

# Air Quality and Winter Vehicle Use in Yellowstone National Park



Air Resources Division

John D. Ray  
Atmospheric Chemist  
Air Resources Division  
National Park Service  
Denver, CO



West Yellowstone Entrance

## Monitoring Participants:

Air Resource Specialists  
Ft. Collins, CO

State of Montana  
Dept of Environmental Quality

Yellowstone National Park

NPS Air Resources Division  
Denver, CO

## Topics covered

- Current and past CO & PM ambient concentrations.**
- Relationship of CO concentrations to winter vehicle numbers.**
- Multiple sources for PM<sub>2.5</sub>**
- Contributions by different types of vehicles.**



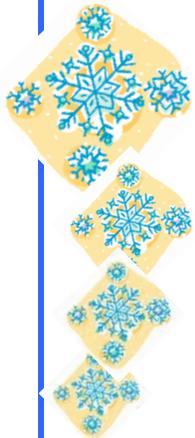
# Background

Snowmobiles became an issue in the 1990's as the numbers visiting the park began to increase. The current Winter Use Plan is the result of several law suits and policy changes.

Changes in entrance procedures and positive-pressure ventilation of the kiosk stations greatly reduced the exposure of park staff to unhealthy pollutants.

Ambient monitoring was first done in short-term studies. A monitoring station has been at the West Entrance since 1998. Over the last three winters monitoring was also done at Old Faithful.

The introduction of 4-stroke snowmobiles, guided groups, and limits on the daily number of entries was designed to control the emissions, noise, and adverse wildlife interactions.



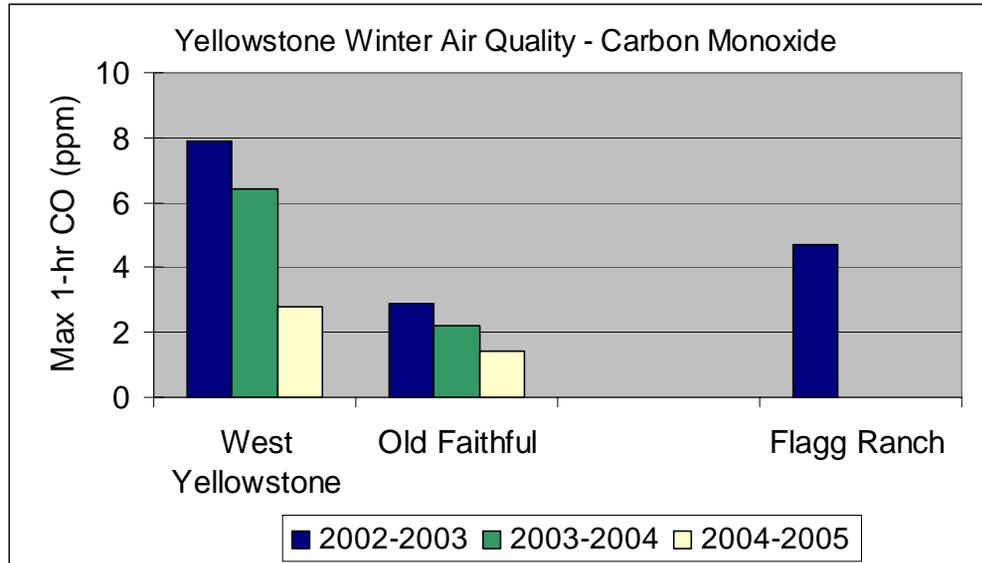
# What are the Issues?

Ambient air monitoring can't answer all the questions and issues surrounding the snowmobile controversy, but can address these items:

- Is the Winter Use Plan working to improve air quality?
- Is the park air quality in an acceptable range?
- Have snowmobile emissions gotten cleaner?
- How many snowmobiles can be allowed into the park and still keep acceptable air quality?
- Is there a correlation of the air pollutants to the snowmobiles?
- Are there other emission sources that are of concern?
- Can other steps besides limits on snowmobiles be taken to improve air quality?
- How much improvement is needed?



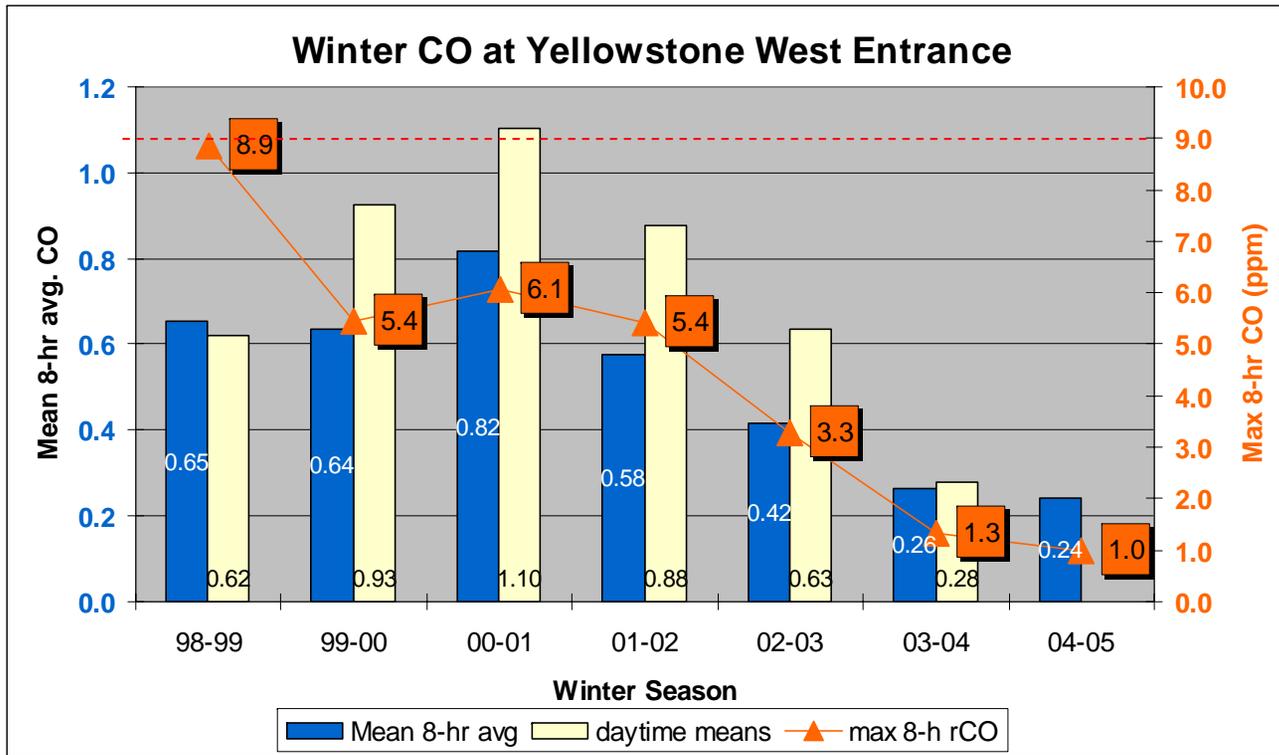
# Is the Air Quality Getting Better?



Of the 3 locations monitored, the West Entrance has the highest pollutant concentrations.

Maximum 1-hour CO concentrations have been decreasing.

