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Modelling the response of 7 Alpine glaciers using a coupled mass-balance geometric model forced with gridded observed climate data and GCM and RCM results.

Romain Candela (1), Sarah Raper (1), and Roger Braithwaite (2)

(1) Center for Air Transport and the Environment, Manchester Metropolitan University, Manchester, United Kingdom , (2) School of Environment and Development, University of Manchester, Manchester, United Kingdom

Seven Alpine glaciers are investigated using an updated version of the coupled Temperature-Index Mass-Balance – Geometric Ice Volume model developed by Dr. Raper and Dr. Braithwaite [Raper and Braithwaite, 2000]. The set of 7 glaciers have continuous relatively long-term mass-balance and area observation series and belong to the 30 Reference glaciers of the World Monitoring Service. The final purpose of our project is to produce a new estimation of the contribution of the Alpine glaciers to the sea-level rise.

For each glacier the model was calibrated for the years between 1958-1967 to 1995 according to the availability of glacier observations. Monthly mean temperature data (0.5 degree Climate Research Unit TS 3.0) and precipitation data (10 minute Alpine Climate Data) were used as forcing. A major uncertainty is the altitudinal precipitation profile at the glacier. To address this problem and capture a range of uncertainty, as part of the calibration process we estimate time-average high, medium and low precipitation profiles for the calibration periods. The model is forced with temperature and precipitation anomalies interpolated from four adjacent grid points. The calibration process involves the estimation of two temperature downscaling parameters that adjust the mean and standard deviation of the temperature data at the glacier surface.

The model is tested by comparing model output with post-1995 observed mass-balance data. Reconstructions of the glacier areas and volumes are made for the period 1901 to 2006 using the gridded climate data detailed above as forcing. For projections of future glacier volume, we force our model with temperature and precipitation climate model results from the Ensembles Project (RT3) for emission scenario A1B up to the year 2100. Hadley Centre model results for three GCM and three RCM runs are used. These climate models have three sensitivities (low, medium and high) and a resolution up to 25 km2 for the RCM.

The volume response times of the individual glaciers are shown to be approximately a hundred years. The survival, or not, of the individual glaciers through the 21th century for the scenario A1B depends mainly on the climate model forcing, the uncertainties in the calibrated precipitation profiles have a lesser effect.