# Development of a New Gravitational Geoid Model for Japan

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**SUMMARY**

The geoid is the equipotential surface that corresponds to global average sea surface, which gives a physical reference for physical heights. Now that GNSS technique has achieved remarkable improvement, geoid model is expected to play an increasingly crucial role in society because it allows us to bridge from GNSS-derived geometrical heights to physical heights which are more useful for practical use. Regional gravimetric geoid model for Japan has been developed by Geospatial Information Authority of Japan (GSI) [e.g. Kuroishi, 1995; Kuroishi 2005]. The latest model named "JGEOID2008" is constructed by applying Remove-Compute-Restore (RCR) techniques under the assumption of Helmert's second method of condensation [Kuroishi, 2009]. This model incorporates the Global Gravitational Model (GGM) from GRACE satellites [Tapley et al., 2005], two-hundred sixty thousands of the terrestrial gravity data, and five-hundred eighty thousands of the shipborne gravity data for sea and ocean surrounding Japan. As a consequence, JGEOID2008 is consistent with the geoid values measured by GNSS/Leveling method at 816 benchmark within 10 cm in the standard deviation. In this study, we further improve the current Japanese gravitational geoid model by incorporating up-to-date GGM from GOCE satellite, marine gravity data from satellite altimetry, and additional terrestrial gravity data. The method of gravitational geoid modelling is based on RCR technique with Helmert's second method of condensation. First, we investigate the impacts of the newly adopted GGMs to geoid determination by experimenting with seven GGMs published in recent years. Based on the result, we employ GO_CONS_GCF_2_DIR_R5 model [Bruinsma et al., 2014] as GGM. Next, we update marine gravity data. Here we use the altimetry-derived marine gravity data instead of the shipborne data because the shipborne data is known to contain a large number of outliers [Kuroishi, 2005]. We adopt Global Marine Gravity model v23.1 from Cryosat-2 & JASON-1 satellites provide by Sandwell et al. (2014). Last, we add thirty-thousands of the terrestrial gravity data collected in these 10 years. As a consequent, we have succeeded to create the Japanese gravitational geoid model with

an accuracy of 8 cm or less in the standard deviation compared with GNSS/Leveling geoid undulations.