Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG034-01 Room:102 Time:May 27 08:30-08:45

Stagnation of global warming in the mid 20th century can be explained by atmospheric nuclear explosions

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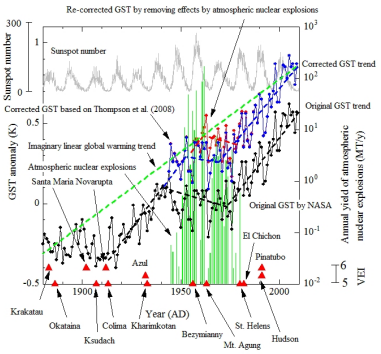
GST has been rising from 1880 to 2010. This phenomenon is, of course, called global warming at present. GST shows stagnation between 1880 and 1917 although GHG has been rising in this period. This stagnation would be due to the inactive sun and the giant eruptions with VEI rating of 6. It is known that sulfate aerosols from giant eruptions reach the stratosphere and shade insolation thereby lead GST drop. Stagnation of 0.5K can be seen between 1945 and 1976 and would not be explained by solar activity and eruptions because the sun was very active until 1965 and VEI ratings of eruptions of Bezymianny in 1956 and Mt. Agung in 1963 are only 5 and they occurred after the GST drop in 1945.

This stagnation in global warming in mid 20th century could not be simulated by the latest AOGCM. Hansen et al. (2007) suggested natural oscillations and soot blown to the Arctic from industrial activity at the outset of World War II as possible causes. Nagashima et al. (2005) suggested increase in organic aerosols and Schledinger & Ramankutty (1994) suggested AMO. AMO is, however, in the current author's opinion, not a cause but a result from some radiative forcings. Thompson (2008) suggested that the discontinuous 0.3K GST drop in 1945 was due to change in the measuring method for SST. The stagnation, however, can still be observed after adding 0.3K to GST after 1945 with smaller duration and GST drop of 0.3K.

It is known that 504 atmospheric nuclear explosions with total yield of 440 MT were carried out during 1945 and 1980. This period coincides with the stagnation period. It was predicted that submicron soot and dust which were generated by nuclear wars with 100-5000 MT yield inhibited insolation and caused GST drop which was large enough to exterminate human in some cases (well known as "Nuclear Winter" by TTAPS, Robock et al. 2007, etc.). GST drop by soot was considered to be the main cause of GST drop in the studies. The actual atmospheric nuclear explosions were ignored in those studies because nuclear weapons tests did not cause soot and Hiroshima and Nagasaki were very small yields although they generated soot. TTAPS also showed effects of dust as well as soot. GST drop by nuclear weapons tests was estimated based on TTAPS results. GST drop by Hiroshima and Nagasaki was estimated based on the latest AOGCM results shown in Robock et al. (2007). Tests on sea and at high altitude were not included in the calculation. Dust amount which was injected into stratosphere was estimated considering explosion altitude and nuclear yield which affected radius of fireball and the altitude of mushroom cloud. The estimated GST drop showed a peak value of 0.17K and was mainly due to the large yield Hydrogen bombs by Soviet Union. GST which was corrected again by the estimated nuclear explosion effect rises straight from 1917 to 1965 and then slightly dropped by 0.2K till 1976. This drop can be attributed to the inactive sun between 1965 and 1976.

Arakawa (1954) suggested that the extraordinary cold summer in Northern Japan might be due to the hydrogen bomb tests at Bikini atoll by US. Landsberg (1958) also pointed out possible effects of hydrogen bombs. Kondratyev (1988) suggested air temperature drop by NO2 generated by the hydrogen bombs. Hishida (2001 in Japanese), not quantitatively, but pointed out possible effects of the raids at the end of the World War II and atmospheric nuclear explosions afterwards on SST and GST.

Atmospheric nuclear explosions can be regarded as full-scale in situ tests for nuclear winter. This research first gives evidences to nuclear winter, which was just simulation before. It is expected that the nuclear deterrent would be strengthened. Mt. Agung eruption seems to be overestimated in the present climate simulations to mitigate contradiction between observation and simulation. The global climate can be more precisely predicted by adjusting parameters considering the effects of atmospheric nuclear explosions.



