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THE GLOBAL ATMOSPHERIC RESEARCH PROGRAMME (GARP)

P. R. PISHAROTY

Physical Research Laboratory, Navarangpura, Ahmedabad-9

THE International Union for Geodesy and Geophysics created a Committee on Atmospheric Sciences (CAS) and requested it "to develop an expanded programme of atmospheric science research". The CAS was created in June 1964 to advise the International Council of Scientific Unions on matters arising from the following two UN resolutions:

Resolution 1721 (XVI) December 1961, which recommended "members and WMO to study measures to advance the state of atmospheric sciences and technology in order to improve existing weather forecasting capabilities and to further the study of the basic physical processes that effect climate" and Resolution 1802 (XVII) December 1962, which recommended that WMO "develop in greater detail its plan for an expanded programme to strengthen meteorological services and research", and invited ICSU through its unions and national academies "to develop an expanded programme of atmospheric science research which will complement the programmes fostered by the World Meteorological Organization".

Since 1962, a major effort to respond to the two UN resolutions has been made by the WMO resulting in the formulation of the

World Weather Watch (WWW) Programme. The last WMO Congress which met in Geneva in April 1967 approved detailed plans for the further developments of the weather observing networks maintained by member nations.

In recent years rather remarkable progress had been made in formulating physico-mathematical models of the atmosphere, treated as a fluid dynamical system, and in using powerful computers to integrate the governing thermohydrodynamic equations to stimulate and forecast the behaviour of the atmosphere. In parallel with this, the development of the meteorological satellite has introduced a dramatic new observational capability. Several countries in middle latitudes now produce objective numerical forecasts of the evolution of weather systems over periods of 2-3 days and these are rapidly superseding traditional methods of forecasting the main features of the pressure, temperature and wind fields, at least in middle latitudes. Using very complex models of the global atmospheric circulation, it has been possible to simulate the major features of the world's climate and to conduct numerical experiments which strongly indicate that it should be possible to produce reliable forecasts of the major features of the weather for about one week ahead.

But this cannot be realized without an adequate coverage of meteorological observations over the whole globe including oceanic and tropical regions. The World Meteorological Organization is already operating an observational system but it is at present inadequate in coverage and performance for the above purpose. An improved system, the World Weather Watch, is being evolved to meet this requirement. It is based on a global observation system, including satellite observations, a global telecommunications system, and a global data-processing system based on a number of world and regional centres that will, in general, use powerful computers to process the observational data and produce numerical weather analyses and forecasts on the global regional scales.

However, in order to produce reliable forecasts for more than 2-3 days ahead, it will be necessary to improve our understanding of a number of atmospheric processes that determine the evolution of weather on the time scale of a week or more and to incorporate these processes more realistically into the numerical models. It is well known that large-scale atmospheric processes are significantly affected by cumulus convections particularly over the tropics. A satisfactory method of parameterising this effect in numerical weather prediction models has yet to be developed. Also, a great deal of investigation will be required to establish the optimum observational network to meet these requirements. The formulation of realistic physical models of the atmosphere and the optimum design of the observation system are the main objectives of the *Global Atmospheric Research Programme (GARP)*, which is a joint programme of WMO and ICSU.

The programme's ultimate goal is to provide a *scientifically sound physical basis for long-range weather prediction*. The GARP effort is not an operational programme but a research effort which will involve many atmospheric scientists and technologists from government services and laboratories, universities and industry, from many countries. The planning of this activity is being co-ordinated by a Joint Organisation Committee

of twelve Scientists, of which Prof. P. R. Pisharoty is the scientist from India. As the promise of GARP is completed and demonstrated, appropriate modifications and extensions will be incorporated into the operational part of the WWW as needed and funded.

The operational part of the World Weather Watch, at present and its expected structure in the future, is the responsibility of the nations of the world which operate it through the World Meteorological Organisation.

The Global Atmospheric Research Programme (GARP) is thus a programme for studying those physical processes in the troposphere and stratosphere that are essential for an understanding of:

- (a) The transient behaviour of the atmosphere as manifested in the large-scale fluctuations which control changes of the weather; this would lead to increasing the accuracy of forecasting over periods from one day to several weeks.
- (b) The factors that determine the statistical properties of the general circulation of the atmosphere which would lead to better understanding of the physical basis of climate.

This programme consists of two distinct parts, which are, however, closely interrelated:

- (1) The design and testing by computational methods of a series of theoretical models of relevant aspects of the atmosphere's behaviour to permit an increasingly precise description of the significant physical processes including small-scale tropical cumulus convection and their interactions.
- (2) Observational and experimental studies of the atmosphere to provide the data required for the design of such theoretical models and the testing of their validity.

The global experiment is now planned for the year 1975 or 1976. The special committee jointly set up by the World Meteorological Organisation and the International Council for Scientific Unions is working on the plan.