Observation of Radon-222 Concentration in Air and Sea Water in Arctic Sea.

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Because of its inertness and low solubility in water, radon-222 (Rn) in the atmosphere and sea water can be utilized as a tracer to analyze atmospheric transport and air-sea exchange of gaseous substances. Observational data on levels of Rn concentration in air and sea water are still limited in the high latitudinal regions. A series of observation of atmospheric and sea-water Rn concentrations was carried out in this study over the Northwestern Pacific Ocean (NWPO), the Bering Sea (BS) and the Arctic Sea (AS) during the cruises MR08-04 and -05 of the research vessel Mirai. The purposes are; 1) to illustrate the temporal and spatial distributions of Rn concentrations, 2) to infer Rn source strength over the Siberian Continent from atmospheric Rn concentration, and 3) to assess merits of using Rn as a tracer and a possibility of evaluating air-sea gas exchange rate.

The observation was carried out from mid Aug. to early Nov., 2008 along the trajectory of the round cruise from Japan to AS. In whole Sep. the cruise was in AS back and forth in trying to go further northward. The arctic trajectory was in the region from 70-79 deg N and from 175 deg E to 145 deg W. Hourly mean atmospheric Rn concentration was measured continuously by introducing air at 12.5 m from the sea surface to a high sensitivity radon monitor. The monitor detects alpha particles from the Rn decay products collected by a high-voltage electrostatic field onto a PIN photodiode. Alpha spectrometry was used to evaluate Rn concentration from alpha particle count for polonium-214. Rn concentration in sea water was also continuously measured with another radon monitor by degasifying Rn from sea water sampled at the depth of 4.5 m. Additional sea water samples were obtained at 20 locations (11 samples from AS, 9 from BS and NWPO) for radium-226 content analysis. The concentration values reported in this abstract are preliminary ones based on pre-cruise calibration of the monitors and may change by a few tens of percent after a precise post-cruise calibration.

The atmospheric Rn concentration was measured to be as low as 0.2-0.6 Bq m^{-3} for most period in AS except for occasional high concentration episodes exceeding 1.0 Bq m^{-3} with a maximum of 3.4 Bq m^{-3}. Whereas over BS and NWPO, the concentration varied periodically and widely from 0.5-5.8 Bq m^{-3}. The mean atmospheric Rn concentration was evaluated to be 0.45+/-0.24 Bq m^{-3} for AS and 2.36+/-1.05 Bq m^{-3} for the rest.

The mean sea water Rn concentration was evaluated to be 0.80+/-0.10 Bq m^{-3} for AS and 1.03+/-0.08 Bq m^{-3} for the rest. Although the difference in the concentration between the regions exceeds the standard deviations of the concentration values, it is premature to conclude that the difference is significant. This is because we have not thoroughly evaluated and excluded erroneous effect from the carrier air for degasification, which was made from ambient air with a Rn trap process. However, it is still interesting to notice that the atmospheric Rn concentrations are sometimes higher than the concentration in equilibrium with that in sea water in BS and NWPO. This implies that Rn is transported from the atmosphere into the sea in such cases in these regions. This point can be discussed more definitely after the radium content analysis completes.

A series of three-dimensional atmospheric Rn transport simulation for the period showed that the simulation results agreed well with the observation. It was also shown that the high concentration episodes over AS and the periodic concentration variation over BS and NWPO were caused by long-range transport of Rn mainly from the Siberian Continent. It is worthwhile mentioning that the atmospheric concentration can exceed a few Bq m^{-3} at locations far off-shore. This implies merits of using the present data to estimate continental Rn source strength but demerits of using Rn as a tracer of air-sea gas exchange in these regions.