

JOINT COLLOQUIA

(Summaries of papers presented)

25 July 1957

Contributions to the Heat and Mass Economy of
the Antarctic Ice Cap

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The heat economy of the antarctic continent and its coasts is characterised by the small water vapour content of the cold atmosphere, by the transparency of the generally thin clouds for shortwave and to some degree even for long-wave radiation, and above all by the continuous white surface which absorbs only a small fraction of the global radiation falling upon it. With clear sky outgoing exceeds incoming radiation near the antarctic coast to a height of the sun of 27° , on the ice cap itself to an even bigger height. Hence the ice cap loses almost continuously throughout the year heat by radiation; it represents a powerful sink of heat. The bigger the cloud cover, the smaller the loss of heat; even in midsummer clear days are in the Antarctic cold days. The annual mean loss of radiative heat energy of the ice cap can be estimated to 36 kcal/cm^2 , or for the whole ice cap to about 10^{12} horsepower. The loss seems largely to be replaced by convectional transfer to the surface of heat from warmer air entering the continent. The heat of condensation released by formation of snow and hoarfrost is probably of minor importance.

It was stated in the discussion that it should not be ruled out that the antarctic ice cap was at the present time increasing in mass; a decrease corresponding to that noticed in most extrapolar glaciers was unlikely. Concerning the temperature conditions in the ice cap itself it was pointed out that in a thick ice cap with negligible motion the flux of the internal heat of the earth from the underlying rock would enforce freezing point temperature and some melting at the bottom. In a moving ice cap additional frictional heat would be generated, but on the other hand some heat would be transported horizontally away from the central parts of the ice cap and there the temperatures might be lower than in an ice cap at rest.

Reference:

Loewe F. 1956 Contributions to the glaciology of the Antarctic J. Glaciology 2 pp 657-665

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Heat and Water transfer in Soils

by D.A. de Vries

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The processes of heat and water transfer in soils influence the boundary conditions for heat and water flow at the lower limit of the atmosphere. These processes are therefore of importance in the study of both the microclimate and macroclimate (energy balance, transformation of air masses). The experimental and theoretical investigation of these phenomena has advanced rapidly during the past ten years.

Water moves in the soil in the liquid and in the vapour phase. Liquid transfer is governed by Darcy's law (Baver, 1956), which can be written:

$$q_l = -\rho_l K \nabla \Phi = -\rho_l K \nabla \psi - \rho_l K \mathbf{k} \quad (1)$$

where q_l ($\text{g cm}^{-2} \text{sec}^{-1}$) is the liquid flux density, ρ_l (g cm^{-3}) the density of liquid water, Φ (cm) the hydraulic head and K (cm sec^{-1}) the hydraulic conductivity. $\Phi = \psi + z$ where ψ (cm) is the pressure head and z (cm) the gravitational head. If atmospheric pressure is taken as the datum for ψ this quantity is positive below the water table and negative above the water table. \mathbf{k} is a unit vector in the z -direction (positive upwards). In unsaturated soil both ψ and K decrease rapidly with decreasing moisture content.

Movement in the vapour phase is a process of diffusion of water vapour in the air-filled pores. The vapour flux density, q_v ($\text{g cm}^{-2} \text{sec}^{-1}$) can therefore be expressed as:

$$q_v = -D_v \nabla p_v \quad (2)$$