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Tracking Potential Sources of Peak Ozone Concentrations in the Upper Troposphere over the Arabian Gulf Region

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In August 2013, the Qatar Environment and Energy Research Institute (QEERI), was the first to launch temporally highly resolved ozonesondes in the Middle East region. The data from 20 launches consistently show changes in meteorological parameters at about 5.5 km above the surface, which are more pronounced following a change in synoptic conditions on 15 August 2013, including temperature inversions, corresponding change in potential temperatures, relative humidity, and significant wind shear. These changes are typically associated with a large scale subtropical subsidence layer in accordance with previous aircraft studies in this region. Below the inversion layer, the ozone follows typical patterns for lower tropospheric measurements, starting in the surface layer up to 0.5 km above the ground level around noon at about 66$\pm$15 ppbv. However, above the subsidence inversion, ozone mixing ratios begin to increase to 79$\pm$13 ppbv between 6-12 km with maximum values $\sim$ 100 ppbv around 8 km, then decreasing again before reaching the stratosphere.
Three-day HYSPLIT back trajectories indicate that ozone levels are typically about 17% lower in the 6-12 km range under wind flow conditions from the East than in cases when trajectories came from the Mediterranean. High pressure may lead to subsidence of ozone from the upper troposphere/lower stratosphere and eventually cause an increase of ozone mixing ratios by $\sim$18% above average between 6-7 km, i.e. slightly above subtropical subsidence layer. Under the impact of regional convective activity and associated lightning, ozone mixing ratios can increase by more than 35% averaged over the 9-12 km altitude range. In both cases maximum ozone in the mid to upper troposphere reached more than 100 ppbv.