Development of deformation models to support modernized datums in Africa

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SUMMARY

Many national coordinate reference systems across Africa are founded on classical datums from the 1950s-1990s. These legacy systems often contain significant distortions and are ill-suited for modern GNSS-based positioning. As static datums, they lack the necessary models to correct for crustal motion between the epoch of measurement and the datum's reference epoch. Consequently, a continental effort is underway to replace them with semi-dynamic datums aligned with the International Terrestrial Reference Frame (ITRF), a transition that necessitates robust deformation models.

This paper outlines how Trimble Geodetic Libraries (TGL) support this modernization, focusing on two principal modeling approaches relevant to the African continent. First, for countries situated entirely on a stable tectonic plate, such as the Nubia or Somalia plates, horizontal velocity is determined by applying the plate's absolute Euler Pole model. Second, for countries affected by active deformation, such as the Nubia-Somalia plate boundary, a spatially varying velocity model is required to accurately represent the more complex crustal motion.

We demonstrate these implementations through four recent case studies. In Ivory Coast (RGCI 2022) and Nigeria (NGD2012), both located on the stable Nubia Plate, the ITRF2020 Nubia Euler pole model is used to manage crustal motion. In Tanzania, which lies within the active plate boundary zone, the official TAREF11 datum is supported by a dedicated velocity grid. Finally, for South Africa, a sequential transformation was developed. This process transforms coordinates from the ITRF-based TRIGNET VRS to the official Hartebeesthoek94 datum by first applying a velocity model and then a datum grid to reconcile the frames.