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# Influence of cloud radiative effects on tropical rain belts in the mid-Holocene

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Paleoenvironmental data in particular vegetation and lake-levels in Sahara shows that at mid-Holocene (6,000 years ago) African monsoon extended much further north than today. Much of this change results from the changes in insolation driven by precession of the Earth's orbit, but in the state-of-the-art climate models, this factor alone is insufficient to explain the magnitude of the change. Previous studies showed that ocean and vegetation feedbacks affect the mid-Holocene monsoon and that the incorporation of these feedbacks in models improves the simulation of the hydrological cycle. However, it is not sufficient to reduce the discrepancies between simulated and reconstructed surface climates.

In this study, we investigate the impacts of atmospheric cloud radiative effects (ACRE) on tropical rain belts during the mid-Holocene. This is done by running a general circulation model with and without cloud-radiation interactions using the IPSL model. The ACRE impacts include (1) a small northward shift of the tropical rain belts, (2) a decrease in tropical precipitation, (3) a narrowing and a strengthening of the ascending motions of the tropical overturning circulation, and (4) an intensification of African easterly wave activity, but contraction of tropical rain belts and decrease in precipitation over West Africa. The ACRE have large impacts on the hydrological cycle over West Africa, but it is not enough to explain the magnitude of the change at mid-Holocene.