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A Semi-Vectorization Algorithm to Synthesis of Gravitational Anomaly Quantities on the Earth's Surface

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The Earth's gravitational potential can be expressed by the well-known spherical harmonic expansion. The computational time of summing up this expansion is an important practical issue which can be reduced by an efficient numerical algorithm. This paper proposes such a method for block-wise synthesizing the anomaly quantities on the Earth surface using vectorization.

Fully-vectorization means transformation of the summations to the simple matrix and vector products. It is not a practical for the matrices with large dimensions. Here a semi-vectorization algorithm is proposed to avoid working with large vectors and matrices. It speeds up the computations by using one loop for the summation either on degrees or on orders. The former is a good option to synthesize the anomaly quantities on the Earth surface considering a digital elevation model (DEM). This approach is more efficient than the two-step method which computes the quantities on the reference ellipsoid and continues them upward to the Earth surface. The algorithm has been coded in MATLAB which synthesizes a global grid of $5' \times 5'$ (corresponding 9 million points) of gravity anomaly or geoid height using a geopotential model to degree 360 in 10000 seconds by an ordinary computer with 2G RAM.