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ASTER-derived DEMs for glacier studies: Comparison of available software packages

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Digital elevation models (DEMs) are widely used in glaciological applications to extract glacier parameters such as surface elevation, slope, aspect and hypsometry. Combining these parameters with glacier outlines extracted from satellite imagery has the potential to produce valuable glacier inventories covering large areas. Changes in glacial mass balance over time have been derived by comparing changes in DEMs acquired at different times. DEMs are also being used to derive indirect estimates of mass balance. In high altitude remote mountain areas, DEMs derived from satellite stereo imagery may constitute the only source of data on glacier elevation and area. A careful evaluation of the various algorithms for DEM generation, as well as uncertainties associated with each of the algorithms, is needed before applying these tools for extensive areas.

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is proving to be a valuable source for elevation data over glacierized terrain. ASTER acquires along-track stereo images, making it suitable for generation of DEMs. However, evaluations of ASTER DEM accuracy, especially in high altitude, rugged mountain terrain, remain limited. It is safe to say that there is no consensus over an established DEM generation method especially suitable for creating elevation data from ASTER imagery for glacier terrain. Furthermore, the suitability and accuracy of available software packages capable of generating DEMs from ASTER has been addressed only in a handful of studies. With the increasing availability of glacier outlines worldwide being produced within the framework of the Global Land and Ice Monitoring from Space (GLIMS) project, glaciologists need like to know the best tools to extract

glacier elevation data to use for glacier change detection.

This paper evaluates the characteristics and suitability of DEMs derived from ASTER imagery at two remote sites in the Peruvian Andes and Western Himalaya.. We evaluate the performance of four software packages for constructing DEMâEURŹs for glaciological studies: PCI Geomatica, ENVI, Silcast (used to generate NASAâEURŹs on-demand DEM product distributed by the LPDAAC), and Leica Photogrammetry Suite (LPS). We describe the errors in each DEM with respect to topographic characteristics (elevation, slope, aspect) and evaluate and compare the errors introduced by small, low-elevation clouds. We also examine how the availability of ground control points and optimized gain settings influence the accuracy of the DEMs, and how the interpolation procedures, which in some packages cannot be controlled by the user, influence the quality of the product. Our main objective is to aid researchers who wish to use ASTER-derived DEMs in glaciological work by detailing the strengths and weaknesses of each software package and describing how to optimize performance of a chosen package.