北極域の雲と特性と海氷相互作用研究

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Study of interaction between Arctic cloud properties and sea-ice

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We examined relationship between vertical structure of cloud properties and sea-ice in the Arctic. Cloud frequency of occurrence and phase were derived by the analysis of CloudSat radar and CALIPSO lidar data for four years from June 2006 to December 2010. We first applied cloud mask scheme (KU-mask) to determine cloud three-dimensional location [Hagihara et al., 2010]. Then cloud particle classification scheme (KU-type) was applied to distinguish cloud water and ice from CALIPSO [Yoshida et al., 2010]. Ice microphysics was also examined by the ice microphysics algorithm (KU-micro) [Okamoto et al., 2010]. Water vapor and temperature were retrieve by infrared sounder AIRS on Aqua [Ishimoto et al., 2014]. For the sea-ice extent, JAXA-L2 product of sea-ice concentration from microwave radiometer AMSR-E on Aqua was used to derive sea-ice pixels in Arctic regions. When sea-ice concentration is larger than 15%, the sea ice is assigned for the latitude >65N. We found the total cloud cover has a local maximum in May, local minimum in July and local maximum in September to October periods. Cloud particle type classification showed that water cloud cover exceeded between May and October than that of ice clouds and ice cloud cover exceeded between November and March than that of water clouds. The maximum of cloud cover corresponds to the minimum of sea-ice area. Analysis of vertical structure of water clouds indicated that cloud cover at low-level was the largest among the three height categories and low level clouds was smallest in July and largest in September and October. Therefore it was suggested that the decrease of water cloud cover at low-level increased of solar radiation at the surface, leading to decline the sea-ice extent in September due to the accumulation of surface heating. And the open water might help generation of water clouds. We recently introduced a method to estimate ice super-saturation inside clouds by combined use of ice water content retrieved from CloudSat and CALIPSO and water vapor amount from AIRS. In summer, RHcr was as large as 120% over Arctic regions and the values were generally higher than other regions except for some land areas, e.g., over west part of United States, near west part of south Africa and east part of Asia. Higher values of RHcr were also found in the Arctic than other regions in DJF periods.

Ground-based 95GHz cloud radar (Falcon-A, developed by Chiba University) and micro pulse polarization lidar observations have been conducted to investigate the cloud generation mechanism and cloud life time. Analysis of cloud particle type based on the lidar depolarization ratio and attenuation with cloud radar signals showed the super-cooled water cloud layers often persisted for more than several hours and were accompanied ice precipitation below. The horizontally oriented ice particles were also frequently identified, which was consistent with the analysis of CALIPSO [Yoshida et al., 2010, Hirakata et al., 2014]. Radar reflectivity factor showed very large values (>0dBZe) and the retrieval effective radius by radar-lidar algorithm adapted from CloudSat-CALIPSO one was very large (exceeded 200μm), which was unexpected.

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