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Mass balance evolution of Martial Este Glacier, Tierra del Fuego (Argentina) for the period 1960–2009

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Abstract. The Martial Este Glacier in southern Tierra del Fuego was studied in order to estimate the surface mass balance from 1960 until 2009. For this reason a degree-day model was calibrated. Air temperature and precipitation data obtained from 3 weather stations as well as glaciological measurements were applied. The model was driven using a vertical air temperature gradient of 0.69 K/100 m, a degree-day factor for snow of 4.7 mm w.e. K⁻¹ day⁻¹, a degree-day factor for ice of 9.4 mm w.e. K⁻¹ day⁻¹ and a precipitation gradient of 22%/100 m. For the purpose of surface mass balance reconstruction for the time period 1960 until 2006 a winter vertical air temperature gradient of 0.57 K/100 m and a summer vertical air temperature gradient of 0.71 K/100 m were added as well as a digital terrain model. The key finding is an almost continuous negative mass balance of -772 mm w.e. a⁻¹ throughout this period. While the calculation of the mass balance for the period 1960–2006 is based on instrumental records, the mass balance for the years 2007 until 2009 was estimated based on the IPCC SRES A2-scenario. To accomplish this estimation, the dataset of the global climate model HadCM3 was statistically downscaled to fit local conditions at Martial Este Glacier. Subsequently, the downscaled air temperature and precipitation were applied to a volume-area scaling glacier change model. Findings reveal an enduring deglaciation resulting in a surface area reduction of nearly 93% until 2009. This implicates that the Martial Este Glacier might be melted off at the beginning of the 22nd century.

Full Article in PDF (PDF, 1311 KB)

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