UEA

Mapping the Atmospheric and Oceanic Circulations and other Climatic Parameters at the time of the Last Glacial Maximum about 17000 years ago

Collected Abstracts

of the International (CLIMAP) Conference held at Norwich in May 1973

Climatic Research Unit
School of Environmental Sciences
University of East Anglia, Norwich

CRU RP2

Climatic Research Unit Research Publication No. 2. (CRURP 2)

Proceedings of the International Conference on

MAPPING THE ATMOSPHERIC AND OCEANIC CIRCULATIONS AND OTHER CLIMATIC PARAMETERS AT THE TIME OF THE LAST GLACIAL MAXIMUM ABOUT 17 000 YEARS AGO

and comparisons with today's conditions and
those of the so-called Little Ice Age in recent centuries

held at Norwich, 17 - 22 May 1973

COLLECTED ABSTRACTS

1974

Climatic Research Unit
School of Environmental Sciences
University of East Anglia
Norwich, England

CRU RP 2

CONTENTS LIST

Climatic Research Unit Research Publication No. 2 CRURP 2
University of East Anglia, Norwich.

Proceedings of the International Conference on

MAPPING THE ATMOSPHERIC AND OCEANIC CIRCULATIONS AND OTHER CLIMATIC PARAMETERS AT THE TIME OF THE LAST MAXIMUM OF GLACIATION ABOUT 17 000 YEARS AGO

and comparisons with today's conditions and those of the so-called Little Ice Age in recent centuries

COLLECTED ABSTRACTS

Editor: H. H. LAMB (Director, Climatic Research Unit, Norwich)

Introduction.

The conference was held in the Climatic Research Unit, in the School of Environmental Sciences of the University of East Anglia at Norwich, England, from 17th to 22nd May 1973, in conjunction with the CLIMAP program in which several universities and other institutions in the United States are engaged, as part of the work of the International Decade of Ocean Exploration (IDOE), with the support of the National Science Foundation, Washington, D.C.

The intention of the conference was to bring together the oceanographers and marine geologists primarily concerned in the CLIMAP program, and some of the palaeobotanists, tree-ring workers and others best acquainted with the global distribution of evidence of past climates on land, with meteorologists and climatologists working in the field of climatic change. This aim was abundantly rewarded with the attendance of 34 scientists, representing a great variety of relevant expertises, from Britain, France, Germany, Japan, the Netherlands and U.S.A. It is thought that this collaboration must lead to a fuller and more reliable analysis of the regime of the glacial maximum than has previously been attainable.

One day of the meeting was largely devoted to considering the nature of the so-called Little Ice Age which developed within the current millennium; and it was noted that there were certain pattern similarities with the major cold climate event of around 17 000 - 20 000 years ago, notably in the occurrence of a region with sea surface temperatures as warm as or somewhat warmer than now in the subtropical zone of the North Atlantic Ocean.

After considering the climate of the Little Ice Age in recent centuries, the subsequent climatic recovery and the latest climatic trends, and reviewing the possibilities of reconstructing in some detail the climatic developments of the last 1000 years, the conference turned to the relevance of palaeoclimatic studies to the anxious questions concerning the future development of our climate. The meeting heard with great interest from Dr. Häfele estimates of the probable amount of artificial output of energy that will be developed by Man over the coming decades and centuries.

Though this meeting had the immediate aim of discovering how much of the regime of the last glaciation can now be mapped, there were underlying general questions of immediate practical importance to many long-range planning decisions today in agriculture, industry, government and international affairs:

(1) How does climatic change affect various regions of the globe? Is the direction of climatic change uniform globally or are there geographical differences which can be understood?
(2) What meteorological and oceanographic circulation patterns can we infer from the past records of climatic change?
(3) What is the rate of major climatic change?
(4) What regions of the globe are likely to be most affected, and in what way, by future climatic changes?

(5) What is the probability of being able to predict long-term climatic trends over the next century or so?

The palaeoclimatic record reviewed at the meeting indicated a perspective in which the present climatic situation falls clearly after the warmest phases of postglacial times; and, when the postglacial chronology is compared with other interglacials, it appears likely that one of the sharpest cooling phases preceding the next glaciation should occur at some so far indeterminable time within the next 1200 years or so.

There is a clear need to improve knowledge of the facts of the past climatic record on a great variety of time scales and by meteorological and oceanographic analysis of those facts (as well as by theoretical modelling) to arrive at a better understanding of the processes involved in climatic change. This understanding must also include the effects of Man's various activities tending either to produce a net warming or a net cooling of the global climate.

