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Mass balance of Vatnajokull outlet glaciers back to 1958

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A simple model using upper-air meteorological variables in the NCEP-NCAR Reanalysis database is used to model seasonal components of mass balance of five Vatnaj\"{o}kull outlet glaciers. It was developed for glaciers in North America and has been applied to glaciers in Norway and Sweden. The model, calibrated over the period of record POR of mass balance observations 1991-2001 was used to reconstruct the mass balance series over 1958-2003 for each outlet glacier.

The model uses temperature, relative humidity, and wind at 850 hPa and temperature at 1000 hPa. Winter balance b_w depends on the product of humidity and the wind component in a particular critical direction ϕ' that is glacier specific. For each glacier, ϕ' favors flow around the icecap rather than over the top of it. The main determinant of summer balance b_s is temperature interpolated at 1200 meters. Over the POR, the model had percent r^2 ranging from 41 to 93 for b_w, 55 to 84 for b_s.

Over the five glaciers, sensitivity to 1K warming averaged -1.08 meters per year water equivalent (m/a w.e.), due mainly to increased ablation -0.83 and secondarily to shift of precipitation from snow to rain -0.25. Sensitivity to 10 percent increase in precipitation averaged $+0.16$.

In the reconstructed series, the biggest shift in net balance b_n at all five glaciers is between the means of 1958-1994 and 1995-2003. The 5-glacier average of the -0.66 b_n shift consisted of -0.54 in b_s and -0.12 in b_w, all in m/a w.e.

Over the POR, the five-glacier range 0.39 of mean b_w is small, but glacier to glacier correlation is low, reflecting the interaction with their individual ϕ' of year to year variation in wind direction. By contrast, the range 1.07 of mean b_s

is large, but glacier to glacier correlation is high because spatial variation of annual temperature anomalies is weak. That is, the glaciers had separate sensitivities to wind direction but similar sensitivities to temperature.