Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

ACC31-01 Room:104 Time:May 23 09:00-09:15

Chemical analysis of three snow pits of inland Antarctic Expedition 2007/2008 (JASE)

HOSHINA, Yu[1*], FUJITA, Koji[1], NAKAZAWA, Fumio[2], Yoshinori Iizuka[3], MIYAKE, Takayuki[4], HIRABAYASHI, Motohiro[2], KURAMOTO, Takayuki[5], MOTOYAMA, Hideaki[2], FUJITA, Shuji[2]

[1]Nagoya University, [2]National Institute of Polar Research, [3]Institute of Low Temperature Science, Hokkaido University, [4]The University of Shiga Prefecture, [5]Institute of Mountain Science, Shinshu University

To understand the spatial-temporal variability of glaciological environment in Dronning Maud Land, a 2800 km traverse was carried out by Japanese Swedish Antarctic Expedition (JASE traverse) in austral summer 2007/2008 (Fujita et al., 2011). The route of this traverse is crossing Syowa-Dome Fuji-EPICA DML (Kohnen)-Wasa. In this expedition, 4 or 2 m deep snow pits were dug at Dome Fuji (DF) and Meeting Pint (MP) and Middle Point (Mid.P). We analyzed for water stable isotopes, major soluble ions and tritium content with 2 cm intervals. We counted summer layers of snow pits using nssSO_4^{2-}, tritium content, sodium ion, chloride ion and crust layers. Snow accumulation rates are 29.3 kg m^{-2} a^{-1} of DF, 34.8 kg m^{-2} a^{-1} of Mid.P and 0.7 kg m^{-2} a^{-1}, MP by dating of snow pits.

Comparing ion compositions between three snow pits, there is not significant difference of them. In other hands, we show negative correlation between water stable isotope and ion concentrations. These correlations are well at inland site (DF).

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ACC31-02 Room:104 Time:May 23 09:15-09:30

Multi-millennial-scale climatic variations in Antarctica during the last eight glacial cycles

KAWAMURA, Kenji[1*], Dome Fuji Ice Core Research Group[1]

[1]National Institute of Polar Research

Climatic variability on millennial timescales, characterized by abrupt temperature changes in the Northern Hemisphere and inter-hemispheric seesaw, have been well documented for the last glacial period by many paleoclimatic records. It is also evident that very large inter-hemispheric seesaw occurred during the last deglaciation. The cause for these variations is thought to be the variations of freshwater flux into North Atlantic ocean from surrounding ice sheets, which can change the strength of meridional overturning circulation and associated poleward heat transports. Therefore, millennial-scale variations in Antarctica or elsewhere may tell us about ice sheet variability in the Northern Hemisphere. However, the frequency and magnitude of such events are uncertain for older glacial periods and terminations because of the lack of suitable climatic records. Here we present a 720,000-yr ice-core isotopic record along the second Dome Fuji ice core, East Antarctica. Synchronizing and stacking this record with existing Dome C ice-core record permits robust identification of multi-millennial-scale Antarctic warming events over the last eight glacial cycles. Dust proxies in Marine Isotope Stage 16 in the Dome Fuji core (oldest glacial period in this core) show that the millennial-scale variations of dust flux are negatively correlated with Antarctic temperature for all identified events. This demonstrates that changes of aridity in the dust source region, presumably Patagonia, occurred in concert with Antarctic climate changes. A bandpass filter (3,000 - 15,000 yr periodicities) was applied to the stacked isotope record to account for loss of resolution in the old (deep) part. This allows us to identify large Antarctic warming events with a constant criteria through 800,000 years. We find a positive relationship between repetition period of multi-millennial-scale events and Antarctic temperature, with exceptions in glacial maxima. The data suggests instability of Northern Hemisphere ice sheets in intermediate glacial condition and also a role of climatic precession, presumably through Northern Hemisphere summer insolation, affecting ice sheet mass balance. Multi-millennial-scale events becomes infrequent in times of large precession variations in early parts of glacial periods, implicating long freshwater release due to strong summer insolation forcing. Very large multi-millennial-scale events are identified at glacial terminations, suggesting that the terminations in general involve abrupt and large climatic transitions which are overlaying on the slow orbital-scale variations.

