

BOOK REVIEW

P. Raethjen: *Dynamik der Zyklonen*, Leipzig 1953, 384 pp., 92 figures. Akademische Verlagsgesellschaft, Geest & Portig K.-G.

A large number of books covering various fields within meteorology have been published since the war. However, at least within the field of dynamic meteorology most of these have merely aimed at developing the very basic relations and tools in the field and have only given very brief introductions to more advanced ideas. This state of affairs is very understandable. In the first place there was a real lack of elementary text-books when the big training programs were started during the war and this need had to be met first. In the second place, our knowledge of the behaviour of the atmosphere as well as of the laws that govern its behaviour has been increasing very rapidly during this same time. However, as time goes on it will be felt more and more important to try to summarize into one consistent picture what has been accomplished up to the present time. As yet any such attempt necessarily must be fairly incomplete and the interpretation arrived at would also to a large extent depend upon the "school of thought" from which the author stemmed. Still such attempts would be very valuable and stimulating. The present book by Professor Raethjen from the University of Hamburg represents such an attempt. It is not a text-book but a research report.

The book covers a much wider scope within the field of dynamic meteorology than the title at first seems to indicate. Since the problem of the formation and behaviour of cyclones never can be treated as an isolated phenomenon, many problems concerning the general circulation of the atmosphere are taken up for detailed discussion.

It is quite apparent to anyone reading this book that the differences in approach between the German and the Anglo-Saxon groups of meteorologists that developed during the war, have not yet been fully eliminated. This may not stand out so clearly when looking through the bibliography where a large number of, for example, American investigations of later years are listed. However, it is quite clear, as is also pointed out in the preface, that these investigations have not always been fully considered. At some places the results thus obtained are in disagreement with recent findings elsewhere and sometimes one would like to have had a more detailed comparison between the different results. Such a comparison

would also have been useful to eliminate certain misunderstandings because of terminology that now may arise. Examples of this will be given below.

The book is divided into two parts: one non-mathematical and one mathematical part. This procedure is especially good as done here. The non-mathematical part is not merely a description of observed facts but an attempt to explain the main physical ideas which are used as the basis for the theoretical treatment in the latter part of the book. A synoptic meteorologist without any advanced training in mathematics will thus be able to grasp the general ideas of the book and certainly dynamic meteorology should be written not only for those meteorologists that have a certain skill in mathematics.

In the preface the author points out that the mathematical treatment has not been made more accurate than seems justified from a meteorological point of view. This is certainly an important principle when working in theoretical meteorology. It seems to the reviewer, however, that some of the assumptions made are too restrictive and that thus certain important *physical* relations may have been left out of the picture. Furthermore meteorology seems now to have reached the stage when it is not always sufficient any longer merely to make sure that the orders of magnitude are correct but, if possible, one wants quantitative forecasts. Some cases will be given below where this criticism seems to be justified.

The two first chapters of the book are devoted to a critical discussion of previous ideas of cyclogenesis and certain simple but sometimes overlooked facts are pointed out. The author is very sceptical about any attempt to deal with cyclones as small perturbations superimposed upon a certain type of basic current. The reviewer agrees by and large but wants to point out that certain quantitative agreements have been obtained from such investigations in recent years.

In the third chapter the author reviews and interprets some of the most important aerological observations made lately. The interaction between the mean field of motion and the cyclones is very clearly described as well as the structure and behaviour of the jet-stream but few details are given. Furthermore, the slope between the boundary between the cold and warm air in fig. 17, where the former is advancing seems hardly to be synoptically confirmed. In the

light of the later discussion of the approximate geostrophic balance of atmospheric motion the discussion of the maintenance of a diffluence field ("Delta") does not seem conclusive.

The general circulation of the atmosphere is discussed in some detail in the following chapter. It would have been desirable if some of the quantitative data that have been obtained at MIT, Cambridge and University of California had been discussed in comparison with the development presented by the author. With regard to the proposed tropopause circulation the reviewer would like to ask if we really know that the tropospheric air mainly enters the stratosphere in tropical latitudes?

