PROCEEDINGS
OF
THE SIXTH U.S.-JAPAN WORKSHOP ON GLOBAL CLIMATE CHANGE

Future Directions of Global Change Research: Observations; Process Studies; and Simulation and Prediction of Climate Change

February 24-26, 1998
Honolulu, Hawaii, U.S.A.

CONTENTS

6th U.S.-Japan Workshop on Global Change
Joint Communiqué

I. Preamble

This workshop was the sixth in a series of U.S.-Japan Workshops on Global Change Research held under the framework of the U.S.-Japan Agreement on *Cooperation in Research and Development in Science and Technology.* These workshops contribute to the implementation of global change research activities, fostered by the scientists of Japan and the United States, through information exchanges and discussions which promote long-term collaborations that benefit society.

The sixth U.S.-Japan Workshop was held at the East-West Center on the campus of the University of Hawaii-Manoa in Honolulu, Hawaii, on 24-26 February 1998. The workshop focused on the topic *of Directions for Global Change Research: Observations; Process Studies; and Simulation and Prediction of Climate Change.* The agenda is attached at Appendix A.

Seventy-seven individuals participated in the workshop, including researchers, scientists, and science managers from government agencies and ministries, national institutions and universities of both Japan and the United States. The list of participants is attached at Appendix B. The workshop was sponsored primarily by the U.S. Global Change Research Program (USGCRP) and the Science and Technology Agency of Japan (STA). Preparation and coordination of the workshop was carried out in cooperation with the U.S. National Science Foundation ~SF), the Meteorological Research Institute (MRJ) of the Japan Meteorological Agency (JMA), and the University Corporation for Atmospheric Research (UCAR).

This workshop was organized into three working groups that considered reports from each of the participants concerning the status of research on global change. In response to the charge of the workshop, the working groups prepared recommendations and summaries on potential future directions of global change research. These areas are summarized in Section II of the communiqué

II. Future Directions of Global Change Research: Observations, Process Studies, and Simulation and Prediction of Climate Change

(1) Observation Systems and Process Studies for Climate Change Research

Although the following three priority areas can stand on their own merits, they share some resource requirements and together offer a promise of much improved societally-relevant climate prediction in the Asian, Pacific and North American regions. A conscious decision was made not to recommend or prioritize individual measurements or observing technologies at this time as these are best done within the context of the focused areas that follow.

Pacific Basin-wide Extended Climate Study. Energetic, large-scale physical and biogeochemical variability in the upper Pacific Ocean exists on time scales from roughly seasonal through decadal, much of which is neither well-measured nor yet well-tested in models and utilized in climate predictions. This oceanic variability has strong relationships with the tropical and extra-tropical atmosphere, through ENSO and the dominant atmospheric teleconnection patterns (principally the PNA), both of which have significant influence over North American climate fluctuations. These atmospheric modes exhibit broad-band variability in this range of time scales. The shallow tropical ocean aspects of ENSO are fairly well explored, but only on time scales of up to a year or two and without understanding the other oceanic connections or the roles of the extra-tropical oceans. With the advent of remotely sensed observations such as radar altimetry and scatterometry together with in situ observational platforms such as moored buoys, drifting buoys, and profiling floats, there is both the need and opportunity to synthesize and characterize the coupled ocean-atmosphere system for the Pacific Ocean basin. This would enable:

- an accurate, quantitative description of the low-frequency, three-dimensional circulation and associated thermohaline structure of the upper Pacific Ocean;
- an ability to test models of this circulation and the intrinsic modes of variability as well as those due to coupling with the atmosphere; and
- an understanding of the processes which couple the tropical, subtropical, and subarctic wind-driven gyres, for the purpose of testing basin-scale hypotheses concerning the role of the Pacific Ocean in climate variability on a broad range of time scales.

Related atmospheric issues include:

- Steady-state and transient response to SST anomalies, including changes in storm tracks and blocking, which could give rise to significant impacts on regional climate; and
- Other sources of inter-decadal variability over the Pacific sector.

Rescue of Historical and Paleoenvironmental Data. Rapid progress in our understanding of climate variability in the Asia-Pacific region is limited by the lack of available observations. For this reason, priority must be placed on rescuing many of the needed satellite and historical in situ observations that exist in isolated laboratories and government offices. In addition, critical centuries-long observational time series can be obtained from paleoenvironmental proxies such as corals, tree-rings, ice-cores and sediment. Priority must also be given to collecting and integrating paleoenvironmental time series into the public-domain observational framework being used to document, understand and model the full range of seasonal to inter-decadal Asia-Pacific climate variability.

Large-scale land-atmosphere-hydrology interaction and application studies. Extensive efforts of understanding and modeling large-scale land-atmosphere-hydrology interactions and subsequent applications for societal benefit are underway over Eurasia, North America and other continents as part of GEWEX and IGBP-related projects. Scaling-up and parameterization of heterogeneous land-surface processes in sub-grid scales are being promoted by using high-resolution satellite remote sensing technique with intensive in-situ observations. In the Asia-Pacific region, these

studies are also important for understanding mechanisms of the ENSO-monsoon system through assessing the roles of land-surface processes on Asian monsoon variability. The role of Soil moisture in climate variability with seasonal to inter-annual time-scales is also a key issue for climate studies over these continents.

Coordination and cooperation among the continental-scale and regional experiments are being promoted in various ways. In 2001-2002, it is being planned that all the continental-scale experiments (GCIP, MAGS, LBA, BALTEX and GAME) have a coordinated Intensive Observing Period (lOP) under the new satellite observing systems (EOS series, ADEOS-il, ENVISAT etc.) to assess the role of soil moisture in the global hydrological cycle and climate variability.

Within the context of U.S.-Japan joint research, it is strongly proposed that GAME, GCIP and the U.S. component of LBA, should be strongly coordinated through exchange of data and information, cooperation in process studies and long-term monitoring, and model development. Moreover, land-atmosphere climate variability impacts society on regional scales. Hence, the downscaling to regional climate of land, atmosphere and hydrology interactions is an essential issue for Asia and North America. Of particular importance is the manner in which land-atmosphere interactions are manifested in economically important sectors such as marine and terrestrial ecosystems, agriculture, forestry, water resources, aquaculture and fisheries.

(2) Simulation and Prediction Models

Observed changes in the climate system over the 20th century provide a means of evaluating climate models. The past century has experienced a wide range of climate variability and change. It is proposed that United States and Japanese coupled-climate-system models be forced with identical temporal changes in greenhouse gases, sulfate aerosols and solar irradiance for the period 1870 to 1990. These forcing data sets are being prepared by the NCAR Climate System Model working group on Chemistry and Climate Change. These data sets will be made available to interested U.S. and Japanese scientists when they are available.

Much can also be learned by carrying out atmospheric model simulations that employ the observed sea surface temperature changes in addition to the changes in atmospheric chemical composition. It is proposed that scientists from Japan and the U.S. carry out 120-year atmospheric climate model simulations using these data sets. Results from both coupled and uncoupled models will also be of interest to proposed U.S./Japan decadal variability activities.

