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Current and future Arctic atmospheric observations

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Abstract

The reduction of September Arctic Sea ice extent over recent decades induced changes in atmosphere structures. To investigate the impact of sea ice retreat on an atmosphere, atmospheric observations have been conducted over the ice-free area in the Chukchi and Beaufort seas using meteorological instruments (e.g., ceilometer for cloud base height, radiosondes and drones for vertical atmospheric profiling, C-band Doppler radar for three-dimensional structures of snow and rain) on the Japanese research vessel Mirai [1-4]. The cloud base height observation by the ceilometer on RV Mirai over the ice-free area during 1999 and 2010 showed a decrease in the frequency of low-level clouds with a base height below 500 m compared with observation over an ice-covered area in 1998 due to the deepening of the boundary layer [1]. The shipboard C-band Doppler radar and ceilometer observations detected a convective cloud with relatively large snowfall near marginal ice zone. Ice crystals, which can grow into larger snowflakes by aggregation and riming, were detected by Cloud Particle Sensor (CPS) sondes during summer and early winter. During autumn and early winter, an increase in precipitation was found over the Chukchi and Beaufort seas, contributing to an increase in snow depth on sea ice [5]. The enhanced snow depth on sea ice prevented ice growth during winter and spring.

Although the atmosphere changes associated with sea ice loss were investigated using the unique atmospheric observation data from the Mirai, the Mirai is classified as an ice-strengthened ship and thus is limited to areas and seasons without ice cover [1-4]. Therefore, there are no observational evidences for the change in atmosphere on sea ice and its impact on snow and sea ice because the results of its changes impact on sea ice after the autumn were based on reanalysis data and a numerical model [5]. During autumn and winter, atmospheric responses to changes in midlatitude atmospheric and/or oceanic circulations promoted poleward transports of aerosols and water vapor from midlatitude [6], would promote the changes in atmospheric structure and snow over the sea ice areas. In fact, the air mass over forest fire areas in western Canada transported the Mirai over Arctic Ocean, would influence on the middle troposphere ice clouds obtained by the CPS sonde during Mirai Arctic cruise in September 2023. However, observations for ice clouds were limited to only ice-free areas. A new Japanese ice breaker ship is vital to investigate the air-sea interaction over Arctic Ocean during all seasons. In addition, the arctic vertical atmospheric observations over ocean [2-3] and sea ice [7] in Arctic Ocean reduce error and uncertainty over the Arctic Ocean at initial condition for weather forecasts, improving troposphere circulation representation (e.g. low-pressure system, hurricane, typhoon) over the

midlatitude Northern Hemisphere. The atmospheric vertical profiling on sea ice would help the improvement of atmospheric circulation over the Northern Hemisphere.

[References]

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