

JOINT COLLOQUIA

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Towards numerical forecasting for the Australian region

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Dr. Radok, University Department of Meteorology, outlined the main theoretical work in the field of numerical forecasting, with special emphasis on the barotropic model and recent modifications introduced to allow for variations in tropopause height and for a better wind approximation than the geostrophic. In the Australian region difficulties are expected to arise from the absence of data especially in the SW quadrant but their true extent can only be judged from actual computations which are being prepared for the CSIRAC computer at Melbourne University. In the discussion Dr. Berson stressed the point that the barotropic model holds not merely for an atmosphere in which the wind does not change with height but also for some level in a fairly realistic baroclinic atmosphere. That level might have to be determined experimentally for Australian conditions.

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At this colloquium Dr. E. Kraus of the Snowy Mountains Authority discussed two topics, summaries of which follow.

The use of polynomial representation in
forecasting and climatology

Practically all meteorological and, for that matter, most geophysical observations, have the characteristics of time series or discreet space samples of such continuous quantities as pressure, temperature, salinity and so forth.

Large numbers of observations have often to be represented by an approximate analytical function. This is necessary, particularly if functional relations have to be established between two different time series. Least square representation is one of the means of doing so. There are, however, several disadvantages in orthodox least

square approximations. In particular, approximations by functions of a degree higher than fourth become extensively laborious. Moreover, if for example, it is found that an approximation by a fourth degree function is not sufficiently accurate and that say a fifth degree approximation is required, the whole computation has to be repeated.

The method of orthogonal polynomials greatly reduces the computational labour involved in least square approximation in the special case of time series with a fixed observation time, or of observational grid in space with uniform distance between neighbouring sampling points. The method allows progressive calculation, i.e. if an approximation by a function of degree n is found insufficiently accurate, an approximation by a function of degree $n + 1$ can be easily computed. The computation can be continued until an approximation of any specified accuracy has been obtained.

After a brief mathematical introduction the method was illustrated by the approximation of a hydrograph of the Tumut River in New South Wales. It was shown that the shape of the hydrograph was determined with an accuracy of 96.2% by four polynomial co-efficients. The use of six co-efficients would have made the representation 99.1% accurate. Polynomial approximation could be particularly useful for the establishment of rainfall-runoff relationships, as streamflow and rainfall are both time series which can be readily approximated.

The method can also be used to represent two-dimensional arrays, such as isobaric charts, or three-dimensional fields. As an example, it was found that the pressure configuration over Australia and the neighbouring ocean as given by the surface chart and the 700, 500, 300 and 200 mb charts, could be represented by 20 polynomial co-efficients with an accuracy of better than 82%. Representation of this type can be used for climatological investigations, planning of air routes and so forth.

To use polynomial co-efficients as a forecasting tool, it is necessary to relate them by means of regression equations to the element to be forecast. For this purpose a sufficiently long series of historical records is necessary. Whether or not the method can be used to forecast the rainfall quantitatively has not yet been proved.

The chance to do so in the Snowy Mountains area would appear to be reasonable, as an overwhelmingly large component of precipitations there is of an orographic nature and hence directly affected by the pressure configuration. Furthermore, in the operation of the Snowy scheme, the forecast of very high rainfall volumes, which are statistically rare events, may be of comparatively little interest.

In the discussion Dr. Radok asked whether it was intended to make full use of the orthogonality by discarding in any particular case all terms failing to contribute significantly to the goodness of fit. This would of course raise the significance of the remainder. In reply Dr. Kraus said that this was not envisaged as it would be difficult to fit into the electronic computing routine.

The fluctuations in the evaporation-precipitation on cycle of the trades

Evaporation increases with surface wind speed and hence with the energy of the Trade wind circulation. The main heat source of the latter is due to the heat of condensation which is mainly liberated in the equatorial trough. It can be shown that the liberated heat of condensation is linearly related to the mean evaporation at a specified earlier time.

On this basis a mathematical model has been constructed. It is based on a difference equation which shows that the evaporation precipitation cycle of the Trade may be affected by disturbances with a period of roughly 15-20 days. It is also shown that small disturbances will tend to be amplified. Frictional dissipation prevents, however, an infinite amplification, i.e. the cycle is on the whole a stable phenomenon.

Initial disturbances may be associated with changes in the efficiency of the atmospheric heat engine, mainly as a result of changes in the height and intensity of tropospheric radiational cooling.