1.3 IMPACT OF LONG-RANGE TRANSPORT ON OZONE POLLUTION IN THE OKLAHOMA CITY METRO AREA

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1. INTRODUCTION

The major air quality concern in the Oklahoma City (OKC) metro area is ground level ozone pollution. In particular, during the summer months the daily ozone concentrations tend to exceed the NAAQS for ozone and a certain risk exists that OKC will be assigned as non-attainment area. Although high ozone concentrations are related to precursor emissions in urban areas, ozone pollution is not solely an urban problem. A recent review (Solomon et al., 2000) of findings obtained in a number of European and North American studies clearly indicates that tropospheric ozone pollution is a multi-scale problem extending even up to continental boundaries. As a consequence, ozone concentrations are very sensitive to meteorological conditions on a broad scale range. Key phenomena for understanding of ozone accumulation have been quoted, including extra-urban scale transport winds, vertical structures of wind fields and mixing processes, as well as mesoscale convergence zones and transport processes (Hidy, 2000). The analysis of wind data clearly indicates that southern wind directions are dominant in the OKC area. This data prompted to study the impact of long-range pollutant transport from areas south of Oklahoma on local air quality. Of particular interest has been the influence of the urban plume originating in the Dallas -Ft. Worth (DFW) area.

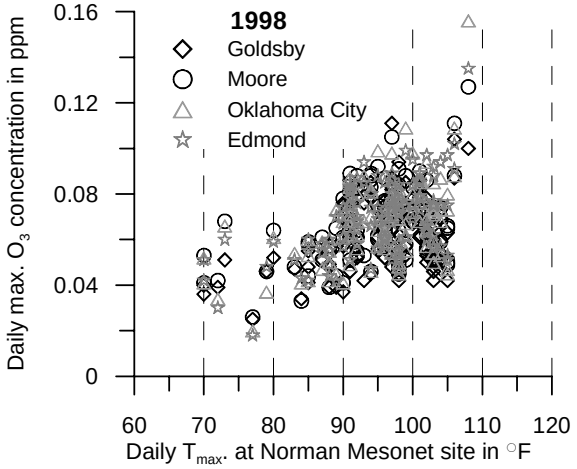

Fig. 1: Temperature correlation of the daily maximum 1-hour ozone concentration measured at the OKC metro area air-quality monitoring stations

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2. OZONE CLIMATOLOGY IN THE OKC AREA

In order to verify the hypothesis that long-range transport has a strong influence on ozone pollution in the OKC metro area, air quality data from all available Oklahoma monitoring stations have been analyzed for the ozone seasons during 1998-2000. Fig. 1 illustrates the strong correlation between daily ozone peaks in the OKC metro area and the daily maximum temperature. Furthermore it becomes obvious that similar ozone levels occur at all four monitoring stations in the OKC metro area, although their location with respect to local precursor emissions is pretty different. This is a first indication that the OKC O_3-levels are influenced by regional factors.

To investigate the correlation between the ozone air quality in Oklahoma and Texas, the daily maximum 8-hour ozone concentrations at the four OKC and four DFW metro area air-quality monitoring stations were determined for the summer months in 1998. Fig. 2a shows a comparison for September 1998. The similarity in the pollution levels and in their temporal variability, which was also observed during the other months, is remarkable. Obviously, the O_3 concentrations in OKC and DFW are strongly correlated (Fig. 2b). This correlation can be partially explained by the linked weather pattern in OKC and DFW. However, even under similar local meteorological conditions, local O_3 production will result in significant differences in the O_3 levels, since the emissions in both areas are quite different. Thus, the strong correlation in the magnitude of O_3 peaks indicates that long-range transport of ozone and precursor pollutants plays an important role,

For a further analysis, weeklong ozone episodes during the summer months in 1998, 1999 and 2000 were selected. As an example, Fig. 3 shows the diurnal variation of the 1h O_3 concentrations at the OKC stations. An exceedance of the NAAQS in OKC was observed on 09/05/98. The maximum ozone concentration is usually observed during mid-day or mid-afternoon hours, and the ozone concentrations decrease during the evening and night hours due to NO titration and deposition processes.

For comparison O_3 concentrations recorded at a monitoring station located on a 620 m high mountain (Buffalo mountain) in the rural, southeastern part of Oklahoma, are also plotted in Fig. 3. The results highlight the differences in the diurnal ozone cycle at different elevations. It appears that the Buffalo mountain station was typically above the nocturnal inversion layer and inside the nocturnal residual layer. Inside this layer, the nighttime ozone concentrations remain high since precursor emissions causing the ozone titration near the ground are not reaching this layer. Except for 09/05, the

daytime peak levels at the remote, rural Buffalo mountain site reach almost the same levels as at the urban sites. On 09/03 and 09/04, the two days prior to the OKC exceedance, the Buffalo mountain data show pronounced secondary peaks in the evening and early nighttime hours, Furthermore, remarkably high ozone concentrations were measured at the urban sites during the nights preceding the exceedance. Solomon et al. (2000) discuss that evening events are usually attributed to transport of surface ozone and precursor pollutants from upwind locations. Morning or early morning events were related to downward mixing of ozone from aloft during the breakdown of the nighttime inversion layer. Accordingly, the secondary peaks at the OKC and Buffalo mountain stations point out that long-range transport of pollutants from upwind areas affect the air quality in Oklahoma.

