tidal current calculations in the Strait on a scientifically sound basis.

The major accomplishments of the project made by the highly qualified principal and associated investigators include:

The initiation and completion of a large field measurement program to determine the hydrography and flows in Taiwan Strait (TS).

Collection of tidal elevation data and harmonic analyses of elevation and current data to obtain tidal harmonic components.

Development of a numerical model to simulate tides in TS.

Establishment of a large scale 2-D model for specifying boundary conditions.

Calibration of model and comparison between model results and observations.

The modeling development and the eventual operational nowcast model of TS are the major foci of this project. Significant progress has been made to date despite the inherent difficulties of starting such an ambitious project from scratch. To continue this worthwhile effort, which is receiving increased interest from the Navy, the EPA, and other state and local agencies, more man power is needed. At the present time, the leading scientist must carry out

a large amount of routine data processing in addition to their scientific endeavors reducing their efficiency.

Recommendations:

The project needs an additional postdoc to develop, test, and run numerical models. An additional data processing technician is also needed.

The modeling approach until now was in part dictated by the need for quick attainment of results and in part by the special conditions of TS, such as its complex topography and strong tides. The choice of using the Semtner model as implemented by professor Chao was therefore a judicious decision which has been validated by the results. However, as the modeling progresses from pure tides to wind-driven and baroclinic flows, it is valuable to assess the model and its capabilities relative to other widely accepted models, such as the Princeton Ocean Model and Miami Isopycnal/Hybrid Coordinate Model (MICOM/HYCOM). Because there are a number of processes that are handled differently and with different emphasis in these models some tests should be made to choose the more appropriate for continued modeling of TS.

Carry out comparison tests between the present TSNOW model and other potential candidates such as POM. Particular attention should be paid to effects of steep topography, surface and bottom boundary layers, and flow representation in shallow waters (coastal jets, tides and plumes). Good model performance near the coast is required by the planned coastal oceanography program. It is also recommended that a nested model approach be pursued to allow a detailed TS model within a larger regional model to help alleviate problems of boundary condition specification.

The processing of data has hitherto focused on tides. Available data also contain information on the subtidal low-frequency variability that is part of the longer term transport picture of TS. This is a vast largely untapped resource which should be put to use, so that important decisions on model physics can be supported.

As soon as possible, the project should establish protocols and begin the analysis of existing data for low-frequency response to forcings from wind and Kuroshio current. These results can guide the direction and extent of future data collection efforts and modeling.

It is recognized that to follow some or all of the above recommendations will be contingent on the addition of qualified staff, which as indicated should consist of at least one postdoc with modeling experience and one data analysis/processing technician. And thus a recommendation is made to attempt to hire such persons, which will also help project continuity and critical mass.

b. SEATS - South East Asian Time Series Study

Frank Shiah led the SEATS program for one year before he was hired away by the National Taiwan University. At the present time, there is no scientist to lead the SEATS program. Three post-docs and several assistants are working on the project. Dr. Kon-Kee Liu is the consulting professor of this project. George Wong and Yuan Hui Li have also served in an advisory role. Despite of the lack of a mature and continued scientific leadership in the Center for this project, the study has made remarkable progress. Much credit has to be given to the dedication of the three post-docs.

Accomplishments:

Bi-monthly cruises have been conducted for over a year to obtain samples from designated locations in the northern South China Sea.

Analytical capability at the world class level has been developed in the Center for the determination of phosphate, nitrate, silicate, total carbon dioxide and alkalinity in seawater, parameters that are important to our understanding of the carbon system. The high quality of the data has been clearly demonstrated from the comparison of depth profiles taken at the same station but for a time interval of months apart. The data points in the deep water essentially fall right on top of each other, indicating the high reproducibility of the measuring techniques. In fact, the uncertainty for total carbon dioxide measurements is about $1 \mu\text{mol/kg}$, and for alkalinity is about $4 \mu\text{mol/kg}$. The precisions in the determinations of phosphate, nitrate, dissolved oxygen, and salinity are $\pm 0.5\%$, $\pm 0.4\%$, $\pm 0.1\%$ and ± 0.001 respectively. These are the current state-of-the-art uncertainties for these measurements. The achievement of these high precision measurements makes it possible that high quality carbon data will be obtained for the study of carbon cycle in the South China Sea. The potential for determining the variations of carbon sink for the anthropogenic CO_2 in the South China Sea will contribute greatly to the global climate changes caused by the increasing atmospheric CO_2 .

