

**Knippertz, P. and Stuut, J.-B.W. (eds.): Mineral Dust – A Key Player in the Earth System.** Springer, Dordrecht–Heidelberg–New York–London, 2014. 509 p.

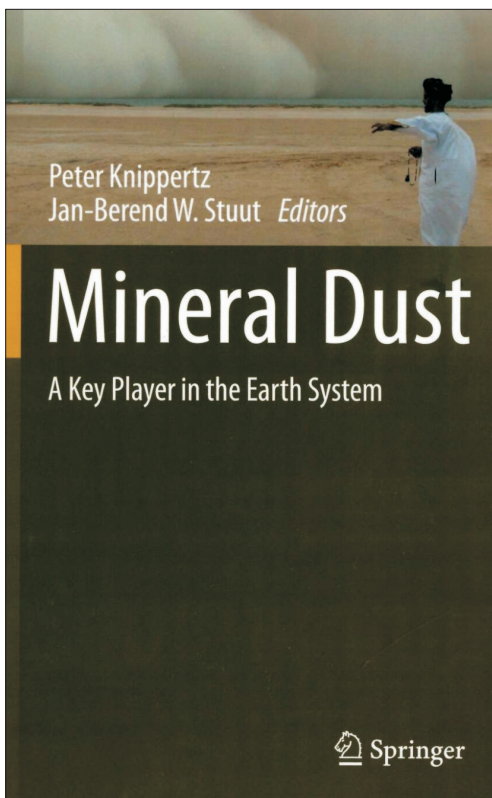
Windblown dust deflated from arid-semiarid areas and aeolian dust deposits are standing in the focal point of environmental scientific studies. Huge amount – billions of tons – of mineral dust is emitted annually from the major source areas. Rapidly growing body of scientific publications recognized and confirmed that mineral dust has considerable impacts on numerous atmospheric, climatic and biogeochemical processes, and it plays an important role in the modification of global energy and carbon budgets. Atmospheric dust has also an effect on human health, agriculture, traffic and industrial production. Mineral dust related investigations are regarded as truly interdisciplinary studies. The editors, Peter KNIPPERTZ and Jan-Berend W. STUUT, well-known experts from various perspectives of dust storms and mineral dust and the 60 contributing authors give a comprehensive overview of the full range of mineral dust research.

The 509 (+25) page book is organized into four main thematic sections: characteristics of mineral

dust particles; global dust cycle; impacts of dust on the Earth system; and aeolian dust deposits as climate archives. Chapter 1 ('Introduction') is an overview by the two authors on the importance, history and recent developments of dust research, so it gives a short introduction into the topic.

In Chapter 2 Dirk SCHEUVENS and Konrad KANDLER provide a detailed discussion of chemical composition, shape and morphology of particles and the grain size distribution of mineral dust with a special attention to individual particle analysis. Climatic (e.g. radiative forcing effects), other environmental (e.g. nutrient supply) and human health effects of particles with different physicochemical properties are also discussed in this part. Thereby, this section provides a foundation for subsequent chapters. Chapter 3 by Daniel R. MUHS *et al.* discusses the geographical distribution of recent and past global dust source areas. The most widely used methods (field studies, geomorphological perspectives, satellite observations, back-trajectory analyses, geochemical and isotopic methods) to identify dust source areas are properly summarized in this part. Chapter 4 by Alex R. BAKER *et al.* is dealing with the so-called atmospheric ageing of freshly emitted particles. After the emission from the source area, mineral dust is exposed to a number of processes that alters its properties. These physical and chemical processes have an effect on dust reactivity, hygroscopicity and atmospheric composition, which in turn affects the direct and indirect climatic impacts of ageing-modified atmospheric mineral particles.

