Toward the development of a comprehensive and integrated climate change observation system:

Observations for the monitoring of greenhouse gases and the carbon cycle and for the assessment of the impacts of climate change

Summary

July 2008

Office for Coordination of Climate Change Observation (OCCCO),
supported by the Ministry of the Environment and the Japan Meteorological Agency

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Foreword

Climate change due to global warming is a pressing concern. In order to overcome this problem, it is essential to develop models that can predict future climate changes and to use observation data for monitoring the climate changes and validating the model results. Recently, the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) addressed the importance of observation data.

In 2004, the Council for Science and Technology Policy (CSTP) released the "Earth Observation Promotion Strategy," which proposes the establishment of a national earth observation alliance in order to enhance the cooperation among organizations, ministries, and institutions. Approximately 2 years have passed since the establishment of the Japanese Alliance for Climate Change Observation (JACCO) and Office for Coordination of Climate Change Observation (OCCCO) in 2006 (See the next page).

The Earth Observation Promotion Strategy addresses important issues related to the climate change due to global warming. These issues include the observation of the following aspects: (1) atmospheric, terrestrial, and oceanic greenhouse gases mainly in Asia and Oceania, (2) terrestrial and oceanic carbon cycles and ecosystems, and (3) climate change impact in vulnerable areas such as the cryosphere and coastal areas. The Scientific Working Group of OCCCO investigated these issues by promoting data standardization, enhancing data sharing, promoting the collaborative use of observation platforms and samples, improving temporal and spatial gaps in observation, and enhancing observation elements. We have summarized the results of their investigation in this report.

We distributed this report to relevant scientists, ministries, and organizations in March 2008. We clarified the current status, problems, and future outlook for the essential topics in order to create an integrated climate change observation system in Japan based on the ongoing climate change observations and future plans. We also indicated the direction in which climate change observation systems in Japan should develop.

Because this report is extensive, the Scientific Advisory Board of JACCO proposed to issue this summary for the convenience of planning future policies. The Steering Committee of JACCO agreed to issue this summary in March 2008.

This summary was compiled for the complete report by the Scientific Advisory Board. Please refer to the complete report for details.

I would like to extend my heartfelt gratitude to the members of the Scientific Advisory Board who have contributed to this summary and the members of the Scientific Working Group who have helped in developing the complete volume.

July 2008

Isao Koike
Chair, Scientific Advisory Board of JACCO

What is JACCO?

The Japanese Alliance for Climate Change Observation (JACCO) was established by the Ministry of the Environment (MOE) and the Japan Meteorological Agency (JMA) in April 2006 to plan and coordinate comprehensive climate change observation systems.

The organization of JACCO is shown in Figure 1. The steering committee consists of relevant ministries, agencies, and institutions that observe the climate changes. The steering committee is jointly chaired by the MOE and JMA. The Scientific Advisory Board of JACCO consists of leading scientists from the field of climate science to provide the steering committee with scientific advice.

The Office for Coordination of Climate Change Observation (OCCCO), located in the Center for Global Environmental Research (CGER) of the National Institute for Environmental Studies (NIES), supports the activities of JACCO. The OCCCO performs the following activities: (1) the assessment of the need for climate change observations, (2) the enhancement of the accessibility of observation data and coordination of the use of observational platforms in collaboration with the Scientific Working Group, (3) convening of meetings, and (4) managing of public relations activities.

