

T. ICHIYE (editor)

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**OCEAN HYDRODYNAMICS
OF THE JAPAN AND
EAST CHINA SEAS**

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OCEAN HYDRODYNAMICS OF THE JAPAN AND EAST CHINA SEAS

Edited by

T. ICHIYE

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PREFACE

OCEANOGRAPHIC FEATURES OF THE JAPAN AND EAST CHINA SEAS

The Japan and East China Seas form the western marginal seas of the North Pacific Ocean together with the South China Sea. However, in oceanographic characteristics, the two seas are completely different. The East China Sea (including the Yellow Sea and Bohai Bay here) is a broad continental shelf with depths less than 200 m. Its hydrography is strongly influenced by effluents from the Changiang (Yantze) and the Huang Ho (Yellow River) on its eastern open boundary (see Guan of this volume for comprehensive description). The circulation of this sea seems to be influenced by the wind, particularly the prevailing northwesterly wind in colder seasons, by the effluents and by the intrusion from the Kuroshio (see Yuan, Jing, and Kang of this volume for dynamics). The sediment transport from the two large rivers is estimated by Milliman of WHOI as equivalent to dumping a few Great Walls per year. The suspended matter by this transport makes the sea most interesting for sedimentologists and chemical oceanographers.

The Japan Sea, on the other hand, is a semi-enclosed basin reaching more than 3000 meters in depth. Its hydrography and circulation are also unique in a basin of this size. The warm and saline water from the Kuroshio enters through its southern inlet, the Tsushima Strait and forms the Tsushima Current System in the upper 300 m. The current splits in two main branches: one moves off the Japanese coast and the other off the Korean coast. Eventually most of the water flows out from the northern two outlets, the Tsugaru and Soya Straits. However, the bulk of the water with low temperature and salinity in the Japan Sea is formed in the northern half of the sea and spreads almost uniformly below 300 m. Thus this sea is in fact a "miniature ocean" (see Ichiye of this volume for hydrography and dynamics).

HISTORICAL ASPECTS

It is strange that these two seas were not widely used historically for transportation by the people of three countries bordering them, China, Korea, and Japan, though the civilization in the region, particularly of China was developed as early as that of the Mediterranean. Perhaps this is mainly because of difficulties in navigation of these seas and of the land based culture of the ancient China in contrast to maritime cultures of Egypt, the Mid-East and Greece.

The Japanese, though islanders, were not seafaring people as Vikings, Polynesians, the Mediterranean peoples and north Europeans until in recent years. This is because the seas surrounding Japan are rough for the primitive navigation and also because the land itself is moderate in climate and, though limited in arable land area, was sufficient to provide its inhabitants with necessities in the old days, unlike the British Isles. This is illustrated by a fact that the Japanese can preserve the indigeneous culture even to this day, although they have been influenced by the Chinese culture through Korea since the third century B.C. The Tsushima (Korea) Strait is approximately 115 miles wide, as compared to 21 miles for the Dover Strait. This difference keeps Japan's isolation from its neighbors far greater than the peoples of the British Isles (Fairbanks, T. K., Reischauer, E. O., and A. M. Craig, *East Asia, Tradition and Transformation*, Houghton-Mifflin, New York, 1973).

Until modern ages, the two seas were usually peaceful. The Korean Strait was not only a conduit of the Chinese culture into Japan but also of steady flow of people from Korea to Japan until the early ninth century. The Japanese also sent embassies to China from the sixth century until the ninth century at first along the Korean coast, then over the east China Sea across the five hundred miles of open sea without benefit of navigational skills, mainly to learn the Chinese culture, particularly of the Tang Dynasty. After then, though official exchanges between the two countries stopped, trading ships from Japan visited Korea and China since the eleventh century.

Two times the Korean Strait was used as the route by invading armies, first by the Mongol fleets invading Japan in the thirteenth century and second by a Japanese General, Toyotomi Hideyoshi invading Korea in the late sixteenth century. The Japanese merchant adventurers greatly increased their trades with China in the thirteenth and fourteenth centuries but later they often seized what they wanted when officials of Korea and China restricted their trades and were called by the peoples of the two countries as "Waco" (Japanese pirates). After consolidation of the Ming dynasty in China in the fifteenth century, trades between Japan and China thrived until the early seventeenth century when the Japanese government closed the country. However, even during this period of forced isolation of Japan tricles of trades and transportation were carried out through the Korean Strait and the East China Sea between Japan and the Asian continent.

