EUROPEAN
GEOPHYSICAL
SOCIETY

European Geophysical Society

Annales Geophysicae

Part II

Oceans, Atmosphere, Hydrology & Nonlinear Geophysics

Supplement II to Volume 12

DEGREE-DAY GLACIER MASS BALANCE MODELLING IMPROVED BY INCLUSION OF A TIME-DEPENDENT TEMPERATURE LAPSE RATE

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A degree-day glacier mass balance model has been developed within the Nordic cooperative reseach program "Climate Changes and Energy Production". It is based on existing degree-day hydrological and glacier mass balance models (Johannesson and Laumann, 1993), and computes the mass balance as a function of elevation using temperature and precipitation data from meteorological stations in the vicinity of the glacier. The model was applied from Nigardsbreen in southern Norway which has a 30 year mass balance record. The best fit parameter set for the whole period was then used to calculate a daily mass balance record which was compared with the daily discharge record in the basin. Computed discarge tends to be higher than that measured in spring and early summer. This effect can be partly compensated for if a time-dependent temperature lapse-rate is used.

THE NATURE OF SUDDEN FLOW PERTURBATIONS IN THE JÖKULSÁ Á SÓLHEIMASANDI GLACIAL RIVER, SOUTH ICELAND

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Detailed monitoring of glacio-fluvial processes in the Jökulsá á Sólheimasandi glacial river, southern Iceland, revealed frequent, sudden and short-lived river flow perturbations ('heartbeat' events) in 1988. Although similar features have been noted elsewhere, these Icelandic results are useful because: (a) river stage was monitored on both banks using two different measurement systems (float recorder and pressure transducer) to discount the possibility of instrumental error; (b) the 2-minute datalogging scan interval allowed, for the first time, the precise timing, duration and structure of these flow perturbations to be quantified; and (c) concurrent data on their possible controls and implications (e.g. radiation receipt, air and river temperature, turbidity, electrical conductivity) were also logged. At least 34 events between 4 July and 10 August 1988 were identified, lasting about 40 minutes each. They consisted of a sharp drop in stage, followed by an equally sudden 'rebound' to a higher level before a return to prior flow levels. They tended to occur under conditions of *generally* rising stages, around times of daily flow maxima or minima. From consideration of mass balance calculations and event incidence in relation to water quality variables, it seems likely that perturbations result from a dam-breach mechanism, possibly related to ice-calving or subglacial tunnel collapse. Flow perturbations may usefully represent a proxy data-series for such phenomena, therefore, and are also important in sediment transport enhancement.

SNOWMELT AND RAINFALL CONTRIBUTIONS TO EXTREME FLOODS IN SWEDEN.

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The relative importance of rainfall and snowmelt as causes of extreme floods in Sweden is poorly known. The spring flood, dominated by snowmelt, is normally the largest flood during the year in most of the country. Rainfall in the melt period may, however, increase the flood peak. The memory, as well as the nonlinearity, of the system, must be taken into account in an estimation of the flood causes.

A method for quantifying the contributions from rainfall and snowmelt to extreme floods in Sweden was developed. The method is based on a conceptual hydrological model. It was applied to 34 unregulated basins in different parts of Sweden. It was concluded that snowmelt is the dominant flood causing process in most of Sweden. Rainfall is less important, exept in southern Sweden and in regulated rivers.

THE MODELLING OF MOUNTAIN HYDROLOGY FROM INCOMPLETE CLIMATOLOGICAL DATA

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The US National Weather Service River Forecast System (NWSRFS)-snow accumulation and ablation model, as well as the soil moisture accounting model are developed and tested for purposes of modelling a mountain area (the Mesochora catchment in Central Greece) by using incomplete precipitation and temperature daily records. A combinatorial technique of the Thiessen method and station availability condition, including elevation correction, is aopted for areal and elevation integration of snowmelt model input data. For such an input modelling, the snowmelt model has been proved capable of predicting the initiation of snow accumulation in the fall and the gradual melting of the snowpack in the late winter and spring, while the rainfall-runoff model,which accepts as input the snowmelt model output 'rain plus melt', has also proved capable of accurately reproducing both the magnitude and timing of the annual and monthly runoff. On a daily basis, the runoff model reproduces satisfactorily the historic data, while some discrepancies arise owing to antecedent dry conditions and extreme rainfalls.

SNOWMELT RUNOFF OF AN ALPINE SNOW COVER DEDUCED FROM AUTOMATIC MEASUREMENTS

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In spring 1993 energy balance measurements were performed during the entire snow-melt period over a seasonal snow cover near Davos, Switzerland at 2540 m a.s.l. Net radiation clearly dominates the energy balance, accounting for more than 90% of the melt energy. The turbulent heat fluxes are of minor importance in average, but can exceed net radiation during föhn periods. The daily mean melt energy was also obtained from

- lysimeter readings at the same location
- a degree-day approach
- a parameterized energy balance using independent variables (temperature, humidity, windspeed and global radiation) from a nearby automatic weather station and synoptic cloud cover observations.

Comparison of these approaches shows a need for very accurate parameterizations of longwave incoming radition and albedo in order to obtain a runoff prediction which performs better than the degree-day approach. Such parameterizations are discussed in the presentation.

GLACIAL MOULINS : SPACE STRUCTURE, FUNCTIONING AND ROLE IN GLACIAL HYDROLOGY.

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Available informations about glacial moulins in alpine or arctic glaciers found in the litterature or given by the recent speleologic explorations suggest some common spatial features which are caracteristic of the water diging.
By that one can infer the conditions in which the surface melting water can reach or not the bed of the glacier.
Morphologic evidences show that during winter the moulins are filled by water when deformation of the ice at depth closes tightly the conduit.
Finally these intra-glacial cavities with maximum known depths of 60 to 180 meters constitute very favourable places to undertake ice deformation studies mainly because the temperature range near 0° C. and the shear stresses up to 10 bars.