4.2.4. ANALYSIS OF CO AND O_3 DATA FROM CAPE POINT OBSERVATORY (1994-1998)

Cape Point Observatory (CPT) is located at the southern tip of Africa (34°S) on a peninsula (Figure 4.14). This figure shows the average transport pathways to CPT and their frequency of occurrence. The 5-day fetch is often in the remote South Atlantic. Cape Point is one of a few sites measuring trace gases transported from the southern oceans. However, Cape Point is also located 60 km from Cape Town, a city of more than two million people; therefore, pollution from car exhaust and industry does at times reach the observatory. In collaboration with the two sponsors of the observatory, the Fraunhofer Institute in Germany and the South African Weather Bureau, 5 years (1994-1998) of hourly CO and O_3 measurements were obtained to develop an automated selection technique that removes Cape Town pollution and then analyzes the remaining baseline data.

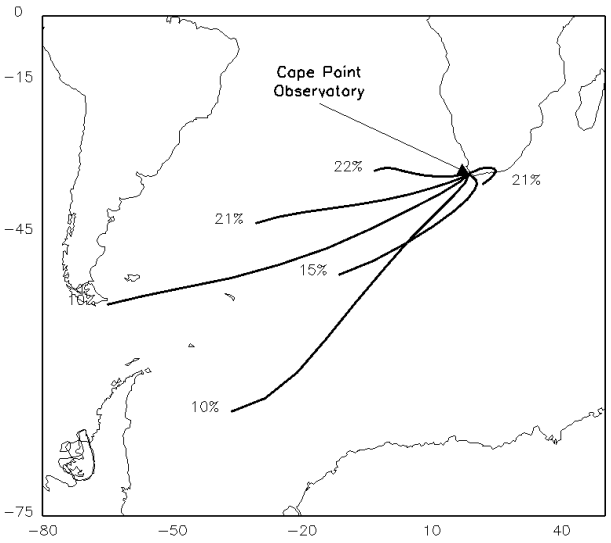

Fig. 4.14. Average transport pathways to CPT with their frequency of occurrence, based on 1994-1998 5-day back isentropic trajectories arriving at 500 m.

Figure 4.15 shows the results of the selection procedure. The red plus signs are rejected data; the blue dots are selected data. Most of the discarded data points occur during austral winter when local meteorology makes pollution episodes at CPT more likely to occur. The selection procedure is an iterative technique that first fits a smooth curve to the hourly data and then removes the smooth curve to obtain residuals. The residuals are filtered and points above the +1 standard deviation (S.D.) limit are discarded. The process continues until no points are discarded. The O_3 measurements were selected by pairing them with the selected CO data set. To further reduce the data set, 3-hr averages were formed about 0000 and 1200 GMT corresponding to arrival times for the trajectories. These twice-daily averages are shown in Figure 4.15.

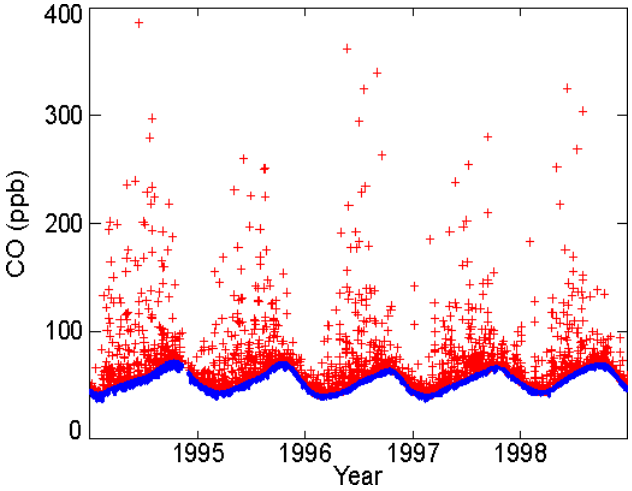

Fig. 4.15. Results of the +1 S.D. selection process. Red plus signs mark rejected data; blue dots are the final selected points for CPT CO data.