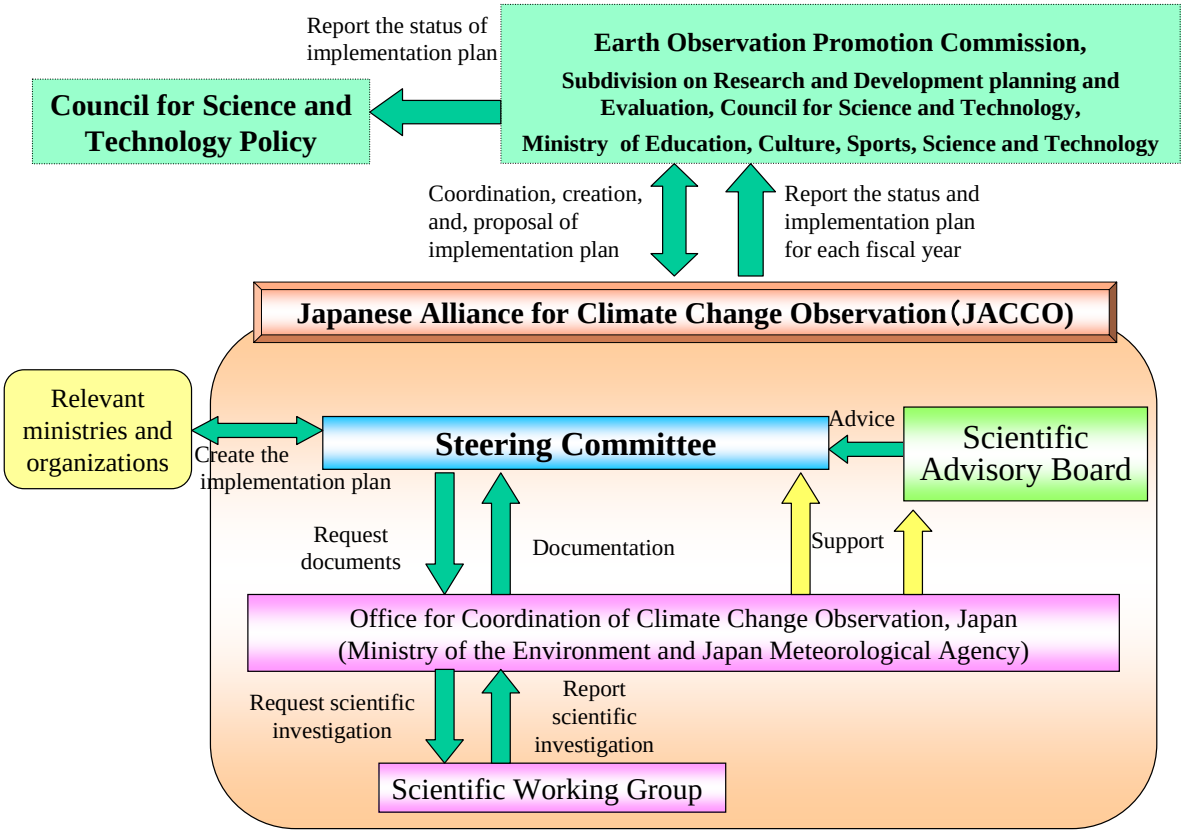

Figure 1: The organization of JACCO

Chapter 1 Introduction

The deterioration of the global environment, especially global warming, has become an important environmental issue in the 21st century. This issue requires immediate response and urgent action by governments. In order to solve these problems, promoting long-term, continuous, comprehensive, and integrated observation of the earth is essential.

The "Earth Observation Promotion Strategy," released in 2004, has proposed an increase in the cooperation among organizations, ministries, and institutions because climate changes due to global warming should be monitored as a nation.

Subsequently, in April 2006, the Japanese Alliance for Climate Change Observation (JACCO) was launched by the Ministry of the Environment (MOE) and the Japan Meteorological Agency (JMA). The Office for Coordination of Climate Change Observation (OCCCO), located in the Center for Global Environmental Research (CGER) of the National Institute for Environmental Studies (NIES), serves as the secretariat for JACCO. OCCCO supports the integrated activities of JACCO.

The Earth Observation Promotion Strategy advocates the establishment of an integrated earth observation system, which requires understanding of the status and problems of Japan's earth observation programs. The Scientific Working Group of OCCCO decided to issue a report on the current status, problems, and the future outlook of the climatic change observation system.

