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LETTER TO THE EDITOR

Comments on "Global mass and energy requirements for glacial oscillations and their implications for mean ocean temperature oscillations"

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The article by Saltzman (1977) in a recent issue of *Tellus* presents a number of interesting problems. Saltzman assumes that the latent heat of fusion released during the growth of the Würm/Wisconsin continental ice-sheets was absorbed by the oceans, since there might be radiative balance at the top of the atmosphere. It is not clear from his article as to why some or all of this additional latent heat should not be radiated directly to space. This would seem likely since the additional energy will be released by the formation of snow in low/medium level clouds near or over the ice sheets, and these clouds are already radiating to space.

Another interesting point concerns the relative importance of the additional energy released by the formation of the ice sheets, which is the product of the volume of the continental ice-sheets (47.3×10^{21} cm^3) $\times$ latent heat of fusion of ice and equal to 3.78×10^{24} cal. This is equivalent to a total ocean temperature change of about 2.8 °C. There is considerable evidence that global precipitation, and therefore latent-heat release, was reduced during the Würm/Wisconsin glaciations leading to changes in global energy fluxes. Gates (1976) quotes a value of about 14% for the precipitation reduction at 18,000 B.P. Assuming that the daily latent-heat release into the atmosphere at present is about 9.0×10^{20} cal day^{-1} (Newell, 1974), then this suggests a drop in the latent heat released at 18,000 B.P. of about 1.3×10^{20} cal day^{-1}. Thus the additional heat of fusion released over some thousands of years by the growing ice sheets would soon be swamped by the general fall in atmospheric latent-heat release due to decreasing global precipitation.

Lastly, there is ample evidence that the glacial atmosphere was drier than at present. This would lead to a decrease in the greenhouse effect due to water vapour and an increase in the ocean-surface cooling to space. This could by itself probably account for the observed fall in the global ocean-surface temperatures at 18,000 B.P.

REFERENCES

Gates, W. L. 1976. The numerical simulation of ice-age climate with a global general circulation model. *J. Atmos. Sci. 33*, 1844–1873.

Newell, R. E. 1974. Changes in the poleward energy flux by the atmosphere and ocean as a possible cause for ice ages. *Quaternary Res. 4*, 117–127.

Saltzman, B. 1977. Global mass and energy requirements for glacial oscillations and their implications for mean ocean temperature oscillations. *Tellus 29*, 205–212.