DESSERT METEOROLOGY

This review originally appeared in the Bulletin of the American Meteorological Society (BAMS) Vol. 87, No. 8, pp. 1100-1102.

Hot and cold deserts together cover about 40% of the Earth’s land surface. After the oceans, they are among the most important elements of the global climate system. Despite a lot of research done on many aspects of desert ecosystems, little attention has been paid toward compiling these efforts into a book. Weather-wise, a recent book titled Desert Meteorology filled this gap. The author was a professor at The Pennsylvania State University, with a current joint appointment with NCAR and the University of Colorado. He has done an excellent job of writing this book.

Desert Meteorology addresses all aspects of desert weather, such as large- and local-scale causes of aridity; precipitation characteristics, dust storms, floods, and climate change in deserts; numerical modeling of desert atmosphere; and the effect of desert weather on humans. The book, the first in the desert ecosystems series, is well-written and well-organized, with the assumption that the reader has only a basic knowledge of meteorology, physics, and calculus, making it useful to those in a wide range of disciplines. Desert Meteorology has 20 chapters, many two-dimensional boxes on specifics throughout the book, with suggested general references for further reading, questions, problems, and exercises at the end of each chapter. Each chapter starts with informative phrases from many scientists, writers, and experts about general desert characteristics. The book has five appendices (a glossary; abbreviations; units, numerical constants, and conversion factors; symbols; and maps of the world), along with hints to solving some problems and exercises, and thorough references at the end.

After a short introduction in chapter 1 that emphasizes the advantage of having a comprehensive book on desert meteorology and climate and sets the framework for the rest of the book, the second chapter describes the atmospheric dynamics in desert regions. Among interesting topics in this chapter, the author addresses the dynamics feedback mechanisms that may cause and sustain deserts, along with the dynamics of desert heat lows. Chapter 3 is devoted to the climate of the world desert. After describing the general meteorological, physiological, and vegetative characteristics of deserts in this chapter, the author focuses on the African, North and South American, Australian, Asian, and European deserts and arid areas. The new concept of “ocean deserts” is also introduced in this chapter. By merging information from five kinds of satellites, from global-model-based precipitation reanalysis, and from precipitation gauges at resolution of 2.5° latitude by 2.5° longitude, the author illustrates that, in general, large areas of ocean to the west of major land masses have arid climates (precipitation in the range of 18–55 cm yr⁻¹.) Some color plates are also included at the end of chapter 3.

The concept of atmospheric and surface energy budget of deserts is covered in chapter 4. Basic radiation laws, the geometric relationship between the Earth and the Sun,
examples of desert and nondesert energy budgets, the “oasis effect,” and the effect of mineral aerosols on the desert radiation budget are thoroughly described in this chapter. Chapter 5, “Surface Physics of the Unvegetated Sandy Desert Landscape,” takes a quantitative approach toward computation of sensible, latent, and soil heat fluxes over unvegetated desert regions. The effects of sparse vegetation on the desert surface energy and water budgets and winds near the surface are described in chapter 6. The concept of desert substrate such as salt flats, playas, salars, sabkhas, salt pans, etc. (the variety of names throughout the arid world that stand for lower portions of arid basins with internal drainage, flat and generally barren areas, periodical flooding and accumulation of sediment, and sometimes having water tables near the surface), along with their effects on the surface energy budget, are introduced in chapter 7.

Chapter 8 describes desert-surface physical characteristics, such as albedo, thermal properties, aerodynamic roughness, emissivity, and hydraulic properties. Numerical modeling of desert atmosphere in chapter 9 is devoted to the interesting general concept of numerical weather prediction and examples of atmospheric model applications in arid areas (United Arab Emirates, Great Basin Desert, and Arabian Desert). Chapter 10, “Desert Boundary Layers,” starts with the basic concept of boundary-layer structure and unique aspects of the desert boundary layers. Numerous examples about vertical wind, temperature, and moisture profiles in desert regions are presented in this chapter.

Chapters 11 and 12, “Desert Microclimates” and “Dynamic Interactions among Desert Microclimates,” respectively, describe causes of large horizontal variations in a variety of surface properties, such as the type of substrate; the depth of water tables; the type and density of vegetation; and topographic elevation, slope, and aspects. These contrasts in surface properties affect the related surface energy, moisture, and momentum fluxes that yield atmospheric variability, such as rainfall, temperature, and windfall. These near-surface and boundary-layer properties define the microclimate of the lower atmosphere in desert regions. Numerous illustrations and examples in these two chapters clarify the concepts of interaction among desert microclimates.

Desert rainfall is covered in chapter 13. Rainfall events in deserts are more or less very rare occurrences. Some places may have rainless periods for many years or decades, while others may receive torrential rain and the associated runoff. The interesting topics of artificial rainfall enhancement in arid areas and dew and fog deposition in the desert are also covered in this chapter. Chapter 14 explores the anthropogenic effects on the desert atmosphere. With this regard, the author categorizes these effects as irrigation, livestock grazing and overgrazing, lowering of the water table, introduction of nonnative vegetation, dryland agriculture, urbanization, and off-road vehicle use. Each category is described thoroughly.

Changes in desert climate are explored in chapter 15. Time scales of climate and aridity, a summary of recent climate periods, methods and examples of estimating climate change in arid regions, and manifestations and causes of climate change in deserts are discussed. Chapter 16 covers severe weather in the desert, including dust and sand storms, rainstorms, floods, and debris flows. Chapter 17 briefly describes effects of desert dusts
on the global and other regional environments. Desertification, including its extent and anthropogenic and natural contributions, is discussed in chapter 18.

Biometeorology of humans in desert environments is covered in chapter 19. In biometeorology, the response of living organisms—such as plants, animals, and humans—to weather and climate is studied. This chapter is devoted to the effects of the desert environment on humans. There are nice discussions about the heat balance of the human body in the desert, the process of maintaining body heat and water balance, and acclimatization to the desert environment, along with economizing water, reducing the heat load, physical effects of heat stress and dehydration, physical effects of desert mineral dust, and psychological and electrostatics effects. The last chapter covers optical properties of desert atmospheres. The concepts of mirage, effects of atmospheric dust on sunsets and sunrises, crepuscular phenomenon (shadows seen in the sky as a result of the presence of dust), and scintillation (optical haze) are described in this short and informative chapter.

*Desert Meteorology* is a comprehensive and extraordinary book on desert ecosystems, and should be read, referred to, or even browsed through by everyone interested in and concerned with the fate of our planet.

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