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Spin-up behavior of soil moisture content in land surface model for East Asia

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Efficient and accurate initialization of soil moisture content is critical for the reliable prediction of weather and climate. The spin-up procedure, wherein a land surface model (LSM) is run until the modeled state converges to the equilibrium, is typically used for soil moisture initialization. The spin-up behavior of soil moisture content is closely linked to the memory of the initial soil moisture content of the LSM, and this memory depends on the unique properties of each LSM. Therefore, different LSMs show inconsistencies in the initial soil moisture contents (the so-called soil moisture inconsistency problem) even when they are run under the same atmospheric conditions. In this study, we examined the impact of such soil moisture inconsistency on the spin-up behavior of an offline LSM for East Asia. In particular, we focused on the unique features of the spin-up timescale over East Asia, which is influenced by heavy rainfall events during the Asian summer monsoon. Our results indicate the following: (1) the LSM approaches the same equilibrium despite the difference in the initial soil moisture contents. However, the spin-up time is reduced if the output from the same LSM is used and the model is initialized before heavy rainfall events. (2) The spin-up timescale shows strong dependence on the magnitude of the evaporative fraction. A spin-up time of three months was sufficient for the Asian region affected by the summer monsoon but a spin-up time of several years was required for the Asian dry land. Our findings provide practical guidelines for the LSM spin-up and initialization of soil moisture content for regional climate modeling in East Asia.