In order to strategically prioritize the issues, the Earth Observation Promotion Strategy proposed the elucidation of phenomena related to global warming, prediction of the effects of climate change, and mitigation of and adaptation to global warming. It addressed the issues in Japan related to the following aspects: the monitoring of the atmospheric, terrestrial, and oceanic greenhouse gases mainly in Asia and Oceania; the observation of the terrestrial and oceanic carbon cycles and ecosystems; and the monitoring of the impact of climate change in vulnerable areas such as the cryosphere and coastal areas. Therefore, we investigated issues concerning the promotion of data standardization, enhancement of data sharing, promotion of the collaborative use of observation platforms and samples, improvement of temporal and spatial gaps in observation, and enrichment of observation elements, as shown in Table 1. We proposed that this observation be maintained and expanded in the future for monitoring greenhouse gases and the carbon cycle as well as for assessing the impact of climate change.

The numerous activities mentioned in each section of the complete volume have been performed amidst limited financial and personnel resources. The data for some field experiments were shared according to internationally agreed frameworks. However, data sharing is necessary for promoting and developing the observation for all fields and such sharing requires a lot of effort.

The report entitled "Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC)" states that the results of long-term observation revealed the warming of the climate system. Further, under the section "Key uncertainties for observational findings," the report emphasizes the need for future observations.

The Earth Observation Promotion Commission of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) released the article "The concept for Japanese Earth Observation in the fiscal year 2008" in July 2007. This article addressed the importance of long-term observation of the earth in the future (mentioned in section II). Further, it mentioned that the goals stated in the IPCC AR4 could be achieved with long-term satellite and in situ observations. In addition, it argued that it is necessary for governments to promote long-term continuous earth observation so that the scientific basis for climate change can be established.

In this summary, we have included issues that need to be addressed urgently so that international, interorganization, and interdisciplinary cooperation for the proposed and investigated observation activities mentioned in the complete volume can be achieved. We have summarized the future collaborative activities and outlooks for climate change observation in the following sections.

Chapter 2 Promotion of data standardization

Observations for the monitoring of greenhouse gases, the carbon cycle, and for the assessment of

the impacts of climate change are carried out all over the world; these observations help to clarify the mechanism underlying climate change. Japan plays a major role in this field. However, atmospheric, oceanic, and terrestrial observational data are insufficient and the data need to be integrated for elucidating the global carbon cycle and projecting the climate change. This integration is indispensable for the global assessment of the impacts of climate change.

Data integration requires data standardization, which makes the observations from all organizations comparable. Valuable observation data are thereby utilized effectively. Data standardization can only be achieved by collaborative work among organizations across the world involved in observation of climate change.

Although data collected by oceanic and atmospheric monitoring are being standardized by several programs, including Global Atmospheric Watch (GAW) of the World Meteorological Organization (WMO), additional efforts are still required. Further, because efforts for the standardization of terrestrial data are few, development in this field is particularly required. For assessing the impact of climate change, data standardization has been advanced for certain types of data, including data collected by sea level observations. However, improvements in the standardization are required for various other types of data, including data collected by the observation of the cryosphere and ecosystems.

(1) Observation of greenhouse gases and the carbon cycle

For standardizing the data collected by the observation of the atmosphere and oceans, the establishment of a mechanism to promote standardization internationally is necessary. Moreover, collaborations and alliances for the routine intercomparison of measurement techniques are required. These collaborations and alliances can be established by forming a network of the organizations that are involved in the observation of the atmosphere and oceans. Data interoperability can be ensured by establishing such frameworks.

In order to reduce the uncertainty of observations related to the terrestrial carbon balance, immediate action is required to compare the different observations and standardize the measurement methods. The development of methods that will improve the accuracy of the observations is important. This can be achieved by conducting comprehensive and intensive observations at different sites and identifying the elements that result in large uncertainty.

Intercomparisons of terrestrial carbon balance observations in Asia are expected using the round-robin system.

(2) Assessment of the impact of climate change

Research on data standardization for sea level observations is underway. However, the standardization of data on the cryosphere and ecosystems is still in the early stages of development despite the high sensitivity of these elements to climate change. Therefore, data standardization for these areas is immediately required.

