

Ozone Evolution in the Mexico City Plumes during the MIRAGE-Mex Field Campaign

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Collaborators:

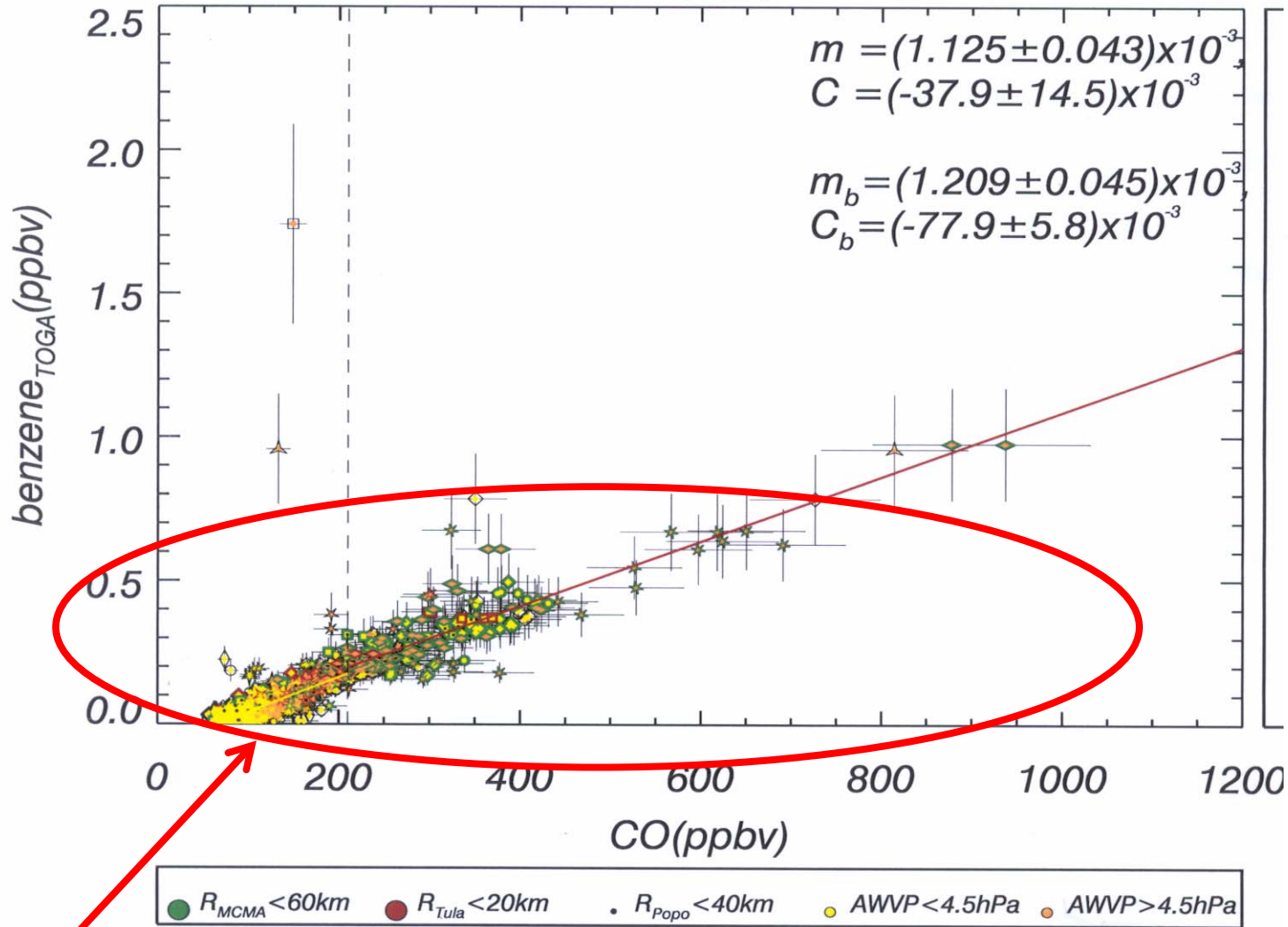
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Andy Weinheimer,
Teresa Campos



