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Thermofluidodynamic modelling of the Adamello Glacier in a future climate scenario. Will the largest Italian glacier disappear by 2080?

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A thermofluidodynamic model was applied to the study case of the Adamello glacier (17,24 km2, after ASTER 2003 data), located in the Central Alps. The dynamic of the glacier was first simulated in the current climate conditions (1996-2007) and then using future climate projection resulting from the PCM A1b scenarios. Using the finite element code Elmer the dynamic equations were solved for the velocity field and the free surface elevation. The glacier was modelled with a 3D mesh composed by 28050 nodes and subdivided into 10 vertical layers. Elevation of the free surface and bedrock recorded in 1991 and in 1996 were used as boundary and initial conditions. For each simulated year a top surface temperature of -7.5 °C was considered for the winter semester in the ablation season the glacier's temperature was set to 0°C. During melting a fixed bottom velocity was applied to simulate the slip behaviour. As a Neumann boundary condition on the glacier's top surface the seasonal mass balance estimated from the energy-balance over the 1995-2009 period was assumed, with a mean value of -1.4 m/a. The reliability of the energy balance was verified with point measurement at ablation stakes over two ablation seasons, with runoff data and remote sensing. The maximum simulated surface velocities of the order of 100 m/a, a value consistent with observations of speed of some ablation stakes. In order to assess the validity of the results, the change in the thickness of the glacier observed between 1998 and 2007 (DEM difference) was compared to the simulated change in the free surface elevation. Another useful application of the modeling result is the identification of the ice divide of 5 glaciological units in the Sarca and Oglio subbasins, separated from a hydrological point of view, which is not a trivial task to be performed in the field. Another verification is done comparing the simulated glacier's extent in the year 2015 starting from 1996 initial conditions. The simulation using climate change projections results in a total disappearance of the largest Italian glacier by the year 2080 with severe implications on the hydrological cycle, microclimatic conditions, landscape and tourism.