India. It is attractively designed in a coffee table book format with larger-than-life size photographs of butterflies in their natural habitats. The book is divided into to two parts, viz. 7 Edens and 70 Fairies. The first part provides a brief overview of biodiversity of the seven nuclear power plants of India. The second part deals with the description of 70 butterfly species recorded from the nuclear power plants. The species descriptions are organized according to butterfly families. A brief overview of the family is provided before species description. Each species is illustrated with multiple photographs in its natural habitat. The text part of the species description is divided into subsections such as common name, scientific name, physical characteristics, similar species, distribution and status, habitat, habit, favourite flowers, life cycle and host plants. The book ends with a section on butterfly gardens and an appendix of the species list with nectar and host plants.

Overall the book is well designed and provides useful information on butterflies of the nuclear power plants. The current list of 70 species may not be a complete checklist of the species occurring in the study area. Hence, a detailed checklist of species documented from all the seven nuclear power plants would have added more value to the book. Errors such as map of India without Lakshadweep, Andaman and Nicobar, and Uttarakhand could have been avoided. However, the book is an asset to libraries and useful for creating conservation awareness.

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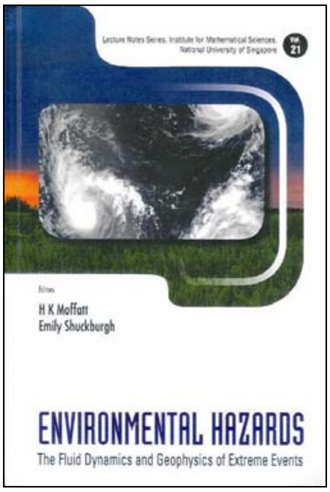

Environmental Hazards: The Fluid Dynamics and Geophysics of Extreme Events. H. K. Moffatt and Emily Shuckburgh (eds). World Scientific Publishing Co Pte Ltd, 5 Toh Tuck Link, Singapore 596 224. 2011. xiv + 315 pp. Price is not mentioned.

Some extreme environmental events leave such a trail of disastrous consequences that they become etched in our minds. Memories of hurricane *Sandy* of 2012, Fukushima earthquake and tsunami of 2011 and Indus floods of 2010 are still fresh, but those of the Andaman–Sumatra earthquake and tsunami of 2004 have not faded away.

It is however instructive to examine data on such disasters recorded over a long time. Emergency Events Database (EMDAT, http://www.emdat.be) is one such database maintained by University Catholic Louvain, Belgium. It includes those extreme events which result in more than ten reported deaths or reported displacement of more than 100 persons or declaration of an emergency by the concerned government. The database has core data on over 18,000 such events since 1900. Jayawardena, in a chapter in the book under review, discusses the results of a study of 1000 worst natural disasters reported in 1900–2006. Two points deserve special attention. First, floods, windstorms and droughts account for nearly seven out of eight of these natural disasters. Second, windstorms have nearly doubled and floods nearly quadrupled from 1980–1982 to 2004–2006. Evidently, there is an urgent need to marshal all the human resources that we can muster towards attaining greater scientific understanding of such events.

To put it simply, the Earth has two envelopes, atmosphere being the outer and total, and oceans being the inner and partial. Both are rather thin as their height or depth is smaller by over two orders of magnitude than their horizontal dimensions. Prolonged action of gravity has made them stratified and the outermost part, the upper and middle stratosphere, and the innermost part, deep sea, extremely stable. Solar radiation heats up the lowermost part of the atmosphere, the planetary boundary layer, and the uppermost part of the ocean, the mixed layer, where stability is usually the least. Greenhouse effects of certain atmospheric trace gases, moisture and aerosols are well known.

Tilt of the Earth's rotational axis with the orbital plane results in the incoming radiation being larger, in the annual mean, than the outgoing (reflected plus emitted) radiation in the tropical low latitudes (30°S–30°N) and being smaller in the northern and the southern mid and high-latitudes. The resulting equator-to-pole temperature gradient determines the large-scale annual flow patterns of the atmosphere and the ocean. Their most striking feature, two westerly mid-latitude jet streams, is the consequence of Coriolis acceleration. These jets seasonally oscillate around ~30° North or South. The seasonal variation of their speed results in a similar variation in their instability. It is the seasonally growing disturbances advected by the jets, which are primarily responsible for the transport of heat, mostly in the form of latent heat, over mid-latitudes to the radiation-deficit mid and high-latitude regions. When the Earth is in a warming phase, its thermoregulation requires increasing poleward heat transport and therefore, increasingly more heat-transporting disturbances. There lies the built-in connection between the warming planet and increasingly intense large-scale extreme events.