After the opening of Japan in 1866, these trades were greatly expanded. Unfortunately, at the same time Japan's policy collided with the interest of continental powers of Asia and these two seas are remembered as scenes of great sea battles, first the Yellow Sea Battle of 1904 and second the Japan

Sea (Tsushima) Battle in 1905, both ending in overwhelming victories of the Japanese fleets. During World War II, the Japan Sea was dubbed as "the Emperor's wading pool" but some foolhardy U.S. submarines ventured into it from the early stage of the conflict. It is again unfortunate that the Japan Sea has become a household word since the incident of the shooting down of a Korean airliner in September of last year.

JECSS PROGRAM

The JECSS (Japan and East China Seas Study) Program was started informally in 1980 and the First Workshop was convened on June 1 to 4 in 1981 at Tsukuba University with the support of the Hidaka Foundation by a joint convenership of Professor K. Takano of the University and myself. Numbers of participants were forty-one (twenty-seven from Japan, seven from the U.S., six from Korea and one from China) and twenty-four papers were presented. The proceedings of 94 pages were published by the Japanese-French Oceanographical Society (Tokyo) as a compilation of thirteen papers which were published in "La mer", journal of the Society. At the plenary session of the Workshop, three main decisions for the operation of the program were made in addition to promoting the cooperative study among participating countries and for publishing the proceedings. These items are: (1) the Second Workshop will be held in April in Japan, (2) the recognition by IOC (International Oceanography Commission) of UNESCO or other international organizations will be sought, and (3) oceanographers of China (Taiwan) will be invited.

During 1982 preparation for the JECSS-II Workshop was carried out mainly in Japan by Professor Takano. Late that year the JECSS Program was recognized as an associate program of the WESTPAC Program which has been an international cooperative research project sponsored by IOC-UNESCO. Also the Second Workshop at Tsukuba University was sponsored by the Japan Marine Science and Technology Center (JAMSTEC), IBM-Japan at Tokyo Scientific Center (TSC), Oceanography Section of the American Geophysical Union, Japanese-French Oceanographical Society and the Oceanographical Society of Japan with the same conveners, Ichiye and Takano. As local organizers, Dr. K. Muneyama (JAMSTEC) and Dr. Y. Tozawa (IBM) were included in addition to Professor Takano.

In December 1982 invitations to potential participants from the U.S., China (Beijing and Taipei), Korea, and the U.S.S.R. were sent by Ichiye and to those from Japan by Takano. The 2nd Workshop was convened on April 22 to 27, 1983, at Tsukuba University and was participated by forty-six people (twenty-seven from Japan, seven from Korea, six from China and six from the U.S.) and thirty-eight papers were presented. The program of the Workshop

is attached at the end of this preface.

Four design sessions were held to plan future cooperative studies of the two seas. One is on experiments using drifters. The subjects to be studied may be focused on branching of the Tsushima Current from Kuroshio, meander of the Tsushima Current and coastal currents along China and Korea. Drifters newly developed by WHOI were recommended because of their easy handling, moderate price and uncomplicated tracking by local Loran C stations. The second session is on cooperative measurements by use of moored current meters and conventional hydrographic methods. A Korea-Japan joint program of direct current measurements in the Korean Strait was discussed. Also talked about was more coordination of on-going hydrographic surveys carried out by different government organizations of Korea and Japan. The third session is on improvement of usage of satellite remote sensing in the two seas. It was emphasized that Japan has centers which specialize in storing the data on the two seas both from the U.S. and Japanese satellites and that the sea truths are unusually abundant around Japan because of various routine hydrographic surveys of Japanese organizations. The fourth session was on cooperation in modelling. In this field, synthesizing numerical modelling of the East China Sea by Chinese and Korean modellers was urged. Also, a joint venture was proposed by Chinese, Japanese and Korean theoreticians to understand the dynamics of the circulation in the Japan and East China Seas. In plenary sessions publication of the proceedings and the newsletter were discussed. The Editorial Board listed below was set up for publication of the proceedings. The newsletter was to be published quarterly by JAMSTEC and IBM-Japan with Dr. Muneyama serving as editor. Finally it was decided that the 3rd JECSS Workshop will be held in 1985 in Tsukuba during the Science EXPO there.