Outline

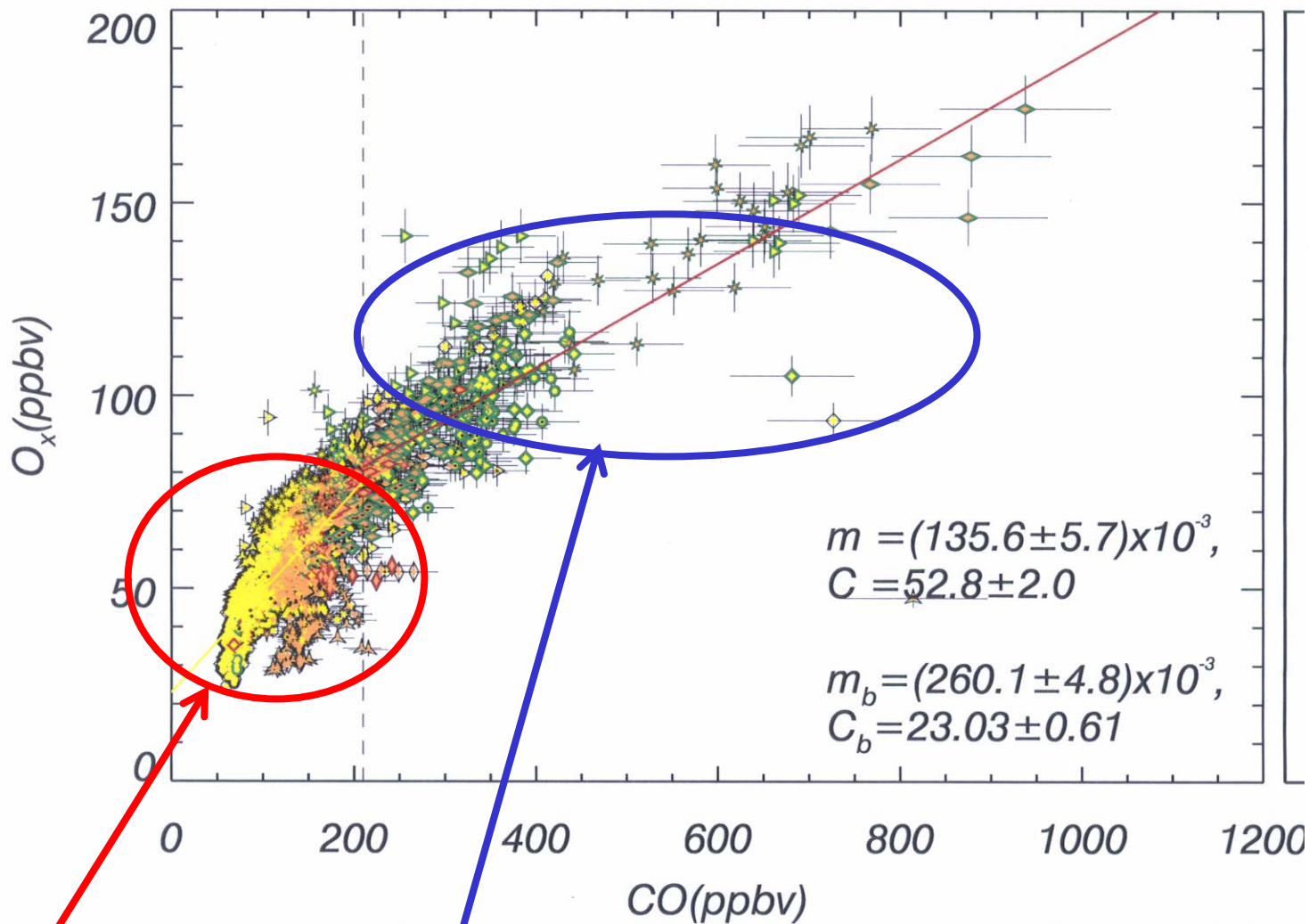
- Data and Model Comparison
 - (1) To evaluate model
 - (2) To study the ozone formation in different ages of the plumes
- Ozone evolution (WRF-Chem)
 - (1) Ozone and other oxidants in the plumes
 - (2) OH reactivity in the plumes

benzene_{TOGA} vs CO



Clearly linear aggression in both young and aged plumes

O_x vs CO



Aged plume
Slope is high

Young plume slope is low

Plot from Mckenna



Benzene and CO: Linear correlation

Emitted from prime sources (Anthropogenic)

Decrease resulted from dilutions and chemical reactions (OH)

Ozone and CO: non-Linear correlation

CO is emitted from prime sources (Anthropogenic)

O₃ is chemical produced

In the **young** plume Ozone/CO is **low**

In the **aged** plume Ozone/CO is **high**

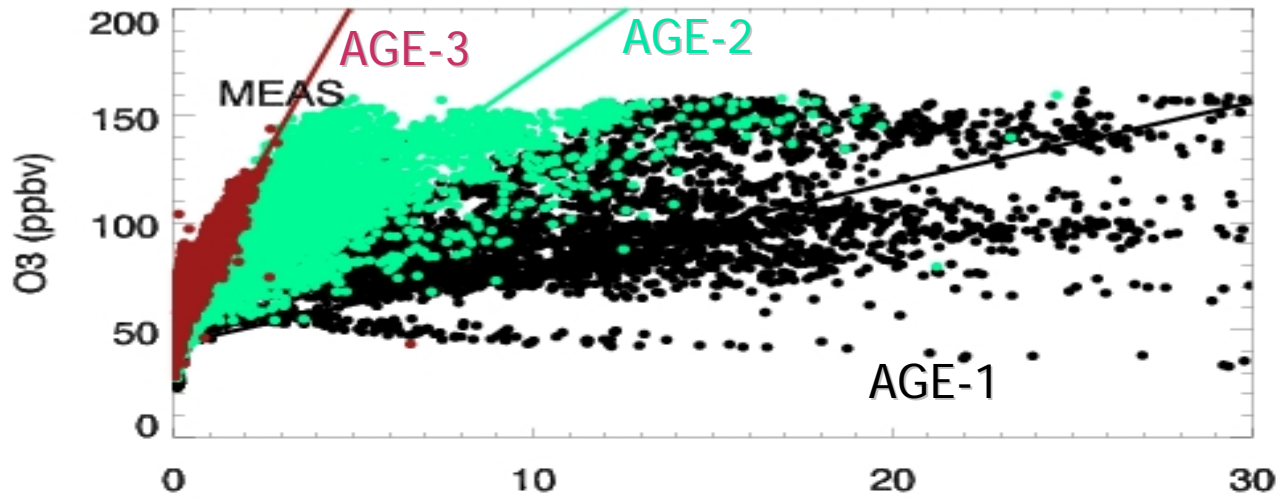
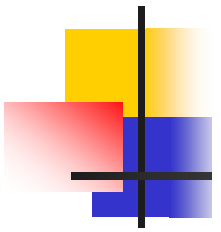


