



Global glacier volume projections for the 21st century including the dynamical response to changes in climate

R. H. Giesen and J. Oerlemans

Institute for Marine and Atmospheric research Utrecht, Utrecht University, Utrecht, Netherlands (r.h.giesen@uu.nl)

The total ice volume contained in glaciers is small compared to the volume of the Greenland and Antarctic Ice Sheets. However, glaciers respond much faster to a changing climate and therefore increased runoff from glaciers is expected to contribute significantly to sea-level rise in the 21st century. Estimates of the global contribution of glaciers to sea-level rise are often based on modelling changes in the surface mass balance, while changes in glacier size are accounted for with volume-area scaling. The models are calibrated with mass balance measurements, which are biased to small glaciers in regions like Central Europe and Scandinavia, containing a minimal fraction of the total ice volume stored in glaciers. Consequently, these models provide highly uncertain glacier volume projections for the regions containing most of the ice volume (e.g. Arctic Canada, Alaska, Himalaya). We present an alternative approach, with a focus on the dynamical glacier response to changes in climate. Glacier volume projections are performed with a one-dimensional ice-flow model, coupled to a simple surface mass balance model. The surface mass balance model uses monthly values of air temperature and precipitation as input and separately calculates the contributions of net solar radiation and other fluxes to the energy balance. The coupled model is applied to synthetic glaciers with a mass balance profile and geometry based on large glaciers in different regions. By forcing the model with projected 21st century changes in air temperature, precipitation and incoming solar radiation, we obtain new estimates of volume changes in glacierized regions around the globe.