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Scaling of variable components of GRACE monthly gravity field solution constrained by Kaula's rule

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It is reported that monthly mass variations of the Earth obtained from GRACE satellite gravity mission successfully recover seasonal mass variations of ocean or landwater. Thus, using GRACE monthly solutions, we can improve ocean or landwater model.

It is well known that satellite measurement errors of GRACE monthly gravity field solutions increases in short wavelength. On the other hand, even in long wavelength, GRACE solutions contain relatively large error and it cannot be negligible when the variable components are discussed. One of the large error sources in long wavelength is aliasing error which comes from mismodeling of short period atmospheric effect. Thus, even in long wavelength, degree variances of the variable components of GRACE monthly solutions show large power compared with the one expected from ocean or landwater model. In principle, we can obtain approximate degree variance of 'true' signal by estimating and subtracting error degree variance from the one of the GRACE variable components.

However, in case that the calibrated standard deviation released by GRACE data center is used as the error level, the obtained degree variance is still larger than the one of the model estimation. It means that there are two possibilities, that is, underestimation of model's power and/or underestimation of GRACE error in long wavelength.

It is reported that degree variance of variable components of the Earth's gravity field shows inverse proportion to n^3 (n: degree) (Kaula's rule) as well as the ones of static components (Ogawa and Heki, 2006). In this study, we firstly subtracted the calibrated standard deviation from GRACE degree variance, and scaled the residual using Kaula's rule as a constraint. After that, the scaled degree variance was compared with non-scaled one and model's one, and discussed whether the scaling and the estimated error level is agreeable or not. We also discussed the value of the coefficient of Kaula's rule, and degree dependency and temporal dependency of the scaling factor.