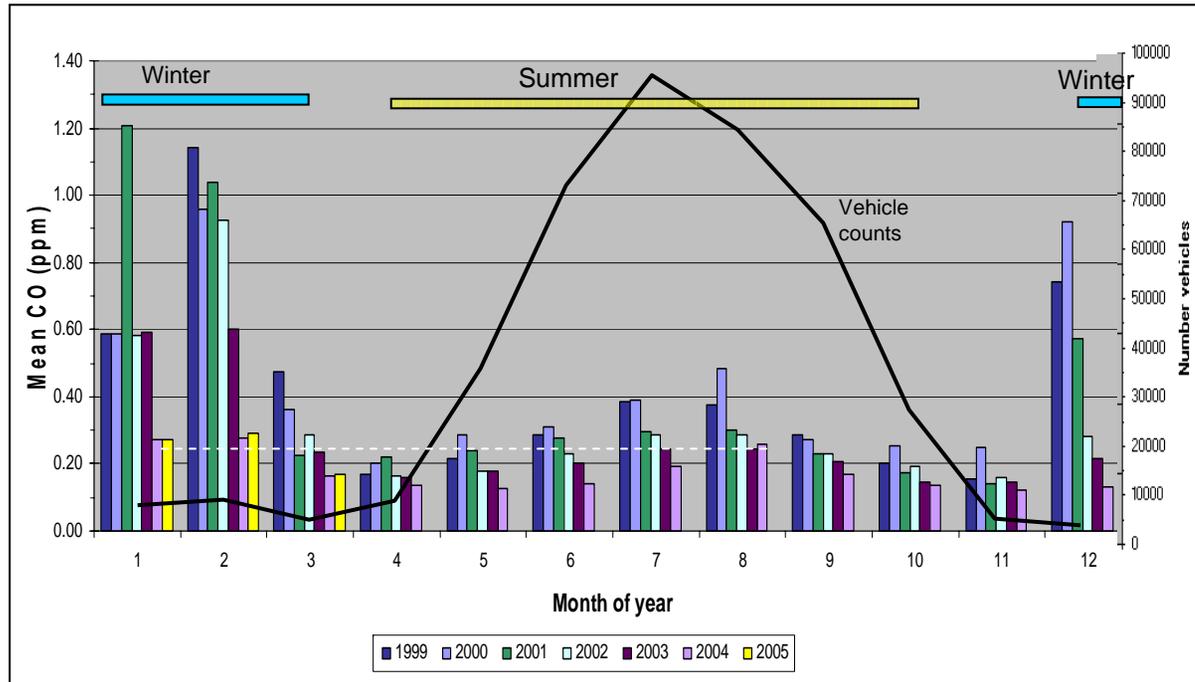
## CO Changes over 7 Winters



Since the high in Winter 2000-2001, CO concentrations have been decreasing at the West Entrance.

CO concentrations are higher during the day and near the background at night. 8-hour concentrations are now well below the NAAQS standard.

# Comparison of Winter and Summer CO

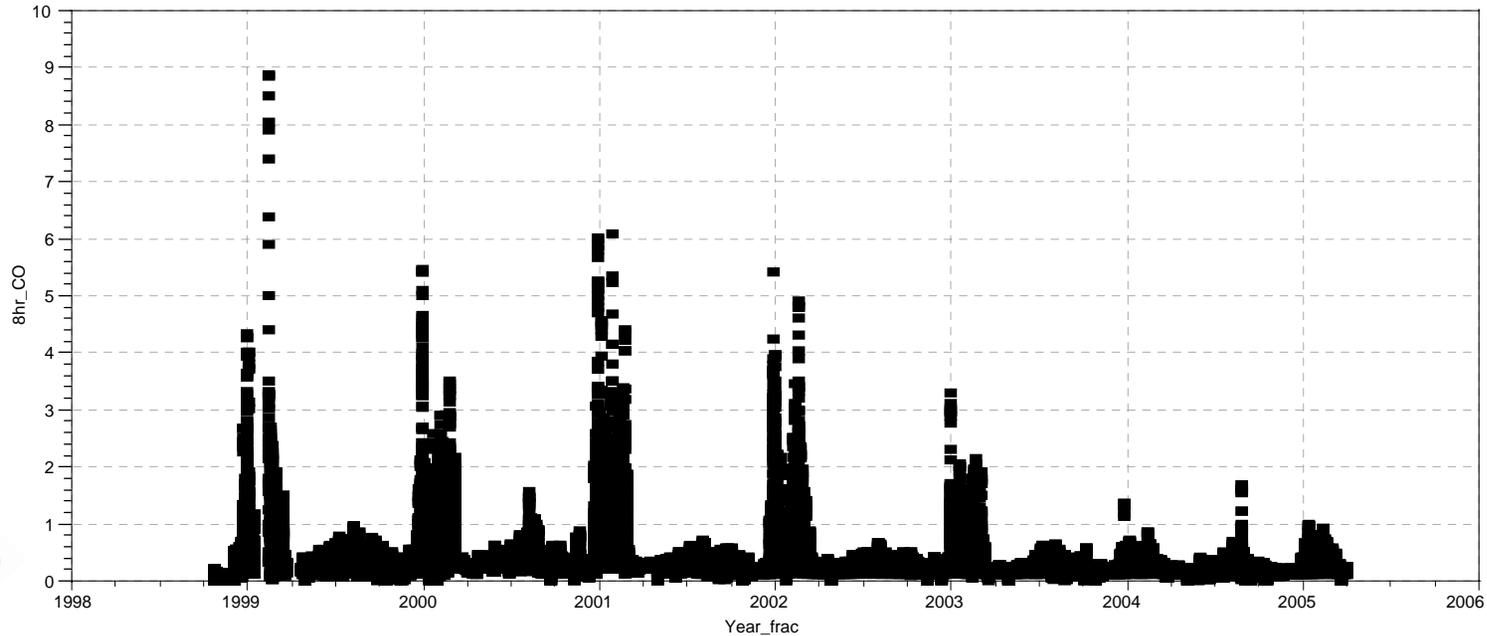


The mean monthly CO at the West Entrance has an annual cycle with the highest concentrations in Winter and lowest concentrations in Spring and Fall.

The Winter mean CO is now about what is seen in July and August.

The traffic in summer is many times that of the winter months.

