

# Accelerated melting and disappearance of glaciers and ice caps

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Glaciers and ice caps (GIC) are losing mass and raising global sea level. The rate of glacier retreat has been difficult to quantify because long-term mass-balance observations have been available for only a few dozen of the Earth's estimated 300,000 to 400,000 GIC. An easily measured property, especially for remote sensing, is the AAR, the ratio of the accumulation area to the total area of a glacier. For a glacier in balance with its local climate, the average mass balance is zero and the AAR is equal to its equilibrium value,  $AAR_0$ . Given a sustained value of  $AAR < AAR_0$ , a glacier will retreat from lower elevations until the AAR is restored to its equilibrium value. Here, we present a data set of 84 observed GICs from 1995–2009 and show that most GICs are even farther from equilibrium than previously estimated. For the past decade, 2000–2009, these GICs have an average AAR of 35%, far below the mean equilibrium value of 58%. Our analysis suggests that in order to be in balance with the present climate, the Earth's GICs must lose ~40% of their volume, raising global sea level by ~240 mm. Extrapolation of recent trends suggests that if the climate continues to warm for another two decades, GIC volume will ultimately decline by 75% or more.