

PAGES 1st Asia 2k Workshop in Japan

Program & Abstracts



**Lecture Hall, Graduate School of Environmental Studies
Nagoya University, Japan**

August 26–27, 2010

Co-organized by:

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

Hosted by:

Graduate School of Environmental Studies, Nagoya University

Program

Day 1: August 26, Thursday

09:00–09:10 Local Organizing Committee
Opening Remarks and Business Announce

<Tree Ring>

Chair: Quansheng Ge (Inst. Geog. Sci. CAS, China)

09:10–09:40 Edward Cook (Lamont-Doherty Earth Observatory, USA)
[**Keynote**] The Monsoon Asia Drought Atlas: A new tool for modeling Asian monsoon variability over the past millennium

09:40–10:00 Yu Liu (Inst. Earth Env. CAS, China)
Temperature variations during the last 2485 years on the mid-eastern Tibetan Plateau inferred from tree rings

10:00–10:20 Xuemei Shao (Inst. Geog. Sci. CAS, China)
A 2800-year drought history recorded by tree ring widths in the northeast Tibetan Plateau

10:20–10:50 Coffee Break & **Poster Session**

10:50–11:20 Hemant Borgaonkar (Indian Inst. Trop. Meteorol., India)
[**Keynote**] Climate change signature in tree-ring proxies from Indian subcontinent

11:20–11:40 Ram Yadav (Birbal Sahni Institute of Palaeobotany)
Tree ring based millennium long climate records from the Himalayan region, India

11:40–12:00 Jonathan Palmer (Gondwana Tree-Ring Laboratory, New Zealand)
The dendroclimatic potential of conifers from northern Pakistan

12:00–14:00 Lunch Break & **Poster Session**

Chair: Edward Cook (Lamont-Doherty Earth Observatory)

14:00–14:30 Brendan Buckley (Lamont-Doherty Earth Observatory, USA)
[**Keynote**] A millennial perspective on the climate of Southeast Asia from tree rings

14:30–14:50 William Wright (Academia Sinica, Taiwan)
A 1,000 year reconstruction of the western Pacific pattern and associated paleoclimate

14:50–15:10 Koh Yasue (Shinshu University)
Past 250 years climate reconstruction in Japan from tree-ring width and density

15:10–15:30 Yasuharu Hoshino (Tohoku University)
Development of the tree-ring chronology over the last 2ka in Japan

15:30–16:00 Coffee Break & **Poster Session**

16:00–16:20 Takeshi Nakatsuka (Nagoya University)

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

<Modeling>

16:20–16:40 Nicholas Graham (Scripps Institution of Oceanography, USA)

Global climate reorganization during medieval times and effects on Asia

16:40–17:00 Masakazu Yoshimori (University of Tokyo)

The last millennium PMIP3/CMIP5 and PCMIP experiment for IPCC AR5 and the perspectives

18:00–20:00 Reception at Mei-Dining

Day 2: August 27, Friday

<Glacier>

Chair: Brendan Buckley (Lamont-Doherty Earth Observatory)

09:00–09:30 Olga Solomina (Inst. Geog. RAS, Russia)

[Keynote] Progress in 2ka reconstructions in Russia

09:30–09:50 Koji Fujita (Nagoya University)

Changes in cryosphere in the Asian highland

<Stalagmite>

09:50–10:10 V. Padmakumari (Nat. Geophys. Res. Inst., India)

Paleomonsoon variations in Himalaya during ~2300 to ~800 yrs B.P. : Inference from stable oxygen and carbon isotopes in speleothem

10:10–10:30 Chotika Muangsong (Mahidol University, Thailand)

Multi-proxy approach of a stalagmite for climate reconstruction in northwestern Thailand

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

<Lake Sediment>

11:00–11:20 R. Shankar (Mangalore University, India)

Paleo-monsoon history of the last two millennia from Southern Indian lake sediment magnetism

11:20–11:40 Kazuyoshi Yamada (Naruto University of Education)

High-resolution reconstruction of the East Asian monsoon activities over the last 2k and 30k years using Japanese annually laminated lake sediments

<Marine Archives >

Chair: Hemant Borgaonkar (Indian Inst. Trop. Meteorol)

11:40–12:00 Min-Te Chen (Nat. Taiwan Ocean University, Taiwan)

2K climate records of the western Pacific marginal seas: A new window for understanding land-sea and human effects

12:00–12:20 S. Ahmad (Nat. Geophys. Res. Inst., India)

Reconstruction of past sea surface temperature (SST) in the eastern Arabian Sea from oxygen isotopic compositions of scleractinian corals

12:20–14:20 Lunch Break & **Poster Session**

<Historical Documents>

14:20–14:50 Quansheng Ge (Inst. Geog. Sci. CAS, China)

[Keynote] Climatic change in China during the past 2000 years: An overview

14:50–15:10 Takanori Nagano (Kobe University)

Reconstruction of past precipitation in the northwestern China using archive data of Qing dynasty

15:10–15:30 Masumi Zaiki (Seikei University)

Climate reconstruction in Japan based on historical documents

15:30–16:00 Coffee Break & **Poster Session**

<Discussion>

Chair: Olga Solomina (Inst. Geog. RAS, Russia)

16:00–17:00 Science Committee

Discussion towards the integration of Asia 2k data

List of Posters

<Tree Ring>

Yasuhiko T. Yamaguchi (University of Tokyo)

Synchronized Northern Hemisphere climate change and solar magnetic cycles during the Maunder Minimum

Yumiko Watanabe (Kyoto University)

Comparison between tree-ring data of Sungkai (*Peronema canescens*) and meteorological data from west Java, Indonesia

Hiroki Ogasa (Tokyo Institute of Technology)

Climatic implications of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ variations in a Japanese cedar on Yakushima Island

Kenjiro Sho (Nagoya Institute of Technology)

Tree-ring $\delta^{18}\text{O}$ variation since the 18th century and its comparison to instrumental and historical climatic records in Lake Biwa area, Japan

Yoshitaka Fukuoka (Rissho University)

The review on the inter-space-correlation and the inter-species' correlation among the tree ring growth curves used for the cross-dating in Japan in connecting with the other paleo-climate materials

Masaki Sano (Nagoya University)

Increasing aridity over the past 223 years in the Nepal Himalaya inferred from a tree-ring $\delta^{18}\text{O}$ chronology

Tomoaki Ida (Shinshu University)

Development of ring-width and maximum-density chronologies of Yaku-sugi (*Cryptomeria japonica*)

Sachiko Wakui (Shinshu University)

Differences in climatic responses of tree-ring widths and densities of Japanese beech growing in various sites in Japan

Qiang Li (Nagoya University)

Hydroclimate variability in North China and its link with ENSO: insights from tree-ring cellulose $\delta^{18}\text{O}$

<Lake Sediment>

Fujio Kumon (Shinshu University)

Detailed climate change in the late Holocene deduced from total organic carbon content of the lake sediments, central Japan

Koji Seto (Shimane University)

Past 2000 years paleoenvironmental changes in core sediments of Nakaumi Lagoon, Southern Japan – correlation with solar activity and anthropogenic changes

Kota Katsuki (Kochi University)

Effects of human activities on the Lagoons along the Okhotsk coast during the last centuries

Yoshiki Miyata (Nagoya University)

Possibility of the fluctuation of freshwater reservoir effect at Lake Biwa from Jomon period to the present days

Atsunori Nakamura (University of Tokyo)

Late Holocene variability of the Asian monsoon: Reconstruction from sediment cores obtained from Lake Rara, western Nepal

Toshihiko Sugai (University of Tokyo)

Geochemical analysis of lacustrine sediments of the Balkhash Lake and its implication for paleoclimate changes during the late Holocene

Chiyuki Narama (Research Institute for Humanity and Nature)

The lake-level changes in Central Asia during the last 1000 years based on historical map

Takashi Chiba (University of Tokyo)

Age of low lake level stages during the last 2000 years, inferred from diatom analysis in Balkhash Lake, Central Asia

<Stalagmite>

Ming Tan (Inst. Geol. Geophys. CAS, China)

Circulation effect: climate significance of the short term variability of the oxygen isotopes in stalagmites from monsoonal China

Ming Tan (Inst. Geol. Geophys. CAS, China)

The paradox of China's monsoon climate during the 1920s and 1930s: Fact, mechanism, and probable cause

Yumiko Watanabe (Kyoto University)

Paleoclimatological study using stalagmite from Java Island, Indonesia

<Coral>

Ryuji Asami (University of Ryukyus)

Boron isotope variability in an annually-banded coral skeleton from the northwest tropical Pacific Ocean

Hiroko Iijima (University of Tokyo)

Reconstruction of sea-surface temperature and salinity changes from fossil corals of Marshall Islands

Yuta Kawakubo (University of Tokyo)

A 432-year-long paleoceanography recorded in *Porites* in Kikai Islands, Southern Japan

<Marine Sediment>

Ritsuo Nomura (Shimane University)

Foraminiferal evidence for sea-level variations in the coastal lagoon: The 1980s event implicating the decrease water circulation

<Glacier>

Hirofumi Sasaki (Hokkaido University)

Is atmospheric iron deposition important for primary production? Lessons from Alaskan Ice core

<Modeling>

Masakazu Yoshimori (University of Tokyo)

A GCM simulation of the last millennium

Abstracts

The Monsoon Asia Drought Atlas: A new tool for modeling Asian monsoon variability over the past millennium

Edward R. Cook, Kevin J. Anchukaitis, Brendan M. Buckley, Rosanne D. D'Arrigo, Gordon C. Jacoby, William E. Wright

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The Asian monsoon system directly affects the lives of more than half of humanity worldwide. Yet, the dynamical processes that govern its complex spatiotemporal variability are not well enough understood to model and predict its behavior, due in part to inadequate long-term climate observations over most of Asia. To rectify this deficiency, we have developed seasonally resolved spatial reconstructions of Asian monsoon drought and wetness over the past millennium from a network of long tree-ring chronologies. This 'Monsoon Asia Drought Atlas' (MADA) provides the spatiotemporal details of known historic monsoon failures and reveals the occurrence of previously unknown monsoon megadroughts in ways never before possible. The MADA thus provides a long-term context for recent Asian monsoon variability that is critically needed for climate modeling, prediction, and attribution studies.

Keywords: Asian monsoon, tree rings, climate reconstruction, drought atlas

Temperature variations during the last 2485 years on the mid-eastern Tibetan Plateau inferred from tree rings

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4. Graduate School of the Chinese Academy of Sciences, Beijing, China

By combining living trees and archaeological wood, the annual mean temperatures were reconstructed based on ring-width indices of the mid-eastern Tibetan Plateau for the past 2485 years. The climate variations revealed by the reconstruction indicate that there were four periods to have average temperatures similar to or even higher than that mean of 1970 to 2000 AD. A particularly notable rapid shift from cold to warm, we call it the "Eastern Jin Event", occurred from 348 AD to 413 AD. Calculation results show that the temperature variations over the mid-eastern Tibetan Plateau are not only representative for large parts of north-central China, but also closely correspond to those of the entire Northern Hemisphere over long time scales. During the last 2485 years, the downfall of most major dynasties in China coincides with intervals of low temperature. Compared with the temperature records in other regions of China during the last 1000 years, this reconstruction from the Tibetan Plateau shows a significant warming trend after the 1950s.

Keywords: mid-eastern Tibetan Plateau, tree rings, temperature variations, dynasty's downfall

A 2800-year drought history recorded by tree-ring widths in the northeast Tibetan Plateau

Xuemei Shao¹, Yan Xu¹, Haifeng Zhu², Zhi-Yong Yin³, Eryuan Liang³

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Based on a tree-ring width chronology of Qilian juniper (*Sabina przewalskii* Kom.) developed in the northeastern Qaidam Basin (northeastern Qinghai-Tibetan Plateau), China, a 2800-year drought history was reconstructed for the study area. The chronology is composed of archaeological wood samples from 13 sites, samples of living trees growing at a site with relatively good moisture condition and other long living trees from multiple sites approximately 100 m below the local upper treeline. The 2-sample Kolmogorov-Smirnov (K-S) test results suggested that the archaeological wood and long living ring-width series belonged to the same statistical population, which allowed the construction of a single, regional composite chronology. Correlation analyses indicated that the ring-width variations of the archaeological wood had statistical characteristics that were more similar to those trees from the lower part of the forest belt, where the moisture regime during the months at the onset of the growing season was the primary control on tree growth. Therefore, the entire composite chronology is moisture-sensitive. The climate data we used to represent drought were the water balance deficit (DEF) at the Delinghe meteorological station (37°22'N, 97°22'E, 2981.5 m.a.s.l.). DEF is defined as the difference between the potential evapotranspiration and actual evapotranspiration. It is a measure of the unmet demand of vegetation water usage and high values of DEF can be treated as an indicator of water shortage or drought conditions. In our previous study we found that DEF could perform better than the Palmer's Drought Severity Index (PDSI) in the study area. The reconstructed DEF accounted for 68.6% of the variance in the instrumental data in 1956-2004 and the calibration equation was verified by the split-sample verification tests. The reconstructed series varied at the inter-decadal to centennial timescales, with ten major multi-decadal severe drought events in the past 2850 years, especially for two prominent events centered on AD 1480s and AD 1710s. On the other hand, significant wet periods were found centered on AD 590s and AD 1570s, and also in the past 30 years. Correlation analyses between the reconstructed drought history and the residual $\Delta 14 C$ series from the IntCal04 calibration curve found that there were strong positive correlations during AD 525-870 and 1275-1870, while significant negative correlations existed during 875-380 BC, 225 BC – AD 20, and AD 975-1220.

