Preface

The mathematical equations that govern the evolution of the atmosphere and the oceans are essentially a system of coupled nonlinear partial differential equations that do not provide for closed form analytical exact solutions. In situations where closed form analytical solutions are not available, one employs numerical methods for solving the governing mathematical equations that are responsible for the evolution of the atmospheric and oceanic systems. It is clear that advances in numerical methods have contributed greatly to our current understanding of the science of the Earth system in general and the sciences of the atmosphere and oceans, in particular. This book, *Numerical Methods for Atmospheric and Oceanic Sciences*, is written with an objective to provide a detailed and broad overview of the various numerical methods that are applied to fluid systems in general, and in particular to the fluid systems that manifest in the natural environment such as the atmosphere and hydrosphere. Most of the material included in this book has evolved from a single semester course that I taught on "Numerical Weather Prediction" as well as another course that I had taught earlier titled "Numerical Weather Prediction and Modeling." The approach followed in writing this book is to provide adequate theoretical and background discussions that go beyond mere outlining and mentioning the various numerical schemes.

I have dedicated this book to the memory of Professor T. N. Krishnamurti, former Lawton Distinguished Professor, Department of Earth, Ocean and Atmospheric Science, Florida State University, USA, for his pioneering research contributions in the areas of numerical weather prediction, short and long range monsoon prediction, inter-seasonal and inter-annual variability of the tropical atmosphere. Professor Krishnamurti visited my institute twice, once in 2014 and again in 2015. I was truly amazed with Professor Krishnamurti's depth of knowledge, his prolific research output as well as the huge impact of his research on the science of the atmosphere. I am extremely indebted to Professor S. Lakshmivarahan, George Lynn Cross Research Professor Emeritus of the University of Oklahoma, USA, for readily agreeing to my request to write a Foreword for this book. I am certain that a Foreword from someone of his stature and eminence would contribute immensely to the popularity of the book. I greatly value the comments and suggestions from five anonymous

peer experts on the book that led to the inclusion of two new chapters and also to minor reorganization of the book. The aforementioned comments also resulted in the inclusion of programming examples using python language in the book, a feature that students, researchers and teachers would find most useful. I am obliged to Professor Geoffrey Vallis of the University of Exeter, UK, for allowing me to modify and use a couple of python codes from his book.

I would be failing in my duty if I did not acknowledge the help and assistance that I received from my colleague Professor A. Salih, and from other scientists such as Dr. R. Krishnan of the Indian Institute of Tropical Meteorology, Pune, Professor A. D. Rao of Indian Institute of Technology, Delhi, Professor G. Bala of the Indian Institute of Science, Bangalore, and Professor B. Chakrapani of Cochin University of Science and Technology in the preparation of this book. While Professor Salih and Professor Chakrapani almost read through the entire book, others took time off from their busy schedule and read through a few chapters of this book. Their suggestions and comments have contributed to the overall improvement of the book. I also received very specific and pertinent comments from my nephew Dr. S. Prahlad working at the National Institute of Aerospace, Hampton, USA, that I found to be very helpful.

I am extremely thankful to my PhD student Mr. Vibin Jose who assisted me greatly during the preparation of this book, especially in the production of the python programs and the figures. I thank my former post-graduate students Mr. Vikram and Ms. Akshaya Nikumbh who also helped with a few python programs.

I have received excellent and unstinted support from Dr. Vaishali Thapliyal, Ms. Qudsiya Ahmed, and Mr. Vikash Tiwari of Cambridge University Press who have been extremely helpful during the period of this book project. I also thank Mr. R. Adarsh of the Thiruvanathapuram branch of Cambridge University Press who patiently heard and cleared several of my queries in the initial stage of the book proposal.

I have received a lot of support and encouragement from Dr. B. N. Suresh, the present chancellor of my institute who was the founding director of my institute when I wrote my first book. I wish to thank Dr. V. K. Dadhwal, former director of my institute who provided all help and assistance and encouraged me to complete the project. I also thank Shri S. Somanath, present director of my institute for his help and support. I have also benefited from the encouragement that I have received from several well-wishers, collaborators, friends, and faculty colleagues from my institute and other institutions on the book project, a list too long to mention and include here. I have been extremely fortunate to be blessed by my parents and Almighty at all stages of my career. Finally, I wish to acknowledge the quiet support and encouragement that I received from my family and thank them for their love, patience, and forbearance.