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New Climatology for Old

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Dr Radok, Head of the Meteorology Department, University of Melbourne, opened his address by explaining that its title referred to the exchanging of one's old clothes for new from a barrow man. One could not always be guaranteed of getting something better. What he had to say should be viewed in this context. Nevertheless, he felt that it appeared climatology was at present in the position of being able to make a completely new start.

The methods of the 'old climatology' from the end of the last century were reviewed. The traditional methods of investigation generally assumed steady state climates and the 'Klimagram' was perhaps the most sophisticated method of presentation of the climate of a locality or region. The concept of climate normals is also inherent in this approach. Dr Radok pointed out the problems of persistence or autocorrelation in meteorological data. This, together with the fact that climate normals and variances were subject to change with time, made it difficult to apply simple statistical theory, based on the Gaussian distribution, to climatological data.

The beginning of the 'new look climatology' was brought about by two factors. The first was socio-economic and there were three major, climatically based upsets which characterised it; the failure of the 1972 Russian wheat crop which resulted in massive purchases of wheat by that country, especially from the reserves of the United States; the disappearance of the Humboldt Current off the coast of South America which led to a failure of the anchovy harvest, leading in turn to stress on the soya bean market; and drought induced famine and large population movements in the Sahel region of North Africa. The question being asked throughout the world was 'Are we becoming more dependent on the weather?', as it had been thought that recent research and technology had just about eliminated the climatic factor from agriculture and food production. By considering the amount of arable land which could be brought into use and the state of the world's food reserves, Dr Radok indicated that a critical point had been reached at which one or two bad years in one or more of the world's major grain producing areas could put the world's food supply in jeopardy. The pressures of increasing world population were adding to the problem and attention should not be diverted by one or two good years. It is a problem which will not go away.

It was this short-term climatology, of time scales of a year or so, and not the more dramatic question of whether or not we are about to enter another ice age, which brought real new interest to the subject.

The second reason for this new interest was that of the increasing availability of the incredible range of improved technological developments in the collection and processing of climatic data, particularly in satellites and computers. Computers were now being put to use in a number of roles other than the 'traditional' role as a vehicle for atmospheric modellers; this latter use being perhaps the oldest part of the new climatology.

Dr Radok then gave a brief background of the beginnings of the new climatology in the United States. He pointed out that the broadly based National Science Foundation, rather than the National Oceanographic and Atmospheric Administration, was to the forefront in setting up a US climate dynamics program. He felt this was perhaps just as well because of the interdisciplinary nature of the problem.

The four major areas of interest in the program are:

(1) climate data assembly and analysis;

(2) climate index monitoring and forecasting;

(3) climate modelling;

(4) climate impact assessment.

There were four major development points in the assembly of past data. These were the ascent of Nimbus IV, the International Geophysical Year, the period of instrumental record and finally the distant past. The longest period of instrumental record is that of Manley's synthesis of temperature records for central England back to 1659. For information prior to the instrumental record one has to rely on 'proxy' data from tree rings, distribution of pollen stores, glaciological movements, oxygen-isotope ratios in deep ice cores and archaeological evidence. The concurrent period of available instrument records provides the means of calibrating this proxy data. Nevertheless, it is often very difficult to interpret the relative changes from these proxy tools in the absolute terms of changes in climatic variables.

Dr Radok then summarised the record of past climate changes as prepared by the American National Academy of Science. One feature which did not seem to have attracted much attention was that the interglacials appeared to be getting warmer. Was this trend likely to continue? It must be remembered that this evidence of past climates, impressive as it seems, was still based on relatively sketchy information.

Turning to the second area of interest in the NSF program, it was noted that it is now possible to store an enormous quantity of conventional data on a relatively small number of magnetic tapes for transfer to any research institution which might require it. However, as an example of the rather dramatic, but sobering, aspects of the data explosion which the new climatologists were confronted with, it was pointed out that around 14 400 tapes per year would be required to store all the information received from the two polar satellites scheduled for operation during the First GARP Global Experiment and around 100 000 tapes per year for the four geostationary satellites.

Such was the speed with which the data could be collected and analysed, that it was possible to talk of 'real-time' climate. One could now follow changes in climate much as one can follow changes in the synoptic weather. Monthly climatological summaries for the globe could now be prepared within a few weeks of the end of the month. Satellites too were providing real-time climatic data, for example, the albedo of the earth's surface and estimates of the surface heat budget. The problems with much of this information lay in its interpretation. However, computers could be used to help here through digitisation of visual data and conversion of raw data into simpler and summary forms. The all weather satellite (AWS, Nimbus V), which could observe in the microwave band, could detect, through cloud, such things as soil moisture and could make quantitative estimates of rainfall over the sea. This satellite was also capable of observing changes in the structure and extent of the polar ice caps and surrounding sea ice.

