中国海洋环境观测系统的建设与发展

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前言

减少和防止海洋灾害最有效的措施，就是能对海洋灾害能作出准确、及时的预报。为此，需要建立先进的海洋观测系统和海洋灾害预报系统。其中，海洋观测系统主要任务是为建立和确认海洋灾害预报模式和进行海洋灾害预报提供海洋环境长期、连续、综合的基础观测资料。因此，海洋观测系统是海洋灾害预报系统的基础，是海洋减灾防灾工作的一个重要组成部分。

经过几十年的努力，中国已建成了初具规模的海洋观测系统。但总体技术水平比较低，满足不了海洋灾害预报等部门对海洋观测资料的需要。所以，建设中国海洋观测系统成为海洋减灾防灾需要的当务之急。

一、建立一个完整的海洋环境立体观测框架结构

中国海洋环境立体观测系统建设具体观测手段包括：

1. 海岸/海岛海洋站

中国大陆海岸线长 18000 公里，海岛 6500 多个，目前已建有 61 个海岸/海岛海洋站。为了满足海洋学观测的要求，在中国沿海共需均匀建立 100 多个海岸/海岛海洋站；而在河口及水文要素变化复杂地区和海洋灾害多发区，则还应加密设站。

2. 海上石油平台海洋站

目前在我国各海域已有海上石油平台有 30 多个，是进行海洋观测的理想载体。利用海上石油平台建立海洋站，将会形成一个包围我国沿海海域的远程环境监测网，是提高海洋灾害预报准确度和时效性的一种正在开发利用的新的数据源。

3. 海洋资料浮标

海洋资料浮标可在恶劣的海况下自动观测，为海洋灾害预报提供有代表性的、实时的观测资料。我国已研制成功了直径 3m 和直径 10m 两种型号的海洋资料浮标。目前，海洋资料浮标网建设的目标是保证有效运行浮标的数量达到 14 个左右。

4. 坐底/潜标测量系统

坐底/潜标测量系统可以避免恶劣的天气海况和人为造成的破坏，为海洋灾害预报模式研究和业务化运行可提供海洋灾害全过程的实测资料。我国已研制完成了千米潜标测量系统，并正在进行更大深度和多要素测量的潜标系统的研制，

5. 观测船

观测船是获取大范围、长时间海上观测资料的重要手段。我国从 1972 年开始，组织了部分海上运输船舶、海洋渔轮等开展了志愿船观测工作。根据“全国海洋开发规划”的要求，2000 年前，支持现有 214 艘商船测报，增加 20 艘渔船和 28 艘调查船开展水文气象定时同步观测和加强断面观测。

6. 岸基高频地波雷达站

岸基高频地波雷达站能对所覆盖海区内的海面动力场及浮冰进行实时、连续、超视距探测，是海洋观测中的一种新的观测手段。我国已建立了一个测冰雷达站，并研制了海态监测分析雷达样机。今后，我们将利用这一新的探测手段，加强对近岸区域

海洋动力要素及浮冰的观测。

7. 海监飞机

海监飞机是对海洋环境进行中小尺度观测和应急监视的重要手段。我国现拥有的飞机数量和配置的仪器设备与实际需要相差太远，计划再增加海监飞机数量和装备新的仪器设备，以提高监视频率和扩大监视范围。

8. 遥感卫星

遥感卫星已成为海洋环境监测的主导手段。目前，国内主要应用国外卫星遥感数据开展海洋应用研究。另外，我国计划也要发射自己的海洋卫星。

以上各种观测手段各有其特点和局限性，而将这些手段有机的组合在一起，可实现对海洋环境进行空间点、线、面相结合，尺度上宏观和微观相结合，管理上常规测量和应急响应相结合，技术上遥感和器测相结合的观测布局，从而形成一个全方位、全天候、全时域的立体观测的框架结构。

二、加速海洋观测技术和仪器设备的研究和开发

海洋环境立体观测框架中的各种手段所配置的海洋观测仪器设备，是直接获取海洋环境观测数据的基本工具，当前，重点研制和开发的仪器设备主要有以下几种：

1. 海面自动观测系统

该系统的各组成部分均按标准化、系列化和模块化的结构设计，然后针对海岸/海岛海洋站、海上石油平台站、海洋资料浮标和观测船等不同载体的具体技术要求，集成为各种现场实用的自动观测系统。该系统重点要解决的技术问题是：

