

Climate and glacier mass balance in the Icelandic highland

Research idea submitted in connection with preparations for IPY 2007-2008

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Motivation

The climate of Iceland has been characterised by large and rapid changes during the last 100 years, which are believed to be to a large degree driven by changing conditions in the neighbouring North Atlantic ocean. The changes in the climate have been clearly reflected in the advance and retreat of glaciers, which cover about 10% of the surface area of the country. The associated glacier mass balance variations have led to substantial hydrological variability due to numerous glacier fed rivers in the Icelandic highland. Glaciology and hydrology of the Icelandic highland is of local economic importance due to many hydroelectric power plants in the country. Scientific studies of the climate and glaciers of Iceland is also of a broader relevance as a part of an international effort to study the response of sub-polar glaciers to climate changes and the contribution of glaciers and small ice caps to the ongoing rise in global sea-level. Icelandic glaciers are unusually accessible for research due to their proximity to habited areas and can therefore be used to obtain scientific information about changing glaciological conditions that are much more difficult to acquire in other areas of the Earth with similar climates.

The surface and bedrock topography of all the large ice caps in Iceland has been mapped in exceptional detail and extensive surface data has been collected on mass balance, velocity and meteorological parameters.

Proposed research

It is proposed to use the International Polar Year to make an effort to characterise the climate of the Icelandic highland, in particular the climatological and hydrological conditions of ice caps and glaciers in the country. Furthermore, the response of glaciers and glacier hydrology to past and possible future climate changes will be studied. Existing mass balance measurements on the main ice caps of Iceland contain a wealth of information about precipitation in the mountainous glaciated region of the highland. This information may be analysed and extended with meteorological model computations to produce precipitation maps covering the whole country. This research will extend ongoing glaciological research projects that have been conducted in collaboration between several Icelandic research institutes during the last years with support from Nordic and national sources.

The research effort will consist of subprojects within several fields:

Meteorology

Precipitation in the Icelandic highland will be modelled using the ERA40 data set from ECMWF, available snow accumulation measurements from glaciated areas, and precipitation measurements

from meteorological stations. The aim of the computations will be to produce gridded maps of monthly precipitation covering the whole country since 1958. Existing studies of temperature in the Icelandic highland will be extended by an analysis of the ERA40 data set.

Glaciology

Glacier mass balance will be modelled based on the results of the meteorological studies described above using available mass balance data from the main ice caps of the country. Special emphasis will be given to the relationship between climate variations and mass balance variations during the interval spanned by the mass balance data. Dynamic glacier models of the main ice caps in the country will be calibrated based on mass balance modelling, dated ice horizons in ablation areas based on tephrochronology, and available information about climate and glacier variations in Iceland during the last several hundred years.

Hydrology

Glacier mass balance and hydrological modelling will be used to model diurnal and seasonal variations in glacier river discharge, including storage of melt water in the firn and routing of melt water through the subglacial hydraulic system to the glacier margin.

Climate change

Information about climate variations during the last 100 years and scenarios for possible climate changes in the future will be used to assess the future development of glaciers and glacier hydrology in Iceland. This work will involve coupled dynamic and mass balance glacier models.

Participants

It is envisioned that the main institutes in Iceland involved in meteorological, hydrological and glaciological research; the Icelandic Meteorological Office, the National Energy Authority, and the University of Iceland, will collaborate on this project. An active involvement of societies, institutions and companies that have played a role in research in these fields in the country in the past, such as the National Power Company, the Iceland Glaciological Society and the Icelandic Public Roads Administration is also intended. Collaboration with the glacier museum at Höfn in Hornafjörður about dissemination of results to people traveling in the neighbourhood of Icelandic glaciers should, furthermore, be a part of the IPY effort.