Results of typical calculations were presented, using both model and observed atmospheres, from which it appears that the maximum change in optical path when the height of closest approach of the signal beam is very near zero is about 200 metres and a resolution equal to the wavelength used (perhaps 1 cm) should be possible. The sensitivity to change of the optical path is about 1 m per N-unit (N is equal to 10^6 (refractive index -1)) and this, near the surface, corresponds to about ½% in density. The resolution along the beam is of the order of 300 to 500 km, though features down to 100 km or less in size should be detectable.

Given an atmosphere and the profile of refractive index in it, the calculation of change in optical path is straight-forward, but the problems of the reverse to deduce the profile from the optical path change are likely to be considerable. Moreover, serious difficulties of interpretation of the radio measurements are likely due to the strong effect of water vapour on refractive index, which is thus not a function of density alone, and due to imprecise knowledge of satellite position, since the distance between master and slave satellites must be known to an accuracy equal to the resolution desired in measuring optical path changes.

Dr. Sargeant then described measurements made by the University of Wisconsin on propagation of microwaves by tropospheric forward scattering over a total path of some 200 km. The dependence of the Doppler shift of frequency on antenna azimuth angle (measured from the great circle joining the two stations) was demonstrated, and the relationship between this frequency shift and the lateral component of the velocity of the scatterers was discussed. A correlation technique was described, which also makes it possible to determine the height of the scatterers so that a vertical profile of the lateral velocity component can be constructed.

R.J. T.

31 July 1968

RESULTS OF A SOUTHERN HEMISPHERE FORECAST WITH A NINE-LEVEL MATHEMATICAL MODEL

By R.H. Clarke

Mr. Clarke of CSIRO Division of Meteorological Physics, Aspendale, Victoria has recently returned from the United States, where he was attached to Dr. J. Smagorinsky's group at the Geophysical Fluid Dynamics Laboratory of ESSA in Washington.

Using the nine-level primitive equation model developed by Smagorinsky (1965), forecasts for the Southern Hemisphere for a period of 14 days from 1 March 1965 have been produced. Before presenting the results of these forecasts, the speaker devoted considerable discussion to the problems associated with the preparation of suitable initial data for such forecasts. The initial data required were manual (vertically consistent) analyses of the mass, temperature and moisture fields for all standard pressure levels from 1000 mb to 10 mb for five days; the climatological, latitudinal distributions of cloud, water vapour, carbon dioxide and ozone for use in radiation computations; and a suitable smoothed field of orography. It is further required that the initial data be interpolated to the grid system required by the existing prediction model. Finally, the balance equation and the omega equation are employed to produce dynamically conditioned initial horizontal and vertical wind fields.

The experimental results presented included correlation coefficients between predicted and manually analysed height changes at 500 mb, R.M.S. errors between predicted and observed heights, and selected individual forecast days for various levels and particular geographical areas. Certain diagnostic results were also presented - for example, the meridional profiles of temperature, zonal wind and zonal kinetic energy.

Assuming that correlation coefficients provide a guide to the performance of a particular model, the results for the individual experiment attempted suggest useful forecasting ability up to a period of 3-4 days. Surprisingly, the model performance for the data sparse Southern Hemisphere is comparable with that obtained for the Northern Hemisphere. The correlation coefficient fell gradually during the first six days of the forecast and then rose to a high, and probably unrepeatable, secondary maximum around the seventh or eighth day. This secondary maximum was then followed by a further decline. The root mean square error distribution of height showed a similar pattern.

Synoptic deficiencies of the forecasts presented were the consistent errors occurring in the longitudinal position of upper troughs and the failure of the model to adequately predict the development and subsequent movement of cut-off lows. The diagnostic results, however, indicate considerable dynamic similitude between the atmosphere and the model.

In the general discussion that followed Mr. Clarke's address, Mr. Gauntlett inquired whether consistent phase errors in the forecasts were a manifestation of the finite difference scheme employed or perhaps the result of some physical deficiency in the model. In reply, Mr. Clarke acknowledged the possibility of the finite difference scheme causing a decrease in the phase velocity due to truncation errors. He suggested that further sources of error might be inaccuracies in the initial analyses and insufficient horizontal resolution in the forecasting model.

Dr. Tucker suggested that the rise of the correlation coefficient after one week could be explained by assuming that after this period the major wave components of the forecast field had, through a consistent accumulation of forecasting errors, once again become in phase with the analysed field. In reply, the speaker explained that a detailed examination of the model forecasts did not support this theory. In the speaker's opinion, the apparent poor performance of the model around the fifth and sixth days was geographically restricted to the data sparse area of the central Pacific and could be attributed to low quality verifying analyses in that area.

Mr. Wallington queried the significance of correlation coefficients in assessing the performance of a particular forecasting model over extended periods. He suggested the alternative procedure of identifying features of the synoptic pattern and studying how the model accommodated the movement and development of these particular features.

REFERENCE

Smagorinsky, J. 1965 Monthly Weather Review, 93, No. 12, Dec. 1965.

D.J. G.

28 August 1968

TROPOSPHERIC JET STREAMS IN THE SOUTHERN HEMISPHERE

By T.T. Gibson

Mr. Gibson of the Meteorology Department, University of Melbourne, introduced the topic by drawing attention to the importance of the extratropical jet stream (ETJ) as a dynamical feature of the upper troposphere. He commented that, whereas meteorologists in Australia tend to attribute to the sub-tropical jet stream (STJ) a predominant control of the weather systems in their area, his own training in Canada made him conscious of the significance of the ETJ.