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CLIMATIC VARIABLES AND MASS BALANCE OF ALPINE GLACIERS DURING A PERIOD OF CLIMATE FLUCTUATION

(Abstract)

by

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Parameterisation of relationships between climate and glacier mass balance is of considerable importance in understanding and modelling how temporal variability in climate affects the quantity of perennial snow and ice stored in glaciers, and the runoff from glacierised areas. Influences of year-to-year variations in air temperatures are pertinent in the absence of long records of measured energy balance and in view of predictions of future climate scenarios in terms of temperature. Measurements of temperature and precipitation from several stations in Alpine valleys in the Rhone basin, Wallis, Switzerland have been analysed to indicate trends in climate from 1930 to 1988. Actual measurements of mass balance of Griesgletscher, ablation calculated from runoff and net accumulation estimated from totalising rain gauges for Findelengletscher and Gornergletscher beginning in the late 1960s, and runoff from Aletschgletscher since 1930, were taken as annual glaciological responses to climatic variation. Variables to represent climatic elements and interactions between precipitation and temperature were selected according to degree of correlation with glacier response variables, and climate-glacier response relationships were assessed by multiple regression. Subsets of the data representing the coolest (1972–81) and warmest (1943–52) decades were also analysed to indicate whether relationships amongst climatic variables and between climate and mass balance remain the same under contrasting climatic conditions.

Overall, mean summer air temperature variables for the months May through September and June through August provide the highest levels of explanation of variance of ablation and mass balance respectively (75–82%). Addition of a precipitation variable (winter, spring or summer) in multiple regression increases explanation to a maximum of 91%. Spring and summer precipitation variables are negatively correlated with ablation. Positive degree days and temperature-summer snow functions provide alternatives to temperature. Event-based analysis of the coolest and warmest years selected by rank order invokes high precipitation in May and low May-June temperatures and summer snowfall events as significant variables.

Relationships between climatic variables indicate that warmer-than-average winters have higher precipitation, but at summer and annual time scales precipitation is slightly negatively associated with temperature. At the decadal level, warmer periods appear to be influenced by increased frequency of continental anticyclonic conditions, in an area subject to both maritime and continental influences. These analyses of climatic variables indicate that summer energy inputs dominate glacier mass balance. Relationships between precipitation and temperature are complex and were changeable during a fluctuation of about 1° over 40 years. Effects of a potentially warmer future on the form of precipitation in spring, summer and autumn are not clear, so estimates of changes of mass balance have been calculated for contrasting precipitation regimes.

EVALUATION OF LANDSAT, SPOT, AND SOJUZKARTA DATA OF ANTARCTICA FOR ICE AND CLIMATE RESEARCH

(Abstract)

by

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Satellite data have proved suitable and cost-effective for ice and climate research in Antarctica. They have been used in numerous research efforts, including: monitoring coastal change, determining velocities of outlet glaciers, defining blue ice areas, tracking the movement of icebergs, and as a base for overlaying radar and other data. This paper reviews the data acquired since 1972 by the Landsat, SPOT and Sojuzkarta space systems and illustrates where good-quality (±10% cloud cover) data are available.

The Landsat 1, 2, and 3 satellites acquired approximately 10 000 multispectral scanner (MSS) (80 m resolution) and return-beam vidicon (RBV) (30 m resolution) photographic and digital images of Antarctica between 1972 and 1983. The quality of these images has been evaluated by USGS to determine the feasibility of using them for glaciological, climatological, and geological research. Results have been plotted on a base map of Antarctica and show about 45% of the nominal scene centers, or about 70% of the geographic area of the continent, to be covered by good-quality imagery. Landsat 4 started acquiring data in 1982 and Landsat 5 in 1984. Together the two satellites acquired more than 4 500 thematic mapper (TM) (30 m resolution) and MSS images of Antarctica through the 1988–89 austral summer season, which may be the last