Keywords: tree-ring widths, drought history, Qinghai-Tibetan, climate reconstruction

Climate change signature in tree-ring proxies from Indian subcontinent

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Monsoon systems act as a dominant component of the climate over South Asia since geological times. Broad inferences about past climatic conditions have been drawn mostly from the palaeoclimatic investigations of lake sediments, archaeological evidences, historical accounts etc. However, a comprehensive picture of climatic changes and fluctuations during the recent past is yet to emerge as the information is either vague, fragmentary or scattered in many places and languages. Dendroclimatology offers useful method of studying the climate of recent past, which is important for better understanding of monsoon in the context of global climate change.

A wide tree-ring data network from western Himalayan region as well as from central and peninsular India have been established. These include several ring width and density chronologies of *Pinus*, *Picea*, *Cedrus*, *Abies* covering entire area of western Himalaya, and *Tectona grandis* (teak) from central and peninsular India. Tree-ring based reconstructed pre-monsoon (March-April-May) summer climate of Western Himalaya do not show any significant increasing or decreasing trend since past three to four centuries. It also reveals that Little Ice Age (LIA) effect was not prominent over the Himalaya. However, high altitude and near glacier tree-ring chronologies are good indicators of glacier fluctuations. An unprecedented enhancement in growth during the last few decades is detected in long tree-ring records of high altitude Himalayan conifers. Dendroclimatological investigation indicates significant positive relationship of tree-ring index series with winter (December-January-February) temperature and summer precipitation and inverse relationship with summer temperature. Higher growth in recent few decades detected in the tree-ring chronology has been noticed coinciding with the rapid retreat of the Himalayan glaciers. Suppressed and released growth patterns in tree-ring chronology have also been observed to be well related to the past glacial fluctuation records of the region (Borgaonkar et al, 2009). The higher and lower tree growth epochs in tree-ring records have reasonably been found to be coinciding to the various glacial fluctuation records.

In tropical region of south and southwest Asia number of groups have been working to establish good quality tree-ring data network to understand monsoon variability and related global parameters (e.g. ENSO) in the recent past. In this context, teak (*Tectona grandis*) from Indonesia, Thailand, Java, India have been demonstrated as a potential source for high resolution spatial reconstruction of climate. These studies indicate great potential of *Tectona grandis* in reconstruction of monsoon precipitation. We have presented a 523-year-long tree-ring width index chronology of Teak (*Tectona grandis* L.F.) from south India. Dendroclimatological investigation indicates significant positive relationship of tree-ring index series with Indian summer monsoon rainfall (ISM) and related global parameters like Southern Oscillation Index (SOI). Frequency of occurrence of low tree growth index was significantly higher during the recorded deficient monsoon rainfall years, associated with El Nino events since the late 18th century. Prior to that, many low tree growth years occurred in the known El Nino years, probably because of associated deficient monsoon rainfall. Such monsoon climate sensitive teak tree-ring chronologies lead to the usefulness of tropical teak chronologies to understand the past vagaries of monsoon.

Keywords: Himalayan conifers, Teak (*Tectona grandis*), Indian Summer Monsoon, Droughts, El Nino

Tree ring based millennium long climate records from the Himalayan region, India

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The Himalayan system imposing the highest mountain barrier on the Earth has significant influence on regional and hemispheric circulation system. Climate state over the region not only affects the well being of locals but millions of people inhabiting lowland areas in India and neighboring countries as well. Our understanding on climate change and related issues in mountain areas in India is constrained by parochial weather records. Long-term high-resolution climate records supplementing the weather records back to past several centuries and millennia provide valuable baseline data to understand natural variability in climate and anthropogenic impact over it.

Tree-ring records from sites ranging from very hot to extreme cold and arid, moisture deficient to high rainfall areas in western and eastern Himalayan region have been investigated to develop long-term climate records. The life span and climate sensitivity of even same species have been found to vary over different sites. The trees growing over moisture stressed sites are usually older than their counter parts over the mesic sites. Around two millennia long ring-width chronology of *Juniperus polycarpos* from moisture stressed site in the western Himalayan region, India has been developed. The other chronologies of *Cedrus deodara* and *Pinus gerardiana* from moisture stressed sites, as well, span over the last millennium. These chronologies have been used to develop well calibrated millennium long mean summer temperature (Yadav et al., 2009) and precipitation records (Yadav 2010). These are the first such record of the state of temperature and precipitation over the Medieval Warm and Little Ice Age period in the Himalayan region. The long-term temperature and precipitation records developed from the western Himalayan region show linkage with El Nino Southern Oscillation (ENSO) and the Indian summer monsoon rainfall (ISMR). This strongly supports that the long-term climate records from the Himalayan region have profound implications on global climatology.

The dendroclimatic potential of conifers from northern Pakistan

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A collection of 28 tree-ring chronologies from six different species located in northern Pakistan were evaluated in terms of their potential for dendroclimatic reconstructions. 15 of the sites are new while the remaining 13 (all *Juniperus excelsa*) have been reported earlier. Several species had trees attaining ages of around 700 years (*Cedrus deodara*, *Pinus gerardiana*, *P. wallichiana* and *Picea smithiana*) but the juniper was clearly the oldest with some trees greater than 1,000 years. Correlations between the site chronologies declined with increasing separation distance. This was consistently seen both between sites of the same species and between sites composed of different species. This led to a situation where a much stronger correlation occurred at a site between two different species adjacent to each other rather than between the same species but separated by as little as 0.5km. Such results highlight the obvious strong elevational gradients present in this mountainous region (where some elevations are over 7,000 m). They also lend support to the practice of multi-species combinations for better spatial and temporal coverage. The best prospects for this appears to be *Cedrus deodara* and *Pinus gerardiana* and is consistent with studies from neighbouring India. The comparison to 0.5° gridded climate data was strongest from the same two species though *Picea smithiana* at one site was also highly significant. A general climate correlation pattern from all species was evident that starts with a strong negative relationship to temperature in the previous October, then turns towards positive during winter, before again becoming significantly negative by the current May. The previous October signal is thought to be a lag effect where hot temperatures (and low soil-moisture) stress the trees, thereby reducing reserves available for the following spring. Similarly, hot temperatures in late spring (May) lead to greater soil moisture losses and tree transpiration costs. Conversely, there is an extended strong positive precipitation correlation from late winter to spring (January to May). This ends abruptly and there is no evidence of a summer (June-September) monsoon signal seen in the rainfall correlation functions.

Keywords: northern Pakistan, Himalayan conifers, dendroclimatic potential

A millennial perspective on the climate of Southeast Asia from tree rings

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Over the past decade great strides have been made in pushing the boundaries of tropical dendrochronology, and we now have robust reconstructed records of climate from Southeast Asian tree rings that nearly span the past millennium. The longest of these records is the 750-year reconstruction of March-May Palmer Drought Severity Index (PDSI) from the Vietnamese cypress *Fokienia hodginsii* from the species-rich montane forests of Bidoup Nui Ba National Park in southern Vietnam. The second such record is a 550-year reconstruction from northern Vietnam at Mu Cang Chai, from the same species. These two records reveal periods of episodic drought and pluvials that often lasted decades and coincided with key periods of social upheaval across Southeast Asia, in particular the early 15th century Khmer demise at Angkor and the late 18th century collapse of all major kingdoms across the region. We now have additional collections of *Fokienia* that span the length of Vietnam and Laos (12° to 23° North), providing a unique opportunity to analyze the spatial variability of significant past episodes of hydroclimate variability over Indochina. Links to ENSO variability are highlighted, particularly on decadal time scales, and newly developed stable isotope records increase the information we are able to glean from these amazing records. Vietnam is home to 36 species of conifer from 19 genera, and we identify several species that produce annual rings, can be crossdated, and can be used for climate reconstruction with annual and even subannual resolution, and span most of the past millennium.

A 1,000 year reconstruction of the western Pacific pattern and associated paleoclimate

William Wright

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Millennial age Taiwanese trees, *Chamaecyparis obtusa* var. *formosana*, have been assessed for climate reconstruction potential using dendrochronological techniques. High frequency changes in the tree-ring width time series (CIL) are highly correlated with the Western Pacific Oscillation, a north-south middle troposphere pressure oscillation between the high and mid-latitudes over the northern Pacific, oscillations that are linked to changes in the speed and meridional flow of the polar and subtropical jet streams. A 1,000+ year reconstruction of the Western Pacific Oscillation will be presented.

CIL is significantly correlated with temperature time series from sea level weather stations in Taiwan, though most of the regressions are not very stable through time. However, significant correlations between the Western Pacific Oscillation and NCEP/NCAR reanalyzed temperature over northern Taiwan indicate a disconnect between temperatures at the surface and temperatures at elevation, suggesting that the tree rings may be a more accurate recorder of local temperatures than is indicated by the correlations with local weather stations. A 1,000+ year reconstruction of the first differenced relationship between CIL and a sea level weather station will be presented and commonalities with other temperature reconstructions will be discussed.

CIL is also significantly correlated with eastern tropical Pacific sea surface temperatures but only after about 1950. Teleconnections between eastern Pacific sea surface temperatures and surface climate time series in the northern Atlantic have previously been described, and both Western Pacific Oscillation and CIL are significantly correlated with sea surface temperatures in the northern Atlantic. The longer CIL record reveals a 100+ year teleconnection with northern Atlantic sea surface temperatures. Stability of the more distant north Atlantic teleconnection and instability of the eastern tropical Pacific teleconnection will be discussed.

Keywords: dendroclimatology, teleconnection, Western Pacific Oscillation, sea surface temperature, jet stream

Past 250 years climate reconstruction in Japan from tree-ring width and density

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The potential usefulness of tree-ring widths and densities from old natural forests in northern, central and southern Japan as indicators of climatic changes has been evaluated. Cores taken from Sakhalin spruce (*Picea glehnii*) at 3 sites and Japanese ash (*Fraxinus mandshurica* var. *japonica*) at 2 sites in northern Hokkaido, northern Japanese hemlock (*Tsuga diversifolia*) and Ezo spruce (*Picea jezoensis* var. *hondoensis*) at Akaishi mountains in central Honshu and Yaku-sugi (*Cryptomeria japonica*) at 3 sites in Yaku Island in southern Kyushu were subjected to X-ray densitometry. Ring width and maximum density were measured for conifers and ring width, earlywood width and latewood width were measured for ring-porous hardwood (Japanese ash). Ring-width chronologies of spruces and hemlock are correlated mainly to local monthly temperature, but the responses differ among the sites. By contrast, maximum densities positively correlated with summer temperature and negatively correlated with summer precipitation in spite of differences in species and site conditions. Ring-width and latewood width chronologies of Japanese ash are correlated with July - September temperature. These observations suggest that both maximum density of spruces and hemlock and ring width of Japanese ash are suitable indicators for reconstruction of the climate in past summer. Both ring width and maximum density of Yaku-sugi revealed positive correlation with sunshine duration and negative correlation with precipitation of the growing season. These might be caused by rainy and cloudy climate conditions of Yaku Island.

The reconstruction models for summer temperature in northern Hokkaido and central Honshu were calibrated and statistically verified. That for May – June sunshine duration in southern Kyushu was also statistically verified. The trends in reconstructed climatic factors after 1758 revealed consistency from early 1800s to early 1900s. For other period, they did not show consistency. There are possibilities that the occurrence of climate shift or human disturbances, etc. The reason should be carefully clarified later. The research indicates that the tree-ring density of annual rings, which can be obtained by densitometric analysis, should be important parameters for reconstruction of climate in Japan.

Development of the tree-ring chronology over the last 2ka in Japan

Yasuharu Hoshino^{1,2}, Motonari Ohyama¹, Hitoshi Yonenobu³

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2. JSPS Research Fellow
3. Graduate School of Education, Naruto University of Education, Japan

The East Asian monsoon is an important component of the global climate system. Long-term, high-resolution climate records are essential in order to better understand the nature of the East Asian monsoon and the issues of the recent global warming. Various archives such as tree rings, ice cores, varves and historical documents have provided effective proxy data for the past climate variability. Tree rings have given annually-resolved quantitative reconstructions of the past temperatures, precipitation, drought indices and other climatic parameters. There have been recent efforts to improve the coverage of dendroclimatic reconstructions in the East Asian region. However, the tree-ring records are still sparse in Japan. Therefore, it is worth developing tree-ring chronologies and investigating the potential of tree-ring reconstruction using various species in Japan. In this study, we report on the recent development of tree-ring chronologies for the last two thousand years using Hinoki cypress (*Chamaecyparis obtusa*), Sawara cypress (*C. pisifera*), Hiba arbor-vitae (*Thujopsis dolabrata* var. *honda*), Japanese cedar (*Cryptomeria japonica*) and Japanese beech (*Fagus crenata*) by collecting wood samples from living trees, buried logs, and historical and archaeological wood in Japan. We also present dendroclimatic reconstructions using living trees in Japan.

