

29 May 1969

## THE INTERNATIONAL SYMPOSIUM ON NUMERICAL WEATHER PREDICTION, TOKYO, 1968

By M. J. D. Jenssen

Dr. Jenssen, from the Meteorology Department, University of Melbourne, presented a summary of the more important and interesting papers submitted at the Tokyo Conference. He explained that the Conference had been divided into various sections which included:

- Section 1. The Physical Basis of Forecasting
- Section 2. Atmospheric Models
- Section 3. The Tropics
- Section 4. Long Range Forecasting

In Section 1 emphasis was placed on small scale effects and aspects of atmospheric energetics. Models by Gambo and Asai parameterized cumulus-scale convective motions within the grid area. Gambo's model gave substantially better results when "moist" convective parameterization was used instead of "dry" convection. Asai found in his model that for cumulus towers to be sustained, vertical velocities greater than 10 cm/sec were required, and more than 10 percent of the grid area needed to be covered by cloud.

Energy dissipation was discussed by Leith, who examined artificial eddy viscosity coefficients used as a means of obtaining computational stability. He found that the cascade of energy between wavelengths depended on the type of atmospheric energy spectra assumed, and was zero for energy being a  $-3$  power function of wave number.

Kung had made determinations of synoptic scale dissipation over North America. Of the total energy dissipated in his atmosphere, about 35 percent was in the boundary layer and about 65 percent at the jet stream level.

Section 2 contained papers dealing with atmospheric models which forecast precipitation and weather, models of mountain flow and stratospheric models. Bushby described a 10-level precipitation model with a very small grid and the inclusion of topography. Allowance was made for the possibility of evaporation of falling rain and the lapse rate was assumed to depend approximately linearly on the relative humidity. Kwizak obtained 24-hour rainfall predictions from a 3-layer model using the potential vorticity equation. His results were improved when latent heat released was fed back into the model.

Fisher, Magata and Queney contributed papers on flow over mountains. Fisher considered zonal flow up to a longitudinal barrier, which gave realistic lee-side troughs except for very low zonal flow. Magata studied flow about a conical mountain using 6 co-ordinates with encouraging results. Queney's results led him to believe that steady state laminar flow was never present in the atmosphere, and that a dissipative sink of energy existed near the tropopause.

A stratospheric model was proposed by Berkovsky but no results were available. Bugaev described a statistical treatment of the "26-month oscillation" in which the variations were fitted by sine functions with 27 and 8, 10 and 40 month components.

Prediction of the I. T. C. Z. and hurricanes were the major topics in Section 3 of the Conference. Charney attempted a numerical methods explanation of the I. T. C. Z. and in his scheme he found that condensation accounted for 90 percent of the energy generated in the region. The resulting system maintained an I. T. C. Z. if condensation heating was greater than adiabatic expansional cooling. However, the main drawback was that the width of the I. T. C. Z. depended on the finite-difference scheme used. An even more detailed, full primitive equation model due to Krishnamurti was started in balanced conditions and produced its own I. T. C. Z.

Dr. Jenssen was impressed with the sophistication and success of the hurricane forecasting models, particularly one due to Rosenthal who used a 7-level primitive equation model. His model predicted a hurricane eye and gave sporadic down draughts in the eye which is believed not to have been forecast before. Tests with and without sensible heat transfer demonstrated its extreme importance, as no hurricane developed in the latter case. Realistic time scales were also obtained.

Adem presented a paper on a long-range model which included effects such as heat storage in the earth-atmosphere system, advection, radiation, evaporation, condensation, friction and energy considerations. Winn-Nielsen showed how it is possible to simulate features such as atmospheric lags behind the solar cycle, while Huss and Doron, using a very simple general circulation model, obtained realistic index and hydrological cycles.

Using primitive equations, Kasahara showed that orography was more important than thermal effects in anchoring the semi-permanent circulation patterns on a global network.

Predictability was treated by Lorenz; his conclusion was that the limit of predictability depended on energy transfer between wavelengths and hence depended critically on the energy spectra assumed in the model. An upper limit for weather prediction was given as about 17 days.

Problems of verification of objective analyses were discussed by Gandin and Nitta, while Sasaki, Morel and Cornen, Okamura and Masuda spoke on the effects of boundaries, the use of staggered grids and finite difference approximations on hexagonal lattices.

In concluding his talk, Dr. Jenssen remarked that due to the large number and variety of papers he was unable to discuss them all and he would, on request, be quite willing to lend the papers to be photocopied.

Discussion and question time followed. Dr. Tucker asked what emphasis was being placed on finite difference techniques? Dr. Jenssen considered that the basic problems for global forecasting schemes had been solved with regard to hexagonal co-ordinates, conservation of mass, momentum, etc., but in his opinion, the problems of changes in results due to changes in techniques had not been emphasized sufficiently and needed further work. Dr. Tucker remarked that it appeared as if work had been concentrated on refining models rather than investigating

actual physical processes of the atmosphere; he then asked the speaker for his opinion on the important trends of the future. Agreeing with this statement, Dr. Jenssen thought that important lines of research would be

- (i) parameterization of sub-grid scale convective elements,
- (ii) redundancy experiments to determine the most efficient use of data, and
- (iii) investigations into theoretical and experimental predictabilities of atmospheric motions.

Dr. Priestley enquired where the main developments were occurring and whether it had definitely been determined whether orography, topography, or thermal effects caused anchoring of the general circulation features. In the speaker's opinion, the main numerical modelling work was in America and England, followed by Russia, France and Japan. Also, topography or orography, i. e. the effect of mountains, had caused the geographical anchoring of thermal systems in Kasahara's model.

Mr. Langford asked the speaker to elaborate on the difficulties of objective analyses, to which Dr. Jenssen replied that the most important problem was adjusting initial fields to provide internal consistency with the forecast models.

M. E. V.

26 June 1969

## PLANT GROWTH WITHOUT TEARS, OR A MODEL OF A GROWING PASTURE

By G. W. Paltridge

Dr. Paltridge of the C.S.I.R.O. Division of Meteorological Physics, Aspendale, Victoria, introduced his subject by intimating that models were of two types, viz. pure simulation concerned only with the end result, and those in which interest is centred on how the model works. He stressed that his model was developed from physical principles and embraced the concept of specific layers within the crop canopy and throughout the root zone. Biochemical activity within the canopy was defined by the rate of production of dry matter in the various strata. With a given distribution of crop and root, and with soil-water and plant nutrients non-limiting, it is postulated that growth can be determined by the treatment of data for air temperature, wind speed, radiation and concentration of  $\text{CO}_2$  in the atmosphere above the crop canopy. Growth rate (GR) is identified with the rate of photosynthesis (PS) and the relationship between PS of a given layer and the meteorological parameters indicated above is given as

$$\text{PS} = F(R, \text{CO}_2, A)$$