Natural and Human-induced Changes in Terrestrial Water Storage over the Indian Subcontinent

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Terrestrial Water Storage (TWS), which is composed of water stored above and underneath the land surface, influences the water cycle through multiple pathways. Near the surface, soil water controls evapotranspiration (ET) and hence water-energy exchange between the land surface and the atmosphere, directly affecting the physical climate; by limiting ET, soil water availability affects land ecosystem dynamics, indirectly affecting the climate; immediately below, the shallow phreatic groundwater feeds streams, lakes and wetlands; further down, groundwater storage in the aquifers provides vital support for water and food (via irrigation) security in societies on arid and semi-arid lands. Thus, understanding the changes in TWS is the key to understanding the dynamics of groundwater systems, especially in highly managed agro-ecosystems, toward identifying and solving groundwater related problems. In this study, we use a global land surface model (LSM) called the HiGW-MAT, which simulates both natural and human-induced changes in the terrestrial water cycle, to explore the changes in various TWS components over the Indian subcontinent. The model explicitly simulates the changes in different TWS components caused by both natural climate variability and human land-water management. We combine model results of TWS change with the data derived from the Gravity Recovery and Climate Experiment (GRACE) satellite mission to understand how groundwater systems are responding to climatic drivers and human land-water management in the region. Results indicate a rapid decline of groundwater resources in part of the region; these results are in line with previous findings but provide further insights on the changes and interactions between different TWS components which are explicitly simulated by the model. Finally, we compare the results from the simulations with and without human impacts to attribute the changes in TWS components to natural and human-induced causes.

Keywords: Hydrological cycle, terrestrial water storage, groundwater, GRACE

