



Ever since climate change began to be recognized as a serious threat to living comfortably on this planet, ocean-current and mean sea-level monitoring began to attract considerably more attention from climatologists and environmentalists across the globe. Although more than 71 percent of the Earth is covered by ocean, the myriad large- and fine-scale water motions taking place within the ocean are hardly known to many. Over the past few decades, however, scientific debate on the nature and possible causes underlying climate change and the role of ocean currents in this change has intensified.

Present knowledge of ocean currents in the world oceans has accumulated from measurements made through a variety of ingenious devices, including satellite-borne, seafloor-mounted, and vessel-mounted sensors as well as moored and freely drifting instrumentation deployed at various depths in different regions of the oceans. This book summarizes the methods used for surface, subsurface, and abyssal ocean-current measurement and highlights some of the important applications of such measurements in academic and operational interests.

The methods of ocean-current measurement discussed in this book are broadly categorized under Lagrangian measurement (i.e., finding the path of particular parcels of water masses as they traverse horizontally from place to place), Eulerian measurement (i.e., water-current measurement at geographically fixed positions), vertical profiling techniques (i.e., measurement of currents at different depths along specified vertical columns of water

in the ocean), and imaging of seawater motion signatures (e.g., surf zone circulation cells, upwelling, fronts, etc.). While describing the technological aspects of oceanic current measurement, which are the major thrust of this book, adequate attention has also been paid to the history and evolution of ocean-current measurement technologies, from primitive to state-of-the-art. Thus, attempts have been made to cover all major aspects of ocean-current measurement to the present. This historical perspective allows the reader to gain awareness of the difficulties with which current measurements were made in the past and how advances in technology made ocean-current measurement relatively much simpler in the present era.

In the course of describing the technology of ocean-current measurement, the incredible acumen and perseverance exhibited by a few erudite technologists and oceanographers and the important role played by them in the invention of some of the state-of-the-art remote sensing tools are covered in some detail. Shining examples of four such inventions that deserve special mention in this context are HF Doppler radar technology for real-time time-series remote mapping of sea surface current vectors; Swallow floats and their improved variants for tracing the trajectories of subsurface and abyssal currents; acoustic Doppler profilers for measuring both directional waves and current profiles; and acoustic tomography techniques for integrated measurement of water motions across large ocean basins, straits, coastal waters, and even rivers. During the initial untiring experiments that culminated in these path-breaking inventions, thoughtful technologists and oceanographers found invaluable “signals” in what mediocre oceanographers who lacked acumen would have termed “instrument noise,” “high-frequency contamination,” or “deployment error.” It is my hope that discussions of the step-by-step technological leaps made in the field of ocean-current measurement over the years will kindle sufficient enthusiasm in the minds of young researchers and academicians to cause them to continue these traditions.

This book consists of 13 chapters. The introductory chapter provides a brief overview of the major ocean-current circulations in the world oceans and their implications for mankind. Special emphasis has been given to the planet-spanning thermohaline circulation known as the

ocean's *conveyor-belt circulation* and its crucial role in climate change, a hot topic in recent decades. Apart from this and the technological aspects of ocean-current measurement, the book provides a brief discussion of the importance of ocean-current measurement for a wide spectrum of applications, extending from the domain of scientific research to the domain of a multitude of ocean engineering applications.

When I began to write this book, there was a dearth of comprehensive and authentic books that cover various aspects of ocean-current measurement technologies and implications of ocean currents. This book addresses these issues in a detailed manner, keeping in mind the broad spectrum of oceanographic and academic communities as well as the general public. While addressing the state-of-the-art in ocean current measurement, the book emphasizes that every technology has its own merits and limitations. These aspects are addressed at appropriate places in this book. This approach is expected to enable the reader to capture a holistic view of the technologies that are available and help the oceanographic communities choose the most appropriate technologies for their specific needs and applications. I am hopeful that both the nonspecialist readers who have an interest in the broad subject of global ocean circulation and its impacts and the specialists who

want to know more about the recent technologies used for ocean-current measurements will find this book a source of valuable information. The book will be of particular interest to advanced students in ocean engineering and, more generally, to oceanographers in a variety of disciplines.

Researchers at universities and oceanographic institutions need to stay up to date with the latest technological developments. Keeping this need in mind, this book endeavors to provide valuable information compiled from an extensive knowledge base scattered in a variety of journal publications and conference proceedings in the domains of technology and science.

I felt honored by the encouraging review of my first Elsevier book, *Tsunamis: Detection, Monitoring, and Early-Warning Technologies*, published in February 2011, which awoke great interest internationally. This success was a great motivation for me to work on and complete this present book, *Measuring Ocean Currents: Tools, Technologies, and Data*.



**Antony Joseph**