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Observation of gravity fluctuations due to tide-induced groundwater table fluctuations with two superconducting gravimeters

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Estimation of aquifer hydraulic properties is necessary for predicting groundwater flow and hence managing groundwater resources. Analysis of tide-induced groundwater table fluctuations in unconfined aquifers is one of the methods to estimate aquifer properties. Changes in groundwater level affect surface gravity. Consequently, surface gravity in coastal regions is expected to fluctuate due to the groundwater table fluctuations and is potentially useful for estimating aquifer properties. Moreover, gravity measurements are sensitive to mass redistribution around the observation location and therefore are useful for estimating the storage coefficient of an aquifer. In this study, surface gravity and unconfined groundwater level were measured continuously near the coast of Japan to observe gravity fluctuations due to the tide-induced groundwater table fluctuations. Groundwater level measured in two wells at 60 and 90 m distances from the coastline fluctuated in response to ocean tides. Two superconducting gravimeters (SGs) were installed at 70 and 80 m distances from the coastline and at an elevation of 8 m. After taking the difference between gravity values recorded with the two SGs and then correcting the gravity difference for ocean loading effects, diurnal and semi-diurnal gravity fluctuations, which are possibly due to tide-induced groundwater table fluctuations, were recognized. These results suggest that gravity monitoring with two SGs at different distances from the coastline can be useful for observing gravity fluctuations due to tide-induced groundwater table fluctuations and possibly for estimating aquifer hydraulic properties.