Lorius, C., Merlivat, L., Jouzel, J., and Pourchet, M. 1979. A 30,000 year isotope climatic record from antarctic ice. *Nature*, 280, 644–648.

Mosley-Thompson, E. 1980. *911 years of microparticle deposition at the South Pole* (Institute of Polar Studies Report No. 73). Columbus: The Ohio State University.

Petit, J. R., Jouzel, J., Pourchet, M., and Merlivat, L. 1980. *Spatial and temporal changes of accumulation and stable isotope content in the Dome C area (Antarctica).* Paper presented at the meeting of the 17th General Assembly International Union of Geodesy and Geophysics, Canberra, Australia, December 1979.

Thompson, L. G., and Mosley-Thompson, E. 1980. *Temporal variability of microparticle properties in polar ice sheets.* Paper presented at the meeting of the 17th General Assembly International Union of Geodesy and Geophysics, Canberra, Australia, December 1979.

Thompson, L. G., Mosley-Thompson, E., and Petit, J. R. 1980. *Glaciological interpretation of microparticle concentrations from the French 905-meter Dome C, Antarctica core.* Paper presented at the meeting of the 17th General Assembly International Union of Geodesy and Geophysics, Canberra, Australia, December 1979.

Shallow-depth temperature models for Dome C

RICHARD E. EWING

Institute of Polar Studies
and
Department of Mathematics
The Ohio State University
Columbus, Ohio 43210

The development of accurate shallow-depth numerical temperature models for heat transfer in firn and ice is very important for understanding the mechanism and effects of heat flow within glaciers. Data taken at Dome C during the 1978–79 and 1979–80 field seasons is being used both to help determine thermal properties of the firn necessary for building the models and also to test the resulting equations. Once a working model is obtained, it can be used to make reverse calculations from measured temperature profiles from Domc C to a depth of about 100 meters to derive past, decade-scale, climatic, and surface temperature changes. These results will be valuable for understanding the climate change at the surface of the ice sheet and for understanding the general process of heat transfer into the ice sheet surface. The models will also be valuable in guiding the choice of locations, techniques, and needed accuracies for future data measurements in the field.

W. F. Budd and his colleagues have established the great value of deep temperature-profile interpretation (Budd, Jenssen and Radok 1973). Our models concentrate on the more localized changes in thermal properties of the firn as it gradually changes to ice under compaction. The first area of our research is centered on accurately determining values of thermal conductivity and specific heat, which vary with depth and density, from measured data from Dome C.

Richard Falk and I first constructed and analyzed a method for computing the thermal properties of firn from measured data and determined what type of field data would be necessary to obtain reasonable error estimates. Guided by this analysis, we constructed an experimental apparatus which was used at Dome C in 1978–79, modified, and used again in 1979–80. The apparatus consists of an insulated stack of control cylinders of lucite, a sample cylinder from a field core, and plates of copper containing thermisters. The thermisters in the stack allow us to obtain temperature measurements in the field as a function of time as an induced heat pulse passes through the sample. Since we know the thermal properties of lucite, it can be used as a control medium to determine the heat flux at the ends of the firn sample. A description of the apparatus and a brief analysis of the resulting mathematical problem, complete with error analysis, is forthcoming (Ewing and Falk in press a). We are now computing the thermal properties from the measured data from Dome C, and will publish the results when they are available.

Ian Whillans and John Bolzan, also from the Institute of Polar Studies at Ohio State University, obtained temperature distributions to depths of about 100 meters from bore holes at the South Pole Station and at Dome C which contain some large temperature anomalies. The second part of my antarctic activities concerns possible mathematical interpretation of these anomalies using the newer shallow-depth temperature models described earlier.

Falk and I (in press b) are now extending my earlier (Ewing 1975) ideas and analysis for numerical calculation of temperatures backward in time using finite element numerical procedures. We are now using the ideas in these papers to take the measured temperature anomalies from Antarctica and try to infer what might have caused the anomalies—a major climatic change, a change in the elevation of the glacier, or some other reason. Bolzan and Whillans have done some preliminary boundary control type of calculations, forward in time, to try to explain the measured anomalies. We are presently combining the inference-making process with refined boundary control ideas to determine climate changes which could have caused such anomalies. The accurate shallow-depth temperature models discussed earlier are very important to this effort. Brief surveys of the mathematical literature on this problem and descriptions and analysis of the new numerical methods for this problem have appeared or will appear elsewhere (Ewing and Falk in press a, in press b).