Chapters of Part II describe global dust budget via discussion of emission, transport and deposition mechanisms. In Chapter 5 Béatrice MARTICORENA introduces our knowledge of dust production processes and wind-surface interactions leading to dust emission episodes. Physics of main stages of dust emission (erosion threshold, saltation flux and dust production by sandblasting) is overviewed properly in this section. Peter KNIPPERTZ discusses the main meteorological aspects of dust storms in Chapter 6. Meteorological situations leading to stronger near-surface winds which exceed the local emission threshold are identified and classified in this part of the book. According to the findings, key meteorological drivers of intense emissions are connected to large-scale monsoon-type flows, mobile synoptic-scale systems, gust fronts of convective storms and intense dry convections of daytime planetary boundary layer. Once dust is entrained into the atmosphere spatiotemporal distribution of dust-loaded air-masses should be known as accurate as possible. Isabelle CHIAPELLO in 'Dust



Observations and Climatology' section (Chapter 7) examines the different methods of observations from ground-based networks to remote sensing of satellites. Inter-annual variability and trend analyses of dust observation time-series allow us to gain insight into the climatological aspects of dust cycles also from a local, regional and global viewpoint. In Chapter 8 Gilles BERGAMETTI and Gilles FORËT discuss the dry and wet dust depositional mechanisms. These processes determine the atmospheric lifetime of particles and the dust accumulation budget of depositional areas. The authors describe the physics of strongly size dependent removal processes, the measured data of field campaigns and also the uncertainties of simulated dust mass budget. Ina TEGEN and Michael SCHULTZ summarize in Chapter 9 the possibilities of application of numerical models in dust research. Computer models are ideal tools to investigate these previously mentioned detailed processes; however, there are also some shortcomings of the simulations (e.g. numerical models are often unable to reproduce the small-scale wind events). Angela BENEDETTI and her 23 co-authors provide in the Chapter 10 an overview on the operational dust predictions which became prominent in the recent years. Dust models applied in operational forecast systems produce daily predictions of dust fields.

The third part of the book is dealing with the impacts of mineral dust. In Chapter 11 Ellie HIGHWOOD and Claire RYDER discuss the radiative effects of atmospheric dust. This direct impacts (reflection, absorption, scattering) are dependent on the optical properties and so are sensitive to size and composition of dust particles. Dust optical thickness, single-scattering albedo, real and imaginary refractive index determination and measurement methods and applications are also discussed in detail in this section. Athanasios NENES *et al.* explain the indirect impacts of atmospheric particles via microphysical interactions

with clouds (Chapter 12). Mineral dust acting as cloud condensation nuclei and ice nuclei has an important effect on cloud formation, optical properties of cloud and also on precipitation. General microphysics, the role of ageing and climatic effects are discussed in this chapter, while a more comprehensive overview of dust radiative forcing upon climate is given by Ron L. MILLER *et al.* in Chapter 13. Biogeochemical impacts of dust on another key climatic component on the global carbon cycle is explained in Chapter 14 by Tim JICKELLS *et al.* Deposited dust material provides a nutrient supply to terrestrial and marine ecosystems and enhances the primary production. Relationships between atmospheric mineral dust and human health are discussed by Suzette A. MORMAN and Geoffrey S. PLUMLEE in Chapter 15. These effects are ranging from respiratory diseases (asthma, nonindustrial silicosis) caused by the smallest size fractions of atmospheric particulate matter to bacterial meningitis outbreaks in the 'meningitis belt' of sub-Saharan Africa.

Last part of the book is concerned with aeolian dust deposits as climate archives. The most important terrestrial dust archives are the 'loess records', which are explained in detail by D.R. MUHS *et al.* in Chapter 16. All of the most important loess regions are introduced in this section after a short description of general characteristics of loess and loess stratigraphy. Subaquatic dust deposits are discussed by J.-B.W. STUUT in the Chapter 17, while dust material found in ice core archives is explained in the last section (Chapter 18) by Paul VALLELONGA and Anders SVENSSON.

The overall impression of this well-produced, high-quality work is absolutely positive. This book will undoubtedly find wide relevance and it is an essential handbook for scholars with an interest in Earth Sciences including geology, geography, chemistry, meteorology and climatology.

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