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ORIGINAL PAPER

An analysis on the dust aerosol climatology over the major dust sources in the northern hemisphere

P. Sivaprasad[1] · **C. A. Babu**[2] · **A. A. Samah**[1] · **P. R. Jayakrishnan**[1]

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Abstract The paper addresses influence of dust particles on the aerosol loading over the major deserts in the northern hemisphere. The role of dust aerosols in the total aerosol concentration and size distribution of the particles are analysed. It is observed that the aerosol loading is high in the northern hemisphere of which the deserts and adjoining areas in Asia and Africa play a leading role. Over the entire oceanic region, except some parts of the Atlantic Ocean near to the West coast of Africa and the Arabian Sea, aerosol loading is less. The Sahara Desert is the prominent source of dust aerosols throughout the year. The deserts of Asia are also prominent sources of dust aerosols on a global basis. Above 70% of the total aerosol optical depth (AOD) is contributed by the dust particles, reaching to around 90% during spring months March, April and May over the Sahara Desert, which is the major source of dust aerosols. Goddard Chemistry Aerosol Radiation and Transport model is used to estimate the dust aerosol concentration over the deserts of Asia and Africa. The model output almost agrees with the regions of dust loading obtained from the Envisat/SCIAMACHY. Hence, the model is reliable in estimating the dust aerosol loading over the major dust aerosol sources. The major portion of the total dust loading belongs to coarse mode particles.

Keywords Aerosols · Dust · GOCART model · Desert

✉ P. Sivaprasad
savimarine@yahoo.com

[1] Institute of Ocean and Earth Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia

[2] Department of Atmospheric Sciences, Cochin University of Science and Technology, Cochin 682016, India

Introduction

Aerosols are classified to natural and anthropogenic on the basis of their origin and method of formation. Mineral dust particles play a major role in the atmospheric aerosol loading and optical depth (Tegen et al. 1997). Desert dust aerosols modify cloud optical properties and lifetime by interacting with liquid or ice clouds (DeMott et al. 2003; Mahowald and Kiehl 2003). Hence, they play a vital role in the precipitation process (Creamean et al. 2013). Cloud nucleation and optical properties are also affected by the dust aerosols (Levin et al. 1996). Mineral dust particles play a vital role on the radiation balance of the atmosphere (Tegen et al. 1997; Li et al. 2004). Hence, the climate of the Earth is significantly affected by dust aerosol particles. Dust aerosols affect the human health while inhaling the dust particles. The smaller particles deposit in the gas-exchange region of the lungs; hence, it adversely affects the human health in comparison with large particles (Brunekreef and Holgate 2002). Dust aerosols are deposited in the oceans and affect the productivity in the oceans (Duce 1995; Prospero 1996a, b).

Desert dust aerosols are inserted into the atmosphere by suspension, saltation and creeping processes associated with wind erosion (Shao 2008; Kok et al. 2012). The atmospheric residence time of the aerosols is dependent on the size of the particle. Smaller particles deposit much slower than larger particles (Seinfeld and Pandis 1998). Fennec field campaign conducted in the Sahara Desert by Ryder et al. (2013) reported that the residence time of dust aerosols larger than 20 μm is of the order of 12 h. The size of dust aerosols plays a significant role on their optical and microphysical properties and transport towards the other regions (Tegen and Lacis 1996). The small particles (< 50 μm) entrained into the boundary layer by the erosion and mixing action of the low level wind on the Earth's surface get transported long distances (Prospero

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