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Mass balance of Langjökull ice cap in Iceland during different climate settings; deduced from multi-temporal DEM´s from 1936 to 2008, and in situ mass balance measurements 1997-2009

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We describe the mass balance of Langjökull ice cap (920 km^2, 190 km^3) during several time intervals that span most of the 20th century until present, hence for different climate conditions. Langjökull located in midwest Iceland is highly sensitive to climate change, with an elevation range 460 - 1440 m a.s.l., zero balance ELA of 960 m and a zero balance mass turnover of 1.75 m/yr w. eq..

Since 1997 the mass balance of Langjökull has been monitored by conventional mass balance measurements at 22 sites on the glacier, and from this data digital maps of the winter, summer and annual balance have been produced for every glaciological year. The mass balance was also assessed from estimation of ice volume changes by comparing several DEM's: from 1936 and 1945-46 (from digitized contour lines of revised published maps based on aerial photographs and geodetic survey), 1986 (from digitized contour lines of maps based on aerial photographs and point measurements from an inertial navigation system), 1997 (from D-GPS surface profile survey, about 1 km between lines) and 2004 (SPOT5-HRG). The accuracy of the SPOT5-HRG DEM was estimated to be within 2 m in elevation by analyzing the residue of the DEM and an ensemble of points and profile elevation data surveyed by kinematic GPS, both on and in near vicinity of the ice cap. The SPOT5-HRG DEM was used as a reference map for both co-registration and to improve the accuracy and details of the older maps.

The difference between the 1997-2004 net balance estimated by volume change and in situ measurements is negligible ($\sim$10 cm w. eq.). During the two extremely warm periods 1936-1946 and 1997-2008 the mass balance was similar; -1.6 and -1.4 m/yr w. eq., respectively. The colder climate 1946-1986 and cooler yet in 1986-1997 resulted in mass balance close to zero; -0.3 and -0.2 m/yr w. eq., respectively.