Asymptotic models of atmospheric flows

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Zeytounian, R. *Asymptotic Modeling of Atmospheric Flows*, Springer-Verlag, Berlin, 1990, 396 p.

Physicists and hydrodynamicists specializing in the field of dynamic meteorology are not overindulged by a large amount of monograph literature on this subject. Each new book is an event of a kind and deserves attention.

Professor Zeytounian considers meteorology to be a subfield of modern hydrodynamics. The aim of the book is to present dynamic meteorology by basing it on methods of the theory of singular perturbations borrowed from the experience of hydrodynamic investigations. In a certain sense the book under review is an encyclopedia on the application of the asymptotic methods of meteorology. In this lies its greatest usefulness.

It is appropriate to give a more topical idea of the contents of the book. It consists of 13 chapters. The first four chapters are essentially introductory, they give an idea of the atmosphere as a hydrodynamical system. Here also are introduced the fundamental dimensionless criteria of similarity and on their basis the equations of hydrodynamics and the boundary conditions are formulated in a dimensionless form convenient for the application of asymptotic methods. The principal types of waves in the atmosphere are analyzed (acoustic, internal and Rossby waves) in connection with the well-known problem of the filtration of "unnecessary" solutions in describing large-scale processes.

In Ch. 5 the author takes a kind of a "time out" presenting the concept of the book and its final aim—"to asymptotize" (in his words) dynamic meteorology. Here also are presented the ideas of two asymptotic methods which later are used systematically in the book: the method of joining asymptotic expansions and the method of scale separation (into "rapid" and "slow" variables) and illustrations of their use (Ch. 6). The following chapters containing the basic subject matter are divided into chapters devoted to hydrodynamic approximations used in dynamic meteorology (Chs. 7–10), and chapters devoted to atmospheric models (Chs. 11–13). R. Zeytounian succeeded in carrying out a thorough asymptotic derivation and analysis (including a comparative one) of the quasistatic approximation, the Boussinesq approximation (the "free convection" approximation), the incompressible fluid approximation (the density is a Lagrangian invariant) and, finally, the deep convection approximation. This is a definite merit of the book.

Chapter 11 examines the classical quasigeostrophic model of the atmosphere, and the so-called, "ageostrophic model" (taking into account corrections to the geostrophic wind of a higher order of smallness), and also the problem of the Ekman boundary layer taking into account processes of adaptation to the hydrodynamic regimes that have been discussed.

Chapter 12 is devoted to a less rough—quasisolenoidal model of the atmosphere (only the smallness of the Mach numbers is required). Both the classical and the results obtained by the author (with Professor J. P. Guiraud as coauthor) are discussed. Finally, the last Ch. 13 is of a more applied nature: it presents asymptotic approaches to modelling mesometeorological processes (breezes, mountain lee wave, waves on slopes).

The book contains an appendix where the author utilizes his experience with working with asymptotic series for an illustrative derivation of the equations of the overall circulation of the atmosphere.

Possibly it is worthwhile to say a few words about the author himself. R. Zeytounian was born in France, then lived in our country, worked in the Hydrometeorological Center of the USSR, worked there on dynamic meteorology, and now for over 25 years has again lived in France, working in the field of hydrodynamics, but having retained his love of meteorology. Professor Zeytounian is well acquainted with Soviet literature (less so with the most recent years of publication), and this is reflected in the list of references.

All Zeytounian's labor, all the emotions which he expended in writing the book are directed towards involving the reader in using asymptotic methods in dynamic meteorology by demonstrating their possibilities. This aim is to a large extent attained. At the same time, as often happens, the merits of the book turn into its defects. The author has demonstrated an approach to the problem that is analytic to the highest degree, and practically does not appeal to geometrical images. As a result the book contains over 1500 numbered formulas and 6 diagrams.

The formal presentation of results, the absence of their physical interpretation even in the first 4 chapters, devoted to the fundamentals of dynamic meteorology, to a certain extent diminish the value of the monograph. But on the whole the book is useful without doubt; it can serve as valuable reference material on the application of asymptotic methods in hydrodynamics, supplementing the available literature on dynamic meteorology. It is specifically from this point of view that one should examine the question of the expediency of translating the book into Russian. In translating the book into Russian it is appropriate to "refresh" it by a modern set of references on analytic investigations of atmospheric flows. This will require the translator to possess a definite ability to make the translation of such a book more readable than its English version which cannot be regarded as being successful. This reproach is directed not to the author of the book, but to its translator from French into English.

Translated by G. M. Volkoff

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