Define the age of plumes

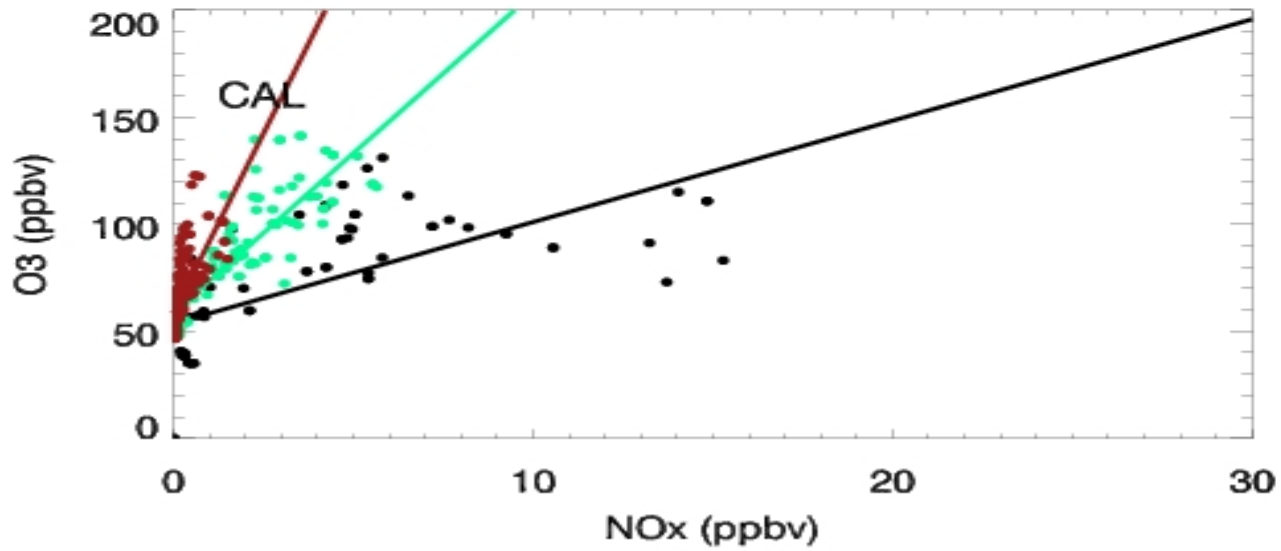
$$\text{Age} = -\ln(\text{NO}_x/\text{NO}_y)$$

- | | |
|-----------------------|------------------|
| (1) AGE-1 (Age = 0-1) | Young age plume |
| (2) AGE-2 (Age = 1-2) | Middle age plume |
| (3) AGE-3 (Age > 2) | Old age plume |

Ozone-NOx correlation

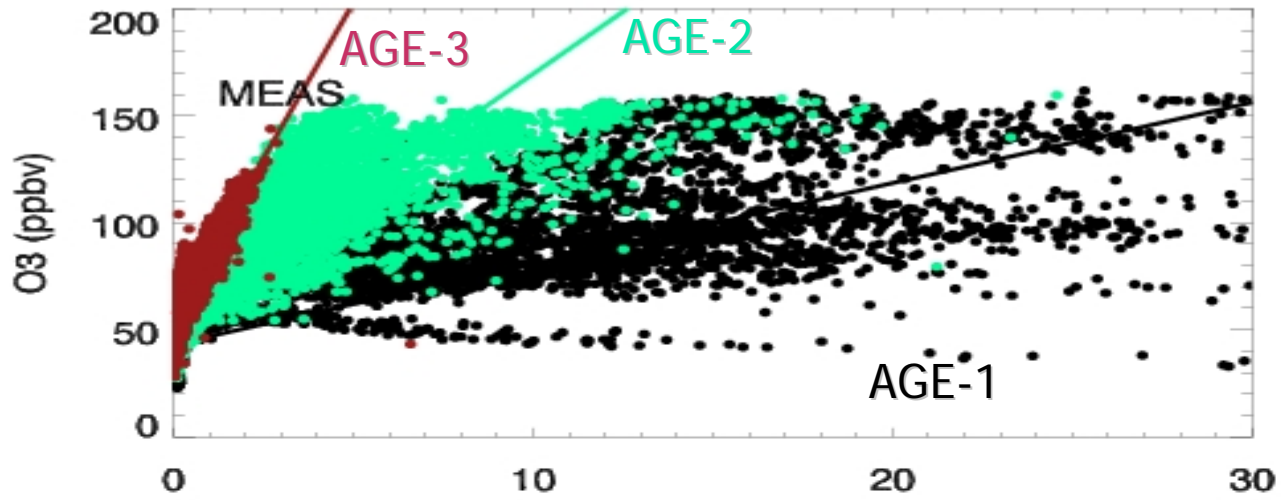
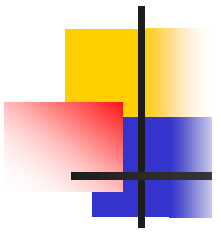