Keywords: tree ring, chronology development, dendroclimatic reconstruction

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

Takeshi Nakatsuka¹, Keiko Ohnishi², Hiroyuki Tsuji², Takumi Mitsutani³, Koh Yasue⁴, Takeshi Fujiwara⁵ and Yoshikazu Sampei⁶

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We present here the first result of a network on yearly resolutions of tree-ring cellulose oxygen isotope measurements in Japan, containing 7 sites from sub-boreal (Hokkaido) to sub-tropical (Kagoshima) regions, 4 of which extend over 250 years. Because the oxygen isotope ratio in tree-ring cellulose is governed only by the oxygen isotope ratio in precipitation (water vapor) and the local relative humidity without any large biological effects, it is one of the most promising proxies for reconstruction of past water cycles in yearly and/or seasonal time resolutions. Especially in humid and temperate regions in Asia like Japan, it was quite difficult to obtain past summer monsoon information by traditional dendrochronological methods based on the tree-ring width. Therefore, the oxygen isotope ratio in tree-ring cellulose must become an indispensable proxy to reconstruct 2K climate variations in Asia.

Variations in tree-ring cellulose oxygen isotope ratios are well correlated with those of local summer relative humidity all over Japan, providing us with some new findings on the long-term characteristics of variations in Japanese Summer Monsoon. 1) Inter-annual change in a summer rain front activity, characteristic in East Asia (Baiu and Meiyu in Japan and China, respectively), can be reconstructed by the tree-ring oxygen isotope ratios in central Japan, showing that there has been a predominant but non-stationary relationship between Baiu and ENSO during last three centuries. The ENSO-Baiu teleconnection demonstrates cyclic reversal at every 40 years interval, and it is accorded by multi-decadal PDO variations, suggesting that SST distribution in North Pacific controls the spatiotemporal impacts of ENSO on East Asia Summer Monsoon. 2) There is a long-term increasing trend of the tree-ring oxygen isotope ratios from 18th to 20th century in southern and central Japan, probably reflecting the regional decreases in relative humidity with global warming. 3) In the 17 and 18th centuries, abrupt decadal-scale drops in the tree-ring oxygen isotopic ratios were often observed together with simultaneous abrupt rises of its carbon isotopic ratios at several sites in southwestern Japan. Because they cannot be explained by the changes in local water environment, it must have been caused by decadal scale of atmospheric circulation changes, such as abrupt enhancements of East Asian Summer Monsoon related to variations in solar activity during Little Ice Age.

Because there are only few tree-ring width chronologies sensitive to summer water environment in humid regions like Japan, spatial combinations of the newly determined oxygen isotope chronologies in Wet Asia with the traditional tree-ring width chronologies in Dry Asia must be highly requested in the nearest future.

Keywords: Tree Ring, Cellulose, Oxygen Isotope, Japan, Summer Monsoon

Global climate reorganization during medieval times and effects on Asia

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A range of *in-situ* proxy records indicate that tropical eastern and central Pacific SSTs were relatively cool during the “Medieval Climate Anomaly” (MCA, ~900-1350 AD). This idea is further supported by the hydroclimate changes indicated by proxy records from extra-tropical western North and South America. At the same time, clear indications of a distinct MCA are also found in proxy records distributed around the planet, some far removed from the Pacific sector. Further, some of the climate shifts inferred from these latter records are inconsistent in strength or character of those expected on the basis of a cooler tropical Pacific alone, as judged from observations and model results. Among such “inconsistent” changes (some intriguingly abrupt and near-synchronous) are indications from a stronger NAO with impacts on Europe and the North Atlantic, aridity in equatorial Africa and along the coastal fringes of southwest Asia, and increased monsoon rainfall in parts of eastern Asia. These findings suggest that MCA climate changes were not driven by a cooler tropical Pacific alone, suggesting an important role for SST changes in other tropical oceans.

Evidence for what these “not only cool tropical Pacific” SST changes may have been come from model simulations of the climate and circulation impacts ensuing from the late 20th century warming of the Indian Ocean, results which show several of the “inconsistent” MCA features noted above. Following this evidence, we tested the idea of warmer Indo-Pacific Warm Pool (IPWP) SSTs in Medieval times using a series of full-physics global coupled model simulations in which IPWP SSTs were increased slightly over the range ~0.2-0.8C. The global climate and circulation shifts seen in the model results closely resemble many of those inferred from global proxy records for the MCA, including those not well explained by a cooler tropical Pacific alone, e.g., aridity in southwest Asia and equatorial Africa. Interestingly the simulated changes include cooling in the tropical eastern Pacific as well as North Atlantic sea ice retreat during the MCA. Overall, the findings support a stronger zonal SST gradient between the Indo-Pacific Warm Pool and the eastern/central tropical Pacific SST during medieval times relative to subsequent centuries, a pattern consistent with that derived in a recently published statistical reconstruction.

The presentation will give a brief review the medieval climate and circulation changes suggested by proxy records, then synthesize of the proxy data with the coupled model results with emphasis on those in Asia.

Keywords: Medieval Climate Anomaly, tropical SSTs, hydroclimate.

The last millennium PMIP3/CMIP5 and PCMIP experiment for IPCC AR5 and the perspectives

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Paleoclimate modelling aids in understanding mechanisms of large scale climate change in the past. It is also useful in validating models used for future climate projections such as those reported by Intergovernmental Panel on Climate Change (IPCC). Paleoclimate Modelling Intercomparison Project (PMIP) in its 3rd phase announced the protocol for the last millennium simulation (850 – 1850 AD) in order to serve for the IPCC Assessment Report 5 (AR5), for the first time jointly with Coupled Modelling Intercomparison Project 5 (CMIP5).

The last millennium simulation in the PMIP3/CMIP5/AR5 will be carried out by multi GCMs including MIROC GCM in contrast to the AR4 in which simulations are conducted mostly by reduced climate models with few GCMs. The climate models will be run with five kinds of forcing varied in time: solar, volcanic, greenhouse gases, land use and orbital element. Four solar and two volcanic forcing candidates are provided in order to cover the range of uncertainty in the forcing reconstruction. While the four solar forcings are similar each other, they are substantially different from ones typically used in previous studies. The two volcanic forcings are quite different each other. Some of the impact of these uncertainties will be addressed by combining GCM and reduced climate model results.

A simulation of the last millennium was carried out using the MIROC-3.2 coupled atmosphere-ocean general circulation model (GCM). The model is first spun up under the perpetual 850A.D. condition until it reaches the quasi-equilibrium state. The model is then integrated with time-varying boundary conditions. The time-varying forcing for 850-1850A.D. includes variations of solar activity, volcanic eruptions, greenhouse gas concentrations, and orbital variations. After 1850A.D. the model is also forced with time-varying aerosol emissions, ozone concentrations, and land use changes until 2000A.D. The preliminary analysis on the simulation is presented. Northern Hemisphere mean temperature exhibits variations that are within the range of multiple reconstructions except several large volcanic events. The disagreement between the simulated and the reconstructed climates does not immediately imply the model deficiency because two volcanic forcing reconstructions do not agree in magnitude on these volcanic events. Processes responsible for climate variability in the North Pacific are investigated. On the time scale longer than 7 years, about 40% of the temperature variance is explained by globally-synchronous changes and about 21% is explained by the Pacific Decadal Oscillation (PDO) which explains about 37% of the variance in the unforced control simulation.

As the number of millennial simulations is highly limited due to the GCM's computational cost, we also tested a potential of a model of intermediate complexity (EMIC) as a surrogate of the GCM. A comparison between the GCM and the EMIC suggest that this EMIC exhibits remarkably similar time evolution for hemispheric mean temperature when forced with the equivalent radiative forcing. A series of sensitivity experiments using the EMIC as a surrogate of the GCM are also presented in terms of the impact of forcing uncertainty on the hemispheric-scale temperature variations.

Keywords: PMIP3/CMIP5, GCM simulation, EMIC simulation, Northern Hemisphere temperature

Progress in 2ka reconstructions in Russia

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The first multiproxy quantitative reconstruction of annual, summer, winter temperature and sum of annual precipitation for the East European Plain covering the last 1,5-2 millennia takes into account mostly palynological and historical data calibrated against instrumental records up to 250 years long (Klimenko et al., 2001; Klimenko, Solomimna, 2010). The accuracy of the reconstruction is $\pm 0.2^{\circ}\text{C}$.

The reconstructions show the negative linear trends in air temperature in the last millennium, while in the 20th century these trends abruptly changed to the positive ones in annual and winter temperature. No sign of summer warming in the 20th century in the East European Plain was evident either from instrumental records or from proxy-based reconstructions until the very recent time. In this context the summer temperature in Moscow region in 2010 exceeding the highest historical values of the last 130 years by up to seven degrees C is quite impressive. No millennium-long trend in annual precipitation in the East European Plain is identified in the multi-proxy reconstruction in the last 2 ka. A drought period in this reconstruction in 9-11th centuries agrees with the evidences of soils buried in the alluvium of the rivers of the East European Plain and dated by 14C.

The longest summer temperature reconstructions in the sub-arctic are from Taymir (Naurzbaev et al., 2002) and Yamal (Khantemirov et al., in press) peninsulas. They show a long-term negative trends inverted in the 19th century. Ice core records in the Franz Jozef Land (800 years long) (Henderson, 2000) and Severnaya Zemlya (1800 years long) (Opel et al., 2010) provide information on climatic and environmental changes in the high Arctic.

Ice core (Eichler et al., 2008), lake sediments (Kalugin et al., 2008), and tree-ring series (Myglan (in preparation) are available in the Altay Mts. The temperature sensitive tree-ring series show an unusual extremely high growth in 1-5th centuries AD, which might be connected to a different combination of climatic factors limiting the ring growth. Unfortunately the other proxies are too short to be used for the explanation of this phenomenon. In the Northern Caucasus the ice core from the Elbrus glacier 182 m long (bedrock reached) was obtained in summer 2009 (Mikhaleenko et al., 2010). In combination with the summer temperature reconstruction based on the tree-ring density (Dolgova, Solomina, 2010) the ice core records will be used for the first multi-proxy reconstruction in Caucasus.

Changes in cryosphere in the Asian highland

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Fate of Himalayan glaciers wrongly described in IPCC-AR4-WG2 is the recent hottest matter of debate in climate sciences. The debate seems to be baseless, however, because few observational facts have been reported so far. We have observed 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. Giving a 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 than in 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 recent 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 Gregoriev ice core, the Kyrgyz Tianshan Mountains.

Paleomonsoon variations in Himalaya during ~2300 to ~800 yrs B.P. : Inference from stable oxygen and carbon isotopes in speleothem

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Speleothem (calcite in this context, precipitated in a cave environment), growing over centuries are very useful proxies for continental paleoclimate. Oxygen isotopes in speleothem are related to the $\delta^{18}\text{O}$ of the local precipitation and to the temperature in the cave during calcite precipitation. In the tropics it is found that $\delta^{18}\text{O}$ of precipitation is inversely related to the amount of rainfall. In tropical caves, $\delta^{18}\text{O}$ of freshly deposited calcite layers on a growing speleothem is depleted with increasing precipitation and temperature. Hence, $\delta^{18}\text{O}$ of speleothem is a proxy for the past variations of $\delta^{18}\text{O}$ of meteoric water and mean annual surface air temperature. $\delta^{13}\text{C}$ in speleothem depends upon type of vegetation (C3 or C4), dripping rate of water, bedrock dissolution rate and seasonal variations in the soil pCO_2 in a complex fashion.

Stable oxygen and carbon isotopic ratios for 1500 yrs (~2300 to ~ 800 yrs B. P) in a stalagmite from Himalaya are presented here. This 28 cm long stalagmite was collected in March, 2008 from the Kothinal cave, Uttarkashi, India from an altitude of 1927m (30° 49'N and 78° 01'E). Ages were determined by U/Th dating method. $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ measurements were carried out in 108 samples at 0.8 mm interval.

The $\delta^{18}\text{O}$ ratios show variations ranging from - 9.79‰ to - 8.65‰ and $\delta^{13}\text{C}$ from - 4.34‰ to - 2.29 ‰. Based on several spikes of enrichment and depletion in the $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ data, different dry and wet events are recognized. Depleted values of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ during ~ 900, 1000 to 1100, ~ 1200, ~ 1350, ~ 1950, ~ 2150 and ~ 22500 yr B.P. look to be times of monsoon precipitation. Dry periods of ~ 800, ~ 950, ~ 1175, ~ 1400, ~ 2100 and ~ 2300 yr B.P. are observed. Among these, an intense monsoonal period ~1000 yr B.P. and dry period ~ 2100 yr B. P. are very prominent. Signals of similar climatic conditions ~ 2000 yrs B.P. and ~ 1000 yrs B.P. have also been recorded from other geographically distinct localities.