Keywords: global warming, atmospheric nuclear explosions, nuclear winter

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ACG034-02 Room:102 Time:May 27 08:45-09:00

Possibility of climate reconstruction on monthly/seasonal scales by oxygen isotope ratios in tropical ringless trees

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Tree rings have been used as one of the best natural archives of past climate, resulting in tree-ring networks available in various regions of the world. However, the terrestrial tropics have produced the fewest tree-ring records because most of tropical trees do not form annual rings. Recent progress in isotope dendrochronology, on the other hand, reveals that oxygen isotope ratios of tree cellulose are primarily governed by two climatic factors, i.e., oxygen isotope ratios of source water and relative humidity, both of which are considered to vary significantly according to hydroclimatic seasonality. It is therefore expected to obtain past climate records on seasonal/monthly or perhaps weekly scales by measuring oxygen isotope ratios of tropical trees lacking annual rings.

One tree sampled from each of two even-aged plantations (3 and 2 years old, respectively, in Paksuun and Nong Boua) of Eucalyptus, with a distance of 30 km between them, in central Laos was utilized for this study. The stem diameters (1.3m above the ground) of the sampled trees from Paksuun and Nong Boua were 11.5 cm and 12.8 cm, respectively. A $4 * 6$ mm radial section extending from the pith to cambium was cut from a stem disc, and was subsampled on a rotary microtome at 20 um increments. Twenty-five slices were then aggregated into a single sample for a sampling resolution of 0.5mm. Following the standard practice in isotope dendrochronology, whole wood was extracted to cellulose through a series of chemical steps. In the case of Nong Boua, 2-slice sample out of 25 slices was only subjected to removal of resins, whereas the remaining 23-slice sample was extracted to cellulose, in the same way as the samples from Paksuun. This aims to know the extent to which isotopic variations are correlated between wood and cellulose samples, and thus to know whether large number of samples can be rapidly prepared without extracting cellulose. Oxygen isotope ratios of cellulose and wood samples were determined by an isotope ratio mass spectrometer interfaced with a pyrolysis-type elemental analyzer (TCEA?IRMS). The standard deviation derived from repeatedly measured standard material was 0.2 per mill.

The oxygen isotope ratios from Paksuun and Nong Boua showed similar variations in spite of a distance of 30 km between the sites, indicating that common signals related to regional climate were recorded in the sampled trees. The oxygen isotope ratios are then compared with 15-day moving averages of relative humidity at the Paksan meteorological station located near the sampling sites. Large periodic oscillations, which correspond to wet and dry seasons, appearing in relative humidity were found in the isotope records. Intra-seasonal variations of the isotope records were also correlated with those of relative humidity. Growth rates were the highest in the rainy season, in which the sampling interval of 0.5 mm corresponded to weekly resolution. Oxygen isotope ratios of whole wood samples were highly correlated with those of cellulose samples ($r = 0.97$, $p < 0.001$), suggesting that measuring whole wood instead of cellulose is now feasible to rapidly process large number of samples.

Keywords: Oxygen isotope ratio, Cellulose, Relative humidity

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ACG034-03 Room:102 Time:May 27 09:00-09:15

Environmental changes and civilizations of the Pan Pacific regions

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The ”Pan Pacific Environmental Changes and Civilizations” (PPECC) project is a multidisciplinary research program funded by KAKENHI. Here, we are undertaking coring campaigns over the Pan Pacific regions in order to study the variability of past environmental changes using annually laminated lake sediments.

Keywords: paleoenvironmental reconstructions, lake sediments, varve, pan pacific region, rise and fall of civilizations

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ACG034-04 Room:102 Time:May 27 09:15-09:30

Oxygen isotope record of the stalagmites from Itoigawa and intensity of the Holocene Asian monsoon

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A stalagmite has been recognized valuable in terms of a paleoclimatic archive. Especially, oxygen isotopic records in stalagmites have provided information on short/long-term shifts in moisture source, temperature changes, and rainfall amount.