Editorial Board:

T. Ichiye (Chairman)	Department of Oceanography, Texas A&M University
K.-L. Fan	Institute of Oceanography, National Taiwan University
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S. Moriyasu	Meteorological Res. Inst., Japan Meteorol. Agency
K. Takano	Inst. of Biological Sci., Tsukuba University
Y. Toba	Geophysical Inst., Tohoku University

The formal report cannot convey the atmosphere of the meeting. Exchange of ideas and opinions were very intense and cordial even after the formal session, mainly because most participants were lodged in facilities on the campus of Tsukuba University. A one-day excursion on Sunday, April 24 to Mashiko porcelain center and the resort area Nikko enhanced such exchanges in addition to the reception and picnic parties on campus and other informal

gatherings.

PROCEEDINGS OF THE JECSS-II

After the meeting, publication of the proceedings was offered by Dr. Henk van der Rijst of Elsevier Science Publishers as a book in their Elsevier Oceanography Series. In order to make prompt publication the manuscripts are to be prepared in camera-ready form. In July the potential authors were notified of this decision with instructions for preparation of their manuscripts. They were also notified to send their draft copies to members of the Editorial Board in respective countries for review in scientific contents and to the Chairman of the Board for general editorial review.

Manuscripts started to reach me in mid-September. Although my task is to review these manuscripts from an editorial point of view, I found it worthwhile to have them reviewed by other oceanographers for their scientific content also and particularly for language for papers written by non-English speaking authors.

I could ask reviewers all over the U.S. for papers submitted to the proceedings. I decided against this, since from my experiences in reviewing numerous papers, a reviewer would not send a thorough review within a short time if he is not really concerned with publication of the paper. Therefore I chose reviewers from my colleagues at our University, mostly from our Department. Their names are listed alphabetically as follows: D. Brooks, J. Klinck, D. McGrail, S. Patterson, R. O. Reid, K. Rikiishi (visiting staff), A. Vastano and R. Whitaker of the Oceanography Department and J. M. Niedzwecki of the Ocean Engineering Department. All of these reviewers are faculty or scientific staff and have already published a number of papers in the fields closely related to the subjects discussed in the submitted papers. It turns out that the advantage of choosing my colleagues on campus as reviewers was not only their prompt response but also was to get their verbal commentaries in addition to their written ones. I transmitted them to each author as much as possible.

Meanwhile, Professor Takano also reviewed all papers by the Japanese authors and some by authors from China and Korea. Besides, he has made camera-ready copies of four papers from China (Mainland) to facilitate their publication. In fact, preparation of a camera-ready copy needs quite an effort by each author. Most authors did excellently in this difficult task within a limited period of time. Since the deadline unfortunately coincided with the Christmas-New Year mail rush, there were delays for some final copies to reach me.

ARRANGEMENT OF THIS VOLUME

Contributed papers could be grouped according to the two seas. However, some papers dealt with subjects applicable to both seas. Also some papers treated processes in both seas. Therefore they are arranged by their subjects: hydrography and descriptive oceanography, analytical and numerical modelling, coastal phenomena, sea level and tides, measurements and data analysis. Within each subject the papers are arranged from general to particular in their treatment. This classification is arbitrary and some papers transcend the boundaries. Therefore I hope that the readers may consider each paper as independent.

There are some omissions in subjects dealt with by the contributed papers. Notable is a comprehensive description of hydrography of the Japan Sea, despite abundance of the hydrographic data available. I have tried to remedy this in my paper which is an expansion of my presentation at the workshop but perhaps without much success since the original work was mainly on dynamics of the circulation in the Japan Sea. This deficiency will hopefully be remedied in the JECSS III Workshop.