Stalactite from the Gupteswar cave (Orissa) shows an extreme arid period around 2000 yr B.P. that is consistent with our data though there could be some chronological uncertainty. Stalactite in Sota cave (Uttar Pradesh) yielded mean $\delta^{18}\text{O}$ of -8.12+ 0.63 ‰, similar to the present $\delta^{18}\text{O}$ of - 9.79‰ and $\delta^{13}\text{C}$ value of -13. 73 +0.56 ‰, which is very different, could be due to the difference in soil cover above the caves.

The Mean $\delta^{18}\text{O}$ values in the present study are found to be depleted (-9.76 ‰) in samples of the older section (>2 ka BP) as compared to those (- 9.31 ‰) in the younger section (< 2 ka BP). The general depletion in $\delta^{18}\text{O}$, as compared to the $\delta^{18}\text{O}$ values at Sota, Gupteswar, Dandak in Chattisgarh and Akalagavi in Karnataka could be due to “continental effect”, considering the geographical position of Kothinal cave. However, not much change is observed in the average $\delta^{13}\text{C}$. The positive correlation observed between $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ in this study suggests that $\delta^{13}\text{C}$ is also dominantly controlled by rainfall variations.

Multi-proxy approach of a stalagmite for climate reconstruction in northwestern Thailand

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The analysis of $\delta^{18}\text{O}$, growth rate, and grey level profiles of a stalagmite NJ1 from Namjang cave, Mae Hong Son province, Thailand, provides a robust proxy for the late monsoon rainfall over the past 1700 years. Based on the precise chronology by comparison of annually laminae counting and ^{230}Th dating, the stalagmite accepted deposition during three periods as follows: 306-907 AD, 967-1806 AD and 1886-2005 AD, respectively, with two hiatuses in between these three periods.

The minimum of $\delta^{18}\text{O}$, associated with maximum growth rate and grey level, indicates more rainfall in the late monsoon season (ASO), and possibly stronger Thailand monsoon (TM). Hence, the variations in all three parameters demonstrate six periods of stronger TM occurred at approximately 490-590 AD, 1050-1110 AD, 1200-1410 AD, 1465-1540 AD, 1600-1720 AD and 1950-2000 AD respectively. They also reveal six periods of relatively weak TM occurred at approximately 600-700 AD, 710-810 AD, 1150-1190 AD, 1560-1590 AD, 1750-1800 AD and 1886-1950 AD, respectively. Some of these variations synchronize with stalagmite records from China, India and Oman, but discrepancy among these records is also observed. This study demonstrates that stalagmite NJ1 can be used to document paleoclimate variability in northwestern Thailand.

Keywords: Stalagmite; oxygen isotope; growth rate; grey level; Thailand monsoon rainfall

Paleo-monsoon history of the last two millennia from Southern Indian lake sediment magnetism

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We have investigated the environmental magnetic properties of sediments from two lakes from Southern India: Thimmannanayakanakere (TK) (14° 12' N; 76° 24' E) and Pookot Lake (11° 32' 30" N; 76° 01' 38" E). Other proxy data were also studied for a limited number of samples. Carbon-14 dating provided the chronological framework. We have used magnetic susceptibility as a proxy for reconstructing paleomonsoon in the *tropical* Southern India.

For TK sediments, magnetic susceptibility (χ_{lf}) is positively correlated with instrumental rainfall data for Chitradurga Station ($r=0.45$) and Peninsular India ($r=0.65$). For Pookot sediments too, χ_{lf} is positively correlated with instrumental rainfall data (IMD) for Vayittiri Station ($r=0.44$), Kerala ($r=0.38$) and Peninsular India ($r=0.38$), suggesting the possibility of using χ_{lf} as a paleomonsoon proxy. Further, the χ_{lf} -rainfall correlation is bolstered by historical data from Chitradurga region (for the AD 1876-77 drought and the AD 1741 excess rainfall event) and by proxy data from other parts of India (speleothems; a tree ring from western India and lake deposits of Rajasthan). Ruling out magnetite from biogenic and anthropogenic sources, we have reconstructed the paleomonsoon profile for the past 2000 years. Several periods of drought and high precipitation that we discerned correlate well with proxy data from other localities in India, Oman and the Arabian Sea. A deficient monsoon is recorded during the Little Ice Age and a strong monsoon during the Medieval Warm Period. The interpretations made are corroborated by geochemical and other proxy data for the same sediment samples. Other details of the reconstructed monsoon for parts of Southern India will be presented at the workshop.

High-resolution reconstruction of the East Asian monsoon activities over the last 2k and 30k years using Japanese annually laminated lake sediments

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In Japan, annually laminated (varved) lake sediments have been found at several sites since 1991. These lake sediments enable us to reconstruct past climate changes with high-resolution. We obtained new lake sediment records from Megata three maar lakes (so-called as Lake Ichi-, Ni- and San-no-Megata) in 2006 and 2008, situated on the Oga Peninsula along the Sea of Japan coast, northeastern Japan. Here we present these lake records concerned with the reconstruction of the Asian monsoon activities over the last 30k and 2 k, respectively.

In Lake Ichi-no-Megata, 37-m long sediment cores were recovered. Most of the sediment sequences were thinly laminated. Although these laminations had different structures and composition between the Holocene and the last glacial period, they have been related to an annual cycle of deposition. Multiple AMS ¹⁴C dates enabled us to establish the detailed chronology agreed well with tephrostratigraphy over the last 30,000 years. As one of our results, it is suggested that main transition between Holocene and the last glacial period was at 14,300 cal BP.

On the other hand, micro-sedimentological, geochemical data from Lakes Ni-no-Megata and San-no-Megata sediment cores were used to reconstruct climate changes over the last 2000 years. Comparing these records in two neighboring maar lakes allowed reconstruction of centennial scale climate change concerned the East Asian monsoon activities without the influence of human activities. S content and coarse mineral grains records showed that long-term climate changes, with one warm/humid interval from AD 1200 to 750, and two cold/dry intervals from AD/BC to 750, AD 1200 to the present. These climate changes had similar trends to Asian monsoon records in China, and could correspond to the Dark Age Cold Period, the Medieval Warm Period and the Little Ice Age climate changes in Europe. Moreover, short-term climatic deterioration events occurred in the 6th, 10th and 18th centuries. Particularly the event around the 10th century was well correlated with other paleoclimate proxies in China, Europe and Mesoamerica, suggesting tele-connection by atmospheric circulation through the Northern Hemisphere. However, the record was asynchronous with solar activity. This might suggest the solar forcing has indirectly influenced lake sedimentation associated with Asian monsoon activities in Japan.

Keywords: lake sediments, varve, East Asian monsoon, Megata maar lakes, NE Japan

2K climate records of the western Pacific marginal Seas: A new window for understanding land-sea and human effects

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Northern Hemisphere surface temperature reconstructions suggest that the late twentieth century was warmer than any other time during the past 2K. These temperature reconstructions are based largely on terrestrial records. However, few high-resolution temperature reconstructions are available from the oceans. Previous studies using cores with sedimentation rates ~20-40 cm/kyr from the South and East China Sea present millennial-centennial resolution and show clearly a long-term trend of cooling and possibly freshening conditions since the middle Holocene (~5 ka). The ocean climate patterns are attributed to a slow southward migration of ITCZ and a weakening of summer monsoon in the East Asia. The long-term trend is observable in most cave sediment records in nearby regions. Recently, marine reconstructions of past 2K climate have become available through giant coring techniques, which provide large volume and sufficient material for retrieving climate records from ultra-high sedimentation sites (~400-800 cm/kyr) site near Yellow Sea. The ultra-high resolution records show abrupt, possibly decadal-scale variations in the past 2K. Superimposed on a long-term cooling trend since the 2ka, the records are interrupted by ~2-3°C cooling in sea surface at ~1500 and 400 BP. While the age model of our records is limited by insufficient carbon material for AMS C¹⁴ dating, our study indicates that ocean climate in the western Pacific marginal seas show a tight coupling with the East Asian monsoon system and remote forcing of Northern Hemisphere climate on decadal-centennial–millennial timescales. Future research opportunities brought by the ultra-high resolution record are to identify any human effect in causing or interacting with the abrupt climate changes.

Reconstruction of past sea surface temperature (SST) in the eastern Arabian Sea from oxygen isotopic compositions of scleractinian corals

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Coral-based climate reconstruction has emerged as a very useful tool for a better understanding of the natural climate variability and its relationship with forcing mechanisms. Living scleractinian corals (eg. *Porites* spp.) provide an excellent archive of paleoclimatic records on extremely high-resolution time scale. Stable carbon ($\delta^{13}\text{C}$) and oxygen ($\delta^{18}\text{O}$) isotopes in coral bands are increasingly used for tracing climatic and monsoonal histories on monthly to weekly time scales. Oxygen isotopes are useful in determining past sea surface temperature (SST) and sea surface salinity (SSS) changes, whereas carbon isotopes in determining seasonal changes in productivity and coral's metabolic processes.

Lakshadweep Archipelago, in the eastern Arabian Sea, consists of several small islands between latitude 10-12°N and longitude 72-74°E. Large changes in both the physical environment and chemical composition are known to occur around these islands in response to monsoon forcing, El Nino and Indian Ocean Dipole. Lowering in SST around these islands is linked to the southwest monsoon intensity and consequent upwelling. Seasonal bands in genus *Porites* corresponding to the monsoon season (June–September) are characterized by high $\delta^{18}\text{O}$ (due to lower temperature) relative to the bands deposited during the non-monsoon periods. Previously published $\delta^{18}\text{O}$ records from the shallow-water corals of these islands demonstrated monsoon-induced reduction in SST during the monsoon months of June to September (Chakraborty and Ramesh, 1993; Ahmad, et al., 2010). The coral's skeletal $\delta^{18}\text{O}$ values during the monsoon and non-monsoon months are mainly controlled by the fluctuations in SST.

We have generated monthly-scale sea surface temperature record for the 20th century using drilled coral colonies from the lagoon of Kavaratti island. Our SST record is based on oxygen isotopic measurements in more than 1200 coral samples. This record is obtained from the two drilled coral cores from the underwater growing *Porites lutea* colony. The most striking feature of our $\delta^{18}\text{O}$ record is a gradual increase in mean SST for the 20th century. Our results clearly show that the monsoon-derived upwelling, which brings colder water to the surface, has decreased considerably during the 20th century. The annual mean SST around these islands has increased by $\sim 0.8^\circ\text{C}$ during the 20th century. This increase is higher compared to the global surface temperature increase of $\sim 0.6^\circ\text{C}$. Spectral analysis of the SST data shows decadal to inter-decadal climate variability.

In addition, oxygen isotopes and X-ray radiography also indicate significant decrease in calcification rate from 1993 to 2003 AD in two drilled *Porites lutea* colonies. This is consistent with the Great Barrier Reef's (GBR) records of a decrease in calcification rate of genus *Porites* in recent pasts. This decrease in calcification rate of Lakshadweep corals, since 1993, is attributed to the SST increase and/or ocean acidification.

Keywords: Scleractinian Corals, Lakshadweep Archipelago, Carbon & Oxygen Isotopes, SST.

Climatic change in China during the past 2000 years: An overview

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Information of pre-instrumental history of climate is needed to study past climate changes, which also helps differentiate “natural” versus “anthropogenic” climate changes. There were many studies conducted over the last several decades in China using historical documents and natural archives (e.g., tree-ring, ice-core, stalagmite, lake sediment, etc.) for climate reconstructions. In particular, since the 1970s, the climate-related records contained in Chinese historical documents have been systematically extracted. The efforts over three-decades have resulted in the archives of climate records spanning over 2,000 years. The historical documents include the following categories: Chinese classical documents, local gazettes, Archives of the Qing Dynasty (1644-1911) and the Republic of China, and private diaries. Among the archives, *Qing-Yu-Lu* that provided daily weather records and *Yu-Xue-Fen-Cun* that recorded each precipitation event as either the depth of rainfall infiltration into the soil or the snow depth, are very valuable because they provided quantitative climate information. Based on these documents, many long-term climate series have been developed, such as the 2,000-year winter half-year temperature of the middle and lower reaches of the Yellow and Yangtze Rivers, the 1,500-year precipitation over eastern China, seasonal precipitation, and the length of rainy-season induced from the East Asian Summer Monsoon intensity in the middle and lower reaches of the Yellow River and the middle and lower reaches of the Yangtze River (the Mei-Yu events) for the past 300 years. Spatial and temporal patterns of climate variations, in particular the extremes, were identified and analyzed. The coherence of temperature reconstructions from historical documents in China by different studies was also addressed in this overview.