A method for the storage of seawater samples for subsequent determinations of dissolved nutrients has been devised and verified. This will allow seawater samples to be collected, stored onboard ship and then returned to a shore based lab for the determination of the nutrients. This capability for overcoming the storage problem so that the samples need not be analyzed onboard ship immediately after sample collection has eluded Taiwanese oceanographers for over a decade even after many attempts to solve this problem. This new capability will greatly reduce the logistical problems associated with onboard analyses.

These initial successes in SEATS have attracted quite a bit of interest and respect for Taiwan in the international oceanographic community. SEATS is potentially the first oceanographic project in which Taiwan may play a leadership role while oceanographers from other countries will seek the opportunity to participate in the project.

Recommendations:

A scientist with the appropriate qualifications should be hired as soon as possible to provide a more stable scientific leadership for the SEATS program. If none is available, considerations should be given to the promotion of one of the post-docs of the project to the scientist level to head up this program.

An all-out effort should be made to preserve the expertise that has been developed and accumulated in the past three years. The personnel policies of the Center should be modified so that the key post-docs and assistants may stay with the Center. This may be accomplished by creating senior-technician and technician positions along the same line as the Precious Instrument Center and by promoting qualified post-docs to the scientist level.

A time series study is an ever expanding program. The present analytical program should be expanded to eventually cover the parameters that are measured at the Hawaii Ocean Time Series Station and the Bermuda Atlantic Time Series Station. An immediate next step is to develop the capability to measure primary production and low level nutrients.

Aside from measurements in discrete samples, the capability of deploying moored instruments/sensors should be developed as soon as possible. The moored instruments/sensors

should include CTD (conductivity-temperature-depth sensors), current meter, nutrient monitors and bio-optical sensors and sediment traps. In order to assess the potential influence of mesoscale eddies, the deployment of multiple moorings (a minimum of three) should be considered.

The rate and level of expansion of the SEATS program should be commensurate with the resources that are made available to the program.

A concerted effort should be made to digest the data as they become available and to turn the results into publications.

c. Coastal Oceanography

The coastal oceanography program is designed as a pilot project to demonstrate how the source, transport and fate of pollutants from the rivers of Taiwan to its coastal waters may be characterized and quantified. The Tan Shiu River has been chosen for this demonstration project. If this pilot project is proved successful, other rivers/estuaries may be studied in a similar fashion.

The coastal oceanography program presented by Liangshuo Wen represents exciting and much needed research in the coastal zone. However, the problems are complex and require a carefully planned approach. For example, the present plan involves almost exclusively only the water column. However, many pollutants are particle-reactive and they are expected to reside primarily in the particulate phase and especially in the sediments. Thus, components on particle dynamics, sediment transport, sedimentary geochemistry and the effects on benthic organisms should also be included in the program. It is recommended that this project begin with assembling the existing data and knowledge followed by a development of a conceptual model which can guide the direction of research in subsequent years. Much work has already been done to develop such conceptual models at other places and this work need not be duplicated. A workshop with knowledgeable participants may be the most efficient way to accomplish this task. Dr. John Wang has recently been involved in the development of a conceptual model for Biscayne Bay in Florida and he would be pleased to provide what information is available on that effort. The field work for the coastal oceanography project must be carefully planned to optimize the benefits of limited funding and to address the most critical problems. It seems that the guidance of more experienced people is particularly desirable for this project given the complexities and the relative inexperience of the Center scientific staff.

