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Vertical ozone concentration profiles in the Middle East: WRF-Chem predictions vs. balloon measurements

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The greater Middle Eastern area is made up by more than 20 countries with over 400 million inhabitants. Due to extensive land conversion, intense industrialization and rapid urban population growth in recent years, the region's air quality is changing. High ozone levels affected by free tropospheric subsidence, long range transport and local production in large metropolitan areas of the region are of major concern.

In this study we analyze data from i) a continuously operated (24/7) ground monitoring station, and ii) an ozonesonde station, both operated in Doha by the Qatar Environment and Energy Research Institute coupled with simulations using a three-dimensional regional air quality model. Ozonesondes were launched at 1300 LT (1000 UTC) weekly during a summertime month (August 2015) representative of extremely hot and humid atmospheric conditions and a wintertime period (January/February 2016) of cool and dry conditions in the area. The same periods were simulated by the 3-D meteorology-chemistry model WRF-Chem (Weather Research Forecasting with Chemistry) which was employed over the Arabian Peninsula with a triple-nested domain configuration and a high grid resolution over the state of Qatar (2×2 km).

Comparison of model predictions against observations show high correlation coefficients and encouragingly low biases in all meteorological variables. During wintertime, ozone is overall well predicted (R = 0.82) while the summertime comparison is more challenging (Fractional Error = 0.45). A sensitivity study was conducted to identify the most representative planetary boundary layer parameterization that better predicts air quality and meteorological parameters both at the surface and at higher altitudes for each season/meteorological regime studied. The necessity of examining the emission data available for this region is highlighted.