ACKNOWLEDGEMENTS

If this volume is of any value for oceanographic community and general readers, the credit is due to the authors. Also members of the Editorial Board and reviewers are appreciated for their efforts. Among the individuals who contributed to the JECSS program, the share of Professor Takano is the greatest, not only in organizing the Workshop with Drs. Tozawa and Muneyama but in finishing up this volume. Also, it is fortunate that Dr. Rikiishi, as a visiting research scientist, has offered his volunteer service for editing this volume with meticulous care. Mrs. Debbie Paul of the Department of Oceanography typed editorial correspondences. The JECSS Program has become almost our family business. My wife, Chiyoko, accompanied me in the First JECSS Workshop, designed artworks of the proceedings and went to Japan after the JECSS I for fixing some loose ends of my trip. My elder daughter Toshiko accompanied me at the JECSS II to help in organizing it. My younger daughter, Keiko, also helped me in sending letters and notices for the JECSS II.

Publication is subsidized by IBM, Japan. My work for editing this volume is supported by the Office of Naval Research.

Takashi Ichiye
January 2, 1984
at College Station, Texas, U.S.A.

THE PROGRAM OF THE SECOND JECSS (JAPAN AND EAST CHINA SEAS STUDY) WORKSHOP
(The asterisk (*) indicates the author who presented the paper.)

April 22 (Friday Morning)

1 OPENING REMARKS

Chairman: Tozawa, Y. (IBM-Japan)

- (1-1) PROBLEMS HOPEFULLY TO BE DISCUSSED DURING JECSS-II WORKSHOP
Ichiye, T. (Texas A&M University)

2 HYDROGRAPHY AND DESCRIPTIVE OCEANOGRAPHY (GENERAL FEATURES OF THE JAPAN AND EAST CHINA SEAS)

Chairman: Huh, O. I. (LSU)

- (2-1) MAJOR FEATURES OF THE SHALLOW WATER HYDROGRAPHY IN THE EAST CHINA SEA AND HUANGHAI SEA
Guan, B. (Inst. Oceanol.)
- (2-2) WATER MASSES, CIRCULATION AND REMOTE SENSING IN THE EAST CHINA SEA
Limeburner, R. (WHOI)

April 22 (Friday Afternoon)

- (2-3) WATER MASSES AND DISTRIBUTION OF PROPERTIES IN THE SEA OF JAPAN
Kim, K. (Seoul National University)

Chairman: Kim, K. (Seoul National University)

- (2-4) CHARACTERISTICS OF THE KUROSHIO AND THE CURRENT IN THE TAIWAN STRAIT
Fan, K.-L.* and Chen, J.-C. (National Taiwan University)
- (2-5) A TEST OF GEOSTROPHIC APPROXIMATION IN THE WEST CHANNEL OF KOREAN STRAIT
Wiseman, W. J., Huh*, O., Shim, T. and Chuang, W.-S. (LSU)
- (2-6) OCEANOGRAPHIC SURVEY RESULT OF SUMMER 1981 AND SPRING 1982 IN THE SOUTH-WESTERN PART OF THE JAPAN SEA
Byung, S.-K. (KORDI)
- (2-7) TIDES AROUND TAIWAN
Yin, F. (National Kaohsiung Inst. Mar. Technol.)

April 23 (Saturday Morning)

3 HYDROGRAPHY AND DESCRIPTIVE OCEANOGRAPHY (SPECIAL TOPICS)

Chairman: Nishida, H. (Hydrog. Dept.)

- (3-1) MEASUREMENT OF STORM-GENERATED BAROCLINIC MOTION ON THE EAST COAST OF SOUTH KOREA
Seung, Y. H.* (Inha University) and Byun, S.-K. (KORDI)
- (3-2) VARIABILITY OF MONTHLY MEAN SEA LEVEL AND ITS REGIONAL FEATURES AROUND JAPAN AND KOREA
Tomizawa, K.*, Hanawa, K., Kurasawa, Y. and Toba, Y. (Tohoku Univ.)
- (3-3) COASTAL CURRENTS AND HYDROGRAPHY OF THE JAPAN SEA
Odamaki, M. (Hydrog. Dept.)
- (3-4) DIFFERENCES OF MOLECULAR NATURES OF METAL ORGANIC COMPOUNDS AMONG THE WATER OF THE EAST CHINA SEA, JAPAN SEA AND WESTERN NORTH PACIFIC
Sugimura, Y.* and Suzuki, Y. (Meteorol. Res. Inst.)

