



Long-range transport of Saharan dust and chemical transformations over the Eastern Mediterranean

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Three recent Saharan dust outbreaks during different seasons (4-6 days in winter of 2009, late autumn of 2010 and summer of 2011) are selected in order to study the chemical footprint and aging processes of dust intrusions over the Eastern Mediterranean (EM). The applied model system (PMCAMx, WRF and GEOS-CHEM) and methodology are found competent to reproduce dust production, long-range transport and chemical transformations over the EM, with the synergistic use of synoptic patterns analysis, optical depth retrievals, back-trajectories, surface and satellite aerosol measurements. The dust loads were high during the cold period events and much lighter during summertime, when transport was mainly in the free troposphere. In all cases, dust originated from the northwest and/or west Saharan desert and reached the EM from the west/southwest. Sensitivity runs underlie the effect of dust transport on the chemical constituents of aerosols over the EM and show a large impact on calcium (70-90% of maximum daily values $2-5 \mu\text{g m}^{-3}$), with its gradient at surface level being around -10% per 100 km along the dust pathway. For the cold period cases, this value can also be considered analogous to the dust dissipation ratio, because the plume is vertically extended down to the surface layers. Interestingly, the surface particulate nitrate concentrations over the EM are reversely affected by the approaching dust loads, exhibiting the highest values (up to $6 \mu\text{g m}^{-3}$) and the largest dust fraction (ca. 70%) during summertime. This is attributed to the enhanced nitric acid formation under high atmospheric temperature and insolation, its uptake onto the carbonate dust particles, and their effective accumulation, due to low deposition rates over the sea and scarce precipitation. Sulfate formation onto dust particles is found insignificant (rapid reaction with ammonia and/or sea-salt), while the influence of dust and sea-salt on sodium, when spatio-temporal averages are calculated, is approximately equal.