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Global Crust Plates Seamless Modeling and LOD Visualization with 3D Grid for Earth System (3D-GES)

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Many works have been done on the representation and the mapping of global crust for its great importance in Geology, Geophysics, Seismology, Marine Sceince, Global Change and Earth System Science (ESS), e.g. motion of tectonic plate, mechanism of disastrous earthquake, simulation of seismic wave propagation, and calculation of Bouguer gravity anomaly. Planar contour map on global crust is a general way, which samples the thickness of global crust in a regular interval based on an appropriate projection such as Mercator, UTM (Ute et al., 1999; Nina et al., 2006;). Whereas, the planar contour map has many shortcomings in continuous representation and integral visualization. For example, it does not support 3D seamless spatial visualization in global scale, it is difficult to support advanced spatial statistics with GIS and geo-statistics software, and it is inconvenient to represent more information than thickness itself. In the past decades, may researchers turn to employ other data models, such as regular 3D rectangle grid (3D-RG) in Cartesian space and 3D longitude-latitude grid (3D-LLG) in manifold space. However, 3D-RG is not topologically equal to the earth for planar projection adopted, which imposes a variety of limitations on many applications, such as the simulation of seismic wave propagatio; 3D-LLG has an intrinsic defect on grid size in that its the grid shrinks quickly near the North and South Pole.

The modelling method and a global seamless 3D model of the earth crust constructed with Three-Dimensional Grid for Earth system (3D-GES) is introduced in this paper. 3D-GES is a high performance spheroid-based grid, of many advantages in spheroid structured, global exhaustively cover, spatial seamless, geometric hierarchy, multiple resolution, approximate size, and exoteric design (Wu & Yu, 2009a; 2009b). 3D-GES is a better replacement of 3D-LLG for global crust modeling.

In the case introduced here, the boundaries and thicknesses of the seven great plates (Eurasia, Africa, American, Pacific, India,) of the Earth were taken as source data for 3D seamless modeling. The key faults in levels of details (LOD) and chief rock components in China, inside the Eurasia plate, were taken as source data for LOD modeling and visualization. The data are available in various forms including contour map, raster image, profile mesh or vector, special data treatments such as rasterization and body-filling should be done. This paper takes vector as the source data to detailly introduce the modeling process, using a strategy of seed-filling algorithm based on 3D-GES. Geo-objects in the model are represented in a specific set of girds, attached with a variety of corresponding data values, e.g. plates name, rock component, density, wave velocity, etc.. All the geo-objects in the model are organized in a number of structural records, which are composed of related data values and grid code, which is a universal order number in 3D-GES in that the grid code itself is a novel geocentric coordinate in the earth system.

Forthermore, spatial analysis and geo-statistics on global crust is thought to be promising directly upon the code system with the aid of specially designed algorithms. Tyipical cases and issue discussions are accompanied in the paper.

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