Keywords: Dome Fuji ice core, Antarctica, Millennial scale climatic changes, Orbital variations, Bipolar seesaw, Glacial terminations

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ACC31-03 Room:104 Time:May 23 09:30-09:45

Modelling the Abrupt climate change in millennial scale and its influence upon ice sheets during the middle level glacia

ABE-OUCHI, Ayako[1*], Fuyuki Saito[2], Akira Oka[1], Rumi Ohgaito[2], Kunio Takahashi[2]

[1]AORI, University of Tokyo, [2]JAMSTEC

Abrupt climate change in millennial time scale such as D-O cycles and AIM recorded in ice cores occurs more frequent with high amplitude during the middle level glacial climate state than in the interglacial state or the full glacial state. The mechanism of the frequent occurrence of abrupt change through the Atlantic meridional overturning circulation is unclear and the necessity of the high frequency during the middle level glacial stated is not known. Here we use a coupled ocean atmosphere model, MIROC, to compare the detailed nature of the response to fresh water release (0 to 0.1Sv under different initial condition) of AMOC under middle level glacial state with interglacial or full glacial state. Under middle level glacial state, the AMOC is stronger at the basic state (without water release), nearly switches off with small amount of fresh water release of 0.05 Sv and induces larger cooling in the Northern hemisphere than other background climate states. The recovery of AMOC is induced from a nearly swithed off AMOC state by reducing the fresh water release to 0.01Sv or less, lead by the gradual response in the low latitude and followed by the lagged but sudden response in the convection and sea ice area in the North Atlantic. Laurentide and Fenno-Scandian Ice sheets' melt water estimated by an ice sheet model IcIES is consistent to the melt water amount needed for the AMOC change under middle glacial state, showing a possibility of favorable condition of self sustained oscillation between ice sheet and ocean meridional overturning under middle level glacial climate.

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ACC31-04 Room:104 Time:May 23 09:45-10:00

Variability of aerosols at NEEM, Greenland during the last glacial period

GOTO-AZUMA, Kumiko[1*], Anna Wegner[2], Margareta Hansson[3], Motohiro Hirabayashi[1], Birthe Twarloh[2], Takayuki Kuramoto[4], Takayuki Miyake[5], Hideaki Motoyama[1], NEEM Aerosol Consortium members[6]

[1]National Institute of Polar Research, [2]Alfred Wegener Institute for Polar and Marine Research, [3]Stockholm University, [4]Shinshu University, [5]The University of Shiga Prefecture, [6]NEEM project

A new deep ice core was drilled at NEEM, Greenland during the 2008-2011 field season. The bedrock was reached at 2540m depth. During 2009- 2011, CFA (Continuous Flow Analysis) was carried out. Discrete samples were collected from the CFA melt fractions, and were distributed to different laboratories. Ionic species were analyzed at National Institute of Polar Research (Japan) and Alfred Wegener Institute for Polar and Marine Research (Germany) with ion chromatographs. Here we present and compare the ion concentration data obtained by both institutes. Most of the ions show good agreement between the two institutes. Concentrations of calcium, sodium, chloride, fluoride, sulfate, potassium and magnesium, show large variations associated with Dansgaard-Oeschger (DO) events, as has been already reported for other Greenland ice cores. New ion data obtained from the NEEM deep core display large variability of oxalate and phosphate concentrations during DO events. On the other hand, nitrate, ammonium and methanesulfonate do not show such variations. The millennial scale variations of ions are thought to be caused by changes in atmospheric circulation and source strength.

Keywords: NEEM, Greenland, ice core, last glacial period, ion concentration, Dansgaard-Oeschger (DO) events

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ACC31-05 Room:104 Time:May 23 10:00-10:15

Climate change for the past 100 ka viewed from the TOC contents of the sediment cores MD10-3304 and 3312 from Japan Sea

KUMON, Fujio[1*], URABE, Tasuku[2], KURIYAMA, Manato[3], MATSUMOTO, Ryo[4]

[1]Faculty of Science, Shinshu University, [2]Faculty of Science, Shinshu University, [3]Graduate School of Science, Nagoya University, [4]Dept of Earth and Planetary Science, University of Tokyo

Sediment cores, MD10-3304 and 3312 are collected from two sites on a mound at 896 m depth and a small ridge at 1026 m depth off Joetsu, Japan Sea during the MD179 cruise. They are composed mostly of silty clay with several maker tephra beds. Based on the relationship between the depths and ages of the identified tephra and 14C measurements, the bottom age of the cores are estimated as old as 102 ka and 125 ka respectively. Total organic carbon (TOC) and total nitrogen (TN) have been analyzed onr the cores in every 2 cm or 4 cm intervals corresponding to 50 to 100 years.

