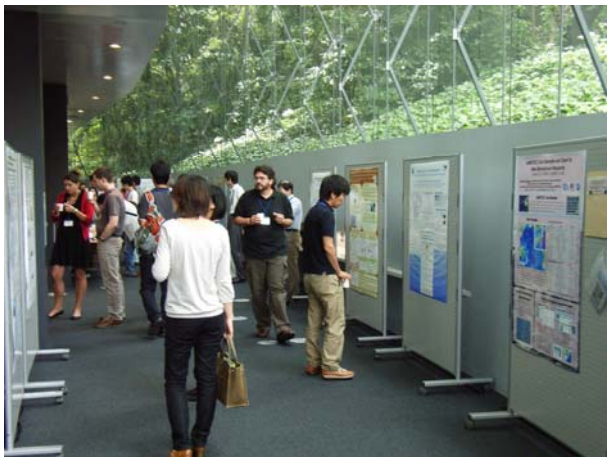
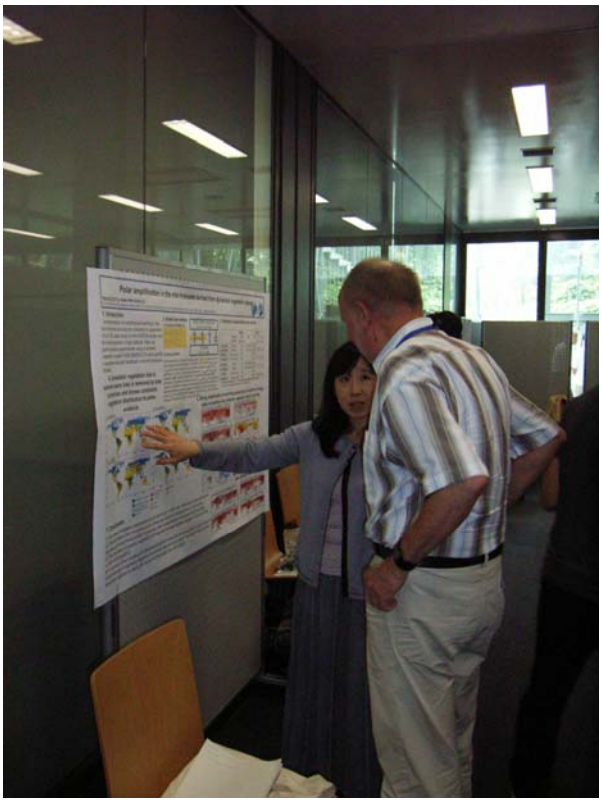
2010 PAGES Regional Workshop in Japan

Program and Abstracts





Noyori Memorial Conference Hall, Nagoya University, JAPAN
June 5 – 6, 2010

Co-organized by:

Nagoya University Global COE “From earth system science to basic and clinical environmental studies”

Co-supported by:

Japan Drilling Earth Science Consortium

Hosted by:

Graduate School of Environmental Studies, Nagoya University

Hydrospheric Atmospheric Research Center, Nagoya University

Program

2010 PAGES Regional Workshop in Japan

<Schedule> June 5 (Sat) - June 6 (Sun), 2010
<Venue> Noyori Memorial Conference Hall (1st Floor, Large Meeting Room), Nagoya University, Japan

Day 1: June 5, Saturday

09:30-09:40 Local Organizing Committee
Opening Remarks

09:40-09:50 Tetsuzo YASUNARI (GCOE Leader)
Introduction of Nagoya University GCOE program

09:50-10:10 Thorsten KIEFER (PAGES IPO Executive Director)
Introduction of PAGES and Aims of this regional workshop

<<Session on PAGES Focus 4>>
Chair: Hikaru TAKAHARA (Kyoto Prefectural University)

10:10-10:35 John DEARING (University of Southampton, UK)
Keynote on **PAGES Focus 4 (Human-climate-ecosystem interactions)**

10:35-11:00 Coffee Break & **Poster Session**

11:00-11:25 Tetsuzo YASUNARI (Nagoya University)
Changes in the Asian monsoon climate during 1700-1850 induced by preindustrial cultivation

11:25-11:50 Takakazu YUMOTO (Research Institute of Humanity and Nature)
Human-nature interaction and climate in the Japanese Archipelago

11:50-13:15 Lunch Break & **Poster Session**

<<Session on PAGES Focus 2 & CCT 2 (Part 1)>>

Chair: Tatsuhiko SAKAMOTO (JAMSTEC)

13:15-13:40 Heinz WANNER (Univeristy of Bern, Switzerland)

Keynote on **PAGES Focus 2 (Regional Climate Dynamics)**

13:40-14:05 Hodaka KAWAHATA (University of Tokyo)

One result from IMAGES and the relevant studies in Japan – the relationship between environmental change and human activity during the mid-Holocene in Japan -

14:05-14:30 Koji FUJITA (Nagoya University)

Recent changes in Himalayan glaciers and ice core studies in the Asian highland

14:30-15:15 Coffee Break & **Poster Session**

<<Session on PAGES Focus 2 & CCT 2 (Part 2)>>

Chair: Yasufumi IRYU (Nagoya University)

15:15-15:40 Fatima ABRANTES (National Laboratory of Energy and Geology, Portugal)

Keynote on **PAGES Cross-Cutting Theme 2** (Proxy Development, Calibration and Validation)

15:40-16:05 Atsushi SUZUKI (Geological Survey of Japan, AIST)

Climate events in the earliest 20th century detected in coral records from Ishigaki and Ogasawara Islands, Japan.

16:05-16:30 Takeshi NAKATSUKA (Nagoya University)

Spatial and temporal reconstructions of past Asian summer monsoon activities using oxygen isotopic ratios of tree-ring cellulose

16:30-16:55 Masumi ZAIKI (Seikei University)

Document-based reconstruction of paleoclimate in Japan

18:00-20:00 Reception at "Green Salon Higashiyama" in Nagoya University

Day 2: June 6, Sunday

<<Session on PAGES Focus 1>>

Chair: Tomohisa IRINO (Hokkaido University)

09:00-09:40 Bette OTTO-BLIESNER (National Center for Atmospheric Research, USA) and Cathy WHITLOCK (Montana State University, USA)

Keynote on **PAGES Focus 1 (Climate forcings)**

09:40-10:05 Yusuke YOKOYAMA (University of Tokyo)

Detecting Holocene sea level changes of Antarctic ice sheet

10:05-10:30 Hiroko MIYAHARA (University of Tokyo)

Historical changes in solar activity and its impact on regional-global climate.

10:30-11:00 Coffee Break & **Poster Session**

<<Session on PAGES CCT 3>>

Chair: Akio KITOH (Meteorological Research Institute, Japan)

11:00-11:25 Bette OTTO-BLIESNER (National Center for Atmospheric Research, USA)

Keynote on **PAGES Cross-Cutting Theme 3 (Modeling)**

11:25-11:50 Ayako ABE-OUCHI (University of Tokyo)

Forcing and feedbacks for the change of sea level and climate throughout the glacial-interglacial cycle: A modelling perspective in Japan.

