An attempt to improve the estimation accuracy of the atmospheric pressure effect

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As a cooperative observation of GGP-Japan, we are conducting the SG (Superconducting Gravimeter) observation at Kamioka from October 22 in 2004. Kamioka site (36.423056N, 137.31083E, 350m in altitude) is located at about 80 km west of the Matsushiro SG site. One of the main scientific targets of this cooperative observation is to increase the reliability of the detection of such weak signals originating from the Earth's core as the core under tone, Slichiter triplets and the time variation in the tidal factor related to the free core resonance. As well known, a problem in the analysis of these weak signals is how we accurately estimate and correct the atmospheric pressure (A.P.) effects. Usually (or conventionally) the A.P. effects are corrected by using the local pressure data obtained at the observation site. However, for example, as shown in the works by Boy et al. (1998), Petrov & Boy (2004), it is not adequate only using the local pressure data to realize the correction at the accuracy better than 1 microGal.

To improve the estimation accuracy of the A.P. effect, we have done a test computation using a fine pressure data (spatial resolution: 10 km by 10 km), which are provided by JMA (Japan Meteorological Agency) for the region around Japanese (i.e. the area of 21.9N to 44.1N in latitude and 107.5E to 150.8E in longitude) so called as JMA-MANAL (Meso-scale Analysis) data. This assimilation model gives the time variations in the geopotential heights of the pressure levels of 20 in number (up-to 10 hPa) and the temperature at each height. Computation for the gravity effect, especially in its attraction part, is sensitive to the accuracy of the surface pressure and the 3-dimensional air mass distribution. We computed the vertical profile of air mass distribution at each grid point based on the equation of state of gas. To represent these as possible as precisely, we introduce two kinds of topographic digital elevation map (DEM). One is ETOPO2 of 2' in resolution and other is a DEM of 0.5' by 0.75' provided by Geographical Survey Institute of Japan. For the distant places more than about 6 deg in the angular distance from the observation site, we used a global air model called JMA GANAL (Global Analysis) model of the spatial resolution of 1.25 deg by 1.25 deg and of 23 layers (up-to the pressure level of 0.4 hPa). The time resolution is 6 hours for both the MANAL and GANAL data.

From the present study, we have confirmed the efficiency of using such fine pressure data as the JMA MANAL to improve the accuracy of the estimation of A.P. effects. From the comparison between the gravity residuals obtained by BAYTAP-analysis only taking into account the local pressure variations and those obtained by correcting the tidal components and the A.P. effects estimated using the meteorological data; we find, in the case of Kamioka, the correction only using the local pressure data does not well represent the effect of the pressure variations more than a few days in the period (i.e. the variations more than a few 100 km in the spatial scale). A remaining problem is how we include the frequency dependency of the IB response of the ocean into the convolution integral, as well as how we accurately interpolate the model data in the time-space domain, when we apply the correction values estimated using the model data to the analysis of high frequency phenomena shorter than 1 hour in period.