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東アジア夏季モンスーンの千年スケール変動の実態と偏西風との関係
Dynamics of millennial-scale variation in East Asian Summer Monsoon intensity and its relation to the Westerly jet

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Recently, increasing evidence demonstrated the occurrence of multicentennial to millennial-scale climate changes during the Holocene (e.g., Bond et al., 2001; Mayewski et al., 2004). Although some of these climate changes were inferred to be global-scale, the spatial extent and physical mechanisms of these changes are still controversial. In the East Asia, millennial-scale variations of the East Asian summer monsoon (hereafter call EASM) intensity have been examined using the best-dated records of stalagmite-derived oxygen isotope from caves in central China (e.g., Wang et al., 2005; Hu et al., 2008). However, due to the spatial heterogeneity of the EASM precipitation changes (e.g., An et al., 2000; Dayem et al., 2010), stalagmite-derived oxygen isotope records seem to represent local or regional variations of the EASM precipitation, not to represent dynamic changes of the EASM. Therefore, we need additional records to examine the nature and spatial extent of the EASM variations during the Holocene.

To date, many additional records representing the EASM precipitation changes were reported from lacustrine, loess-paleosol, and peat bog sediments in China, and marine sediments of the surrounding oceans. Among them, we selected the records with high sensitivity and chronological precision, and examine the multicentennial- to millennial-scale spatial changes of the EASM precipitation during the Holocene. Furthermore, here we focused on the role of the westerly jet (hereafter call WJ) on the spatial precipitation pattern of EASM (e.g., Liang and Wang, 1998; Sampe and Xie, 2010). Sampe and Xie (2010) demonstrated that eastward advection of warm air from the eastern flank of the Tibetan Plateau along the WJ axis triggers the convection that forms the rainband and further that the WJ anchors the rainband by guiding transient weather disturbances, which promote convection by intensifying moisture advection with upward motion. Therefore, the WJ is necessary to develop a rainband at middle to high latitude of East Asia. In our previous study, we presented provenance changes of the aeolian dust in Japan Sea sediments reflect the earlier/later jump of the WJ to the north of the Tibetan Plateau (Nagashima et al., 2011). Then here we reconstructed provenance changes of the aeolian dust in Japan Sea sediments during the Holocene, and compared the results with spatial precipitation changes in China.

Examination of the paleo-precipitation records in China and provenance of dust in Japan Sea sediments reveals large events around 9.5, 8.3, 5.5, 2.2, and 0.4 kyr BP, with large contribution of aeolian dust from the Taklimakan Desert (we interpret as representing earlier jump of the WJ to the north of the Tibetan Plateau) together with the large precipitation in northern China (e.g., Hong et al., 2005) and small precipitation in central to southern China (e.g., Hu et al., 2008; Kubota et al., 2010). This may indicate that multicentennial to millennial-scale changes of the (seasonal) WJ path during the Holocene caused dynamic changes of the EASM precipitation, with earlier jump of the WJ to the north of the Tibetan Plateau increased precipitation in northern China and decreased precipitation in central to southern China.

The presented events were coincide within the dating error with the events revealed from the GISP2 sodium and potassium ion records, which are considered as reflecting the intensity of Icelandic Low and Siberian High, respectively (Mayewski et al., 1997; Meeker and Mayewski, 2002), and the events revealed from the stalagmite oxygen isotope record from Pink Panther Cave in southwestern United States, which is considered as reflecting (at least partly) precipitation of North American monsoon, suggesting the events spread at least hemispheric-scale and reorganization of the atmospheric circulation systems may happen from low to high latitudes. We will further discuss the possible cause of the coupled WJ-EASM variations during the Holocene.

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