11:50-13:00 Lunch Break & **Poster Session**

<<Session on PAGES Focus 3 & CCT 1 (Part 1)>>

Chair: Hajime KAYANNE (University of Tokyo)

13:00-13:25 Thorsten KIEFER (PAGES IPO Executive Director)
Keynote on **PAGES Focus 3 (global earth-system dynamics)**

13:25-13:50 Kenji KAWAMURA (National Institute of Polar Research)
Millennial-scale climatic changes during the last seven glacial periods: perspective from the Dome Fuji ice core records

13:50-14:15 Ryuji TADA (University of Tokyo)
Millennial-scale Asian monsoon dynamics, its tele-connection mechanism, and possible linkage with solar activity

14:15-14:45 Coffee Break & **Poster Session**

<<Session on PAGES Focus 3 & CCT 1 (Part 2)>>

Chair: Kotaro YAMAGATA (Joetsu University of Education)

14:45-15:10 Pierre FRANCUS (Institute of National Scientific Research, Canada), Steve COLMAN (University of Minnesota, USA) and Chris TURNEY (University of Exeter, UK)
Keynote on **PAGES Cross-Cutting Theme 1 (Chronology)**

15:10-15:35 Yusuke OKAZAKI (JAMSTEC)
Ocean circulation in the North Pacific during the last glacial termination

15:35-16:00 Naomi HARADA (JAMSTEC)
Large-scale blooms of *Emiliania huxleyi* in the Bering Sea during the past 100 years and its implication of recent global biogeochemical changes

16:00-17:00 **Overall discussion**

17:00-17:15 Local Organizing Committee
Closing Remarks

List of Posters

Ishiwatari R., N. Fujino, D. Brincat, S. Yamamoto, H. Takahara, K. Shichi, S. K. Krivonogov

A 35 kys record of organic matter composition and $\delta^{13}C$ of *n*-alkanes in bog sediments close to Lake Baikal: Implications for the paleoenvironmental study

Yamamoto S., J. Kitano, Y. Tomiyama, R. Ishiwatari, H. Uemura

Influence of human activity and natural disaster to lake sediment revealed by records of sedimentary organic matter

Ishiwatari R., K. Negishi, H. Yoshikawa, S. Yamamoto

Glalcial-interglacial productivity and environmental changes in Lake Biwa, Japan: A sediment core study of organic carbon, chlorins and biomarkers

Murakami S.

Atmospheric Energetics in Glacial Climate

Kawano S., T. Irizuki, R. Nomura

Bay environmental changes with relation to the opening of the Manzeki-seto in Tsushima Island, Southwest Japan

Sagawa Y., C. Saito, Y. Hanafusa, H. Saito

Data sites of sediment core samples collected by JAMSTEC cruises

Tomiyama T., H. Machiyama, W. Soh

JAMSTEC core samples are open to after-moratorium requests

Kitamura A., Yamamoto N., Ishimura T., Irino T., Tsunogai U.

Paleothermometer using the oxygen isotope ratio of cavernicolous micro-bivalve *Carditella iejimensis*: Application to paleoceanographic reconstructions of East China Sea during the last 7,000 years

Nagashima K. H. Nishido, M. Kayama, S. Toyoda, Y. Igarashi, R. Tada

Provenance study of Asian dust based on cathodoluminescence analysis of single quartz grain

Onodera J., K. Takahashi

Silicoflagellate flux and oceanographic conditions in the northern Subarctic Pacific and the southern Bering Sea, '90-94

Kamae Y., H. Ueda, A. Kitoh

Weakening of tropical atmospheric circulation in the Middle Pliocene

Yamagata K.

The influence of human-induced hydrological change on the flood plain environment of the Amur River

Yamagata K., T. Sone

Application of tephrochronology to the glacial and periglacial environment study in Kamchatka Peninsula, Russia

Okamoto S.

Re-evaluation of past summer temperature reconstruction by melt features in Belukha ice cores, Siberian Altai

Sano M., B. M. Buckley, T. Sweda

Tree-ring based hydroclimate reconstruction over northern Vietnam from Fokienia hodginsii

Yasudomi Y., Y. Motoyama, T. Oba

Marine environmental change during the last interglacial in the Northwestern Pacific based on radiolarian assemblages

Kano A., M. Hori, C.-C. Shen

Reconsideration of climate in Japan during the last deglaciation: a stalagmite record

Mitsuguchi T., P. X. Dang, H. Kitagawa, T. Uchida, Y. Shibata

Coral Sr/Ca and Mg/Ca records from 1948 through 1999 in Con Dao Island, Vietnam: Monitoring of ENSO and East Asian monsoon in the South China Sea

Mitsuguchi T., P. X. Dang, H. Kitagawa, Y. Shibata

Seawater ^{14}C time series of AD 1948-1999 in the tropical South China Sea: Reconstruction from coral annual bands

Mitsuguchi T., E. Matsumoto, T. Uchida, P. J. Isdale, T. Kawana, H. Kan

Early mid-Holocene sea-surface temperature in the Ryukyu Islands: Reconstruction from coral Mg/Ca and Sr/Ca ratios

Kawakubo Y., Y. Yokoyama, A. Suzuki, Chantal Alibert, Steve Eggins

A 423-year-long paleoceanography recorded in Porites coral in Kikai Island, Southern Japan

Obrochta S., Yokoyama Y., S. Sakai, K. Kimoto, M. Inoue, K. Ohkushi, H. Amakawa, H. Kawahata

Holocene to last glacial ITF variability

Yamane M., Y. Yokoyama

East Antarctic Ice Sheet fluctuations and global climate changes during the last 5Myr

Kubota K., Y. Yokoyama, S. Sakai, H. Matsuzaki, T. Toyohuku, K. Iijima, T.i Osada, P. Ajithprasad, S. K. Bhattacharya

Mid Holocene climate reconstruction using oxygen isotopic composition of modern and fossil catfish otolith (*Ariopsis* spp.) in North West India and its relation to Indus civilization.

Nakamura A., Y. Yokoyama, H. Maemoku, H. Yagi, M. Okamura, H. Matsuoka, N. Miyake, T. Osada, H. Teramura, T.i Yamada, D. . Adhikari, V. Dangol, H. Matsuzaki

Holocene variability of the Asian monsoon inferred from a sediment core obtained from Lake Rara, western Nepal

Sawada K., T. Sawai, O. Seki

Transport and diagenesis of higher plant terpenoids in soil, peat and lacustrine sediment from northern Hokkaido

Asami, R., Felis, T., Deschamps, P., Hanawa, K., Iryu, Y., Bard, E., Durand, N. and Murayama, M.

Evidence for tropical South Pacific climate change during the Younger Dryas and the Bølling-Allerød from geochemical records of fossil Tahiti corals.

Morimoto M., O. Abe, K. Yamada, N. Yoshida, P. Ghosh

Estimation of allogenic and authigenic carbonates in sediments from Lake Hovsgol, Mongolia using multi isotopes

Qiang Li, Takeshi Nakatsuka, Kimitaka Kawamura, Yu Liu

Hydroclimatic variation detected by tree-ring cellulose $\delta^{18}O$ in North China since A.D. 1675

Hongo C., H. Kayanne

Spatial and temporal variations of coral species diversity in the Pacific during the past 10,000 years

Nakamura N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, T. Yamagata

Mode shift in the Indian Ocean through 20th century Recorded in Kenyan Coral

Iijima H., H. Kayanne, N. Nakamura

Past 100 years inter-annual sea surface salinity changes in the Western Pacific based on coral isotope analysis

Ogawa N.O. , N. Ohkouchi, Y. Chikaraishi

Trophic level vs. eutrophication: A case study in Lake Biwa with nitrogen isotopic compositions of amino acids

Saito K., S. Marchenko, V. Romanovsky, N. Bigelow, K. Yoshikawa, J. Walsh

Thermally-conditioned paleo-permafrost variations from global climate modeling

Hayashi R.

