

**THE OCEANOGRAPHIC DATABASE OF THE SOUTH CHINA SEA
AND ADJACENT WATERS**

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ABSTRACT The paper provides the general information about the initial oceanographic database - the first step toward the establishment of Vietnam Oceanographic Data Center (VODC), especially, about the process of data acquisition, quality control, storage and management and also about the volume and type of all data available in the database.

CƠ SỞ DỮ LIỆU HẢI ĐÔNG HỌC BIỂN NÔNG VÀ KÊ CĂN

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TÓM TẮT Bài báo cung cấp thông tin tổng quát về việc thiết lập cơ sở dữ liệu hải đông học ban đầu nhằm tiến đến thành lập Ngân Hàng Dữ liệu biển Quốc gia, các bước và quá trình kiểm kê thu thập, phân giá chất lượng, lưu trữ và quản lý dữ liệu hải đông học Biển Nông và Kê căn. Ngoài ra, bài báo còn cho thấy chung loại và khối lượng toàn bộ dữ liệu hiện có trong cơ sở dữ liệu.

INTRODUCTION

Since 1996 in the framework of the National Project KHCN-06.01 on establishment of the Vietnam Oceanographic Data Bank the Oceanographic Database of the South China Sea and adjacent waters began to be built and called VODC database. The software package VODC for PC version 2.0 designed and developed by the programmer group of Nhatrang Institute of Oceanography [4] is used for data inventory, collection, quality control, storage and management. The geographic area chosen for data management

is the whole South China Sea (SCS) and adjacent waters limited by the longitudes 99°E and 125°E, and the latitudes 5°S and 25°N. The data types chosen for management in the project are the basic data of natural condition, resources and marine environment indicated in the Table 1.

Besides, we are now preparing a Web Site called VODC Homepage to support some oceanographic information and data services to users [5].

The main characteristics of the primarily established Oceanographic Database are given below.

Table 1: The data types chosen for management at present time

Data type code	Data type	Data type code	Data type
M05	Occasional standard meteorological measurements	D03	Currents measured from ship drift
		D04	GEK
M06	Routine standard meteorological measurements	D05	Surface drifters/drifting buoys
M90	Other meteorological measurements	D06	Neutrally buoyant floats
H10	CTD stations	D09	Sea level measurements
H11	Subsurface measurement underway (T, S)	D71	Current profiler (ADCP)
H13	Bathythermograph drops	D72	Instrumented wave measurements
H16	Transparency	D90	Other physical oceanographic measurements
H17	Optics (underwater light levels)	G01	Dredge
H21	Oxygen	G02	Grab
H22	Phosphates	G03	Core-rock
H23	Total-P	G04	Core-soft bottom
H24	Nitrates	G26	Seismic reflection
H25	Nitrites	G27	Gravity measurements
H26	Silicates	G28	Magnetic measurements
H27	Alkalinity	G73	Single-beam echosounding
H28	pH	G74	Multi-beam echosounding
H31	Radioactivity	G90	Other geological or geophysical measurements
H71	Surface measurement underway (T, S)	B01	Primary productivity
H74	Carbon dioxide	B02	Chlorophyll-a
H75	Total-N	B06	Dissolved organic matter
H76	Ammonia	B08	Phytoplankton
H90	Other chemical oceanographic measurements	B09	Zooplankton
P01	Suspended matter	B13	Eggs/larvae
P02	Trace metals	B16	Benthic bacteria/micro-organisms
P03	Petroleum residues	B17	Phytobenthos
P04	Pesticides	B18	Zoobenthos
P90	Other contaminant measurements	B71	Particulate organic matter
D01	Current meters	B90	Other biological measurements

DATA SOURCES

The oceanographic information and data were derived from:

- Domestic marine research institutions: Institute of Oceanography in Nhatrang (IO), Branch of IO in Hanoi, Marine Hydrometeorological Center in Hanoi, Center of Marine Geology and Mineral Resources, Center of Marine Mechanics, Vietnam IOC and National Programmes of Marine Research

(NPMR). Only data inventory was made for Hydrometeorological Center in Ho Chi Minh City, Research Institute of Marine Products in Haiphong, Institute of Oil and Gas, Branch of IO in Haiphong and Hanoi State University.

- Overseas oceanographic data centers: World Data Center-A (WDC-A), World Data Center-B (WDC-B), Ocean Climate Laboratory US National Oceanographic Data Center (OCL NODC) and Japan Oceanographic Data Center (JODC).

