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


MIS21-P01 Room:Convention Hall Time:May 27 18:15-19:30

# Dynamics of Antarctic Circumpolar Current, Weddell Gyre and sea ice distribution

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The Southern Ocean has played an important role in the evolution of the global climate system. Area of sea ice shows a large seasonal variation in the Southern Ocean. The Southern Ocean circulation is dominated by the Antarctic Circumpolar Current (ACC), the world's longest and largest current system. The Weddell Gyre is a large clockwise gyre in the Southern Ocean, and contribute sea ice distribution in the Atlnatic and Indian sectors of the Southern Ocean. Sea ice coverage on sea surface strongly affects the climate of the Southern Hemisphere through its impacts on the energy and gas budget, on the atmospheric circulation, on the hydrological cycle, and on the biological productivity. We plan to reveal the dynamics of Southern Ocean subsystems and those interaction with global climate change by modern ocanographyical obserbations, sediment trap experiments, paleoceanographic applorch in piston and drilling cores, and climate model experiments.

Keywords: Southern Ocean, Antarctic Circumpolar Current, Weddell Gyre, sea ice, climate change

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MIS21-P02 Room:Convention Hall Time:May 27 18:15-19:30

# Towards understanding of Antarctic ice sheet and climate variations and interactions

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This presentation introduces a research plan about Antarctic ice sheet and climate, and their interactions. The plan aims at revealing the Antarctic ice sheet climate in terms of their status, variability and interactions in the present and past. Emphases will be laid on (1) analyses and proxy developments for reconstructing the past temperature, accumulation rate, sea ice and carbon cycle, as well as (2) modern observations of the ice sheet margin and ocean.

Keywords: Antarctic ice sheet, Climate change, Ice core, Ice sheet melting

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MIS21-P03 Room:Convention Hall Time:May 27 18:15-19:30

# Interaction of the solid Earth and the Antarctic ice sheet

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The Antarctic ice sheet, which relates to the global climate changes through the sea level rise and ocean circulation, is an essential element of the Earth system for predicting the future environment changes. Thus many studies of the ice sheet changes have been conducted by means of geomorphological, geological, geodetic surveys, as well as satellite gravimetry and satellite altimetry. However these studies thus far conducted have been affected by the large uncertainties of GIA (Glacial Isostatic Adjustment), which is the rheological response of the solid Earth to the ice mass loading. Therefore the precise estimation of the GIA effects is an urgent and the most important task for these studies. The effects of GIA, on the other hand, include valuable information about the rheological properties of the solid Earth. Thus the observational studies of the GIA effects should greatly contribute to investigate the inner structure of the Earth. GIA as a keyword to investigate the interaction between the solid Earth and the ice sheet changes is an important research target not only for a practical requirement of predicting global changes but also for a more pure scientific interest to know the structures of the deep Earth's interior.

In view of these points, we plan to conduct geomorphological, geological and geodetic surveys in the inland mountain areas and the coastal areas in East Antarctica, where the in-situ data for constraining GIA models are very few. In addition, we will conduct very precise monitoring of the land movements at Syowa Station using space geodetic observations such as SLR (Satellite Laser Ranging) and VLBI (Very Long Baseline Interferometer) as well as sea bottom geomorphological surveys on continental shelves using new technology of ROV (Remotely operated Vehicle) and AUV (Autonomous Underwater Vehicle). Combining these observations with the analyses of the sea bottom cores obtained by the bowling surveys on the continental shelves, various satellite data analyses and numerical modeling, we will precisely estimate the response of the solid Earth due to the GIA effects and corresponding sea level changes. These procedures lead us to a precise GIA model and constructing a reliable ice melting history after LGM (the Last Glacial Maximum) and the viscoelastic structure of the Earth's interior.

To achieve the above target, we mainly plan to conduct the following research items;

(1) glacial topographic surveys, geological surveys, gravity measurements, and GNSS measurements in Yamato Mountains,

(2) reevaluations of the glacial topography in Sor-Rondane Mountains, Belgica Mountains, and Yamato Montains by combining the in-situ data thus far obtained with the newly developed DEMs (Digital Elevation Model) using satellite data,

(3) continue the geodetic observations including the tide gauge monitoring at Syowa Station,

(4) absolute gravity measurements and GNSS measurements at the outcrops along the coastal area near Syowa Station,

(5) micro glacier topography analysis of the detailed airborne photographic data obtained by an unmanned aerial vehicle near the outcrops,

(6) improving the accuracies of the retreat ages of the ice sheets using the cosmogenic nuclide exposure ages of the basement bowling samples and the moraine rocks,

(7) precise monitoring of the present day ice sheet movements and sea level changes by means of InSAR, satellite gravimetry and altimetry.