Millennial-scale vegatation response to the East Asian monsoon for the last 40,000 years based on a pollen record of Lake Biwa, the central Japan

Irino T.

Past seasonal variability of the Japan Sea surface water deduced from bivalve shells

Watanabe Y., H. Matsuoka, S. Sakai, M. Yamada, S. Ohsawa, M. Kiguchi, T. Satomura, S. Nakai, B. Brahmantyo, K. A. Maryunani, T. Tagami, K. Takemura, S. Yoden

Paleoclimatological study using stalagmites from Java Island, Indonesia

Abe, O.

Clumped isotopes in coral skeletons

Seto K., D. L .Dettman, H. Takata, S. Kishiba, T. Sato

Paleoenvironmental change in a coastal lagoon during the past 2000 years as recorded in the sediment of Lake Nakaumi, Southwest Japan

Sasaki N., Takahara H., and Kishimoto G.

Fire and human impacts on vegetation changes during the Holocene in the Kyoto basin, Japan

Nomura R.

Decadal changes in response to human activities and sea-level change in the 20th Japanese lagoons: Foraminiferal evidence

O'hishi, R and Abe-Ouchi, A

Polar amplification in the mid-Holocene derived from dynamical vegetation change

Yoshimori, M and Abe-Ouchi, A.

Application of climate feedback analysis to paleoclimate modelling

Chikamoto, M. O, A. Abe-Ouchi, A. Oka, and R. Ohgaito

Interaction between ocean circulation and sea-ice coverage controlling the marine carbon cycle

Nakamura T., Hoshino M., Tanaka T., Yoshida H., Saito T., Tsukada K., Katsurada Y.

Possibilities of human migration from river flood plain to highland area at around 2000 cal BC: ^{14}C ages of remains from archeological sites in the Bishri Region, Middle Euphrates, Syria

Tsugeki N. K., Urabe J., Hayami Y., Kuwae M., and Nakanishi M.

Phytoplankton dynamics in Lake Biwa during the 20th century: Complex responses to changes in nutrient status and climate variation

Abstracts

Focus 4: Past Human-Climate-Ecosystem Interactions (PHAROS)

This Focus addresses the long-term interactions among past climate conditions, ecological processes and human activities during the Holocene. Emphasis lies in comparing regional-scale reconstructions of environmental and climatic processes using natural archives, documentary and instrumental data, with evidence of past human activity obtained from historical, paleoecological and archaeological records. The Focus promotes regional integration of records and dynamic modeling to: (1) understand better the nature of climate-human-ecosystem interactions; (2) quantify the roles of different natural and anthropogenic drivers in forcing environmental change; (3) examine the feedbacks between anthropogenic activity and the natural system and; (4) provide integrated datasets for model development and data-model comparisons.

Overarching Questions:

- What are the historical patterns of human interactions with climate change and ecological processes?
- How can we learn from these past patterns and interactions in order to better understand and manage natural ecosystems at present and in the future?

Focus Goals

- To understand and quantify the nature of human activities that have influenced the functioning of ecological systems. For example, the historic links between climate, human activities (such as irrigation practices) and soil erosion in different world regions.
- To elucidate feedbacks from human activities to the climate system. For example, determining the impact (local to global) of deforestation on climate.
- To describe how human and climate impacts have interacted with internal system dynamics. For example, the extent to which river channel changes are a consequence of external forces, such as land use and climate, or internal forces, such as hydraulic dynamics and system configuration.

- To explore the sensitivity and resilience of modern ecological systems to new or increased stresses from human activities and climate change. For example, to identify those ecological processes that have been the most responsive to past rapid climate change and which may be sensitive to projected climate change in the future.
- To synthesize and integrate findings on past human-climate-ecosystem interactions in order to help develop appropriate sustainable management strategies. For example, determining the historical range of variability in natural disturbance regimes, the reference conditions that are most relevant for ecosystem restoration or the land use that appears most appropriate in the face of projected change.

Changes in the Asian monsoon climate during 1700 -1850 induced by preindustrial cultivation

Tetsuzo Yasunari*,
Kumiko Tanaka, and Kazuyuki. Saito
** Hydrospheric Atmospheric Research Center, Nagoya University*

Preindustrial changes in the Asian summer monsoon climate from the 1700s to the 1850s were estimated with an atmospheric general circulation model (AGCM) using historical global land cover/use change data reconstructed for the last 300 years. Extended cultivation resulted in a decrease in monsoon rainfall over the Indian subcontinent and southeastern China and an associated weakening of the Asian summer monsoon circulation. The precipitation decrease in India was marked and was consistent with the observational changes derived from examining the Himalayan ice cores for the concurrent period. Between the 1700s and the 1850s, the anthropogenic increases in greenhouse gases and aerosols were still minor; also, no long-term trends in natural climate variations, such as those caused by the ocean, solar activity, or volcanoes, were reported. Thus, we propose that the land cover / use change was the major source of disturbances to the climate during that period. This report will set forward quantitative examination of the actual impacts of land cover/use changes on Asian monsoons, relative to the impact of greenhouse gases and aerosols, viewed in the context of global warming on the interannual, decadal, and centennial time scales.

Human-nature interaction and climate in the Japanese Archipelago

Takakazu Yumoto
Research Institute for Humanity and Nature

The Japanese Archipelago extends over 3000 km from North to South, and includes subarctic, cool temperate, warm temperate and subtropical climatic zones. It is evident that, even during the global environmental changes that have taken place over the past 100.000 years, these various climatic zones were present. As a result, the characteristics of the natural environment and the human subsistence activities within the Japanese Archipelago varied greatly, as did the relationships between nature and human activity. Under the influence of climatic change and human activities, the distributions of individual species of plants and animals in the Japanese Archipelago and its surrounding landmasses have been constantly changing. Populations of plants and animals have repeatedly divided, expanded and diminished in response to changes in the availability of suitable habitat. Where suitable habitat was not available, the species became extinct.

The knowledge and skills that humans have developed concerning individual species can be considered to contain both the idea that biological resources should be used in sustainable way, and the desire to harvest without fear of exhausting the resources. Although ethnological research has highlighted phenomena such as public management of lands and resources, and environmental preservation through limited harvest, it is still unclear when, in which region and among whom the philosophy of preservation was put into practice, or under which social conditions it became an influential way of thinking. Throughout the period of human habitation, the Japanese Archipelago has been blessed with a warm climate and abundant rainfall, and consequently abundant biological resources. But what is the history of overuse and exhaustion of those resources? And how did individual species fare in this historical process? This presentation will show our tentative results on these issues, based on the results of a trans-disciplinary project “A New Cultural and Historical Exploration into Human-Nature Relationships in the Japanese Archipelago”.

Focus 2: Regional Climate Dynamics

This Focus seeks to achieve a better understanding of past regional climatic and environmental dynamics through comparison of reconstructions and model simulations. Activities contribute towards a global coverage of high-resolution, well-dated paleoclimatic data, reconstructions of past climate-state parameters (e.g., temperature, precipitation, atmospheric pressure fields), a better understanding of past modes of climate variability and their teleconnections, and of rapid and extreme climate events at the regional scale. The Focus hosts activities that promote data-model comparisons and collaborates closely with Cross-Cutting Theme 2 on proxy development and calibration. The timescales covered by this Focus encompass the last 130 ka, in particular the time streams of the last glacial-interglacial cycle, the Holocene, and the last 2 ka.

Overarching Questions

- How have regional climate and the Earth's natural environment changed in the past?
- What are the main patterns and modes of climate variability on sub-decadal to orbital timescales?
- How do climate variability and extreme events relate to the mean state of the climate system?