Following the Kyoto conference, the demand has increased to provide the results of climate-change simulations to the community of climate-change impact and policy analysts so that they can estimate the likely impacts of climate change and develop abatement and adaptation strategies that are robust against the uncertainties of future climate change. At the present time, however, there is no single location where these analysts can find out what climate-change simulations have been performed; obtain the data from these simulations, manipulate these data to the space and time frames of interest; and generate scenarios of the geographical distribution of climate change. Because a large number of climate-change simulations have been, are being, and will be

performed by the United States and Japan, a leadership role should be taken jointly by the United States and Japan to establish a Climate-Change-Simulation Information System to inventory and archive climate-change simulation results and provide the tools required to generate geographical scenarios of climate change for impact and policy analysts.

The advent of new parallel high speed supercomputers invites the development of a new generation of climate models. These models will hone resolution sufficient to describe regional climate and will address more complex processes in the climate system that are not included in the current generation models. The design of such models is not yet completed. We need discussions on optimal use of parallel computing technology; physical, biological and chemical processes suitable for high resolution models; parameterization of various processes in the earth climate system that are not properly incorporated in current generation models; and optimal balance between resolution and sophistication of various processes for maximum predictive skill.

Recent advances in our understanding of the mechanisms of climate variability at intra-seasonal to inter-annual time scales and in our ability to model and predict ENSO phenomena suggest that it should be possible to produce societally beneficial climate forecasts using global observations and complex models of the coupled ocean-land-atmosphere system. Although marginally accurate forecasts of seasonal anomalies are of great value to the Asian countries because the economies of these countries are sensitive to climate anomalies, increasing the skill of predictions remains an important goal. In addition, better understanding is required of the flindamental limits of predictability of phenomena such as ENSO and the monsoon as well as the interaction of these phenomena.

III. Recommendations for Cooperative Research Between Japan and the U.S.

Each of the working groups gave careful consideration to the identification of mutually beneficial cooperative research projects among the United States and Japan. The scope of some of these projects is outlined in the above paragraphs describing outcomes of the working group sessions.

1. Establish a U.S./Japan Ad Hoc Planning/Drafting Committee whose activities would be to:
    - develop a summary document describing decadal climate variability of the coupled atmosphere-ocean-ice-land system in the Pacific Basin; and
    - plan a multinational workshop in the late summer or fall of 1998 at the IPRC.

    Items to be discussed in the workshop should include:

    - dynamic model-based synthesis and analysis of observations;
    - coupled model simulations, predictability studies and diagnostic studies of decadal variability;
    - observational studies of variability and needs for changes in or enhancements to our observational systems;

- present status of historical data sets and possibilities for improvements in these data by data archeology;
- development of paleoclimate data sets for study of decadal variability;
- impact of decadal climate variability on fisheries, water supply and other important parts of the natural system; and
- assessment of the appropriate combination of in situ instrumental, paleoclimatic and satellite observations that are required, and work to ensure the economic feasibility of long-term monitoring.

This workshop would explore the possibility of developing a scientific research program in decadal climate variability in the Pacific Basin, building upon the concept of a basin-scale extended climate study.

2. Establish a bilateral Japan-U.S. Scientific Working Group (SWG) to coordinate the archeology and rescue of satellite, in situ instrumental, and paleoclimatic data critical to documenting, understanding and simulating the full range of seasonal to inter-decadal Asian Pacific climate variability. This should include the integration of these data into existing databases, along with careful documentation of data to ensure easy interdisciplinary sharing of data.

3. Hold a workshop to develop cooperative research to be promoted between the hydrologists and atmospheric scientists involved in land-atmosphere-hydrology interaction studies to fully utilize the forthcoming observations from programs such as GAME and platforms such as TRMM, possibly as part of the joint research program under IPRC.

4. Hold a workshop to establish a set of cooperative U.S.-Japan studies to investigate a suite of regional climate scenarios, driven by large-scale global climate forcing, in order to assess regional ecological and societal impacts.

5. Carry out simulations of the 20~ century climate with coupled and uncoupled models that employ identical changes in forcing factors. Inter-comparison of results from the coupled model simulations should be carried out and a workshop should be held at IPRC to present results from these simulations.

6. Convene a workshop of the users of climate-change simulation results to define the capabilities required of a Climate-Change-Simulation Information System to inventory and archive climate-change simulation results and provide the tools to generate graphical scenarios of climate change for impact and policy analysis.

7. Hold a workshop to discuss ideas on basic design of next-generation climate/NWP models, computational methods and physical processes for these models.

8. Hold a workshop to carry out systematic model inter-comparison on simulation and predictability of ENSO and monsoon and intra-seasonal variability through carefully coordinated experiments.

9. Representatives from the United States and Japan should be selected to prepare regular (e.g. quarterly) Internet WWW reports which provide background information, as well as current developments in their respective countries with regard to the exchange of data nationally and internationally, so that scientists can keep abreast of the situation and play an active role in the development of national policy that is science-data friendly.

IV. Workshop Conclusions

Workshop participants from both Japan and the United States agree that there are important opportunities for cooperation between the two countries to use global change information for the benefit of society. The workshop especially recognized the importance of collaborations between the United States and Japan which are being implemented through the Frontier Research Program on Global Change (FRPGC), the International Pacific Research Center (IPRC) and the International Arctic Research Center (IARC) which began in 1997.

Consensus conclusions of the workshop participants were based on the following themes for cooperative research activities among Japanese and U.S. scientists:

CLWAR - Pacific focus - inter-annual to inter-decadal variability;
GEWEX - Land surface/hydrology - intra-seasonal to intra-annual variability;
IPCC - multi-decadal to centennial;
Data sets - ensuring that appropriate data are produced, assembled, archived, and made freely available; and

· Advanced climate models and computers made available for global change research.

The workshop considered modes of implementing the recommendations and means of reporting on the results of the recommended actions. The workshop suggested two approaches to reporting subsequent responses to the recommendations:

1. The responsible agencies in the two nations will report the workshop recommendations to the appropriate national committees. In addition, the agencies will be responsible for reporting to the Coordinating Committees of the U.S. Japan Agreement on Cooperation in Research and Development in Science and Technology. Those reports will include the responses of the agencies to the recommendations and the ultimate results of the recommended actions.

2. The workshop identified U.S. and Japanese contact persons who will facilitate the exchange of information and document progress on the recommended collaborative activities (attached Annex).

26 February 1998
East-West Center
Honolulu, Hawaii

Co-Chair from Japan:

Mr. Junichi Nose
Director General of
Meteorological Research Institute
Japan Meteorological Agency

Co-Chair from the United States:

Dr. Richard S. Greenfield
Director
Division of Atmospheric Sciences
Directorate of Geosciences
National Science Foundation

ANNEX

LIST OF U.S.-JAPAN CONTACT PERSONS FOR THE RECOMMENDED ACTIVITIES (SEE COMMUNIQUÉ)

RECOMMENDATION 1: Maurice Blackmon and Taro Matsuno

RECOMMENDATION 2: Paul Berkman, Jonathan Overpeck and Hiroki Kondo

RECOMMENDATION 3: Jim Shuttleworth and Tesuzo Yasunari

RECOMMENDATION 4: Bill Easterling, Peter Lamb and Yosei Hayashi

RECOMMENDATION 5: Jeff Kiehl and Masato Sugi

RECOMMENDATION 6: Michael Schlesinger and Shiro Hatakeyama

RECOMMENDATION 7: Maurice Blackmon and Akimasa Sumi

RECOMMENDATION 8: Jagadish Shukla and Akio Kitoh*

RECOMMENDATION 9 Richard Greenfield, Hiroki Kondo, and Kiyotoshi Takahashi*

*Were nominated but did not attend workshop. Addresses are listed, however, in list of participants at Appendix C.