April 23 (Saturday Afternoon)

4 CURRENTS

Chairman: Seung, Y.-H. (Inha. Univ.)

- (4-1) UTILIZATION AND INTERPRETATION OF DRIFTER DATA
Kirwan, A. D. (Univ. South Florida)
- (4-2) OCEAN CONDITION AND RESULTS OF TRACKING ARGOS BUOYS IN THE SOUTHERN EAST CHINA SEA
Nishida, H. (Hydrog. Dept.)
- (4-3) CURRENTS MEASUREMENTS WITH MOORED INSTRUMENTS AND DRIFTERS IN THE TSUSHIMA CURRENTS
Miita, T. (Fukuoka Fish. Experimental Sta.)
Read by Kawatate, K.
- (4-4) AN UNDERWATER SLIDING VEHICLE FOR COLLECTING OCEANIC DATA: A PLAN AND PRELIMINARY RESULTS
Tsuji, Y.*, Nomoto, M. and Sasaki, K. (JAMSTEC)
- (4-5) A TENTATIVE DESIGN OF MOORED LINES FOR MEASURING THE TSUSHIMA WARM CURRENT
Kawatate, K. (Kyushu Univ.)
- (4-6) SOME ASPECTS OF THE CIRCULATION IN THE EAST CHINA SEA
Hsueh, Y. (Florida State Univ.)
Read by Kim, K.

April 25 (Monday Morning)

Chairman: Milliman, J. (WHOI)

- (4-7) LOW FREQUENCY FLUCTUATIONS OF NEARSHORE SURFACE CURRENT OFF BUKU ON THE EAST COAST OF KOREA
Lie, H.-J. (KORDI)
- (4-8) STRUCTURE OF THE TIDAL FLOW AROUND THE AINOSHIMA ISLAND OFF THE NORTH-EAST COAST OF KYUSHU
Kaneko, A. (Kyushu Univ.)
- (4-9) WAVE PREDICTION IN THE JAPAN AND EAST CHINA SEAS USING THE DAS-5 MODEL
Park, Y.-H. (Jeju National Univ.)
GROUP DISCUSSION ON DEVELOPMENT OF DRIFTERS AND CURRENT METERS TO THE TSUSHIMA CURRENT
Chief Panelist: Kirwan, A. D.

April 25 (Monday Afternoon)

5 THEORY AND MODELING

Chairman: Jing, Z.-H. (Shandong College of Oceanol.)

- (5-1) INERTIAL INLET-OUTLET FLOW IN CIRCULAR BASINS
Masuda, A. (Kyushu Univ.)
- (5-2) BAROTROPIC FLOWS IN A CIRCULAR BASIN AT MID-LATITUDE
Sakai, S. (Univ. of Kyoto)
- (5-3) EXPERIMENTAL STUDIES ON THE FORMATION AND DEGENERATION PROCESSES OF THE TSUGARU WARM CURRENT
Sugimoto, T. and Kawasaki, Y.* (Univ. of Tokyo)

Chairman: Masuda, A. (Kyushu Univ.)

- (5-4) NONLINEAR MODELS OF COASTAL UPWELLING AND ITS JET IN A CONTINUOUSLY STRATIFIED SEA
Jing, Z.-H. (Shandong College of Oceanol.)

- (5-5) NUMERICAL MODELING OF THE CIRCULATION IN THE EAST CHINA SEA
Yuan, Y.* and Su, J. (Seond Inst. Oceanol.)
- (5-6) A THREE DIMENSIONAL MODEL OF THE EAST CHINA SEA
Choi, B.-H. (Sung Kyunkwan Univ.)

April 26 (Tuesday Morning)

- (5-7) ANALYTICAL MODEL OF UPWELLING INCLUDED BY TIDAL CURRENT PAST PENINSULAS IN THE YELLOW SEA
Xia, Z.-W. (First Inst. Oceanol.)
- GROUP DISCUSSION ON SYNTHESIS OF THE MODELING OF THE JECSS AREA
Chief Panelists: Choi, B.-H. and Masuda, A.