Active participation in the International Partnerships in Ice Core Sciences (IPICS), which provides an international framework for ice core data, and the promotion of the Japan Long-Term Ecological Research Network (JaLTER) are required.

Improvement in the accuracy of assessing world forest resources is also desirable because forests are important carbon dioxide sinks.

Chapter 3 Enhancement of data sharing

The collection and integration of data from across the world are crucial for monitoring the climate change, assessing its impact, and improving climate change predictions. Global-scale databases thus developed will become important international shared property. Providing open access to data and enhancing data sharing are necessary for establishing such a database.

However, open access to data is often delayed because scientists in charge of the data require long durations and enormous efforts for data analysis and calibration as well as for the prioritization of data usage. Therefore, individuals and organizations involved in the data production should receive credit

for their efforts even if the data is made publicly available at an early date. It will be necessary to ensure this in order to promote open access to the data and enhance data sharing.

In order to enhance data sharing, the data management system of each organization should be strengthened. Further, the government should adopt policies that promote open access to the data obtained by the organizations.

Data sharing among organizations and disciplines will promote collaborative research activities. JACCO is expected to promote such activities.

Data sharing is being promoted by the Data Integration and Analysis System (DIAS) under the "Earth Observation and Ocean Exploration System" of National Key Technologies in the third Science and Technology Basic Plan of Japan. It is important to promote data sharing by encouraging cooperation among the organizations participating in this project.

(1) Observation of greenhouse gases and the carbon cycle

Several international efforts such as the International Oceanographic Data and Information Exchange (IODE), the World Data Center for Greenhouse Gases (WDCGG) of GAW, and the Carbon Dioxide Information Analysis Center (CDIAC) are involved in the enhancement of sharing data on the atmosphere and oceans.

On the other hand, efforts to enhance the sharing of data pertaining to terrestrial observations are still few. Thus far, data distribution has been limited to relevant scientists through research projects such as FLUXNET and AsiaFlux. It is necessary to fund such research networks in order to ensure stable operation and enhance the function of the project offices.

The volume of data, particularly from satellites, can be increased. Moreover, the data formats will vary according to needs for data utilization. The data center is indispensable as an international framework for sharing the data that are collected systematically, managed reasonably, integrated, and then converted for scientific and social purposes.

(2) Assessment of the impact of climate change

Most of the sea level data in Japan are integrated at the Japan Oceanographic Data Center (JODC) and the Coastal Movements Data Center (CMDC). The Global Sea Level Observing System (GLOSS) provides global or regional, high-quality sea level data networks. These frameworks require to be developed further.

Sharing of data on the cryosphere and ecosystems is in the nascent stage of development. Data for terrestrial ecosystems, in contrast to data for the atmosphere and oceans, are not easily registered in the database because the registration of such data may affect the interests of the countries that produce the data.

Sharing of data on the cryosphere and ecosystems still requires development, and this development depends on the personal efforts of scientists. In order to enhance data sharing, institutional frameworks should be developed strategically. The establishment of data centers at national institutes is necessary for collecting data and providing access to them.

With regard to socioeconomic data, it is necessary to enhance the collection of information on data sources, to integrate various data together with digitized historical records, and to increase the capacity of data utilization in developing countries. The effective utilization of observation data from various fields and the socioeconomic attributes are important for clarifying the mechanism of the carbon cycle, creating a model of climate change phenomena and their impact, detecting and monitoring the impacts of climate change, and evaluating the effect of various adaptation and mitigation measures.

International and national organizations have produced a variety of information and have established various databases. In particular, the Global Change Master Directory of the USA plays an important role in managing and searching sources of such data. An independent information source directory in the Japanese language is required for searching data related to climate change in Japan in order to enhance national data utilization. In addition, information sources should be registered in an international directory for enhanced data utilization.