SECTION II

Working Group 1: Observation Svstems for Climate Change Research

WG Membership: A. Busalacchi (Co-chair), T. Yasunari (Co-chair), J. Overpeck (Rapporteur), R. Chinman, W. Easterling, M. Fukada (part-time), R. Greenfleld (part-time), R. Hallgren, K. Harada, T. Hatakeyama, Y. Hatanaka, Y. Hayashi, M. Hishida, R. Lukas (part-time), G. Meyers, T. Mizuno, M. Murakami, R. Newell, K. Otoi, J. Shuttleworth, J. Shukla (part-time), S. Ueda, S. Ueno, D. Waliser (part-time), T. Waseda, G. Weller (part-time), T. Wilheit, S. Yamamoto

Preamble

A stronger observational basis is clearly needed for achieving an improved understanding of climate variability and predictability, as well as for using this predictive capability to make societially useful climate change assessments. Our ability to detect climate change and attribute observed change to unambiguous causes is also limited by the lack of long-term climate observations. For these reasons, a working group was established to focus on building an improved climate observation strategy. Fortunately, a record of close Japan-U.S. collaboration already exists. For example, Japan and the United States enjoy a strong collaborative working relationship for in situ and space-based observational measurements, for example, TOGA TAO,/TRITON, TRMM, SeaWiFS/OCTS, NSCAT/QUICKSCAT, GAME Flux Monitoring, IGBP Fluxnet. This report proposes new observational efforts and approaches that can be built on this record of success.

Regionally, the North Pacific, defined roughly as the Pacific north of about 20^0S, is the region with the greatest influence on the regional climatic variability of the United States and Japan. For this reason, there is real mandate for enhanced Japan-U.S. leadership in understanding climate variability of this region. There is also a recognition, however, that the wider Pacific region is also key to understanding climate variability and predictability, a fact that leads Japan and the United States to encourage other nations to join them in understanding Asia-Pacific climate variability.

The recent success of TOGA, the tropical Pacific Observing System, and development of a useful ENSO prediction capability still leaves many questions unanswered regarding the nature of seasonal to inter-annual climate variability in the Asian-Pacific region. New attention must be placed on the Asian-Australian monsoon system, as well as on longer4erm modulation of the ENSO and monsoon variability. It is now recognized that significant decadal modulation of these systems exists, and also that modes of inter-decadal North Pacific variability must be understood in order to advance potential climate prediction skill. Lastly, natural inter-decadal variability of the last few centuries must be understood if we are to unambiguously detect human-induced climate change.

The observational foundation for Asia-Pacific climate studies is one of the best yet developed and this fact is one key reason why a predictive understanding has already emerged from the region. However, much remains to be done in terms of filling large gaps in both observational coverage

and the understanding built on observations. The purpose of this working group report is to push forward a more integrated and effective ocean-atmosphere-terrestrial observations strategy that is driven by clear scientific needs. No one type of data is enough for this strategy, but rather complementary arrays of satellite, in situ instrumental and paleoclimatic observations must be used together to meet our objectives.

Although the Working Group acknowledged the importance of small P1-based scientific effort, it felt that priority had to be placed on defining the most urgent climate variability research that no one country could accomplish alone. Close Japanese-U.S. collaboration on the following priorities will lead to results that neither country could achieve on their own. Past bilateral success points to future progress.

Proposed joint efforts

The Observations Working Group proposes that three areas of major potential joint Japan-U.S. collaboration get priority. Although each priority can stand on its own merits, they share some resource requirements and together offer a promise of much improved societially-relevant climate prediction in the Asian, Pacific and North American regions. A conscious decision was made not to recommend or prioritize individual measurements or observing technologies at this time as these are best done within the context of the focused areas that follow.

North Pacific Basin-wide Extended Climate Study (BECS). As spelled out in Lukas (1 997); energetic, large-scale physical and biogeochemical variability in the upper Pacific Ocean exists on time scales from roughly seasonal through decadal, much of which is neither well measured, nor yet well tested in models and utilized in climate predictions. This oceanic variability has strong relationships with the tropical and extra-tropical atmosphere, through ENSO and the dominant atmospheric teleconnection patterns (principally the PNA), both of which have significant influence over North American climate fluctuations.

These atmospheric modes exhibit broad-band variability in this range of time scales. The shallow tropical ocean aspects of ENSO are fairly well explored, but only on time scales of up to a year or two, and without understanding the other oceanic connections or the roles of the extra-tropical oceans. With the advent of remotely sensed observations such as radar altimetry and scatterometry, together with in situ observational platforms such as moored buoys, drifting buoys, and profiling floats, there is both the need and opportunity to synthesize and characterize the coupled ocean-atmosphere system for the North Pacific Ocean basin. This would enable:

- an accurate, quantitative description of the low-frequency, three-dimensional circulation and associated thermohaline structure of the upper Pacific Ocean;
- an ability to test models of this circulation and the intrinsic modes of variability as well as those due to coupling with the atmosphere; and
- an understanding of the processes which couple the tropical, subtropical, and subarctic wind-driven gyres, for the purpose of testing basin-scale hypotheses concerning the role of the North Pacific Ocean in climate variability on a broad range of time scales.

We propose joint Japanese-U.S. leadership be established for the execution of BECS to describe and understand climatic variability within and between the tropical and subtropical Pacific Ocean, particularly with regard to decadal variability. Underlying hypotheses are discussed in Lukas (1997). The exploration of North Pacific variability, and the testing of current hypotheses, will require extensive observations across the region. Principal objectives will be to measure ocean and atmospheric variability, to identify dominant time-space patterns of temperature and salinity anomalies and their pathways, and to assess the controlling dynamic processes.

· **Recommendation bullet**

It is proposed that a bilateral Japan-U.S. Scientific Working Group (SWG) be established to coordinate planning of Pacific Basin-Wide Extended Climate Study (BECS) and to explore a joint Japan-U.S. commitment to BECS as part of their nations' commitment to CLIVAR. Broadening of BECS (Lukas, 1997) to include a stronger atmospheric component and perhaps a broader geographical focus should also be investigated. The proposed SWG should also assess the appropriate combination of in situ instrumental, paleoclimatic and satellite observations that are required and work to ensure the economic feasibility of long-term monitoring.

Data Rescue and Archeology. Rapid progress in our understanding of climate variability in the Asia-Pacific region, particularly away from the tropical TAO/TRITON observing system, is limited by the lack of available observations. At the same time, many of the needed observations do exist in isolated laboratories, government offices and locked up in paleoenvironmental proxies such as corals, tree-rings, ice-cores and sediment. For this reason, priority must be given to getting these paleoenvironmental time series into the public domain and integrated with the other, already existing, observational data needed to document, understand and model the full range of seasonal to inter-decadal Asia-Pacific climate variability. A data archeology and rescue effort of this nature would directly support decadal-scale studies of North Pacific coupled climate variability, as well as research on land-atmosphere interaction in the Asia-Pacific region on time scales spanning seasonal to inter-decadal. Given the scientific goals of Asia-Pacific climate studies, particular focus should be placed on:

· Geostationary and polar-orbiting satellite data archeology;
· Instrumental data rescue/archeology, with particular emphasis on:
  - rescue of instrumental data from countries in the Asian monsoon region (e.g., temperature and precipitation);
  - finding and rescuing additional oceanographic data sets; and
  - release of formerly classified data;
· Collection of paleoclimatic records from multiple sources (e.g., tree rings, corals, ice cores and sediments), with particular attention to those proxy records presently at serious risk of destruction due to:
  - coral reef destruction;
  - glacier melting; and
  - deforestation;

- A paleoclimatic focus that includes the last several centuries, as well as time periods characterized by different climate forcing (e.g., 6000 years ago); and
- The creation of user-friendly integrated databases, making sure that original data are maintained wherever possible

- **Recommendation bullet**

  It is proposed that a bilateral Japan-U.S. Scientific Working Group (SWG) be established to coordinate the archeology and rescue of satellite, in situ instrumental, and paleoclimatic data critical to documenting, understanding and simulating the full range of seasonal to inter-decadal Asian Pacific climate variability. This should include the integration of these data into existing databases, along with careful documentation of data to ensure easy interdisciplinary sharing of data.