Scientists from the days of Newton and Euler have modelled air and water alike, which the ancient Greeks may not approve, as a fluid, or a continuum (material filling space continuously) that is incapable of resisting change of shape, and they have represented the effects of molecular structure indirectly by fluid properties like viscosity and thermal conductivity. But the resulting governing Navier–Stokes equations have posed formidable challenges. A frequent approach is to use approximations that are appropriate. In the context of the atmosphere and the ocean, one common approximation, which filters out acoustic waves, ignores all changes in fluid density, except their effect on the gravitational force (buoyancy force). Another one ignores the centrifugal force and the vertical component of Coriolis force in the analysis relative to the rotating frame of the Earth. Further, several classes of disturbances are studied when they can be regarded as small in some sense. Can such an approach give any useful insight in extreme events? Well, it turns out that tsunami in the deep ocean can be quite adequately represented as such a wave. But when it approaches the coast, reduced depth makes the wave enter a different regime, where the bottom topography can result in extreme damage in certain localized spots, as Nageswara Rao *et al.* have shown for sites near Krishnapatnam and Gangapatnam on the Andhra Pradesh coast (*Curr. Sci.*, 2012, **103**, 1206–1209). Also, an atmospheric wave can travel far and trigger changes of a different kind altogether. For example, Behera and Yamagata in the book under review, have pointed out that diabatic heating around India during monsoon can excite a westward long Rossby wave that can connect to circulation changes in the Mediterranean Sea/Sahara region and the westerly jet can act as a waveguide for eastward-propagating tropospheric disturbance connecting to changes in circulation over East Asia. But a deeper general understanding of fluid phenomena requires the key fluid dynamic concept of vorticity or the curl of fluid velocity.

The present book is based on lectures given at a two-week Spring School on ‘Fluid Dynamics and Geophysics of Environmental Hazards’ organized by the International Union of Theoretical and Applied Mechanics (IUTAM) and the International Union of Geodesy and Geophysics (IUGG) and held in 2009 at the Institute of Mathematical Sciences, National University of Singapore. It attracted about 50 participants, mostly from the Asia-Pacific region. The first nine chapters are based on the course lectures and the last one on a selected presentation by the participants.

The book starts with a lively introduction of vorticity by Keith Moffatt with several thought-provoking comments. In the next chapter, Koh and Linden explain the effects of stratification and rotation of the Earth with imaginative use of dimensional analysis. They take the reader on a journey from surface and internal gravity waves, through convection, entrainment, self-similarity, plumes in stratified fluids (e.g. winter haze in metros) and fires to gravity currents and buoyancy-induced coastal currents. Shuckburgh explains the connection between weather and climate by giving a lucid exposition of radiative transfer through the atmosphere, long-term climate changes, and their effects on dynamics of the atmosphere and the ocean and the general circulation.

In the fourth chapter, Behera and Yamagata explain the ocean–atmosphere modes of the Pacific Ocean (El Nino, La Nina and the recently found El Nino Modoki) and of the Indian Ocean (Indian Ocean Dipole) and their impact on faraway regions. Kerry Emmanuel explores largely empirically, the connection between the hurricanes and climate change in terms of genesis potential index based on sea surface temperature, stability properties of the lower troposphere and shear in the mid-troposphere. The Atlantic Ocean affords a good theatre to test the ideas as nearly five decades of recorded data are available. Peter Haynes gives a lucid exposition of transport and mixing of atmospheric pollutants, pointing out the subtle distinction between stirring and mixing. The chapter includes several fascinating case studies combining models using back trajectories and chemical measurements. In one of them, the model captures how smoke from forest fires in Russia travels around the world in 17 days.

Extreme events in the mid-latitudes are discussed by Tetzlaff, Zimmer and Faulwetter in the seventh chapter. It explains how sustained rain can occur if there is sufficient horizontal energy transport in the atmosphere with sufficient horizontal convergence, as an air column can support both upward-moving moist air and downward flow of rain drops. There is also an interesting discussion on non-hydrostatic meso-scale modelling of orographic precipitation. Jayawardhane gives a general framework for hydrometerological and environmental hazards. The complexity of the real world and the demand for forecasting of likelihood of extreme events lead to a discussion of non-dynamic models like neural network models. There is also an excellent discussion of water quality in rivers and streams. The last two chapters introduce the reader to the nonlinear world of tsunamis and the elusive rogue waves.

The book has several commendable features. The chapters are self-contained, and they have minimal overlap and generally consistent notation. They start from first principles and accelerate rapidly to current topics keeping mathematical aspects to bare minimum and giving sufficient experimental support for major results. Although individual styles differ, they are generally easy to read.

Well organized and well edited, this book provides fast pathways to ambitious young minds to race to the frontiers. If my experience in reading this book is any guide, time and effort spent in reading this book carefully should bring abundant rewards of broader and deeper understanding. I would strongly recommend this book to the libraries of all major higher educational, R&D and regulatory institutions, especially in fields related to Earth and environmental sciences. In my view, there is a strong case for bringing out a student edition, which does not compromise on the quality of printing. In particular, all the figures in colour should be printed in colour, and the font should be chosen so that it is easy on the eyes.

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