(1) 新型测量传感器，包括：

a.. 海浪方向测量；

b. 声学多普勒海流剖面测量；

c. 生态/污染参数测量等；

(2) 通用数据采集处理器

该装置按统一的结构和总线方式、设计成多种功能化的模块，并开发一种统一的标准化语言，这样根据载体的特点和测量的要求，便可组装成各种适用的测量系统。

(3) 标准工作电源

该电源包括内置和外接两部分。通常采用市电(220V, 50HZ)或太阳能电池作为外接电源，并同时对内置蓄电池浮动充电；当外接电源供电中断时，自动改为由内置蓄电池供电。

2. 坐底式自动测量系统

该系统主要是通过对海洋环境场某些声学参数的测量来监测海洋灾害的全过程变化，测量数据记录在水下存储器内，并可定时通过声数据传输到岸上或其它载体上，需解决的技术问题是：

a. 从波浪和海流数据中提取波向谱信息的技术；

b. 水中测量数据的实时传输技术；

c. 系统工作的可靠性、安全性；

3. 高频地波雷达探测系统

高频地波雷达探测系统通过对双站雷达的回波进行采样和数据分析处理，提取出共同覆盖海域的海面动力环境参数。我国拟研制开发的岸基中程高频雷达海洋环境探

测系统的主要研制工作包括：

a. 雷达系统研制

主要完成对海面探测信号的发射、回波信号的接收与处理，并形成海洋回波多普勒谱图。

b. 雷达应用软件开发

- 由一部雷达探测数据绘制径向海流图；由两部雷达探测数据绘制矢量海流图；
- 由海洋雷达回波多普勒谱反出浪高谱，并求出均方浪高，然后再导出有效浪高。
- 由回波多普勒谱间接提取浪向、风速。

4. 卫星海洋应用技术

目前，国内主要应用国外卫星遥感数据开展海洋应用研究。其建设和发展目标是：

(1) 建成覆盖我国全海域的国际先进的地面接收站，并联网。

(2) 卫星遥感资料信息处理技术研究，重点是对遥感数据进行预处理和图象分析，应用对遥感机理研究得出的各种海洋要素反演公式，计算出海洋动力、海洋地形、海冰等要素信息。

