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Mass balance- and volume changes of two ice caps in Iceland, deduced from SPOT5 derived DEM and field elevation data

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Digital elevation models have been constructed for two ice caps in Iceland, the 920 km^2 Langjökull and 600 km^2 Mýrdalsjökull (in late august 2004 and 2006, respectively), using high resolution SPOT5 stereo pairs from the across-track high-resolution-geometry (HRG) sensor. Control points and profiles measured with kinematic GPS at and around the ice caps are used to constrain the models. DEM elevation accuracy of $\sim$2 m is obtained. Dense (about 1 km apart) surface elevation DGPS profiles were surveyed on Langjökull 1997, several kinematic GPS profiles in 2007 and elevation at 22 sites has been measured every spring and autumn since 1997. The surface elevation of Mýrdalsjökull has been surveyed along $\sim$15 profiles every spring and autumn since 1999, from airborne radar and kinematic GPS on surface traverses using kinematic or DPGS. We provide a method, based on Markov random field modeling and simulating annealing optimization, to efficiently produce a time series of elevation maps with high spatial coverage. The inputs are DEM that describe spatial variability, and in-$situ$ elevation data providing temporal elevation changes along the surface profiles and sparse observation sites. Comparison of the resulting 1997 and 2004 DEMs for Langjökull yields a volume loss of 11.5 km^3 w.eq. which is far within error boundaries of the 11.8 km^3 w.eq. volume loss obtained from mass balance observations (measured every year since 1996-97). Mass balance has not been measured directly at Mýrdalsjökull, but is estimated from the difference between the derived DEMs.