Some more detailed and specific needs also appear urgent, viz:

(1) a central, international, storage data bank for pollen data.

(2) a close study, using radiocarbon data and appropriate meteorological analysis, of evidence of times of rapid climatic (and stratigraphic) change.

Particular interest attaches to those types of data which give the finest time resolution for studying periods of rapid change.

(3) to establish the relationship of areas with drier and wetter climates than now to the atmospheric and ocean circulation during the time of maximum glaciation (and at other times of generally colder or warmer climate than now).

(4) to know better the differential behaviour of different ice sheets, and of different ice streams or parts of the ice front within the same ice sheet, during times of ice advance and recession (and any effects registered on the ocean bed).

The meeting was under the joint leadership of Professor H. H. Lamb of the Climatic Research Unit, Norwich and Dr. J. D. Hays of the Lamont-Doherty Geological Observatory of Columbia University, New York.

Most participants, visitors and members of the Climatic Research Unit alike, have commented that the conference was very instructive and rewarding, and it was correspondingly enjoyed. Sincere thanks are due to the parent institutions of all those who were enabled to attend and to the Royal Society of London for its grant towards the expenses of running the meeting.

H. H. LAMB

SECTION 1: TECHNIQUES

COMPARISON OF ISOTOPE AND FAUNAL METHODS: PALAEOCLIMATIC INVESTIGATION OF A LATE PLEISTOCENE CARIBBEAN DEEP-SEA CORE

by John Imbrie, Jan Van Donk and Nilva G. Kipp

A simplified and more accurate version of the quantitative palaeoenvironmental method proposed by Imbrie and Kipp (1971) is based on untransformed rather than transformed species per cent data. The method yields faunal indices (Ts, Tw, S), useful both as objective measures of palaeontological properties and as estimates of Pleistocene sea-surface summer and winter temperatures (Ts, Tw) and salinity (S). Similarly, the oxygen-isotope method yields objective measurements of δO^{18}, useful stratigraphically and as indications of past changes in isotopic water composition and temperature.

Laboratory errors of the two methods have about the same magnitude relative to ranges observed in core V12-122. Accuracy of faunal indices as estimates of ocean conditions is evaluated by study of modern oceanographic data and sea-bed samples. Under favourable conditions, accuracy is apparently limited primarily by the degree of ecological control exercised by the estimated parameter. Accuracy of the isotopic palaeotemperature estimates is limited primarily by uncertainty as to the magnitude of the water-correction term in the isotope equation, a value which combines global ice-volume and local evaporation-precipitation effects.

Curves of δO^{18} and S in Caribbean core V12-122 record all or part of seven major climatic cycles, and display a fundamental periodicity of about 85 000 years. The cycles are lettered A-G on Fig. 1 and correlated with Kukla's loess cycles in Central Europe. Ts and Tw curves (highly correlated) show small but significant differences compared to S and δO^{18}: two phase shifts in estimated temperature minima, and a long-term increasing trend.

Amplitude-frequency histograms of Tw and δO^{18} indicate that only two per cent of the time during the past 450 000 years have Caribbean temperatures been as warm and isotopic ratios as low as they are today (Fig. 2).

A comparison of the magnitude of δO^{18} change (2.2 o/oo) during the shift from late-glacial to post-glacial times with that of the faunally-estimated change in average temperature (2.2°C) provides a basis for estimating the associated change in isotopic water composition (1.8 o/oo) by back-calculation in the isotope equation. At least 0.4 o/oo of this change in A is attributed to an evaporation-precipitation effect, and the balance (1.4 o/oo) to an ice-volume effect.

Isotopic and faunal methods monitor different responses to global climatic change. Used in conjunction, they provide deeper insights into the past than either could achieve alone.

