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Added Value of a Convection Permitting Model in Simulating Atmospheric Water Cycle Over the Asian Water Tower

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The Tibetan Plateau (TP) is known as Asian Water Tower and its atmospheric water cycle has been a lasting challenge to climate modeling community. Here, we compare two sets of the Met Office Unified Model simulations—one is a convection-parameterized version (large-scale model; LSM) and the other is a convection-permitting model (CPM) simulation. The added value of the CPM in terms of atmospheric water cycle process is analyzed, including external moisture transport, fraction of atmospheric water vapor converting to precipitation and the precipitation recycle ratio. Results show that the simulated TP precipitation and evaporation for the summer of 2009 is significantly improved in the CPM. First, the overestimation of atmospheric water cycle by LSM is improved in CPM due to a reasonable representation of the fraction of atmospheric water vapor converting to precipitation. The overestimation of precipitation recycle ratio also indicates the LSM generates excessive convection compared to the CPM and therefore has a larger wet bias over the TP. Second, a better simulation of local precipitation has feedback on the circulation. Compared with the LSM, the less moisture convergence in the CPM is dominated by the stronger outflow through the eastern edge of the TP rather than the weaker inflow, implying the upscale effects of the resolved moist convection on the moisture transport over the TP. Our results imply that the CPM is a useful tool in the reproduction of moisture transport and atmospheric water cycle process over the Asian Water Tower and other regions of the world with complex topography.