Geophysical Research Abstracts, Vol. 9, 03023, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03023

Rapid evolution of a proglacial coastal lake in Iceland, studied with long term ground observations, remote sensing data and iceflow modeling

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We describe changes (in length, thickness, volume, ice fluxes) of the glacier outlet, Breiðamerkurjökull, which drains south from Vatnajökull down to the coastal outwash plain Breiðamerkursandur, SE-Iceland. The glacier calves into the proglacial lake Jökulsárlón that has been expanding since its first appearance in 1933, and is now $\sim$18 km^2 in area. Glacial sediment is deposited in the lake instead of compensating for coastal abrasion by ocean waves at the mouth of the river Jökulsá. The glacier front has retreated $\sim$6 km since 1890 and areas covered by 300 m thick ice are now free of ice. The expanding lake obtains thermal energy from ocean tidal water and the calving rates into the lake have increased rapidly during the last two decades. Optical SPOT5 remote sensing images are used to observe the present velocity field and surface elevations as well as to monitor the calving margin. The glaciers dynamics are described by a finite-element ice flow model, defined as the sum of deformation velocity and basal sliding considering the basal water pressure, coupled to empirical models of the mass balance and the calving rate. The calving rate is expected to increase rapidly when the glacier retreats 2 km inland where the bed slopes from 200 m to 300 m below sea level. Model calculations suggest a retreat rate of the calving front position that implies an average lake growth rate of 0.4 km^2 yr^{-1}. At that rate Breiðamerkurjökull would retreat after $\sim$200 years from a 25 km long overdeepening which he excavated during its Little Ice Age advance and almost vanish in $\sim$400 years. Given other suggested climate change scenarios the outlet glacier may vanish in 150 years.