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Simulation of tectonic evolution of the Kanto basin of Japan since 1 Ma due to subduction of the Pacific and Philippine sea plates and collision of the Izu-Bonin arc

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The Kanto basin, the largest lowland in Japan, developed by flexure as a result of (1) the subduction of the Philippine Sea (PHS) and the Pacific (PAC) plates and (2) the collision of the Izu-Bonin arc with the Japanese island arc. Geomorphological, geological, and thermochronological data on long-term vertical movements over the last 1 My suggest that subsidence initially affected the entire Kanto basin after which the area of subsidence gradually narrowed until, finally, the basin began to experience uplift. In this study, we modelled the tectonic evolution of the Kanto basin following the method of Matsu'ura and Sato (1989) for a kinematic subduction model with dislocations, in order to quantitatively assess the effects of PHS and PAC subduction. We include the steady slip-rate deficit (permanent locking rate at the plate interface) in our model to account for collision process. We explore how the arc-arc collision process has been affected by a westerly shift in the PHS plate motion vector with respect to the Eurasian plate, thought to have occurred between 1.0-0.5 Ma, using long-term vertical deformation data to constrain extent of the locked zone on the plate interface. We evaluated the change in vertical deformation rate for two scenarios: (1) a synchronous shift in the orientation of the locked zone as PHS plate motion shifts and (2) a delayed shift in the orientation of the locked zone following a change in plate motion. Observed changes in the subsidence/uplift pattern are better explained by scenario (2), suggesting that recent (<1 My) deformation in the Kanto basin shows a lag in crustal response to the shift in plate motion. We also calculated recent stress accumulation rates and found a good match with observed earthquake mechanisms, which shows that intraplate earthquakes serve to release stress accumulated through long-term plate interactions.