Downloaded from rsta.royalsocietypublishing.org

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Preface

P. Wadhams, J. A. Dowdeswell and A. N. Schofield

Phil. Trans. R. Soc. Lond. A 1995 **352**, 199-200
doi: 10.1098/rsta.1995.0063

Email alerting service Receive free email alerts when new articles cite this article - sign up in the box at the top right-hand corner of the article or click **here**

To subscribe to *Phil. Trans. R. Soc. Lond. A* go to:
http://rsta.royalsocietypublishing.org/subscriptions

This journal is © 1995 The Royal Society

Downloaded from rsta.royalsocietypublishing.org

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Preface

By P. Wadhams[1], J. A. Dowdeswell[2] and A. N. Schofield[3]

[1]*Scott Polar Research Institute, University of Cambridge, Cambridge CB2 1ER, UK*
[2]*Centre for Glaciology, Institute of Earth Studies, University of Wales, Aberystwyth, Dyfed SY23 3DB, Wales, UK*
[3]*Department of Engineering, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, UK*

On 12–13 October 1994 the Royal Society held a Discussion Meeting on the Arctic and Environmental Change. The fourteen papers, each of which is published here, gave a broad insight into the transformation of the Arctic which we can expect during the next century on account of anthropogenic warming.

The special importance of the Arctic to the global warming problem is made clear in the first paper by Cattle & Crossley, which shows the results of the latest general circulation model (GCM) produced by the Hadley Centre for Climate Prediction and Research. Within 70 years, the Arctic is predicted to warm by at least 4 °C on an annual average, and in places by more than 8 °C, as compared to values of 0–4 °C elsewhere in the world and even a slight cooling in parts of the Southern Ocean. The warming will be greater in the winter, and this large Arctic enhancement of global warming persists even when the moderating effect of sulphate aerosols is taken into account. One mechanism contributing to this enhancement is ice–albedo feedback, whereby the retreat of seasonal snow on land, and sea ice in the ocean, reduces average albedo and so generates a positive feedback loop.

If these predictions are correct, it is in the Arctic that we can expect to observe global warming at its most powerful. Papers by Barry and McIntyre discuss how the circulation and fluxes in the lower and upper atmosphere can be expected to vary, while Pyle describes recent results which show how ozone loss is becoming significant in the Arctic as well as the Antarctic. Stanhill offers a cautionary note with an analysis of solar irradiance and how this is affected by pollution so as to lessen any warming effect.

Moving on to impacts, Callaghan describes the effects of climatic warming on terrestrial ecology and Gradinger on marine ecology. Perhaps the most significant effects will be on the ocean and cryosphere. Rudels shows how ocean thermohaline structure is affected by the reduced amount of cooling and sea ice production in winter. Wadhams discusses observed and expected changes to Arctic sea ice extent and thickness, and Dowdeswell the impacts on Arctic glaciers, where a wholesale retreat would make a significant contribution to sea-level rise. Wingham presents evidence from satellites that the Greenland Ice Sheet is itself experiencing fluctuations in volume. On land, an important change will be the melting and retreat of permafrost; Williams discusses the likely effects.

The meeting ended with two papers on past climates, as revealed both by Greenland ice cores and by sediment cores in the polar North Atlantic. Dowdeswell & White demonstrate the very rapid rates of past climate change in ice-core records.

© 1995 The Royal Society

TEX Paper

The Royal Society is collaborating with JSTOR to digitize, preserve, and extend access to *Philosophical Transactions: Physical Sciences and Engineering.* www.jstor.org

Downloaded from rsta.royalsocietypublishing.org

Thiede discusses the timing of the inception of Northern Hemisphere ice sheets, and the palaeoceanography of the Norwegian–Greenland Sea.

The two final papers provided a natural entry point into an informal discussion meeting which was held on the following day under the auspices of the CIBA Foundation, and which was attended by many of the contributors to the Royal Society meeting. The topic was 'rapid climatic change', and a key result which stimulated much discussion was the recent dataset from Greenland ice cores which shows a relatively stable climate since the recovery from the last full glacial period, but rapid short-term fluctuations before that, sometimes including excursions of several degrees in air temperature occurring within a few decades. These changes were more rapid and extreme than the model-predicted anthropogenic changes of today, and yet clearly Man was not the culprit. The possibility of the reappearance of such an unstable climate, independent of Man, was a problem which the delegates regarded as of central importance.

When scientists have explained recent geological history in popular terms they have up to now expressed uncertainty as to whether the late Cenozoic ice age is yet over, or whether the present time is simply an interglacial interval. The fragmentary record preserved on land has appeared to indicate that both the North American and Eurasian ice sheets went through a number of cycles of formation, expansion and recession during the Pleistocene, with glacial episodes separated by warmer interglacial intervals. That view is no longer adequate.

Recent data acquired from Greenland ice cores give a continuous record in great detail. The unexpected rapid climate changes that one of these cores shows for the Eemian 'interglaciation' (a warm period lasting about 10 000 years that occurred about 115 000 years ago) are in striking contrast to the rises in global temperature and in sea level since the beginning of the Holocene (about 10 000 years ago). The Holocene record is smoother and more continuous than any other part of the record.

The retreat of ice led to the development of grasslands at high latitudes all around the world, an environment in which the northern nations of mankind came into existence. It was the stability of the Holocene climate that allowed human society to develop rapidly in the past 10 000 years. If any human activities could provoke unexpected rapid climate changes, it would be important to predict them and to eliminate the activity if possible. However, no climate model at present explains rapid changes of the kind seen in these past records.

It is clear that much more needs to be known before rapid climate changes can be predicted. This in turn raises questions about all predictions. How good is our present state of physical knowledge on the basis of the present generation of numerical models? Returning to the Arctic, it is possible that a better coupling of ice–ocean interaction processes into GCMs could lead to a new understanding of rapid changes, while a continued monitoring of environmental changes in the Arctic is vital for the detection of the onset of significant warming.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES