



Major 20th Century Contribution to Sea Level Rise from Uncharted Glaciers

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Global mean sea-level rise (GMSLR) during the 20th century was caused by glacier and ice sheet mass loss, thermal expansion of ocean water, and change of terrestrial water storage. Whether based on observations or results of climate models, the sum of estimates of each of these contributors tends to fall short of the observed GMSLR. All estimates of the glacier contribution to GMSLR rely on the application of glacier inventory data, which are known to undersample the smallest glacier size classes. Here we show that these missing glaciers (those that we expect to exist today but which are not represented in the inventories) may have contributed 42.6 mm to GMSLR during the period 1901 to 2015, even though their current ice mass is very small (less than 5 mm sea-level equivalent). Additionally, glaciers that completely melted within the 20th century, and which are therefore not included in global glacier inventories (vanished glaciers), may have contributed 5.1 mm to GMSLR. Together, uncharted glaciers (missing glaciers and vanished glaciers combined) made an estimated contribution of 47.7 mm to GMSLR, and the failure to consider these glaciers may be the cause of difficulties in closing the GMSLR budget during the 20th century. Because of these glaciers' small current ice mass, their potential to impact future GMSLR is much smaller.