Experiences with Full-Waveform Data Processing and Radiometric Calibration of ALS Campaigns within C4Austria

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The Institute of Photogrammetry and Remote Sensing at the Vienna University of Technology (I.P.F.) is project partner within C4Austria (Climate Change Consequences for the Cryosphere, Austrian Climate Research Programme A963633). Within this project, ALS campaigns from autumn 2009 and 2010 have been processed at the IPF, covering the block glaciers at Hintereisferner, Äußeres Hochebenkar, Ölgrube, Reichenkar and Schrankar. Both datasets were delivered with full-waveform (FWF) data. Unfortunately, the FWF data of 2009 were not processible due to hardware and storage problems of the instrument whereas the FWF recording and processing of the 2010 campaign were successful.

FWF data analysis, processing and radiometric calibration are an active research topic at the I.P.F. for nearly one decade. In addition to 3D point clouds as delivered by "classic" discrete-return ALS systems, FWF data allow for calculating radiometric and physical quantities for each acquired 3D point such as echo width, backscatter cross-section and reflectance. Since the FWF activities at the I.P.F. were mainly focussed on data recorded by systems of one local manufacturer (RIEGL LMS GmbH), the adaptation of developed algorithms and processing strategies to FWF data captured by a system of another manufacturer (Optech Inc.) has been both desirable and challenging. In this study, we present the workflow for the processing of Optech FWF ALS data. It starts with the extraction of 3D points and FWF parameters (amplitude, echo width) by Gaussian Decomposition in the local scanner coordinate system and is followed by direct georeferencing and map projection of these points. In subsequent steps, geometric quality control and enhancement in the form of strip adjustment by least-squares matching were performed for optimal alignment of the strip-wise point clouds. These steps are prerequisites for proper radiometric calibration.

As a result, the geometrically and radiometrically calibrated dataset contains for each target: the exact 3D location, the local surface orientation, the FWF parameters amplitude and width of both the transmitted laser pulse and of the echo generated by the target, and finally the target reflectance. This target reflectance is a physical object property with respect to the used laser wavelength (1064 nm), but independent of mission parameters. Strip adjustment and radiometric calibration were performed in the I.P.F. ALS software suite OPALS (Orientation and Processing of ALS data). Their promising results have given empirical evidence for the validity of the established processing strategies for Optech FWF data.

In the ALS campaign of autumn 2011, additional in-situ measurements with a reflectometer were captured at the date of the flight. This enables an absolute radiometric calibration of the recorded ALS data as input for multi-temporal feature detection and surface classification.

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