



Repeated glacial-lake outburst floods in Patagonia, Chile: hazard assessment simulations with increasingly complex models

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Patagonian glaciers are experiencing one of the fastest retreats on Earth, inferred to be a direct response to recorded climate change in South America. The dynamic response of the region's glaciers to climate change was evidenced when four self-similar glacial-lake outburst floods (GLOFs) occurred in April, October, December 2008 and March 2009, the largest floods from this glacier on record. On each occasion, the lake Cachet 2, in the Northern Patagonia Ice-Field, dammed by the Colonia glacier, released about 200 million m³ water into the Colonia river. The lake has refilled rapidly, such that further outbreak floods can be expected. Pipeflow calculations of the subglacial tunnel drainage and 1D hydraulic models (mobile-bed) of the river flood give consistent results, with estimated peak discharge circa 3000 m³s⁻¹. These floods were larger in magnitude than any flood on record, according to gauged data since 1963. However, geomorphological analysis of the Colonia valley shows physical evidence of former catastrophic outburst floods from a larger glacial lake, with flood discharges possibly as high as 16,000 m³s⁻¹. Due to potential impacts of climate change on glacier dynamics in the area, GLOFs may increase future flood risks for infrastructure and population, particularly relevant in view of the current development of hydropower projects in Chilean Patagonia, as well as affect physical and biological response in the river, floodplain, and fjord ecosystems. Numerical tools and results are explored towards providing a framework and recommendations for hazard assessment.