Millennial to orbital scale variability of Asian monsoon and its impact on oceanography of the Japan Sea

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Since demonstration of the millennial-scale large and abrupt climatic changes known as Dansgaard-Oeschger Cycles(DOC) from Greenland ice core records(GRIP and GISP 2), their significance and extent have been intensively studied. Now its hemispheric (to global) nature is widely accepted and involvement of significant parts of the earths climate system is increasingly recognized. However, the entire structure of the subsystems and feedback mechanisms involved in the DOC is not fully understood, the ultimate driving force is controversial, and the regional patterns of climatic changes associated with the DOC are far from clear. Through the high resolution studies of loess sequences and marginal sea sediments in East Asia, it becomes increasingly evident that Asian monsoon is an important part of the climatic system that is responding to the DOCs. It becomes also evident that the sediments of the East Asian marginal seas record the behavior of Asian monsoon with high time-resolution. Recent high-resolution studies of these marginal sea sediments demonstrated that the oceanography of these marginal seas has been strongly influenced by DOCs through modulation of monsoon precipitation patterns and consequent changes in river discharges. It is especially so for the Japan Sea into which approximately 70% of the water (and nutrients) discharged from the Yangtze River (and Yellow River) flow at present. Simple calculation of phosphorous budget in the Japan Sea suggests that nearly all phosphorous supplied through the Tsushima Strait is trapped in the Japan Sea sediments. The calculation also suggests that up to 4 times increase in phosphorous supply to the sea is necessary to explain the deposition of dark layers during interstadials of the DOC. So, we propose that significant amount of nutrients has been supplied from the Yangtze River to the sea during the time of intensified summer monsoon, and that the Japan Sea has been acting as a nutrient trap due to its shallow sill depth except for the times with very low sea levels (less than -90m). If accumulation of the organic carbon in the sea can be regarded as a manifestation of the nutrient delivery from the Yangtze and Yellow Rivers, then we can reconstruct the history of the summer monsoon variability and its evolution by examining the organic carbon accumulation record of the Japan Sea. We can also reconstruct movement of the summer monsoon front and intensity of westeries by comparing the eolian dust flux and grain size between the sites with different latitudes. We believe that studies on the variability, onset and evolution of Asian monsoon will give important clues for understanding the ultimate driving force and feedback mechanisms of the DOCs. Our studies also demonstrate that surface productivity, position of the subpolar front, and deep-water oxygenation level in the Japan Sea have been changed drastically in association with the DOCs. This, in turn, suggests that oceanographic condition of the Japan Sea has been responding very sensitive to the changes in terrestrial climate.