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RESEARCH ARTICLE

SolidEarth: a new Digital Earth system for the modeling and visualization of the whole Earth space

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Abstract Although many of the first-generation Digital Earth systems have proven to be quite useful for the modeling and visualization of geospatial objects relevant to the Earth's surface and near-surface, they were not designed for the purpose of modeling and application in geological or atmospheric space. There is a pressing need for a new Digital Earth system that can process geospatial information with full dimensionality. In this paper, we present a new Digital Earth system, termed SolidEarth, as an alternative virtual globe for the modeling and visualization of the whole Earth space including its surface, interior, and exterior space. SolidEarth consists of four functional components: modeling in geographical space, modeling in geological space, modeling in atmospheric space, and, integrated visualization and analysis. SolidEarth has a comprehensive treatment to the third spatial dimension and a series of sophisticated 3D spatial analysis functions. Therefore, it is well-suited to the volumetric representation and visual analysis of the inner/outer spheres in Earth space. SolidEarth can be used in a number of fields such as geoscience research and education, the construction of Digital Earth applications, and other professional practices of Earth science.

Keywords Digital Earth, Earth space, full dimensionality, visualization

1 Introduction

In January 1998, the idea of a Digital Earth was first formally proposed by former US vice-president Al Gore at the California Science Center, and a vision of Digital Earth as a computer-based, multi-resolution, and three-dimensional (3D) representation of the entire Earth was also articulated (Gore, 1999). Since then, impressive progress has been made in basic theories, implementation techniques, and building applications of Digital Earth all over the world. To support the development of the Digital Earth, a series of sophisticated and powerful virtual globes, such as Google Earth, NASA's WorldWind, Microsoft's Bing Maps, ESRI's ArcGIS Explorer, Wuhan University's GeoGlobe, the Chinese Academy of Sciences Digital Earth Prototype System, Unidata's Integrated Data Viewer, Digitnext's VirtualGeo, and other free geo-browsers (Goodchild et al., 2012), have been created, that have subsequently evoked world-wide interest and entered the public consciousness (Butler, 2006; Craglia et al., 2008; Bailey and Chen, 2011; Guo, 2012). As the representatives of the first-generation Digital Earth system, these virtual globes not only offer users the capability to image, analyze, synthesize, model, and interpret geospatial objects and spatial phenomena on different spatial aggregation, but also possess the ability to enhance science by providing reliable platforms for exploring, discovering, analyzing, exchanging, and sharing geospatial information in scientific research and pedagogy (Butler, 2006; de Paor and Whitmeyer, 2011; Martínez-Graña et al., 2013; Wang et al., 2013). Nowadays, Digital Earth systems are important and everyday tools used by scientists, educators, government officials, and the general public to conduct research, exchange ideas, and share knowledge with a global perspective in a natural and intuitive way (Yang et al., 2010; Guo, 2012; Yu and Gong, 2012; Zhu et al., 2014).

The first-generation Digital Earth systems, such as the Google Earth virtual globe, focus on the access, display, analysis, and service of geospatial information relevant to the Earth's surface and near-surface (Butler, 2006; Craglia et al., 2008, 2012). They can help users to process data with better resolution and to extract information existing in geographical space. Therefore, they are particularly useful

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