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Dust deposition events in Caucasus Mountains as revealed by shallow ice cores from Mt Elbrus

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Dust aerosol transported to the high mountains and is deposited and stored in snow pack and glacier ice. Present and past records of dust stored in glaciers provide valuable information on frequency of deposition events, source regions and atmospheric pathways of mineral dust. The Caucasus Mountains, located between the Black and the Caspian seas is a glacierized region affected by deposition of desert dust from the Middle East and Sahara.
In this study, a combination of ice core analysis, remote sensing and air mass trajectory modelling was used to identify the source regions of dust deposited on the glaciers of Mt Elbrus in the central Greater Caucasus and to characterize atmospheric pathways of dust with high temporal and spatial resolution. Shallow ice cores were extracted at Mt Elbrus in 2009 and 2012. Dust deposition events, recorded as brown layers in the snow, firn and ice were dated to the precision on months using oxygen and deuterium isotopic analyses. Examination of the local meteorological and NCEP/NCAR reanalysis data and application of HYSPLIT atmospheric trajectory model enabled dating dust deposition events with a precision of days, identification of potential source regions of desert dust and its pathways in the atmosphere. Examination of red-blue green infrared composite imagery from Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) on board the Meteosat Second Generation (MSG) satellite enabled further provenancing of desert dust with high temporal (hours) and spatial (c. 100 km) resolution. Seventeen dust layers deposited between May 2009 and July 2012 were detected in the shallow cores. The source regions of the desert dust transported to Mt Elbrus were primarily located in the Middle East, in particular in eastern Syria and in the Syrian Desert at the border between Saudi Arabia, Iraq and Jordan. Northern Sahara, the foothills of the Djebel Akhdar Mountains in eastern Libya and the border region between Libya and Algeria were other important sources of desert dust. Fifteen dust deposition events occurred between March and June and two events occurred in October. The relatively high frequency of dust deposition events on Mt Elbrus may be due to the prolonged 2007–2010 drought in the Middle East resulting in more frequent activation of dust sources.
Particle size and shape distributions were analysed for each dust sample using scanning electron microscope (SEM). The volume median diameter of dust particles from dust samples ranged from 3 to 13 microns. Particles with diameter of 1-10 microns accounted for $90\pm3\%$ of the analysed samples.
Detailed characterization of desert dust pathways from the Middle East and Sahara to the Caucasus leads to better understanding of pathways of desert dust in the atmosphere and highlights the importance of the Elbrus deep ice cores for the reconstruction of past environmental conditions in the south-eastern Europe and the Middle East in the future.
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