Delayed Asian monsoon onset during the Medieval Warm Period: PMIP3 multi model study

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The Asian monsoon develops over tropical-to-subtropical South and East Asia and is characterized by salient seasonal variation in atmospheric circulation between land and ocean. Long term integrations of climate models on hundred or thousand year timescale reveal that the past variation in seasonal and latitudinal distributions of solar radiation due to orbital parameters forces long-term Asian monsoon variability. Enhanced summertime insolation at the top of the atmosphere (TOA) and resultant warmer Eurasian Continent during the Medieval Warm Period (MWP; 950-1250 A.D.) compared to the Little Ice Age (LIA; 1400-1700 A.D.) reinforces the Asian summer monsoon. The last millennium simulations conducted under the Paleoclimate Modeling Intercomparison Project phase 3 (PMIP3) reveal that the enhanced land-sea thermal contrast and monsoon during the MWP are largely consistent among models. The TOA radiation as a driving factor for the Asian monsoon has its peak anomaly (MWP minus LIA) during July to September (JAS) over the Northern Hemisphere mid and high latitudes. In contrast, the TOA radiation between boreal winter and pre-monsoon period (April to June; AMJ) shows negative anomaly (less insolation during the MWP compared to the LIA). The seasonally asymmetric radiative forcing can result in early/delayed onset of summer monsoon (e.g. Ueda et al. 2011). The current study examines physical relationship between timing of monsoon onset and variation of insolation during the MWP by using results of PMIP3 multi-model archive and idealized sensitivity simulations in a coupled climate model.
PMIP3 multi-model ensemble-mean shows warmer Eurasian Continent and enhanced Asian summer monsoon in JAS but inversely shows cooler Eurasian Continent in AMJ and delayed monsoon onset. Land-sea contrast in tropospheric temperature (between 200 and 500 hPa) can be used as an index for monsoon intensity. Sensitivity experiments performed by MRI atmosphere-ocean coupled general circulation model prescribed with orbital forcing during the two periods can reproduce the above regional anomalies including monsoon. The results of this study indicate that the delayed monsoon onset during the MWP is primarily forced by the orbital parameters and therefore robust feature among climate models.

Reference
Ueda, H., et al. 2011. Clim. Dyn., doi:10.1007/s00382-010-0975-z.

Keywords: Asian monsoon, Land-sea contrast, Medieval Warm Period, Little Ice Age