Large-scale land-atmosphere-hydrology interaction studies. Extensive efforts of understanding and modeling large-scale land-atmosphere-hydrology interactions are underway over Eurasia, North America and other continents as part of GEWEX and IGBP-related projects. Scaling-up and parameterization of heterogeneous land-surface processes in sub-grid scales are being promoted by using high-resolution satellite remote sensing technique with intensive in situ observations. In the Asia-Pacific region, these studies are also important for understanding mechanisms of the ENSO-monsoon system through assessing the roles of land-surface processes on Asian monsoon variability.

The influence of soil moisture in climate variability with seasonal to inter-annual time-scales is also a key issue for climate studies over these continents. Coordination and cooperation among the continental-scale and regional experiments are being promoted in various way. In 2001-2002, it is being planned for all the continental-scale experiments (GCIP, MAGS, LBA, BALTEX and GAME) to have a coordinated Intensive Observing Period (lOP) under the new satellite observing systems (EOS series, ADEOS-II, ENVISAT, etc.) to assess the role of soil moisture in the global hydrological cycle and climate variability. Within the context of U.S.-Japan joint research, it is strongly recommended that GCIP and GAME should be coordinated, through exchange of data and information, cooperation in process studies and long-term monitoring, and model development. The impact of climate variability on agriculture and economy in regional-scales, i.e., down-scaling to regional climate and hydrology, is another essential issue for Asia and North America.

- **Recommendation bullet**

  It is proposed that a workshop and cooperative research be promoted between the hydrologists and meteorologists involved in land-atmosphere-hydrology interaction studies, possibly as part of the joint research program under the IPRC. A working group on land surface process modeling is also strongly recommended in order to fully utilize the forthcoming observations from programs such as GAME and platforms such as TRMM.

Possible implementation strategies.

Special attention must be given to ensure progress in bilateral planning and implementation of the scientific efforts proposed above. The working group identified several possible ways in which progress could be enhanced. These include:

The utilization of IPRC and IARC as means for U.S.-Japanese scientific coordination, including:
- visiting fellowships, both long-term and short-term;
- workshops - some already planned; and
- general project planning and implementation.

· The establishment of bilateral working groups to keep the efforts going. This could be initiated by appointing Japanese and U.S. Co-Chairs.

· The redefinition of the annual U.S.-Japan Global Change workshops to ensure continuity from year to year. For example, a regular schedule of project progress reports and assessments would help maintain momentum and scientific focus.

· Encouragement of participation by other countries in the Pacific region, including efforts to focus southward in Pacific, westward into Indian Ocean, and westward in Asian terrestrial monsoon region.

· Exploration by both U.S. and Japanese funding agencies of mechanisms that can be used to focus resources on each of the proposed science objectives

· Possible joint Japan-U.S. proposal requests and review, focused on both P1-based science, as well as larger collaborative efforts.

· Tie in with established large international programs, and more specifically a definition of possible joint U.S./Japan contributions to programs such as CLIVAR and GEWEX.

Scientific Data Sharing at Risk.

It should be noted that the observational topics listed above may be moot unless attention is given to the following:

The free and unrestricted exchange of global data is essential for detecting, understanding and coping with global change. The development and evaluation of global climate models requires extensive atmospheric, oceanic, and terrestrial data. For various reasons, restrictions on the exchange of some data have arisen in recent years, especially with respect to commercial data and information issues.

The WMO has developed procedures for exchange of meteorological data which advocate the free and unrestricted exchange of data for research, education, and certain global change data, but

do permit restriction on the use of selected data. The World Intellectual Property Organization (WIPO) is considering general rules protecting databases than could have dramatic impact on earth science data. Japan and the United States have played leadership roles in terms of advocating the free and unrestricted exchange of environmental data. However, the situation continues to evolve and the rush for further data restrictions remains.

It is proposed that representatives from the United States and Japan be selected to prepare quarterly reports which provide background information, as well as current developments in their respective countries with regard to the exchange of data nationally and internationally, so that scientists can keep abreast of the situation and hopefully play a role in the development of policy that is science-friendly.

Working Group 2: Process Studies of the Climate System

This working group was concerned with identifying the process studies that are needed to understand and predict the behavior of the climate system on a wide range of space- and time-scales. The deliberations involved 18 short presentations by scientists from Japan and the U.S. on their current research, each of which was followed by a group discussion. This approach permitted the development of the generalized research agenda that follows from considerable discussion of specific contemporary research issues.

The most fundamental need to emerge was for investigation of key space- and time-scales issues, and particularly the crucial scale-interactions and cascades that are being increasingly recognized. It is essential that future process studies ultimately provide information on the causes and predictability of climate anomalies and their societal impacts that occur in particular regions. While this approach recognizes that societal impacts are "local," it must equally acknowledge that their causation generally involves very large-scale (and even "global") behavior of the climate system. Accordingly, the needed research must give strong attention to "down-scaling," through a combination of innovative empirical approaches and the linking of models of varying spatial resolution.

Of comparable importance to those space-scales interactions are time-scale relationships that underlie distinctive weather system patterns that impact society. At the short-period extreme, these can involve the recurrence of particular intra-seasonal variations, e.g., stormtrack anomalies, to the point where they are responsible for striking patterns of decadal-scale variability of seasonal mean values. The need to understand the mechanisms of decadal-multi-decadal interactions was identified as high priority, as was the emerging issue of the relations between the El Nino (2-7 years) and anthropogenic (multi-decadal-to-century) time-scale behavior. At the long-period extreme, apparent "singularities" in the paleoclimatic record need substantial clarification. Such "singularities" are periods (e.g., mid-Holocene) for which there is considerable and diverse evidence of climate change, but the extent to which the evidence can be reconciled and attributed to particular forcings is not yet clear. Progress in this especially challenging area will require highly effective interdisciplinary collaboration.

Implicit in the above generalized research agenda are the themes that are embodied in three important contemporary international programs - GEWEX (water-energy cycles for multi-scale regions for intra-seasonal and inter-annual time-scales), CLIVAR (inter-annual-to-decadal scale continental and global variability), and IPCC (multi-decadal-to-century variations). The agenda thus also recognizes the role of land-atmosphere coupling, as well as ocean-atmosphere interactions, for regional climate variability. Indeed, there is much opportunity to investigate the relative contributions of these two groups of processes, and the interactions between them, for non-monsoonal regional climate variability around the North Pacific Rim, including the Arctic.

