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Natural and anthropogenic air pollution in the Middle East

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Due to intensive industrial development in the recent decades, the major megacities in the Middle East (ME) experience a strong anthropogenic pollution because of NO_x emissions caused by excessive traffic, SO_2 emissions caused by oil refinery, power generation, and water desalination, on the top of the high dust pollution transported from the ambient desert regions. In this work, WRF-Chem regional model is deployed to simulate aerosol and gaseous concentrations over the ME during the whole 2015 year on 10x10 km grid. GOCART dust emission and GOCART aerosol module coupled with the RACM chemical mechanism are used. The boundary and initial conditions (BC&IC) for all meteorological parameters and for a subset of chemical species are derived from the NASA Modern-Era Retrospective analysis for Research and Applications v2 (MERRA2) reanalysis. Emissions fields for organics and black carbon, NO_3, NO, NO_2, CO, NH3, NH4, and particulate matter are obtained from the EDGAR HTAP v4 anthropogenic emission inventory. For SO_2 sources we use satellite-derived SO_2 emissions inventory, since the SO_2 column loadings in our test runs with EDGAR HTAP emissions were inconsistent with Ozone Monitoring Instrument (OMI) retrievals and ECMWF Monitoring Atmospheric Composition and Climate (MACC) reanalysis. The dust emissions are tuned to match the Aerosol Robotic NETwork (AERONET) and MERRA2 aerosol optical depth. We found that meteorological and chemical BC&IC built from MERRA2 add in the consistency of the pollution transport simulations. The dust PM10 concentrations often exceed the World Health Organization (WHO) air-quality standards. Although dust is the major natural pollutant, the anthropogenic sulfate and nitrate aerosols could significantly increase the PM2.5 concentrations in the cities. The gaseous pollutants, including O_3, NO_2, SO_2, CO in the ME megacities are within allowable limits in most of the cases.