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Linkages in biogeochemical cycles between surface ocean and lower atmosphere

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Increase of the substances emitted to the atmosphere by human activities and global warming change the amount of land origin substances transporting to the ocean, and influence the marine ecosystems, such as the species and amount of marine organism. While carbon and nitrogen are taken up by marine organism, the amount of trace gases produced from marine organism may change. The release of marine biogenic gases into the atmosphere, the gases will be oxidized and converted to particles (aerosols). It is believed to modify the property and the amount of clouds and to change the lifetime of clouds and the reflection of the sunlight to the earth surface. I would like to introduce the research results revealed the seamless interaction between the atmosphere and the ocean through the marine biological activities.

Across these series of studies were carried out with the collaboration of the scientists from the various fields such as atmospheric chemistry, marine meteorology, marine chemistry, marine biology, and marine physics. As a study area, marine atmospheric boundary layer from the sea surface to the altitude of 2 km above and ocean surface water layer shallower than 200 m of euphotic zone were defined. The joint observation cruises by research vessels have been conducted in collaborative research issues, and it has been collaborated with the land-based atmospheric observations and satellite observations simultaneously.

In the subarctic region of the North Pacific Ocean, we were able to ascertain that atmospheric iron supply to the ocean as a natural phenomenon was observed during a Kosa event and enhanced marine biological activity by in-situ measurement of a research cruise. In addition the marine biological production increased by the supply of iron in the volcanic ash during the eruption in the Aleutian Islands and measured the increased trace gases productions caused by the marine organisms.

The measurement of volatile organic compounds in and over the Pacific Ocean, the gases released from the ocean was converted to organic aerosols in the marine atmosphere. In particular by the 2008 eruption of Kilauea volcano in the Hawaii Islands, production of aerosols over the central North Pacific increased the cloud coverage and the reduction of cloud droplet size by the observations. It strengthened the negative radiative forcing at sea, and the sea surface water temperature reduction was demonstrated. It clarified the possible presence of indirect effects on marine ecosystems.

By the development of direct measurement techniques on shipboard for aerosol generation and annihilation processes in marine atmosphere covering 70% of the Earth's surface, it becomes possible to obtain the important findings of the various processes of the air-sea interface.

On the other hand, by global warming, stratification of ocean surface water is enhanced and causes an increase in plankton to perform nitrogen fixation in the subtropical North Pacific. Atmospheric supply of substances is extremely important for control of plankton fate and species in this region. Based on the observation, vertical mixing of surface seawater by meteorological phenomena such as passage of low-pressure systems and typhoons enhanced the biological production, an incubation experiment of simulated mixing water by typhoon was carried out on shipboard. As a result, large size diatoms increased and it was suggested the possibility of efficient carbon transport into the deep ocean, and succeeded in quantification of its amounts by a model. These findings, changes in the marine structure due to climate change suggest that marine organism contributes for the change of the carbon cycle between the marine atmosphere and the marine ecosystem.

Keywords: biogeochemistry, material cycles between surface ocean and lower atmosphere, marine biogenic substances, atmospheric anthropogenic substances, marine ecosystem, IGBP/SOLAS