Issues in the ground validation of space gravity – The GHYRAF (Gravity and HYdrology in AFrica) project

The goal of this project is a comparison between models and multi-disciplinary data (surface and space gravity, geodesy, hydrology, and meteorology) of seasonal changes in water storage in Africa from the desert zone in the Sahara (null test zone) to the equatorial monsoon region with strong changes due to large rainfall. It will also provide an excellent opportunity to check the agreement between the temporal gravity changes derived from GRACE (presently in operation) and GOCE (to be launched end of 2007) space missions and surface gravity observations. Our proposal includes two ground-based measurement experiments. The first one is the repeated survey of an absolute gravity profile to assess the large soil moisture changes as predicted by recent hydrological models. The gravity measurements on this profile will involve, in addition to the Tamanrasset site (Algeria) with almost no hydrological contribution, the sites of Diffa close to lake Chad and Niamey in Niger, and Djougou in Benin; these two last sites are located in the investigation zone of the AMMA (Multi Disciplinary Model of African Monsoon) program. The Djougou hydrometeorological site, where a high density of in-situ hydrology measurements are available (SO/ORE AMMA-CATCH) will benefit from permanent observations with a high precision superconducting gravimeter (SG) and act as a continuously monitored base station in a region of large water storage changes. The absolute gravity measurements will require a close cooperation between several groups of European geodesists who have shown their ability to perform the frequent measurements demanded by the project namely a repetition every two months during two years in order to estimate the annual cycle. In addition, continuous precise GPS stations along the profiles will help to assess the vertical deformation that alters ground gravity but that is not directly seen by the satellites. Since gravity is sensitive to all hydrological scales, local gravity effects will be isolated using models taking into account in-situ measurements of hydrological parameters at each station. Finally we will use new approaches to generate highly tuned data from the GRACE inter-satellite distances to maximize the time and spatial resolution of the satellite data in this area. This project will allow the first ground validation of the GRACE mission and efficiently constrain the hydrological models in the African monsoon region. Moreover it will enhance the cooperation between the various sub-disciplines (absolute and relative gravimetry, geodesy, hydrology, and satellite geodesy) involved in the French ongoing activities in Africa. Finally, by an optimal way to combine information from space and ground gravity, this project will provide a better characterization of continental water storage, particularly in the critical areas of water management in the African continent. An extension to the global scale with climatic impact is of course also foreseen as part of the project.

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