On the third area of interest in the NSF program some of the work being carried out was mentioned briefly. In Dr Radok's opinion the main features of the climate to be accounted for by the modellers were: the relationship between the strength of the Hadley Circulation and the meridional temperature gradient; the likely changes in the general circulation between glacial and interglacial periods; the occurrence of quasi-persistent phenomena in the atmosphere such as cut-offs and blocking patterns - these features, occurring in any season, are often the factors which produce climatic anomalies. Finally, Dr Radok saw that the climate modellers must come to grips with the circulation of the ocean, an area in which so far there had been minimal progress. It has been shown that oceanic analogues to the atmospheric 'cut-off' or 'cold pool' do exist. These must have a significant effect on the medium term climate.

On the final area of the NSF program Dr Radok used an example of an apparent change of variation in the Indian monsoon to emphasise the impact that climatic changes can have on man's activities. However, it was often difficult to detect such subtle but significant changes when they were occurring let alone to attempt to predict them.

What sort of information should be obtained for practical impact studies and how should it be presented? One possibility was to combine different parameters in the form of an index; alternatively the variance or power spectra of climatic variables could be computed. Most statistical treatments involve a certain amount of smoothing or averaging to remove the so-called 'noise'. Perhaps it was time methods were developed to interpret, in climatic terms, some of the noise as well?

Summarising, Dr Radok emphasised that the essence of the new climatology was to look at the facts. The modellers, the data collectors and the data constructors certainly had a great deal to do. If one had to make a ranking of priorities then it would seem that the interpretation of the new information now becoming available was perhaps the most important and crucial feature of the new climatology.

After the address discussion opened with a reiteration of the seriousness of the present food crisis. Dr Radok pointed out that the technologically advanced countries would be insulated somewhat, however there were countries already suffering starvation and these would be in a worse condition given further bad years. Dr Priestley questioned how far the graph of dwindling food reserves was really a graph of climate. Dr Radok agreed that there were factors other than climate influencing food reserves but it was nevertheless a very important consideration. While a simple extrapolation of the graph would indeed lead to a doomsday situation fairly rapidly, it was also possible that measures such as changes in political policies could lead to a gradual building or levelling out of reserves. Ingenuity and technology would also have a part to play.

Dr Tucker, referring to Dr Radok's somewhat disparaging reference to atmospheric modelling as the oldest part of the new climatology, asked what methods he would propose to synthesise all the complicated interacting mechanisms involved, other than the use of numerical models. In reply Dr Radok confessed to being somewhat provocative and stated that his intention was certainly not to down-grade the role of the modeller. He pointed out that the other three areas of the NSF climate program were designed in essence to buy time for the numerical modellers, who will of course provide the ultimate answers. However, no one could predict when that would be and in the mean-time there was certainly a lot of information to be gleaned from the new data coming in. Following on, Dr Tucker stated that Dr Radok had, in the beginning of his address, emphasised the small role so far played by NOAA in the setting up of a US climate program since there were many more things than the atmosphere and the oceans involved; why then, during the course of the address had other factors not become evident? There were a lot of people pontificating about climate and really what they meant was that *if* the climate changed then the consequences would be such and such. The actual climate and variation of climate was surely an atmospheric and oceanographic problem alone. Dr Radok stated that NOAA, being a rather large organisation, had been slow to react but was now becoming more active in the field. Certainly the answers lay in the atmosphere and the oceans and probably in the ice as well.

A short discussion then proceeded on the availability of funds in the US for climate research. Dr Radok thought that while it might take some time, sufficient funds would become available, particularly in such areas as ocean monitoring where it was most needed.

Dr Zillman asked to what extent the increasing interest in climatology had been politically inspired. Dr Radok briefly related the history from the first warnings by Kukla and Mathews to the US President of a coming ice age through to the setting up of the NSF climate program.

In the final question Mr Morgan asked what attempts were being made to measure changes in incoming solar radiation. Dr Radok pointed out the difficulties in continuous monitoring of the sun and referred to the possibility of a 'sun-stationary' satellite. NASA did have a program for measuring variations in the solar constant. However, it was unlikely that a knowledge of variations in the solar constant, if they were significant, would in itself provide immediate answers. Complicated feedback processes mean that the right answers would probably only come from the application of successful numerical models.

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