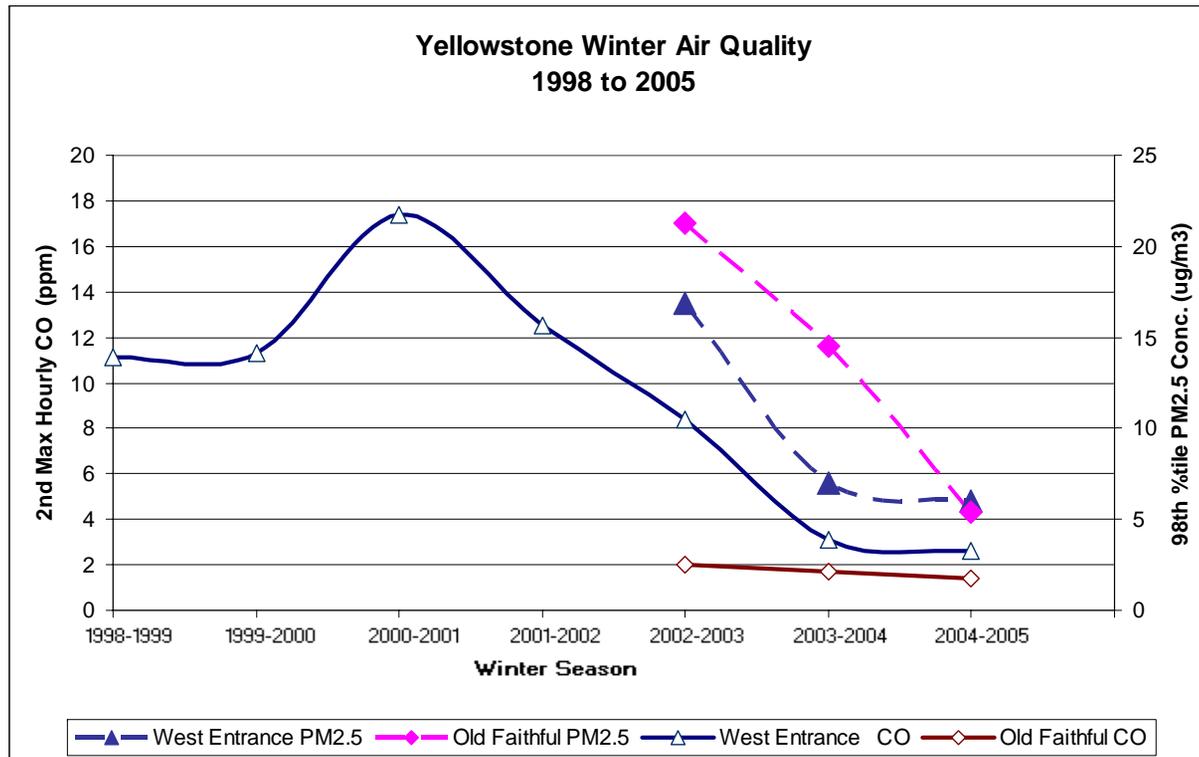
## West Entrance CO Patterns



Both the peak 1-hr, 8-hr, and mean CO concentrations have decreased since 1998-1999 when monitoring started.

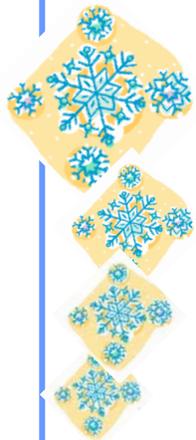
A few days each season define the highest concentrations. These tend to be days with the highest winter traffic.

# Historical Comparison CO and PM2.5



At the West Entrance both the CO and PM have decreased and leveled out in the last two winters.

At Old Faithful, CO and PM have decreased but the shape of the curve is different. There is no sign of a leveling out. Also, the PM2.5 is higher at Old Faithful whereas the CO has always been lower there than at the West Entrance.



# Is the Air Quality Getting Better?



Both the CO and PM2.5 concentrations have decreased at the West Entrance and at Old Faithful.

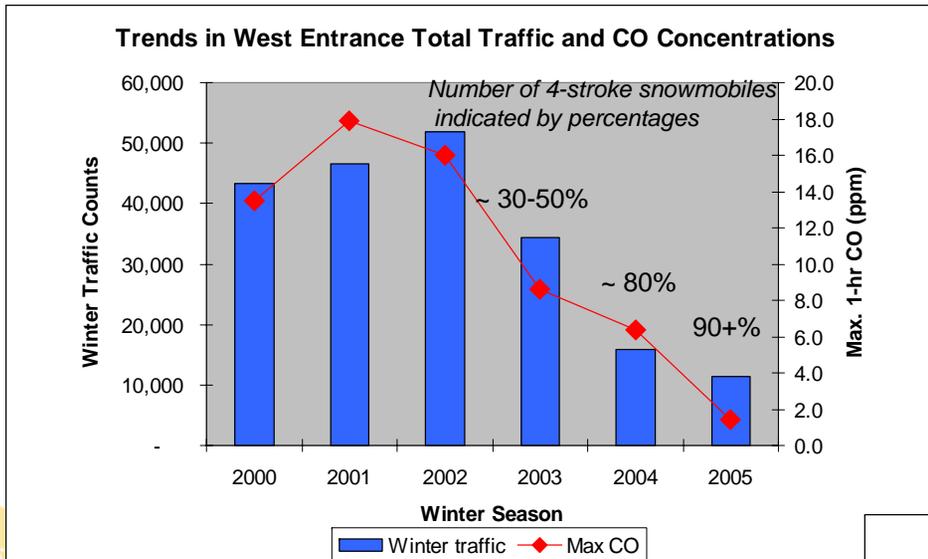
Winter concentrations of pollutants are well below the standards and getting close to the summertime concentrations.

**Is the Winter Air Quality Getting Better at Yellowstone ?**

**Yes** . . . maybe

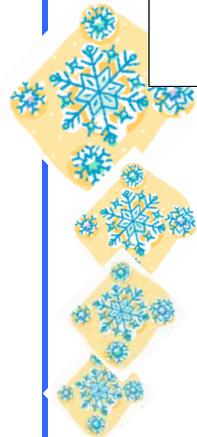


# Why is AQ better? WUP working?



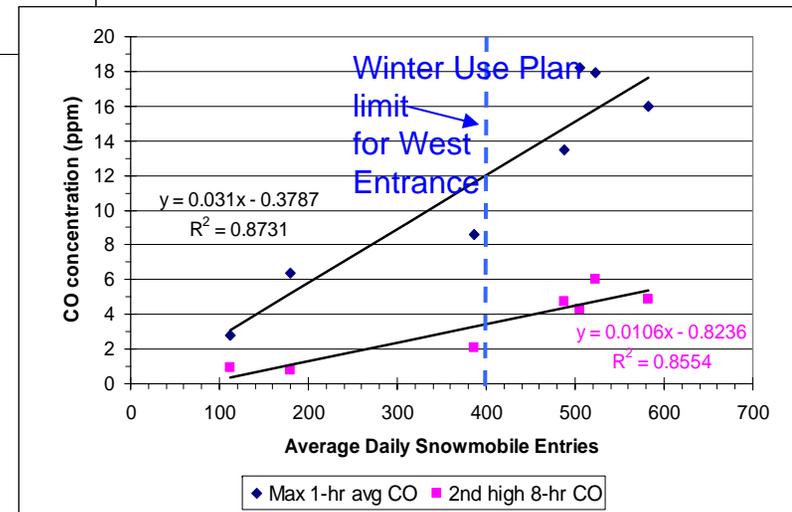
Along with the decreased CO concentrations:

- the winter traffic has decreased
- the percentage of lower-emission 4-stroke snowmobiles has increased. 2-stroke snowmobiles are now less than 10% of total being used inside the park.



