DEM GENERATION WITH RADARSAT-2 ULTRA-FINE MODE DATA USING RFM

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Technical Commission VII Symposium 2010

KEY WORDS: Geometric modeling, DEM/DTM, High resolution, Radarsat, Algorithms

ABSTRACT:

Due to high spatial resolution of these recent spaceborne sensors, a large number of researchers around the world have investigated radargrammetric methods using different deterministic models (Toutin, 2004). They were applied for 3D point positioning and feature extraction as well as generation of digital surface models (DSMs). However, the recently-renewed empirical model, the rational function models (RFM), was only applied with high-resolution (HR) optical data, e.g. Ikonos and others due to their limited capability to model high-frequency distortions (Grodecki, 2001, Fraser et al., 2002, Tao and Hu, 2002). With the launch of Radarsat-2, research studies at the Canada Centre for Remote Sensing (CCRS) evaluated its geometry and the accuracy of 3D cartographic localisation and DEM generation potential as part of the Canadian Space Agency's Science and Operational Applications Research program. In the first step, the Toutin's 3-D radargrammetric model, previously developed for Radarsat-1, was adapted to Radarsat-2 sensor and tested on different modes and beams (Toutin, and Chénier, 2009, Toutin et al., 2010). Afterwards, the empirical model, the RFM, provided by MDA with Radarsat-2 data was evaluated in term of robustness, applicability and accuracy. RFMs can be used in two approaches (Madani 1999): 1) to approximate an already-solved existing 3D physical model; and 2) to normally compute the unknowns of all the four third-order polynomial functions with ground control points (GCPs). Since biases or errors still exist after applying the RFMs, their results need to be post-processed depending on sensor and image parameters: either to compute 2D polynomial functions with few accurate GCPs (Tao and Hu, 2002, Fraser and Hanley, 2005), or to refine the original RFs parameters with linear equations requesting more accurate GCPs. While MDA mentioned that Radarsat-2 RFM are extremely accurate in the ability to match a rigorous zero-Doppler SAR model, because of its stability (no issues on attitude variations) (Robertson, personal communications, 2009). Therefore, RFM "systematic" accuracy is limited by the orbit (5 m at 90%) and calibration timing uncertainties. The large number of research works on RFM were only realized these last seven years on optical data and demonstrated that RFM are sensitive to the pre-processing of the data, the viewing angles and the terrain relief, which also affect the choice of polynomial functions of their post-processing. Because SAR images display more geometric distortions than optical images and it is the first time that RFM can be tested with HR SAR data, it was thus necessary to address these previous issues. The objectives of this paper are to expand on these different results, applied to ultra-fine mode SAR images (3-m resolution) of Radarsat-2. First, the RFM by themselves are evaluated as a function of the viewing angles. Second, their post-processing using different polynomial functions (zero to second order) and source, number and accuracy of GCPs are evaluated. Finally, different DSMs are generated using the best solutions from previous tests on RFM post-processing and thus compared to DSM generated with the deterministic Toutin's model.

TOPIC: Geometric modeling
ALTERNATIVE TOPIC: Image processing and pattern recognition