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Global Glacier Surface Elevation Change and Geodetic Mass Balance Estimations derived by Spaceborne Digital Elevation Models

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Glaciers worldwide undergo drastic changes in adaption to changing climatic conditions. Accelerated retreat and surface lowering have been reported by numerous studies from various glaciated regions. A detailed knowledge about their status is of broad public interest, as glaciers are essential fresh water resources in semi-arid and arid regions and drivers of sea level change. The aim of this study is to provide a status information in respect to the mass change of mountain glaciers between 60° N and 56° S. Our glacier specific dataset covers a time range between 2000 and 2011-2015. We derive digital elevation models (DEM) from TanDEM-X (Terra SAR-Add-on for Digital Elevation Measurements), a SAR bi-static satellite radar mission operated by the German Aerospace Center DLR and EADS. We primarily use scenes from the years 2011 -2013 acquired during the first global DEM phase of the mission. These DEMs are co-registered and compared to DEMs of the Shuttle Radar Topography Mission (SRTM) acquired in February 2000. we compute surface elevation change and calculate geodetic mass balance on the glaciated areas outside the polar regions.

Our results show a total glacier mass change rate of -19.43±0.60 Gt a^{-1} for the South American continent over the observation period. This loss is predominantly driven by the large Patagonian icefields and its outlet glaciers. Regarding Tierra del Fuego and tropical South America our results show less distinct glacier depletion than previously conducted studies. For the High Mountain Asia covering the Himalaya, Nyainqentangla, Hindu Kush and Karakoram ranges our preliminary results reveal a mass change rate of -9.7±0.79 Gt a^{-1}. This value is lower than previously published works.

To complete the global perspective, more than 3000 TanDEM-X datasets are currently passing through our elaborated processing chain to derive elevation change data also for the remaining regions (North American Continent, New Zealand and the missing regions of Asia). The approach will result in an unprecedented, nearly worldwide consistent elevation change database for individual glaciers. It will help understand the fate of terrestrial ice bodies on different geographic scales and support modelling activities as a fundamental cal/val dataset. We recommend regular acquisitions of TanDEM-X imagery over glaciated ground to update this baseline data. The technology and developed methods constitute highly efficient tools for large-scale monitoring in particular in regions of pervasive cloud cover.