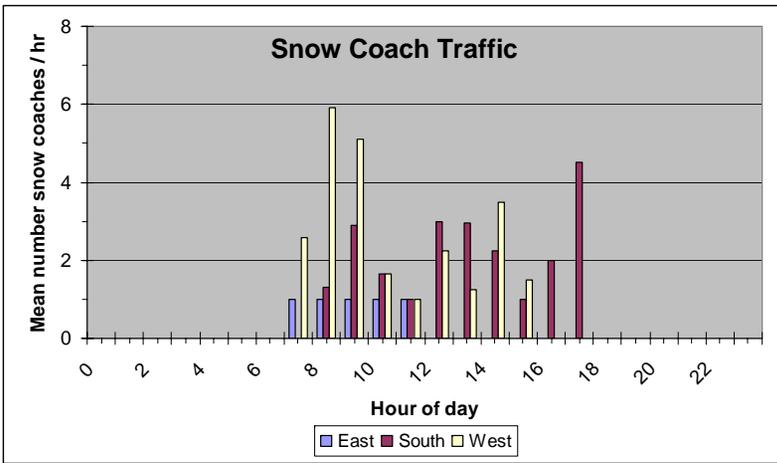
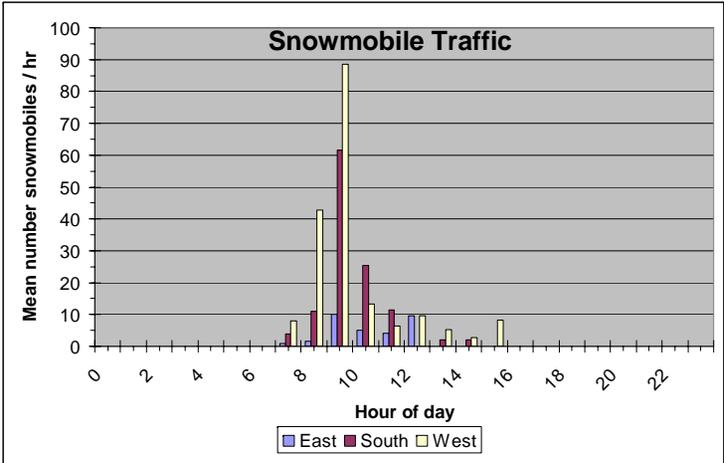
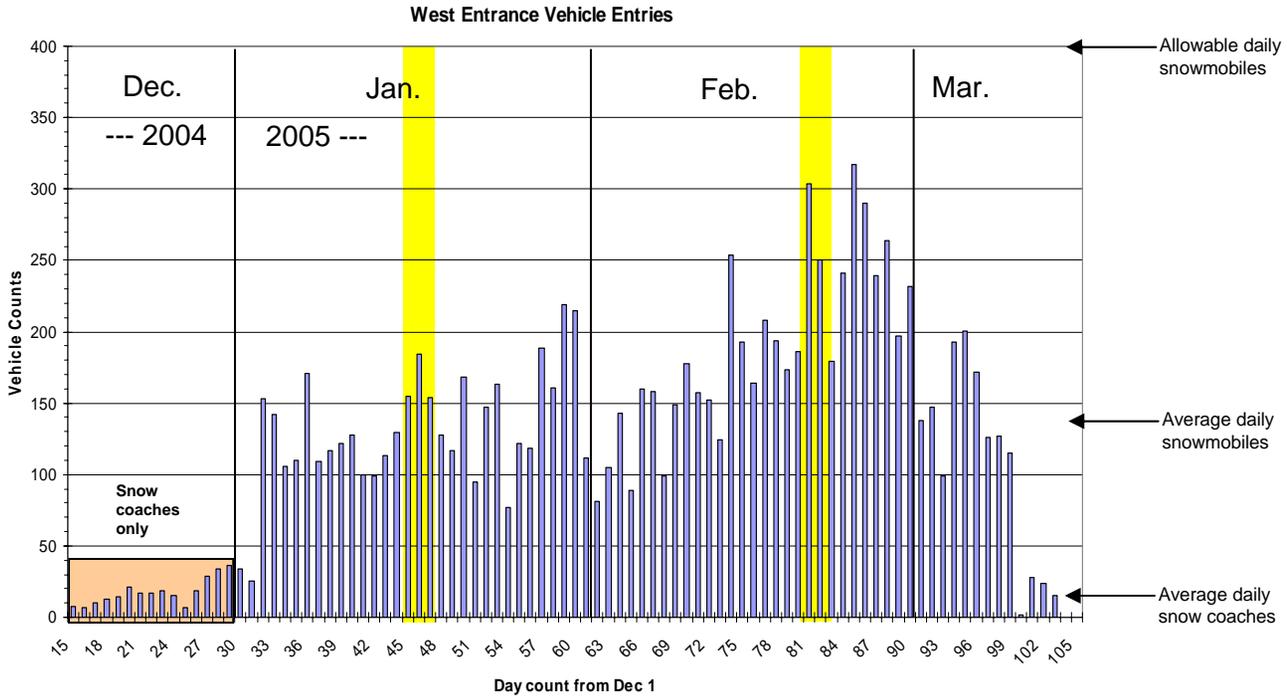
The decrease in winter traffic accounts for about 80% of the CO change.

If the maximum daily allowable number of snowmobiles were to enter the park, the expected CO would be about 12 ppm max. 1-hr and 3.8 ppm max. 8-hr.

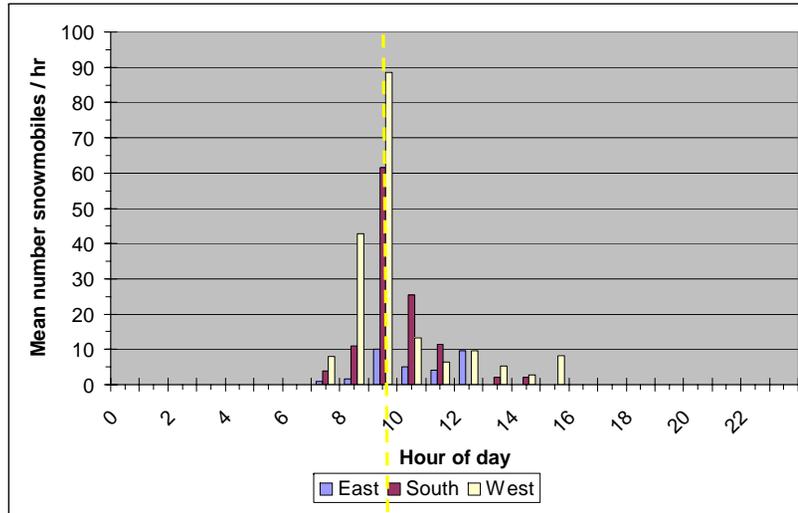


Relationship between air quality and daily traffic.

