

Reply

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In view of the controversial nature of the subject and the empiricism of my own model, Prof. Budyko's comments and results are very gratifying. The strengthened conclusion that our present climate is highly unstable and that we are, so to speak, on the brink of an ice age is one that should not be taken lightly by meteorologists, especially those interested in weather modification.

The association of an ice age with a decrease of the solar constant by only a few per cent (or with an increase of the planetary albedo by 5–10%) does not seem at all unreasonable. The periodic advances of the ice sheets during the past million years and, in fact, even the presence of the Greenland and antarctic ice caps today, seem to me to be indicative of climatic instability caused mainly either by small fluctuations in the solar output or by variations in the earth's orbit around the sun.

In spite of the close agreement between my results and those of Prof. Budyko, there still exists a need for a more rigorous approach to the problem via the complex numerical models being developed by Manabe and Bryan (1969) and Saltzman (1968), among others. Although it does not seem very likely, it is possible that nonlinear effects included in these models, but not in the more simple ones, could yield vastly different results. Furthermore, the simple empirical relationships used by Prof. Budyko and myself may not be valid when extrapolated to extreme conditions.

REFERENCES

- Manabe, S., and K. Bryan, 1969: Climatic calculation with a combined ocean-atmosphere model. *J. Atmos. Sci.*, **26**, 786–789.
- Saltzman, B., 1968: Steady state solutions for axially-symmetric climatic variables. *Pure Appl. Geophys.*, **69**, 237–259.