We analyzed two stalagmites (FG-01 and FG-02) collected from a cave, in Itoigawa city, SW Niigata Prefecture. Both have transparent appearance and a relatively straight growth center. U-Th dates were provided only for FG-01 and indicated that the uppermost 19.5 cm was deposited since 10.5 ka (thousands years ago). However, in terms of isotopic disequilibrium, FG-O1 is less suitable for the climatic archive than FG-02, for which The U-Th dates were not obtained yet. Then, the correlation based on the carbon isotope profiles provided the age model for FF-02 indicating that the uppermost 19.8 cm have been deposited since 8,500 year B.P.

The oxygen isotopic values of FG-02 change in a range from -7.6 to -10.0 permil. The relationship between the values of the uppermost sub-specimen and dripwater is nearly consistent with cave temperature. In terms of the isotopic trend, the oxygen profile was divided at 3.3 ka. The values mildly fluctuate from -8.3 to -9.2 permil in the lower part. Whereas the upper stalagmite records distinct trends consisting of decrease from -8.3 (3.3 ka) to -9.5 permil (2.0 ka), stable interval until 0.3 ka, and steep increasing to the present. This upper oxygen isotopic profile overall appears the opposite trend of the late Holocene records the Chinese caves, which have been considered reflecting intensity of the Asian Summer Monsoon (ASM). Oppositional trend likely resulted from the difference in dominant source and season of rainfall. As commonly in East Asia, it rains more in summer due to the ASM in south China. Whereas in Niigata Prefecture located in the Japan Sea climatic zone, it rains (and snow) more in winter than in summer. This unique rainfall seasonality is definitely the influence from the Asian Winter Monsoon (AWM) that is initially cold and dry wind in the continent, but becomes wet from moisture uptake from relatively warm water mass in the Japan Sea, and brings rain and snow to the Japan Sea side of Honshu and Hokkaido Islands. Therefore, the oxygen profile of FG-02 is unique in terms of a potential archive of the AWM intensity. This assumption is probably true, because the recent shift (from -9.0 to -7.6 permil) is consistent with the recent decreasing trend in the annual rainfall observed in Takada, ˜40 km NE from the cave. However, the lower part does not appear the oppositional trend with the Chinese records. In early-middle Holocene, rainfall pattern in Itoigawa might be different from the present seasonality and the oxygen isotopic value was substantially influenced by the summer rainfall fraction.

Keywords: Stalagminte, Holocene, Paleoclimate

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ACG034-05 Room:102 Time:May 27 09:30-09:45

Millennial-scale variations in East Asian summer monsoon during the last glacial period in the northern East China Sea

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Long-term rainfall records are particularly important for regions impacted by the Asian monsoon, because prediction of changes in future precipitation pattern in that area is controversial. Previous studies of the East Asian summer monsoon [EASM] based on oxygen isotope [$d^{18}O$] of speleothems claimed that millennial-scale variations in the EASM has been associated with abrupt climate changes in the high-latitude North Atlantic region called the Dansgaard-Oeschger [D-O] events and Heinrich events during the last glacial period. However, interpretation of speleothem $d^{18}O$ is difficult and suffered from uncertainties such as effect of temperature, local evaporation, $d^{18}O$ of source, and transport distance from source. Thus, past changes in regional precipitation pattern and intensity have not fully understood yet.

Today, interannual variability of sea surface salinity [SSS] in the northern East China Sea [ECS] during summer is influenced strongly by the discharge from the Yangtze River. Thus, in the northern ECS, variation in $d^{18}O$ of seawater [$d^{18}O$]{sw}], a function of salinity, reflects variation in regional summer rainfall over the Yangtze River catchment, which occupies large part of South China. In this study, we aim to reveal large-scale changes in regional EASM precipitation and consequent changes in the discharge from the Yangtze River by reconstructing the summer sea surface temperature [SST] and sea surface salinity [SSS] in the northern East China during MIS 3 and 2.

The marine sediment core, KR07-12-01recovered from the northern ECS was used in this study to reconstruct SST and SSS. An age model of KR07-12-01 was constructed based on fifteen 14C-dating points and ash layers Kikai-Akahoya (7.3 ka) and Aira-Tanzawa (29 ka). The base of the core reached 42 ka and the sediment accumulated continuously without any interruption except for the two ash layers.