Meas

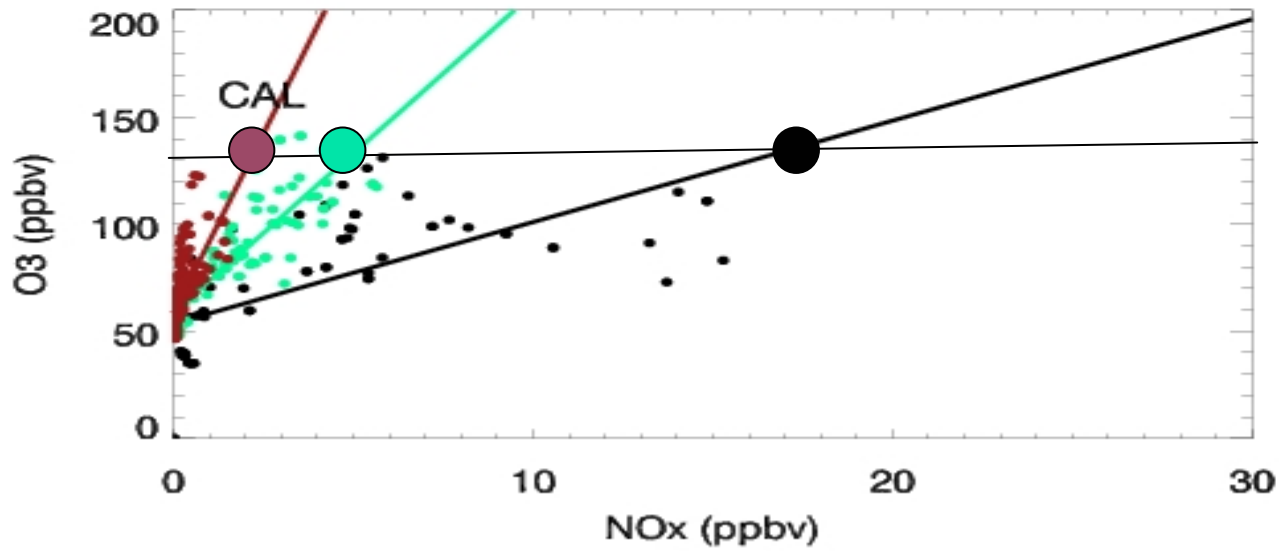


Model

Ozone-NOx correlation

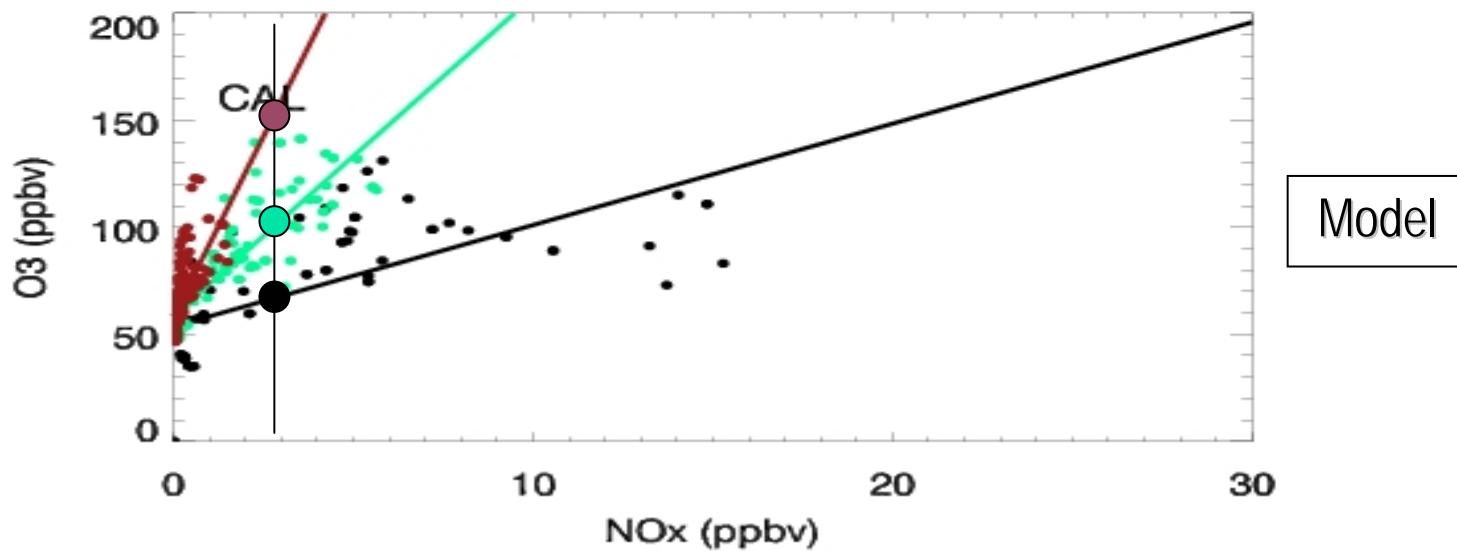
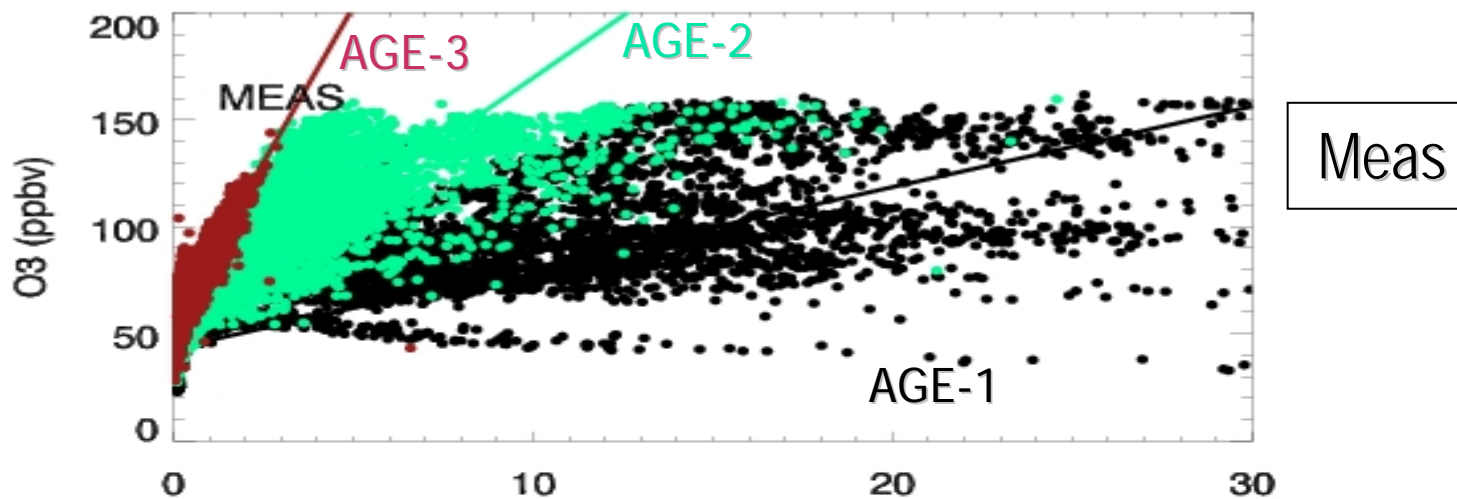
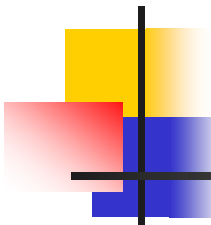