Of comparable importance is the need to sustain the vigorous inquiry into Pacific Ocean processes so characteristic of the last 15 years. The oceanic processes that invite inquiry in the regional climate context range from sensitively located frontal situations (e.g., to east of Japan), through subduction processes in the subtropical gyre, to the basin-scale behavior of the North Pacific (e.g.,

through a "basin-wide" extended climate study). It is essential that all of the above work proceeds through the combined use of empirical and modeling approaches. The empirical work would involve both the analysis of historical data and the collection and analysis of new data through specially designed intensive field observations.

The above research agenda would be most effectively pursued through a variety of institutional arrangements that are overseen by a "steering committee" dedicated to the Japan-U.S. bilateral. The 'ARC and IPRC should play catalytic roles in the development of programs that would range from small P1 meetings (that may be partly at the participants' expense), to larger workshops, to specialized working groups, to program-level Announcements of Opportunities for funding separately or jointly by both nations, to the awarding of Visiting Fellowships. It should be possible to arrange for Visiting Fellowships at not only 'ARC and IPRC, but also at other appropriate institutions in both countries.

Working Group 3: Simulation and Prediction Models

Comprehensive models of the atmosphere-ocean-land surface-sea ice system offer the opportunity for quantitative simulation and prediction of climate variability and climate change. Climate system modeling is being actively pursued in several laboratories in the United States and in Japan. This working group found many areas of common interest and areas where collaborative research would be valuable.

Studies of anthropogenic climate change are underway in both countries. A better understanding of the evolution of climate change in the 2Oth century is one important issue being investigated. Several groups have simulated the change in climate due to the projected increase in carbon dioxide, but more comprehensive experiments are underway in which the concentrations of greenhouse gases and sulfate aerosols over the past century are used as forcing for coupled models to see if the changes in climate match observations. These runs will be continued by projecting the growth of these forcings into the 2lst century. Since these projections are uncertain, a range of plausible scenarios will be required. A proposal was made to hold a workshop to compare model responses to common forcings.

The development of the "Earth Simulator" project in Japan was discussed. This new computer will offer a major opportunity for the development and use of greatly improved, more comprehensive models. A discussion of how to plan for the development of these models led to a proposal for a workshop in the United States that would allow interested modelers to share ideas about the design of these models.

Climate variability on decadal, inter-annual, and intra-seasonal time scales was discussed. Coupled model simulations of inter-decadal variability were discussed. While some of the simulated variability seemed similar from model to model, there were examples of important differences as well. At present, the processes leading to this variability are unclear. A workshop to discuss and compare this further was suggested. However, it became clear that other Working Groups were also interested in climate variability on this time scale, so a joint recommendation for a comprehensive workshop was formulated in collaboration with members of working groups 1 and 2.

Inter-annual climate variability has been investigated for two decades and great progress has been made in understanding and modeling of the ENSO phenomenon. A basic prediction capability has been developed. Even though basic predictions are beneficial, improved capability is likely to be even more valuable. In addition to ENSO, prediction of the Asian monsoon would have a positive benefit. Unfortunately, monsoon prediction is still unsuccessful. It was also recognized that intra-seasonal variability is an important component of inter-annual variability, especially on a regional scale. A workshop was proposed to discuss the status of prediction of inter-annual prediction as well as how to determine better the fundamental limits of predictability of this variability.

The working group also discussed the impact of climate predictions and climate change simulations on different user groups. The needs of economists, ecologists, and others include

data sets with higher resolution or different temporal frequency from that usually specified by atmospheric and ocean scientists. A proposal was advanced to collect data from a variety of climate change simulations and provide it to users, along with software that would allow the data sets to be customized for the needs of the individual users.

One presentation was made on carbon metabolism between atmosphere and pedosphere under global warming and a cooperative research was proposed on carbon cycle modeling focusing on this process. Another presentation was made on the long-range transport of $S0_2$ and sulfate aerosols and a cooperative research on validation of models which include chemical processes with field observation data of sulfate aerosols.

APPENDICES

APPENDIX A

6th Japan-U.S. Workshop on Global Change

Future Directions of Global Change Research: Observations; Process Studies; and Simulation and Prediction of Climate Change

February 24-26,1998
East-West Center, Honolulu, Hawaii

Monday, February 23

5:00PM	Meeting of Co-Chairs (Lanai Room)
5:30PM	Meeting of Co-chairs, Working Group Chairs and Rapporteurs (Lanai Room)
6:30PM	Welcome Reception, Ilikai Hotel; distribution of meeting materials and individual research information (Imperial Suite)

Tuesday, February 24

8:30 AM	Bus departs the Hotel Ilikai for the East-West Center
9:00 AM	Welcome by Co-Chairs; meeting materials and individual research information will be available (Keoni Auditorium, East-West Center)
9:30 AM	Keynote lecture - "Role of the Pacific and the Arctic in the Inter-decadal Climate Variability" Dr. Mike Wallace
10:00 AM	Keynote lecture - "Future Direction of Global Change Research" Prof. Taro Matsuno
10:30 AM	Coffee Break
10:45 AM	Keynote lecture - "Availability of Environmental Data for Assessment and Research" Dr. Richard Hallgren
11:15 AM	Keynote lecture - "The Study of Natural and Anthropogenic Changes of Pacific Climate by Coupled Atmosphere Models" Dr. Syukuro Manabe
11:45 AM	General discussion and questions
12:15 PM	Lunch at the East-West Center - Lunch to include 15 minute presentations from the International Pacific Research Center (IPRC) and International Arctic Research Center (IARC).
1:30 PM	Plenary session - Organization of the meeting; charge to working groups

Tuesday, February 24 con't

2:00PM	Working Group Sessions -
	All participants are asked to make a brief self introduction.
3:00 PM	Break
3:30 PM	Working Group Sessions - Continued self introductions
5:00 PM	Plenary session - Review progress and discuss next days agenda/plans
5:30 PM	Adjourn
5:45 PM	Bus to returns to the Ilikai
6:30 PM	U.S. Hosted Reception - Ilikai Hotel (Poolside)

Wednesday February 25

8:30AM	Bus departs for East-West Center
9:00PM	Working group sessions

Discussions of future tasks or projects and how cooperation between Japan and the United States could benefit the identified tasks and projects. Discussions in the each of the Working Groups should include, but not be limited to:

WG1: Observation Systems for Climate Change Research - (Keoni Auditorium) Space-based observations (earth observation satellites, meteorological satellites), in situ observations (ground stations, marine meteorological and oceanographic observations on board ships, ocean data buoys, drifting buoys), climate data archives and assimilation.

WG2: Process Studies of the Climate System - (Kamehameha Room) Cloud-radiation, atmosphere-ocean-land interaction, convective clouds, marine stratus clouds, ocean eddies, deep convection in the polar oceans, land surface, processes, snow cover, sea ice, etc.

WG3: Simulation and Prediction Models - (Tagore Room)
Simulation of the twentieth century climate, climate change prediction, high resolution climate models.