(3) 卫星遥感信息产品应用技术开发，重点是制作灾害性海况预报产品。

三、建立一个现代化的观测资料通信网

通信网的主要功能是把海洋环境现场观测的数据实时、准确地传输到各级预报台站，为制作预报产品提供基础资料。该网络主要采用以下几种通信方式：

1. 公共电话交换网（PSTN）

用于具有公共电话网连接能力的海岸/海岛海洋站、高频地波雷达站等与所属中心站，中心站与所在各省台和区台之间的数据传输。

2. 海事卫星通讯（INMARSAT）

用于海上浮标、海上石油平台、观测船、监测飞机和没有公共电话网的海岸/海岛站与所属区台和国家预报台之间的数据通讯。

3. 中国分组交换网（CHINAPAC）

用于卫星遥感地面接收站与相关业务中心进行数据交换。

4. 甚小口径卫星终端（VSAT）

用于由北京主站到区台、省台和由区台到中心站的二级分层网状卫星通信，担负预报系统多种业务通信服务。

5. 国际互连网（INTERNET）

进行国内和国际间、各台站之间海洋实时和历史资料的高速和实时传输。

四、实施对策和建议

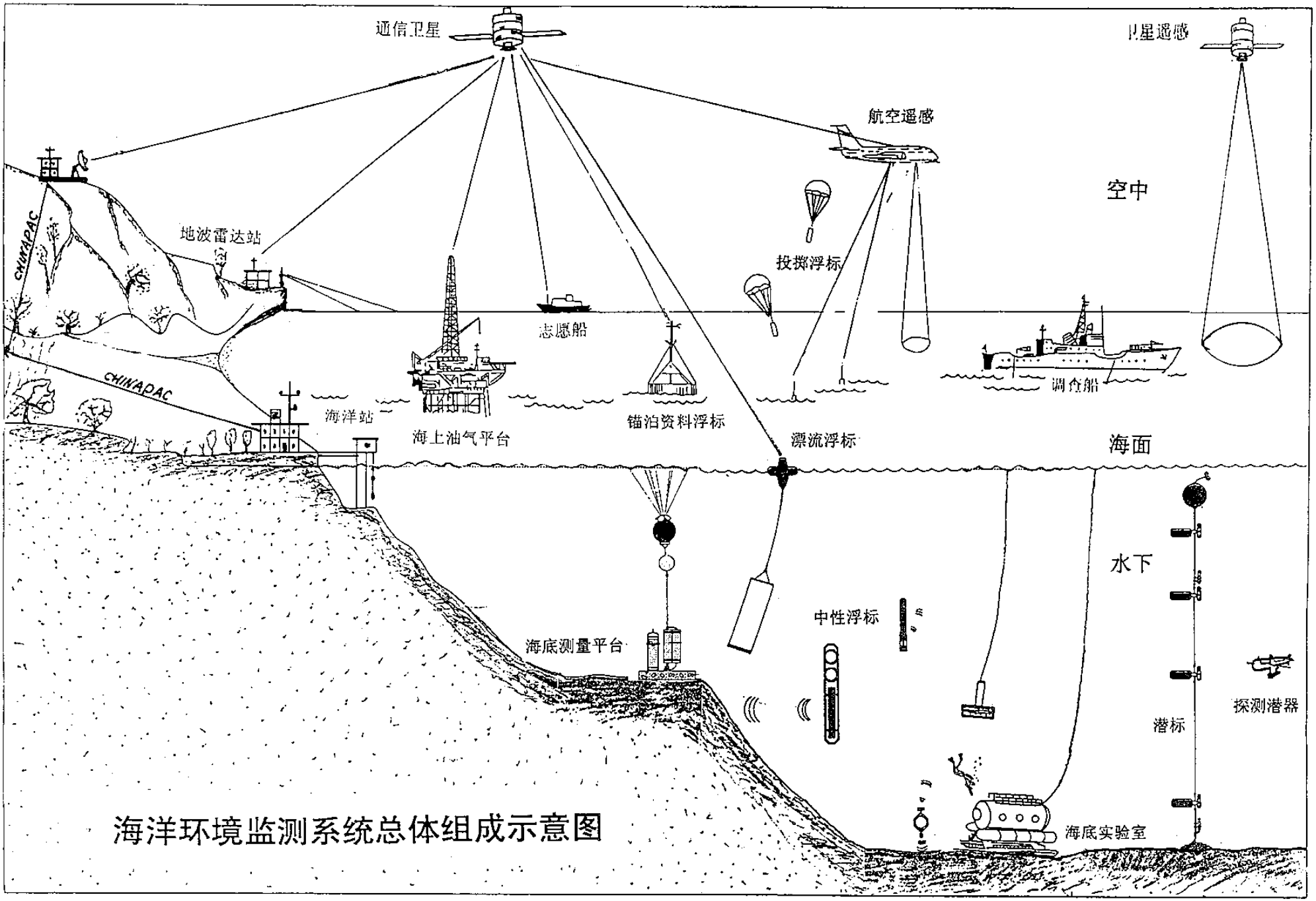
(1) 建设和发展我国的海洋环境观测系统，并进入 GOOS 框架，是我国海洋界的一项重要任务，应引起我国政府和有关部门的高度重视。

(2) 当前建设和发展中国海洋环境观测系统的重点是要研究海洋观测的高新技术、研制新型的观测仪器和设备、扩充现有的观测手段，并采用现代化的通信方式组成一个完整的海洋环境立体观测网,。

(3) 建设和发展中国海洋观测系统是一项复杂的工程性研究项目，应由国家海洋局牵头，会同国家有关部门共同拟订建设计划，并组织国内的技术优势单位参与该计划

的实施。

(4) 在中国海洋观测系统的建设和发展中要积极开展国际合作，特别是通过引进国外的观测技术、仪器设备和管理经验，把中国海洋观测系统建设成为一个具有国际先进水平的业务系统。



海洋环境监测系统总体组成示意图

CONSTRUCTION AND PROGRESS OF OCEAN NVIRONMENT OBSERVATION SYSTEM IN CHINA

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Introduction

The most effective measure to reduce and prevent the marine disaster loss is to forecast the marine disasters accurately and timely.

For this reason, advanced ocean observation system and marine disaster forecasting system is needed to construct. Particularly, the ocean observation system serves mainly to provide long-term, continuous, comprehensive basic observation information for constructing and recognizing marine disaster forecasting models and releasing the marine disaster forecasting. Therefore, the ocean observation system is the base of marine disaster forecasting system and one of the most important components of marine disaster reduction and prevention.

China has set up an integrated ocean observation system through efforts in a couple of decades, though its technical level remains not very advanced, and this system can't meet the needs of the marine disaster forecasting institutions for ocean observation data. Therefore, the construction of Chinese ocean environment observation system has become the urgent matter of marine disaster reduction and prevention.

