

Visit to Chinese oceanographic establishments*

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1. Introduction

During June and July of this year, I visited six main oceanographic establishments in four cities in China by invitation of Academia Sinica (AS) through efforts of Dr. Hanli MAO, Deputy Director Emeritus, Institute of Oceanology (OI), AS, Qingdao. We (invitation was extended to my wife who had lived in Manchurian District for more than 16 years) arrived at Beijing on May 31, then visited IOAS from June 4 to June 8. We went through Shanghai to Hangzhou from June 9 to 14, visiting the Second Institute of Oceanology, NBO there. On June 13 we flew to Gangzhou, visiting the South Sea Institute of Oceanography, AS from June 14 to 17, then we flew to Dalian, visiting Institute of Marine Environmental Protection, NBO from June 19 to 28. Then we returned to Qingdao, staying there until July 23, while I worked at IOAS and also visited Shangdong College of Oceanography and the First Institute of Oceanography, NBO. My purposes of visit are to present seminars and lectures mainly on my current research subjects and to prepare joint research programs to be submitted to USNSF mainly on dynamics and hydrography of the East China Seas and other adjacent seas of China. A more detailed report will be published in this journal after I collect sufficient materials through correspondence with various oceanographers who cordially treated me during my visit.

2. Outline of oceanographic establishments in China

It seems to me that in China oceanography becomes one of priority sciences as a part of the national modernization programs which include improving people's living standard and developing science in general. Therefore, oceanography is not only considered as one field of

science, but as contributing to economical development by helping marine transportation, fisheries, petroleum production, etc. State organizations supervising oceanography are AS which emphasizes oceanography as academic science and NBO which is more or less mission-oriented, though at most institutions the boundary is not so sharp as Japanese agencies such as Japan Meteorological Agency, Hydrographic Department or Japanese Fisheries Agency. Unlike US or Japan, very few universities offer an oceanography program *per se*. Only exception may be Shangdong College of Oceanography (SCO) which was established as the college for ocean sciences only but has expanded its scope recently to include even humanity programs.

3. Qingdao

Qingdao may be considered as the center of oceanographic activities in China with three institutes mentioned above with an additional fishery institute which I did not visit. Among the three institutes, IOAS seems to be the center of academic oceanography with more than 600 scientific and technical persons operating three research vessels of 3300, 1100 and 720 tons each. It covers all phases of oceanography but right now is rather heavily involved in geophysical-geological oceanography. Prof. MAO, Prof. G. GUAN and others are working on hydrography of the Yellow and East China Seas. Prof. MAO and his group have been working for some years on meso-scale eddies south of Cheju Island. My former colleagues at my Department, Mr. G. FANG and Mr. F. ZHANG are continuing their previous research topics with expanded scopes, the former on numerical modeling of tidal current in the Bohai and Yellow Sea with non-linear bottom stresses and the latter on hydrographic measurements of the Yantze River effluent for applying his models of diffusion in a shear current.

My discussions with Dr. MAO and Messrs. FANG and ZHANG have resulted in two joint

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projects. One is to study bottom dissipation processes in the Bohai for tidal and wind-driven currents using analytical and numerical modeling. The results will be calibrated by analyzing historical current data of the Bohai for tidal and wind-driven currents using analytical and numerical modeling. The results will be calibrated by analyzing historical current data of the Bohai collected by Chinese oceanographers. The other project is to study the exchange of the Kuroshio with the shelf water over the shelf break in the East China Sea. Three approaches will be tried. One is two-layer numerical modeling in a rectangular sea with the Kuroshio flowing in the upper layer with appropriate boundary conditions on open and solid boundaries. (This approach will be pursued also jointly with Mr. L. LI of Dalian). The other is stability analysis of the baroclinic Kuroshio along the curved shelf break. The third is EOF analysis of hydrographic data and IR images along the Kuroshio from north of Taiwan to its turning point west of Kyushu.

We also discussed with Dr. MAO about the Fourth JECSS (Japan and East China Seas Study) Workshop. The JECSS III was convened in May this year at Tsukuba University with co-conveners Prof. Kenzo Takano and myself and its plenary session decided that the JECSS IV will be held in China in 1987. I recommended Qingdao as the meeting place, since half of the oceanographers in China are working there and also good lodging facilities are available. Later Prof. TAKANO concurred with this proposal. Dr. MAO gracefully accepted the recommendation and will head the organizing committee for this meeting. He has started to solicit funds for the workshop from Academia Sinica, NBO, Ministry of Education and others.