Mg/Ca records revealed that lower SST events are observed at 39-40, ˜33, ˜29 ka in the studied core, which coincide with D-O stadials #9, #6, and #5, respectively, suggesting teleconnection between high-latitude North Atlantic and mid-latitude EASM regions. Positive shifts of $d^{18}O_{sw}$ by ˜0.4permil were observed at ˜39, ˜33, ˜35.5, ˜32, and ˜30 ka in the northern ECS, which seems to coincide with Heinrich event #4, D-O stadial #6, #7, and Heinrich event #3, respectively. These higher $d^{18}O_{sw}$ events in the ECS also coincide with maxima of stalagmites' $d^{18}O$ in South China. These results suggest that the EASM precipitation decreased in South China during colder periods in MIS 3 and 2 in the North Atlantic region.

On the other hand, previous studies in the ECS revealed that the $d^{18}O_{sw}$ in the northern ECS has not changed significantly associated with Younger Dryas[YD] cold event during the last deglaciation. This is in contrast with stalagmites records from eastern China, which show significant changes in association with YD. Whereas, the terrestrial records from lakes and peats in the South China suggest that the EASM precipitation has not decreased in association with YD event in that region during the last deglaciation.

The decreases in discharge from the Yangtze River during the cold periods of MIS 3 and 2 are consistent with stalagmite records. However, the discrepancy occurs between ECS $d^{18}O_{sw}$ of stalagmites and $d^{18}O$ during the deglaciation. The discrepancy could be due to the difference in global boundary condition such as the presence or absence of large ice sheets on Eurasian and North American continents. At present, the limit of EASM reaches northern China. On the other hand, the limit of the EASM likely shifted southward within South China during the last glacial period. Due to the southward shift of the EASM limit, the southern China was more easily affected by millennial scale variations in the EASM limit position during the last glacial period. Thus the decreases in EASM precipitation in southern China were associated with the abrupt changes in North Atlantic.

Keywords: Last glacial period, Dansgaard-Oeschger event, Heinrich event, East Asian summer monsoon, Mg/Ca ratio, East China Sea

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ACG034-06 Room:102 Time:May 27 09:45-10:00

Deep-water ventilation changes in the NW Pacific since the last glacial period

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We present detailed ventilation records in the mid-latitudinal NW Pacific off Kashima since the last glacial period based on coexisting planktic and benthic foraminifer radiocarbon measurements of MD01-2420 core (36 degree 04 min. N, 141 degree 49 min. E; water depth: 2101 m). During the early phase of the termination between 17.5 and 15 kyr B.P., the radionuclide {sup}231{/sup}Pa to {sup}230{/sup}Th ratio in northern Atlantic sediments suggest shutdown of the Atlantic Meridional Overturning Circulation (AMOC) triggered by a massive discharge of fresh water to the North Atlantic (Heinrich Event 1; H1). Because of 190 per mil drop of {sup}14{/sup}C to {sup}12{/sup}C ratio in the atmosphere and atmospheric carbon dioxide rise by 40 ppm during H1, renewal of isolated carbon reservoir in deep water is thought to be linked to reorganizations in AMOC. Deep water has a large capability to store carbon as 50 times as large as the atmosphere and Pacific Ocean is volumetrically most important.

Our recent study suggests that deepwater was formed in the North Pacific extending to a depth of ˜2500 m during H1, with the establishment of a deep Pacific Meridional Overturning Circulation (PMOC). The main simulated pathway of deepwater spreading is along the western margin of the North Pacific, in a deep western boundary current analogous to the one currently in the North Atlantic. However, ventilation records are still limited and we need more records particularly in deepwater below 2000 m. MD01-2420 core is an ideal sample for reconstructing past ventilation changes because of its high sedimentation rates (˜25 cm/kyr) and good preservation of CaCO{sub}3{/sub}. We would like to discuss perspective toward an understanding the role of the North Pacific in global ocean circulation and carbon cycle.