For each episode the regional weather pattern and vertical structure of the atmospheric boundary layer has also been investigated (not shown) using data from the Oklahoma Mesonet and NOAA radiosonde data archive. The role of pollutants transport above the nocturnal stable surface layer and subsequent vertical mixing inside the boundary layer as well as the role regional flow patterns could be identified.

3. CONCLUSIONS

The data analysis provides evidence that the OKC air quality is affected by long-range transport of pollutants from upwind areas. During the summer months southerly wind directions are dominant and accordingly pollutants transport from Texas is a major concern. However, the analysis of the acquired air quality and meteorology data permits only qualitative predictions concerning the correlation between local and regional scale pollution levels. In order to quantify the contribution of local versus regional scale emissions a photochemical modeling study must be performed, in which the modeling domain should cover the area of the state of Oklahoma and a significant part of Texas.

4. REFERNCES

Hidy, G.M., 2000. Ozone process insights from field experiments Part I: Overview. *Atmospheric Environment* **34**, 2001-2022.

Solomon, P., Cowling, E., Hidy, G., Furiness, C., 2000. Comparison of scientific findings from major ozone field studies in North America and Europe. *Atmospheric Environment,* **34**, 1885-1920.

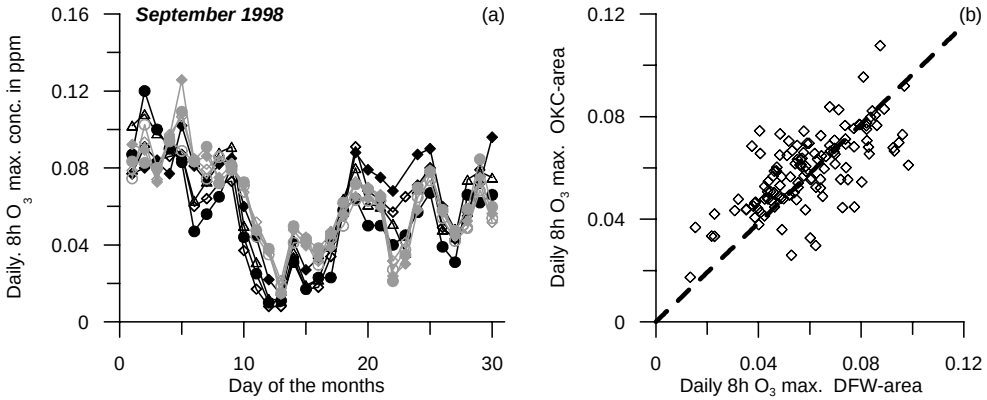

Fig. 2: Daily, maximum 8h O_3 concentration at 4 OKC and 4 DFW metro area air-quality monitoring stations during September 1998 (plot a) and correlation between the average values (based on the 4 stations shown in plot a) in the OKC and DFW area during the ozone season (June-September) 1998.

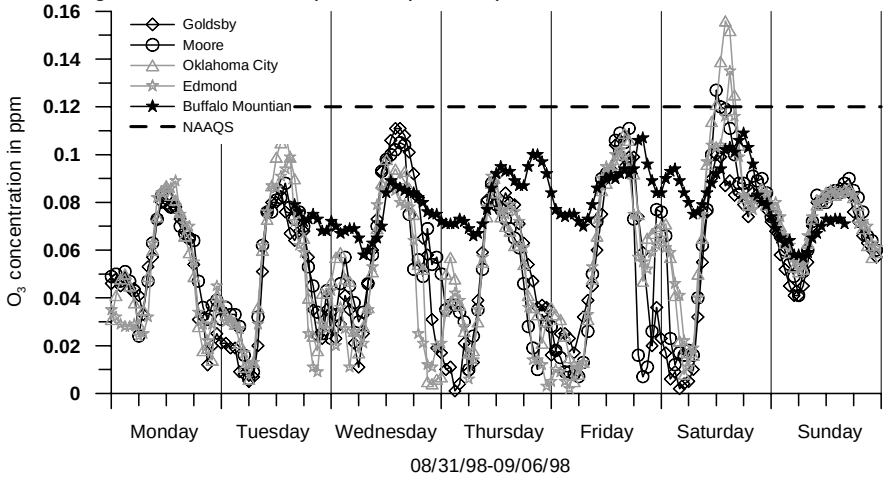

Fig. 3: Hourly O_3 concentrations at OKC air-quality monitoring stations during an episode in August/September 1998.