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Groundwater dynamics in the Amazon basin from remotely sensed observations and hydrological models

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Groundwater plays a key role in the terrestrial hydrological cycle and the water balance on the continents. It accounts for more than 30% (i.e. 8,000,000 km3 to 10,000,000 km3) of global fresh-water resources, and is also the major resource of water supply for 40% of the world's population and 50% of the world's food production. However, groundwater storage and its variations are still poorly known at global scale due to the limited extent of current monitoring networks. Most of the studies on geohydrology in the Amazon basin were carried out at local scale except a recent study that pointed out evidences on regional scale groundwater flows using a geothermal method. Gravimetry from space offers the unique opportunity to monitor water resources at basin to continental scales. The Gravity Recovery And Climate Experiment (GRACE) mission, launched in 2002, detects tiny changes in the Earth's gravity field which can be related to spatio-temporal variations of TWS at monthly or sub-monthly time-scales. Variations in groundwater storage (GW) can be separated from the TWS anomalies measured by GRACE using external information on the other hydrological reservoirs such as in situ observations, model outputs, or both. Very few studies have been undertaken yet in large river basins characterized by extensive wetlands and floodplains, due to the lack of reliable and timely information about the extent, spatial distribution, as well as the amount of water stored in wetlands and floods and their temporal variations. Using multi-satellite observations for surface water storage (SW) and hydrological outputs for soil moisture (SM), variations in GW were estimated in the Negro basin, the second largest tributary of the Amazon in terms of discharge. Here, the same approach was applied in the whole Amazon basin, allowing to estimate the contribution of each hydrological reservoir to TWS, to monitor its time variations, and to map the annual changes in the aquifers over 2003-2007. These estimates were compared to hydrological model outputs from WGHM and ISBA and validated against in situ data from wells. For the whole Amazon basin, SW, SM and GW represent around 45%, 25%, and 30% of the TWS respectively.