The timing of orbital-scale changes in the East Asian summer monsoon, westerly jet, and northwestern Pacific surface temperature

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Based on the model simulation of early 1980's (Kutzbach, 1981), it is proposed that tropical monsoons vary in response to the intensity of summer (July) solar radiation caused by changes in Earth's orbit. Recent stalagmite oxygen isotope data from Chinese Caves supports the idea, showing East Asian summer monsoon (EASM) variation in harmony with the radiation change of the Northern Hemisphere (NH) dominated by 23,000-year precession cycle, with no/small phase-lag (e.g., Wang et al. 2001, 2008). Thus, Ruddiman (2003, 2006) demonstrated that EASM directly responds to NH precession-driven radiation. However, Clemens and Prell (1990, 2003, 2007) demonstrated the presence of large phase-lag of the EASM/Indian summer monsoon variations to the NH-radiation changes and suggested the combined response to multiple forcing mechanisms including NH and Southern Hemisphere (SH) radiation as well as global ice volume. In order to know which is correct and examine the dominant systems which control orbital-scale climate changes in low to middle-latitude of NH, here we investigate the responses of other middle-latitude atmospheric and oceanic circulation changes to the NH-radiation, as well as more detailed examination of the orbital-scale EASM variation.

At present, EASM front, the major convection/rainfall band, moves northward in concert with the northward migration of the westerly jet (WJ) over the East Asia from April to September, suggesting that behavior of the WJ is coupled with variability of the EASM (Liang and Wang, 1998). Then, we examined the orbital-scale variation in the WJ during the last 150 kyr, which was reconstructed by the provenance study of the aeolian dust in the Japan Sea sediments from latitudinal different sites (Nagashima et al., 2007; Nagashima et al in prep.). The result shows WJ varies in association with NH-radiation changes with small to medium phase-lag, suggesting the combined response to multiple forcing mechanisms as is suggested by Clemens and Prell (2003), although the influence of NH-radiation seems to be dominant. On the other hand, sea surface temperature of the northwestern Pacific (Yamamoto et al., 2005 Figure 2a), which reflects the North-South shifts of the subarctic boundary in northwestern Pacific (Yamamoto et al., 2004; Harada et al., 2004) , shows orbital scale variations with large phase-lag to the precession cycle, also suggesting the combined response to multiple forcing mechanisms. At the presentation, we will show the result of cross-spectral analysis for these records, and discuss the possible mechanisms controlling orbital-scale atmosphere/ocean variations in middle-latitude.