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Which DEM is the best for glaciology? -Evaluation of global-scale DEM products-

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Digital elevation models (DEMs) are fundamental geospatial data to study glacier distribution, changes, dynamics, mass balance and various geomorphological conditions. This study evaluates latest global-scale free DEMs in order to clarify their superiority and inferiority in glaciological uses. Three DEMs are now available; the 1-arcsec. product obtained from the Shuttle Radar Topographic Mission (SRTM1), the second version of Global Digital Elevation Model of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER GDEM2), and the first resampled dataset acquired by the Advanced Land observing Satellite, namely ALOS World 3D-30m (AW3D30). These DEMs have common specifications of global coverage (<60ºS/N for SRTM1), freely downloadable via internet, and 1-arcsec. ($\sim$30 m) pixel spacing. We carried out quantitative accuracy evaluation and spatial analysis of missing data (i.e. "void") distribution for these DEMs.

Elevation values of the three DEMs are validated at check points (CPs), where elevation was measured by Geospatial Information Authority of Japan, in (A) the Japan Alps (as steep mountains with glaciation), in (B) Mt. Fuji (as monotonous hillslope), and in (C) the Tone river basin (as an flat plain). In all study sites, AW3D30 has the smallest errors against the CP elevation values (A: -6.1 ± 8.6 m, B: $+0.1\pm3.9$ m, C: $+0.1\pm2.5$ m as the mean value and standard deviation of elevation differences). SRTM1 is secondly accurate (A: $^{-1}7.8\pm16.3$ m, B: $+1.3\pm6.4$ m, C: $+0.1\pm3.1$ m,), followed by ASTER GDEM2 (A: $^{-1}3.9\pm20.8$ m, B: -3.9 ± 10.0 m, C: $+4.3\pm3.8$ m,). This accuracy differences among the DEMs are greater in steeper terrains (A>B>C). In the Tone river basin, SRTM1 has equivalent accuracy to AW3D30. High resolution (2.5 m) of the original stereo-pair images for AW3D30 (i.e. ALOS PRISM imagery) contributes for the best absolute accuracy.

Glaciers on rather flat terrains are usually distributed in higher latitude (e.g. Antarctica and Greenland), where SRTM1 is unable. Glaciers at mid-to-low latitudes glaciers are usually distributed in high and steep mountains, where SRTM1 has lower accuracy than AW3D30. AW3D30 would contributes as a preferable option for glaciology in a global scale. At the tops of high mountains in the Nepal Himalaya, however, AW3D30 has a large area of data missing due to snow cover. This inferiority should be improved by filling with other datasets in the next version. ASTER GDEM2 has less area of data missing in the Nepal Himalaya, which would contribute for coarse uses such as generation of river basin, brief drawing of a topographic map, etc.