North African dust transport toward the western Mediterranean basin: Atmospheric controls on dust source activation and transport pathways during June-July 2013

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Abstract. Dust transported from North African source region toward the Mediterranean basin and Europe is an ubiquitous phenomenon in the Mediterranean region. Winds formed by large-scale pressure gradients foster dust entrainment into the atmosphere over North African dust source regions and advection of dust downwind. The constellation of centers of high and low pressure determines wind speed and direction, and thus the chance for dust emission over Northern Africa and transport toward the Mediterranean.

We present characteristics of the atmospheric dust life-cycle determining dust transport toward the Mediterranean basin with focus on the ChArMEx (Chemistry-Aerosol Mediterranean Experiment) special observation period in June and July 2013 using the atmosphere-dust model COSMO-MUSCAT (COSMO: COnsortium for Small-scale MOdelling; MUSCAT: MUltiScale Chemistry Aerosol Transport Model). Modes of atmospheric circulation are identified from empirical orthogonal function (EOF) analysis of the geopotential height at 850 hPa and compared to EOFs calculated from 1979-2015 ERA-Interim reanalysis. Two different phases are identified from the first EOF, which in total explain 45% of the variance. They are characterized by the propagation of the subtropical ridge into the Mediterranean basin, the position of the Saharan heat low and the predominant Iberian heat low and discussed illustrating a dipole pattern for enhanced (reduced) dust emission fluxes, stronger (weaker) meridional dust transport, and consequent increased (decreased) atmospheric dust concentrations and deposition fluxes. In case of a predominant high pressure zone over the western and central Mediterranean (positive phase), a hot spot in dust emission flux is evident over the Grand Erg Occidental and reduced level of atmospheric dust loading occurs over the western Mediterranean basin. The meridional transport in northward direction is reduced due to prevailing northerly winds. In case of a predominant heat low trough linking the Iberian and the Sahara heat low (negative phase), meridional dust transport toward the western Mediterranean is increased due to prevailing southerly winds resulting into an enhanced atmospheric dust loading over the western Mediterranean.

Altogether, results form this study illustrate the relevance of knowing dust source location and characteristics in concert with atmospheric circulation. The study elaborates the question on the variability of summertime dust transport toward the Mediterranean and Europe with regard to atmospheric circulation conditions controlling dust emission and transport routes of Saharan

dust, exemplarily for the two-month period June to July 2013. Ultimately, outcomes from this study contribute to the understanding of the variance in dust transport into a populated region.