Focus Goals

- Develop datasets that describe the patterns of past climate change and climate variability at the regional scale, including the major climate state variables, such as air pressure, temperature, precipitation or precipitation minus evaporation (P-E) and atmospheric and oceanic circulation patterns, for the last 2 ka and wherever possible during the last glacial cycle (last 130 ka).
- Examine the regional response of marine and terrestrial ecosystems to large-scale changes in the climate system. Activities towards this goal are coordinated with Focus 4 and offer links with the DIVERSITAS program.
- Better understand the mechanisms (natural and anthropogenic forcing, internal variability, feedbacks, sensitivity) operating in the climate system that determined regional variations, including abrupt and extreme climate

events, of climate and environment over the past 130 ka.

- Understand the modes of variability, such as ENSO/PDO, NAO/AMO, the teleconnections between them, and their influence on regional climate history.
- Carry out ensemble simulations of past climate variability with suitable climate models of different complexity, in close coordination with the reconstruction activities and with Focus 1 and CCT 3.
- Support improvements in model development and data-model comparison approaches to better constrain the drivers and mechanisms of regional climate change on different timescales.

One result from IMAGES and the relevant studies in Japan – the relationship between environmental change and human activity during the mid-Holocene in Japan -

Hodaka Kawahata
Graduate School of Frontier Sciences, The University of Tokyo

Reconstruction of the long-term response of ocean environments to various climate changes (e.g., ENSO: El Nino/Southern Oscillation, Asian monsoon, Glacial-Interglacial change) is an essential step for better understanding of climate system of the Earth. We took more than ten cores under an umbrella of the IMAGES (International Marine past Global Changes Study) program in the western Pacific from the equatorial region to the Okhotsk Sea in 1998 and 2001 and collected relevant and additional cores for the promotion of PAGES program. On result comes from off the northern part of the Japanese Island to understand the relationship between environmental change and human activity at the Sannai-Maruyama ruin, which is the most famous ones in Japan during the mid-Holocene. We analyzed alkenone temperature, organic carbon and nitrogen content, pollen abundance and assemblage and other environmental parameters in the marine core collected near the ruin. The establishment of the settlement of the people can be attributed mainly to a great increase in the food supply under warm climatic conditions, whereas the decline of the settlement may have been determined primarily by climatic cooling (2.0 °C), which caused both a reduction in the terrestrial food supply and the onset of severe winters. Synchronization of the decline of civilization between the Sannai-Maruyama and north Mesopotamia and along the Yangtze River around 4.0–4.3 cal. kyr B.P. could have been affected by regional to global scale of climatic change [Kawahata et al., 2008].

References

Kawahata, H., Yamamoto, H., Ohkuchi, K., Yokoyama, Y., Kimoto' K., Ohshima, H. and Matsuzaki, H. (2009) Changes of environments and human activity at the Sannai-Maruyama ruins in Japan during the mid-Holocene Hypsithermal climatic interval. *Quaternary Science Reviews*., **28**, 964-974.

Recent changes in Himalayan glaciers and ice core studies in the Asian highland

Koji Fujita
Graduate School of Environmental Studies, Nagoya University

Fate of Himalayan glaciers mentioned in the IPCC report is the recent hottest matter of debate in climate science. The debate seems to be baseless, however, because few observational facts have been reported so far. We have observed the changes in glaciers by ground survey in the Nepal Himalaya since the 1970s. In this presentation, we show up-to-date results with respect to changes in Himalayan glaciers whose wastage is accelerated in the recent decade.

We also show a short review on ice core studies in the Asian highland. In the last two decades, a dozen of ice cores have been drilled from Asian glaciers. Putting time scale on ice core is still challenge to be tackled because many ice cores retrieved at the elevation lower than 6000 m a.s.l. are affected by some sort of melt. Counting dust and/or pollen peaks is a unique method in this region while counting seasonal cycles of chemical species is an ordinary method in the Polar Regions. It has been reported bismuth as a marker of volcanic events and radio active isotope of lead for absolute dating. Interpretation of water stable isotopes is more complicated the Polar Regions because the isotopes do not simply depend on temperature in the seasonal basis, especially under the Indian monsoon. Although some studies have asserted the water stable isotopes as proxy of precipitation because of an ‘amount-affect’ on the isotopes, no comparison with accumulation itself has been performed so far.

We briefly show our recents results with respect to summer temperature reconstruction from Belukha ice cores, the Russian Alta Mts. and a drastic deglaciation during the Bølling-Allerød period revealed by soil sample at the bottom of Grigoriev ice core, the Kyrgyz Tienshan Mts.

Cross-Cutting Theme 2: Proxy Development, Calibration and Validation

This Theme supports improvement of the precision and accuracy of paleo-proxies as a basis for high-quality reconstructions of past global change to complement instrumental data. It includes efforts on proxy interpretation and development, analytical innovation, inter-laboratory comparisons, and calibration refinement, which lead to uncertainty reduction in proxy-based reconstructions.

Goals

The overarching goal of this CCT is to support advances in the precision and accuracy of paleo-proxies in order to generate high-quality records of past global change that can complement instrumental data and modeling efforts. To this end, specific aims include improvement in proxy interpretation and development, refinement of analysis and calibration, and encouragement/facilitation of inter-laboratory comparisons.

To improve the quality of proxy records and the resulting reconstructions, the following key objectives have been identified in the steps from site selection to reconstruction:

- *Discovering new proxies:* In order to arrive at a comprehensive reconstruction of Earth's environmental history, it is necessary to expand the available range of proxies to include environmental parameters, for which we have basically no (e.g., cloud formation,) or only poor (e.g., ocean salinity, sea ice cover, ice sheet thickness, dimethyl sulfide (DMS)) proxies at hand. PAGES prepares the ground for this by facilitating knowledge exchange among researchers studying past records and those interested in modern processes (e.g., biologists, geophysicists, geochemists, glaciologists, oceanographers and climatologists).

- *Opitimizing site selection:* Observational data (e.g., results from IGBP sister projects and WCRP) and model runs with simulated proxies can assist site selection by identifying sites sensitive to environmental change and proxy

response. PAGES provides a platform for communication with these groups and supports campaigns to study key locations and undersampled regions.

- *Improving sample analysis:* Progress in the ever-increasing quality of field and laboratory measurements usually results from innovations, often of technical nature, by specialist scientists. PAGES can contribute to analytical improvement by organizing group efforts such as inter-laboratory comparison/calibration studies.

- *Providing calibration datasets:* The calibration of proxy data requires large sets of samples or proxy-datasets from the (quasi-modern) calibration period, as well as optimal datasets of instrumental measurements. Collaboration with other projects in IGBP, WCRP, and the broader ESSP community can help to identify and provide datasets for calibration.

- *Validating proxy interpretation:* A deeper understanding of the biological, physical and chemical controls on the formation of proxies and proxy-archives, and of their post-depositional history (alteration, transport, etc.) is necessary to reliably and quantitatively interpret the proxy data with respect to their representation of environmental and climatic parameters. To this end, PAGES actively promotes interaction of paleo and modern and of cross-disciplinary approaches. In addition, combination of multiple independent lines of evidence, e.g., multi-proxy strategies and data-modeling comparisons, is promoted as a complementary approach to increase confidence in reconstructions.

- *Quantifying and expressing proxy-data uncertainties*: Beyond efforts to reduce uncertainties in general, the coherent and quantitative expression of uncertainties is a major task within CCT2. This is addressed according to the requirements of modeling studies and in close collaboration with statisticians, and with working groups of the Foci 1-3.

