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Geodetic impact of water storage variations: the GHYRAF (Gravity and Hydrology in Africa) experiment

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Continental hydrology (soil moisture, water table) processes redistribute underground water and hence lead to alter the gravity and shape of the Earth because of loading effects (elastic + attraction contributions). We present a new experience in West Africa where we will try to retrieve the signature in gravity and vertical GPS of water storage changes. We concentrate geographically on three regions in West Africa: the Sahara (Tamanrasset, South of Algeria) with almost no rainfall, the Sahelian zone (Niamey and Diffa in Niger) and the equatorial monsoon band (Djougou, Benin Republic) with heavy rainfall. Our experience combines two kinds of ground gravity measurements: the repetition with an absolute gravimeter (AG) every two months of a North-South profile during the 3 year project (2008-2010) and the continuous monitoring of the time-variable gravity with a superconducting gravimeter (SG) at a fixed station with large soil moisture changes. All the gravity points will be collocated with permanent GPS stations in order to independently estimate the gravity contribution due to the vertical motion of the instrument in the Earth's gravity field. Since gravity is sensitive to various length scales involved in hydrology, we will rely on dense in-situ measurements (rain gauges, piezometers, soil moisture) to model local gravity effects. The first goal is to better characterize the annual cycle of water storage in West Africa and to assess the predictions of global hydrology models (GLDAS, LadWorld) for this region. Our project will also allow to validate satellite gravity observations (mainly GRACE but also upcoming GOCE) with the help of ground gravity and geodetic observations.