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# Vertical Movement Estimates along the Black Sea Coast from GPS and Satellite Altimetry - Tide Gauge

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## Abstract

Tide gauges measure sea level change relative to the land. Thus, absolute sea level measurements from satellite altimetry minus tide gauge records can provide an estimation of vertical land movement at tide gauge sites. These estimates can be compared with the vertical rates derived from measurements of the nearby Global Positioning System (GPS) stations. In this study, we investigate vertical land movements at the 7 tide gauge sites along the Black Sea coast considering measurements from the nearby co-located GPS stations with these tide gauge stations as well the difference between altimetry and tide gauge observations. For this aim, 3 tide gauge stations (Sile, Sinop, and Trabzon) from the Turkish National Sea Level Monitoring System (TUDES) and 4 tide gauge stations (Constantza, Varna, Bourgas, and Tuapse) from the Permanent Service for Mean Sea Level (PSMSL) have been selected. Besides that, this study includes the vertical displacement time series analysis from 7 GPS stations which close to these tide gauge stations: the data of SLEE, SINP and TRBN stations which belong the Turkish National Permanent Real Time Kinematic Network (TUSAGA-Active) have been processed using GAMIT/GLOBK whereas the time series of TGTO, VARN, BUR3, and TUAP have been directly provided from the Nevada Geodetic Laboratory (NGL). Accordingly, at all the tide gauge sites except for Sile, significant vertical movements are found from altimetry minus tide gauge. On the other hand, a land subsidence movement is observed at Sile tide gauge site from GPS over 2009–2014. Other vertical rate estimates show a good agreement with GPS-derived estimates. While the results indicate land subsidence motions at Varna, Bourgas, Trabzon, and Tuapse, land uplift motions are seen at Constantza and Sinop during the observation periods.

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