Climate events in the earliest 20th century detected in coral records from Ishigaki and Ogasawara Islands, Japan.

Atsushi Suzuki
Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST)

Although knowledge of the past environments has been highly expected, there have been only few studies conducted on ocean environment exceed a century especially in the subtropical Northwestern Pacific due to a lack of observational data. Recently, however, two century-long coral records have become available, one is from Ishigaki Islands, southern Ryukyus (Mishima et al., in press) and the other is from Ogasawara Islands (Felis et al., 2009). Coral skeletal oxygen isotope data from Ishigaki showed a consistent profile with available sea surface temperature (SST) information for the post-1890s. The coral-based SST reconstruction enabled investigations on the relationships with the East Asian winter Monsoon (EAWM) and El Nino Southern Oscillation (ENSO). The Ishigaki coral record characteristically revealed the abrupt cooling during 1900-1905. This timing was consistent with exclusively cold winter in which Japan's lowest observational air temperature in 1902. It was suggested that development of Siberian High intensified the EAWM at this period. Also, it is probable that the cooling occurred in relation to the surface ocean freshening detected in the Ogasawara coral record in the early-twentieth-century [Felis et al., 2009]. Above consistency suggests the mutually coupled phenomenon uniquely found in the earliest 1900s in the northwestern subtropical Pacific.

References

Felis, T., A. Suzuki, H. Kuhnert, M. Dima, G. Lohmann, and H. Kawahata (2009), Subtropical coral reveals abrupt early-twentieth-century freshening in the western North Pacific Ocean, *Geology*, **37**, 527-530, doi:10.1130/G25581A.1

Mishima, M., Suzuki, A., Nagao, M., Ishimura, T., Inoue, M., and Kawahata, H. Abrupt shift toward cooler condition in the Earliest 20th Century detected in a 165-year coral record from Ishigaki Island, southwestern Japan. *Geophysical Research Letters*, in press.

Spatial and temporal reconstructions of past Asian summer monsoon activities using oxygen isotopic ratios of tree-ring cellulose

Takeshi Nakatsuka
Graduate School of Environmental Studies, Nagoya University

Tree ring is one of the most important proxies for past climate changes and has been applied in many regions on the world and referred frequently in authorized climatic publications such as IPCC reports. The excellence of tree ring as paleoclimate proxy is owing to its exact chronology, long continuity of records, wide coverage on land and endurance even after cutting or burying etc. However, the tree ring has not been utilized very well in Asia, especially in temperate and humid regions of South and East Asia including Japan, until now. It is because climate does not usually control the tree growth in the temperate and humid areas and, in the densely populated Asian forests, tree rings mainly reflect long term competition with neighboring trees rather than climate changes.

Recent development of oxygen isotope measurements for organic matter has provided us with a novel tool to reconstruct past climate change using oxygen isotopic ratios of tree-ring cellulose. Because the variation in oxygen isotope ratio of tree-ring cellulose only depends on the two climatic parameters, oxygen isotope ratios of precipitation and relative humidity in the growing season, it can record past changes in hydroclimate independent from any ecological disturbances. So far, many long time series of oxygen isotope ratios have been obtained for tree-ring celluloses in Asian countries including Japan, and it has been proved that the oxygen isotope ratio of tree-ring cellulose reflects the summer hydroclimate (precipitation amounts and relative humidity) very well in all of the studied areas, indicating its usefulness for Asian summer monsoon studies such as teleconnection analyses of climate dynamics and evaluations of human-ecosystem-climate interactions in humid and temperate regions.

Document-based reconstruction of paleoclimate in Japan

Masumi Zaiki
Seikei University, Japan

Numerous studies in many parts of the world have reconstructed past climate conditions based on instrumental and proxy data. As the official meteorological observation network of the Japan Meteorological Agency was first established in the 1870s, historical documents are an important type of proxy data for reconstructing the climate of Japan before this time.

Japanese historical documents such as old diaries from individuals, clan offices and shrines often include daily weather descriptions. Many of these weather descriptions for the Edo Period (the 17^{th} - 19^{th} centuries) have been coded into a database by Japanese climatologists and have been used to reconstruct seasonal temperatures, the length of the rainy season (Baiu), global solar radiation, and synoptic weather patterns. The dates of cherry blossom flowering, the freezing of lakes, and the harvesting of crops extracted from historical documents have also been used for climate reconstruction studies.

Recently, another type of historical document—instrumental weather records—has been recovered for several locations in Japan in the 19th century. The recovered data extend the beginning of the instrumental series back from 1872 to 1819. These data were converted to modern units, digitized, and homogenized to account for changes in elevation and differing observation schedules. The corrected and homogenized data were shown to be reasonable based on homogeneity tests and comparison with modern data. The instrumental temperature data show good agreement with the reconstructed temperatures from the old diaries. These two types of historical documents are not only individually useful, but are also useful for crosschecking the results from other proxies.

Focus 1: Climate Forcings

This Focus fosters activities that aim to produce improved, extended, and consistent time series of climate forcing parameters, both natural and anthropogenic, including solar insolation and irradiance intensity, volcanic activity, land cover, sea ice, and greenhouse gas and aerosol concentrations. Furthermore, Focus 1 aims to quantitatively understand the causes and impacts of variations in climate forcings, including climate sensitivity and the carbon cycle-climate feedback.

Overarching Questions

- How did the main climate forcing factors vary in the past?
- How sensitive was (and is) the climate system to these forcings?
- What caused the natural greenhouse gas and aerosol variations?
- To what extent can paleodata constrain the climate sensitivity and the carbon cycle-climate feedback?
- In what precise sequence and over what timescales did changes in forcings, climate, and ecological systems occur?

Theme Goals

- *Orbital solar insolation* - To tie together the timing of insolation changes and of climatic and environmental responses and to unravel how the geometric, spatial, and seasonal components of orbital insolation changes affected the Earth System.
- *Solar irradiance* – To improve the documentation and understanding of solar irradiance variations. This necessitates progress in our understanding of irradiance proxies, such as sunspot numbers and cosmogenic signatures in ice cores and tree rings, and that we disentangle solar from non-solar influences. The ultimate goals are to extend the low-frequency solar forcing record back through the entire Holocene, retrieve more detailed and spatially distributed records of cosmogenic isotopes, and interpret them in association with modeling of the mechanisms affecting the isotope concentration in ice and marine sediments.
- *Volcanic aerosols* – To establish dates, latitude, magnitude and radiative impact

of explosive volcanic eruptions through correlation of more ice core records and the development of new tracers, such as the identification of stratospheric eruptions through studies of isotopes in sulfate. The ultimate goal is to extend the detailed record of volcanic forcing through the entire Holocene.

