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Satellite altimetry and GOCE contribution to the pre-definition of the Kingdom of Saudi Arabia (KSA) Vertical Network

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The availability of a unified and well-established national vertical system and frame is of outmost importance in support of everyday geodetic, surveying and engineering applications. Vertical reference system (VRS) modernization and unification has gained increased importance especially during the last years due to the advent of gravity-field dedicated missions and GOCE in particular, since it is the first time that an unprecedented in accuracy dataset of gravity field functionals has become available at a global scale. The Kingdom of Saudi Arabia VRS is outdated and exhibits significant tilts and biases, so that during the last couple of years an extensive effort has been put forth in order to: re-measure by traditional levelling the entire network, establish new benchmarks (BMs), perform high-quality absolute and relative gravity observations and construct new tide-gauge (TG) stations in both the Arab and Red Seas.

The Current work focuses on the combined analysis of the existing, recently collected, terrestrial observations with satellite altimetry data and the latest GOCE-based Earth Geopotential Models (EGMs) in order to provide a pre-definition of the KSA VRS. To that respect, a 30-year satellite altimetry time-series is constructed for each TG station in order to derive both the Mean Sea Level (MSL) as well as the sea level trends. This information is analyzed, through Wavelet (WL) Multi-resolution Analysis (MRA), with the TG sea level records in order to determine annual, semi-annual and secular trends of the Red and Arab Sea variations. Finally, the so-derived trends and MSL are combined with local gravity observations at the TG BMs, levelling offsets between the TGs and the network BMs, levelling observations between the network BMs themselves and GOCE-based EGM-derived geoid heights and potential values.

The validation of GOCE contribution and of the satellite altimetry derived MSL and trends is based on a simultaneous adjustment of the entire KSA vertical network, keeping fixed various TG stations and investigating the distortions introduced in the adjusted BM orthometric heights. Finally, a pre-definition of the KSA VRS is detailed as vertical offsets and potential differences δWo relative to the recently adopted conventional zero-level geopotential value by IAG. Conclusions regarding the contribution of satellite altimetry and GOCE are drown along with the necessary information for the definition of the KSA vertical datum and its connection to an International Height References System (IHRS).