Geophysical Research Abstracts, Vol. 7, 06565, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06565

Application of inventory data for estimating characteristics of and regional climate-change effects on mountain glaciers: a comparison between the European Alps and the New Zealand Alps

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An extensive data basis on topographic glacier parameters has been built up in regional past glacier inventories. Repetition of such glacier inventory work is planned at time intervals, which are comparable to characteristic dynamic response times of mountain glaciers. This will help analyzing changes at a regional scale and assessing the representativity of continuous measurements, which can only be carried out on a few selected glaciers. In addition, glacier inventory data also serve as a statistical basis for extrapolating the results of observations or model calculations from individual glaciers and for simulating regional aspects of past and potential future climate change effects. This latter application requires the introduction of a parameterization scheme using simple algorithms for unmeasured glaciers. In the present study, the data base from national glacier inventories in the European and the New Zealand Alps contain a total of 5154 and 3132 perennial surface ice bodies and refers to the time of the mid-1970s. Only 1763 or 35% for the European Alps and 708 or 23% for the New Zealand Alps of these total numbers are ice patches larger than 0.2 km2 with complete information available about surface area, total length, maximum and minimum altitude. The parameterization scheme is being applied to the latter part of these samples. The remaining ice bodies are perennial ice patches and glacierets smaller than 0.2 km2 and

are treated separately.

Total surface area of the inventoried European Alps and the New Zealand Alps surface ice bodies are 2909 km2 and 1139 km2, respectively. The surface area of the 1763 European Alps and 708 New Zealand Alps $>$ 0.2 km2 are 2533 km2 or 88% and 983 km2 or 86% of the total surface area, respectively. The total volume of these glaciers is calculated as 126 km3 for the European Alps and as 51 km3 for the New Zealand Alps. Overall volume of perennial surface ice existing in the New Zealand Alps in 1978 is thus about 60 km3. This volume corresponds to a sea-level rise of about 0.18 mm, for the European Alps a value of 0.35 mm is calculated. These small values point to the limited significance for sea level rise but also to the vulnerability regarding climate effects of glaciers in comparable high mountain areas with predominantly small glaciers. From available length change measurements (1850 to 1978) of some selected larger glaciers, the mean specific mass balance was estimated for different regions in New Zealand. For this purpose the New Zealand glaciers were separated into two classes for the parameterization: a) maritime (wet) and b) continental (dry) based on different mass balance gradients. The reconstructed mean annual specific mass balances for specific regions are [in mm w.e.]: Fiord -0.29, West -0.45, East (dry) -0.37, East (wet) -0.41, Nord (dry) -0.38. Corresponding values for the Alps, where no mass balance gradient differentiation was made are -0.33. Smaller temporal reaction of the glaciers in both mountain areas was sometimes completely different, such as an advancing period of the glaciers at the maritime west coast of the Southern Island in New Zealand in the 80th and 90th of the last century.