1 ESTABLISH A COMPREHNSIVE OCEAN ENVIRONMENT THREE-DIMENSIONAL OBSERVATION FRAMEWORK

The observation measures of Chinese ocean environment three-dimensional observation system consist of coastal / island marine observatory, offshore oil exploitation platform observatory, marine data buoy system, bottom-based / submerged observation system, observing ship, coastal high-frequency ground wave radar, marine surveillance aircraft and remote-sensing satellite.

1.1 Coastal / Island Marine Observatory

China has a coastal line 18000 km in length and 6500 islands. In present 61 coastal / island marine observatories have been set up. But to satisfy marine observation, it is necessary to set up more than one hundred such observatories well distributed and more densely in estuaries, areas with complicated variable hydrographic elements and disaster frequently-occurring sites.

1.2 Offshore Oil Exploitation Platform Observatory

Up to present in Chinese Seas there are more than thirty offshore oil exploitation platforms which are ideal station sites for ocean observation. It will form an offshore environment remote monitoring framework surrounding Chinese coast to set

up marine observations on offshore oil exploitation platforms, and provide new-exploited data sources for increasing the accuracy and time effectiveness of marine disaster forecasting.

1.3 Marine Data Buoy System

Marine data buoy system is able to observe automatically during the worst sea state and provide present and real-time observation data to marine disaster forecasting. China has developed marine data buoy system with 10 m or 3 m diameter disk buoy. It is needed to keep 14 buoy systems operated effectively in the offshore marine data buoy system network.

1.4 Bottom-based/Submerged Observation System

Bottom-based/Submerged Observation System is able to prevent the destruction by the worst weather and sea state or human violence, but provide real data about the entire process of marine disaster for the research and vocational operation of marine disaster forecasting model. The submerged buoy system of 1000 m depth has been developed and this system of greater depth and capable to measure multi-element are developing in our country.

1.5 Observing Ship

Observing ship is an important platform for acquiring ocean observation data in vast area and long time period. Since 1972, China has organized a part of sea-going transportation ships and fishing vessels as voluntary observing ships (VOS). According to the "National Ocean Exploitation Program", before 2000 China will sustain 214 VOS available, add 20 fishing vessels and 28 research vessels to measure hydro-meteorology periodically and synchronously as well as to intensify the transect survey.

1.6 Coastal High-Frequency Ground Wave Radar

A kind of new ocean observation system, the coastal high-frequency ground wave radar is able to real-time, continuous and over-the-horizon detect sea surface dynamic field and floating ice in covered area. China has set up an ice-detecting radar station, and is also developing a prototype of sea state detecting / analyzing radar. We will utilize the new detection system to intensify the detection of dynamic oceanographic elements and floating ice in coastal area.

1.7 Marine Surveillance Aircraft

The marine surveillance aircraft is a main vehicle for middle/small scale monitoring and emergency surveillance. At present the sum of the aircraft and the instruments and equipment aboard the aircraft in China are too scarce compared with necessary. We are planning to increase the sum of the aircraft and furnish with advanced instruments and equipment so as to increase the frequency and area of surveillance.

1.8 Remote-Sensing Satellite

The remote-sensing satellite has become a lead measure of marine environment monitoring. At present China is adopting remote-sensing data from foreign satellite to conduct oceanographic research. In addition, China is preparing to launch own ocean satellite.

All above-mentioned observing measures have its own characteristic and restriction. Combined these measures organically as a whole it is practicable to realize an ocean environment observation framework. In the framework point, line and surface of space are given consideration, macro-scale and micro-scale are both given consideration, both routine monitoring and emergency surveillance of management, remote-sensing and sensor measurement of technique are also considered, so as to form a all-direction, all-weather and whole time domain three-dimensional observation framework.

2 SPEED UP R&D OF OCEAN OBSERVATION TECHNIQUES AND INSTRUMENTS / EQUIPMENT

The ocean observation instruments/equipment furnished to the component of the three-dimensional ocean environment observation framework are main tools for acquiring directly ocean environment observation data. At the present, the main instruments/equipment under R&D in China are listed as sea surface automatic observation system, bottom-based automatic measuring system, high-frequency ground wave radar detection system and satellite remote-sensing application.

2.1 Sea Surface Automatic Observation System

This system is consisted of components with standardized, serialized and modularized design, then they are integrated into various practical in-situ automatic observation system according to the particular technical demands of coastal/island observatory, offshore oil platform observatory, marine data buoy and/or observing ship. The techniques needed to resolve may be as following.

