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Contribution of oceanic and vegetation feedbacks to Holocene climate change in monsoonal Asia

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The Asian monsoon is the most complex and strongest monsoon system of the world, affecting the climate in large parts of Asia. Primarily driven by energy gradients between the Asian continent and adjacent oceans, the intensity of the monsoon is supposed to be very sensitive to external as well as internal forcings. Therefore, the significant Holocene climate change revealed by paleoreconstructions might be related to both, the direct effect of the orbital induced insolation change as well as strong internal interactions between the different components of the climate system.

To quantify the impact of vegetation- and ocean-atmosphere feedbacks as well as their synergy on the Holocene climate change, we analysed a set of coupled numerical experiments with pre-industrial and mid-Holocene (6000 years before present) orbital configurations. These were performed with the Earth system model ECHAM5/JSBACH-MPIOM including a dynamic vegetation module. The contributions of the different factors were separated by using the factor-separation technique.

Our results show that the oceanic feedback significantly influences the mid- to late-Holocene climate change, whereas the contributions of vegetation-atmosphere interactions and synergy are rather small for the Asian monsoon region. An interactive ocean modifies the temperature response to the insolation forcing and strongly increases the mid-Holocene Asian summer monsoon precipitation. Nevertheless, most of the climate change in our simulations can be attributed to the direct effect of the atmosphere.