Moreover, by using 23 recently published proxy temperature series (derived from historical documents, tree rings, stalagmites, ice core, and lake sediments with annual to decadal resolutions) over China, the uncertainties and regional differences of temperature reconstructions during the past 2000 years in China were assessed. Results indicated that, although large uncertainties are found for the period prior to the 16th century, high levels of consistency were identified in all regions during the recent 500-years, highlighted by the two cold periods during the 1620s–1710s and 1800s–1860s, and the warming during the 20th century. The latter first started in the Tibetan Plateau, Northwest and Northeast China, and then migrated to Central East and Southeast China. Our analyses also indicate that the warming during the 10–14th centuries in some regions might be comparable in magnitude to the warming of the last few decades of the 20th century, which was unprecedented within the past 500 years.

Keywords: climatic change, past 2000 years, China, proxy data

Reconstruction of past precipitation in the northwestern China using archive data of Qing dynasty

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A group of official reports were found from archives of Qing dynasty (1694-1911) in The First Historical Archives of China. They included daily data of depths of wet-fronts observed after precipitation events. The reports were made by city governor-generals and governors under the command of the Qing Emperor. If these depths could be successfully converted, precipitation pattern of more than 80 cities can be reconstructed for the period of nearly 200 years in the 18th and 19th century.

For validating relation between depths of wet-fronts and amount of precipitation, a set of artificial precipitation tests were conducted in 6 different locations in the Heihe River Basin in the northwestern China in 2008. A simple relation was found between precipitation depths and depths of wet-fronts across different types of light textured soils (except for crust-forming soils) when antecedent soil moisture was low. Under these conditions, apparent wet-front depths did not change largely even 12 hours after the precipitation event, proving the robustness of the ancient observation method. For the case of successive precipitation events with high antecedent soil moisture, wet-front development was more dependent on a preceding condition.

The reconstructed past precipitation data were then compared to present daily precipitation datasets provided by APHRODITE. Reliability of reconstructed past precipitation was low for high time-resolution analysis due to inconsistency of measurements. Mean monthly precipitation calculated from reconstructed data (1749-1849) was higher than mean monthly precipitation of the present years (1980-2004) in majority of cities.

Climate reconstruction in Japan based on historical documents

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Reconstruction of past climate conditions using instrumental and proxy data have been made by numerous studies. As the official meteorological observation network by the Japan meteorological Agency was established in the 1870s in Japan, proxy data are essential for the climate reconstruction before the foundation. Japanese old diary, which includes daily weather descriptions mainly for the Edo period (the 17th and the 19th century), is a one of potentially useful proxy data. Most of the weather descriptions have been coded into the Database by Japanese climatologists. There are a variety of reconstruction studies based on daily weather descriptions, such as seasonal temperature, length of Baiu, global solar radiation, and synoptic weather pattern.

Recently instrumental weather records from several locations over Japan covering the 19th century, which is a period where no instrumental data in Japan were believed to exist, were recovered. The recovered data extend the start of the instrumental series back from 1872 to 1819. The temperature and pressure readings in the recovered documents were converted to modern units and digitized into computer readable form. The pressures were corrected for temperature, height, and gravity where needed. The temperatures were homogenized according to the various changes in location heights. Then, homogenization for various observation schedules was also taken into account. The corrected and homogenized data were shown to be reasonable in terms of comparison with modern data and the homogeneity test. These temperatures of July and January also showed the good agreements with the reconstructed temperatures from the old diaries.

The recovered instrumental data were used for a preliminary calculation of a West Japan Temperature series, a representative temperature series for the area. The results support evidence for the existence of a warm epoch in the 1850s in west Japan followed by a downward temperature trend that lasted until the early 20th century as previously inferred from documentary data.

Synchronized Northern Hemisphere climate change and solar magnetic cycles during the Maunder Minimum

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The Maunder Minimum (1645-1715 AD) is a useful period to investigate possible sun-climate linkages as sunspots became exceedingly rare and the characteristics of solar cycles were different from those of today. Here, we report annual variations in the oxygen isotopic composition ($\delta^{18}\text{O}$) of tree-ring cellulose in central Japan during the Maunder Minimum. We were able to explore possible sun-climate connections through high-temporal-resolution solar activity (radiocarbon contents; $\Delta^{14}\text{C}$) and climate ($\delta^{18}\text{O}$) isotope records derived from annual tree rings. The tree-ring $\delta^{18}\text{O}$ record in Japan shows distinct negative $\delta^{18}\text{O}$ spikes (wetter rainy seasons) coinciding with rapid cooling in Greenland and with decreases in Northern Hemisphere mean temperature at around minima of decadal solar cycles. We have determined that the climate signals in all three records strongly correlate with changes in the polarity of solar dipole magnetic field, suggesting a causal link to Galactic Cosmic Rays (GCRs). These findings are further supported by a comparison between the inter-annual patterns of tree-ring $\delta^{18}\text{O}$ record and the GCR flux reconstructed by an ice-core ^{10}Be record. Therefore, the variation of GCR flux associated with the multi-decadal cycles of solar magnetic field seem to be causally related to the significant and widespread climate changes at least during the Maunder Minimum.

Keywords: Maunder Minimum, solar cycle, cosmic ray, tree ring, isotope

Comparison between tree-ring data of Sungkai (*Peronema canescens*) and meteorological data from West Java, Indonesia

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In this study, in order to assess the reliability of various parameters in tree-rings as climate proxies, we performed a systematic comparison between temporal variation of meteorological data (precipitation, relative humidity and hours of sunlight) and those of four parameters (ring width, mean vessel area of earlywood, $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) in tree-rings collected from Java Island, Indonesia.

The analyzed sample is Sungkai (*Peronema canescens* Jack), which is very intimate with teak. It was collected from a site in Serang, West Java, Indonesia. Precipitation records from Serang show a large seasonal cycle, which oscillated between a dry season (around May to October) and a wet season (November to April). Seasonal cycle forms annual growth rings in Sungkai. The sample was cut down in December of 2004 and was observed 25 of tree-ring, showing that its growth spanned the interval from 1980 to 2004. We investigated the correlations between four parameters of tree-rings and climate parameters during 1988-2004, because the growth rate before 1987 is higher than latter rate.

The result of ring width shows a good positive correlation with the precipitation in the last dry season, just like teak as shown in D'Arrigo et al. (1994). Ring width also correlated with relative humidity and hours of sunlight in last dry season. The mean vessel area of earlywood shows significant correlations with relative humidity and hours of sunlight for rainy season (growth period). Furthermore, the results of stable isotopic ratios of alpha-cellulose sample, which is divided each ring into three parts (earlywood, inner latewood and outer latewood), $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ vary from 22‰ to 28‰ and from -28‰ to -24‰, respectively. The results of $\delta^{13}\text{C}$ show distinct annual cycle, which values of earlywood are highest and followed by decrease during the remainder. There is no significant correlation between $\delta^{13}\text{C}$ values and meteorological data. On the other hand, annual averaged $\delta^{18}\text{O}$ records show a negative correlation with relative humidity in rainy season, although the variation has no typical seasonal pattern. Our results is consistent with the model of Farquhar and Lloyd (1993), which illustrated that $\delta^{18}\text{O}$ values of alpha-cellulose are influenced by relative humidity and there are negative correlations between both.

As described above, it is highly likely that Sungkai is also available for paleoclimate reconstruction. Although only one sample has been investigated in this study, the reliability of proxies needs to be further verified by additional data from other Sungkai samples in this region.

Keywords: dendroclimatology, tree-ring, Indonesia, stable isotopes

Climatic implications of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ variations in a Japanese cedar on Yakushima Island

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At the present day, there are many paleoclimate reconstructions by proxies and the reconstructions over the last 2000 years are reconstructed by mainly tree-ring width. However a detailed growth mechanism of tree-ring width is not revealed and there are some problems like divergence effect. In this study, tree-ring $\delta^{13}\text{C}$, $\delta^{18}\text{O}$ and tree-ring width of Japanese cedar (*Cryptomeria japonica*) in Yakushima Island from AD300 to AD432 were measured annually. The variability of the $\delta^{18}\text{O}$ of Japanese cedar (*Cryptomeria japonica*) in Yakushima Island from AD300 to AD432 is 6.9‰. The variabilities of the $\delta^{18}\text{O}$ of other Japanese cedars in Yakushima Island from AD1950 to AD2010 are from 7.5~9.9‰. The variability of the $\delta^{18}\text{O}$ of Japanese cedar in central Japan from AD1612 to AD1756 is about 4.7‰ (Yamaguchi, in prep). The variations of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ have shown clear periodicities. $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ has 44, 13 and 8 year cycles and 44, 22, 16 and 13 year cycles, respectively. These periodicities of tree ring $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ may have some relations with climate change.

Keywords: carbon isotope, oxygen isotope, Yakushima island

Tree-ring $\delta^{18}\text{O}$ variation since the 18th century and its comparison to instrumental and historical climatic records in Lake Biwa area, Japan

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Tree-ring and historical documentary records have been studied aiming at estimating climatic and hydrologic environments in historical times in the Lake Biwa area, central Japan. We measured stable oxygen isotope composition ($\delta^{18}\text{O}$) of tree-ring cellulose of a Japanese cypress (*Chamaecyparis obtusa* Endl.) tree collected from the Mt. Tanakami site (34°55'N, 135°59'E) for 1724–1993 (270 rings). Correlation coefficients were calculated between the $\delta^{18}\text{O}$ values of tree rings and monthly climatic data at the nearest stations for the instrumental observation period. Climatic factors considered include monthly mean temperature, precipitation, relative humidity, sunshine duration, and number of precipitation days. As results, the $\delta^{18}\text{O}$ value was found to be strongly correlated with mean relative humidity in June ($r=-0.70$). Statistically significant ($p<0.05$) correlation with precipitation in June ($r=-0.39$) and number of precipitation days in June ($r=-0.27$) was also found. We attempted to reconstruct the long-term variation of relative humidity in June and the beginning date of the Baiu rainy season based on regression analysis.

Moreover, we obtained chronologies of the number of precipitation days and PI (Precipitation Index) in June using daily weather records from 8 historical diaries from the Lake Biwa area spanning 1731–1912. Here PI is defined as the summation of the number of precipitation days with the weights of 'light rain': '(ordinary) rain': 'heavy rain'=1:2:5. Both chronologies were compared with the tree-ring $\delta^{18}\text{O}$ chronology and the possibility of multi-proxy approach to improve reliability of climatic reconstruction was explored.

Keywords: tree-ring $\delta^{18}\text{O}$, *Chamaecyparis obtusa*, Lake Biwa area, historical weather records

The review on the inter-space-correlation and the inter-species' correlation among the tree ring growth curves used for the cross-dating in Japan in connecting with the other paleo-climate materials

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I. Introduction

On the paleoclimatic reconstruction and a period decision, it is necessary to accomplish on the area representativeness and to review whether the correlation among the areas and the correlation among the treespecies are intentional.. Also, we attempted to consider about the reliability only in the tree- ring for deciding the absolute year and for reconstructing the paleoclimatic and more to consider the relation and the continuity with paleo-climate material..

II. About the correlations among the sampling spots and among the tree species of the tree ring growth

On this problem, Noda,M.(1993) manifested that as for the Japanese cypress in 7 prefectures such as Mie Prefecture, Wakayama Prefecture and Nagano Prefecture the confidence limit distance among the spots is 371 km from the result of the correlative analysis, while it is verified that the cryptomeria in Tokushima Prefecture and Gifu Prefecture and so on has close connection between the spot interval of 248km, and that the interval of the difference treespecies such as Japanese cypress and the cryptomeria is 362km.

By Mitsutani's paper " Decifering Ancient from the tree ring" (1989), he analyzed the correlations among five Japanese cypresses of Nagano, Gifu, Wakayama and Kouchi Prefs.,and he also analyzed the correlations among the difference treespecies such as Japanese cypress Spanish mackerel hiba arborvitae umbrella pine in Nagano Prefecture. A significant correlation- between the Japanese cypress in Kiso and Yakujima's cryptomeria is shown in figure. It was clarified that the change of the Japanese cypress cryptomeria in Kouchi is similar to the tree ring pattern of Yakujima cryptomeria about 450 km away from.

The authors attempted to analized the correlations among the areas using figure 2 with the maximum density of the conifer tree ring in Northern hemisphere which Schweingruber (1989) introduced.

The result is shown in correlation matrix by attempting to compute correlations among the spots 1750 since then about 7 spots excepting central Siberia with little number of years. The correlation is good for the tree ring in the U.S.A. State of Maine with Spain but there is little correlation in the others. Not to be correlated and that the tree ring in Scotland is near any spot (the country) completely attract attention.

As for South Alps, the correlation is high respectively with the main U.S., northern Carpatian, South Alps and Nepal about Norway, northern Carpatian, Nepal and Spain. The thing with interest is the fact that there is high correlation among 3 spots in Europe with Nepal. It is noteworthy that the high correlation with Nepal in the distant place makes suggest Koppen's climatic division.

III. Possibility of cross-dating of the tree ring growth and the other paleo- climate material

The authors think it necessary to contrast with the tree ring and the other paleo climate material, e.g. the old diary record, and Omiwatari's ceremony record, the icehouse record and so on from the such meaning. The records of the Omiwatari during Middle Ages is gotten but , it is unclear in the ancient times.