(1) Sophisticated measuring sensors, e.g.

- wave direction sensor;
- ADCP;
- ecological/pollutant parameters sensor.

(2) General data acquisition-processor.

This device is designed as various multiple modular with unified structure and bus connection, and a standard language is developed, as a result considering the character of platform and the demand of measurement, various appropriate measuring system can be easily composed.

(3) Standard power supply.

The power supply consists of internal and exterior parts. Generally, commercial electricity (220 V, 50 Hz) or solar energy cell is adopted as exterior power supply, and floating charged internal batteries. When the exterior supply has built-in internal batteries feeds the instrument automatically.

2.2 Bottom-based Automatic Measuring System

This system engaged in measuring the marine environment field acoustically to monitor the whole process of marine disaster, measuring data are recorded in memory seated in underwater unit, and are possible to be transmitted to coastal or other platforms through acoustical communication. The following techniques are needed to develop , e. g.

- extraction of wave direction spectrum information from wave and current data;

- real-time transmission of underwater measuring data;
- reliability and safety of system.

2.3 High-Frequency Ground Wave Radar Detection System

This system consisted of bi-station radar is able to extraction sea surface above-mentioned dynamic elements of the overlapped area by two radar antennas through sampling and analyzing the echo data of the radar.

(1) R&D of the hardware of radar system.

Particularly, transmitter of sea surface detection signal, receiver and processing of echo signal, analyzer of Doppler spectrum of echo is needed to develop.

(2) Development of radar applied software

- Plotting radius current diagram from detection data with single radar, plotting vector current diagram from detection data with two radars.
- Inverting wave height spectrum from marine radar echo Doppler spectrum, calculating root- mean-square wave height, then conducting significant wave height.
- Extracting wave direction and wind speed from radar echo Doppler spectrum.

2.3 Satellite Remote Sensing Application

Up to present, China has applied remote-sensing data from foreign satellite to conduct oceanographic applied. research. The objective of construction and development in the near future will be as following.

- Constructing advanced satellite ground stations covered whole Chinese Seas and connecting them to a network.
- Researching satellite remote-sensing data information processing, particularly pre-processing of remote-sensing data and image analyzing, inverting equations for calculating marine dynamic, topographic and sea ice elements information from studying the remote-sensing mechanisms.
- Developing the application of satellite remote-sensing information products, particularly producing disastrous sea state forecasting.

3 CONSTRUCT A MODERNIZED OBSERVATION INFORMATION COMMUNICATION FRAMEWORK

The function of the communication network concentrates in transmitting marine environment in-situ observing data accurately and in real-time to forecasting center of every class for producing forecasting products as basic information. Following communication networks are used in this framework.

- **Public Switched Telephone Network (PSTN)**

Used in the data transmission between coastal/island marine observatory, high frequency ground wave radar station linked with public telephone network and their center-station belonged, also between center-station and province-station/branch forecasting center belonged.

- **International Maritime Satellite-C (INMARSAT-C)**

Used in the data communication between marine data buoy, offshore oil platform, observing ship, surveillance aircraft and coastal/island observatory without public telephone link and branch forecasting center belonged/national forecasting center.

- **China Public Packet Switched Data Network (CHINAPAC)**

Used in data transmission between satellite ground station and related service center.

- **Very Small Aperture Terminal (VSAT)**

Used in communication between master station in Beijing and branch station, province station, slave station as second sub-network satellite communication, to undertake various business communication service of forecasting system.

- INTERNET

Used in high speed and real-time communication for domestic and international, or between stations real-time or historical marine information.

4 STRATAGY AND SUGGESTION

- It is an important task for Chinese oceanic community to construct and develop Chinese

ocean environment observation system and get it into GOOS framework, and should cause Chinese government and related department and institution to pay high attention to it.

- The present key point of constructing and developing Chinese ocean environment observation system lies in researching high/new technology of ocean observation, developing sophisticated observing instrument and equipment, widening the scope of observation methods and adopting modern communication to compose a comprehensive ocean environment three-dimensional observation network.
- It is a complicated, engineering-oriented project to construct and develop Chinese ocean observation system,. And this project should lead by SOA along, who invited related national department to draw up a plan together and organizes domestic institutions prevailing in technology to practice it.
- International cooperation should be carried out in construction and development of Chinese ocean observation system. Chinese oceanic community has to introduce advanced observation technique, instrument/equipment and management experiences from abroad and pushes Chinese marine observation system to be a service system with international advanced level.