10:15 AM	Coffee break
10:30 AM	Working group sessions
1215 AM	Working lunch at East-West Center
1:30PM	Working group sessions and drafting of working group report
3:00PM	Break

Wednesday, February 25 con't

3:30PM	Working group sessions continue
5:00PM	Plenary session - status reports from working groups
5:30PM	Adjourn
5:45 PM	Bus returns to the Ilikai
6:30PM	Japanese Hosted Reception - Ilikai Hotel (Harbor View Suite, Yacht Harbor Tower)

Thursday February 26

8:30 AM	Bus departs for the East-West Center
9:00 AM	Session of workshop co-chairs, working group co-chairs, and rapporteurs to draft communiqué
10:15AM	Coffee break
10:30 AM	Plenary session - discussion and finalization of communique'.
12:15PM	Working lunch at East-West Center
1:30PM	Continued preparation of communiqué
3:00PM	Break
3:30PM	Discussion and approval of communiqué (brief summary of key conclusions and recommendations of the workshop)
5:30PM	Adjourn

APPENDIX B

LIST OF ACRONYMS

ADEOS-II: Advanced Earth Observing System II
BALTEX: Baltic Sea Experiment (GEWEX)
BEC S: Pacific Basin-wide Extended Climate Study
CLIVAR: Climate Variability and Predictability
ENSO:El Niño Southern Oscillation
ENVISAT: European Environmental Satellite
EOS: Earth Observing System
FRPGC:Frontier Research Program on Global Change
GAME: GEWEX Asian Monsoon Experiment
GCIP: GEWEX Continental Scale International Project
GEWEX: Global Energy and Water Cycle Experiment
IARC:International Arctic Research Center
IGBP: International Geosphere-Biosphere Program
lOP: Intensive Observing Period
IPCC: Intergovernmental Panel on Climate Change
IPRC: International Pacific Research Center
JMA: Japan Meteorological Agency
LBA: Large Scale Biosphere-Atmosphere Experiment
MAGS: Mackenzie River GEWEX
MRI: Meteorological Research Institute of Japan
NCAR: National Center for Atmospheric Research
NSF: National Science Foundation
PNA: Pacific North American
SeaWiFS: Sea-viewing Wide Field-of-view Sensor
STA: Science and Technology Agency of Japan
SWG: Scientific Working Group
TAO: Tropical Atmosphere Ocean (Moored Buoy Array)
TOGA: Tropical Oceans and the Global Atmosphere
TRMM:Tropical Rainfall measuring Mission
TRITON: Triangle Trans-Ocean (Moored Buoy) Network
UCAR: University Corporation for Atmospheric Research
USGCRP: U.S. Global Change Research Program
WIPO: World Intellectual Property Organization
WWW: World Weather Watch

APPENDIX C

LIST OF PARTICIPANTS

Roni Avissar
Department of Environmental Sciences
Rutgers University
14 College Farm Road
New Brunswick, NJ 08901-8551
USA
(1) 732-932-9520
(1) 732-932-1038
avissar@gaia.rutgers.edu

David S. Battisti
Dept. of Atmospheric Sciences, AK-40
University of Washington
Seattle, WA 98195
USA
(1) 206-543-2019
(1) 206-543-0308
david@atmos.washington.edu

Paul Arthur Berkman
Byrd Polar Research Center
The Ohio State University
108 Scott Hall
1090 Carmack Road
Columbus, OH 43210
USA
(1) 614-292-3670
(1) 614-292-4697
PAUL+@osu.edu

Maurice Blackmon
Director
Climate and Global Dynamics Division
NCAR
P0 Box 3000
Boulder, CO 80303
USA
(1) 303-497-1389
(1) 303-497-1314
blackmon@ucar.edu

Byron Boville
Climate and Global Dynamics Division
Climate Modeling Section
National Center for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000
USA
(1) 303-497-1337
(1) 303-497-1324
boville@ucar.edu

Antonio J. Busalacchi
Goddard Space Flight Center
Laboratory for Hydrospheric Processes
NASA/National Aeronautics & Space Administration
Code 970, Bldg 22, Rm 274
Greenbelt,MD 20771
USA
(1) 301-286-6171
(1) 301-286-1761
tonyb@neptune.gsfc.nasa.gov

Ujjayant Chakravorty
Department of Agricultural & Resource Economics
Gilmore 112
University of Hawaii
Honolulu, III 96822
USA
(1) 808-956-7279
(1) 808-956-2811
unc@hawaii.edu

Ping Chang
Oceanography Department
Texas A&M University
M53146
College Station, TX 77843-3146
USA
(1) 409-845-8196
(1) 409-847-8879
ping@ocean.tamu.edu

Richard Chinman
Manager, IITA
UCAR
P.O. Box 3000
Boulder, CO 80307-3000
USA
(1) 303-497-8696
(1) 303-497-8668
chinman@ucar.edu

Michael Devin
Directorate of Geosciences
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
USA
(1) 703-306-1993
(1) 703-306-0091
mdevin@nsf.gov

William Easterling
Dept. of Geography
The Pennsylvania State University
323 Walker Bldg.
State College, PA 16802-5011
USA
(1) 814-865-3094
(1) 814-863-7943
easter@gis.psu.edu

Michael Farrell
Director
Oak Ridge National Laboratory
Center for Global Environmental Studies
P0 Box 2008
Oak Ridge,TN 37832
USA
(1) 423-576-7785
(1) 423-576-9977
mff@ornl.gov

Masami Fukuda
Institute of Low Temperature Science
University of Hokkaido
N19 W8 Kita-Ku
Sapporo, 060-0819
JAPAN
(81) 11-706-5492
(81) 11-706-7142
mfukuda@pop.lowtem.hokudai.ac.jp

Nicholas Graham
Director, Experimental Forecast Division
International Research Institute
Scripps Institution of Oceanography
University of California-San Diego
8605 La Jolla Shores Dr., Rm. 424
La Jolla, CA 92093-0224
USA
(1) 619-534-0382
(1) 619-534-8561
ngraham@ucsd.edu

Richard Greenfield
Division of Atmospheric Sciences
National Science Foundation
4201 Wilson Blvd., Rm. 775
Arlington, VA 22230
USA
(1) 703-306-1520
(1) 703-306-0377
rgreenfi@nsf.gov

Tomoyuki Hakamata
MAES/National Institute of
Agro-Environmental Sciences
3-1-1 Kannondai
Tsukuba Ibaraki 305-0856
JAPAN
(81) 298-38-8272
(81) 298-38-8199
tomo@niaes.affrc.go.jp

Richard Hallgren
Executive Director
American Meteorological Society
1200 New York Ave., NW, Suite 410
Washington, DC 20005
USA
(1) 202-682-9006
(1) 202-682-9298
hallgren@dc.ametsoc.org

Koh Harada
NIRE/National Institute for Resources and Environment
16-3Onogawa
Tsukuba, Ibaraki 305-8569
JAPAN
(81) 298-58-8390
(81) 298-58-8357
harada@nire.go.jp

Taro Hatakeyama
Office of Planning
Meteorological Research Institute
1-1 Nagamine
Tsukuba-si, Ibaraki 305-0052
JAPAN
(81) 0298-53-8535
(81) 0298-53-8545
thatakey@mri-jma.go.jp

Shiro Hatakeyama
NIESI National Institute for Environmental Studies
16-2 Onogawa
Tsukuba, Ibaraki 305-0053
JAPAN
(81) 298-50-2502
(81) 298-58-2645
hatashir@nies.go.jp

Yuki Hatanaka
Geodetic Observation Center
Geographical Survey Institute
Kitasato-1
Tsukuba, Ibaraki 305
JAPAN
(81) 298-64-1111
(81) 298-64-6864
hata@gsi-mc.go.jp

