This book comprehensively describes all aspects of gravity flow, a physical process in the environment that is covered in many different disciplines, including meteorology, oceanography, the earth sciences and many industrial processes. The first edition of this book was very well received, and the new edition has been brought completely up to date.

No other book covers a similar range of information. The new edition contains a completely new chapter on gravity currents in satellite imagery, and many new sections, including glacier, purging in pipes, flow over porous media, and recent work on atmospheric bores and sea breezes. The physical processes of gravity currents are described with a variety of laboratory experiments, many from the author's own work.

Gravity Currents is a valuable supplementary textbook for undergraduates and a reference work for research workers in a range of disciplines, including fluid mechanics, meteorology, oceanography and earth sciences. The general reader will also find much of interest, since the physics of the flows involved is clearly described, without advanced mathematics, by numerous photographs and illustrations.

GRAVITY CURRENTS

In the Environment and the Laboratory

Second edition

Protection against the bore in the Qiantang River: an historic scene.

JOHN E SIMPSON University of Cambridge

Second edition

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IN THE ENVIRONMENT AND THE LABORATORY

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Foreword by Steve Thorpe
Professor of Oceanography, The University, Southampton, UK

The day of the gifted amateur scientist is past. No longer may we see his enthusiasm conveyed in a text which will both draw the attention of professional scientists and stimulate the interest of students. Books by learned academics, on the other hand, are sometimes so analytical and abstract that they fail to convey that element of surprise, even awe, which first arouses a spirit of enquiry and the formulation of questions, and leads to the development of experimental results and theoretical description.

Helped perhaps by his background, particularly a lifelong hobby, John Simpson has found a nice compromise. John was a school teacher when I first met him in the late 1960s and, for many years before, had been a very active glider pilot. He has flown over 1000 hours in 40 different types, and it was the effect of sea-breeze fronts on gliders which first interested him in that phenomenon. He 'composed' (his own words) a movie on the subject in 1967, and was awarded the Darton Prize of the Royal Meteorological Society for work published in the journal *Weather*. In 1971 he was appointed as a Research Assistant in the Department of Geophysics in the University of Reading (who must have counted themselves fortunate indeed!) and later, in 1976, he became a Research Associate in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge. There, in 1981, he gained his PhD, 45 years after the award at the same university of his BA. On a recent visit to China he surprised his hosts by asking to be allowed to see the bore on the Qiantang River (see sections 7.4 and figure 7.14), a rare request. His hobby had widened, and his enthusiasm shows.

In first perusing this book the reader will immediately be aware, as I was, of the number of clear and simple diagrams, the beautiful photographs which so vividly illustrate the text, and the extraordinary range of phenomena which belong to the genus 'Gravity Currents'. Many of them are of considerable practical importance in areas such as mining, the discharge of power station effluent or in the chemical industry, as well as in aircraft operations. Others are associated with some of the most impressive natural processes, for example sandstorms and volcanoes. John has himself contributed much to the explanation of these phenomena, especially by his careful laboratory studies. The book provides ample evidence of his academic, analytical approach to physical problems but is also a testimony to the author's delight in natural phenomena, conveying a spirit of wonder in the drama, magnificence and power of the geophysical fluids which are around us.

I welcome this book and hope that it may, in some readers at least, inspire a desire to see for themselves the phenomena it describes and to understand how they come about.

Preface

The need for this book was apparent several years ago when I prepared a short review on the subject of gravity currents. This had been limited to only 20 pages and as I looked into wider environmental aspects I could see the value of a more comprehensive review, of at least ten times the length, on the manifestations of gravity currents and the closely related internal bores and solitary waves. Workers in many scientific disciplines, who are not experienced in fluid mechanics, could benefit from an account of what is already known about the properties of gravity currents and would be able to see how much is applicable to their own specialist subject. As the work developed I could see that the material described, with the many photographs and diagrams I was able to include, would also be of interest to the general reader.

The first part of the book, from Chapter 1 to Chapter 10, deals with the nature of buoyancy-driven flows in the atmosphere and oceans and on the earth's surface. These flows in the atmosphere are at scales from a cold gravity current through an open door of a house to vast squall lines of cold dense air which are hazardous to aircraft. In the ocean the study ranges from the Gulf Stream to river fronts in estuaries and fjords. The formation of these fronts is of biological importance; other important gravity currents are heated effluents from power stations. The section on earth sciences deals with snow avalanches and volcanic gravity currents.

Industrial problems in which gravity currents play an important part are described; a topical example is the spread of a cloud of dense gas which may be poisonous or explosive. The study of gravity currents of gases in mines has a long history.

The second part of the book, Chapter 11 to Chapter 17, deals with 'the anatomy of a gravity current', and examines the many factors which affect their behaviour, including, as well as the nature of the head of the current, the influence of stratification and turbulence in the surroundings. The topics are dealt with by numerous laboratory experiments, and only simple mathematics is included. The final chapter mentions briefly the rapidly growing subject of numerical models of gravity currents.

References are collected together at the end of each chapter to avoid interrupting the text.

Many scientists kindly gave permission for use of striking photographs of phenomena in the environment; most of the laboratory photographs are my own.

I am grateful for the help of Professors R.S. Scorer and S.A. Thorpe and I am indebted to many other friends, especially the following, each of whom commented on the chapter dealing with his speciality: Drs Tim Davies, Herbert Huppert, Jim McQuaid, Alf Mercer, Roger Smith, Steve Sparkes and Alan Thorpe. Dr Chris Bertram read the whole manuscript and suggested many improvements in the presentation. Members of the Department of Applied Mathematics and Theoretical Physics at Cambridge have helped me in many ways; Drs Paul Linden and Jim McDonnel made many helpful comments. My thanks go to Margaret Downing for her able preparation of the diagrams.

Preface to the second edition

In the new edition I have tried to bring the book up to date, and have added some completely new sections.

The new material includes a chapter on gravity currents in satellite imagery, and sections on glaciers, purging in pipes and flow over porous media. Recent field work on the generation of atmospheric bores and on gravity current frontogenesis in the sea breeze has been included. I have dealt with the progress of warnings to aircraft of wind-shear hazards, and of buoyancy driven ventilation flows in buildings. Important new laboratory work on gravity currents with large density differences is included.

Again I am indebted to members of the Department of Applied Mathematics and Theoretical Physics at Cambridge for many helpful discussions and especially to Drs John Bush and Colin Wilson who have suggested many helpful alterations to the text.

I am grateful to Dr G. Kappenberger and J. Hacker for the use of their photographs on the cover of the book.