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A best estimate of surface meltwater in Antarctica

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How much meltwater is produced annually on the surface of the Antarctic Ice Sheet? This question is remarkably difficult to answer. Remote sensing of surface melt has weaknesses, and so has (regional) climate modelling. More precisely: both satellites and models tend to underestimate melt fluxes in regions where most surface melt takes place. Models do not exactly capture the feedback between melt and surface darkening, and cannot represent small-scale high-melt features (blue ice, rocks, ponds) at the model resolution. Satellite-based radar scatterometry suffers from low backscatter reduction over ice and melt pond surfaces. So the current estimates of 80-130 Gt of surface melt per year are likely too low.

Yet, there is a critical role for surface melt in present-day ice-shelf collapse, and even more so in future scenarios of extreme sea-level rise, with hydrofracturing driving accelerated Antarctic mass loss. So knowing even the amount of present-day surface melt is a minimum to understand and predict what the future mass balance will bring.

Here we present our best estimate of Antarctic surface melt by merging satellite remote sensing with output from the regional climate model RACMO$_2$. We combine the full MODIS albedo archive with daily surface melt from RACMO$_2$. Wherever MODIS detects low-albedo ice or rock, surface melt from RACMO$_2$ is recomputed using an energy balance model. This model does not only take into account the additional absorption of sunlight on low-albedo surfaces, but also considers changes in surface roughness, subsurface radiation penetration, and thermal conductivity. In that way, we carefully consider all surface energy fluxes and arrive at the best estimate of surface melt.