Yosei Hayashi
Clinatic Resources
NIAES/ National Institute of
Agro-Environmental Sciences
3-1-1 Kannondai
Tsukuba, Ibaraki 305-8604
JAPAN
(81) 298-38-8206
(81) 298-38-8199
hayyou@niaes.affrc.go.jp

Masataka Hishida
Director, Ocean Research Department
Japan Marine Science & Technology Center/JAMSTEC
2-15 Natsushima-Cho
Yokosuka 237
JAPAN
(81) 468-67-3870
(81) 468-65-3202
hishidam@jamstec.go.jp

Shiro Imawaki
Research Institute for Applies Mechanics
Kyushu University
Kasuga, Fukuoka 816-8580
JAPAN
(81) 92-583-7736
(81) 92-584-2570
imawaki@riam.kyushu-u.ac.jp

Fei-Fei Jin
Department of Meteorology
University of Hawaii
Honolulu, HI 96822
USA
(1) 808-956-4645
(1) 808-956-2877

Sonoko Katoh
JISTEC/Japan International Science & Technology Exchange Center
2-20-5 Takezono
Tsukuba-shi, Ibaraki 305-0032
JAPAN
(81) 298-53-8260
(81) 298-53-8260
skatoh@jistec.jst.go.jp

Takahiro Kayahara
NIED/National Research Institute for Earth Science and Disaster Prevention
3-1 Tennoudai
Tsukuba, Ibaraki 305-0006
JAPAN
(81) 298-51-1611
(81) 298-51-1610
kayahara@ess.bosai.go.jp

Jeffrey T. Kiehl
Climate and Global Dynamics Division
Climate Modeling Section
National Center for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000
USA
(1) 303-497-1350
(1) 303-497-1324
jtkon@ucar.edu

Toru Kimoto
Assistant Director
Frontier Research Promotion Department
Japan Marine Science & Technology Center/JAMSTEC
Seavans North Building 7F
1-2-1 Shibaura, Minato-ku
Tokyo 105-0023
JAPAN
(81) 3-5765-7100
(81) 3-5765-7103
kimotot@jamstec.go.jp

*Akio Kitoh
Climate Research Department
Meteorological Research Institute
I - 1 Nagamine, Tsukuba
Ibaraki, 305-0052
JAPAN
(81) 298-53-8594
(81) 298-55-2552
kitoh@mri-jma.go.jp

Hiroshi Koide
Climate Research Department
Meterological Research Institute
1-1 Nagamine
Tsukuba, Ibaraki 305
JAPAN
(81) 298-53-8597
(81) 298-55-2552
hkoide@mri-jma.go.jp

Hiroki Kondo
Director, Climate Research Department
Meteorological Research Institute
1 - 1, Nagamine,
Tsukuba, Ibaraki 305-0052
JAPAN
(81)298-53-8590
(81) 298-55-2552
hkondo@rnri-jma.go.jp

Shoji Kusunoki
2nd Laboratory, Climate Research
Department
Meterological Research Institute
Japan Meteorological Agency
1 - I Nagamine
Tsukuba, Ibaraki 305-0052
JAPAN
(81) 298-53-8595
(81) 298-55-2552
skusunok@mri-jma.go.jp

Peter Lamb
Director
CIMMS and School of Meteorology
University of Oklahoma
100 East Boyd, Energy Center, Rm. 1110
Norman, OK 73019
USA
(1) 405-325-3041
(1) 405-325-7614
plamb@ou.edu

Roger Lukas
Department of Oceanography
SOEST
University of Hawaii
Marine Sciences Building, Rm. 418
1000 Pope Rd.
Honolulu, HI 96822
USA
(1) 808-956-7896
(1) 808-956-9222
rlukas@iniki.soest.hawaii.edu

Lorenz Magaard
University of Hawaii
Honolulu, HI USA
(1) 808-956-7509
(1) 808-956-5035
lorenz@hawaii.edu

Syukuro Manabe
Frontier Research Program for Global
Change
Seavans North 7F
1-2-1 Shibaura
Minato-ku
Tokyo 105-0023
JAPAN
(81) 3-5765-7100
(81)3-5765-7103
sm@frontier.esto.or.jp

Koki Maruyama
Environmental Science Department
Central Research Institute of Electric Power
Industry/CRIEPI
1646 Akibo
Akibo City, Chiba 270-1194
JAPAN
(81) 471-82-1181
(81) 471-83-2966
maru@criepi.denken.or.jp

Prof. Taroh Matsuno
Graduate School of Environmental Earth Science
Kokkaido University
Sopporo 060
JAPAN
(81) 11-706-2365
(81) 11-726-6234
matsuno@ees.hokudai.ac.jp

Tomonori Matsuura
National Research Institute for Earth Science and Disaster Prevention
3-1 Tennodai
Tsukuba, Ibaraki 305 JAPAN
(81) 298-51-1611
(81) 298-51-1610
matsuura@ess.bosai.go.jp

Gerald A. Meehl
Research Climatologist
Climate and Global Dynamics Division
NCAR/National Center for Atmospheric Research
1850 Table Mesa Drive
Boulder, CO 80303
USA

Gary Meyers
CSIRO Division of Marine Research
GPO Box 1538
Hobart, Tasmania
Australia
(61) 3-62-325208
(61) 3-62-325123
gary.meyers@marine.csiro.au

Robert A. Mickler
Southern Global Change Program
North Carolina State University
1509 Varsity Drive
Raleigh, NC 27606
USA
(1) 919-515-9490
(1) 919-515-3593
robert_mickler@ncsu.edu

Humio Mitsudera
IPRC/International Pacific Research Center
University of Hawaii at Manao
2525 Correra Road
Honolulu, HI 96822
JAPAN
(1) 808-956-5399
(1) 808-956-9452
humiom@soest.hawaii.edu

Motoyasa Miyaa
Tokai University Pacific Center
IPRC Liaison Office
2241 Kapiolani Blvd.
Honolulu, HI 96826
USA
(1) 808-983-4125
(1) 808-983-4199
miyata@hq.esto.or.jp

Tateki Mizuno
National Institute for Resources and Environment/NII~
16-3 Onogawa
Tsukuba 305
JAPAN
(81)298 58 8350
(81) 298 58 8358
miznot@nire.go.jp

Masato Murakami
MRI/Meteorological Research Institute
1-1 Nagamine
Tsukuba, Tharaki 305-0052
JAPAN
(81) 298-53-8531
(81) 298-53-8545
mmuraka@mir-Jma.go.jp

Euchi Muto
STA/ Science and Technology Agency F
2-2-1 Kasumigaseki
Chiyoda-ku, Tokyo 100-0013
JAPAN
(81)3-3580-6561
(81) 3-3581-7442
emuto@sta.go.jp

Shinichi Nagata
JMA/Japan Meteorological Agency
1-3-4 Ohtemachi
Chiyoda-ku
Tokyo 100-0004
Japan
(81)3-3212-8341
(81) 3-3211-2032
shinichi.nagata-a@hq.kishou.go.jp

Hisashi Nakamura
Department of Earth Planetary Physics
University of Tokyo
IGCR/Frontier Research System for Global Change
Bunkyo-ku, 113-0032 Tokyo
JAPAN
(81) 3-3812-2111
(81) 3-3818-3247
hisashi@geoph.s.u-tokyo.ac.jp

