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Reconstruction of the Amazon Basin total water storage over the past decades from GRACE and in situ observations.

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Over continental areas, GRACE-based total water storage (TWS) change-in surface, soil and groundwater reservoirs are expected to represent the main surface mass redistribution on seasonal to interannual time scales. Quantifying the TWS history on longer time scales (i.e., from decadal to multidecadal times scales) is crucial to understand the dominant modes of variability of the continental water cycle. In this study, we propose to reconstruct past TWS using GRACE-based TWS over 2002-2009 and longer time series of hydrological parameters (e.g., rive water level or discharge) using methods formerly developed to reconstruct past 2-D sea level. We apply the approach to Amazon Basin. The reconstruction method of past Amazon Basin TWS (since 1970) combines long time series of in situ river levels along the Amazon River and its main tributaries and 2-D TWS patterns based on GRACE data. The reconstruction uses the spatial structure (EOFs) of the TWS field obtained from the 2-D well resolved spatial fields of GRACE to interpolate optimally the historical measurements from the in situ gauge records. A global grid of TWS field that cover the whole Amazon basin over the gauge records time span 1970-2008 is obtained. The results offer important insight of the main surface, soil and groundwater stocks variability of the Amazon basin over the last 4 decades. The dominant modes of temporal variability are discussed and TWS hindcasts at in situ river stations not used in the analysis are compared to actual observations. We also compare the TWS reconstruction with outputs of global hydrological models. We find that past Amazon Basin TWS reflects the natural variability of the continental water cycle, in particular that associated with the ENSO phenomenon.