Detecting Holocene sea level changes of Antarctic ice sheet

Yusuke Yokoyama*
Masako Yamane, Naohiko Ohkouchi and Hiroyuki Matsuzaki
** University of Tokyo*

Mid to Late Holocene sea-level change can be used for evaluating long-term stability of the Antarctic ice sheet since the end of the last major, approximately 8,000 years ago. Ongoing global warming may trigger disintegration of this ice sheet, with collapse of the West Antarctic Ice Sheet alone potentially producing a more than 3 to 4 m global sea-level rise. Relative sea level records from sites far away from former ice sheet regions (far-field) provide information on total volume of the ocean mass change, which can be interpreted as global ice volume change. However, understanding mechanisms for the ongoing ice sheet fluctuations requires information on the source of meltwaters, provided by records near the Antarctic ice sheet. To address the paucity of information from this region, we have employed two new methods to understand melting history of Antarctic ice sheets, namely cosmogenic radionuclides (CRN) and compound specific isotopes (CSI) measurements, both of which will provide a more complete history of ice sheet behavior. Cosmic rays began bombarding the surface of rocks in Antarctica after deglaciation. Hence, the amount of CRN is proportional to minimum exposure age after ice sheet ablation. CSI is useful for analysis of sediments proximal to ice sheets due to the differing isotopic signals between ice and seawater, up to ca. 300 per mil for hydrogen isotopes. Therefore, meltwater signals can be recorded in CSI produced from surface dwelling algae. Another major obstacle for Antarctic marine geological study is the difficulty in applying radiocarbon dating for to two basic reasons; lack of foraminifers and anomalously old TOC ages because of old carbon contamination from the Antarctic continent. We are using compound specific radiocarbon dating to solve this problem. In this presentation, we introduce these two measures to reconstruct the melting history of Antarctic ice sheet during the Holocene using two particular examples from Lutzow Holm bay in East Antarctica and Ross Sea of West Antarctica.

Historical changes in solar activity and its impact on regional-global climate

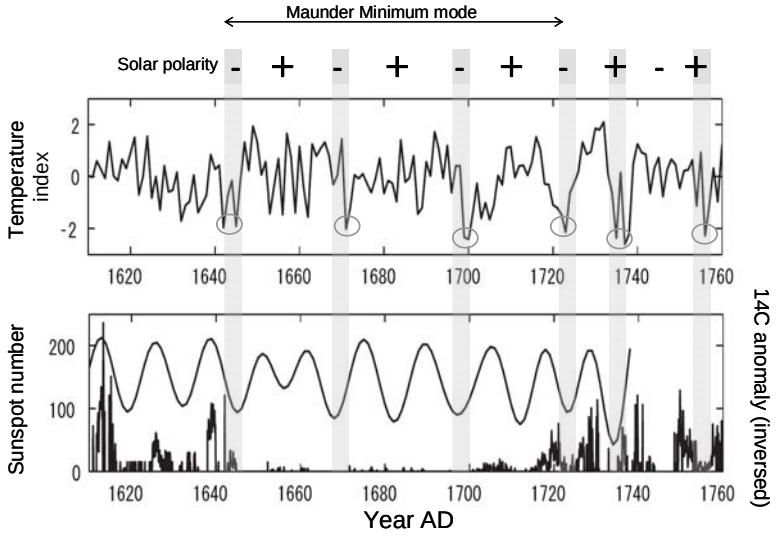
Hiroko Miyahara[1], Yusuke Yokoyama[2], Yasuhiko T. Yamaguchi[2], Kazuho Horiuchi[3], Takeshi Nakatsuka[4], Hiroyuki Matsuzaki[5], Stewart Fallon[6]

1 Institute for Cosmic Ray Research, The University of Tokyo, 2 Atmosphere and Ocean Research Institute, The University of Tokyo, 3 Graduate School of Science and Technology, Hirosaki Univerisy, 4 Department of Earth and Environmental Sciences, Nagoya University, 5 Department of Nuclear Engineering and Management, The University of Tokyo, 6 Australian National University

In this paper, we present the history of 11-year/22-year solar and cosmic-ray cycles in the past reconstructed from the measurements of carbon-14 content in annually resolved tree rings. Based on the reconstruction, we discuss the variability of solar activity in the past as well as the influence of the variable solar and cosmic-ray decadal cycles on climate change.

The long-term variations of solar activity are often reconstructed based on decadal data of cosmogenic nuclides, however, it is difficult to eliminate the effect of the changes in climate change, geomagnetic field intensity, and the anthropogenic effect. So far, multiple scenarios for the long-term variation of solar activity level have been suggested based on the records of cosmogenic nuclides; such as the carbon-14 content in tree rings and the beryllium-10 content in ice cores from polar regions. It prevents us to determine the unique scenario for the history of solar irradiance as an input parameter of climate modeling. We therefore examined the changes of absolute solar activity level by detecting the shortening/ lengthening of the 11-year solar cycles.

We have also examined the influence of the shortening/lengthening 11-year/22-year solar and cosmic-ray cycles on climate change during the Little Ice Age and the Medieval Warm Period. The solar cycles are lengthened to be ~14 years/~28 years at low solar activity level, and are shortened to be ~9 years/~18 years at high solar activity level. We have found that climate cycles are also modulated according to the changing solar cycles. We also find that the 22-year cycles are playing important role in climate change at decadal to multi-decadal time scales (Figure). The 22-year cycle is associated with the reversals of solar magnetic field polarity, and thus is only prominently recognized in the variation of incident cosmic rays at the earth. The mechanisms how the climate system responds to the changes in cosmic rays need further investigations.



Sunspot number: Hoyt and Schatten, 1998
Temperature index: Vinther et al., 2003
Solar cycle and magnetic polarity, Miyahara et al., 2008, 2009

Cross-Cutting Theme 3: Modeling

Numerical models provide a comprehensive, quantitative, and physically coherent framework for exploring couplings and feedbacks between the various components of the Earth System, and as such, modeling is a key element of all the PAGES Foci. Some paleo-specific modeling issues are generally not as relevant to the communities developing Earth System models for future projections. Accordingly, this theme supports efforts to improve model components specific for paleoresearch requirements.

Goals

1. *Fostering the development of strategies for proxy modeling.*
   To maximize the anticipated synergy, focus will be on proxies with wide spatial coverage and for which large data collections already exist (e.g., stable isotopes reflecting the physical and biogeochemical processes in the Earth System). Strategies for including proxies such as aerosols or pollen will also be developed.

2. *Devising methods for the objective comparison of proxy data and modeling results.*
   In present-day climatology, data assimilation has become an important tool for quantifying the state of the climate system based on observations. However, these methods are not readily available for the sparsely distributed paleodata. Successful strategies for assimilation of paleodata could also help scientists working on proxy-based reconstructions to optimize the selection of sampling locations and will be promoted by this CCT. Another issue arises from the fact that proxy-based reconstructions are often widely spaced and associated with uncertainties that are not well constrained. The lack of suitable statistical methods for comparing such data with model output will be addressed by the CCT. This includes strategies for downscaling the output of global models to regional scales (e.g., for lake level, ice sheet, fire, coastal upwelling, or aerosol transport models) are still immature and will be promoted by the CCT. In addition, the CCT will stimulate the development of

coupling techniques for two-way nesting of coupled regional and global climate models.

3. *Promoting the development of comprehensive ESM families.*
   The long timescales associated with geological processes often require integration times that are significantly longer than those used for generating future climate scenarios. To meet this requirement and also rely on the same type of models used in the IPCC community, models should be offered with a range of resolutions and system components suitable for long paleoclimate experiments.

Forcing and feedbacks for the change of climate and sea level throughout the glacial-interglacial cycle: A modelling perspective in Japan

Ayako Abe-Ouchi[1,2]
1. University of Tokyo, 2. JAMSTEC

Aiming at the better understanding on the mechanism of climate change and the furthur validation of climate models used for future projection, paleoclimate modeling using GCM is conducted by 2 groups in Japan. One is lead by Dr. A. Kitoh at MRI/JMA using MRI-GCM, amd the other is lead by myself at University of Tokyo and at JAMSTEC using MIROC-GCM. Both groups have been participated in the PMIP (Paleoclimate Modelling Intercomparison Project) which was kicked off in 1995; in the first phase using only the atmospheric model, in the second phase coupling to the dynamical ocean (Bracconot et al, 2007, Otto-Bliesner et al, 2007, 2009 and others) and now preparing for the 3rd phase introducing new components in the climate model such as dynamical vegetation, carbon cycle etc..with updated boundary conditions and new experiments from Pliocene (3.5Ma) to the last millenium. Here I introduce our recent activity on paleoclimate modeling mainly using MIROC and discuss the direction towards IPCC AR5 and the necessity of possible collaboration with the paleo-data community.

