Geophysical Research Abstracts
Vol. 19, EGU2017-7933, 2017
EGU General Assembly 2017

A new method for gravity field recovery based on frequency analysis of spherical harmonics

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All existing methods for gravity field recovery are mostly based on the space-wise and time-wise approach, whose core processes are constructing the observation equations and solving them by the least square method. It's should be pointed that the least square method means the approximation. On the other hand, we can directly and precisely obtain the coefficients of harmonics by computing the Fast Fourier Transform (FFT) when we do 1-D data (time series) analysis. So the question whether we directly and precisely obtain the coefficients of spherical harmonic by computing 2-D FFT of measurements of satellite gravity mission is of great significance, since this may guide us to a new understanding of the signal components of gravity field and make us determine it quickly by taking advantage of FFT. Like the 1-D data analysis, the 2-D FFT of measurements of satellite can be computed rapidly. If we can determine the relationship between spherical harmonics and 2-D Fourier frequencies and the transfer function from measurements to spherical coefficients, the question mentioned above can be solved. So the objective of this research project is to establish a new method based on frequency analysis of spherical harmonic, which directly compute the confidents of spherical harmonic of gravity field, which is differ from recovery by least squares.

There is a one to one correspondence between frequency spectrum and the time series in 1-D FFT. The 2-D FFT has a similar relationship to 1-D FFT. Owing to the fact that any degree or order (higher than one) of spherical function has multi frequencies and these frequencies may be aliased. Fortunately, the elements and ratio of these frequencies of spherical function can be determined, and we can compute the coefficients of spherical function from 2-D FFT. This relationship can be written as equations and equivalent to a matrix, which is solid and can be derived in advance. Until now the relationship has be determined. Some preliminary results, which only compute lower degree spherical harmonics, indicates that the difference between the input (EGM2008) and output (coefficients from recovery) is smaller than 5E-17, while the minimal precision of computer software (Matlab) is 2.2204E-16.