Meas



Model

Ozone-NOx correlation



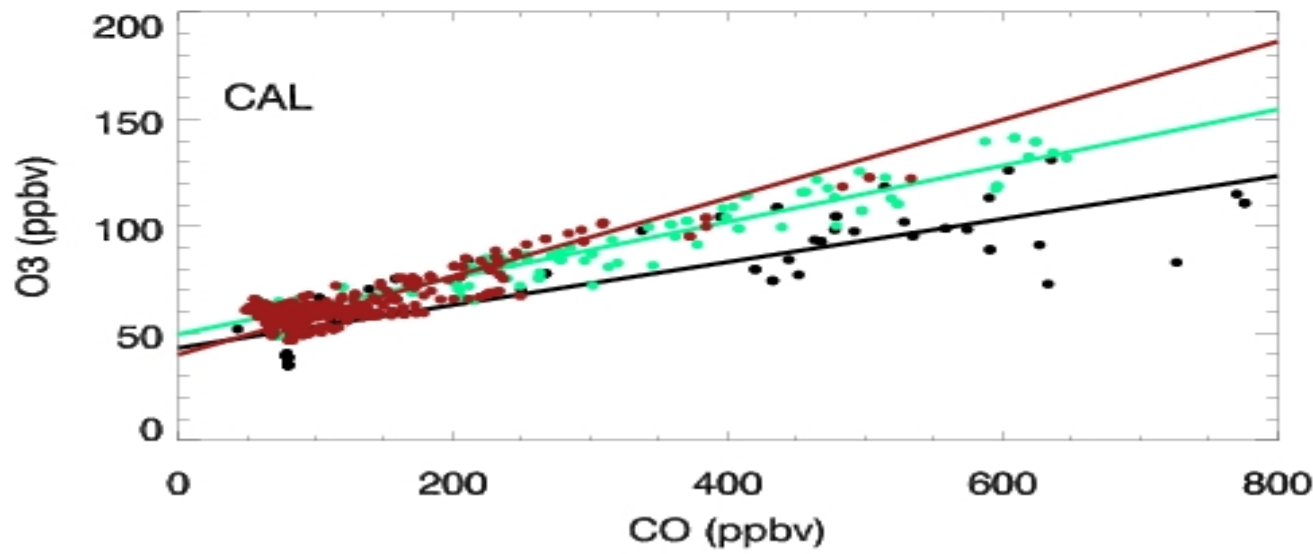
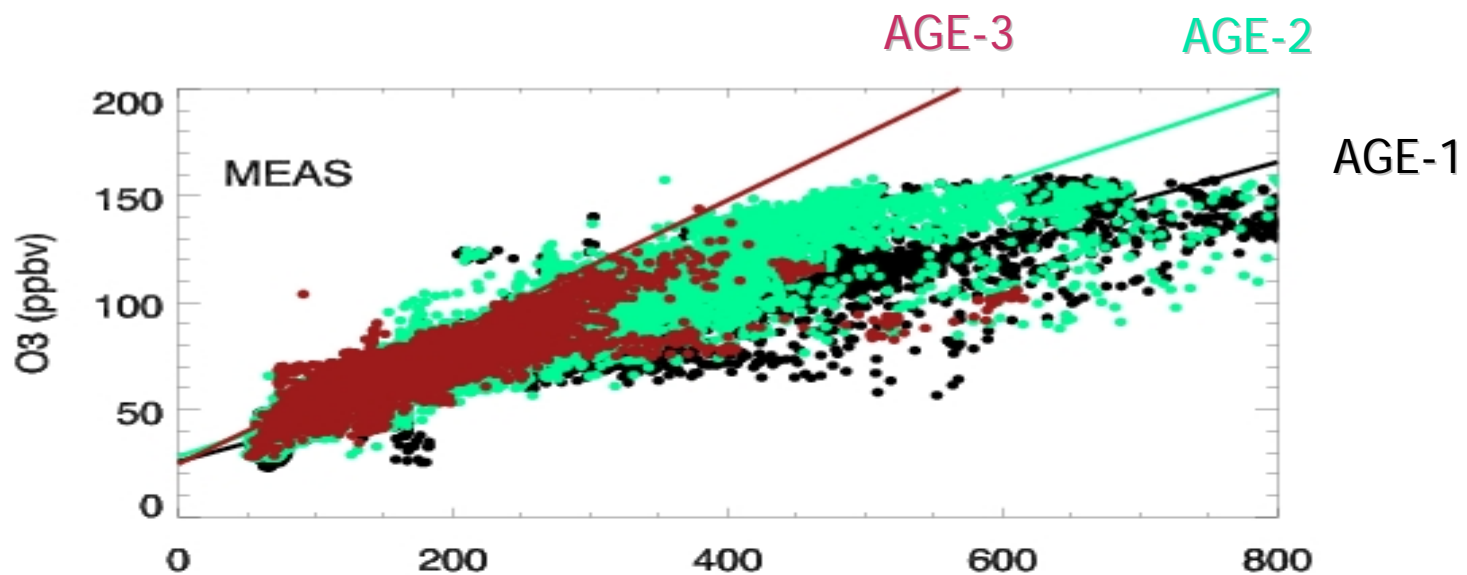
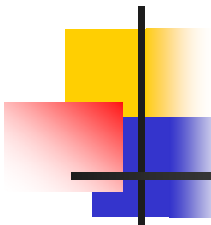


Ozone concentrations are more sensitive to NO_x in old plume than young plume

$\Delta[\text{O}_3]/\Delta[\text{NO}_x] = 4.7$ young age plume

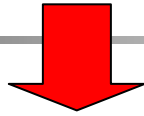
$\Delta[\text{O}_3]/\Delta[\text{NO}_x] = 30$ old age plume