As for the icehouse, the historical records are available and moreover recording an ancient icehouse in Nara era, too, around the little-ice-age in Edo, too, and the record of the icehouse at 800 m altitude Kochi Prefecture Mt. Tebako and icehouse-shrine in Heijokyo and so on become useful.

Increasing aridity over the past 223 years in the Nepal Himalaya inferred from a tree-ring $\delta^{18}\text{O}$ chronology

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A tree-ring $\delta^{18}\text{O}$ chronology of *Abies spectabilis* from the Nepal Himalaya was established to study hydroclimate in the summer monsoon season over the past 223 years (AD 1778–2000). A total of 46 cores were collected from 23 individual trees growing in an open *A. spectabilis* stand near the tree line of 3850 masl in Humla District, western Nepal. Cross-dating was performed by matching ring-width variations for all cores to determine the absolute year of each ring. Of the 40 cores precisely dated, 10 cores from 5 trees were pooled for each year to obtain representative stable isotope records at the site. Response analysis with ambient climatic records revealed that tree-ring $\delta^{18}\text{O}$ was primarily controlled by the amount of rainfall during the monsoon season (June–September). Since tree-ring $\delta^{18}\text{O}$ was simultaneously correlated with temperature, drought history in the monsoon season was reconstructed by calibrating against the Palmer Drought Severity Index (PDSI). Our reconstruction that accounts for 33.7% of the PDSI variance shows a decreasing trend of moisture over the past two centuries, and is consistent with reduction in monsoon precipitation recorded in Himalayan ice-core records. Spatial correlation analysis with global sea surface temperatures suggests that the tropical oceans play a role in modulating hydroclimate in the Nepal Himalaya.

Keywords: Dendrochronology, oxygen isotopes, climate reconstruction, summer monsoon

Development of ring-width and maximum-density chronologies of Yaku-sugi (*Cryptomeria japonica*)

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Dendroclimatic potentials of ring width and maximum density chronologies of Yaku-sugi (*Cryptomeria japonica*), which is known as one of oldest trees in Japan, were examined. A total of 211 cores were taken from 93 living trees at three sites located northern, southern and western slopes of the island. Cores or disks were taken from ancient logs cut several hundreds years before to extend the chronologies. A large number of missing rings and wedging rings were found through cross-dating procedure. About two thirds cores from living trees were cross-dated. Three ring width chronologies and two maximum density chronologies of 251 to 1011 years were developed. Both ring width and maximum density chronologies revealed significant correlations among the sites. A part of cores from ancient logs were also cross-dated. The analyses on climatic responses revealed that both ring width chronologies and maximum density chronologies at the all sites correlated positively with sunshine duration of the growing season. The transfer function for reconstruction of sunshine duration from May to June was successfully statistically verified by a standard dendroclimatological technique. The researches suggest that the potential utility of tree rings of Yaku-sugi for reconstruction of Monsoon for past thousands years.

Differences in climatic responses of tree-ring widths and densities of Japanese beech growing in various sites in Japan

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The climatic responses of radial growth of Japanese beech (*Fagus crenata*), which is the main tree species for deciduous broad leaf forest in Japan, were examined at 10 sites located from northern to southern distribution area in Japan. Cores or disks were taken from 8 to 45 trees per sites. Ring width, mean density and maximum density were measured by X-ray densitometry. Both Ring widths and mean densities were positively correlated with summer temperature at the cooler sites (according to Kira's warmth index) whereas no correlation was observed at the warmer sites. Maximum densities were positively correlated with summer temperature except for Shiiba, the southern distribution limit. The results indicate that forecasted increase in temperature might not inhibit the radial growth of Japanese beech even though they grow at southern distribution limit. The results also indicate that both ring width and maximum density are useful for reconstruction of past summer temperature at cooler sites.

Hydroclimate variability in North China and its link with ENSO: insights from tree-ring cellulose $\delta^{18}\text{O}$

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We present here a tree-ring cellulose $\delta^{18}\text{O}$ chronology from 1675 to 2003, based on five cross-dated tree-ring cores of *Larix principis-rupprechtii* in North China (34-41° N, 107-120° E). The chronology is significantly negative correlation with summer hydroclimate parameters (precipitation, relative humidity and Palmer Drought Severity Index). Incorporating with the physiological mechanism and spatial correlation analysis, this tree-ring cellulose $\delta^{18}\text{O}$ chronology shows a high representative on reflecting regional hydroclimate variability in large area of North China. It is the longest high-resolution chronology of hydroclimate variability based on natural proxy in North China until now. The chronology indicates a long-term drying trend, especial for last half century, in North China. The high-frequency and low-frequency signals are consistent with the extreme climate events, drought frequency and dryness/wetness index derived from historical documents. In addition, significantly spatial correlation between the chronology and equatorial east Pacific Sea Surface Temperature (SST) suggests a close link between hydroclimate in North China and El Niño-South Oscillation (ENSO). Furthermore, comparison between the chronology and several reconstructed ENSO indices illuminates that the influence of ENSO on hydroclimate in North China is similar with the recent observation, and stationary in most time of past 329 years, excepting for such transitory regime shifts as 1750s-1770s, 1800s-1830s, 1850s and 1900s.

Detailed climate change in the late Holocene deduced from total organic carbon content of the lake sediments, central Japan

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Total organic carbon (TOC) contents of lake sediments have been measured at the several lakes from central Japan, namely, Lakes Nojiri, Aoki, Nakatsuna, Kizaki and Biwa, for the last several thousands to a few tens thousands years. The stratigraphic changes of TOC content were correlated and were compared each other by means of tephrochronology, ^{14}C radiometric dating, and normalization of TOC contents. Temporal changes of the normalized TOC contents in the lake sediments have similar patterns.

TOC content varies concordantly with vegetation changes revealed by detailed pollen analysis in the Lake Nojiri. TOC contents of the recent 21 years show a positive relationship with winter temperature as shown in a case study of Lake Kizaki. Therefore, the temporal variation of the normalized TOC recognized commonly in the lakes can be regarded as a proxy of temperature prevailed in central Japan, which had controlled biological productivity in lake water.

The paleoclimate can be reconstructed as follows on the basis of TOC proxy. The climate of the Last Glacial Maximum had been continued until around 20 ka and a slight warming started at that time, associated with large climatic variations. Distinct warming started in 15 ka, and the warming became to its peak in 12 to 11 ka for a short time, followed by a slight cool climate in 10 - 8 ka. Relatively-stable warm climate had prevailed around 7 - 6 ka, namely Hypsithermal time, and it became gradually cool toward the recent. On the way, the relatively-warm terms were found around 3 and 1 ka, and cool periods are found around 2 and 0.3 ka. TOC increases rapidly in the last 100 years. These climatic features have a good concordance with $\delta^{18}\text{O}$ changes in the stalagmites from Dongge Cave in China, which were affected by the Asian monsoon activity.

Keywords; total organic carbon, lake sediment, late Holocene, Lake Biwa, Lake Nojiri

Past 2000 years Paleoenvironmental changes in core sediments of Nakaumi Lagoon, Southwest Japan. – Correlation with solar activity and anthropogenic changes –

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The environment in the brackish-water lake changes by the modification of the artificial landform and landscape evolution with the eustatic change of sea level. The lake water environment in Nakaumi Lagoon, Southwest Japan, has been receiving large effect by the man-made change and landscape evolution. In this study, paleoenvironment change for the past 2000 years is discussed by sedimentologic and geochemical high-resolution analysis of 3 cores collected from Nakaumi Lagoon. This lagoon is located in the Sea of Japan side in the southwest Japan, and is a brackish-water lake of about 86 square kilometer.

Three cores are the length of 3.5~4m, and consist of mud with shell fragment in most horizon. The sample in the 1cm interval are collected from these cores, and carried out the grain size analysis, C, N, S element analyses, etc.

In N1 core, total organic carbon (TOC) contents show the peak (*ca* 3.5%) at the horizon of 380cm, and step-down upward. TOC content shows the lowest value (*ca* 1.5%) at the horizon of 30~40cm. TOC contents increase upward above this horizon. The similar changes of TOC contents are recognized in other core. Total Sulfur (TS) contents show the similar changes with TOC contents. The horizon of TOC peak at 380cm (BC200) in N1 core indicates the most reduced environment judging from TS contents. This is suggested that the closure area (Nakaumi Lagoon) formed by the evolution of the sand bar (Yumigahama Beach). After that, TOC contents decrease by the development of the water circulation system, shallowing for aggradations and increasing of sedimentation rate, and the habitat of the marine organism formed in Nakaumi Lagoon.

Mean grain size fluctuates the range of 6.5~8.0 phi, and show around 7.5 phi in most sample. Mean grain size in N2 core tends to coarsen above the horizon of 70cm. The excursion of mean grain size in N2 core is suggested by the channel change of Iinashi River at AD1665. The distinguished excursion of mean grain size above the horizon of 40cm may have indicated the artificial channel change of Iinashi River at AD1840. The fluctuation of mean grain size in N1 core is similar to the fluctuation of delta-14C. The fluctuation of mean grain size may be indicated climatic change by solar activity.

Keywords: Nakaumi Lagoon, solar activity, anthropogenic change, chemical components

Effects of human activities on the Lagoons along the Okhotsk coast during the last centuries

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Sediment samples from the lagoons along the Okhotsk coast (lakes Saroma, Notoro, and Mokoto) were obtained for the purpose of evaluating anthropogenic effect on the lagoon environmental changes. The lagoon environment and ecology are influenced by not only the internal load, e.g., cultured load, but also the external load, e.g., nutrient input and topographic change. Nature of the east Hokkaido has been changed after the Edo period by the land development. The environment and ecology of the Okhotsk coast lagoons should be affected by this land development. It is remarkable in the lake Mokoto. Based on the XRF analysis of sediment core in the lake Mokoto (09Mk-1C core), the wt% of K₂O and P₂O₅ were clearly increased at the 100 cm depth (about 100 year ago). At the same time, the color of this core also shifts to black, and the lamina layer became clear. These changes indicate that the lake Mokoto was eutrophicated and the bottom layer became the anoxic condition due to the nutrient input as the fertilizer input and/or sediment discharge during the last 100 year. Similar trend was appeared in the results of sediment core obtained from the lake Saroma (05SA-2b core). Since the late 19 century, anoxic condition of bottom layer in the lake Saroma probably spread caused by the sediment discharge from the catchment area according to the changes of diatom assemblages and sand content. However, in case of the lake Saroma, this low-oxygen water in the basins of the lake began to disappear by the first inlet excavation at 1929. The inlet excavation led to obvious shift in the water quality and vegetations in addition to the bottom condition change. Unfortunately, the lacustrine environment of bottom sediments resumes deterioration 20 years after since the first artificial excavation. The inlet excavation was also carried out in the lake Notoro in 1973. According to the chemical component analysis of cores from the lake Notoro, the lacustrine environment was improved after the excavation. However, like the lake Saroma, the bottom condition of the lake Notoro also resumes deterioration recently.

Keywords: Lagoon environments, anthropogenic effect, Okhotsk coast, diatoms, chemical components

Possibility of the fluctuation of freshwater reservoir effect at Lake Biwa from Jomon period to the present days

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We measured the radiocarbon ages of the samples such as molluscan shells, Phragmites and pine leaves collected after 1966 year at Lake Biwa to examine the possibility of freshwater reservoir effects at Lake Biwa. The molluscan shells collected after 1990 year, were hardly affected from the nuclear bomb test, showed 330 – 450 ¹⁴C yrs older radiocarbon ages than that of the coeval atmosphere. Then, the radiocarbon age difference between the shell fossils and wood samples excavated from the Awazu submarine shell midden (~300 ¹⁴C yrs) suggests that the freshwater reservoir effect manifested in the Middle Jomon period at Lake Biwa. Because the present-day average residence time of Lake Biwa water is less than a decade, its direct influence on the reservoir effect is small, which suggests that old carbon has been supplied into Lake Biwa. The both age offsets strongly indicate that there were likely to be freshwater reservoir effects at Lake Biwa for about 5000 years.

A great deal of organic matter has flowed into Lake Biwa. Some very old radiocarbon ages can result from retention of old carbon in peat layers formed by plants such as the ditch reeds that grow along the shore of Lake Biwa. This may have been the result of the inflow of aged subsurface waters that may have dissolved old carbon from the carbonate rocks of Mt. Ibuki and Mt. Ryouzen. Therefore the degree of freshwater reservoir effects at Lake Biwa had a possibility to fluctuate, depending on change of the lake environment such as inflow into the lake and circulation of the lake water.

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Keywords: Freshwater reservoir effect, Lake Biwa

Late Holocene variability of the Asian monsoon : Reconstruction from sediment cores obtained from Lake Rara, western Nepal

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The Asian monsoon is an important component of the Earth's climate system that influences the societal and economic activity of roughly half the world's population (Yancheva et al., 2007). The main driver of large-scale monsoon change over the past 10,000 years has been thought as a slow decrease in summer-time solar radiation (insolation) at 30° N owing to changes in Earth's orbit. However, some monsoon records show abrupt and/ or stepwise changes in shorter timescale (Overpeck et al., 2007).