In chapter five the different possibilities for cyclogenesis are clearly discussed starting from the vorticity considerations. The establishment of the corresponding pressure field is assumed to take place through a process very similar to the one proposed by Rossby some 15 years ago. In the following two chapters certain models for cyclone formation are presented: The well-known model for the generation of a heat-low as well as a simplified picture of the air flow in an extra-tropical cyclone based upon the work by Kleinschmidt Jr. and the author himself. The main reason for a cyclone to deepen and show its typical asymmetry should according to this idea be the irreversibility of the condensation processes because of the release of rain. This may be an important factor, but recent computations at Princeton seem clearly to indicate that a development of a (surface) cyclone may also take place in a (hypothetically) dry atmosphere. Furthermore the reviewer has difficulties in seeing that the reasoning presented to explain cyclone formation in a "Delta"-region is anything but the description of the changes of the vorticity field that have to exist for keeping the field itself stationary (p. 141 ff.).

The mathematical part of the book starts with the development of the vorticity equation and a detailed discussion of its various terms. In the following chapter the importance of the horizontal divergence and vertical velocity for vorticity changes are developed. This presentation is clearly written and easy to follow but might have been supplemented by at least some comments on the main assumptions and simplifications that are involved in the various models for numerical forecasting and the capability of these models of forecasting cyclogenesis.

Following the physical ideas presented before chapter ten and eleven are devoted to the pressure changes induced by the vorticity changes. This line of thinking seems very important to the reviewer.

The whole approach to the problem of the pressure changes as mainly being the reactions of the mass-field because of changes in the wind field has not been stated so explicitly in any of the more well-known books in dynamic meteorology. This principle has earlier been advocated by Rossby but it is quite apparent that the idea as well as the development by professor Raethjen has been done quite independently. However, a more accurate treatment would have been instructive. For example the dissipation of some energy by inertia-gravity waves is automatically excluded in the way the problem is formulated. The very reason that such oscillations never (or seldom) are observed in reality does not depend on surface friction, since the friction would damp the basic current as fast as the oscillations. It depends rather upon the dispersion and interference between a large number of waves originating from different portions of the atmosphere and being of different frequencies and phases.

Chapter twelve gives a discussion of large scale turbulence in relation to cyclone theory. The idea that the maintenance of the permanent centers of action is the result of such a turbulent process along the polar front is a novel and interesting idea but is certainly not proved by the author. The mathematical treatment in this section is again slightly restricted and excludes for example the possibility of mixing with conservation of absolute vorticity.

In the following chapters the idea of long waves is presented. The author also develops an interesting variation of the principle of constant potential vorticity. At the tropopause level two isentropic surfaces are usually at a small vertical distance to the north of the jet stream (in the polar stratosphere). Further south (in the tropical troposphere) these same isentropes spread out in the vertical. Assuming that the wave motion takes place between such fixed isentropic surfaces, the divergence term in the vorticity equation provides the stabilizing factor that is necessary for wave formation. On the other hand it is not obvious to the reviewer in which sense surface friction influences the speed of propagation of the waves as stated on page 288.

The last chapter is devoted to a treatment of the convection cyclone. In particular the application to tropical hurricanes as originally developed by Kleinschmidt Jr. gives a very enlightening picture of some necessary relations that must exist within such a field of motion.

Professor Raethjen's book is interesting to read. Even if one does not always agree with the author

it certainly is useful to follow a presentation of the point of view of an experienced research worker of professor Raethjen's standing. The reviewer believes that some of the theoretical developments need a more detailed treatment which in some cases also has been carried through by other investigations. On the other hand the theories presented are

based upon physical models obtained from a study of current weather maps, a procedure which not always has been followed in meteorology. Finally the book has a very personal touch and it is easy to see that "the Lady of Meteorology" is the great devotion of professor Raethjen.

Bert Bolin