Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

ACC29-P01 Room:Convention Hall Time:May 26 18:15-19:30

Studies of melting ice using laser for ice drilling

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We have studied the melting properties of ice using CO_2 laser at 10.6 micro-meter wavelength. At this wavelength ice strongly absorbs and a hole is drilled along the path of the laser irradiation. The melting speed of ice has been measured at several irradiation intensities and laser excitation angles relative to the horizontal axis. The melting speed of ice increased almost proportionally with the increasing laser excitation intensity. For the laser excitation intensity of about 50 W/cm^2, for instance, the melting speed was estimated to be 4 mm/s and 0.8 mm/s for snow (0.15 g/cm^3) and ice, respectively. Experimental results show that for elevated excitation angles melt-water accumulate in the hole adversely affecting the melting speed of ice. Though the problem of accumulating water during the drilling into ice is necessary to take into consideration, we believe that our concept of a fiber coupled IR laser drilling system could be employed for drilling ice sheets and glaciers.

Keywords: ice, laser, absorption, melt, drilling, ice sheet

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State dependence of climatic instability from ice-core records over the past eight glacial cycles

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Climatic variability on millennial timescales with bipolar seesaw pattern during glacial period has been documented in palaeoclimatic records, but their frequencies and relationships with mean climatic state are still unclear. Here we investigate the long-term characteristics of such variability using a new 700,000-year ice core record from Dome Fuji, East Antarctica, combined with another long Antarctic record. The 10^3- to 10^4-year warming events over the past eight glacial-interglacial cycles are most frequent when Antarctic temperature is slightly below average, equivalent to an intermediate climate during glacial periods. With the ice core data and climate modeling, we suggest that the prerequisite for the most frequent climate instability with bipolar seesaw pattern during the late Pleistocene is not only the extent of continental ice sheets but also low CO2. North Atlantic cooling sets high sensitivity of AMOC and climate to small perturbations such as moderate freshwater anomaly.

Keywords: Dome Fuji ice core, Abrupt climate change, Millennial-scale variability

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Modelling the state dependency of abrupt climate change and bipolar seesaw

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Millennial climate change such as D-O cycles, AIM recorded in ice cores in both Hemispheres is known to show a relatively higher amplitude in the middle-level of a glacial cycle than in the interglacial state or severe glacial state. Although massive discharge or melt water of Ice sheet to ocean is one of the cause thought to be responsible for the millennial climate change, the thermal response to fresh water release in North Atlantic in global models and/or the paleoclimatic data in the region far from North Atlantic do not agree and even do not explain the dependence of the amplitude upon the level of climate state. Here we ran several sensitivity experiments using a coupled atmosphere and ocean GCM (MIROC3.2.2) and show that the response to fresh water release to the ocean and bipolar response is highly dependent on the background climate. The experiments were conducted with 500 years water hosing of 0.05 to 0.1 Sv (where 1 Sv is equivalent to the water flux of 10m sea level rise in 100 years) in the North Atlantic 50-70N in the same manner and position as CMIP/PMIP protocol under different basic states; Modern Hosing under modern climate with the pre-industrial condition, and Glacial hosing under LGM condition (21ka as PMIP, with ice sheets and lowered Greenhouse Gases). The results show largest cooling response in North Atlantic and a reasonable bipolar warming signal as in the ice cores of Antarctica, and the dependence upon background climate is not relatively the same for the both hemisphere. The mechanism of different responses are discussed in detail through the analysis of model experiment of atmosphere, ocean and sea ice coupling.

Keywords: climate model, abrupt climate change