2. Ship Operation and Precious Instrument Center

a. Ship operation

R/V Ocean Researcher-I, -II, and -III have been operated by the National Taiwan University (NTU), National Taiwan Ocean University, and National Sun-Yat-Sen University, respectively. Construction of these ships were financed jointly by the Ministry of Education (MOE) and the National Science Council (NSC). Professional positions for shipboard personnel have been provided by the Ministry of Education, and their salary by the National Science Council. The National Center for Ocean Research (NCOR) does not control the day-to-day operation of the ships, but is in charge of scheduling ship-times for all projects supported by the NSC. NSC-supported projects have the first priority over others in assigning ship-time. So far,

the current operational mode has been working smoothly. However, the communication between ship captain and chief scientists needs improvement. The general consensus among the oceanographic community is: when NCOR becomes a real hard-center, it should fully own and operate all the oceanographic research vessels. A new open-ocean-going research ship is in the active planning stage.

b. Precious Instrument Center (PIC)

PIC was established by the NSC to maintain various scientific instruments that are routinely used on shipboard. PIC was transferred from the NTU to the NCOR when the latter was formed three years ago. Since three technicians from the PIC were moved to the Ocean Data Bank division (ODB), there are only five technicians left in the PIC. Currently the operation of the PIC is entrusted to one of the NCOR's technical adviser, Professor T. Y. Tang. The PIC has its own website and newsletter to publicize the current status of PIC operations. The PIC also assists on the maintenance of the scientific instruments on the Navy's research ship Ta-kuang Chian. The PIC has performed its assigned duties beautifully, considering severe shortage on manpower. It is imperative to increase the number of technicians, by at least two to three peoples, for the effective operation of the PIC.

3. Data Bank and Survey of Marine Resources

The Ocean Data Bank (ODB) of the NCOR is one of the success stories in Taiwan's oceanographic community. The ODB currently has three technical staffs and three assistants and it is supervised by Professor T. Y. Tang. The ODB has been processing CTD (conductivity-temperature-depth sensors) and ADCP (acoustic doppler current profiler) data from the cruises of R/V Researcher I, II and III. The data are presented in graphic forms as ship tracks, spatial distributions of temperature, salinity, and currents, and bottom topographic maps around Taiwan Island. All the figures are accessible through ODB's website. Some are already published as large maps or will be published soon as the Center's Ocean Atlases (1999). The ODB also processes and archives large volume of satellite data from the receiving station at the National Taiwan Ocean University. Those data are also presented as maps, e.g. daily and monthly average SST (sea surface temperature) and chlorophyll-a. Dr. I. I. Lin, a new and bright assistant scientist at the Center, will help the ODB to obtain additional SST and chlorophyll-a data from the South China Sea, and also will provide the monthly wind field around Taiwan by using satellite scatterometer data. The products of the ODB will be heavily utilized by the whole oceanographic community here and abroad. Given the ever expanding scope of services and workload at the ODB, additional manpower for the ODB is a must.

4. International Research Collaboration

During the past three years, the Center participated in two international multi-disciplinary programs: the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) and the International Research Institute for Climate Prediction (IRI-CP). In both cases, the Center was able to provide an unique and effective avenue to organize Taiwan's atmospheric and oceanographic scientists to participate in the preparation, planning and discussion of these two major initiatives with their U.S. counterparts. the organization of the

two Taiwan scientific groups under the auspices of the Center allowed the participation in these two initiatives on a national and institutional basis that otherwise would be difficult to carry out. The preliminary studies and workshops conducted by these two groups and the associated international interactions put the Republic of China in a suitable position ready to engage in further scientific and research activities as the two programs develop in time.

5. Remote Sensing

Satellite remote sensing is one of the main science thrust of the Center. Currently, under this thrust, the Center has two main functions. The first is to process, quality control and distribute remote sensing data to the research community and the general public. The second is to carry out remote sensing research with application to oceanic sciences at the Center and the ocean science community in Taiwan. Regarding the first function, the Center funded Professor Li, from the National Taiwan Ocean University to process sea surface temperature from AVHRR and ocean color data from SeaWiFs. These data are then put on the Ncor data bank for public display and user service. The initial results are very promising, including the development of a website for various capability for data display and download. Given the lack of in-house satellite facility, e.g., HRPT and GIS, the Center's effort to engage in collaboration with external expertise in satellite retrieval is a commendable strategy which will also strengthen the tie between the Center and the university community.