# West Entrance Traffic Patterns

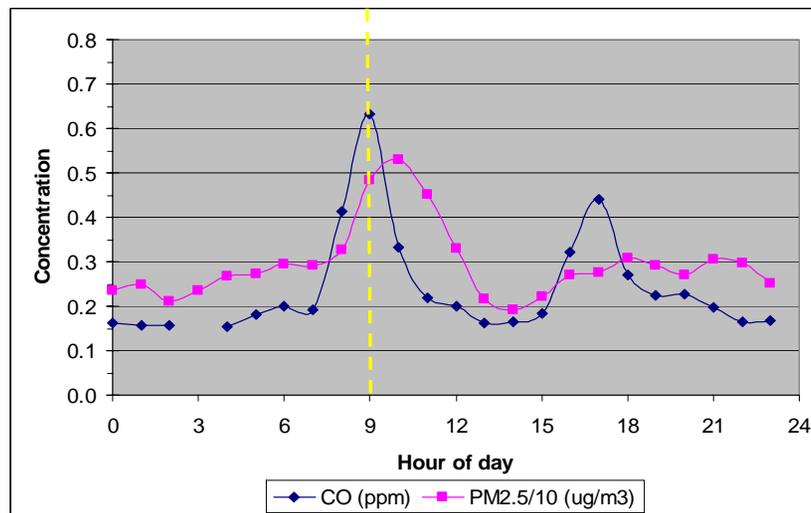


## Diurnal patterns for CO and PM at WE

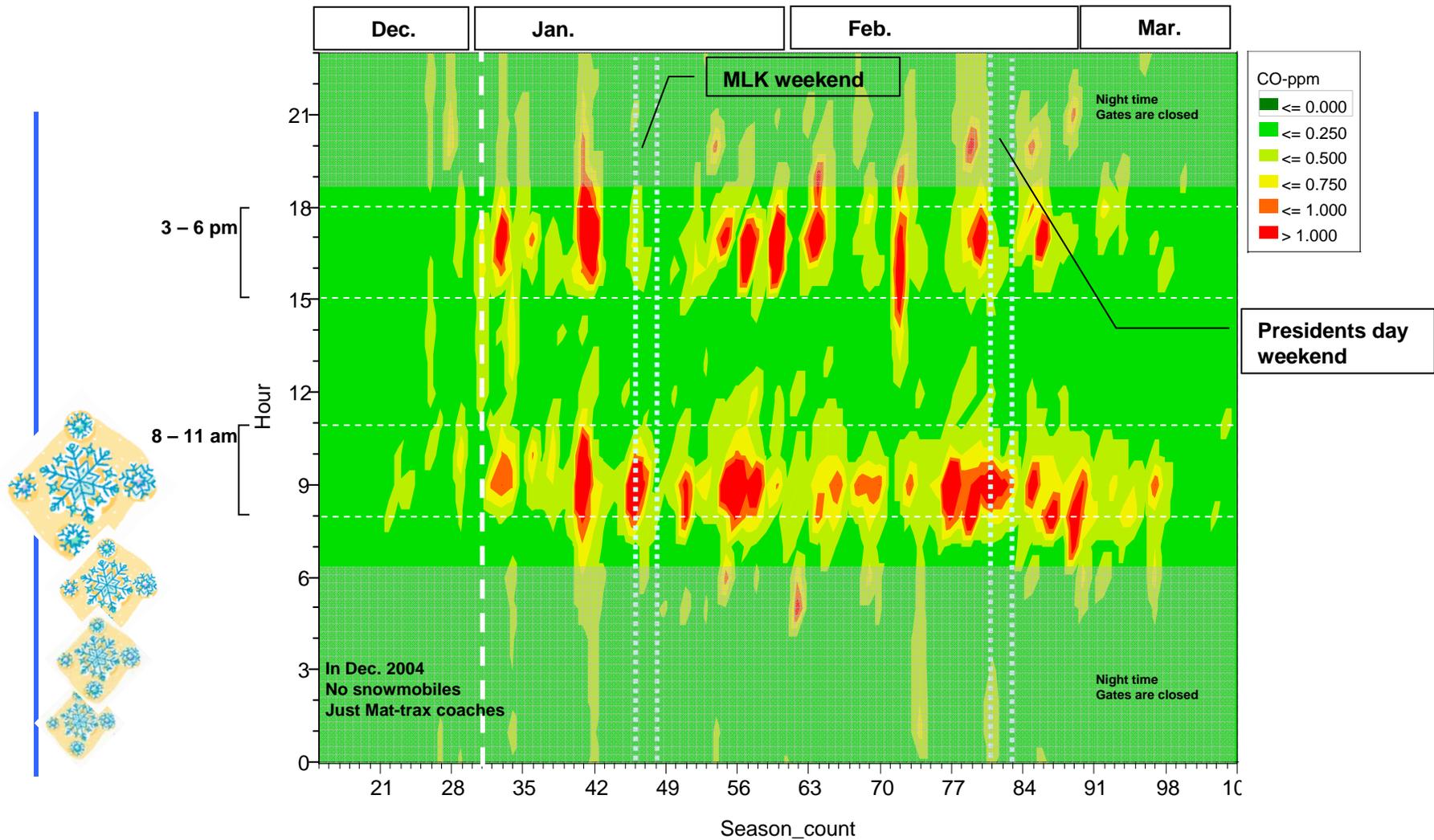


The peak CO concentrations at the West Entrance are between 9 to 10 am when the number of snowmobile entries is highest. A secondary CO peak occurs in the afternoon as the snowmobiles leave the park.

The PM peak for the day at the West Entrance is an hourly later between 10-11 am. An afternoon increase in PM extends well into the night time hours and after the period of exiting traffic.

