

Preface

The text of the Persian poet Rūmī, written some eight centuries ago, and reproduced at the beginning of this book is still relevant to many of our pursuits of knowledge, not least of turbulence. The text illustrates the inability people have in seeing the whole thing, the ‘big picture’. Everybody looks into the problem from his/her viewpoint, and that leads to disagreement and controversy. If we could see the whole thing, our understanding would become complete and there would be no controversy.

The turbulent motion of the atmosphere and oceans, at the heart of the observed general circulation, is undoubtedly very complex and difficult to understand in its entirety. Even ‘bare’ turbulence, without rotation and stratification whose effects are paramount in the atmosphere and oceans, still poses great fundamental challenges for understanding after a century of research. Rotating stratified turbulence is a relatively new research topic. It is also far richer, exhibiting a host of distinct wave types interacting in a complicated and often subtle way with long-lived coherent structures such as jets or currents and vortices. All of this is tied together by basic fluid-dynamical nonlinearity, and this gives rise to a multitude of phenomena: spontaneous wave emission, wave-induced transport, both direct and inverse energy scale cascades, lateral and vertical anisotropy, fronts and transport barriers, anomalous transport in coherent vortices, and a very wide range of dynamical and thermodynamical instabilities.

This book stems from the IUTAM symposium “Rotating Stratified Turbulence and Turbulence in the Atmosphere and Oceans” which took place at the Isaac Newton Institute for Mathematical Sciences in Cambridge from 8 to 12 December 2008, and came at the end of a four-month Programme on “High Reynolds Number Turbulence”. This symposium, widely attended by researchers from around the world, aimed to better understand the complex nature of fluid flows found in Nature, particularly in the Earth’s atmosphere and oceans, but also in other planetary atmospheres and in the Sun’s interior. Talks covered a broad range of subjects, from theoretical studies of fundamental vortex interactions, to laboratory experiments and observations, and to state-of-the-art computational studies. The full programme and videos

of many of the talks can be found at www.newton.ac.uk/programmes/HRT/hrtw04p.html.

The present volume presents a cross-section of the research presented at the symposium, or in some cases, of the research inspired by it. Herein, 23 peer-reviewed papers are collected (39 talks were presented). The research is loosely divided into four main topics: (1) Waves and Imbalance, (2) Turbulence and Convection, (3) Instability and Vortex Dynamics, and (4) Jets: Formation and Structure. In (1), the impact of waves, principally inertia–gravity waves, on the circulation of the atmosphere and oceans is examined. In (2), the distinguishing anisotropic features of atmospheric and oceanic turbulence, and of solar convection, that arise from rotation and stratification are discussed. In (3), vortex dynamical instabilities as well as the interactions between coherent vortices in rotating, stratified flows are examined. And in (4), various models and theories are put forward to explain the formation and persistence of “jets”, nearly zonal currents in the atmosphere and oceans, in the giant gas planets, and probably also in the solar interior.

Research on these topics is rapidly developing, yet we still have much to learn, and there is no shortage of controversy! This volume brings together in a concise way current research by eminent mathematicians, scientists and engineers. As such, this makes an excellent resource for future studies exploring fundamental aspects of atmospheric and oceanic turbulence.

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The Persian text and its translation (adapted from www.khamush.com/tales-from-masnavi.htm#The%20Elephant) were generously provided by Ali Mohebalhojeh. This story of the elephant, we feel, reflects beautifully the struggle we face in understanding many things, and the importance of seeing the whole.