Mason develops Milankovich Ice Age theory

from John Gribbin

ON March 17 Professor B. J. Mason, Director-General of the UK Meteorological Office, delivered this year's Symons Memorial Lecture, in which he presented strong evidence in favour of the 'astronomical' theory of Ice Ages, with his own improvements on the Milankovich model.

Mason's talk, titled "Towards the understanding and prediction of climatic change" covered some familiar ground both at the beginning, where he restated his position in the debate about whether the sunspot cycle and other solar fluctuations affect climate (see *Nature*, **259**, 367; 1976) and at the end, where he stressed the value of computer modelling in our developing understanding of the atmosphere. Professor Mason believes that this is the only way in which we may be able to understand how the climate works although there is a long way to go yet before unique predictions will be possible. In some ways, the centrepiece of the talk was also familiar, at least to readers of *Nature*, in that it dealt with the Milankovich theory of Ice Ages. But Mason presented new, unpublished evidence in support of the theory, and also offered a uniquely persuasive insight into how the energy fluctuations involved could drive both the onset and decline of Ice Ages; it may well be that as a result, March 17, 1976 is remembered as the day when Milankovich's model, after four decades of controversy, at last became established as the leading contender to explain climatic fluctuations with timescales from a few tens to a few hundreds of thousands of years.

The key to this development has been the availability in the past few years, for the first time, of reliable continuous records of both temperature and total ice volume fluctuations covering the past 10^5 yr or more. These are the records obtained by interpreting isotope fluctuations (notably the $^{18}O/^{16}O$ ratio) in both ice cores and in marine cores containing the remains of small creatures such as plankton. The three separate variations in Northern Hemisphere insolation produced by changes in the orbit and inclination of the Earth have periods (in round terms) of 96,000 yr 40,000 yr and 20,000 yr; all three of these periods (and no others as significant) were present in a power spectrum analysis of the planktonic data which Mason had obtained from N. Shackleton in Cambridge (as yet unpublished). Mason stressed the importance of this link between statistically significant periodic variations and a known physical mechanism, contrasting the situation with that of some of the more short term data where seemingly significant peaks often have no physical explanation, and peaks expected on physical grounds (such as the 11-yr solar cycle influence) often are not significant. With this incentive, Mason has reworked some aspects of the Milankovich model in terms of variations in the amount of heat received at different Northern Hemisphere latitudes in different seasons, using both the original astronomical data of Milankovich and modern improvements on the data. North of 45°N the variations due to these effects cover about 4×10^{18} calorie d^{-1} (1.5×10^{21} calorie yr^{-1}), which is about 1% of the total heat received by the polar cap, and Mason reported that he was "staggered" to find the very exact agreement over the past 150,000 yr between times of minimum insolation and the maximum advance of Northern Hemisphere ice.

Mason says "this is impressive, and the last thing I expected" and that the remarkable agreement encouraged him to look at the integrated effect of insolation variations during periods in which the ice cover advanced and retreated. Again for the region north of 45°N, when ice cover developed during the period from 83,000 BP to 18,000 BP the integrated deficiency in insolation produced by Milankovich variations amounted to some 1,000 calorie for each gram of ice formed using Milankovich's figures, or some 556 calorie g^{-1} with the modern figures. Since the latent heat of the water/ice transition is 677 calorie g^{-1}, the figures are impressive even without allowing for the possibly crucial significance of the fact that the variations in insolation are much greater in summer than in winter.

From 18,000 to 6,000 BP, when the ice was melting, the integrated 'excess' heat received was 4.2×10^{24} calorie on Milankovich's figures and 10×10^{24} with the modern astronomical figures, while the latent heat required for the known decrease in volume of the ice was 3.2×10^{24}; a coincidence which stretches across 24 orders of magnitude to agree so closely is certainly not to be dismissed lightly, and work is now in progress at the Meteorological Office to produce a more detailed model taking account of the capacity of the ocean to act as a reservoir of heat and the feedback mechanisms between ice and ocean. Mason even ventured if not a prediction then at least a comment on future climatic fluctuations, pointing out that we are now shifting from a situation in which the Milankovich effect has produced excess insolation in the North (above the mean for the past 150,000 yr or so) to one in which there is a deficit. Simple astronomical calculations show the dip reaching a Northern Hemisphere insolation minimum in about 10,000 yr, but bottoming out before reaching conditions quite so extreme as those which coincided with the maximum advance of the most recent Ice Age. Many members of the packed audience for Mason's lecture will undoubtedly be eagerly awaiting the full model now being developed by A. Gilchrist and others at the Met. Office; some, no doubt, will now be taking a fresh look at the Milankovich model themselves. Meanwhile, in Mason's words, "this effect cannot be laughed away... certainly all the energy quantities are in the right ball park". □

A hundred years ago

LORD SALISBURY, on Monday, named the following as Commissioners under the Oxford University Bill: —Lord Selborne (Chairman), Lord Redesdale, the Dean of Chichester, Mr. Mountague Bernard, Sir Henry Maine, Mr. Matthew White Ridley, and Mr. Justice Grove. The feeling among scientific men is one of intense disappointment, leading to the conclusion that it is useless any longer to consider whether Oxford will ever be in a position to do anything for the promotion of science.

THE report of the Cambridge Board of Mathematical Studies to the Studies' Syndicate contrasts with the reports of most of the other boards in the paucity of its suggestions for improvement. They do not seem to think that very much is required in order to perfect the system of mathematical teaching. They believe in the probable stability and development of the system of intercollegiate lectures, but say very little to assist its development, and they say nothing about the present vehement competition by means of private tuition, and the defective method of study that it induces. In answer to the question how university teaching may be organised so as to give the greatest encouragement to the advancement of knowledge, "the Board offer no suggestions under this head." Is this quite what might have been expected in a report bearing the signatures of Stokes, Cayley, Adams, Clerk-Maxwell, Sir W. Thomson, Tait, Lord Rayleigh and James Stuart? May there not be some unobvious explanation of this phenomenon? The whole report consists of only forty-one lines.

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