CRUISE AND STATION INVENTORY

According to the results of preliminary inventory of available oceanographic data carried out since 1997, there were more than 6,731 oceanographic observation cruises completed in the chosen geographic area, including 679 cruises of Vietnam, 191 cruises of USSR, 3,977 cruises of USA, 624 cruises of Japan, 316 cruises of Australia, 169 cruises of UK, 115 cruises of China, 54 cruises of Thailand, 68 cruises of Indonesia, 8 cruises of the Philippine, 45 cruises of Taiwan, 41 cruises of Singapore, 27 cruises of Canada, 24 cruises of New Zealand, 16 cruises of Netherlands, 7 cruises of Denmark, 4 cruises of France, 3 cruises of Malaysia, 3 cruises of Germany, 2 cruises of India. More than 149,000 serial stations and 742 long-time series of current and wave data were recorded. 34 long-time (4-30 years) series of marine hydrometeorological and environmental monitoring data are available. Majority of cruises were completed during period of 1956-1975 [7].

Cruise inventory (catalog) includes information on data owner, cruise number or name, ship/platform name, ship/platform type, ship/ platform code, country code, start day, end day, departure port, return port, leading laboratory, scientific chief, project name, data medium, data types, number of stations or observations, locations of stations (longitude and latitude), depth interval of observation and remarks (method of observation...).

Station inventory (catalog) includes information on ship/platform name, cruise number or name, ship/platform code, country code, location of station (longitude and latitude), day and time of observation and data types.

DATA ACQUISITION AND VALIDATION

Almost all data of domestic marine research institutions were in manuscript form, but the important part of them has been digitized and computerized by using VODC

software. All data of overseas oceanographic data centers were stored in CD-ROM. They have been converted to the VODC format.

The data stored in VODC database were collected from very different sources and measured by different way, so it is necessary to check for their validation.

A quality control of historical oceanographic data, is very complicated procedure because many information about the data were unknown, for example, the status of calibration of measurement methods and instrument, the parameters of an instrument deployment, the method and skill of sampling and analysis, etc. Therefore, here we can say only about some possible procedures of data quality control. Comprehensive quality control may be made only for data of each individual new cruise, following the procedures indicated in [3, 6].

Quality control procedures are considered to comprise of two following distinct aspects:

a) Automatic quality control: Checks on individual data points or the internal consistency of the data. These checks are mostly applied by computer and provide tests for timing and location errors, physical limits of data, duplicate checks, excessive inversion and gradient check, standard deviation check.

b) Oceanographic assessment: An assessment of the oceanographic "reasonableness" of data set comprising checks on expected patterns or trends and comparisons with other data sources. Higher level oceanographic assessment generally involves the application of further analytical methods (e.g. objective analysis to serial station data, harmonic analysis to long time data series and so on).

For historical and newly collected data the tests for their physical limits must be considered as the first step of automatic data quality control. The limiting values of different variables in the SCS and adjacent waters are given in the Tables 2, 3 and 4, where the Table 2 has been created referred to the historical hydrometeorological data of Vietnam [1] and their variability limits for the

World Ocean [6], the Table 3 – to the result of T - S analyzing about 17,000 STD profiles covering all over the SCS and adjacent waters [2, 8], and the Table 4 – to all the

hydrochemical data available in the VODC database (Table 5) and their variability limits for the North Pacific [3].

Table 2: Limiting values of parameters of meteorology and sea surface state

Parameters	Unit	Limits
Identification information		
Latitude		05 ⁰ S – 25 ⁰ N
Longitude		099 ⁰ E – 125 ⁰ E
Month		01 - 12
Day		01 - 31
Time	h	00.00 – 24.00
Bottom depth	m	0000 – 5000
Ship hydrometeorological and wavemeter observations		
Wind speed	m/s	00 – 75
Wind direction	degs	000 – 360
Air temperature	°C	-05.0 - +45.0
Relative humidity	%	010 – 100
Rainfall	mm/24h	000 – 800
Air pressure	mb	0800 – 1050
Wave height	m	00 – 40
Wave direction	degs	000 – 360
Wave period	s	00 – 30
Water transparency	m	00 – 50
Water colour	scale	01 – 21
Cloud	code	00 – 10
Visibility	code	0 - 9

For many analysis purposes, it is necessary to interpolate data from observed levels to standard depth levels. The standard depth levels selected for the SCS are 0, 10, 20, 30, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500, 4000,

4500, 5000 meters. In principle, the VODC software allows to interpolate from observed levels to any interested levels. Some data quality control checks are made only for standard depth levels, e.g. standard deviation check.

