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Estimating the volume of mid-latitude glacier-like forms on Mars

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Although a substantial reservoir of glacier ice has been identified in the mid-latitudes of Mars, debate still persists regarding the formation, current and former volume, and dynamic evolution of these ice masses. Here we present the first estimate of the ice volume contribution of glacier-like forms (GLFs) – the first order component of Mars' glacial landsystem – from population scale outline mapping. The outlines of 1243 GLFs were manually delineated from 6 m per pixel Context Camera (CTX) images and the volume of each determined using a volume-area scaling approach. Our results show that GLFs cover a surface area of 11344 $\pm$ 393 km^2 and have a total volume of 1744 $\pm$ 441 km^3. Using two end-member scenarios for ice concentration by volume of 30 % (pore ice) and 90 % (debris-covered glacier ice), we calculate the volume of ice contained within GLFs to be between 523 $\pm$ 132 km^3 (480 $\pm$ 121 Gt) and 1570 $\pm$ 397 km^3(1439 $\pm$ 364 Gt), equivalent to a mean global water layer 3 $\pm$ 1 – 10 $\pm$ 3 mm thick. We investigate the local topographic setting of each GLF by reference to the Mars Orbiter Laser Altimeter (MOLA) digital elevation model. Our analysis reveals that globally GLFs are on average larger in latitudes $>36^o$ and on slopes between 2 and 8^o. In the northern hemisphere GLFs between 500 and 2500 m in elevation and in the southern hemisphere GLFs with a northern aspect are also larger on average. The observed spatial patterns of GLF landform and volume distribution suggests that regional to local meteorological and topographical conditions play an important role in GLF ice accumulation and/or preservation. On-going research is aiming to quantify not only current but former GLF volume, as there is strong evidence suggesting that GLFs are the remnants of once larger ice masses.