Scientific visualization for earthquake science and simulation

Louise H. Kellogg, Tony Bernardin, Eric Cowgill, Oliver Kreylos, Mike Oskin, John Rundle, Donald L. Turcotte, M. Burak Yikilmaz. W. M. Keck Center for Active Visualization in Earth Sciences, Departments of Geology, Computer Science, and Physics, University of California, Davis, CA 95616, USA

Recent earthquakes in Haiti, Japan, Mexico and Chile have generated unprecedented quantities and quality of observational data, including LIDAR and InSAR scans of landscape changes. At the same time, earthquake simulations are becoming more complex and computationally intensive. At the Keck Center for Active Visualization in Earth Sciences (KeckCAVES), we are developing and using interactive scientific visualization to process, analyze, and interpret high-resolution data from recent earthquakes and from earthquake simulations. We will present case studies of scientific visualization of LIDAR data from the January, 2010 earthquake in Haiti, aftershock sequences of the 2011 earthquake in Japan, and simulations of earthquakes in California using Virtual California. These case studies demonstrate the use of visualization to map fault offsets in 3D and its potential for driving more accurate earthquake simulations. Our first example is the 2010 earthquake in Haiti. Following the magnitude 7.0 earthquake, an airborne LiDAR point cloud containing over 2.7 billion point measurements of surface features was collected by the Rochester Institute of Technology. We conducted interactive visual analysis of the 66.8 GB Haiti terrain data in a 4-sided, 800 ft^3 immersive virtual-reality environment using the software tools *LiDAR Viewer* and *Crusta*. To our knowledge, this is the first reported virtual field study using such an environment. We remotely characterized the regional fault geometry to discover and measure landforms displaced by surface-rupturing earthquakes. No surface rupture was seen from the 2010 earthquake, but we found evidence of past rupture, with 6-8 m offsets at several sites along a 40 to 60 km stretch of fault. This suggests that an earthquake similar to, or larger than the Mw 7.0 2010 event is possible along the Enriquillo fault near Port-au-Prince. We deduce that the 2010 earthquake was a relatively small event on a boundary between fault sections that ruptured in 1751 and 1770, based on new analysis of historical damage reports and the gap of well-defined fault-zone morphology where the 2010 earthquake occurred. Our study demonstrates how virtual-reality based data visualization transforms analysis of massive LiDAR data sets during rapid scientific response to major natural disasters.