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Modeling and remote sensing of human induced water cycle change

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The global water cycle has been profoundly affected by human land-water management especially during the last century. Since the changes in water cycle can affect the functioning of a wide range of biophysical and biogeochemical processes of the Earth system, it is essential to account for human land-water management in land surface models (LSMs) which are used for water resources assessment and to simulate the land surface hydrologic processes within Earth system models (ESMs). During the last two decades, noteworthy progress has been made in modeling human impacts on the water cycle but sufficient advancements have not yet been made, especially in representing human factors in large-scale LSMs toward integrating them into ESMs. In this study, an integrated modeling framework of continental-scale water cycle, with explicit representation of climate and human induced forces (e.g., irrigation, groundwater pumping) is developed and used to reconstruct the observed water cycle changes in the past and to attribute the observed changes to climatic and human factors. The new model builds upon two different previously developed models: a global LSM called the Human Impacts and GroundWater in the MATSIRO (HiGW-MAT) and a high-resolution regional groundwater model called the LEAF-Hydro-Flood. The model is used to retro-simulate the hydrologic stores and fluxes in close dialogue with in-situ and GRACE satellite based observations at a wide range of river basin scales around the world, with a particular focus on the changes in groundwater dynamics in northwest India, Pakistan, and the High Plains and Central Valley aquifers in the US.