Geodetic constraints for back-arc spreading across the Mariana Trough based on GPS observations

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The Mariana Islands Arc (MA) in the eastern margin of the Philippine Sea plate (PH) provides the best example for the studies of a formation of island arc and a mechanism of back-arc spreading. In the east of the arc, the Pacific plate is subducting at the Mariana Trench with a steeply dipping slab. In the west, geological and geomagnetic evidences suggest that the back-arc spreading is in progress at the Mariana Trough over the past several million years. Kato *et al.* (2003) conducted several GPS campaign measurements at six islands located at 13.6-18.7 N to determine stationary horizontal velocities. They showed that MA is moving apart from PH at a rate ranging from 15 mm/yr at 18.7 N to 45 mm/yr at 13.6 N, which are consistent with geological and geomagnetic estimates for the spreading rates.

We conducted additional GPS campaign measurements including three northern islands aligned from 19.7 to 20.5 N in 2003, 2004 and 2008 to re-determine site velocities and MA-PH relative motion. Observed site velocities show systematic deviations from the predictions from a global plate model. The deviations can be considered as retreat rates of the islands that are caused by the spreading of the Mariana Trough. When we assume MA to be a single block, the estimated location of the MA-PH Euler pole and the spreading rates across the Mariana Trough do not differ significantly from those of Kato *et al.* (2003). Moreover we test two-block and three-block models to reproduce horizontal site velocities of the islands. Along-arc extensions, about 5-10 mm/yr or 0.6-1.3 x 10^{-8} strain/yr, are clear in single-block and two-block models. Short-term (about 16 years) geodetic results obtained in this study are generally consistent with geological and geomagnetic estimates with a much longer time scale (several million years). However, current Euler pole of the MA-PH relative motion, which is estimated at around 21.5 N, is located significantly south of the geographical pole where the width of the back-arc basin converges.