Keywords: ocean circulation, ventilation, North Pacific, last glacial period, Heinrich event 1

Japan Geoscience Union Meeting 2011
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ACG034-07 Room:102 Time:May 27 10:00-10:15

The thermal threshold of the Atlantic overturning circulation and stadial/interstadial periods in glacial climate

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By using results of a state-of-the-art climate model (MIROC), we conducted sensitivity simulations by an ocean general circulation model (COCO) in order to evaluate role of thermal, freshwater, and wind-stress sea surface conditions in controlling the Atlantic meridional overturning circulation (AMOC) in glacial climate. It is demostrated that slight differences in sea surface conditions could lead to very different response of the AMOC; a certain condition leads to the stronger AMOC and slightly different sea surface fluxes result in the weaker AMOC than today. We found the reponse of the AMOC to the thermal condition (i.e., strength of surface cooling) is a key for understanding the behavior of the AMOC in glacial climate. It is implied that two very different states of the AMOC may be possible during glacial periods depending on degree of sea surface cooling: moderate cooling results in strengthening of the circulation whereas sufficient cooling leads to weakening of the circulation. The model results indicate that this is related to response of deep convection in the northern hemisphere; moderate cooling enhances deep convection whereas sea ice covers there entirely and prevents deep convection under sufficient cooling. This suggests existence of thermal threshold of the AMOC during a glacial period: the weak glacial (stadial) AMOC suddenly shifts to the strong (interstadial) AMOC when surface cooling becomes smaller than this threshold. It is speculated that this thermal threshold may be related to existence of stadial and interstadial periods of glacial climate.

Keywords: The Atlantic deep circulation, Climate model, Glacial abrupt climate changes

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ACG034-08 Room:102 Time:May 27 10:15-10:30

Why do GCMs sometimes fail to simulate the LGM AMOC

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To understand and reproduce the Atlantic Meridional Overturning Circulation at Last Glacial Maximum (LGM), which is known to be weaker than present day in strength), is important for the validation of models used for future climate projection, although many Coupled Atmosphere Ocean General Circulation Models (AOGCMs) fail to simulate it. Here we analyze multi AOGCMs and also ran several sensitivity experiments using?MIROC AOGCM in order to examine the reason of difficulty in simulating the NA AMOC at LGM. We show that (1)the change of AMOC in the models are very much dependent on the Temperature bias in the Southern Ocean (2)The formation of ice sheet and Brine rejection in Southern Ocean is crucial for the weakening of AMOC at LGM. (3)Decrease of Greenhouse Gas (GHG) amount under glacial climate is favorable in weakening the NA AMOC while the growth of Northern hemisphere Ice Sheet?strengthens it under a range of GHG level.

Japan Geoscience Union Meeting 2011
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ACG034-09 Room:102 Time:May 27 10:45-11:00

Erosion rates of weathered granitic soil surfaces in Abukuma, Japan deduced from cosmogenic nuclides depth profile

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Measurements of in-situ produced cosmogenic nuclides (CRN) allow us to understand earth surface process quantitatively. It has been successfully used to provide erosion rates in arid region where slow erosion process is taken place (e.g., Gosse and Phillips, 2001). Coupled measurements of CRN provide unique solution of both minimum exposure age and maximum erosion rates (Yokoyama et al., 2005). CRN based erosion rates determination have not been applied extensively in mid latitude humid area, where weathered granitic soils are distributed, due to fast erosion rate, namely long-lived CRN do not have sensitivity to provide both erosion rate and exposure ages. It is therefore required to apply CRN depth profile method to obtain accurate erosion rate for those area yet few studies have been conducted by far. Here we present 10Be and 26Al depth profiles from eastern Abukuma, Japan to understand quantitative erosion rate. Our previous study successfully demonstrated that deeper layers at least 80 cm below surface must be analyzed to achieve highly accurate measurement because near-surface layers are potentially influenced by pedogenic processes (Shiroya et al., 2010). In this study, therefore, we sampled granitic soils from 300cm-deep outcrop.

The sampling sites are located in the eastern Abukuma Mountains, Japan at an altitude of 540 m and 620 m above sea level. CRN (10Be and 26Al) are measured by AMS (Accelerator Mass Spectrometry) at Micro Analysis Laboratory Tandem Accelerator, The University of Tokyo. We will discuss geomorphologic and geologic implications based on the results of CRN measurement including discussions of erosion rates of weathered granitic soils in eastern Abukuma mountains.

