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Global Gravity Field Modeling and Visualization with 3D Grid for Earth System (3D-GES)

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Gravity field, an important features of the Earth, has many applications in earth system science(Norman, 1985), e.g. , studying the geological tectonic, exploring the nature resources, studing gobal changing, and predicting the orbits of satellites and the trajectories of missiles, all of which require not only high precision data but also effective analytic methods. However, present analytic methods, especially for computer modeling -visualoization of gravity data, by using of conventional data models, e.g. profile map, interval contour, and 2D or 3D regular grid, are actually projection-based models in Cartesian plane. These models, transforming the earth surface into a subset of Cartesian plane by via of map projection, have been proven satisfactory in applications dealing with only a portion of the earth's surface (Sahr, 2003). But, the earth's spherical surface is not topologically equivalent to any subset of the Cartesian plane (White, 1998). It is unpractical to analyze the spherical surface with the planar methods (Hou, 2004), especially in condition of large-scale or global-scale, e.g., the data region spans many projection zones.

The 3D Grid for Earth System(3D-GES) (Yu & Wu, 2009a; 2009b) , a three-dimensional spheroid-based grid system equipped with high efficient coding-decoding algorithms, seamless cells, global continuity, approximate size and multiple resolution, is able to be a substituted way to solve the problem. Global terrestrial and oceanic gravity data released by National Geophysical Data Center (NGDC) in 1999 is employed as experimental data in this paper. The data, containing latitude, longitude, elevation, observed gravity, bouguer gravity anomaly, and free-air anomaly, is modeled in 3D-GES through constructing a set of triples that is composed of grid code, data values and time information. The modeling-visualization procedure includes definition of grid resolution, uploading of gravity data into 3D-GES, construction of the triples, and visualization. Triples are stored as records in the relation database (SQL), taking full advantage of its excellent performance on dealing with large amount of data. Finally, a simple spatial analysis based on the 3D model is carried out, along with the visualization of global graivity field.

The global modeling-visualization with 3D-GES will give geophysicist a more convenient way to analyze and a realer environment to visualize global gravity field. Moreover, other earth system data, such as geomagnetic field, temperature filed, earth crust and atmosphere, can be integrated into 3D-GES to facilitate geophysicist to do integral analysis in a global-scale and integrated platform. Further research will concern on spatial analytic and spatial statistic algorithms based on 3D-GES, aiming to develop a noval and powerful tool sets for scientist on Earth System and for various apllications.

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