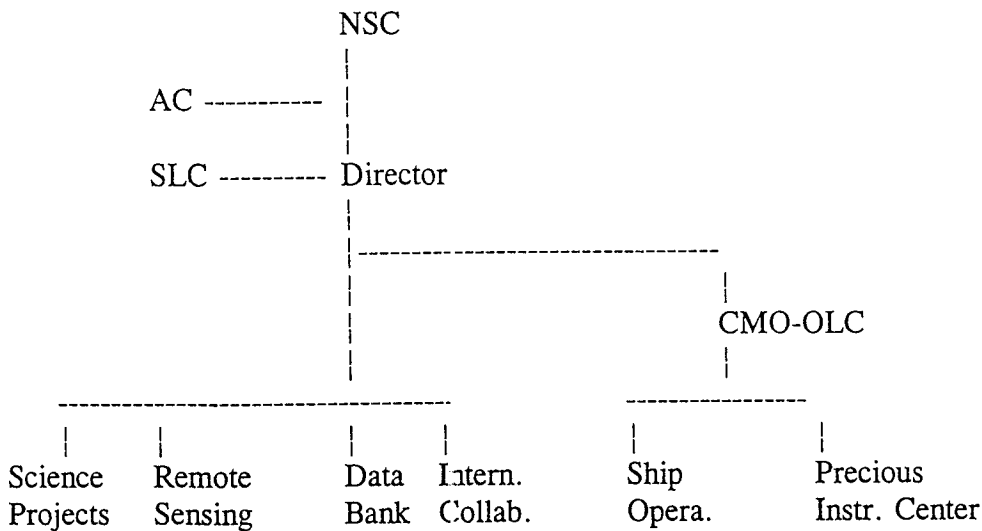
The recent hire of Dr. Lin, a satellite expert from CRISP, has greatly enhanced the potential for remote sensing research at the Center. She presented a very promising, if not overly ambitious, plan for remote sensing research for the Center, which includes using remote sensing data to support Center research, international partnership as well as in-house remote sensing development for a wide range of atmospheric and oceanic applications. Her plan also calls for the collection, archive and distribution of sea-truth data from moorings and ships, which will be most important for cross-calibration with satellite data, and extremely important for a broad spectrum of oceanic science research.

The Advisory Committee notes that among the research thrusts of the Center, remote sensing plays the unique role of providing data for multi-disciplinary research, intersecting various components of oceanic sciences research and application. This component of the research is critically important for the Center in establishing the Center's leadership as a premier center for oceanic research in Taiwan. Recognizing that the remote sensing capability of the Center is still in its embryonic stage that needs protecting and nurturing, the Advisory Committee strongly recommends that the remote sensing team be given adequate technical support for scientific research and for data service. Utmost consideration should be provided by Center management to enable the remote sensing team to function with a proper balance among scientific research, data processing and user service work.

C. Administrative Review

1. Organizational Structure

The organizational structure designed at the inception of the Center was appropriate for an organization at ground zero. After three years of operations, the Center has developed a scientific staff and an administrative structure. The Center personnel should be allowed more autonomy and to exercise more initiative. The role of the Advisory Committee and the Executive Committee should become more consultative in nature. Thus, we recommend the following organization structure:



AC - The Advisory Committee is made up of senior scientists from the overseas and the local community. They are appointed by the Chairman of the National Science Council. They review the progress in and give advice to the direction of the research projects, to affirm the appointment of the Director and the Center scientists. They normally would meet once a year.

SLC - The Science Liaison Committee is made up of the consulting professors of the projects of the Center and one representative from each of the three universities with an oceanography program (NTU, NTOU and NSYSU) but without anyone serving as a consulting professor of the Center. They are appointed by the Director of the Center. This Committee together with the Director will set guidelines on what may be appropriate as a Center project or as a project to be submitted for funding through regular channels to the NSC, review the budget and the proposals of the Center. Members of the Committee act as the liaison between the Center and the academic community and help to promote collaborative research efforts between the Center and members of the academic community. The Committee also serves as a search Committee for the Director and the scientists and post-docs of the Center. The Committee recommends candidates for the Center Director and scientists to the AC for affirmation and candidates for the post-docs to the Director for affirmation. This Committee should meet at regular intervals and as needs arise throughout the year.

CMO-OLC - The Coordinator of Marine Operations and the members of the Operations Liaison

Committee are appointed by the Director. The members of the OLC should include representatives from each university (NTU, NTOU, NSYSU) that operates a research vessel. The CMO-OLC is responsible for the budget and dispensing of funds for the Precious Instrument Center and for the scheduling of the ships. The members of this Committee should also act as the liaison to the universities.

