Case Study of Japan Vertical Reference Frame Challenge and future plan

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Geospatial Information Authority of Japan (GSI) has been developing a highly accurate new gravimetric geoid model of Japan in order to shift from the current vertical datum based on geodetic leveling to the new one based on an accurate gravimetric geoid. In order to develop the accurate geoid model covering the whole territory, it is essential to collect dense and precise gravity data. Gravity data covering wide wavelength range is fundamental to development of an accurate gravimetric geoid model. Satellite gravity missions such as GOCE etc. provides the long wavelength part of the earth's gravity field. As for the short wavelength part, we have already collected more than 300,000 land gravity data in Japanese territory which mainly covers the plain areas. However, there are still data gaps in some areas, especially coastal and shallow marine areas and high mountain regions. Therefore, we have been planning to conduct airborne gravity measurements which cover the whole territory including both the coastal zones and mountain regions. Airborne gravity measurement data are extremely useful to cover the middle wavelength part of the gravity field, which is essential to complement a spectral gap between the long wavelength satellite gravity data and the short wavelength terrestrial gravity data. We will prepare TAGS airborne gravimeter in FY 2018, and will conduct the airborne gravity survey from 2019 to 2022. Along with the measurements, we will develop and evaluate sub-regional prototypes of the gravimetric geoid model with the collected airborne gravity data in each year, and would open them to the public in order to promote its usefulness to our stakeholders. In addition, we will continue to improve the methods for computing the gravimetric geoid model. We have already achieved approximately 5cm accuracy in standard deviation in comparison with GNSS/leveling geodetic data by adopting several improvements in modeling process including 1) improvement of method for modifying Stokes integral kernel, 2) determination of Stokes parameters based on GNSS/leveling data, 3) optimal combination of each gravity data by weighted least squares collocation, 4) introduction of residual terrain model, 5) update of the used data (GGM, marine gravity model and DEM) . The final target accuracy of the model is 2 to 3 cm in standard deviation. After finalizing the geoid model with the new data and methods, we will shift to the new geoid-based vertical datum in 2024.