Geophysical Research Abstracts
Vol. 13, EGU2011-3840, 2011
EGU General Assembly 2011

Melt and runoff simulations from the Greenland Ice Sheet and glaciers peripheral to the Ice Sheet

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Ample evidence indicates the Arctic climate, cryosphere, and hydrological cycle is changing. Long-term temperature observations show warming trends of variable strength throughout the Arctic and Greenland, with an average increase almost twice the global average rate in the past 100 years. Fluctuations in surface melt extent, mass balance, and freshwater runoff from the Greenland Ice Sheet (GrIS), and glaciers and ice caps peripheral to the Ice Sheet, follows climate fluctuations, and response has already been observed and marked by glaciers retreating and thinning along the periphery. Observed meteorological data and a high-resolution (5-km) model were used to simulate GrIS surface melt extent and trends before the satellite era (1960–1979) and during the satellite era through 2010. The period 1960–1972 had a 6% average decrease in melt extent, and 1973–2010 had an increase of 13%, with record melt extent in 2010, due to higher-than-average winter and summer temperatures, and lower-than-average winter precipitation. The runoff contribution to the ocean is likely playing a role in ocean salinity, sea-ice dynamics, global eustatic sea level rise, and thermohaline circulation in the Greenland-Iceland-Norwegian Seas. Presently, we lack detailed information about the spatial and temporal runoff distribution to the ocean from non-glaciated and glaciated areas in Greenland. Runoff hydrographs at catchment outlets represents an integrated response of the upstream watershed to precipitation and other hydrometeorologic processes, e.g., snow and glacier melt. Here, we attempt to improve and simulate the spatial and temporal distribution of Greenland runoff to the ocean: (1) at a local scale from a test area in SE Greenland that includes the Mittivakkat Glacier, the local glacier in Greenland with the longest observed mass balance (since 1995) and front fluctuations (since 1931) time series; and (2) at a regional scale from the GrIS.