Chapter 4 Promotion of the collaborative utilization of observation platforms and samples

For the comprehensive and integrated observation of climate change, it is necessary to promote the collaborative use of observation platforms and samples, enhance the observation framework with mutual supplements, and support long-term continuous observation. Consequently, the systematic integration of existing and future observations should also be enhanced and the collaborative use of the observation platforms and facilities of relevant ministries and organizations should be promoted. It is essential to update the database with detailed information of the observations obtained by each organization, such as the place, facility, time period, frequency, accuracy, and so on. Scientists from different organizations should collaborate to create a research strategy that will interest all scientists so that they participate in developing this framework strategy.

Moreover, a framework should be developed to sustain collaborative observations; such a framework should encourage mutual coordination in the observation between operational organizations, research institutes, and supersites in order to promote long-term observations, actively publicize Japanese achievements, and strongly promote interdisciplinary cooperation.

(1) Observations of greenhouse gases and the carbon cycle

Each organization often uses special technologies and facilities for the specific analysis of elements in the greenhouse and related gases. Therefore, in case an organization is unable to obtain certain data for a gas sample owing to the lack of a special technology, another organization that possesses this technology can perform the required analysis. Such mutual collaboration and sharing of technology help in avoiding gaps in data.

Research vessels for the observation of ocean ecosystems are desired because they enable mutual coordination between operational and research observations.

Moreover, the promotion of the mutual utilization of observation platforms for terrestrial carbon balance via interdisciplinary collaborations is required for the comprehensive clarification of the terrestrial carbon balance.

(2) Assessment of the impact of climate change

An example of information exchange and technology sharing among organizations is that of sea level observation. We urgently require a terrestrial carbon flux supersite for the comprehensive terrestrial observations in various research fields, promotion of the mutual utilization of the data obtained by snow and ice observations, and organization of such activities.

In Japan, the JaLTER was recently launched. Collaboration between JapanFLUX, Monitoring-site 1000, and other projects via JaLTER is important. It is necessary to establish a comprehensive framework in order to observe ecosystems and biodiversity; for this purpose, a supersite for each ecosystem that can be used to collect data and perform field experiments simultaneously should be set up.

Chapter 5 Improvement of temporal and spatial gaps in observation and enhancement of observation elements

Because climate change is a widespread and global phenomenon, individual organizations monitoring it need to overcome spatial and temporal limitations. Therefore, collaborative observations by operational organization and research institutes are required to improve spatial gaps and enhance observation elements.

Research institutes have the advantage of being the sources of information; therefore, they can help clarify spatial variations and its role in climate change. This is achieved by the detailed observation of various observation elements. Research institutes utilize research funding to develop novel observational methods. On the other hand, operational organizations have the advantage of evaluating the long-term temporal variations in climate change by the time-series observation of specific observation elements. In this manner, both the organizations are complementary for obtaining

four-dimensional observations, which includes spatial and temporal variations. For developing policies regarding future observations, organizations should share information pertaining to the development of novel observational methods, data, and results.

Furthermore, satellite observations are indispensable for improving temporal and spatial observation gaps as well as for enhancing observational elements. Satellite observations should be carried out by collaborating with the space research agencies of countries around the world and formulating future observation plans.

Improvement in the temporal and spatial gaps and the enhancement of observation elements are closely related to the promotion of the collaborative use of observation platforms and samples by relevant organizations. In the future, we need to propose new collaborative policies that will include issues related to personnel and funds.

(1) Observation of greenhouse gases and the carbon cycle

With regard to ocean observations, operational organizations are expected to collaborate at the observation sites of the research institutes. It is also expected that an autonomous buoy system will be developed.

Further, we should promote the collaboration between the operational organizations that conduct cruises in the Southern Ocean and the scientific community.

Continuous long-term observations from aircrafts are difficult because of the limited funds and security issues. Therefore, stable and continuous observations should be ensured by using regular commercial flights.

The development of a ground-based atmospheric observation platform is necessary. For this purpose, capacity building is required in Asian countries in order to develop and maintain observational networks in these areas.

The construction of an observation system with high temporal and spatial resolution is necessary for linking in situ observations with satellite image analysis.

