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Characterisation of inversions and mixing heights in the state of Kuwait and their relationship with air quality

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Atmospheric conditions, governed by meteorological factors, have a crucial influence on the dispersion of air pollutants. Dispersion is affected by three main factors; the topography and the characteristics of the surface, wind speed and direction, and atmospheric stability and inversions. If conditions persist in a way that minimize dilution then even relatively small amounts of pollutants emitted into the atmosphere could be sufficient in generating pollution episodes within a region with consequent impact on human health. Thus, knowledge of mixing layer heights (MH) and the thermal structure of the atmospheric boundary layer (ABL) are crucial for the prediction of pollutant dispersion and hence for the appraisal of air quality.

In spite of advance remote sensing technology developed for profiling the atmosphere, radiosounding is still the most reliable and widely distributed procedure for the study of the ABL structure and in the determination of MH. Hence in this work, upper air measurements collected for three consecutive years 2002-2004 from the Kuwaiti International Airport sounding station (WMO-OKBK) launched twice a day (at 00 and 12 UTC), were used to estimate mixing heights and to identify and characterise inversions. Mixing heights as well as surface and elevated inversions were determined and statistically studied. Distinct seasonal variations were observed. Mixing heights were found to be higher during the summer than in the wintertime, while inversions tended to be stronger during the wintertime. Both surface and elevated inversions were found

and the analysis suggested mainly three inversion categories: radiation, subsidence, and frontal. In addition, an unknown type of elevated inversion just below or above the tropopause was also identified. This could be caused by stratospheric folding or the presence of high altitude cirrus cloud.

In general, the results emphasize that while surface inversions characterize the nighttime in this region, elevated inversions were observed both during the day and night. While surface-based inversions can limit dispersal of surface emissions, leading to poor air quality, it can prevent higher emissions from stacks, e.g. from power plants, from grounding and hence lead to improved air quality at a time but can transport the trapped pollutants to further distances and days. These impacts on air quality have also been investigated and are discussed.