A method to quantify the influence of total water storage change on climate elasticity of streamflow

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Numerous studies documented the climate elasticity of streamflow (i.e., precipitation elasticity and potential evapotranspiration elasticity) without considering the total water storage change (dS) based on long-term Budyko framework. However, the values of dS have been found to be a significant component of water balance at short time scales (e.g., annual) and some specific watersheds (e.g., arid regions). The purpose of this paper is to develop a new approach based on the extended Budyko framework to quantify the climate elasticity of streamflow with the influence of dS . The available water under the extended Budyko framework is the effective precipitation (Pe), i.e. the difference between precipitation and dS. The climate elasticity of streamflow with the influence of dS are derived from one recent proposed Budyko-type equation based on proportionality relationship under the extended Budyko framework. The performance of this new approach at annual scale as an example is evaluated for 273 MOPEX watersheds in the United States. Results show that climate elasticity of streamflow with the influence of dS are generally larger than that without considering the influence of dS for study watersheds. Results also indicates that the modeled proportional changes in annual streamflow are significantly biased by using the methods without considering the influence of dS, especially for peak values. This study highlights the needs to consider the influence of dS on climate elasticity of streamflow and provides a framework to quantify the climate elasticity of streamflow with the influence of dS.

Keywords: climate elasticity, total water storage change, MOPEX