

The Asian Monsoon: Causes, History & Effects

by Peter D Clift and R Allan Plumb

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Book Reviewed by Madhav Khandekar³

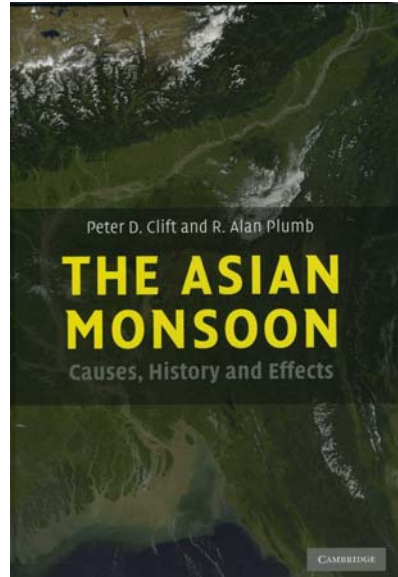
“The Asian monsoon is one of the most dramatic climatic phenomena on earth today, with far-reaching environmental and societal effects. Almost two thirds of humanity live within regions influenced by the monsoon. Monsoon strength and variability have been and will continue to be crucial to the past and future prosperity of the region”.

The preface of this book opens with some dramatic phrases about the Asian monsoon, which indeed impacts two thirds of the world's humanity today, or about 4 billion people living in Asia from Pakistan in the northwest to Indonesia in the southeast and from the Maldiv Islands in the southwest to China in the northeast. The Asian monsoon is the largest seasonal abnormality of the global climate system and exerts a significant impact on the earth's climate system. In the context of present debate on global warming and climate change, it is imperative that a comprehensive understanding of this fascinating and complex climate system must be developed before any meaningful assessment of present and future climate change can be made.

The Asian Monsoon presents a primarily paleo-climatic perspective on the Asian monsoon. The authors, Clift & Plumb (both affiliated with the Massachusetts Institute of Technology in USA), are experts in the area of monsoon climate and have presented a comprehensive account on the evolution and controls of the Asian monsoon over tectonic and orbital time-scales in the first five chapters. The authors have analyzed a large number of research publications on a variety of paleo-oceanographic data to document monsoon evolution and variability over time-scales from several tens of million years BP (Before Present) to just a few thousand to a few hundred years BP. The final chapter of the book deals with the late Holocene (about 5000 y BP) monsoon and human society, which provides an interesting account of social and cultural development of human societies over Asia with particular reference to the Indus Valley civilization (~7000 y BP) over the Indian subcontinent and the Dadiwan culture

³ Madhav Khandekar is a former research scientist from Environment Canada. He is presently on the editorial board of the international Journal *Natural Hazards* and was an Expert Reviewer for the 2007 IPCC climate change documents.

(~7500 y BP) from the Yellow River valley in China. This chapter also discusses monsoon development over the last 1000 years with reference to monsoon variability and political development and changes, especially over India. The book ends with a brief discussion on future evolution of the monsoon in the context of present debate on climate change, this discussion being derived primarily from the 2001 climate change documents prepared by the IPCC (Intergovernmental Panel on Climate Change).



The first chapter of the book presents the meteorology of the monsoons, with relevant schematics and discussions on the sub-tropical jet stream, the Hadley Cell in relation to the tropics, the ITCZ (Inter-tropical Convergence Zone) and the impact of the Indian Ocean on monsoon circulation. It was puzzling and disappointing to find no reference to the Tropical Easterly Jet (TEJ), an important and persistent jet stream

over the Peninsular India (with peak winds of up to 100 knots at about 100 hPa) which owes its existence to the reversal of north-south temperature gradient over south Asia due to presence of the Tibetan Plateau and its significant warming during summer months in relation to the 'cooler' Indian Ocean in the south. It is this TEJ which makes the Asian and in particular the Indian monsoon complex and a fascinating research topic today.

The next two chapters discuss the controls and evolution of the Asian monsoon on tectonic time-scale, from several tens of M y BP to a few hundred years BP. Chapter 2 discusses the importance of the Tibetan Plateau together with the Himalayan mountains (highest mountain chains in the world) on the strength and intensity of monsoons. The Tibetan Plateau is now believed to have evolved at around 45 to 50 M y BP and its importance in controlling the monsoon and rainfall intensity over India, central Asia and over Loess Plateau (in central China) is discussed at length. Once again, it is disappointing to see a complete absence of any reference to TEJ, which has been shown (in many studies in the 1960s by researchers in the India Meteorological Department) to exert an important control on the monsoon circulation and intensity, over the Indian subcontinent and also over parts of northern Africa where the TEJ extends during summer months. In chapter 3, the evolution of Asian monsoon over glacial and interglacial intervals is presented. A large amount of data from ocean floors (e.g., Arabian Sea sediments), weathering histories in the Himalayas and eolian dust records are analyzed to

