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978-0-521-69628-9 - An Introduction to Atmospheric Thermodynamics, Second Edition

Anastasios A. Tsonis

Frontmatter

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## **An Introduction to Atmospheric Thermodynamics**

This new edition is a self-contained, concise but rigorous book introducing the reader to the basics of the subject. It has been brought completely up to date and reorganized to improve the quality and flow of the material.

The introductory chapters provide definitions and useful mathematical and physical notes to help readers understand the basics. The book then describes the topics relevant to atmospheric processes, including the properties of moist air and atmospheric stability. It concludes with a brief introduction to the problem of weather forecasting and the relevance of thermodynamics. Each chapter contains worked examples to complement the theory, as well as a set of student exercises. Solutions to these are available to instructors on a password protected website at [www.cambridge.org/9780521696289](http://www.cambridge.org/9780521696289).

The author has taught atmospheric thermodynamics at undergraduate level for over 20 years and is a highly respected researcher in his field. This book provides an ideal text for short undergraduate courses taken as part of an atmospheric science, meteorology, physics, or natural science program.

ANASTASIOS A. TSONIS is a professor in the Department of Mathematical Sciences at the University of Wisconsin, Milwaukee. His main research interests include nonlinear dynamical systems and their application in climate, climate variability, predictability, and nonlinear time series analysis. He is a member of the American Geophysical Union and the European Geosciences Union.

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We have explained that the causes of the elements are four: the hot, the cold, the dry, and the moist. In every case, heat and cold determine, conjoin, and change things. Thus, hot and cold we describe as active, for combining is a sort of activity. Things dry and moist, on the other hand, are the subjects of that determination. In virtue of their being acted upon, they are thus passive.

Aristotle, *Meteorology*, Book IV

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## Second Edition

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## PREFACE

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This book is intended for a semester undergraduate course in atmospheric thermodynamics. Writing it has been in my mind for a while. The main reason for wanting to write a book like this was that, simply, no such text in atmospheric thermodynamics exists. Do not get me wrong here. Excellent books treating the subject do exist and I have been positively influenced and guided by them in writing this one. However, in the past, atmospheric thermodynamics was either treated at graduate level or at undergraduate level in a partial way (using part of a general book in atmospheric physics) or too fully (thus making it difficult to fit it into a semester course). Starting from this point, my idea was to write a self-contained, short, but rigorous book that provides the basics in atmospheric thermodynamics and prepares undergraduates for the next level. Since atmospheric thermodynamics is established material, the originality of this book lies in its concise style and, I hope, in the effectiveness with which the material is presented. The first two chapters provide basic definitions and some useful mathematical and physical notes that we employ throughout the book. The next three chapters deal with more or less classical thermodynamical issues such as basic gas laws and the first and second laws of thermodynamics. In Chapter 6 we introduce the thermodynamics of water, and in Chapter 7 we discuss in detail the properties of moist air and its role in atmospheric processes. In Chapter 8 we discuss atmospheric stability, and in Chapter 9 we introduce thermodynamic diagrams as tools to visualize thermodynamic processes in the atmosphere and to forecast storm development. Chapter 10 serves as an epilogue and briefly discusses how thermodynamics blends into the weather prediction problem. At the end of each chapter solved examples are supplied. These examples were chosen to complement the theory and provide some direction for the unsolved problems.



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PREFACE

Finally, I would like to extend my sincere thanks to Ms Gail Boviall for typing this book and to Ms Donna Genzmer for drafting the figures.

Anastasios A. Tsonis  
*Milwaukee*