Seasonal sea-ice history of the northern Japan Sea and East Asian winter monsoon fluctuation

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Late Quaternary seasonal sea-ice history of the northern Japan Sea is discussed on the basis of the occurrence of dropstones and ice-rafted debris (IRD) in five sediment cores. IRD was found in all strata except those from the Holocene and oxygen isotope stage 5.5. The largest expansion of sea ice was recognized at the last glacial maximum, when the southern margin of seasonal sea ice was probably located in the vicinity of the Matsumae Plateau. The margin might have expanded further southward to off the Oga Peninsula occasionally. Sea ice expanded southward from mid-stage 5 to the LGM in response to global cooling, but with much fluctuation. Sea ice remained during deglaciation until around 10 ka, but after 10 ka, it retreated northward rapidly in response to global warming and changes in surface water conditions. Higher fluctuations in IRD were found in a core collected from off Rumoi, Hokkaido. More IRD was found in sediments from late stage 3, late stage 5, and early stage 6. The fluctuations were not concordant with global climate change revealed as the standard oxygen isotope curve. Ages of most peaks of IRD in stage 5 are correlative to those of coarsening periods of quartz grain size in the Chinese loess sequences, and to those of stronger polar circulation from the Greenland ice core chemical compositions. Therefore, the IRD fluctuations may have been controlled by regional climate factors such as the strength of the winter monsoon, which is related in turn to high-latitude atmospheric circulation.