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Richard Falk of Rutgers University collaborated on the mathematical analysis, and Bernard Cummiskey and Joe Torok helped extensively in computational aspects. Ian Whillans and John Bolzan of the Institute of Polar Studies at Ohio State University obtained the data and worked closely with me in all aspects of this program.

References

Budd, W. F., Jenssen, D., and Radok, U. 1973. *Derived physical characteristics of the antarctic ice sheet, Mark I* (Publication 78). Melbourne, Australia: University of Melbourne, Meteorology Department.

Ewing, R. E. 1975. The approximation of certain parabolic equations backward in time via Sobolev equations. SIAM *Journal on Mathematical Analysis* (Society of Industrial and Applied Mathematicians), 6, 283–294.

Ewing, R. E., and Falk, R. S. In press. On some ill-posed problems arising in glaciology. In M. Z. Nash (Ed.), *Proceedings of International Symposium on Ill-Posed Problems: Theory and Practice.* Newark, Delaware, 1979(a).

Ewing, R. E., and Falk, R. S. In press. Numerical approximation of parabolic problems backward in time. *Mathematics of Computation* (b).

French field activities at Dome C

CLAUDE LORIUS

Centre National de la Recherche Scientifique
Laboratoire de Glaciologie
Grenoble, France

Following previous work in the Dome C area (Gillet and Rado 1979; Lorius 1975; Lorius and Donnou 1978), a shallow complementary snow sampling program was undertaken during the 1979–80 season, within the International Antarctic Glaciological Project.

The season at Dome C (74°39′S 124°10′E, 3,200-meter elevation) lasted from 12 December 1979 to 24 January 1980. The French team consisted of C. Lorius, M. Legrand, and M. Pourchet but the program was shortened due to the departure of M. Pourchet for medical reasons at the beginning of the season. Investigations were conducted within a few square kilometers using a Ski-Doo.

A comprehensive set of samples was obtained for the full analysis of the main anions and cations in the snow of the high East Antarctica Plateau, as new laboratory facilities now permit determining gas-derived ions such as hydrogen (H), nitrate (NO_3), sulfate (SO_4), and ammonium (NH_4), which are the main components of the impurities. The sampling was achieved using two separate clean pits and a dust-free shallow drill down to a 10-meter depth, where firn should be older than 100 years. Sets of samples were also prepared for artificial radioactivity, lead-210, microparticles, and stable isotope measurements.

In the field, the stake accumulation network set up during the 1974–75 season was remeasured. A γ probe was tested in the field to locate the radioactive fallout layers from nuclear tests and gave promising results for the 1955 layer, which is deep enough to allow the upperlying snow to shelter the probe from natural noise. Conductivity measurements were also performed in the field to investigate the possible input of volcanic dust over the last century. Large samples were melted and filtered to recover cesium-137. Finally, some of the samples stored after the 905-meter deep drilling (Lorius and Donnou 1978) were retrograded for further laboratory analysis.

The National Science Foundation provided logistics support for this project, and it was carried out with the help of Expeditions Polaires Françaises through a grant from Terres Australes et Antarctiques Françaises.

References

Lorius, C. 1975. Glaciological studies at Dome C. *Antarctic Journal of the U.S.*, 10(4), 159.

Lorius, C., and Donnou, D. 1978. A 905-meter deep core drilling at Dome C (East Antarctica) and related surface programs. *Antarctic Journal of the U.S.*, 13(4), 50.

Gillet, F., and Rado, C. 1979. A 180-meter core drilling at Dome C and measurements in the 905-meter hole. *Antarctic Journal of the U.S.*, 14(5), 101.

Polar Ice Coring Office (PICO) drilling activities, 1979–80

KARL C. KUIVINEN,
PHILIP S. MARSHALL, *and* BRUCE R. KOCI

Polar Ice Coring Office
University of Nebraska-Lincoln
Lincoln, Nebraska 68588

The Polar Ice Coring Office (PICO) continued its program of shallow ice core drilling at Amundsen-Scott South Pole Station and Vostok Station (USSR) and completed a program of hot water drilling at Dome C, during the 1979–80 field season. Included in the fieldwork were tests of the new PICO shallow ice coring drill and the PICO hot water drill, recovery of the NSF-Swiss shallow drill stuck at 65 meters depth at Dome C during the United States Antarctic Research Program (USARP) 1978–79 field season, and recovery of data tapes and reactivation of the Norwegian and Soviet Union's