The TOC contents vary from 0.6 % to 2 %, showing quasi-periodic fluctuations, and the stratigraphic profiles of TOC contents of the MD10-3304 and 3312 cores are very similar each other. The temporal changes of TOC in both cores well correspond to the delta 18O profile of the ice core (NGRIP) from Greenland. Short warm period correlative to the Greenland Interstadial (GIS) 1 to 25 can be identified in the profiles for 100 ka (D-O cycle). General trends of both TOC curves are also similar the LR04 curve of marine delta 18O isotope. This fact suggests a strong teleconnection between North Atlantic region and Far East Asia, climate of which are controlled strongly by the same Arctic air mass. In a cold period, the strong cold air mass pushed the polar front southward, and cold air mass occupied around Japan Sea for a longer season. Cooling effect of sea surface temperature and expanded frozen season might be resulted in low biological productivity of Japan Sea TOC contents of the Japan Sea sediment is an excellent proxy of winter temperature in a middle latitude region of Far East Asia.

MD179/Japan Sea gas hydrate cruise of R/V Marion Dufresne was performed under the financial supports from MH21 project.

Keywords: paleoclimate, Japan Sea, total organic carbon, MD10-3312, Greenland ice sheet, D-O cycle

Japan Geoscience Union Meeting 2012
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ACC31-06 Room:104 Time:May 23 10:45-11:00

Solar influence on Greenland temperature anomalies over the past 1000 years

KOBASHI, Takuro[1*], Kunihiko Kodera[2], Jason Box[3], Drew Shindell[4], Masakazu Yoshimori[5], Toshiyuki Nakaegawa[2], Ayako Abe-Ouchi[5], Jinro Ukita[6], Kenji Kawamura[1]

[1]National Institute of Polar Research, [2]Meteorological Research Institute, [3]Bard Polar Research Center, [4]NASA Goddard Institute for Space Studies, [5]University of Tokyo, [6]Niigata University

The surface temperature of the Greenland ice sheet is among the most important climate variables for assessing how climate change may impact human societies associated with accelerating sea level rise. However, the causes of multi-decadal to centennial temperature changes in Greenland are not well understood, largely owing to short observational records. Greenland climate exhibited less warming than Northern Hemisphere (NH) average temperature during the 1960s to 1980s. Thereafter, Greenland has been warming rapidly, whereas the increase in the NH average temperature has been relatively slow. The Greenland temperature anomaly (GTA) relatively to the NH may be linked with the North Atlantic Oscillation/Arctic Oscillation (NAO/AO). Here, we show that the GTA has been caused by solar-induced NAO/AO-like patterns over the past 1000 years. Evidence indicates that the anomaly is likely linked with solar-paced changes in the Atlantic meridional overturning circulation (AMOC) and associated changes in northward oceanic heat transport.

Keywords: Greenland, Climate change, temperature, solar activity

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ACC31-07 Room:104 Time:May 23 11:00-11:15

Sr and Nd isotopic ratio of dust in an ice core drilled on Grigoriev Ice Cap in Tien Shan Mountains

NAGATSUKA, Naoko[1*], TAKEUCHI, Nozomu[1], NAKANO, Takanori[2], SERA, Shuntarou[1], FUJITA, Koji[3], OKAMOTO, Sachiko[3], NAOKI, Kazuhiro[4], Vladimir Aizen[5]

[1]Chiba University, [2]Research Institute for Humanity and Nature, [3]Nagoya University, [4]JAXA, [5]University of Idaho

Eolian mineral dust from vast deserts can be transported globally by wind and effect various environments on the Earth. Dust deposited on glaciers in the past can be obtained by ice core drilling. The past variations in the eolian dust can be reconstructed by particle analysis of ice cores.

Stable isotopic ratios of Sr and Nd provide a means of identifying sources of substances. The means can use for the icecore dusts because it requires low samples for analysis. These isotopic ratios of the icecore dusts may show variation of amount, provenance and pathway of the dust. In this study, we analyzed Sr and Nd isotopic ratio of the icecore dusts drilled on Grigoriev glacier in Kyrgyzstan Tien Shan Mountains.

The ice core was drilled at a snow plateau of 4660 m a.s.l. in 2007. The length is 87.48m and the age estimated 12,000 years. There were prominent dust layers in more than 80m of the ice core. The particle concentrations of the layers were approximately 10 folds of the mean concentration of the ice core. Sr and Nd isotopic ratios of the dust in several layers were lower than those of soil from the bottom of ice core. This suggests that the dust was not derived from soil around the ice cap but from Asian desert sand, which is most likely to be derived from Taklimakan Desert.