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Keywords: cosmogenic nuclide, erosion rate

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ACG034-10 Room:102 Time:May 27 11:00-11:15

The glacial history of Sor Rondane Mountains in Dronning Maud Land, East Antarctica

Yusuke Suganuma[1*], Hideki Miura[1], Albert Zondervan[2]

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Antarctic ice sheet volume and sea ice extent are driven by Earth's global climatic system and more regional parameters such as albedo, thermohaline circulation, productivity of marine organisms, and erosion or weathering rate of base rock. A reconstruction of Antarctic ice sheet variability is essential to begin to understand their interactions. Previous studies have estimated a significant decrease in ice sheet thickness during the last several million years (e.g., Liu et al., 2010). However, the geographical extent of this decrease and its response and feedback to the global climate remain uncertain and topic of debate.

In this study, we focus on the past change of the ice sheet thickness at Sor Rondane Mountains in Dronning Maud Land, East Antarctica, because little is known about this region's deglaciation history. In 2010, we carried out a field expedition to investigate the past change of the ice sheet elevation based on detailed geomorphologic evidence and precise surface exposure ages using the cosmogenic isotopes Be-10 and Al-26. In total, 34 bedrock or erratic samples had been corrected from ca 1000 - 2500 m a.s.l. at the western and central part of Sor Rondane Mountains. Based on these data, we will discuss a relationship between East Antarctic ice sheet change and global climate.

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ACG034-11 Room:102 Time:May 27 11:15-11:30

Glacial melting and uplift estimations around the Sor Rondane Mountains of the East Antarctica since the Pliocene

Hideki Miura[1*], Jun'ichi Okuno[1], Yusuke Suganuma[1]

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The role of the East Antarctic Ice sheet for several global climatic events such as Mid-Pleistocene Transition and Mid- Brunhes Event during the Quaternary era is a great issue for elucidating the global systems. A large part of the Sor-Rondane Mountains in the East Antarctica has been covered by the East Antarctic ice sheet. The glacial geomorphology in this region and Glacial isostatic adjustment model (GIA model) can lead to estimate the glacial melting volume of East Antarctic Ice sheet and its contribution to the global sea-level changes, and the amount of glacial isostatic uplift since the Pliocene.

Keywords: Antarctica, East Antarctic Ice sheet, Glacial fluctuation, Sor-Rondane Mountains, Glacial isostasy, Quaternary

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ACG034-12 Room:102 Time:May 27 11:30-11:45

Changes in ^{230}Th -normalized flux of biogenic components recorded in the south Chilean margin over the past 1.3 kyrs.

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The atmospheric partial pressure of CO_2 ($_pCO_2$), was quite low, 180 ppm during the last glacial maximum (19,000 - 23,000 years ago) and rapidly increased to 280 ppm during the last deglacation (Monnin et al., 2001). The causes of large fluctuation of $_pCO_2$ during the deglaciation has been debated. We would like to understand how much biological pump had contributed to the atmospheric $_pCO_2$ reduction throughout the deglaciation, because its evaluation is still insufficient. The biological pump efficiency changes depending on nutrient concentration, light condition, and phytoplankton assemblages and nutrient, light and phytoplankton assemblages are various in regions. In order to evaluate the biological pump, more data related with the past primary production from many regions are required. The aims of this study is to understand the temporal changes of export fluxes of biogenic materials during the last deglaciation and Holocene, at off Chile, where active biological productivity occurs at present.

We used the sediment core collected near the mouth of Strait of Magellan, Pacific side (52 ^{o} S, 74^o W; water depth ; 560 m). We measured relative content of biogenic components, total organic carbon (TOC), total nitrogen (TN) and biogenic opal (Opal), which are commonly utilized as proxies for productivity, recorded in a sediment core (PC3) covering the past 13,000 years. Thorium-230 (^{230}Th) concentration, which is an insoluble natural radionuclide born to decay of dissolved Uranium- 234 (^{234}U), was also analyzed. When ^{230}Th was born in the sea water, it is promptly scavenged by adsorption on settling particles with a short residence time (= - 40 years). The ^{230}Th-normalization method is based on the assumption that the flux of scavenged ^{230}Th reaching the seafloor is known and equal to the rate of ^{230}Th production from the decay of ^{234}U in the overlying water column. Furthermore, ^{230}Th input associated with terrigenous materials can be corrected by ^{232}Th concentration. Thus, it is useful to estimate quantitatively export flux in the region such as coastal area (Francois et al., 2007). By using the characteristics of ^{230}Th, biogenic components fluxes normalized by ^{230}Th concentration was utilized to understand the changes in biological pump in this study.