Including all these observations, data analyses and various modeling, we finally aim at the quantitative reconstruction of the ice melting history over the last millions years, and the improvement of the models for predicting the future global changes.

Keywords: ice sheet, sea level change, Glacial Isostatic Adjustment, ice sheet melting history, East Antarctica, viscoelastic structure

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MIS21-P04 Room:Convention Hall Time:May 27 18:15-19:30

# The prospect of the observation around the unexplored area in the Southern Ocean

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The primary processes and the mechanism of the various kinds of interactions should be elucidated to understand the changes in the Southern Ocean and the Antarctic ice sheet from the viewpoints of giant reservoirs of heat, water and carbon dioxide, which drive changes in the global climate and ecological system. Especially, the interactions around the boundary between ice sheet and ocean, namely ice shelf and sea ice areas, are key in the context of the Southern Ocean and the Antarctic ice sheet, and the field observation data around this area is essential. However, the field observation data around ice shelf and sea ice areas is very poor because of the difficulties with the observation. The acquisition of the field observation data in the unexplored area around the boundary between ice sheet and ocean, including the edge of sea ice, is required to understand the interactions between the Southern Ocean and the Antarctic ice sheet, and the developments of the observation instruments are also important element to obtain the data.

The underwater robots such as ROV (Remotely Operated Vehicle) and AUV (Autonomous Underwater Vehicle) are widely used in the oceanographic observation in recent years associated with the development of robotics. Introduction of unmanned research vehicles, such as ROV, AUV and USV (Unmanned Surface Vehicle), is urged to obtain the oceanographic and geological observation data around unexplored field, under ice shelf, sea ice and the surrounding areas, and the observation instruments accompanied with the unmanned research vehicles must be developed. The outline of the introduction of unmanned research vehicles and the development of the observation instruments around the boundary between ice sheet and ocean, including the edge of sea ice, is presented, and the future perspective is discussed.

Keywords: Southern Ocean, Antarctic ice sheet, unmanned research vehicles, sea ice, ice shelf

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MIS21-P05 Room:Convention Hall Time:May 27 18:15-19:30

# Integrated modelling of the Antarctic ice sheet, ocean and climate

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Understanding the response of climate, ocean and ice sheet of Antarctic region to forcings in the past, present and future mainly through modelling is the task of this team. As a highest priority, the team develops newly the ice sheet model which deals with the interaction between ice sheet-ice shelf and ocean in order to understand the behaviour of grounding line of ice sheet which and the threshold of condition of substantial retreat. Ocean and ice sheet behaviors in decadal to centennial time scale at present and in the near future as well as the paleoclimate time scale of glacial-interglacial cycle and Plio-Pleistocene change are of interest. We would like to discuss the topics that are needed to be modeled for the Japanese community in this field.

Keywords: Antarctica, climate model

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MIS21-P06 Room:Convention Hall Time:May 27 18:15-19:30

# Recent development of numerical ice-sheet/ice-shelf model IcIES and its application on Antarctic Ice Sheet

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Ice sheet model for Integrated Earth-system Studies (IcIES) has been developed to simulate Greenland and Antarctic ice sheets as well as paleo-climate studies of past Northern Hemisphere ice sheets.

Previous studies using old version of IcIES for the Antarctic ice-sheets have focused on subjects which are insensitive to transient migration of grounding line position. Now we have been restructuring and improving the model to compute flow fields over ice-shelf and on grounding line using the shallow-shelf approximation and a grounding-line flux parameterization (based on Schoof 2007), for better understanding of past/future evolution of ice sheets. In this study details of recent structure of the numerical model is described. Demonstration under ideal and realistic configuration including Greenland and Antarctic ice sheets are presented. Impact on the simulation by variation of technical details such as a convergence criteria in the matrix solver is described to show the influence of long-term simulations.

Keywords: numerical modeling, ice-sheet