For the satellite observation, an observational network is required for validating products and evaluating algorithms related to the Greenhouse Gases Observing Satellite (GOSAT) project. In addition, we need to promote the Global Change Observation Mission (GCOM) and develop an ocean color satellite.

(2) Assessment of the impact of climate change

The personnel and instruments for analyzing ice cores are scarce in Japanese research institutes as compared to research institutes in the European Union and the United States of America. In recent years, the drilling of ice cores has increased. Therefore, it is important to increase the number of instruments and the personnel because this will enable rapid analysis and the establishment of an analysis center with adequate instruments and personnel.

Most of the sea level observation sites in Japan were established after the 1960s. Sea level observations need to be conducted over a long period in order to detect long-term variations.

A comprehensive system for the observation of terrestrial ecosystems and biodiversity is required. This system can be developed by determining a suitable observation site and forming an observational network to study the ecosystems that are vulnerable to climate change.

Moreover, we need to implement the observations of the Advanced Land Observing Satellite (ALOS). The following mission for Advanced Microwave Scanning Radiometer for Earth Observing System (AMSER-E) and Global Imager (GLI) requires immediate planning.

Further, the comparison of the results and the output from terrestrial ecosystem models at the supersite, development of a data distribution system for the comparison, validation of the model outputs, and observations over large areas are required.

Chapter 6 Future outlook

In the future, it is important to consider a concrete implementation policy for the urgent tasks recommended in this report. In Chapter 1, we have pointed out the importance of long-term

observation as mentioned in the article “The concept for Japanese Earth Observation in fiscal year 2008.” The importance of cooperation among organizations, ministries, and institutions for the purpose of long-term observations is emphasized by the Earth Observation Promotion Strategy. A framework should be developed and a budget should be sanctioned in order to perform the tasks specified by the Earth Observation Promotion Commission of MEXT and other government commissions. As pointed out in IPCC AR4, it is important to clarify the mechanism underlying climate changes by studying clouds, aerosols, and atmospheric radiations. However, we have excluded this topic from our report and have focused on other important issues.

As mentioned in Chapter 3, it is important to assess the climate change and its impact as well as to understand the adaptation and vulnerability in order to eliminate the change. Socioeconomic data is required for this purpose. In our report, we aim to promote investigations related to these tasks as well as data collection and distribution for assessing the socioeconomic impact of climate change.

We plan to investigate the abovementioned subjects and other important tasks in depth, and the results of these investigations will be described in our next report.

Table 1: List of Subjects for WG Report-No1.

Inter-disciplinary cooperation: Disciplinary
Inter-organization: Organization
Long-term continuous observation: Long-term