The ^{230}Th -normalized flux of TOC ranged from 5.0 to 45 mg cm^{-2} kyr^{-1} during 13,000 cal. yr BP. The average of TOC flux was 31 mg cm^{-2} kyr^{-1} during the Younger Dryas (YD; 12,900 - 11,500 cal years BP) and 24 mg cm^{-2} kyr^{-1} during the Holocene. The ^{230}Th -normalized flux of TN ranged from 0.6 to 5.0 mg cm^{-2} kyr^{-1}. The average of TN flux was 3.8 mg cm^{-2} kyr^{-1} during the YD and 2.8 mg cm^{-2} kyr^{-1} during the Holocene. The ^{230}Th -normalized fluxes of TOC and TN during the YD was 30% and 40% higher than those during the Holocene, respectively. The ^{230}Th -normalized fluxes of biogenic opal ranged from 7.9 to 165 mg cm^{-2} kyr^{-1} during 13,000 cal. yr BP and average of opal flux was 103 mg cm^{-2} kyr^{-1} and 60 % higher during the YD than 63 mg cm^{-2} kyr^{-1} during the Holocene. Both of TOC and TN fluxes vary associated with changes in marine productivity (Suess, 1980) and biogenic opal flux is also a proxy of relative strength of upwelling. High values of TOC, TN, and biogenic opal during the YD suggest relatively high marine productivity and biological pump due to enhanced upwelling rather than that during the Holocene.

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Keywords: Off Chile, 230-Thorium, biological components, biological pump

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ACG034-13 Room:102 Time:May 27 11:45-12:00

Enhanced shelf sediment weathering during glacial periods damps pCO2 reduction: A negative feedback

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In the past million years and before industrialization, the largest variations in atmospheric CO_2 occurred in connection with the glacial cycles that characterized Earth's climate over this period. The mechanisms responsible for the glacial-interglacial CO_2 changes have remained unresolved. One curios feature of at least the last four glacial-interglacial cycles is that pCO_2 reached about the same upper limit of 280 ppm during peak interglacial periods and about the same lower limit of 180 ppm during peak glacial periods. Here, we show using a numerical model of earth system that enhanced shelf sediment weathering during glacial sea-level low stand will tend to raise pCO_2 and thus stabilize it from further reduction. This is contrary to the so-called shelf nutrient hypothesis (Broecker, 1982), which proposed that increased weathering of nutrients (e.g., phosphate) would enhance the organic carbon pump of the ocean and thus reduce atmospheric pCO_2. We demonstrate that weathering of exposed continental shelves would in fact raise pCO_2 because not all nutrients from weathering will be utilized by biology but more importantly because the spatial distributions of carbon and phosphate from weathering become decoupled in such a way that carbon is preferentially stored in the upper ocean and phosphate in the deep ocean. An extension of this finding suggests that the preferential dissolution of phosphate in shelf sediments during interglacial high stand would tend to enhance biological production and thus stabilize atmospheric pCO_2 from further increase. The impact of sea level-driven continental shelf exposure and submersion on atmospheric CO_2 is therefore a negative feedback that helps explain both the upper and lower limits of atmospheric CO_2 over the Pleistocene.

Keywords: Glacial-Interglacial Cycles, pCO2, Earth system model

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Paleo-permafrost Dynamics in the late Quaternary -Thermally-conditioned reconstruction from Global Climate Modeling-

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Change in the distribution and variations of permafrost in time and space is an important issue in understanding the attribution and consequence of Quaternary climate change, and projection of the future environment. The subsurface hydrothermal regime offers physical foundation and conditions to the various terrestrial processes and activities, ranging from pure physical to ecological to societal aspects. Through several physical and biogeochemical pathways, however, subsurface changes in land are significantly connected to the atmosphere and to the Oceans. Large-scale numerical climate modeling with improved freeze/thaw dynamics is a strong tool for investigation on the impacts and the attribution of changes in the regime. As a preliminary step, we analyzed the surface air temperature outputs from the Paleoclimate Model Intercomparison Project 2 (PMIP2) to examine the thermal conditions to ground freezing under different climate environment for Pre-industrial or 0 thousand years before present (ka), Holocene Optimum or 6ka, and Last Glacial Maximum (LGM) or 21ka. The variables, together with other meteorological variables, will constitute a basis of the forcing data in our successive integration studies.