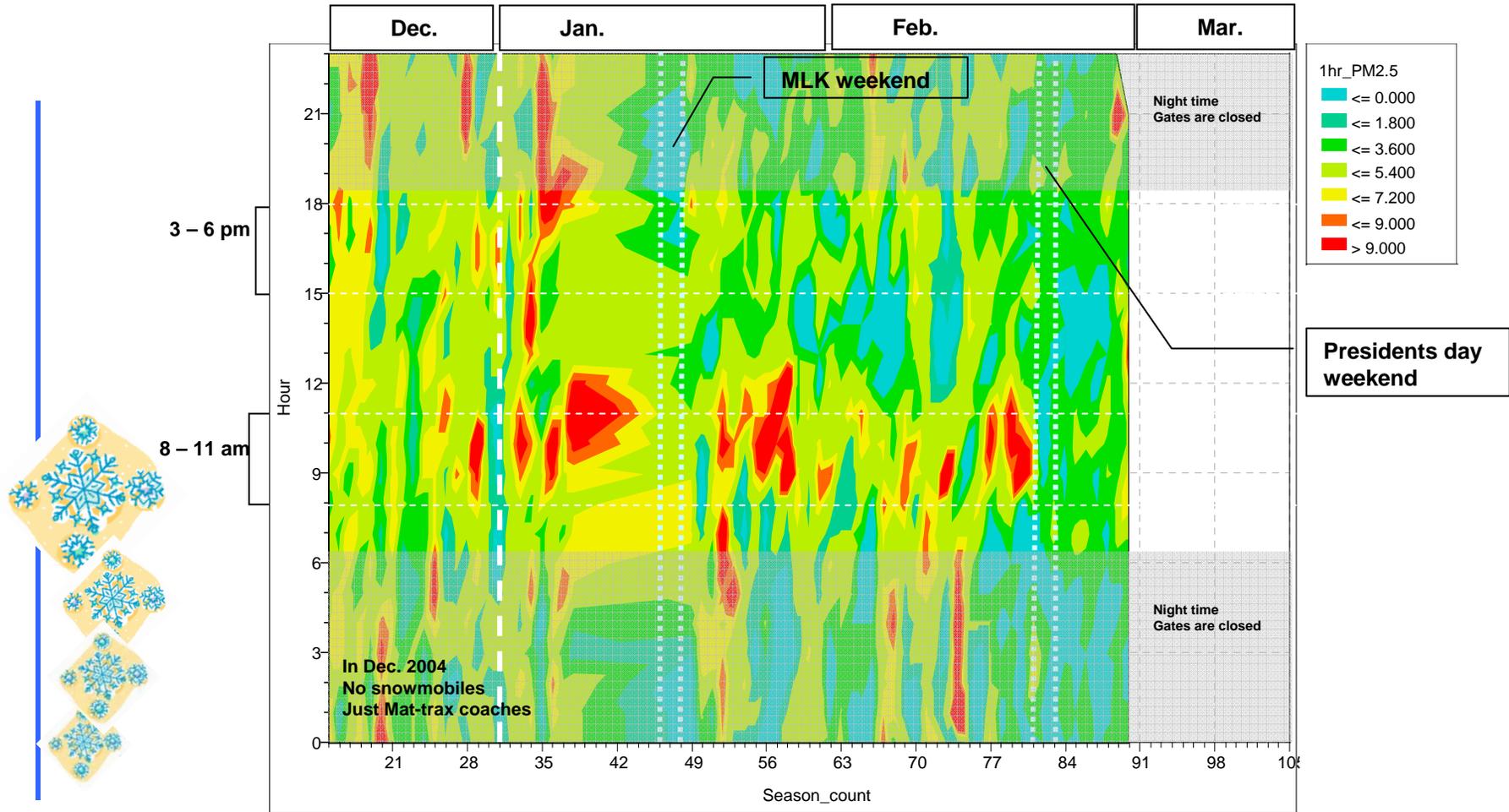


# CO Concentration Patterns at West Entrance



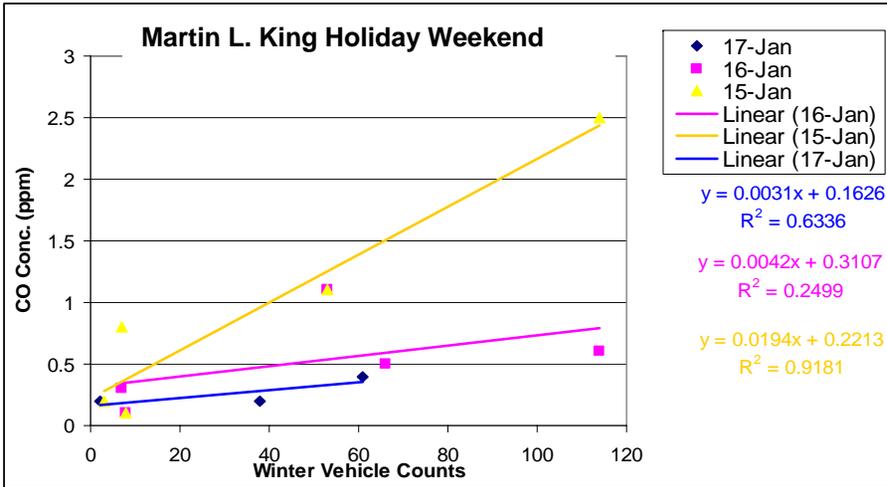
CO concentrations are highest during periods when there is the most traffic. Each day is different for maximum CO, but the pattern repeats of morning and afternoon high periods. Fewer high periods occur in March as traffic decreases and days are warmer.

# PM2.5 Concentration Patterns at West Entrance

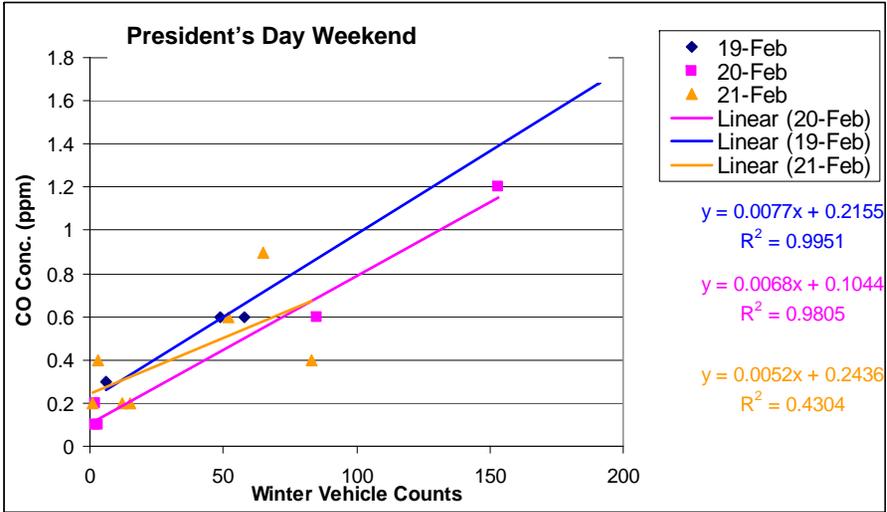


Many periods of higher PM2.5 fall outside the busy periods for snowmobile traffic through the entrance area. PM from West Yellowstone sources such as wood smoke and Other 2-stroke snowmobile traffic is suspected.

# Why is AQ better? WUP working?



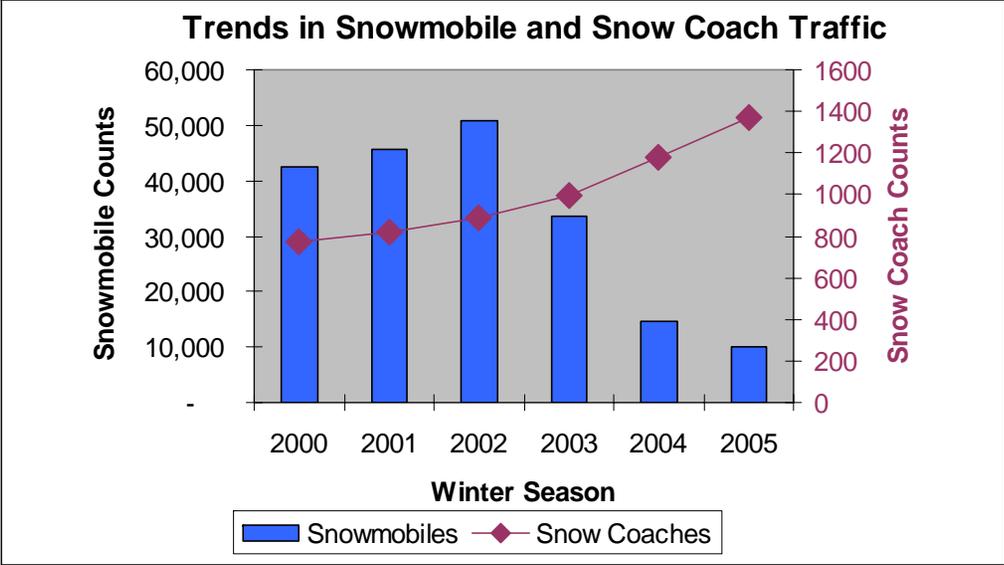
The relationship between ambient CO and the amount of daily traffic changes by day.



For the maximum allowable number of snowmobiles (400) per day for the West Entrance, the average slope would yield 3.3 ppm for the maximum hourly CO. If the highest slope is used, the max would be closer to 7 ppm.

The CO concentrations and traffic volume correlate using hourly data.