Ozone-CO correlation





Ozone concentrations are more sensitive to CO
in old plume than young plume



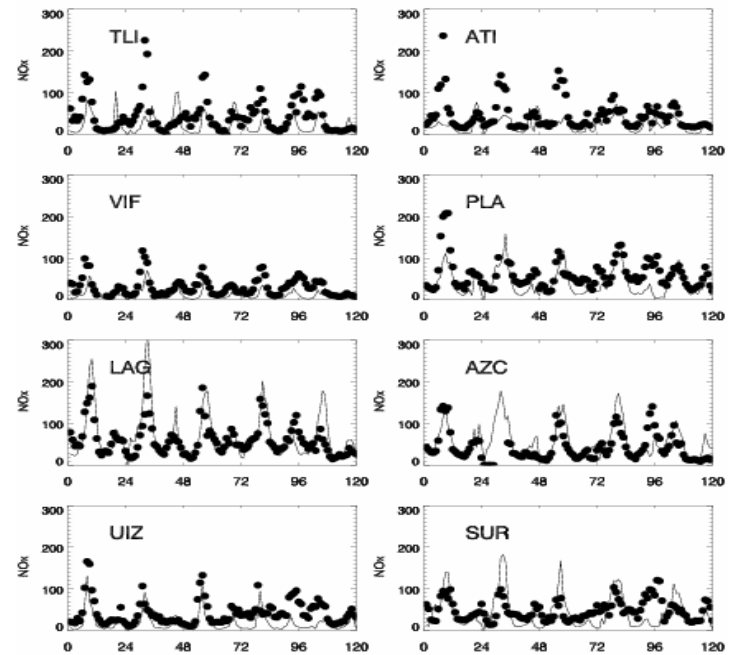
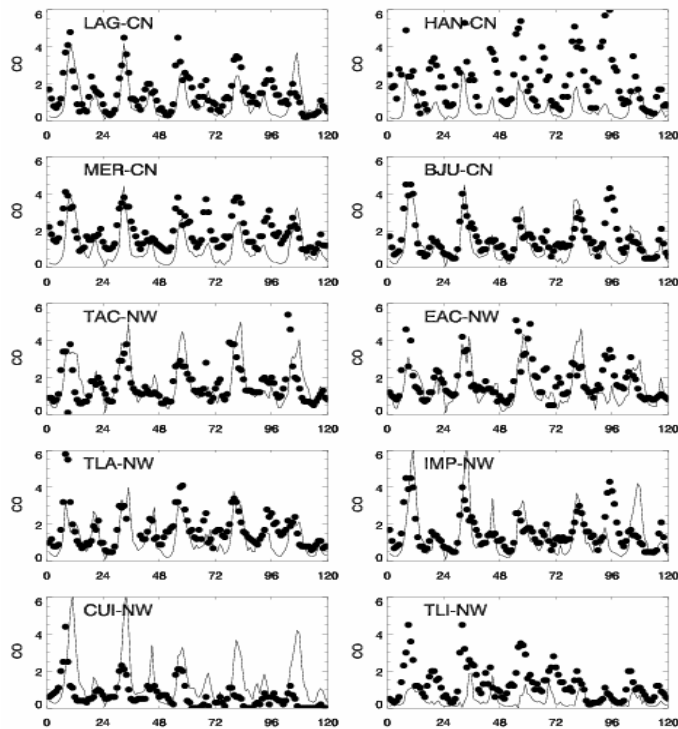
Ozone formation is more efficient per CO
Molecular in aged plume

$$\Delta[\text{O}_3]/\Delta[\text{CO}] = 0.175 \quad \text{young age plume}$$

$$\Delta[\text{O}_3]/\Delta[\text{CO}] = 0.31 \quad \text{old age plume}$$

Ozone evolution in the plumes (WRF-Chem)

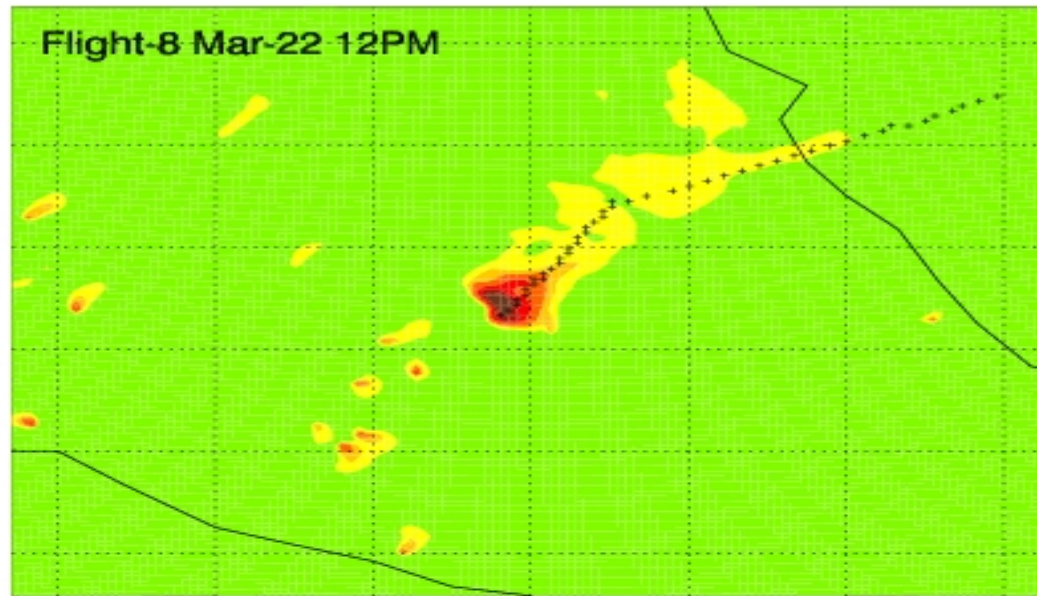
The model is evaluated by surface measurements of CO, NO_x, and O₃ in Mexico City (Tie et al., Atmos Environ, 2007)



