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Hysteresis analysis for investigating storage-discharge dynamics: A case study of the Yangtze river basin

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Terrestrial water storage is an indicator of regional water security. Storage change affects water availability, sediment transport and ecological functions. Principal actions for hydrological extremes, for both floods and droughts, are founded on how to manage water storage. Therefore, quantifying storage for understanding changes of hydrological systems is crucial. Before the 2000s, regional terrestrial storage could solely be estimated using water balance approaches. The Gravity Recovery and Climate Experiment (GRACE), launched in 2002, started to generate storage products based on remote sensing. Although the GRACE data can be useful for representing terrestrial water storage, investigations are needed for understanding the discrepancies between GRACE storage products and the storage estimates from water balance approaches. A possible way to investigate these discrepancies is to study the storage and discharge hysteresis loops. Using the Yangtze river basin as a case study, the storage values are estimated based on the observed precipitation, evaporation and streamflow time series. We analyse the trajectories of storage and discharges from the GRACE data and the water balance approach, and we propose a new way to look at the uncertainty of the storage-discharge hysteresis loops. Results from this study provide insights on how to monitor and study water storage conditions in Asia, and the storage study methods here will provide a framework for other regions to use remote sensing products and field observations together to quantify hydrological changes related to water storage.