# THIRTY YEARS OF MASS BALANCE AND CLIMATE RECORDS ON HINTEREISFERNER: A BASIS FOR MODELLING

## (Abstract)

by

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The effect of the present-day climate on a typical Alpine valley glacier is demonstrated on the 30-a record of mass balance of Hintereisferner. The balances of 1952-53 to 1981-82 were determined by the direct glaciological method, occasionally checked by geodetic volume comparison. The series includes three negative and two positive extremes, the first 15 a being predominantly negative. Specific balances for 100 m altitude zones have been established for all years except two. These records are supplemented by climatic data from a nearby valley station, and, since 1969, by temperature records taken at the equilibrium line and at the glacier front. Based on these and other records, a model is developed that describes the altitudinal and temporal development of mass and energy balance using temperature and precipitation. The performance of this model is tested for various climates.

# SENSITIVITY OF AN ICE-SHEET MODEL TO ATMOSPHERIC VARIABLES

## (Abstract)

by

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Recent studies of long-term climate variations which have employed zonally-averaged ice-sheet models and an equilibrium-line net-budget parameterization (Oerlemans and Bienfait 1981, Pollard 1982) have been able to reproduce many of the complete deglaciations and reinitiations of the northern-hemisphere ice sheets found in the geologic record. However, when the equilibrium-line net-budget parameterization is replaced with an energy-balance equation designed to compute the temperature and ablation at the ice surface, the reinitiation of a zonally-averaged ice sheet is much more difficult than previously indicated.

In order to investigate what magnitude changes in air temperature and surface albedo are necessary to initiate ice-sheet growth, an energy-balance net-budget parameterization, in which these terms are varied, is applied to a zonally-averaged ice sheet that is initiated with either ice-free conditions (low summer surface albedo of 0.16) or with a 10 m-thick ice field (high-surface albedo ranging from 0.7 to 0.8).

The energy-balance net-budget parameterization is made up of two parts: the accumulation rate and the ablation rate. The accumulation rate is parameterized as follows:

$$S_n = P_r * r_a * F_y * e_s/e_{si}$$

where $P_r$ is the present precipitation rate, $r_a$ is the ratio of the density of water to ice, $F_y$ is the fraction of precipitation that falls as snow, and $e_s/e_{si}$ is the ratio of the saturation vapor pressure at the surface air temperature to that at the present surface air temperature. The ablation rate is derived from a surface-energy balance equation of the form:

$$F_P + F_s + (1-a)\,F_{sw} + F_{lw} + F_{ir} = 0$$

where $F_P$ is the latent heat flux, $F_s$ is the sensible heat flux, a is the surface albedo, $F_{sw}$ is the short-wave radiation available at the surface, $F_{lw}$ is the long-wave radiation from the atmosphere, and $F_{ir}$ is the long-wave radiation from the surface. The

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https://doi.org/10.3189/S0260305500003839 Published online by Cambridge University Press