Reginald E. Newell
Department of Earth Atmospheric and Planetary Sciences 54-1824
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge,MA 02139
USA
(1) 617-253-2940
(1) 617-258-9819
susanrm@mit.edu

Junichi Nose
Director
MRI/Meteorological Research Institute
1-1 Nagamine
Tsukuba, Tharaki 305-0052
Japan
(81)298-53-8530
(81)298-53-8545
jnose@mri-jma.go.jp

Lie-Yauw Oey
Atmospheric and Oceanic Science
Princeton University
Sayre Hall
Princeton, NJ O5844
USA
(1) 609-258-5971

Kosei Otoi
2nd Geographic Division, Geographic Department
GSI/Geographical Survey Institute, Ministry of Construction
Kitasato- 1, Tsukuba, Ibaraki 305-0811
JAPAN
(81) 298-64-5935
(81) 298-64-1804
otoi@graph.gsi-mc.go.jp

Jonathan Overpeck
NOAA Paleoclimatology Program
National Geophysical Data Center
325 Broadway, E/GC
Boulder, CO 80303
USA
(1) 303-497-6172
(1) 303-497-6513
jto@ngdc.noaa.gov

Andrey Proshutinsky
Wadati Chair Prof. in Global Change Studies
University of Alaska Fairbanks
200 O'Neil Bldg, P.O. Box 757220
Fairbanks, AK 99775-7220
USA
(1) 907-474-7834,
(1) 907-474-7204
prosh@ims.alaska.edu

Loretta Quinn
Joint Office of Science Support
Program Support Group
University Corporation for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000
USA
(1) 303-497-8670
(1) 303-497-8633
lquinn@ucar.edu

Yasuo Sato
Meterological Research Institute/JMA
1 - 1 Nagamine,
Tsukuba, Ibaraki 305-0052
JAPAN
(81) 298-53-8614
(81) 298-53-8614
ysato@mri-jma.go.jp

Michael Schlesinger
Department of Atmospheric Sciences
University of Illinois at Urbana/Champaign
105 5. Gregory Ave., Rm. 101
Urbana,IL 61801
USA
(1) 217-333-2192
(1) 217-244-4393
schlesin@uiatma.atmos.uiuc.edu

Jagadish Shukla
President
Center for Ocean-Land-Atmosphere Studies (COLA)
Institute of Global Environment and Society
4041 Powder Mill Rd., Ste. 302
Calverton, MD 20705-3106
USA
(1) 301-595-7000
(1) 301-595-9793
shukla@cola.iges.org

Kenzo Shuto
Meterological Research Institute
1 - 1, Nagamine, Tsukuba City
Ibaraki
JAPAN
(81) 298-53-8650
(81)298-55-1439
kshuutou@mri-jma.go.jp

James Shuttleworth
Department of Hydrology & Water Resources
University of Arizona
Harshbarger Building 11
Tucson, AZ 85721
USA
(1) 520-621-8787
(1) 520-621-1422
shuttle@hwr.arizona.edu

Soroosh Sorooshian
Department Hydrology & Water Resources
University of Arizona
Harshbarger Building 11
Tucson,AZ 85721
USA
(1) 520-621-1661
(1) 520-621-1422
soroosh@hwr.arizona.edu

Masato Sugi
Meterological Research Institute
1 - 1 Nagaminei, Tsukuba
Ibaraki 305
JAPAN
(81)298-53-8600
(81) *298-55-2552*
msugi@mri-jma.go.jp

Satoshi Sugimoto
El Nino Monitoring and Prediction Center
JMA/Japan Meteorological Agency
JAPAN
(81) 3-3212-8341
(81)3-3211-8406
s_sugi@naps.kishou.go.jp

Akimasa Sumi
Director
Center for Climate System Research
University of Tokyo
4-6-1, Komaba, Megro-ku
Tokyo 153
JAPAN
(81) 3-5453-3951
(81) 3-5453-3964
sumi@ccsr.u-tokyo.ac.jp

*Kiyotoshi Takahashi
Climate Research Department
Meteorological Research Institute
1 - 1 Nagamine, Tsukuba
Ibaraki, 305-0052
JAPAN
(81) 298-53-8670
(81) 298-55-2552
ktakahas@rnri-jma.go.jp

Tomihiko Tomita
IPRC/International Pacific Research Center
University of Hawaii at Manao
2525 Correa Road
Honolulu,HI 96822
USA
(1) 808-956-5399
tomita@soest.hawaii.edu

Shingo Ueda
Lab for Air Quality Measurement
Department of Atmospheric Environmental Protection
NIRE/National Institute for Resources and Environment
16-3 Onogawa
Tsukuba, Ibaraki 305-8569
JAPAN
(81) 298-58-8286
(81) 298-58-8258
shingo@nire.go.jp

Seiichi Ueno
Earth Observing Research Center (EORC)
NASDA/National Space Development Agency of Japan
Roppongi First Building
1-9-9 Roppongi, Minato-ku, Tokyo 106
JAPAN
(81) 3-3224-7088
(81) 3-3224-7051
ueno.seiichi@nasda.go.jp

Duane E. Waliser
Institute for Terrestrial and Planetary Atmospheres
Marine Sciences Research Center
State University of New York at Stony Brook
Endeavor Hall #205
Stony Brook, NY 11794-5000
USA
(1) 516-632-8647
(1) 516-632-6251
waliser@terra.msrc.sunysb.edu

Dr. John M. Wallace
Department of Atmospheric Sciences
University of Washington
Box 351640
Seattle, WA 98195-1640
USA
(1) 206-543-7390
(1) 206-685-3397
wallace@atmos.washington.edu

Gunter Weller
Cooperative Institute for Arctic Research
CIFAR
University of Alaska
203 Eielson Building
Fairbanks, AK 99775
USA
(1) 907-474-7371
(1) 907-474-7290
gunter@gi.alaska.edu

Thomas Wilheit
Meteorology Department
Texas A&M University
Eller O&M Building
College Station, TX 77843-3150
USA
(1) 409-845-0176
(1) 409-862-4466
wilheit@ariel.tamu.edu

Susumu Yamamoto
Environmental Assessment
NIRE/National Institute for Resources and Environment
Onogawa 16-3
Tsukuba, Ibaraki 305-8569
JAPAN
(81) 298-58-8360
(81) 298-58-8358
yamas@nire.go.jp

Tetsuzo Yasunari
Institute of Geoscience
University of Tsukuba
Ibaraki 305
JAPAN
(81) 298-53-4399
(81) 298-51-9764
yasunari@atm.geo.tsukuba.ac.jp

Jong-Hwan Yoon
Professor, DRSC
Research Institute for Applied Mechanics
Kyushu University
6-1 Kasuga-koen Kasuga,
Fukuoka 816
JAPAN
(81) 92-583-7910
(81) 92-583-7492
yoon@riam.kyuhsu-u.ac.jp

Seiji Yukimoto
MRI/Meterological Research Institute
1-1 Nagamine
Tsukuba, Ibaraki 305-0052
JAPAN
(81) 298-53-8611
(81) 298-55-2552
yukimoto@mri-jma.go.jp

Chidong Zhang
Rosenstiel School of Marine & Atmospheric Science
Division of Meteorology & Physical Oceanography
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1096
USA
(1) 305-361-4696
(1) 305-361-4042
czhang@rsmas.miami.edu

*Did not attend workshop but are identified as points of contact for recommended activities in the Annex to the communiqué