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Effects of freeze-thaw process on seasonal persistence of soil moisture anomalies and relationship with summer precipitation

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In the soil freeze/thaw phenomenon, the soil water phase and energy budget change, which can affect the land-atmosphere system. Herein, the role of freeze–thaw–process (FTP) in soil water and heat transport and its effects on soil moisture variation were investigated using the observations and numerical experiments on the Tibetan Plateau (TP). The seasonal persistence of soil moisture anomalies related to soil FTP over TP and relationship with summer precipitation in Eastern China (EC) were also analyzed. The results revealed that no soil FTP (i.e. no water phase change occurred) resulted in drier surface soil moisture is drier by about -0.02 mm3/mm3, reduced by $\sim$10% as a result of enhanced evaporation in after-thaw (AT) period (spring). Soil FTP has a water storage effect, and the storage index (SI) can reach 0.95 at surface layer. Without soil FTP, the soil moisture memory was shortened by about -20 days in March. Soil moisture anomalies from the preceding autumn can be retained to the spring by water storage effect of soil FTP. The soil moisture over the TP during the preceding autumn and winter had the similar climatic effects as spring soil moisture. The wetter soil moisture anomalies in the eastern TP in the spring led to less summer precipitation in south China and the Yellow River basin, and more summer precipitation in the Yangtze River basin and northeast China. Our results suggested that the information related to soil FTP can provide "signal" of seasonal climate prediction.