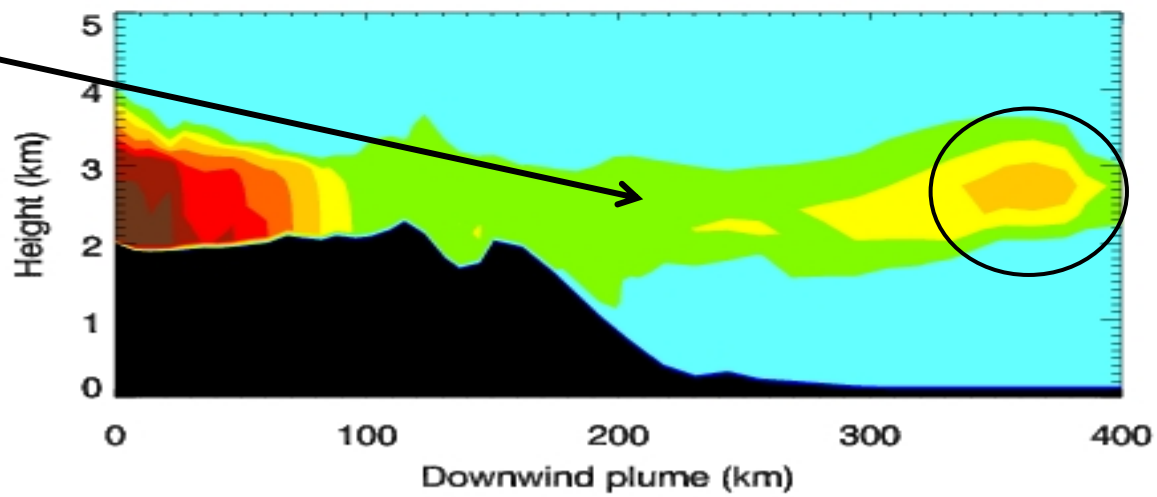
CO

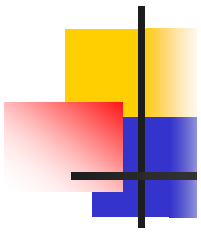
NO_x

Flight 8



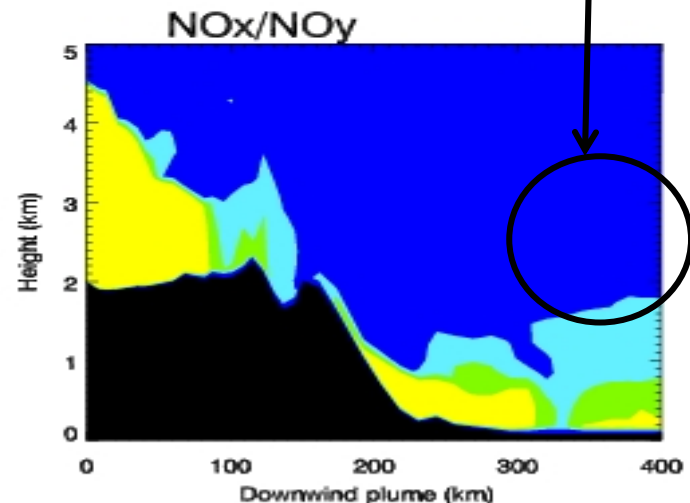
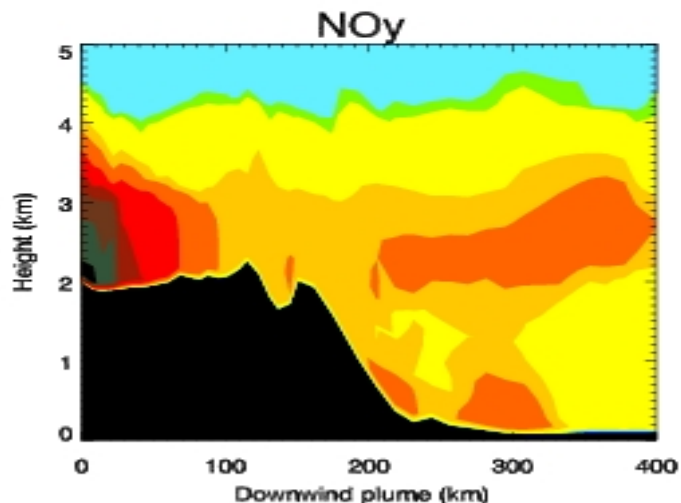
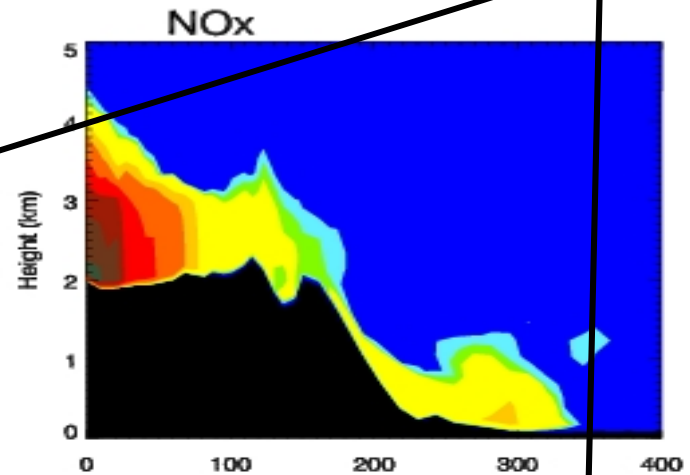
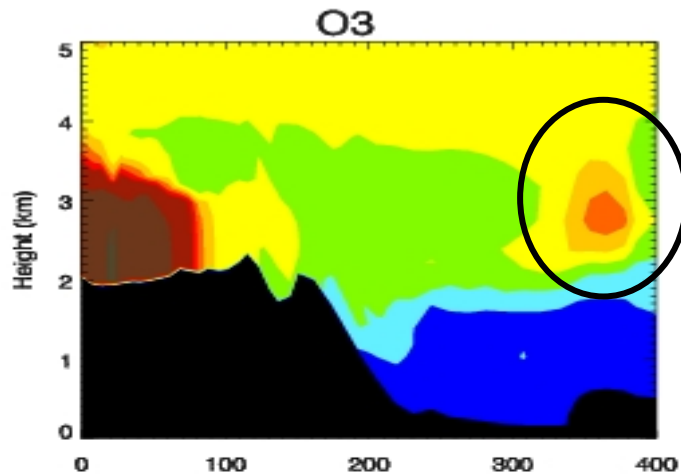
CO plume