The First Institute of Oceanography, NBO is comparable to IOAS in size of personnel and facilities including research vessels but it emphasizes on applied sciences, particularly providing basic data for port and harbor construction in the Bohai, and the Yellow Sea and studying resources and environmental problems of coasts of Jiangsu and Shandong Provinces. It also participated in international programs such as FGGE and Antarctic programs. Mr. Z. XIA is active in analytical and numerical modeling of the Yellow and East China Seas. Shangdong

College of Oceanography (SCO) includes undergraduate teaching of oceanography, but its faculty members engage in research often jointly with those of other institutes. Dr. Z.H. JING is active in theoretical work on circulation of the Yellow Sea and upper ocean dynamics.

During my stay in Qingdao I discussed at three institutes about possible field experiments by use of current meters offered by Prof. TAKANO on board Chinese ships to be deployed on the edge of the Kuroshio in the East China Sea. I also discussed a scheduled visit of the R/V Keitenmaru of Kagoshima University in early next year and probably in summer too. I suggested a preliminary experiment of deploying Takano's current meters on the first cruise of this ship with some Chinese scientists on board.

My two lectures at IOAS were on dynamics of the circulation of the northern East China Sea, particularly branching of the Tsushima Current and review of recent researches of the marginal seas in the U.S. About twenty to thirty audiences attended. I also gave two lectures at SCO on oceanic turbulence and diffusion and on dynamics of Langmuir circulation. Some students and faculty from other departments attended these lectures.

4. The Second Institute of Oceanography

The Second Institute of Oceanography, NBO is located in Hangzhou which is famous for scenic West Lake nearby and also has many historical sites because it was the capital of Sung Dynasty. Hangzhou is not a sea port and the research vessels of the institute are berthed in Shanghai. Closeness to Shanghai and the Chanjian delta stimulate the institute's activities on the marine pollution and delta formation. Prof. Y. YUAN and his several students are active in numerical modeling of the circulation of the East China Sea. Although mixing of the large-scale effluent from the Chanjian with the shelf water may change the circulation on the shelf and provides a unique example in the world ocean, systematic field study of this subject by measuring currents and hydrography is yet to come. Also change of the delta by fluctuations of the Changian transport and by wind, wave and tidal current will be an important topic both in scientific merits and environmental and economic aspects.

Some monitoring of the delta by aerial photography seems to be started but the results are not published yet. I gave a talk on the Tsushima Current and circulation in the Japan Sea for audience of about 20 scientists. I also discussed some of physical oceanography problems studied there with Prof. Y. YUAN and Prof. J. SU who are intensively working on circulation of the East China Sea. Mr. S. MURATA from Tsukuba University is also working on modeling at the Institute since last year.

5. South Sea Institute of Oceanography in Guangzhou

South Sea Institute of Oceanography in Guangzhou belongs to AS. Its size seems to be almost the same as IOAS in Qingdao, with about 300 scientists and technicians and two large research vessels. Their activities are focussed on the South China Sea, though the tropical Pacific Ocean is also included. Moreover, since the sea off the Pearl River delta has been found to store a large amount of petroleum, exploration and extraction of this resource are going on extensively as a joint enterprise with Britain, the United States and Japan. Thus the institute seems to devote its efforts to this direction mainly in geological and geophysical fields but also in physical and chemical oceanography, particularly for wave measurements and prediction, hurricane forecast, hydrography near the delta and others. Prof. J. GAN was a student of Prof. MAO and has worked on statistical analysis of hydrographic data of the East China Sea. Mr. T. YANG, Chief of Physical Oceanography Division, also a student of Prof. MAO has been active on various analytical modeling of wind-driven circulation of the Bohai, currents induced by a hurricane and others. He is currently preparing three dimensional numerical modeling of the circulation in the South China Sea jointly with Canadian oceanographers at Institute of Ocean Sciences. Prof. GAN and Mr. YANG recently moved from Qingdao to Gangzhou to start physical oceanography program there.

