Title: Including Human Activity in Estimates of the Terrestrial Water Cycle using Models and Remote Sensing Satellites

Abstract

The adequacy of freshwater resources for economic, political and social systems depends upon knowledge of variations in the water cycle. Water availability is increasingly impacted by human activities both directly—through irrigation and development—and indirectly through climate change. Thus, understanding human impacts on the water budget is necessary for strategic planning. Specifically, this research addresses the issues of: (i) unquantified irrigation water use, (ii) the need for remote sensing-based *ET* partitioning, (iii) imbalance of the remotely sensed water budget, and (iv) unknown knowledge of irrigation's contribution to groundwater depletion. These issues are addressed through: (i) a new approach to estimate irrigation water use, designed to assimilate remotely sensed soil moisture within a land surface model, (ii) development of a new continental-scale soil evaporation dataset based on the SMAP satellite, (iii) a novel framework for estimating the terrestrial water balance using an ensemble of remotely-sensed datasets, and (iv) a procedure to quantify interactions between irrigation and groundwater depletion using an ensemble of downscaled GRACE-based estimates of groundwater fluxes. These analyses use globally-applicable tools and instruments to quantify components of the hydrologic cycle, with several chapters specifically focusing on the impacts of human activities.