# Why is AQ better? WUP working?

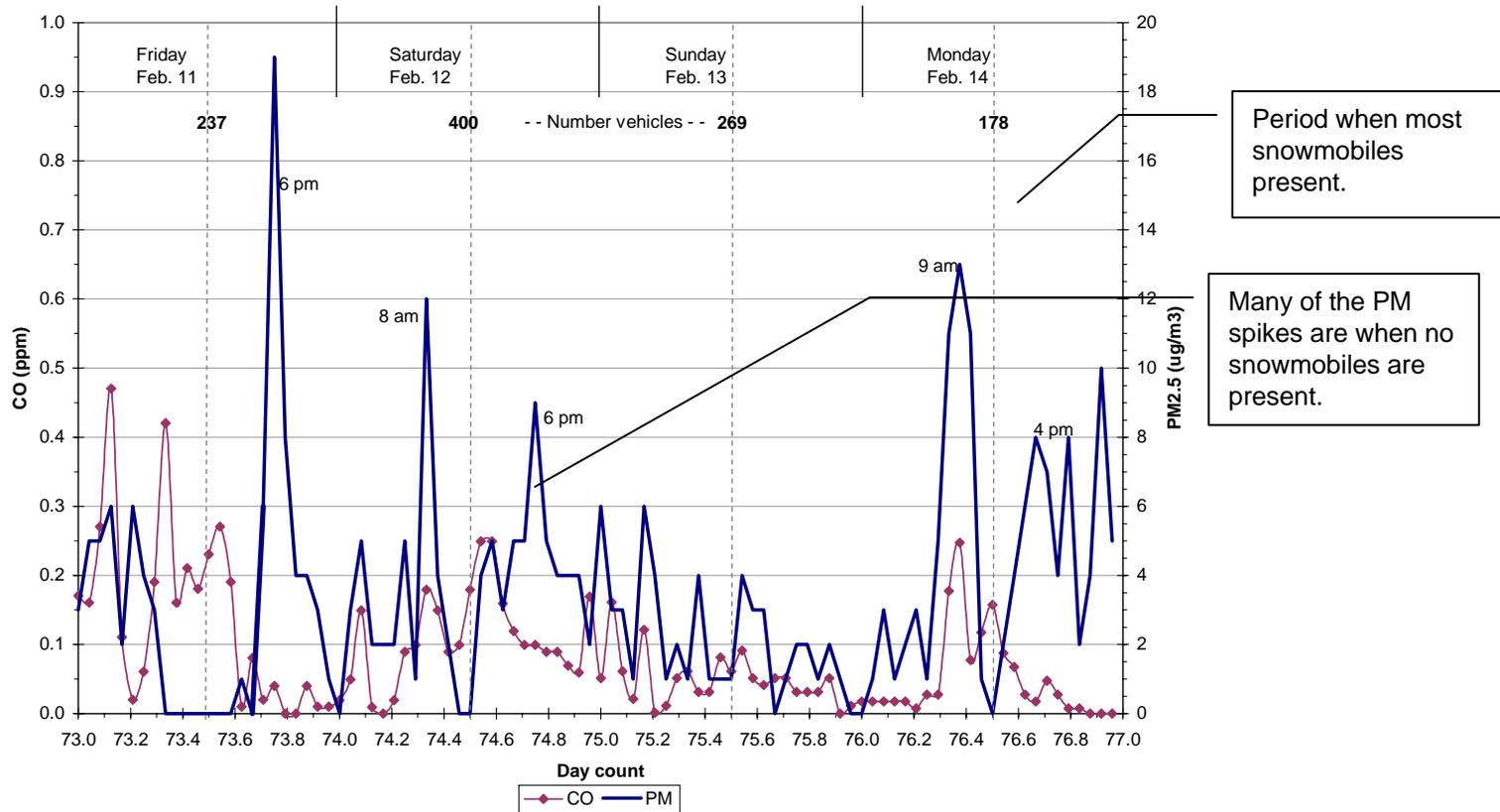


Emission factors and the estimates of traffic for each type of vehicle can be used to get a percentage contribution of CO at the West Entrance:

	Emissions	Portion of traffic
2-stroke snowmobiles	11%	9 %
4-stroke snowmobiles	44%	82 %
Snow coaches	45%	9 %

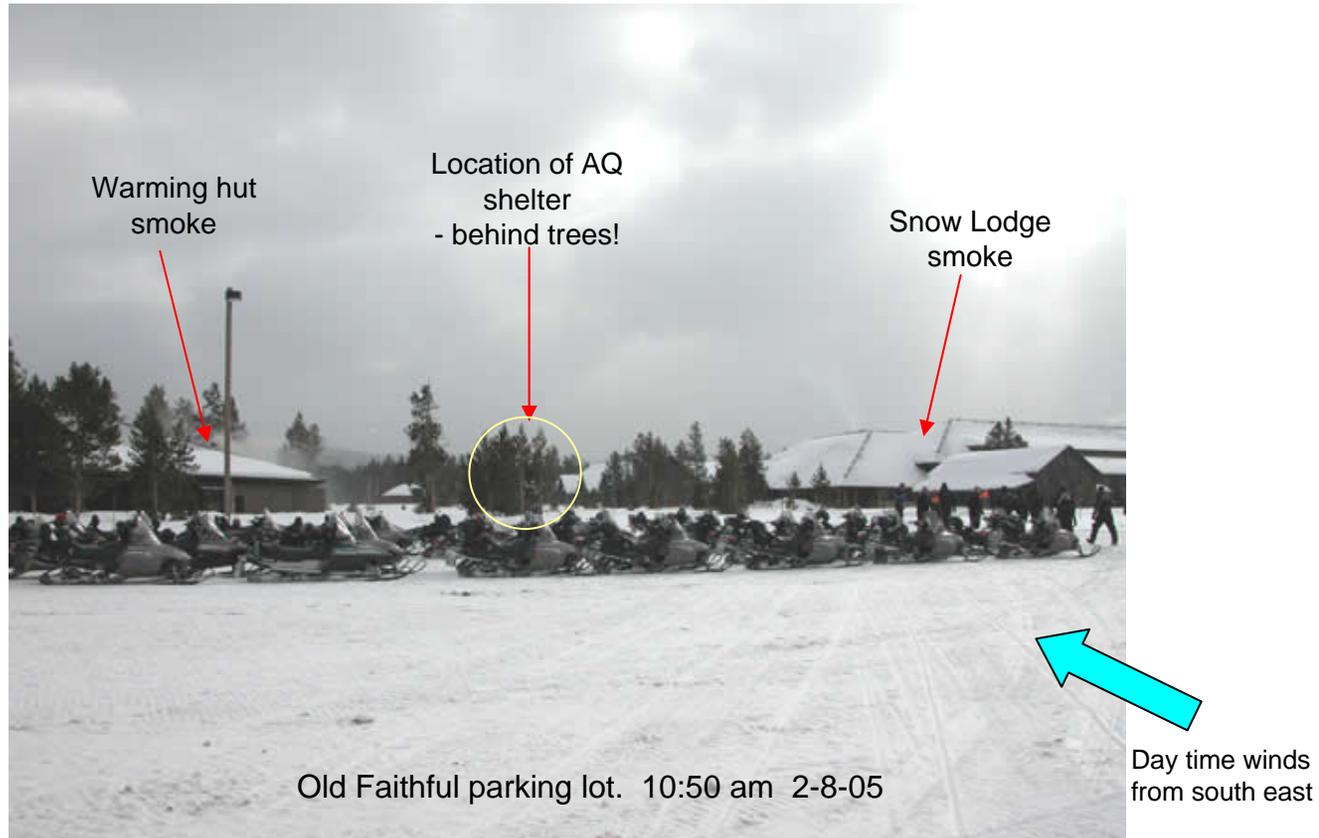
Although snow coaches are more efficient on a gm/mile/passenger basis, they have higher emissions at both idle and cruise than an individual snowmobile. The increase in snow coach numbers is offsetting some of the snowmobile emission reductions.

# PM2.5 and CO Patterns at Old Faithful



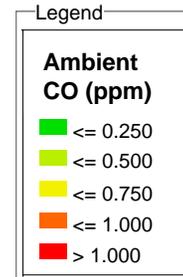
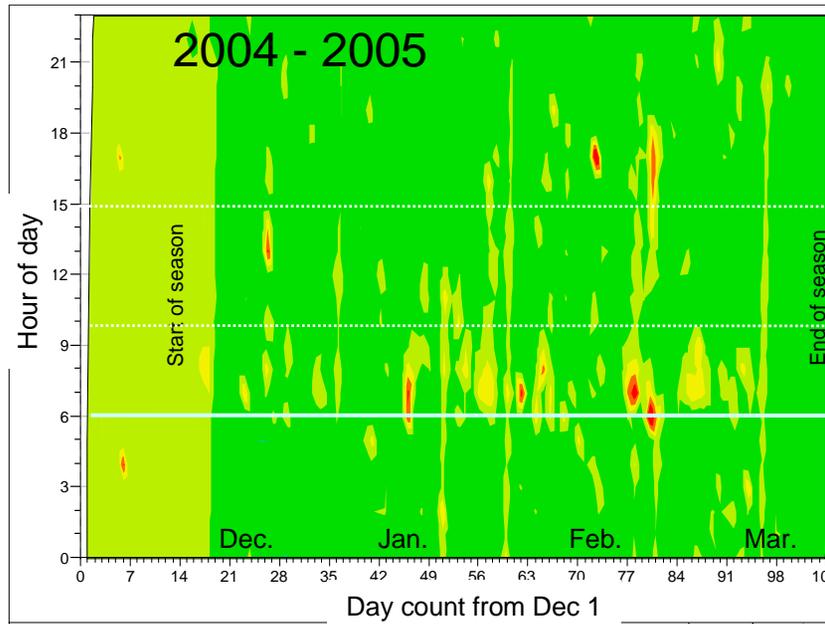
Presidents Day weekend provides an example of what happens at Old Faithful. The maximum number of snowmobiles was on Saturday. A peak in CO is seen during the period of most activity for each of the days. A minor peak in PM is seen on two of the days during mid-day, but two other days had near zero PM. The largest PM peaks are in the evening and at night when it is dark and there is near zero traffic.