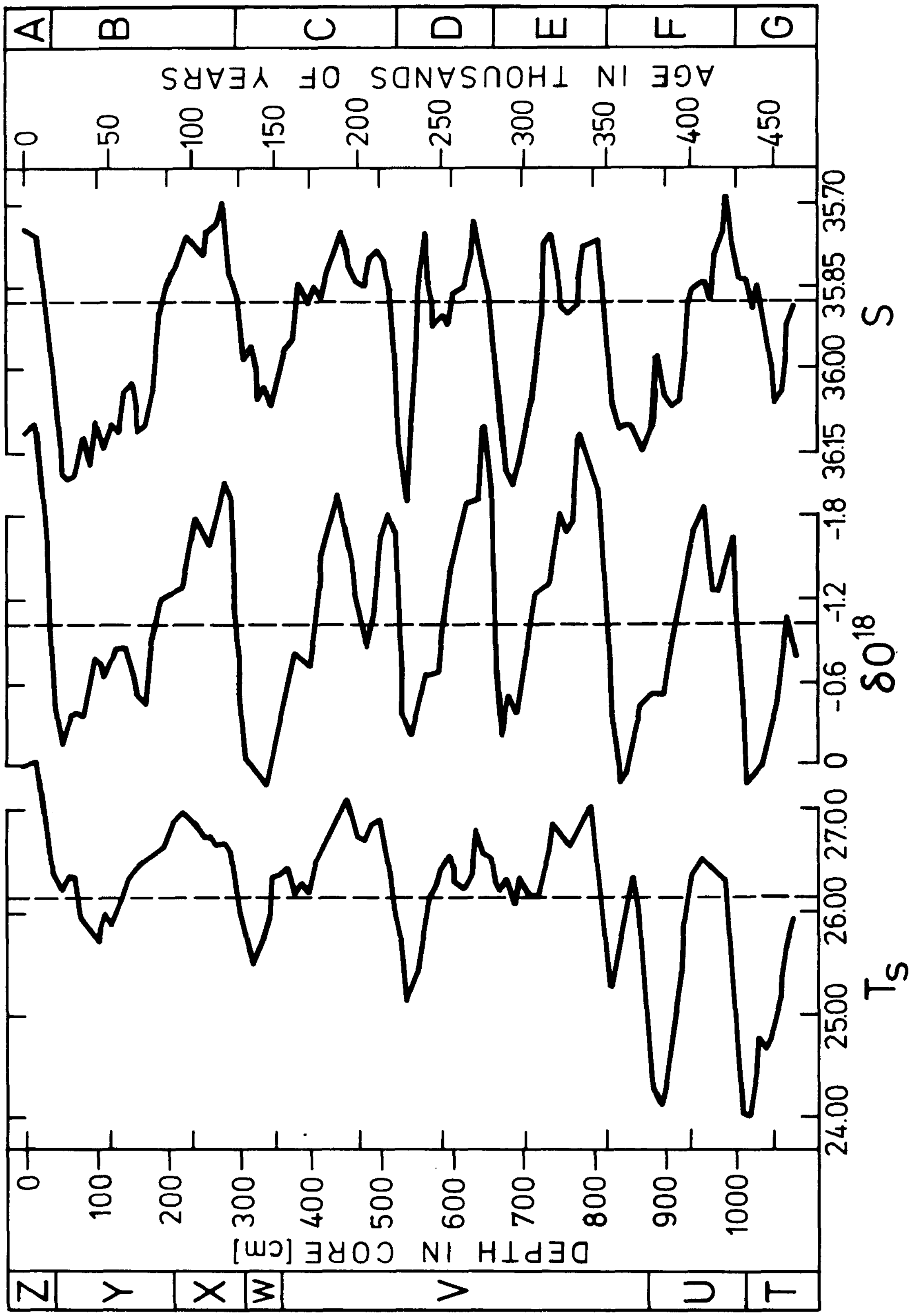

Fig. 1. Plots of foraminiferal index T_s; δO^{18} (*G. ruber*) in 0/00; and foraminiferal index S versus depth for Caribbean core V12-122. The foraminiferal indices are defined by a set of transfer functions F3 and scaled to be unbiased estimates of summer surface water temperature (^oC) and average surface salinity (o/oo), respectively. The faunal index curves are plots of a running mean of three samples.

