Validation of Geometric Accuracy of Global Land Survey (GLS) 2000 Data

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Abstract

The Global Land Survey (GLS) 2000 data were generated from Geocover™ 2000 data with the aim of producing a global data set of accuracy better than 25 m Root Mean Square Error (RMSE). An assessment and validation of accuracy of GLS 2000 data set, and its co-registration with Geocover™ 2000 data set is presented here. Since the availability of global data sets that have higher nominal accuracy than the GLS 2000 is a concern, the data sets were assessed in three tiers. In the first tier, the data were compared with the Geocover™ 2000 data. This comparison provided a means of localizing regions of higher differences. In the second tier, the GLS 2000 data were compared with systematically corrected Landsat-7 scenes that were obtained in a time period when the spacecraft pointing information was extremely accurate. These comparisons localize regions where the data are consistently off, which may indicate regions of higher errors. The third tier consisted of comparing the GLS 2000 data against higher accuracy reference data. The reference data were the Digital Ortho Quads over the United States, ortho-rectified SPOT data over Australia, and high accuracy check points obtained using triangulation bundle adjustment of Landsat-7 images over selected sites around the world. The study reveals that the geometric errors in Geocover™ 2000 data have been rectified in GLS 2000 data, and that the accuracy of GLS 2000 data can be expected to be better than 25 m RMSE for most of its constituent scenes.

Introduction

The Global Land Survey (GLS) 2000 data set is a collection of images acquired by the Landsat 7 ETM+ sensor, and is the geodetic reference for all Landsat products archived at the US Geological Survey Earth Resources and Observation Science (EROS) Center. The goal of this paper is to provide an assessment of the geometric accuracy of the GLS 2000 data set and compare its accuracy relative to the Geocover™ 2000 data set. The Geocover™™ data sets (1975, 1990, and 2000) were the predecessor to GLS data sets. Studies (Franks *et al.*, 2009; Masek and Covington, 2007) reveal that Geocover™ 2000 data have substantial errors (>100 m) on a per-scene and per-pixel level (Masek and Covington, 2007). Therefore, the Geocover™ 2000 data set images were reprocessed using all available ground control points, Landsat-7 definitive ephemeris, and tie points in a block configuration to create the GLS 2000 reference data set. In addition to the Geocover™ 2000 data set, Geocover™ data sets for 1975 and 1990 were also reprocessed and registered to the GLS 2000 data set forming GLS-1975 and 1990 data sets. New GLS 2005 and 2010 data sets have since been created. The GLS data base is freely available (through EarthExplorer*: http://earthexplorer.usgs.gov/*) global data base selected for each epoch (1975, 1990, 2000, 2005, and 2010) for minimum cloud cover and at peak greenness. They are used in a variety of applications needing a global time series images and provides a baseline for many global change studies (Gutman *et al.*, 2008). The GLS 2000 data set is also the geographic reference for Landsat Data Continuity Mission (LDCM) and serves as standard reference data for a number of satellite data providers around the world (Chander *et al.*, 2010; Sampath, 2012). This makes the task of validating the accuracy of the GLS 2000 data set very important. The most commonly used methods of validating the geometric accuracy of remote sensing data sets involve comparing them against reference data sets of higher accuracy (Chander *et al.*, 2010; Gianinetto and Scaioni, 2008; Li *et al.*, 2007; Sampath, 2012), or using available ground control points (Aguiller *et al.*, 2012; Muller *et al.*, 2012). However, the global coverage of the data sets makes it hard to assess the accuracy, as other independent data sets of comparable accuracy and coverage, or ground control points are limited in availability.

To address the challenges presented by the global coverage of the data, the validation task was divided into three parts. In the first part (or tier), the GLS 2000 data were compared with the Geocover™ 2000 data. In the second tier, the data were compared with Landsat-7 (L7) Level 1G systematic products (radiometrically and geometrically corrected products, without the use of terrain or ground control) acquired during April 2005 through December 2006 when the gyros of the satellite performed extremely well; the platform was considered stable, and the resulting data products were of high accuracy (Lee *et al.*, 2004). The third tier of tests consisted of testing GLS 2000 data against higher accuracy reference data sets, wherever they were available. Most of the available ground control points were used to generate GLS 2000 data, hence they were not used in this assessment. The reference data sets included data from Digital Ortho Quads and SPOT ortho-rectified data from Australia's National Earth Observation Group. In other parts of the world, the GLS 2000 data were validated using a triangulation-based satellite bundle adjustment algorithm. Similar techniques, based on rigorous sensor modeling, have been used by many researchers for improving the accuracy of satellite data (Lutes and Grodecki, 2004; Li *et al.*,

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