## PM2.5 Concentration Patterns at West Entrance

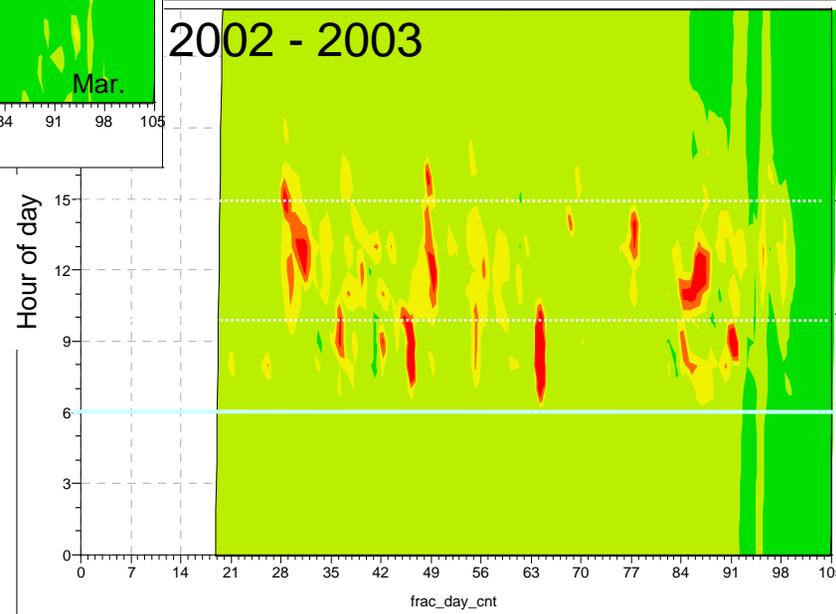


Many periods of higher PM2.5 fall outside the busy periods for snowmobile traffic through the entrance area. PM from West Yellowstone sources such as wood smoke and Other 2-stroke snowmobile traffic is suspected.

# CO Concentration Patterns at Old Faithful



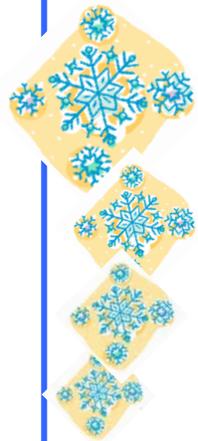
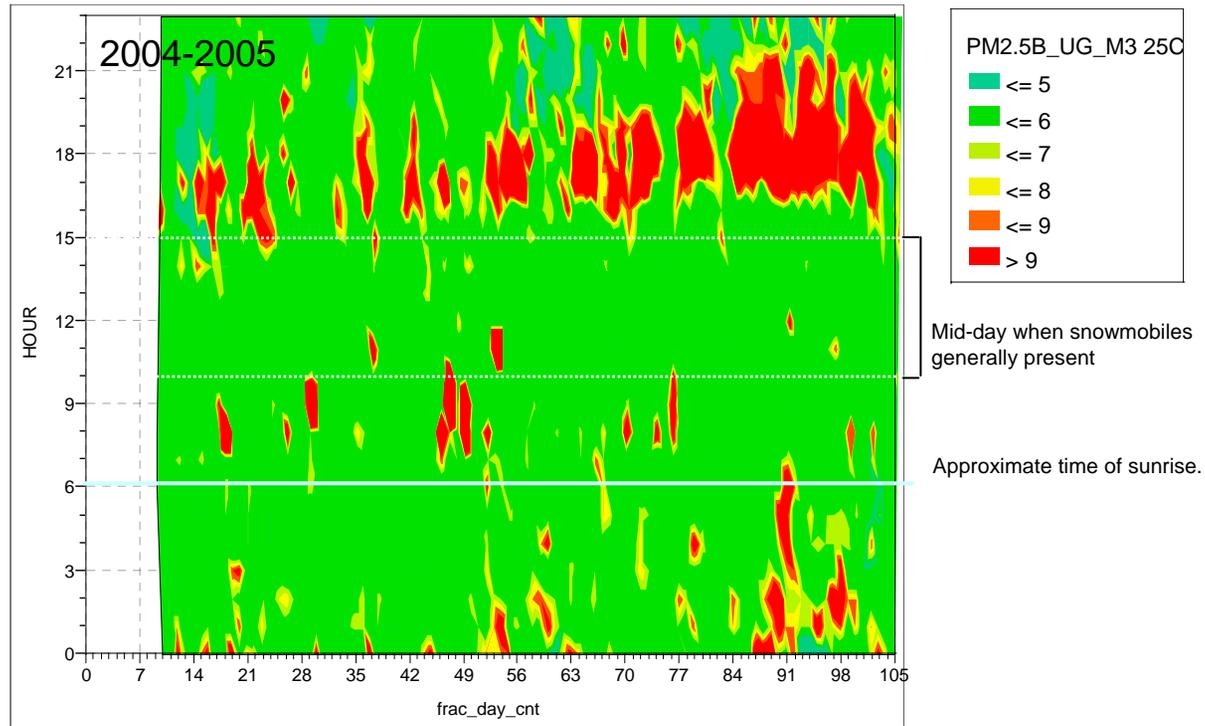
Primary period when snowmobiles are present each day - 10am to 3pm.



A good part of the CO observed at Old Faithful doesn't even occur when snowmobiles are present during mid-day. This is contrast to winter 2002-2003 when most of the high CO periods were during mid-day.



# PM2.5 Concentration Patterns at Old Faithful



Most of the periods of higher PM2.5 at Old Faithful fall outside the busy periods for snowmobile traffic. The highest PM periods are in the evening. PM from other sources such as wood fireplaces or cooking are suspected.

# Why is AQ better? WUP working?



- Most of the decrease in CO is from lower traffic volume.
- Increasing snow coach traffic has offset some of the gains from lower emission snowmobiles.
- The current snowmobile traffic is far below the allowable number. If the limits under the WUP are reached, the expected CO concentrations will be about two-thirds of the national standard.
- Additional local sources of PM and CO are indicated by recent data.



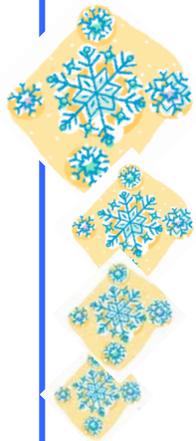
WUP working ?

Maybe not as expected. Snowmobile traffic is way down for reasons other than the WUP itself. Snow coach contributions may be larger than previously expected.

# Summary & Recommendations



- CO and PM2.5 are both decreasing over the last several years.
- The air quality is improved and now well below the standards.
- The reduction in the number of snowmobiles has been the primary reason for improving conditions.
- The snow coaches and remaining 2-stroke snowmobiles make a disproportionate contribution to ambient air pollutants.
- Other local air pollution sources are now being observed.
- Summertime traffic is much cleaner on a per vehicle basis. The mean winter CO concentrations are close to the peak summer concentrations.



mmn

# Summary & Recommendations

- ❑ Hot spots where winter vehicle traffic congregates is the primary air quality concern, especially if park staff and visitors are exposed to the pollutants.
- ❑ Emissions controls and limits on the number of snow coaches may also be needed to keep air quality at present or better conditions.
- ❑ Wood fireplaces and other stationary sources within the park or very near by are making observed negative impacts on air quality. Controls or replacements should be considered for some of the more obvious sources.

