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Dwindling impact of large volcanic eruptions on global glacier changes in the Anthropocene

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Large volcanic eruptions impact climate through the injection of ash and sulfur gas into the atmosphere. While the ash particles fall out rapidly, the gas is converted to sulfate aerosols, which reflect solar radiation in the stratosphere and cause a cooling of the global mean surface temperature. Earlier studies suggested that major volcanic eruptions resulted in positive mass balances and advances of glaciers. Here we perform a multivariate analysis to decompose global glacier mass changes from 1961 to 2005 into components associated with anthropogenic influences, volcanic and solar activity, and El Niño Southern Oscillation (ENSO). We find that the global glacier mass loss was mainly driven by the anthropogenic forcing, interrupted by a few years of intermittent mass gains following large volcanic eruptions. The relative impact of volcanic eruptions is dwindling due to strongly increasing greenhouse gas concentrations since the mid of the 20th century. Furthermore, our study indicates that solar activity and ENSO have limited impacts on climate conditions at glacier locations and that volcanic eruptions alone can hardly explain decadal periods of glacier advances documented since the 16th century.