establish monsoon variability over several M years and in particular the strengthening of the summer monsoon about 8 M y BP due to the Tibetan Plateau. In chapter 4 the evolution of monsoon over orbital time-scales (from a few thousand to hundred thousand years or more) is investigated using a variety of data, e.g. cave data, lake records, eolian data, etc. The earth's orbit exhibits three types of long-term variations, namely eccentricity (~ 100,000 y), obliquity (~ 41000 y) and precession (~ 21000 y) and this also reflects in monsoon strength which varies on the 21, 40 and 100 thousand year time-scales that control periods of glacial advances and retreats. Chapter 5 discusses the erosional impact of the Asian monsoon and how this may have impacted the tectonics of the Asian mountain ranges. The chapter concludes that the monsoon circulation and intensity had a powerful influence on the erosion and weathering of Asia over long and short geological times during the Cenozoic (~ 70 M y) and this erosional impact has resulted in an important coupling between the climate and the tectonic evolution of the mountains.

The last chapter discusses the late Holocene monsoon variability and how this has shaped the human society and culture over Asia. The authors employ records derived from ice cores, speleothems, lakes and peat bogs to assess monsoon strengths since about 8000 y BP to the present. The monsoon strengthening, following the very cold period of Younger Dryas (~ 11000 y BP) allowed vegetation to spread and diversify and this, according to the authors, may have led to the development of the Harappan and Mohenjodaro culture between 9000 to 6000 y BP. Extensive remains of this culture are found in the northwest parts of India (which is now part of Pakistan) along the Indus River valley and in particular along the River Saraswati, referred to many times in the Hindu scriptures, *The Rig Veda*, written about 6000 y BP. The Saraswati River, which was a major river then, has all but disappeared today, most certainly due to drying of the monsoonal climate after 4200 y BP. The drying of Asian monsoon after 5000 y BP is also inferred from sediment records in northeast China where the Dadiwan culture flourished between 8000-6000 y BP when the monsoon rains were abundant. The monsoon variability of the last 1000 years is discussed in conjunction with major political and historical development of Asia, with particular reference to the rise and fall of the Moghul Empire in south Asia (1500-1700 AD). The last section of this chapter deals with the possible impact of present climate change on future monsoon circulation and intensity. This discussion appears to be strongly influenced by the IPCC (2001) projections of significant melting of the Greenland Ice cap leading to an abrupt weakening of the 'North Atlantic heat conveyor belt' and this in turn could lead to a weakening of the Asian monsoon. Studies published in the last five years do not support such scenarios. A study by Kripalani et al (2003 *Natural Hazards June 2003*) shows that the Indian monsoon, and by extension the Asian monsoon, while exhibiting decadal variability with a 30-year cycle, is not influenced by global warming, and the recent 2007 IPCC documents on climate change suggest only a small change (less than 5%) in monsoon intensity over the next 25 to 30

years. Another recent study (Latif et al *J of Climate September 2006*) concludes that the recent observed weakening of the MOC (Meridional Overturning Circulation) in the North Atlantic is part of natural variability and not a result of global warming. Finally, there is considerable uncertainty in projections of future melting of the Greenland Ice cap with publication of several recent studies suggesting that the future warming of the earth's climate due to a doubling of (human-added) atmospheric carbon dioxide may only be about 1°C or so.

In summary, this is a comprehensive book for someone whose interest is in the climate history of the Asian monsoon over last several million years. The Asian monsoon is perhaps the most complex feature of the earth's climate system and per a recent paper (Shukla *Science October 2007*) the present climate models cannot adequately simulate the monsoon intensity and its inter-annual variability. The Indian and Asian Monsoon have witnessed large-scale droughts and floods in the past and will continue to do so, global warming notwithstanding. An important research area at present is the study of inter-annual variability of Asian monsoon and prediction of future droughts and floods. Such a study and the operational knowledge derived from it may enable many Asian countries to develop suitable adaptation measures so as to adjust to the vagaries of future monsoons.

Mountain Weather and Climate

by Roger G. Barry

Cambridge University Press, 2008, 506 pages
Paperback \$80.00, Hardback US\$160.00

Book reviewed by Dov Richard Bensimon⁴

The first word that comes to mind in reading this book is "comprehensive". This book aims to be a reference textbook when it comes to mountain meteorology, and it accomplishes this feat quite convincingly. The author draws on countless studies in the field to cover essentially every angle of the topic one can think of. This is done so, in an organized and logical fashion, making the book relatively easy to follow.

Although the author highlights the findings of the various studies he refers to in the text, he also provides exhaustive bibliographies at the end of each chapter, should the reader want even more information on a given specialized topic. The book is quite well presented, with abundant graphics taken from various sources, but all of which are shown in a relatively uniform style and presentation.

⁴ Environment Canada
2121 route Transcanadienne, Dorval, QC