References

Abe-Ouchi, A.,et al 2007, Clim. Past, 3 , 423-438.
Braconnot, P., et al 2007: Clim. Past, 3, 261-277.
Braconnot, P., et al , 2007: Clim. Past, 3, 279-296.
Hargreaves JC, et al 2007, Clim. Past 3 (1): 77-87
Kurahashi-Nakamura, T. et al, 2007, G. R. L., 34, L20708,
Kurahashi-Nakamura, T.,et al , in press.
Murakami, S., et al 2008, J. Climate, doi:10.1175/2008JCL12104.1.
Ohgaito, R. and A. Abe-Ouchi, 2009, Climate Dynamics, in press,
Ohgaito, R. and A. Abe-Ouchi, 2007, Climate Dynamics,
DOI10.1007/s00382-006-0217-6
O'hishi, R., et al G.R.L. in press
O'hishi, R. and A. Abe-Ouchi, Climate Dynamics, in press
Otto-Bliesener, BL,et al 2007, G. R. L., 34, L12706
Otto-Bliesner, B.L., et al 2009, Climate Dynamics, DOI:10.1007/s00382-008-0509-0.

Saito, F. and A. Abe-Ouchi, Annals of Glaciology, 55, in press.
Takemura,et al, 2009, Atmos. Chem. Phys, 9, 3061-3073.
Timm, O.,et al, 2008, Paleoceanography, 23, PA2221.
Yanase W., and A. Abe-Ouchi, 2007, Clim. Past, 3, 439-451.
Yanase, W. and A. Abe-Ouchi, Journal of Climate, in press.
Yoshimori, M., et al, 2009, J. Climate, 22(12), 3374-3395

Focus 3: Global-scale Earth System Dynamics

This focus looks at large-scale interactions between components of the Earth System (atmosphere, biosphere, cryosphere, hydrosphere) and the links between regional- and global-scale changes. It hosts activities to synthesize records at a global scale, acting as an umbrella for the regional studies of Focus 2 and as a link to the forcings addressed in Focus 1. Working groups address global-scale abrupt and gradual Earth System changes and their underlying processes, including their response to changes in forcings, internal feedbacks and teleconnections.

Overarching Questions

- How do large-scale changes in the Earth System affect regional climatic and environmental conditions?
- How have regions or Earth System components interacted to produce climate and environmental variations on a global scale?
- What are the causes and thresholds of rapid transitions between quasi-stable climatic and environmental states, in particular on timescales that are relevant to society? How reversible are these changes?

Focus Goals

Variability of the Hydrological Cycle:

- To unravel the mechanisms causing variations in both the global and regional monsoon systems.
- To identify and understand teleconnections between global- and regional-scale monsoon variations and other components of the climate system.
- To disentangle the processes leading to shifts in the position and strength of the ITCZ at interdecadal-to-millennial timescales.

Rapid Climate Change:

- Combine well-dated records of centennial to millennial-scale oceanographic and climatic change during the Holocene, the last glacial period, and previous interglacials using both bipolar and global comparisons of data with rigorous quality and age control.

- Characterize the rate of abrupt changes and their temporal relation to the underlying forcings and feedback processes.
- Use data compilations to assess hypotheses on the drivers and effects of past MOC changes to inform assessments of the possibility of such changes in the future and of their potential impacts.

Climate Variability within and between Interglacials:

- Combine well-dated records of multiple glacial cycles over at least the ice core era (800 ka), with the particular goal of understanding the spatial pattern and temporal trends within interglacials.
- Constrain the extent of changes in sea level and ice-sheet extent in past interglacials (link to Focus 1 and PALSEA).
- Determine the variability at multi-annual to millennial timescales within warmer interglacials of the last 800 ka.

Paleo-perspectives on Ocean Biogeochemistry:

- Compile proxy evidence for past global changes in the oceanic N and Fe cycles during rapid climate transitions and to unravel the mechanisms causing the variations.
- Quantify the response of marine organisms and ecosystems to acidification and their feedback on atmospheric CO_2 using paleoceanographic records of historic acidification, as well as examples from high CO_2 worlds in Earth history.
- Compile proxy data on marine productivity at glacial-interglacial and shorter timescales to assess the overall efficiency of the marine biological pump under different climatic boundary conditions.

Millennial-scale climatic changes during the last seven glacial periods: perspective from the Dome Fuji ice core records

Kenji Kawamura*
The Dome Fuji Ice Core Project Members
** National Institute of Polar Research*

Millennial-scale climate variability with inter-hemispheric seesaw during the last glacial period has been documented in a wide variety of paleoclimatic proxies. However, its frequency and magnitude for the older glacial periods, as well as prerequisite of the millennial-scale variations, are still uncertain. We present a new 3,035-m (720,000-yr) ice core record from Dome Fuji, Antarctica. Combination of the two records permits clear identification of multi-millennial-scale warming events in Antarctica (large Antarctic Isotope Maxima, LAIM). LIAM are found to have persisted over the last seven glacial periods, with an overall relationship between the duration of glacial period and the number of events. The Dome Fuji core has thick annual layers (2-3 times thicker than those in the Dome C core) for Marine Isotope Stage 16, the oldest glacial period in the core. Dust flux in this MIS shows millennial-scale variations that are negatively correlated with temperature, suggesting a link of Antarctic temperature with aridity in Patagonia, as seen in the last glacial period. In order to gain further insight into the prerequisite of occurrence of bipolar seesaw, we conducted 1000-yr climate simulations with freshwater forcing (0.05 Sv into the northern North Atlantic) using a fully coupled atmosphere-ocean general circulation model (MIROC GCM). The results suggest that large Antarctic warming and Austral precipitation increase in response to northern freshwater forcing only occur when the combination of background coldness and fresh water amount exceeds some threshold. However, occurrences of very large AIMs in early parts of glacial periods (e.g. MIS 5a-5d) apparently contradict with a threshold concept (such as a need for Antarctic temperature 4 ˚C below Holocene level to produce climate instability, see Loulergue et al., 2007). We speculate that Antarctica ultimately became warmer than the threshold due to intense precession forcing (northern summer insolation), which would maintain the freshwater supply into the North Atlantic by melting ice sheets. This could explain the absence of massive iceberg discharges (Heinrich events) for the large but infrequent bipolar seesaw sequences in the early parts of glacial periods, when ice volume was relatively small (thus relatively stable) but precession amplitude was large.

Millennial-scale Asian monsoon dynamics, its tele-connection mechanism, and possible linkage with solar activity

Ryuji Tada
Department of Earth and Planetary Science, the University of Tokyo

It has been known for some time that East Asian summer monsoon [EASM] varied significantly in association with millennial-scale climatic changes observed in North Atlantic and Greenland (known as Dansgaard-Oeschger Cycles) during the last glacial period. It is also suggested that EASM varied in association with millennial-scale climatic changes in North Atlantic during Holocene, although the association is not necessarily well-established. The tele-connection is probably through changing meandering pattern of subtropical westerly jet because the position of westerly jet over East Asia during summer bounds the northern limit of EASM. During glacial stadials, the westerly jet axis migrated southward and prevented inland penetration of EASM front, whereas the westerly jet axis migrated northward and allowed inland penetration of EASM front during glacial interstadials. On the other hand, the relation between the position of the westerly jet over East Asia and cold-warm climate in the North Atlantic seems to be opposite during Holocene, and presence or absence of Laurentide Ice Sheet could have been responsible for the changes in meandering pattern of the westerly jet between glacial period and Holocene.