Understanding mechanisms of monsoon required high-resolution paleoclimate records. Potential mechanism controlling monsoon changes was proposed previously. Geochemical analyses of a maar sediments revealed that there has been inversely correlated between summer and winter monsoons during the Bølling-Allerød, the Younger Dryas, and the early Holocene and was attributed as the movement of ITCZ (Yancheva et al., 2007). However, these relations are not evident from the maar sediments during the late Holocene.

Here we present a new sediment core record from Lake Rara, western Nepal (82°05'E, 29°32'N). Lake Rara today is located at 3,000m above sea level and has a maximum water depth of 168m. The age model of the sediment core is based on AMS 14C dating on organic materials. Concentrations of major elements were measured by X-ray Fluorescence Analysis (XRF). Intensity of chemical weathering in the catchment area was reconstructed by geochemical indexes such as CIA (chemical index of alternation). Bottom-water redox condition was also reconstructed by Mn/Al ratio. Based on the results, we will discuss evolution and variability of the Asian monsoon during the late Holocene.

Yancheva, G. et al., *Nature* 445, 74-77 (2007)

Overpeck, J.T. et al., *Nature* 445, 270-271 (2007)

Geochemical analysis of lacustrine sediments of the Balkhash Lake and its implication for paleoclimate changes during the late Holocene

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Balkhash Lake is one of the largest terminal lakes with huge hemi arid basin located in the heart of the Asian Continent. The lake sediments potentially have recorded lake level changes reflecting changes of Holocene climate systems in and around the Asian Continent. But except for Endo et al (2009) and Chiba et al (2010) who analyzed 2007 core, we know little about the Holocene history of Balkhash Lake by contrast with recent advances in understanding the late Holocene history of the Aral Sea region (e.g. Boomer et al., 2009).

In 2009 we successively obtained six sediment cores up to 6 m long at four different sites in the eastern part of Balkhash Lake. We report tentative results of the geochemical analysis using high-resolution (100µm) X-ray fluorescence (XRF) instrument focusing on the longest two cores of 200901 (5.67 m long) and 200902 (5.8 m long) obtained at the deepest site (water depth of 21 m) in the Lake, and at the midpoint (water depth of 20 m) between the 200901 site above and the mouth of the Lepsi River, respectively; the horizontal distance from the mouth of the Lepsi River to 200901 (proximal) core site, and that from the 200901 to 200902 (distal) core site are about 20 km. The Lepsi River is the third largest river in the Balkhash lake catchment developing a delta system with steep slope of almost 1 per mill, and it has mid Holocene and late Pleistocene terrace levels and has mountain glaciers at the upper most reaches.

Both 200901 and 02 cores can be divided into three main sedimentary units of A (upper), B (middle) and C (lower); The thickness of unit A and B are about 1.1 and 2.9 meters in 200901 core, and 2.0 and 3.0 meters in 200902 core, respectively. Both unit A and C are characterized by massive whitish clayey sediments which are rich in ostracod and show high Ca counts, while unit B by partly laminated sediments containing relatively low Ca (high Fe and Si) counts. Unit B contains thick (a few ten cm) sand layer with a considerable number of plant and gastropod fragments, two of which at the depth of around 2.8 m in 200901 core dated by AMS ¹⁴C methods show the age of 4512 cal BP and 4684 cal BP. Grain size of the sand layer in 200901 core is coarser than that in 200902 core. The micro laminated structure observed in unit B of 200901 core is concordant with alternation of Ca and Fe peaks, probably reflecting seasonal flood layers. Unit B of 200902 core contains selenite (gypsum) enriched layer at the depth of around 3.6 m. To summarize during early to middle Holocene (from unit A to B), salinity and fluvial input increased and during the late Holocene (unit C) the reverse changes occurred under the strong influence of the lake level changes. Micro XRF analysis coupled with micro palaeontological investigation such as diatom and ostracod analysis along with dense AMS ¹⁴C dating of 2009 cores will provide high-resolution Holocene climatic record of the Balkhash Lake region.

Keywords: Balkhash Lake, Lake sediments, Micro X-ray fluorescence (XRF) analysis, Lake level changes, Kazakhstan

The lake-level changes in Central Asia during the last 1000 years based on historical map

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This study used historical maps and Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) data, to reconstruct the levels of three lakes (the Aral Sea, Lake Issyk-Kul, Lake Balkhash) and investigate environmental changes in Central Asia during the past few centuries. The historical maps made in the 17th through 19th centuries, described the territory and its inhabitants in the English, Russian, Mongolian, Manchu, and Chinese languages. These maps document several differences in lake shorelines, rivers, pastures and fields, residents, and geographical names, compared with the present situation. Historical maps show that the level of Lake Issyk-Kul was 14 m higher than at present during the 17th through mid-19th centuries, when the Chu River was connected to the lake. The Aral Sea and Lake Balkhash also expanded in this period. In contrast, the Aral Sea experienced a drastic decline in lake level during the 12-13th centuries. The increasing level of Lake Issyk-Kul has overtaken nearby 10th to 12th century settlements at the present. Proxy data from tree rings (summer temperatures), ice cores (snow accumulation), glacier variations, soil development, and historical documents indicate that the drastic lake-level declines in the 13th century occurred in a cold, dry environment, whereas the 17th to mid-19th century lake-level increases occurred in the cold, wet conditions during the Little Ice Age. The lake level change under cold climate was caused by changes in precipitation due to lower evaporation and glacial melt rates.

Keywords: Central Asia, proxy data, old map, lake level change, glacier changes, tree-ring data

Age of low lake level stages during the last 2000 years, inferred from diatom analysis in Balkhash Lake, Central Asia

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In arid areas of Central Asia, drying up and water shortage are serious problems. Also the arid areas are sources of aeolian dust. Those problems are caused by changes in water balance, for example, rainfall, evapotranspiration, infiltration, storage, runoff and fluctuation of ice volume in mountain areas. Therefore, environmental changes in arid areas have huge effects on the environment in Central to East Asia. Accordingly, it is important that we discuss changes in water balance in order to reveal environmental changes in the arid areas.

Balkhash Lake is the huge shallow closed lake in Kazakhstan, Central Asia. The bottom sediment is composed of clay and abundant microfossils. The sediment core sample of Balkhash Lake must preserve records of paleoenvironmental changes not only in regional Ili river basin but also in the wide Central Asia.

In order to reconstruct lake level changes in Balkhash Lake, the 2007 core was taken in the west part of the lake and such analyses were carried out, as fossil diatom and ostracod, geochemistry and grain size. Age control of the core is based on Cs-137 for the uppermost part and radiocarbon ages of fossil ostracods from the core. Those provide an age-depth model during the last 2000 years.

Diatom analysis shows mainly two different types of assemblages. One is characterized by dominance of freshwater planktonic species (e. g. *Aulacoseira granulata*), and another is dominated by saline planktonic (e. g. *Thalassiosira lacustris*), saline benthic species (e. g. *Rhopalodia gibba*) and freshwater benthic species (e. g. *Amphora ovalis*) of diatom. The first one suggests higher lake level, and the second one suggests lower lake level, as same interpretation as Stoermer and Smol (1999). Moreover, these assemblages changes are consistent with the observatory records of lake level during the last 100 years. According to the occurrence of these assemblages, the core shows six high lake level stages being dominant in freshwater planktonic species and seven low level stages dominant in saline planktonic species, saline benthic species and freshwater benthic species in the last 2000 years. Moreover, high proportion of fossil ostracoda corresponds to each low level phase. Also, the correlation was recognized between fossil brackish ostracod number (n/g) and relative abundance of saline planktonic and benthic diatoms. Those low level stages, as around 200AD are consistent with the lake level changes in Aral sea chiefly inferred from changes of fossil dinoflagellates assemblages (Sorrel et al., 2006). On the low lake level events around 200 AD, some topographic evidences are observed along the shore of Balkhash lake, and gypsum crystal-rich horizon is found in Aral Sea core (Boroffka et al., 2009). In the lake level change during the last 100 years, diatom assemblages after 1970 are different from the assemblage before 1970. Particularly, *Tryblionella complexa* is observed in the last 30 years. It suggests the influence of human activities including land use (Kubota, 2005) and effects of construction of the Kapchagai dam.

Keywords: Central Asia, Balkhash Lake, Lake level change, Diatom analysis

Circulation effect: Climatic significance of the short term variability of the oxygen isotopes in stalagmites from monsoonal China

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According to recent research, Late Holocene stalagmite oxygen isotope sequences from the same cave or the same region situated in the monsoon zones of China have good reproducibility, which is indicative of a common short-term signal. Also oxygen isotope records from different regions, often located thousands of kilometers apart, are found to possess similar fluctuations on decadal to century scales, indicating that they share the same large scale signal. However, most of these records can not be calibrated with local observed precipitation or temperature data. Comparing with various types of monsoon index represented by Chinese climatologists, the author has found that the common signal embedded within these stalagmite oxygen isotope sequences has a strong correlation with the sea level pressure difference or the index of temperature difference between the land and the sea.

By comparing the sea-level pressure difference of the Indian - Pacific Ocean, as well as the many ocean-atmosphere general circulation observations, with the stalagmite oxygen isotope sequences from the monsoonal area of China, the isotopic variations are found to correspond to the abrupt change in the average of the air-sea decadal circulation in the late 20th century. This confirms that the short-term changes in the stalagmite oxygen isotopes from Monsoon zones in China have significance for understanding changes in atmospheric circulation.

When the temperature of the Indian Ocean and the Middle East Pacific is low, the West Pacific subtropical high becomes weak, and retreats northeastward. In this period, Monsoonal China is mainly controlled by the tropical monsoon trough i.e. the Intertropical Convergence Zone (ITCZ). The water vapor from the Southern Indian Ocean increases, which results in the lighter oxygen isotope in the precipitation, and subsequently in the stalagmite, because of the long trajectory associated with the water vapor. When the temperature of the sea water of the Indian Ocean and the middle-east Pacific is high, the Western Pacific subtropical high becomes strong and subsequently extends southwestward. The Chinese monsoon zone is then controlled by the Meiyu front, which results in the reduction of the water vapor from the Indian Ocean. In contrast, the water vapor from the Western Pacific, which is near Monsoonal China, increases. This implies that the heavier isotopic composition of the precipitation, due to the short transmission distance, is found in the stalagmite oxygen isotope record. Therefore, the author suggests that the changes in the stalagmite oxygen isotope records are due to the Chinese monsoon "circulation effect", which agrees with the Rayleigh fractionation principle and reflects the changes in the Indian / Pacific Ocean circulation.

The paradox of China's monsoon climate during the 1920s and 1930s: Fact, mechanism, and probable cause

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The analysis of data from numerous observation stations and the upper troposphere since 1951 has led climatologists to conclude that strong (weak) East Asian summer monsoons are associated with wet (dry) conditions in North China and dry (wet) conditions in the midstream and downstream portions of the Changjiang (Yangtze River). This has become a classic cognition pattern for summer rainfall distribution in the different monsoonal regions of China. During the 1920s to 1930s, however, an interannual to decadal drought in North and Northwest China coincided with the strongest East Asia summer monsoon of the 20th century. Abundant evidence including records from meteorological stations, historical documents, and tree ring data observed in the northeastern Qinghai-Tibet plateau, central Inner Mongolia, and Guanzhong region support the occurrence of the drought event. On the other hand, both of the East Asian summer monsoon indices reconstructed by Guo et al. and Shi et al. include the 1920s indicate that the highest sea-level atmospheric pressures occurred in the 1920s to 1930s (i.e., this was the period with the strongest East Asian summer monsoon). Though the results vary somewhat from the evaluation report of IPCC-2007 evaluation report, all the indices indicate that the strongest East Asian summer monsoon for the past century occurred in the 1920s.

Therefore, the synchronicity of these two apparently contradictory events, leads to what we call a “climatic paradox.” Our analysis shows that an important mechanism of summer rainfall formation in the monsoon climate region of China is the confluence of the dry, cold air from the north and wet, warm air from the south. This indicates that unlike the drought of the 1980s and 1990s, which was attributable to a weak summer monsoon, the drought mechanism in North China during the 1920s and 1930s was the lack of the cold northern air under the strong summer monsoon. We thus infer that a strong summer monsoon alone is not sufficient to create high rainfall conditions in North China, deepening our understanding of both the modern monsoon as well as paleomonsoon research.

The analytical results presented in this paper may challenge the basic concept of paleoclimate in North China (even whole China), which accepts that strong summer monsoons correlate to warm and wet conditions in the monsoon region. The examination of climatic paradoxes, such as the one described in this paper, provide additional means of understanding climate, both in the past and in the present.

Paleoclimatological Study using Stalagmite from Java Island, Indonesia

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In the last decade, decoding geochemical records in stalagmites has been widely recognized as a powerful tool for the elucidation of paleoclimate/environment of the terrestrial areas. The previous data are mainly reported from areas that are located in middle latitude. However, our project aims at reconstructing past climate variations in the Asian equatorial regions by using geochemical proxies recorded in Indonesian stalagmite.