Flight-8 Mar-22 12PM

High ozone in aged plume



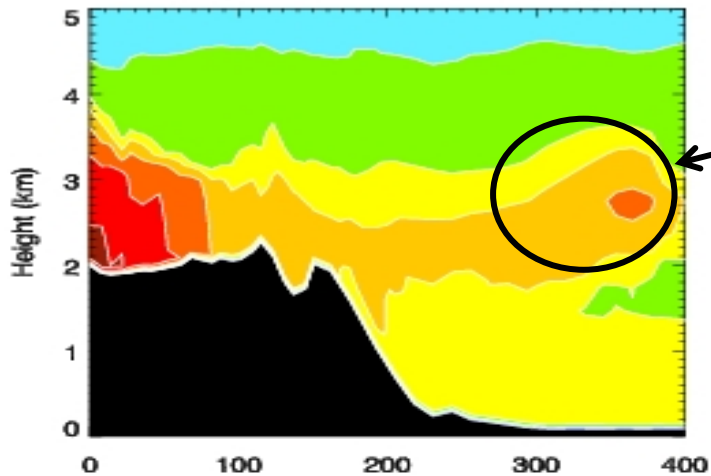
PPBV



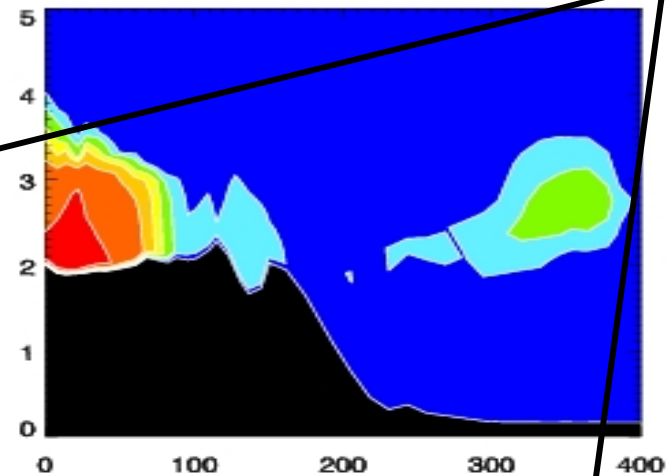
(NOx/NOy)

Flight-8 Mar-22 12PM

CO

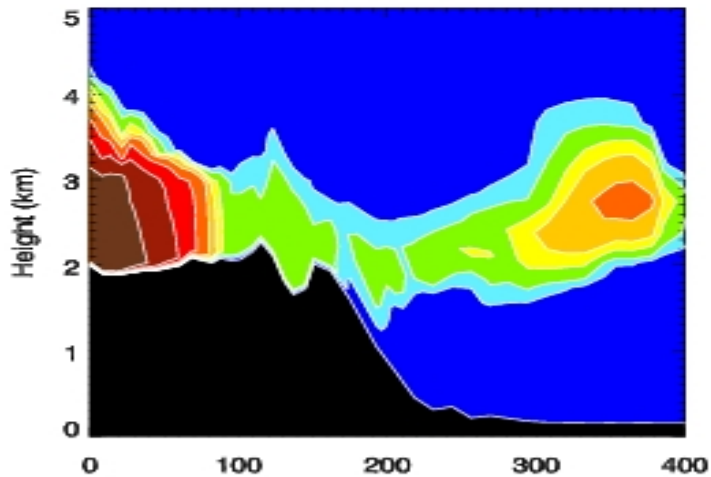


Alkanes

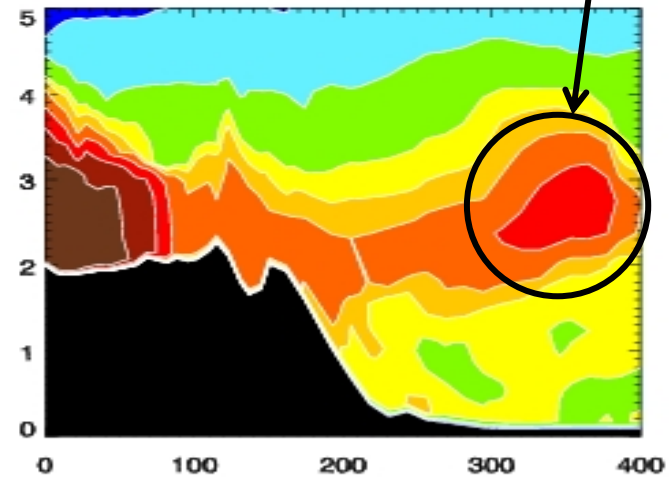


High OH
Reactivity

Alkenes+Arom



OVOCs





Summary

- (1) Ozone production is more efficient in aged plume than young plume.
- (2) Model results are consistent with the measurements
- (3) Model analysis suggests that reactive primary hydrocarbons (such as alkenes and aromatics) have important contributions on OH reactivity in the young plume (near Mexico City), but have less contributions in the aged plume.
- (4) The oxidations of CO and oxygenated organics play important roles in the OH reactivity in the aged plume.
- (5) Alkanes contribute to OH reactivity in both young and old plumes, but are usually not the dominant species in either.



- Oxygenated organics

1. formaldehyde,
2. ketones,
3. glyoxal, methylglyoxal,
4. unsaturated dicarbonyls,
5. peroxyacetyl nitrate,
6. organic nitrates