2. Directorship

In the initial three years of the existence of the Center, the primary duties of the Director were disproportionately administrative in nature. Dr. Min-Pen Chen has served in a leadership role in this entire phase in the development of the Center, two years as the Acting Director and one year as the Deputy Director. He has done an excellent job in building up the administrative structure and the staff of the Center from ground zero. Now that a science team has been assembled and the science projects have become more clearly defined, the Center is entering into a new phase of development. The Director's main responsibility in this new phase should be to lead and facilitate the scientific research in the Center. The National Science Council would like to have an overseas scientist to assume the directorship of the Center. However, since the likelihood that an overseas person may join the Center as its director is slim, we recommend that a local scientist be allowed to become the Director of the Center (not just the Acting Director). This person should be a senior person with a broad outlook in oceanography so that s/he may be able to interact with and be able to be supportive of the investigators in all four sub-disciplines of oceanography. We recommend Dr. Kon-Kee Liu as the Director of the Center for the next term.

3. Hard Center and the Bureau of the Oceans

In order that the vision of the National Science Council for the National Center for Ocean Research may be fully realized, we recommend in the strongest possible term that the Center be converted from a virtual center into a hard independent center as soon as possible. Many of the difficulties in the operation of the Center stem from the fact that it is a virtual center. Thus, we support in concept the plan proposed by Dr. Min-Pen Chen and his colleagues for organizing a hard Center. However, we feel that the first mission of the Center should be to promote high quality oceanographic research rather than national practical oceanographic research. Among the three possible options: (1) a hard center with a board of trustees under the National Science Council, (2) a hard center with a board of trustees under a university and (3) a hard center as a part of the Academia Sinica, we feel that option (2) is the least desirable since it is likely to cause divisiveness among the three universities with a marine program. We consider options (1) and (3) as about equally viable. In option (2), there is more flexibility in the management of the Center. The Center is allowed to or required to solicit soft money support and it is held responsible for its own financial solvency. In order that the Center may concentrate on research rather than fund raising, it must not be required to become too soft. In option (3), the Center is assured to be 100% hard. However, the Academia Sinica lacks the experience in managing the operations of research vessels. No matter which avenue is chosen for creating a hard center, in order to facilitate intellectual exchanges, it is advantageous for the Center to be located in the vicinity of one of the universities with a strong program in oceanography. Furthermore, at the present time, the most urgent need is to convert the Center into a hard center. The avenue for

creating a hard center is of secondary importance.

We strongly support the establishment of a Bureau of the Oceans for Taiwan. We appealed for the formation of such a Bureau in a letter to Premier Shiao last Summer. We continue to feel strongly for this initiative. If a Bureau is formed, the service functions of the Center, including the operation of the research vessels, may be transferred to the Bureau. *A hard center is still needed for the present research functions of the Center. Without its service functions, having the Center as part of the Academic Sinica becomes an even more appealing option.*

D. Additional Comments

1. Foreign cooperation

At the moment all research in oceanography is conducted in Chinese and reports are written in Chinese. While the cultural and societal reasons for this are clear and admirable, it nevertheless is a serious obstacle for the attainment of international recognition. After all, the international language of science is in effect English. Unfamiliarity with English is an obstacle at foreign and national meetings, conferences, and symposia. Published papers and reports in Chinese are not easily read by the worldwide community and are therefore often not well-known.

Recommendation: Increase the use of English in reports and papers. At least relax requirements that written material be in Chinese and leave it as a choice for the authors. Encourage that talks given by visiting scientists who know both Chinese and English be given in English.

2. Infrastructure

To increase the success of the Center, more collaboration with other scientists, engineers, and industry in Taiwan should be encouraged to build on existing strengths and infrastructure. There are untapped opportunities in development of oceanographic and remote sensing instrument technology. Also, the science is dependent on support from government and industry. Thus more efforts should be made to appraise government agencies, not just NSC, and industry on the progress made. This can be achieved in part with an effective web page but also requires personal communication.

3. International collaboration

One of the missions of the Center is to promote international collaboration. Indeed the principal investigators, all quite young, can benefit from close cooperation with more experienced investigators. It would be beneficial to be able to provide limited reimbursement to foreign investigators who put major effort into a joint research project for their time. Apparently the current regulations do not allow this.