Both reminded me that the South China Sea is similar to the Gulf of Mexico in a sense that the Pearl River delta corresponds to the Mississippi delta with rich petroleum reserve

offshore and the circulation is strongly influenced by the Kuroshio or the Gulf Stream, though the Gulf of Mexico is actually the latter's origin. The circulation and the hydrography of the South China Sea may become closer to those of the Gulf of Mexico if the former is rotated by 90° clockwise. Therefore they asked me to give a lecture on the circulation and hydrography of the Gulf of Mexico and the Caribbean Sea which I obliged.

6. Institute of Marine Environmental Protection

Institute of Marine Environmental Protection at Dalian belongs to NBO and is mission-oriented as other institutes of NBO. It is relatively new (about 6 years old) but expanding rapidly. Mr. L. LI studied at my department in 1982-83 and worked on numerical modeling of the northern East China Sea with me. He arranged my visit there. He and Mr. DOU, Chief of Physical Oceanography Section asked me to give three lectures on three days on topics related to the marine pollution. I chose diffusion and dispersions of pollutants in the ocean, scientific results of monitoring ocean dumping in the U.S. and shallow water dynamics and physical oceanography related to pollution control. At present the institute's primary interest is focussed on the Bohai and the northern Yellow Sea. Particularly the Bohai is now in the stage of rapid development in both industrialization and petroleum exploration. Also Dalian and Tienjin are both among the busiest ports in China, only second to Shanghai. Therefore, a number of problems occur in relation to the marine pollution. As the basic problem for pollution caused by oil spill, Mr. DOU and his group are developing numerical models mainly for wind-driven circulation in the Bohai. These models are barotropic but they will expand these to two-layer or three dimensional models because the Bohai is influenced by effluents from three rivers.

The Tienjin-Lyuda districts seem to be most concentrated industrialized area in China. Their industrial wastes are now discharged into the Bohai which has a narrow mouth connected with the Yellow Sea. Therefore, eventually the Bohai will be highly contaminated. The government is planning to prevent this by introducing the

ocean dumping. The plan includes barge dumping in the northern Yellow Sea. Unlike the US practice, they are considering to use a barge which dumps the wastes almost instantaneously by pressure discharge from the barge tank. In the US a barge dumps the waste continuously for tens of kilometers while cruising with a speed of several knots. In order to determine the most efficient monitoring scheme of dumping, a laboratory experiment was started by simulating an instantaneous dumping in a tank.

7. Concluding remarks

Due to excellent arrangements through Dr. MAO, our trip was very successful not only for scientific purposes, but also in familiarizing with both historical and recent cultures of China. We experienced throngs of modernization processes everywhere we visited. At the same time in many places other than mentioned above, such as Beijing, Shenyang and Shanghai, historical relics and sites of more than 5 thousands years old are well-preserved or restored by national and local governments. So we were always thrilled with fast development side by side with the old tradition which could be traced back thousands of years ago.

In oceanography many institutions' attention seems to be focussed on geological and geophysical problems and on fisheries. This is understandable because oceanography also should serve to the people's living and offshore oil and mineral resources as well as living resources in the sea are very important to the Chinese.

Physical oceanography seems to be lagging behind these disciplines because it cannot provide immediate solution for economical development, though basic data for coastal development, marine transportation and harbor construction are sought

mainly through physical oceanography techniques. Also pollution aspects of industrial development has begun to be recognized, thus physical oceanography serves to this purpose extensively.

In practical aspects, scarcity of modern instruments of physical oceanography such as current meters, profiling instruments, and others may hamper extensive field works, although there are a number of research vessels with modern navigation equipments. Also difficulty in access to computers both small, intermediate and large in size is a hindrance to numerical modeling.

Many Chinese scientists including oceanographers repeated to us that one common problem in development in science now is shortage of experienced researchers and qualified teachers of age from 35 to 50 years old, because many researchers and scholars of the age range suffered from the Cultural Revolution during their formative years. However it is emphasized here that the scientific community is well aware of this fact. Particularly in physical oceanography recent graduates from major universities in physics, mathematics and engineering in Beijing, Shanghai and other big cities have been employed in most institutions I visited. These students are mainly doing research at graduate levels of MS or PhD of the US standard under tutelage of some researchers. If this practice is fortified with introduction of some formal courses on basics of physical oceanography at each institution or nearby institute of higher education, the future of Chinese physical oceanography will be bright.

We express our gratitude to Dr. MAO who arranged our trip and also to Messrs. F. ZHANG, L. LI, M. ZHOU and X. ZHANG who accompanied us in Beijing, Shanghai, Hangzhou, Shenyang and in between.