Updated Cox Trends Analysis
February 2008

Cox method: This method uses a statistical model to 'remove' the annual effect of meteorology on ozone (Cox and Chu, 1993). A Weibull survival regression model was fit to the 1997-2007 data to relate daily peak 8-hour ozone concentrations to six daily meteorological variables plus seasonal and annual factors. Meteorological variables included were daily maximum temperature, midday average relative humidity, morning and afternoon wind speed and wind direction. The model is then used to predict 4th high ozone values. By holding the meteorological effects constant, the long term trend can be examined independently of meteorology. Presumably this trend reflects trends in the emissions of ozone precursors. In addition, the annual factor can be held constant to examine the meteorological similarity of each year to other years. Overall, trends in this period are downward or flat at the locations examined. Figure 1 shows the model results for Cleveland for illustration.

A similar model was run to examine meteorologically adjusted trends in seasonal average ozone. This model incorporates more meteorological variables, including rain and long-distance transport (direction and distance). Model development was documented in Camalier et al., 2007. Trends determined by this model for the same set of sites examined above are consistent with those developed by the prior model. The seasonal average trend for the example site in Cleveland is shown in Fig. 2.

Ozone and met data for these models are the same as used in the CART analysis. The meteorological data set, consisting largely of National Weather Service measurements, was provided by EPA and compared to data compiled here. Data were almost identical; the EPA dataset included trajectory information that had been processed by them to incorporate air mass transport predictors so that data was used in here.

All three approaches – CART and these 2 nonlinear regression models--reach similar conclusions; ozone in the urban areas of the LADCO region has declined in the 1997-2007 period, even when meteorological variability is accounted for. The decreases are present whether seasonal average ozone, peak values (annual 4th highs), or a subset of high days with similar meteorology are the targets of interest. The consistency of results across models is a good indication that these trends reflect impacts of regional control measures.

References:

Camalier, L., W. Cox, and P. Dolwick, The effects of meteorology on ozone in urban areas and their use in assessing ozone trends, Atmos. Env. 41: 7127-7137 (2007).

Cox, W., and S.-H. Chu, Meteorologically adjusted ozone trends in urban areas: A probabilistic approach, Atmos. Env. 27B(4):425-434 (1993).

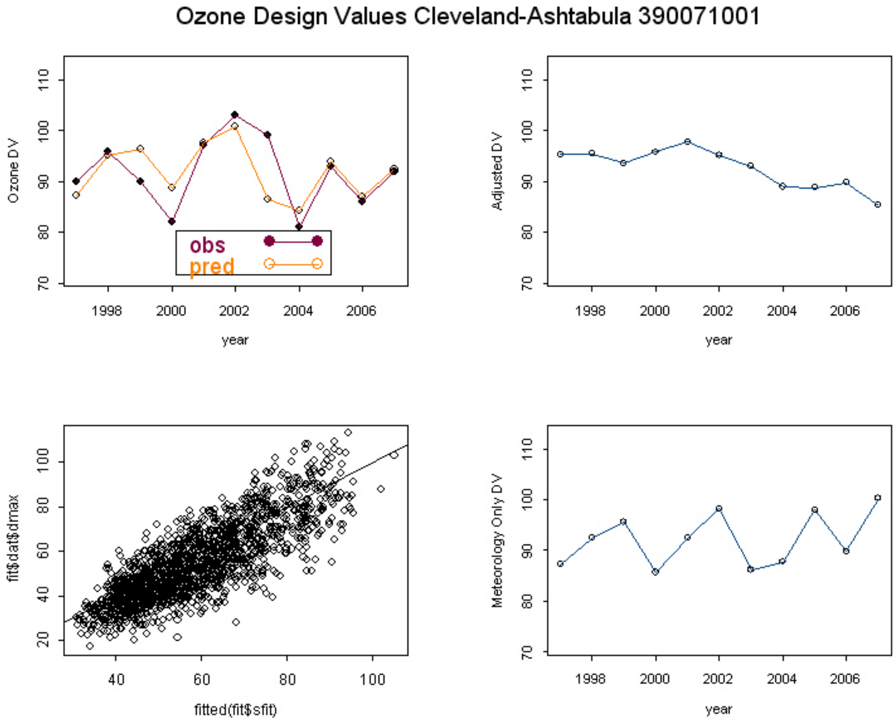

Fig. 1. Model results for Cleveland. Upper left panel shows predicted 4th high O3 vs. observed 4th highs. Lower left panel shows predicted ozone vs. observed ozone for all 11 years. Upper right panel shows the meteorologically adjusted ozone trend (i.e., meteorology effects are removed and remaining trend reflects emissions). Lower right panel shows the trends in ozone adjusted for time (i.e., time effects are removed and the remaining trend reflects meteorology).

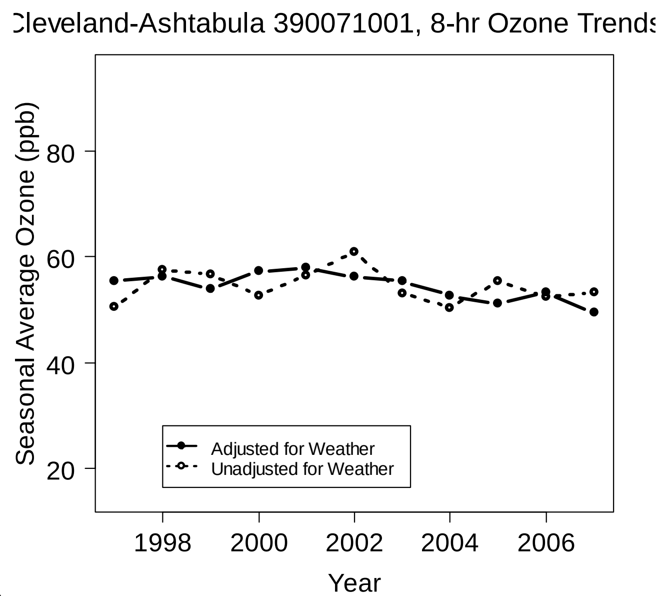

Fig. 2 Seasonal Average Trends in Ozone