1) Promotion of data standardization	Ocean carbon cycle	Atmospheric carbon cycle	Terrestrial carbon cycle	Climate change impact assessment	
	Organization	Organization	Disciplinary	Disciplinary and organization	
	International standard on certified reference material (TCO2, alkalinity, and nutrients) and intercomparison of measurement methods **(Nojiri, Ishii and Ono)**	Standard gas systems in agencies, institutions, and universities **(Matsueda and Mukai)**	Standardization of measurement technology for terrestrial carbon flux observation **(Saigusa, Miyta, and Hiura)**	Standardization of sea level data **(Sakurai, Shimizu, and Miyazaki)**	Data standardization activities of JaLTER and Monitoring site 1000 **(Hiura)**
	Standardization of data format **(Nojiri, Ono, and Ishii)**	Intercomparison of measurement method **(Mukai and Matsueda)**	Intercomparison between micro-meteorological observation and ecological observation **(Saigusa)**	Standardization of snow and ice with ground-based and satellite observation **(Azuma and Fujita)**	World Forest Resources Assessment (FRA2005) **(Chiba)**
		Activity report of Quality Assurance/Science Activity Centre for Asia and the South-West Pacific **(Tsutsumi)**			Standardization of forest information data **(Chiba)**
2) Enhancement of data sharing	Ocean carbon cycle	Atmospheric carbon cycle	Terrestrial carbon cycle	Climate change impact assessment	
	Organization	Organization	Disciplinary	Organization	
	Database for ocean pCO2, TCO2, and alkalinity **(Nojiri, Ishii, and Ono)**	International framework for data sharing **(Mataueda, Mukai, Sugawara, and Tsutsumi)**	Networking for terrestrial carbon flux observation site **(Fujinuma)**	Data sharing of snow and ice observation data including satellite data **(Azuma and Fujita)**	Monitoring for forest resources **(Chiba)**
	Japanese database of oceanographic observation **(Shimizu and Murata)**	Japanese database in agencies, institutions, and universities **(Sugawara and Mukai)**	Integration of micro-meteorological database with ecological database **(Fujinuma)**	Data sharing of sea level observation data **(Sakurai, Shimizu, and Miyazaki)**	Database for marine organisms **(Ono and Shimizu)**
				Database for phenological observation **(Chiba)**	
				Promotion of data sharing of socio-economic data	
				Promoting collection of information source of socio-economic data **(Harasawa)**	
				Integration of various data and digitization of historical data **(Harasawa and Hiura)**	
				Capacity building for data utilization in developing countries **(Harasawa)**	
	Summary and status of data policy **(Matsuura)**, Specific example and problem of data policy **(Harasawa and Tsutsumi)**				
3) Promotion of the collaborative use of observation platforms and samples	Organization	Organization	Disciplinary and organization	Disciplinary and organization	
	Ocean observation platforms and samples **(Nojiri, Ishii, Ono, Hashida, and Murata)**	Atmospheric observation platforms and samples **(Mukari, Sugawara, and Hashida)**	Development of collaborative framework for terrestrial carbon and water cycles and biological observation **(Fujinuma)**	Collaborative use of platforms and samples of snow and ice observation **(Azuma and Fujita)**	Collaboration for sea level observation among agencies, institutions, and universities **(Sakurai, Shimizu, and Miyazaki)**
	Building up framework for collaborative observation on greenhouse gases in oceans **(Nojiri, Ono, and Murata)**			Integrated observation of terrestrial ecosystem and biodiversity **(Hiura)**	
4) Improvement of temporal and spatial gaps in observation and enhancement of observation elements	Promotion of in-situ observation				
	Long-term and organization	Long-term and organization	Long-term	Long-term and organization	
	Promoting collaboration in ocean observation between operational agencies and research institutions **(Ishii and Murata)**	Establishment of framework for long-term continuous observation with aircraft and balloon **(Mukai, Sugawara, and Hashida)**	Implementation of capacity building in Asia for observational network of terrestrial carbon cycle **(Saigusa)**	Long-term continuation and collaboration for sea level observation **(Sakurai, Shimizu, and Miyazaki)**	
	Development of autonomous buoy **(Ishii and Murata)**	Deployment of in-situ ground observation station in the area with spatial observation gap **(Mukai and Hashida)**	Promotion of phenological observation **(Hiura)**	Promotion of long-term and in-situ observation of snow and ice **(Azuma and Fujita)**	
	Promoting observation in Southern Ocean **(Ishii and Murata)**			Enhancement of analytical framework for snow and ice samples (**Azuma and Fujita**)	
	Promotion of satellite observation				
	Organization	Organization	Long-term and organization	Long-term	Long-term
	Monitoring marine phytoplankton **(Matsuura)**	Establishment of efficient operation and validation system for GOSAT **(Matsuura and Imasu)**	Phenological and terrestrial carbon cycle observation by satellite (AVHRR and MODIS etc.) **(Matsuura, Nishida, and Sasai)**	Long-term satellite observation of snow and ice including ALOS glacier surface mapping **(Matsuura and Fujita)**	
	Promotion of process study				
	Organization and Disciplinary		Disciplinary		
	Campaign observation for validation of satellite data **(Matsuura)**		Validation of terrestrial carbon cycle model with observation **(Saigusa)**		

Appendix

Scientific Working Group for OCCCO Report No. 1
"Toward the development of a comprehensive and integrated climate change observation system"

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