Table 3: Temperature and salinity limiting values

Layers of depth (m)	Temperature, °C		Salinity, ‰	
	min	max	min	max
0 - 50	08.00	35.00	00.00	36.50
51 - 100	10.00	31.00	20.00	36.00
101 - 400	07.00	30.00	32.00	36.00
401 - 1100	01.00	18.00	32.50	36.00
1101 - 3000	01.00	12.00	33.00	35.50
>3000	00.00	11.00	34.40	34.80

Table 4: Refined limiting values of some hydro-chemical parameters and primary bio-productivity

Parameter name	Unit	Refined limits	
		min	max
O ₂	ml/l	0.0	10.0
pH	unitless	7.0	9.0
Alkalinity	meq/l	0.4	2.8
PO ₄	μM	0.0	10.0
P _{total}	μM	0.0	8.0
SiO ₃	μM	0.0	300.0
NO ₂	μM	0.0	100.0
NO ₃	μM	0.0	15.0
N _{total}	μM	0.0	30.0
Chlorophyll-a	μg/l	0.0	20.0
Pr.-Productivity	mgC/m ³ /day	0.0	2000.0

ACTUAL OCEANOGRAPHIC DATA HOLDINGS

The type and volume of data available in the VODC Database are presented in Table 5.

CONCLUSION

The above mentioned database can be considered as the initial oceanographic database-the first step toward official establishment of the Vietnam Oceanographic Data Center. For some data type (e.g. in the field of hydrology, hydrochemistry and hydrodynamics) the volume of data is big enough to serve many requirements of exploitation, protection and investigation of the sea. In near future we hope that the database will be updated with data from other domestic and foreign oceanographic data sources.

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Table 5: The type and volume of the oceanographic data of the SCS and adjacent waters available in the VODC Database

Data type	No. of serial stations	No. of time series	No. of observations	Period of observation
HYDROLOGY & HYDROCHEMISTRY				
Temperature	119,628	242	3,380,954	1888-1999
Salinity	29,516	64	524,218	1907-1999
Oxygen	13,209		267,048	1929-1998
Phosphate	7,632		55,775	1929-1998
P _{total}	781		1,583	1991-1998
Nitrate	3,929		26,802	1929-1998
Nitrite	3,704		24,559	1929-1998
N _{total}	810		1,783	1991-1998
Silicate	4,940		35,781	1947-1998
Alkalinity	893		6,465	1961-1998
pH	7,483		49,109	1929-1998
MARINE HYDRO - DYNAMICS				
Surface current	94,514		94,514	1900-1998
Current meters		620	171,965	1980-1998
Sea level		284	209,587	1990-1998
Wave	2,147	122	22,077	1976-1998
MARINE METEOROLOGY				
Air pressure	673	190	23,045	1970-1998
Wind	680	241	33,253	1970-1998
Cloud	529		1,053	1970-1998
Air temperature	440	241	34,009	1970-1998
Humidity	1,053	242	29,183	1970-1998
Rainfall	894	192	4,476	1970-1998
Water colour	261		261	1970-1998
Water transparency	2,246		2,246	1970-1998
GEOLOGY & GEOPHYSICS				
Geochemistry of sediment	5,926 (samples)		118,520	1976-1998
Gravity	4,046		4,046	1990
Magnetics	10,098		10,098	1990
Bathymetry	2,006		2,006	1990
MARINE BIOLOGY				
Primary productivity	628		1,146	1983-1988
Chlorophyll-a	1,894		3,467	1961-1988
Phytoplankton	1,045		4,762	1960-1988
Zooplankton	2,451		26,545	1960-1988
Fish eggs/larvae	2,553		10,097	1960-1988
Phytobenthos	669		790	1990-1998
Zoobenthos	1,424		10,565	1960-1988
MARINE POLLUTION				
Suspended matter	1,471		3,162	1996-1998
Trace metals	910		5,628	1996-1998
Pesticide residues	45		360	1996-1998
Petroleum residues	333		333	1996-1998
Other contaminants			2,959	1996-1998