【Grant-in-Aid for Young Scientists(S)】

Integrated Science and Innovative Science (New multidisciplinary fields)

Title of Project : Mechanisms of glacial-interglacial climatic changes explored with Antarctic ice core analyses and climate modeling

Kenji Kawamura
(National Institute of Polar Research, Division of Research and Education, Assistant Professor)

Research Area : New multidisciplinary fields

Keyword : Environmental change, Antarctic ice cores

【Purpose and Background of the Research】

Global climate has experienced 100,000-year cycles for the past 1,000,000 years, known as the glacial-interglacial cycles. During maximum glacial conditions, ice sheets covered large areas at northern high latitudes with a maximum height of 3 km. Sea level was 130 m lower and Antarctic temperature was 9 degrees colder than present. It is important to clarify the mechanisms for these changes, for advancing our understanding of the climate system and looking into its future. Glacial-interglacial cycles involve key forcings such as greenhouse gases, ice sheets, ocean circulation and aerosols, which are important in the era of anthropogenic climate change, and the past climatic variations were much larger than emerging anthropogenic changes. This study aims at reconstructing atmospheric greenhouse gas concentrations, Antarctic temperature and global ocean temperature in and around the current and past interglacial periods. The data will permit constraining the relative timing between changes of air and ocean temperatures, sea level, greenhouse gases, and orbital parameters for the past global changes. They will also be used as input and evaluation data for numerical modeling, for comprehensively studying climate, ice sheet and carbon cycle changes.

【Research Methods】

The Dome Fuji ice core, Antarctica, will be analyzed for CO_2, CH_4 and N_2O concentrations at a 200-year resolution for the past interglacial periods and transitions into and out of them. The high-resolution analyses require development of new air extraction and measurement systems. For ocean temperature reconstruction, Kr and Xe concentrations will be measured. O_2/N_2 ratios will be measured for improving chronology. In addition, firn air will be sampled at Dome Fuji and measured in the lab, and CH_4 concentration on the ice core will be measured at a 100-year resolution for constraining the age difference between ice and air.

The data will be analyzed in collaboration with paleoceanographers and climate modelers, and will be provided for numerical simulations using state-of-the-art models. Model outputs will be analyzed with available paleoclimatic data.

【Expected Research Achievements and Scientific Significance】

This study will shed light on important climatic problems such as the following.

---Did Northern Hemisphere summer insolation always change before changes in air temperature, ocean temperature and greenhouse gases? Which orbital parameter was the primary trigger for glacial-interglacial cycles?

---If humans have not been present, should climate have already been approaching to the next glacial period?

---What determined the global ocean temperature, and how did it relate with atmospheric CO_2 concentrations?

Because dating accuracy and measurement precision of the Dome Fuji core are extremely high, this study is expected to provide unprecedented data for separating contributions of greenhouse gases and orbital parameters on the global changes. It will enable integration of top-level ice core analyses and climate modeling.

【Publications Relevant to the Project】

・Kawamura, K. et al., Northern Hemisphere forcing of climatic cycles in Antarctica over the past 360,000 years. Nature, 448, 912-916 (2007).

・Lüthi, D., ……, Kawamura, K. and Stocker, T., High-resolution carbon dioxide concentration record 650,000-800,000 years before present, Nature, 453, 379-382 (2008).

【Term of Project】 FY2009-2013

【Budget Allocation】 83,000 Thousand Yen

【Homepage Address and Other Contact Information】

http://polaris.nipr.ac.jp/~kawamura/wakateS
kawamura@nipr.ac.jp