A classification of frozen ground (FG) by freeze index (FI) and thaw index (TI) was constructed based on the occurrence frequency of the permafrost, seasonal freezing or no freezing under the present-day distribution. FI and TI are cumulative temperature values below and above the freezing point, respectively, and are derived from the station-based monthly surface air temperature. The present-day ground freezing distribution is taken from the map compiled by International Permafrost Association map (IPA map). Advantage of this classification method is simplicity and intuitiveness, but it also has limitation resulting from negligence of other important factors that control the sub-surface thermal regimes, such as snow cover, vegetation, soil characteristics and micro-topography.

The method was applied to the PMIP2 output to reconstruct the modeled ”thermaly-conditioned” FG distribution for 0ka, 6ka and 21ka. The 0ka result shows reasonable consistency with the present-day result. The LGM case reconstructed the largest permafrost areas. 0ka and 6ka show similar size of distribution except for the regional differences as compared with observation-based reconstruction maps. For LGM, however, a reconstructed atlas shows presence of continuous permafrost south of 50^{o}N, including north of Alps, which this method failed to successfully represent. This discrepancy indicates either the insufficiency of the method or warmer tendency in the simulations for the region, or both. Beringia was not commonly specified for the LGM among the interations, which may hinder from plausible reproductions in the area of our interest (Alaska and east Siberia) for the period, and from direct comparison with the paleo-records of the region. Substantial elaboration will be needed to prepare for the next-step forcing data.

Keywords: Permafrost, freeze/thaw index, global climate model, Quaternary

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Atmospheric local energetics in mid-Holocene and Last Glacial Maximum climates

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A new diagnostic scheme for the atmospheric local energetics is developed. In contrast to existing ones, this scheme can represent the local feature of the Lorentz energy cycle correctly. A set of interaction energy flux and two different local expressions of energy conversion terms gives the complete information about the three dimensional structure of the energy interactions between mean and eddy fields. By utilizing this scheme, the atmospheric general circulation in the mid-Holocene and Last Glacial Maximum climates simulated by AOGCMs is investigated. A preliminary results will be shown.

Keywords: mid-Holocene, LGM, energetics, AOGCM

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The X-ray tomography of the planktic foraminifera: An useful tracer for evaluating carbonate dissolution

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Oceanic acidification is one of the most concerning issues related with global warming by increasing atmospheric CO2. However, the biological influences for oceanic acidification to oceanic plankton which has carbonate skeletons in the natural conditions are still unclear. Here we propose a new technique assessing shell density of planktic foraminifers quantitatively by the Microfocus X-ray CT scanner (MXCT). We focused on two different types of modern planktic species Globigerina bulloides and Globorotalia inflata to estimate the responses to carbonate dissolution. Former has spheric shells with porous strucures and latter has robust secondary calcite layers, respectively. Both species were taken from surface sediments from ca. 1,000 m water depth in the Southern Ocean that affected less carbonate dissolution.

The mean CT values of individual shells of G. bulloides and G. inflata showed large variations within each specimens and indicated degradation of shell density. It attributed the variations of shell density to differential dissolution on the seafloor, but it was identified as the cause of shell ontogeny in each specimens. Furthermore, we performed dissolution experiments in acidification chamber by using CO2 diffuser at the laboratory to examine progressive dissolution for each species. The decreasing of mean CT values of both species consistent with progress of carbonate dissolution observed by scanning electron microscope (SEM). Early formed shells (inside shells) were thinner compared with outer ones, therefore that were lost earlier than outer shells. On the other hand, outer shells of the final whorl were thicker and resistant to dissolution. However, it was observed remarkable partial dissolution at the inside of walls in the outer shells. In other words, we could recognized the dissolution patterns for each species through these experiment and it indicated that shell density of planktic foraminifers is an useful indicator of carbonate dissolution.

Keywords: Microfocus X-ray CT Scanner, Ocean acidification, carbonate dissolution, planktic foraminifera, X-ray tomography