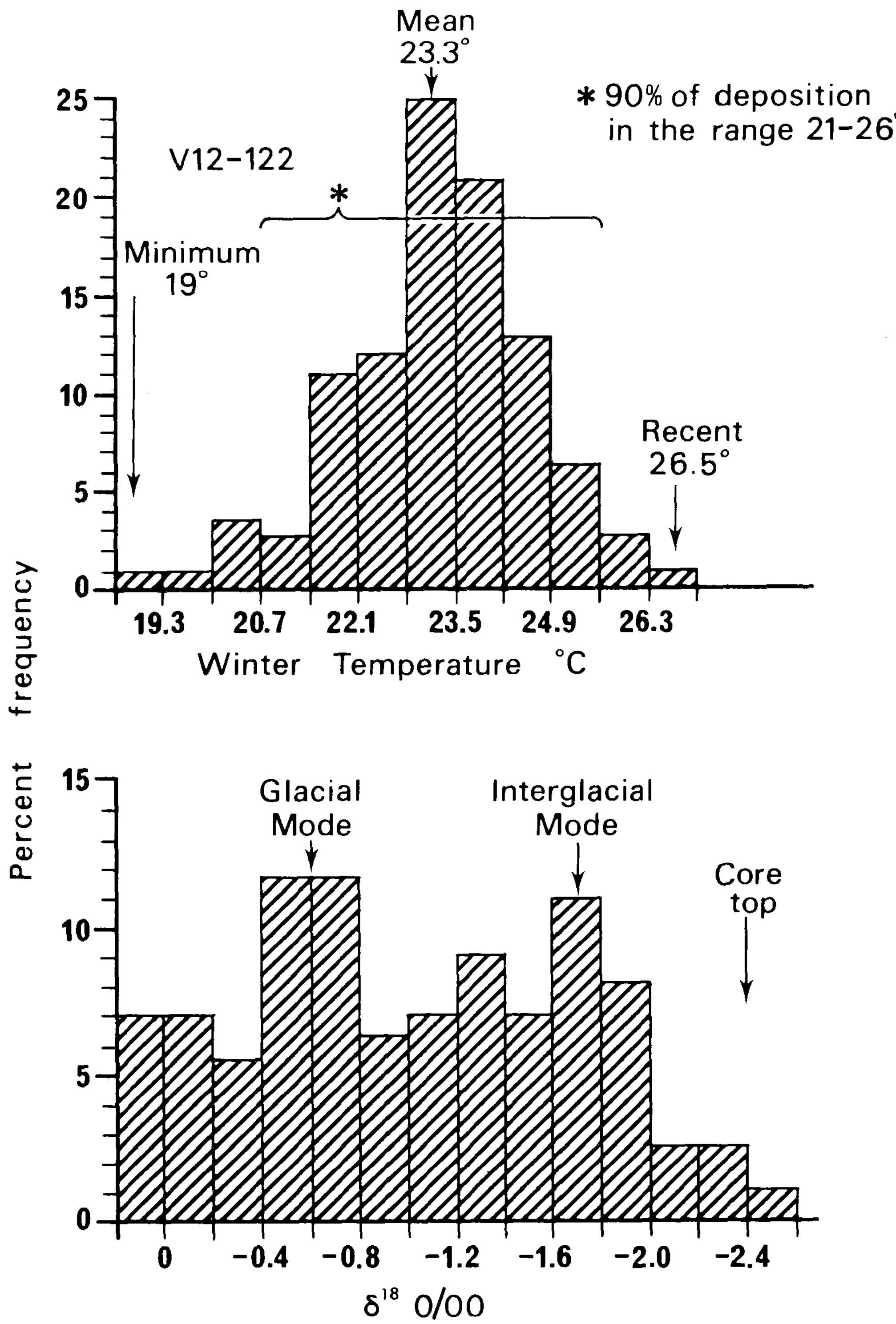

Fig. 2. Amplitude - frequency histograms of Tw and δO^{18} for the past 450 000 years in a core (V12 - 122) from the bed of the Caribbean.

NEW TRANSFER FUNCTIONS FOR ESTIMATING ATLANTIC SEA-SURFACE TEMPERATURES AND SALINITY FROM PLANKTONIC FORAMINIFERAL ASSEMBLAGES

by Nilva G. Kipp

Using methods described by Imbrie and Kipp (1971) and Imbrie, Van Donk and Kipp (1973), new transfer functions relate six planktonic foraminiferal assemblages in Atlantic core tops to seasonal temperatures and salinities at the sea surface and at 100 metres depth, producing estimates with 80% confidence intervals on the order of $\pm$ 1.5 to 2.5°C and $\pm$ .35 to $\pm$ .65°/oo (depending on season and depth). The data base used by Imbrie and Kipp (1971) has been revised and expanded: 75% of the samples in the new data set are from trigger weight cores; geographic coverage has been improved, and samples with moderately high dissolution have been included.

Application of the equations to six short cores in the North Atlantic between the equator and 54°N result in reasonable temperature and salinity ranges. Temperature and salinity curves for four of the cores are generally similar to those previously published; estimates in the other two cores now fall within reasonable ranges.

As a test, the new equations were used with data from a separate set of 37 core tops: more than 80% of the estimates obtained fall within the previously calculated 80% confidence intervals. Estimates from both data sets falling outside of the 80% confidence intervals are randomly distributed with respect to latitude, distance from continents, depth of water and dissolution.

The equations have also been used by McIntyre *et al.* to produce estimated temperature and salinity maps of the North Atlantic for 17 000 years B.P.