Millennial-scale changes in monsoonal climate are also observed in low (to middle) latitude northern hemisphere, which seems to be closely associated with the behavior of ITCZ as well as the westerly jet. The spatial pattern of millennial-scale climatic changes (such as temperature and precipitation) reconstructed in the low (to middle) latitude northern hemisphere during Holocene is similar to the pattern of the difference in climatic conditions (such as temperature and precipitation) between the solar activity maxima and minima, suggesting possible connection with the solar activity. It is possible that low latitude changes in climate pattern in association with changes in solar activities could be the trigger of the millennial-scale climatic changes which propagate into the high-latitude northern hemisphere through changes in meandering pattern of ITCZ and the westerly jet.

Cross-Cutting Theme 1: Chronology

Chronology is crucial to paleoresearch and often constrains the strength of conclusions from paleoenvironmental reconstructions. This Theme supports efforts to improve tools for absolute and relative dating, and to enhance the reliability of reference timescales. It also encourages creative new approaches to solving chronology issues.

Goals

Improve absolute dating:

- reduce the uncertainty of existing radiometric dating methods, i.e., ^{14}C, $^{40}K/^{40}Ar$, $^{40}Ar/^{39}Ar$, Uranium-series;
- improve calibration techniques, particularly for ^{14}C calibration curves and luminescence ages using tree rings, sediment varves, etc.;
- develop new dating methods, e.g. for the time beyond the range of U/Th dating (before ~300,000 years);
- promote laboratory dating intercomparisons (e.g., Ar constants).

Improve chronostratigraphic dating:

- synthesize correlations of regionally occurring well-dated tephra on land and in the ocean with the ice core record;
- compile paleomagnetic master curves for all parts of the globe, including their centennial and millennial-scale variations.

Improve event stratigraphy:

- establish regional event stratigraphy master curves such as the GICC05 coordinated effort by the INTIMATE group of the North Atlantic (Lowe et al., 2008) based on NGRIP ice core;
- develop a global network of high-resolution climate records from different regions and archives, with their time scales consistent between the records and relative to orbital solar insolation over at least the Mid-and Late Pleistocene;

- establish a high-resolution master curve of past global mean sea level change and spatial synopses of local changes.

Ocean circulation in the North Pacific during the last glacial termination

Yusuke Okazaki[1], Axel Timmermann[2], Laurie Menviel[2], Naomi Harada[1], Megumi Chikamoto[1], Ayako Abe-Ouchi[1, 3], and Hirofumi Asahi[3]

1. *Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan*
2. *International Pacific Research Center (IPRC), University of Hawaii, USA*
3. *Atmosphere and Ocean Research Institute, University of Tokyo, Japan*

During the termination of the last ice age between 15 and 17.5 ka, the Atlantic Meridional Overturning Circulation (AMOC) substantially weakened due to freshwater forcing by melting icebergs in the North Atlantic (Heinrich Event 1; H1). The effects of this major reorganization of ocean circulation were documented globally. Although paleoproxy studies argued Pacific intermediate and deep water ventilation changes during the last termination, there is no comprehensive agreement. In order to provide a more comprehensive view on what triggered ventilation changes in the North Pacific during the last termination, we compiled a dataset of published radiocarbon sediment core data in the North Pacific. Together with a climate model simulation, that mimics H1, we determine the effects of AMOC changes on the large-scale conveyor-belt circulation, with an emphasis on the North Pacific. Both sedimentary record and modeling simulation strongly suggest that deep water was formed in the North Pacific extending to a depth of ~2500-3000 m during H1, establishment for a deep Pacific Meridional Overturning Circulation (PMOC). Once the PMOC establishes, the poleward surface currents transport more saline subtropical waters into the North Pacific, thereby providing a positive salinity feedback. A closed Bering Strait facilitates the build-up of such North Pacific salinity anomalies. The main simulated pathway of deepwater spreading is along the western margin of the North Pacific, in a deep western boundary current analogous to the one currently in the North Atlantic. The model results demonstrate that the western boundary flow is the principal factor in establishing the east-west gradient of intermediate-deep-Pacific ventilation, which is also evident in the compilation of radiocarbon-based ventilation data.

Large-scale blooms of *Emiliania huxleyi* in the Bering Sea during the past 100 years and its implication of recent global biogeochemical changes

Naomi Harada*[1], Miyako Sato[1], Kazumasa Oguri[1], Osamu Tadai[2], Sei-ichi Saito[3], Kyoko Hagino-Tomioka[4], Yoshihiro Shiraiwa[5], Yoshinori Tsuji[5], Susumu Konno[6], Richard W. Jordan[6], Kota Katsuki[7], Kyung-Hoon Shin[8], Hisashi Narita[9]

[1]Japan Agency for Marine-Earth Science and Technology; [2]Marine Works Japan Ltd.; [3]Hokkaido University; [4]Okayama University; [5]University of Tsukuba; [6]Yamagata University; [7]Kochi University; [8]Hanyang University; [9]Tokai University

Temporally and spatially large-scale blooms of *Emiliania huxleyi* (*E. huxleyi*) have been distinguished annually in the eastern continental shelf of the Bering Sea since 1997, because ocean color imagery with data from the satellite-borne Sea-viewing Wide Field-of-view sensor was launched in this year. In 1997, a combination of atmospheric mechanisms produced summer weather anomalies such as calm winds, clear skies, and warm air temperature over the Bering Sea and the weather anomalies caused depletion of the subpycnocline nutrient reservoir (Napp and Hunt, 2001). After depletion of nitrate and silicate, a sustained bloom of *E. huxleyi* was observed (Stockwell et al., 2001). Because of the speed and magnitude with which parts of the Bering Sea ecosystem responded to changes in atmospheric factors (Napp and Hunt, 2001) and because a bloom of the coccolithophorid, *Coccolithus pelagicus* has also been detected in the northeastern Atlantic Ocean off Iceland every year since 1997 (Ostermann, 2001), the appearance of an *E. huxleyi* bloom in the Bering Sea could be related to atmospherically forced decadal oscillations or global factors.

We have investigated temporal development of *E. huxleyi* bloom on the continental shelf in the Bering Sea by a biomarker of *E. huxleyi*, C_{37} alkenones flux recorded in the sediments during the past 100 years. As a result, the *E. huxleyi* bloom had already been prominent since the middle of 1970's. We also found the relationship between *E. huxleyi* bloom and activity of Aleutian low and anomaly of Pacific decadal oscillation, however only PDO could not explain the recent high frequent occurrence of *E. huxleyi* bloom. A slightly drop of sea surface salinity might promote *E. huxleyi* growth in the Bering Sea, too. In this presentation, we will also suggest the implications of this regional *E. huxleyi* bloom to understand recent changes in global biogeochemical cycles.

References

Napp and Hunt, 2001, *Fish Oceanogr*., 10, 61-68.
Ostermann, 2001, *WHOI annual report*, pp.17-18.
Stockwell et al., 2001, *Fish Oceanogr*., 10, 99-116