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Importance of research vessels from the viewpoint of air-sea interaction studies

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The atmosphere and the ocean always exchange heat and momentum and affect each other. Air-sea interaction is especially active in the tropics, where the air is warm and humid. It has been well known that the coupling of the atmosphere and the ocean is essentially important for the El Nino phenomena. Recently researchers have also recognized that the oceans have an important role in controlling the atmospheric circulation even in the mid and high latitudes. We cannot predict atmospheric variations accurately without knowing oceanic ones in all the latitudes, not only in the tropics. Research vessels and buoys are indispensable research facilities even for meteorology and climatology because 70% of the earth surface is the oceans. Air-sea coupled model is a powerful tool for the interaction studies. However, there is always imperfectness in numerical models, and we have to do in situ observations to complement model research. We have a presentation on the importance of research vessels from the viewpoint of air-sea interaction studies.

Maritime clouds:
Cloud is one of the important factors that affect heat, saline, and momentum budget in the upper ocean. It is also important for the understanding of the warming in the polar regions, and one of the factors of the largest uncertainty. Radar/lidar of high performance on a research vessel will enable us to do wide-ranging research activities: the structure of maritime precipitable clouds in the tropics, the difference in cloud system between sea-ice and open-water areas, etc. When we operate remote sensing instruments, such as radar, on a vessel, specialized vessel-use ones will be necessary. Such instruments are still rare in the world.

Polar regions:
The warming in the Arctic is twice as fast as the mid and low latitudes, and the decrease in sea-ice area is notable. The change in atmospheric pressure pattern largely contributes to the sea-ice decrease, and the course of low pressure is also affected by the change in sea-ice area (Inoue et al., 2012). The air-sea interaction in the Arctic significantly affects the climate in the mid latitudes, including Japan, and it is very important socially. The Antarctic Ocean is one of the main regions where deep water is formed. Hence the changes in surface heat and momentum fluxes there affect the ocean circulation and the carbon cycle. An enormous amount of heat and brine are released from the upper ocean in the cold season. Baroclinicity increases at the edge of sea ice, which contributes to development of low pressures. However, it is impossible to calculate air-sea heat flux over the region where sea ice exists by using satellite data only. The reliability of reanalysis data is also lower over such regions. We need to continue in situ meteorological observations over the marginal ice zone by large research vessels predominantly. For this purpose, ice strengthening construction as well as full meteorological observation facilities is required.

Improvement in air-sea flux estimation:
Accurate estimation of the amount of air-sea heat, momentum, and water vapor exchange is the most fundamental and important for air-sea interaction studies in any latitudes. Bulk parameterization has been improved mainly by using tropical in situ observations, such as TOGA COARE (e.g., Fairall et al., 2003). However, the estimated surface heat flux value on a basin scale still has quite large uncertainty (e.g., Kawai et al., 2008). We need furthermore international, long-term efforts to improve the flux estimation.

The Above-mentioned subjects are just a part of important air-sea interaction studies. Meteorological instruments of high performance on research vessels are indispensable for such studies. At least, a set of instruments that can derive surface heat and momentum fluxes is required. We must consider installing an automated radiosonde launcher and radar/lidar for large research vessels of more than a few thousand tons.