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Physical processes of desert dust in the atmosphere

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Mineral dust is one of the most important aerosol types in terms of mass and optical depth. It affects radiation and alters liquid and ice cloud properties, as well as precipitation processes. Once dust particles are deposited at the surface, they provide micronutrients to the ocean or to land ecosystems, affecting fishery and agriculture activities. Moreover, very high concentrations of dust are often transported away from Sahara Desert towards Europe. Under such conditions, the smaller PM2.5 particles can be easily inhaled and deposited on the lungs and are related to human health disorders. Furthermore, under certain circumstances cloud icing by mineral dust may impact aviation safety. For these reasons, mineral dust and the associated uncertainties in climate projections are key topics for atmospheric physics research. This is particularly true for the highly dust-affected area of Eastern Mediterranean where the largest climate change effects are also expected in the decades to come. Early theoretical and modeling studies have defined the primary physical processes that lead to dust mobilization, long range transfer and deposition processes. These atmospheric models are being constantly improved with the inclusion of more detailed physical schemes and with the assimilation of in-situ and remote sensing data. This effort results in more detailed representations of the atmospheric physical processes, in accordance with the in-situ (surface stations and airborne) and remote sensing (surface and satellite observations). In general, the most crucial parameter for the emission of dust is the near-surface wind. Increased wind speeds may occur due to synoptic wind forcing, topographic effects (e.g., valley channeling), low-level jets (LLJ) squall lines and storm downdrafts. Most of the above processes result in detached elevated dust plumes over the Mediterranean. Most dust layers in the area are observed at heights of 4–5 km in the troposphere and are associated either with Mediterranean low-pressure systems or with the summer anticyclonic circulation over north Africa. When the plumes reach mainland, their transport over complex terrain can be strongly affected by local wind patterns (e.g., Foehn flows). The description of surface dust emissions also plays a major role in mineral dust research. The development of assimilation methods for including satellite observations in model fields replaces the earlier static dust source maps with dynamic satellite-based emissions maps, allowing a physically based representation of seasonal and annual variations of dust-source strength. Hyperspectral retrievals of soil mineralogy are also implemented in dust models for the description of different types of dust minerals. Additionally, 3D-Var assimilation of dust Aerosol Optical Depth from satellite retrievals is also used for nudging the simulated fields towards the observational satellite values. An overview of the aforementioned physical processes and associated theoretical model developments, as well as the current status of knowledge regarding dust physics in the atmosphere will be discussed.

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References

1. Nickovic, S., Kallos, G., Papadopoulos, A., and Kakaliagou, O.: A model for prediction of desert dust cycle in the atmosphere, J. Geophys. Res., 106, 18113–18129, 2001.
2. Solomos, S., Kallos, G., Kushta, J., Astitha, M., Tremback, C., Nenes, A., Levin, Z.: An integrated modeling study on the effects of mineral dust and sea salt particles on clouds and precipitation, Atmos. Chem. Phys., 11, 873–892, doi:10.5194/acp-11-873-2011, 2011
3. Solomos, S., Kallos, G., Mavromatidis, E., Kushta, J.: "Density Currents as a Desert Dust Mobilization Mechanism", Atmos. Chem. Phys., 12, 11199–11211, doi:10.5194/acp-12-11199-2012, 2012
4. Solomos, S., Kalivitis, N., Mihalopoulos, N., Amiridis, V., Kouvarakis, G., Gkikas, A., Binietoglou, I., Tsekeri, A., Kazadzis, S., Kottas, M., Pradhan, Y., Proestakis, E., Nastos, P.T., Marenco, F. From Tropospheric Folding to Khamsin and Foehn Winds: How Atmospheric Dynamics Advanced a Record-Breaking Dust Episode in

Crete. Atmosphere 2018, 9, 240., 2018
5. Spyrou, C.; Solomos, S.; Bartsotas, N.S.; Douvis, K.C.; Nickovic, S. Development of a Dust Source Map for WRF-Chem Model Based on MODIS NDVI. Atmosphere 2022, 13, 868. https://doi.org/10.3390/atmos13060868

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