

Preface

The chapters contained in this volume correspond to the lectures given during the course “Mixing and Dispersion in Flows Dominated by Rotation and Buoyancy” that was held at the CISM in Udine (Italy), July 6–10, 2015.

Rotation and buoyancy play an essential role in many astrophysical, geophysical, environmental, and industrial flows. They influence the transition to turbulence, strongly affect large-scale (turbulent) flow properties by inducing anisotropy, and also affect boundary-layer dynamics and inertial-range turbulence characteristics. Moreover, rotation and buoyancy may have a strong impact on mixing, and on the dispersion of passive and active tracers and of (inertial) particles and droplets in such flows. The impact of buoyancy or rotation on transport may be direct (gravitational, centrifugal, or Coriolis forces on fluid parcels or particles/droplets) or indirect by the modified flow characteristics. These processes have direct relevance for heat and mass transfer in many natural systems. Examples are (large-scale) convection processes, transport of sediment in coastal flows, dispersion of suspended particulate matter in estuarine flows, in lakes and reservoirs, and dispersion of aerosols and pollutants in the atmospheric boundary layer. Increasing computational capabilities and the rapid development of advanced experimental measurement tools, for example optical diagnostics and particle tracking techniques, provide highly resolved temporal and spatial data sets. This allows the exploration and analysis of more complex flow phenomena and the associated transport processes in more depth.

The aim of this course had been to present an overview of recent developments in this field in a way accessible to participants coming from a variety of fields, including turbulence research, (environmental) fluid mechanics, lake hydrodynamics, or atmospheric physics. Topics to be discussed during the lectures ranged from the fundamentals of rotating and stratified flows, mixing and transport in stratified or rotating turbulence, transport in the atmospheric boundary layer, the dynamics of gravity and turbidity currents, mixing in (stratified) lakes, and the Lagrangian approach to analyze transport processes in geophysical and environmental flows. This goal is not only reflected in this volume and the contributions are aimed at doctoral students and postdoctoral researchers, but also at academic and

industrial researchers and practicing engineers, with a background in mechanical engineering, applied physics, civil engineering, applied mathematics, meteorology, physical oceanography, or physical limnology.

This volume starts with a general introduction on effects of rotation and density stratification on fluid flows by GertJan van Heijst, followed by an overview of the basic phenomena of turbulence and mixing in flows dominated by buoyancy by Paul Linden. Subsequently, the connection is made with certain environmental flow situations, such as mixing in lakes and reservoirs by Damien Bouffard and Alfred Wuëst and energy balances in stably stratified, wall-bounded turbulence by Oscar Flores and James Riley. The Lagrangian approach to unravel transport in turbulence is addressed by Mickaël Bourgoïn. Eckart Meiburg and Mohamad Nasr-Azadani give an overview of recent numerical and modeling developments in the field of gravity and turbidity currents. Finally, several aspects of transport processes in rotating turbulence are reviewed by Herman Clercx.

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Eindhoven, The Netherlands

Herman J.H. Clercx
GertJan F. Van Heijst

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Clercx, H.J.H.; van Heijst, G. (Eds.)

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