Keywords: Sr, Nd isotope ratio, Ice core, Dust provenance

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ACC31-08 Room:104 Time:May 23 11:15-11:30

Trace element analyses in a Gregoriev ice core in Kyrgyz Tien Shan for the period 1800-2007AD

MURAKAMI, Kosei[1*], FUJITA, Koji[1], TAKEUCHI, Nozomu[2], NAKANO, Takanori[3], Kicheol Shin[4], Vladimir B Aizen[5]

[1]Nagoya University, [2]Chiba University, [3]RIHN, [4]AIST, [5]Idaho University

Trace elements contained in ice cores provide various information with respect to environmental changes in the past. However, recent studies dealing such trace elements in ice cores, which were drilled in Asian regions, have been limited to decadal time scale.

In September 2007, a 87-m long ice core was drilled at the Gregoriev Ice Cap, Tien Shan Mountains, Kyrgyzstan. Age scale was given by counting the seasonal variation of pollen species validated with the 1963-tritium horizon up to depth of 67m, and by radiocarbon dating in deeper part. This core was estimated to cover over the past ten thousands years.

In this study, we analyze 53 species trace elements (e.g. Ti, Mn, Ni, Zn, Cd, Sn, Pb, REE) up to depth of 59.7m. We provide the longest continuous data with respect to trace elements in Asian ice cores.

We find that some anthropogenic elements (Ni, Cu, Zn, As, Cd, Sb, Sn, Pb) show different variation from those from the other regions in Asia whereas Ni, Cu, As Sb and Pb show similar variation. Sn concentrations increased slowly since the 1960s and decreased slowly since the 1980s. Cd concentrations exponentially increased since the second half of the 20th century presumably because of the increased fossil fuel consumption and the industrial expansion in this region. Cd concentrations gradually decreased since the 21th century because of the controlled industrial emissions in the Europe and North America. However, industrial expansion of the surrounding area (central Asia), might cause increase of Cd again.

Most of anthropogenic elements (Cu, As, Cd, Sn, Pb) show low concentration compared with the other Asian ice cores, while Antimony was contained in high concentration level (about twice) presumably because of the indigenous product in Kyrgyzstan and neighboring Kazakhstan.

Keywords: ice core, trace elements, anthropogenic elements, Grigoriev ice cap

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ACC31-09 Room:104 Time:May 23 11:30-11:45

Verification of crystal size and water stable isotopes for climatic proxies in Belukha ice core, Siberian Altai

OKAMOTO, Sachiko[1*], FUJITA Koji[1], NARITA Hideki[2], AIZEN Vladimir A.[3], SERA Syuntaro[4], TAKEUCHI Nozomu[4], UETAKE Jun[5], NAKAZAWA Fumio[5], MIYAKE Takayuki[6], NIKITIN Stanislav A.[7], NAKAWO Masayoshi[8]

[1]Nagoya University, [2]Network of Snow and Ice Specialists, [3]University of Idaho, [4]Chiba University, [5]National Institute of Polar Research, [6]The University of Shiga Prefecture, [7]Tomsk State University, [8]National Institutes for the Humanities

The seasonal change of crystal size is utilized for deriving age scale for Belukha ice core, Siberian Altai. Consequently, the upper 154.27 m of the ice core cover the period from 1210 to 2003. Annual median of initial crystal area removed impurities effect (effective crystal area) estimated by the empirical formulas shows significant correlations with air temperature estimated Barnaul temperature. The periods of small effective crystal area agree with the periods of solar activity Minimums. The 5?year averaged oxygen isotope ratio, solar modulation, accumulation and d?excess shows significant correlations. These relationships suggest that oxygen isotope ratio in Belukha ice core represents summer precipitation changes from the Atlantic Ocean and the irradiated solar reduce precipitation. The variation of d?excess means the ratio of precipitation from western recycled water vapor.

Keywords: ice core, crystal size, water stable isotopes, d-excess

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Variation of precipitation reconstructed from Alaskan alpine ice-core

MATOBA, Sumito[1*], Akane Tsushima[1], Takayuki Shiraiwa[1]

[1]Institute of Low Temperature Science, Hokkaido University

We obtained two ice cores from Alaskan alpine glaciers. One is from Mount Wrangell at Wrangell-St. Elias range, and the other from Aurora Peak at Alaska range. Signals of water isotope of both of ice cores showed remarkable seasonal cycle. Then we could estimate annual accumulation from the seasonal cycles of water isotope. While the variation of accumulation at Mount Wrangell did not show any trend for 50-100 years, the variation of accumulation at Aurora Peak showed significant increase trend since 1970s.

Keywords: Ice core, Alaska, Alpine glacier, precipitation, water isotope