6 SEDIMENT TRANSPORT

Chairman: Fan, K.-L. (National Taiwan University)

- (6-1) TRANSPORT OF SUSPENDED PARTICLES FROM THE YANGTZE RIVER TO THE EAST CHINA SEA
Milliman, J.* (WHOI) and Yang, Z.-S. (Shandong College Oceanol.)
- (6-2) TURBIDITY DISTRIBUTION NEAR OCEANIC FRONTS IN THE COASTAL REGIONS OF THE EAST CHINA SEA
Matsuike, K. (Tokyo Fish. Univ.), Okuda, K.* (Tohoku Univ.) and Uehara, K. (USIO Inc.)

7 REMOTE SENSING

Chairman: Toba, Y. (Tohoku University)

- (7-1) THE SOUTH KOREAN COASTAL CURRENT: FALL-SEASON DISCHARGE OF EASTERN YELLOW SEA SURFACE WATER INTO THE SEA OF JAPAN
Huh, O.K.*, Shin, T., Rouse, L.J., Wells, J.T. (LSU) and Na, J.Y. (Univ. of Texas)

April 26 (Tuesday Afternoon)

- (7-2) PATTERNS OF TURBIDITY AND THEIR IMPLICATIONS TO ENTRAINMENT AND TRANSPORT OF SEDIMENT INTO THE SOUTH KOREAN COASTAL CURRENT
Wells, J. T.* and Huh, O. K. (LSU)
- (7-3) AN APPLICABILITY FOR OCEANOGRAPHY OF NOAA-AVHRR AND NIMBUS-7 REMOTE SENSING
Muneyama, K.*, Sasaki, Y., Asanuma, I. (JAMSTEC), Saito, S. and Tozawa, Y. (IBM-Japan)
- (7-4) DATA INTEGRATION TECHNOLOGY OF REMOTE SENSING FOR OCEANOGRAPHY
Tozawa, Y.*, Sato, M., Ioka, M. (IBM-Japan), Muneyama, K., Sasaki, Y., and Asanuma, I. (JAMSTEC)

Chairman: Byung, S.-K. (KORDI)

- (7-5) A SUMMARY OF SATELLITE-DETECTED OCEANIC FRONTS AND WATER MASSES, SEA OF JAPAN, EAST CHINA SEA AND YELLOW SEA
Huh, O. K. (LSU)
- (7-6) SYNTHETIC APERTURE RADAR (SAR) IMAGERY OF STORM-INDUCED SEAS AROUND THE GOTO ISLANDS, JAPAN
Huh, O. I.*, Mastin, G. and Suhayada, J. K. (LSU)
- (7-7) ON THE CHARACTERISTIC STRUCTURE AND THE KUROSHIO EXTENSION
Kawamura, H.*, Hanawa, K. and Toba, Y. (Tohoku University)
- (7-8) STRUCTURE OF HORIZONTAL TURBULENCE IN THE JAPAN SEA
Toba, Y.*, Kawamura, H., Yamashita, F. and Hanawa, K. (Tohoku Univ.)

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April 27 (Wednesday Morning)

GROUP DISCUSSION ON APPLICATION OF REMOTE SENSING TO THE JECSS AREA
Chief Panelists: Huh, O. K. and Toba, Y.

- 8 PLENARY SESSION: PUBLICATION OF THE PROCEEDINGS AND PLAN OF JECSS-III
Chairman: Tozawa, Y.
- 9 DESIGN OF DRIFTER EXPERIMENT
Chairman: Kirwan, A. D. and Nishida, H.

April 27 (Wednesday Afternoon)

- 10 DESIGN OF MOORED CURRENT METER EXPERIMENT
Chairman: Kawatate, K. and Kim, K.
- 11 DESIGN OF COOPERATIVE PROGRAMS OF REMOTE SENSING
Chairman: Tozawa, Y. and Huh, O. K.
- 12 DESIGN OF COOPERATIVE PROGRAMS OF MODELING
Chairman: Jing, Z.-H. and Choi, B.-H.
- 13 CLOSING REMARKS
Guan, B. (Institute of Oceanology)

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