Figure 4.16 shows how the distribution of CO is changed by selection. For each color/fit, the upper line represents a fit to all of the data while the lower line represents a fit to the selected data. The blue line is a polynomial representing the long-term trend. Although the unedited data appear to have a downward trend, the selected data show no linear trend, merely a slow oscillation. The red curve is the polynomial combined with four harmonics representing the average seasonal cycle. The selection shifts the CO average seasonal maximum from July to October and the minimum from the end of January to the end of February. Finally, the green curve is the red curve combined with residuals filtered in the frequency domain. The residuals have variations with periods of about 2 months or more.

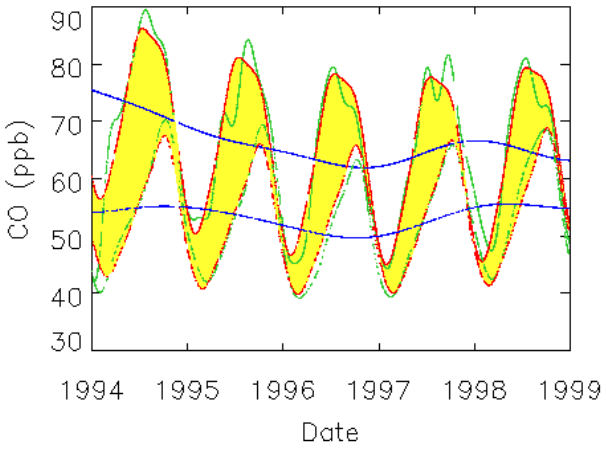

Fig. 4.16. The change to the CPT CO distribution made by selection: for each color, the upper curve is fitted to all the data, and the lower curve is fitted to the selected data. (See text for description of curves.)

CO and O_3 variations on the synoptic time scale attributed to changes in transport were not large. Strong southerly flow resulted in average CO values up to 1 ppb lower and O_3 values 1 ppbv higher than average values in air transported from the latitude of the observatory. These results are consistent with the latitudinal gradients of these species.

Diurnal CO variations in the unedited data set can be up to 80 ppb. The most extreme pollution events occur during winter when local meteorological factors allow more stagnant conditions and recirculation of polluted air. Inversion characteristics and mesoscale winds (land/sea breezes) may contribute to pollution at Cape Point. Figure 4.17 shows the selected CO data set with nighttime values (blue) and daytime values (red). A small diurnal cycle persists in the selected CO data set of 0.2-0.4 ppb (depending on the grouping of the data). This diurnal cycle is statistically significant if all selected data are considered. The selected O_3 data also show small (up to 1 ppbv) diurnal cycles that vary with season. The sources of these remaining diurnal cycles will be investigated in the future.

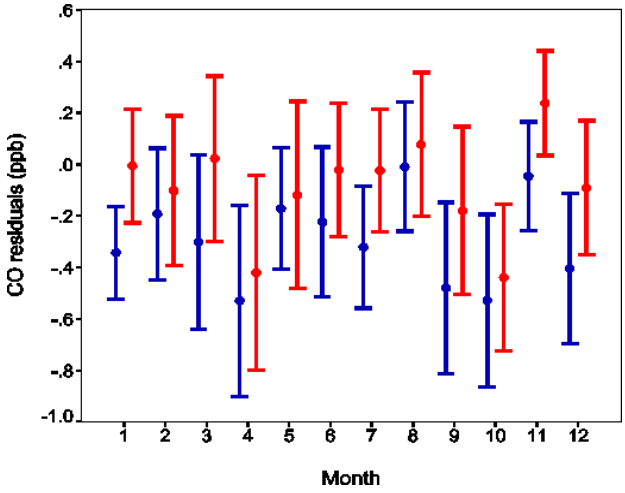

Fig. 4.17. CPT selected CO data set with nighttime values (blue) and daytime values (red). The dots are the monthly average value, and the bars show the 95% confidence interval for 1994-1998.