【Grant-in-Aid for Transformative Research Areas（A）】

A Study of Antarctic Ice Sheet（Global Antarctic Science: connecting the chain of changing huge ice sheet and global environments)

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Project Information	Project Number : 24A402　　Project Period (FY) : 2024-2028 Keywords : Antarctic Ice Sheet, Sea level rise, Ice sheet instability, Cascading global change, Global warming

Purpose and Background of the Research

●Outline of the Research

The Antarctic Ice Sheet is vulnerable to the global warming. It is concerned its instability might lead to an acceleration of global sea level rise faster than expected. The ice discharge can trigger a chain reaction of changes in global climate subsystems. By combining innovative observations, sample analysis, and numerical simulations, our research area aims to examine the **cryosphere changes and interaction between the Antarctic Ice Sheet and the global climate system** over a time axis spanning from tens of thousands of years or more into the near future.

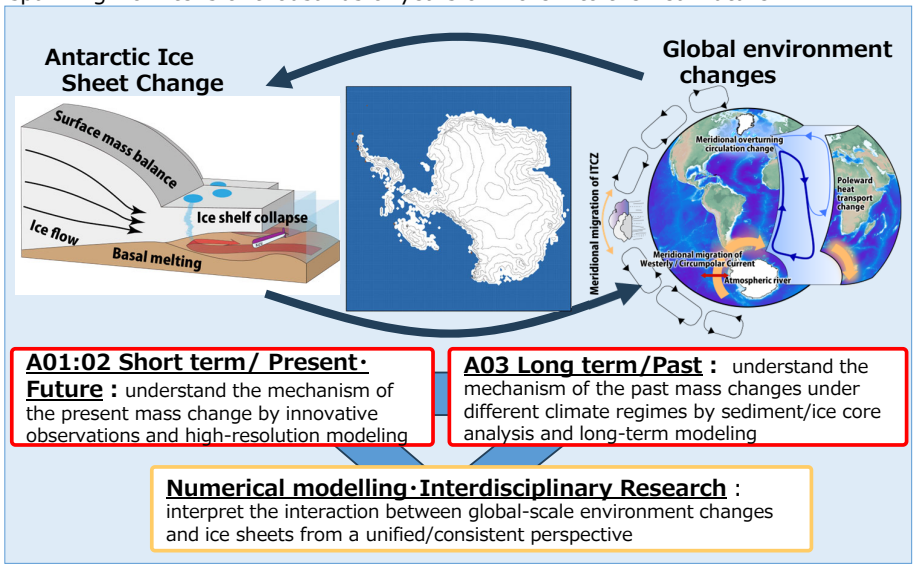

Figure 1. Schematic structure of our research area

●Accelerating discharge of Antarctic Ice Sheet and Global Sea Level Rise

Satellite observations over the last few decades have revealed the **accelerating ice mass loss** from the Antarctic Ice Sheet, which is the largest uncertainty in predicting the future sea level (Fig.2). It is urgent to understand the mechanisms of the instability of the ice sheet, together with the counteracting increasing transport of atmospheric water vapor. During the past interglacial periods of the temperature warmer by 1-2 ℃ than the preindustrial period, the global sea levels then were higher by 6-9 m. The seemingly discordance indicates the lack of our understanding on the mechanism of ice sheet instability and its relationship with the global environment.

●Antarctic Ice Sheet and global climate components

Climate components, affecting the growth and decline of the Antarctic Ice Sheet, include meridional overturning circulation, Antarctic Circumpolar Currents, atmospheric transport, westerly winds, sea ice, etc. (Fig.3). Some components have the characteristic that their changes are linked mutually globally. Changes have been already observed in some factors over the past 20 years. Changes in the Antarctic Ice Sheet will have an impact not only on sea level rise, but also on changes in meridional overturning circulation. In this way, **the interaction between the Antarctic ice sheet and global environmental components** affects both the expansion and contraction of the ice sheet in a complex manner.

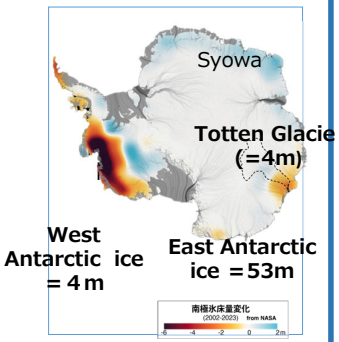

Figure 2. Antarctic ice mass and its recent change

Expected Research Achievements

●Multidisciplinary research for Global Antarctic Science

- For the short time scales from the past few decades to the present/ near future, we conduct **various observations and numerical modeling** from the East Antarctic Ice Sheet to the Southern Ocean. We examine the interaction between fluctuations in ice sheet mass, dynamics, and melting processes and the local-to- global changes in ocean, atmosphere, and material circulation**. Autonomous underwater vehicles** will be deployed beneath hitherto unexplored ice shelves and sea ice, and will be used to investigate the structure of ice, under-ice ocean and sea floor.
- Over the past several hundred thousand years time scales, we aim to reconstruct large-scale changes of Antarctic Ice Sheet, the Southern Ocean, and the global environment with high temporal resolution analysis of **sediment and ice cores** and utilization of numerical models. We will elucidate the actual state and mechanism of the ice sheet changes occurred during the warm interglacial period, etc.
- Through **the integration of the multidisciplinary research** that connects these vastly different temporal and spatial scales, we aim to elucidate the instability of the **East Antarctic Ice Sheet** and their interaction with the global environment (Fig. 4).

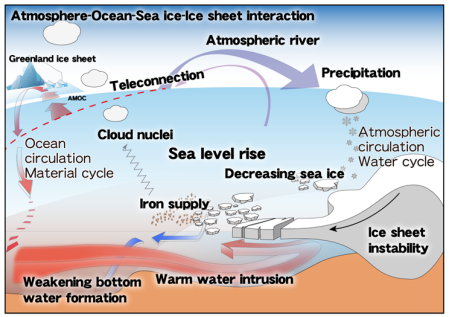

Figure 3. Schematics of the global climate components related to the mass change of the Antarctic Ice Sheet

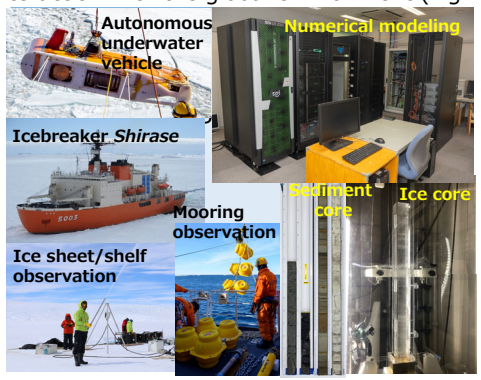

Figure 4. Examples of representative research platforms and methods in our research area

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