It is critical that we reconstruct tropical climate variability over the last several centuries because the tropics appear to play an important role in global climate (Garreaud and Battisti, 1999; Linsley et al., 2000; Evans et al., 2001). In order to reconstruct ancient precipitation for the tropics, we performed the systematic comparison between temporal variation in precipitation and those in stable isotopic ratios (i.e., $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) of a stalagmite, which is collected in Ciawitali Cave, West Java, Indonesia, and also reconstructed precipitation variation for the last 500 years based on isotopic data.

First, we analyzed a stalagmite collected in Ciawitali Cave, and found that the number of growth bands is coincident with the uranium series disequilibrium age within the error. Next, annual variations of isotopic data were compared with that of precipitation since 1950, showing significant, negative correlations. These results suggest that stable isotopic ratios in stalagmites are applicable as effective proxies for ancient precipitation in this study area (Watanabe et al., 2010). Furthermore, we measured carbon and oxygen isotopic ratios of the stalagmite for the last 500 years. In this presentation, we will present the comparison between various climatic factors and isotopic variations of the stalagmite over the last several centuries.

Keywords: stalagmite, precipitation, Indonesia, stable isotopes

Boron isotope variability in an annually-banded coral skeleton from the northwest tropical Pacific Ocean

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Ocean acidification seems to be accelerated due to adsorption of increasing anthropogenic CO₂ emissions from the atmosphere since the Industrial Revolution. This issue should be addressed to evaluate the effect of ocean acidification to calcifying organisms and coral reef ecosystems. However, there are only two long time series of seawater pH off Hawaii and Bermuda for the last several decades and the actual trend and variability of seawater pH for the last several centuries remains unknown.

Massive *Porites* sp. corals, living in tropical and subtropical shallow seawaters, are one of the most informative archive for documenting ocean and climate variability at sea surface for the past. They precipitate annually-banded aragonite skeletons and grow rapidly (up to ~25 mm/year), which can provide chronological control and allow high-resolution sampling. Two previous studies showed paleo-pH variability at sea surface in the southwestern Pacific Ocean for the last several centuries based on boron isotope ratios ($\delta^{11}\text{B}$), an useful proxy of seawater pH, of long-lived *Porites* coral skeletons from the Great Barrier Reef [Pelejero et al. 2005. *Nature*; Wei et al., 2009. *Geochim. Cosmochim. Acta*]. However, no coral-based reconstructions of long-term pH variability in the northern Pacific Ocean have been reported.

In this presentation, we will show boron isotope composition in annually-banded skeletons of a massive *Porites* coral from the northwest tropical Pacific Ocean. Time assignment of this coral was accurately determined by monthly resolved oxygen isotope analysis [Asami et al., 2005. *J. Geophys. Res.*], providing a well-dated time series of sea surface water pH. Our coral-based reconstruction of long-term pH variability in the northwest Pacific Ocean can be a clue to a better understanding of acidification in the Pacific Ocean since the Industrial Revolution, along with boron isotope records from the southwestern Pacific corals.

Keywords: Coral, annually-banded skeleton, boron isotope, pH, the Pacific Ocean

Reconstruction of sea-surface temperature and salinity changes from fossil corals of Marshall Islands

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The Asian monsoon plays a significant role in the global hydrological cycle and affects people living in the monsoon Asia region for water and agricultural fertility. Sea surface temperature in the western tropical Pacific is one of the main factors affecting monsoon precipitation changes [Wen *et al.* 2009; Cai *et al.* 2010]. Decreased sea surface temperature (SST) in the western tropical Pacific, along with an eastward shift of weakened Kuroshio Current, would reduce formation of water vapor over the western tropical Pacific and decrease moisture available for transport via the monsoon circulation from low-latitude Pacific onto Asian inlands, thereby resulting in a weakened summer monsoon. Therefore, reconstruction of past SST change in the western tropical Pacific region will provide useful information for discussing past changes of the Asian monsoon.

Massive coral skeletons, which may include several hundreds of years of continuous coral growth, contain a variety of geochemical tracers that potentially provide invaluable archives of past climate and environments for a shallow tropical ocean region with extremely high time-resolution up to a daily time scale. In this study, we collected modern and fossil (1000 yrBP and 2000 yrBP) *Porites* coral cores from the Marshall Islands in the western tropical Pacific. We measured stable oxygen isotope ratios ($\delta^{18}\text{O}$) that is a proxy of both sea water temperature and salinity, and Sr/Ca ratio that is a proxy of only sea water temperature. The results of Sr/Ca measurements show the cool conditions during 1000 yrBP and 2000 yrBP than those at the present. These results would indicate the weakened Asian summer monsoon during these periods. Moreover by extracting the sea water temperature contributions from the results of stable oxygen isotope, precipitations were marginally increased during the periods of 1000 yrBP and 2000 yrBP than modern periods. During El Niño events, cooler and dryer conditions prevail over the western Pacific including the Marshall Islands. Therefore, the increased precipitation signals in 1000 yrBP and 2000 yrBP would indicate the weakened El Niño conditions, though further investigation may be needed, because these trends differ slightly the previous studies [Moy *et al.* 2002].

A 432-year-long paleoceanography recorded in *Porites* coral in Kikai Island, Southern Japan.

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The East Asian Monsoon (EAM) is an integral part of the global climatic system and especially monsoon-associated precipitation has a great effect on the industrial, agricultural production and human life in populous regions of the East Asia. To understand the dynamics of EAM it is critical to reconstruct variations in the past activities in seasonal resolution. Therefore hermatypic corals, which are widespread in tropical and subtropical oceans, are suitable since they have clear annual density bands.

In June 2009, we obtained a long modern coral core from a coral reef in Kikai Island. The island is located on the eastern boundary of the East China Sea in the northwestern Pacific. Thus its present climate is mainly affected by the EAM. The coral core is approximately 440 cm long and dates back to 432 years on X-ray images. The purpose of this study is to reconstruct continuous 432-year record of sea surface temperature and other parameters based on coral paleo-climate proxies including trace elements, such as Sr, U, and Ba. We analyzed the skeletal elements by using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) at the Research School of Earth Sciences at the Australian National University. It is a very powerful tool to handle long-term record since it requires a relatively brief experimental time compared with the analysis by using isotope dilution or thermal ionization ICP-MS, which we generally use in analyzing the elements in corals. In this time, we will show the initial results using the LA-ICP-MS for analyzing coral proxy records to reconstruct long-term variations in the EAM.

Keyword: coral, Laser Ablation ICP-MS, East Asian Monsoon, Little Ice Age

Foraminiferal evidence for sea-level variations in the coastal lagoon: The 1980s event implicating the decrease water circulation

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Coastal lagoon is sensitive to a climatic variability, and recent global warming have an influence on its biotic and abiotic environments (IPCC (2007; AR4). Many of these assessed items such as temperature increase, sea-level rise, heavy precipitation in relation to global warming are intimately concerned with those in lagoon environment. Human activities are another significant issue for lagoon environments. Both climatic and human influence in the lagoon, particularly in the latter half of the 20th century and up to the present, must be not a separated matter from each other. However, both influences appear in different scale of time and in different geographical places. Sea-level variation is significant to identify common feature of lagoon environment over the larger area of the Japanese Islands. In order to clarify the cause and effect of sea-level rise for the 20th century, we examined a number of sediment cores from the Japanese lagoons by using protozoan foraminiferal assemblage.

Sea levels have been very variable over the last hundred years, showing both long-term and short-term variations. Sea-level rises around the Japanese coast that occurred in the 1940-50s and the 1970s were significant. In a study of Lake Nakaumi, southwest Japan, the marine forms of foraminifera occurred in the central part of the lake, and native foraminifera preferring eutrophic water decreased in the 1940-50s, in response to sea-level rise. In Lake Kugushi, Fukui Prefecture, sea-level rise over the last 60 years is clearly indicated by two kinds of foraminiferal assemblages; the appearance of marine species in the 1950s and 1970s, and the development of a brackish assemblage preferring eutrophic water from the 1980s onward. The latter is an assemblage indicates a well developed halocline and highly eutrophied argillaceous substrates (Nomura and Kawano, 2010, in *Quater. Internat.*). An enlarging of bay mouth has an influence on biotic environment in concert with sea-level variations. The Imagiri-guchi, bay mouth of Lake Hamana-ko opened into the Enshu-nada, the Pacific coast, artificially enlarged in 1954. Both recorded foraminiferal assemblage and core assemblage in the 1950s were characterized by eutrophic assemblage (*Trochammina* and *Ammonia*). The recorded assemblage and core assemblage in the 1970s was, however, composed of mainly *Elphidium excavatum*. The higher sea-levels in the 1970s forced the foraminiferal assemblage to be opportunistic. Further changes are able to recognize in the 1980s when former eutropic assemblage was replaced the *E. excavatum* assemblage and developed in the lake.

Based on the different response of these foraminiferal assemblages to sea-level rise, we suggest that the sea-level rise from the 1980s onward is driven by a different mechanism than those of the 1970s and 1950s. The thermal expansion of seawater will lead to lagoon water that will be more stagnant and eutrophic, with little exchange of coastal marine water. Time series change of the atmospheric pressure in the 1980s is significant suggesting the recent development of water-mass stability of coastal lagoon water.

Keywords: sea-level variation, coastal lagoon, the 1980s event, foraminifera

Is atmospheric iron deposition important for primary production? Lessons from Alaskan ice core

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The northern North Pacific Ocean is one of the High Nutrient Low Chlorophyll (HNLC) ocean areas where biological productivity is too low for high nutrient. It is suggested that the iron plays a key role in phytoplankton growth in these areas. The Asian dust can supply iron into the northern North Pacific (NNP) ocean region on its way to the east. To estimate the iron flux that deposited from the atmosphere, we measured the iron concentration of the 50m ice core drilled at Mt. Wrangell, Alaska in 2003. We obtained the iron concentration profile spanning from 1992 to 2003. The profile showed seasonal peaks appeared in every spring, and remarkable peaks appeared in 2001 and 2002. The Asian dust emission is generally enhanced in spring, and the huge Asian dust events occurred in 2001 and 2002. Accordingly, we suggest the iron concentration of the ice core reflected on the variation of the Asian dust activity. Then we calculated the iron flux from the iron concentration and annual accumulation rates. The iron fluxes from 1992 to 2003 ranged $3.2\text{-}27.0\text{mg/m}^2\cdot\text{yr}$ and the average value was $8.8\text{mg/m}^2\cdot\text{yr}$. These values are comparable to the estimated values by some previous studies.

We then calculated the iron concentration in the sea water when the atmospheric iron deposited in to the ocean. The iron flux of twelve year average ($8.8\text{mg/m}^2\cdot\text{yr}$) and of 2001 ($27.0\text{mg/m}^2\cdot\text{yr}$) from the ice core were used for this calculation. The atmospheric iron that can dissolve to sea water, the condition that ocean primary production can be used, is 2-10%. And the thickness of mixing layer in winter to early spring is approx. 30m, and the phytoplankton also photosynthesizes in sea surface layer. Therefore, in this calculation, we calculated the iron concentration when 2% of the above-referenced fluxes dissolve to 100m depth of the ocean. As a result, these fluxes correspond to approx. 0.03nM and approx. 0.1nM. The iron concentration as condition of phytoplankton growth is approx. 0.2nM in northern North Pacific, and the iron concentration of the sea surface layer in this ocean region is 0.1nM. Therefore, the iron flux of twelve year average can not meet the growth condition, but of 2001 comparable. Therefore, it is possible that the huge dust event such as 2001 influence to ocean primary production.

A GCM Simulation of the Last Millennium

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A simulation of the last millennium is carried out using the MIROC-3.2 coupled atmosphere-ocean general circulation model (GCM). The model is first spun up under the perpetual 850A.D. condition until it reaches the quasi-equilibrium state. The model is then integrated with time-varying boundary conditions. The time-varying forcing for 850-1850A.D. includes variations of solar activity, volcanic eruptions, greenhouse gas concentrations, and orbital variations. After 1850A.D. the model is also forced with time-varying aerosol emissions, ozone concentrations, and land use changes until 2000A.D. The preliminary analysis on the simulation is presented. Northern Hemisphere mean temperature exhibits variations that are within the range of multiple reconstructions except several large volcanic events. The disagreement between the simulated and the reconstructed climates does not immediately imply the model deficiency because two recent volcanic forcing reconstructions do not agree in magnitude on these volcanic events. As the number of millennial simulations is highly limited due to the GCM's computational cost, we also tested a potential of a model of intermediate complexity (EMIC) as a surrogate of the GCM. A comparison between the GCM and the EMIC suggest that this EMIC exhibits remarkably similar time evolution for hemispheric mean temperature when forced with the equivalent radiative forcing. Moreover, processes responsible for climate variability in the North Pacific are investigated. On the time scale longer than 7 years, about 40% of the temperature variance is explained by globally-synchronous changes and about 21% is explained by the Pacific Decadal Oscillation (PDO) which explains about 37% of the variance in the unforced control simulation.

Keywords: GCM simulation, EMIC simulation, Northern Hemisphere temperature, Pacific Decadal Oscillation