Monitoring the annual geodetic mass balance of Bordu and Sary-Tor glaciers, Central Asia, using UAV data

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The geodetic mass balance of a glacier corresponds to glacier-wide volume changes, converted to mass changes using density assumptions. It is typically calculated by differencing multi-temporal digital elevation models. In this study, we show how the annual geodetic mass balance of a glacier can be derived from Uncrewed Aerial Vehicle (UAV) data. The presented workflow is applied to two small to medium-sized glaciers in the Kyrgyz Tien Shan (Central Asia): Bordu glacier and Sary-Tor glacier. The obtained geodetic mass balance of 2021/22 and 2022/23 is compared with the glaciological mass balance derived from ablation stakes and snow pits. A previously calibrated mass balance model is used to correct for the difference in acquisition dates. The results show that the determined geodetic mass balance matches closely with the glaciological mass balance. Besides, for both glaciers the geodetic mass balance does not seem to be particularly sensitive to the assumptions regarding volume-to-mass conversion. Therefore, our results demonstrate that UAVs can serve as a valuable instrument to quantify the annual geodetic mass balance and to validate the glaciological mass balance. The conventional glaciological mass balance estimation often relies on interpolation and extrapolation methods, whereas UAVs offer the potential for direct data acquisition over the entire glacier surface.